Technology Template
“Simple 3D interpolation using cam discs”

Technology CPU

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Foreword

Objective of the technology template

A technology template is a software object or a code block with defined interface, which can easily be integrated into other software projects without extra work and which performs a precisely defined technological task in these projects.

This technology template helps you realize an interpolated motion with up to three axes with constant path velocity using the Technology CPU, the trajectory is specified via an interpolation table.

Main contents of this technology template

This technology template deals with the following key elements:

- Defining a trajectory using an interpolation table
- Generating an interpolated motion
- Synchronizing axes via a set of cam discs for generating the desired motion control.

Delimitation

This technology template does not contain a description…

- ...of the exact technological processes on which this technology template is based.
- ...of the application and use of technology functions and technology objects with the technology CPU.
- ...of the programming of the technology CPU in STEP 7.

Basic knowledge of these topics is required.

Structure of the document

The documentation of this technology template is divided into the following main parts.

Part	Description
Description of the Technology Template	This part of the documentation provides you with basic information on the requirements for using the technology template, the application options and the structure and function of this technology template. The display of the program environment and of the available interfaces facilitates the estimation of the application options of the technology template in your application.
Integration of the Technology Template	This part of the documentation provides detailed information on the procedures for integrating this technology template into new or already existing projects and on the control of the technology template by a user program. It is required to read this part if you want to integrate this technology template into your own application.
Program Description of the Technology Template	This part provides detailed information on the structure and the setup of the technology template enabling you to individually adapt this technology template to your application.
Appendix	This part of the documentation provides further information, e.g. bibliographic references, glossaries, etc.

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Description of the Technology Template

Content

This part of the documentation provides you with basic information on the requirements for using the technology template, the application options and the structure and function of this technology template.

The display of the program environment and of the available interfaces facilitates the estimation of the application options of the technology template in your application.

1 Basic Information

1.1 Requirements

1.1.1 Target group

The technology template is intended for all programmers and users of the technology CPU who easily and quickly want to execute an interpolated motion with up to three axes with constant path velocity, the path velocity being specified via an interpolation table.

Typical fields of application for interpolating motions are handling, pick and place or palletizing machines. The objective of these applications is mostly to pick up a product at a location and to transfer it to a defined destination position on a specified path. The motion is to be executed as smoothly as possible.

1.1.2 Previous knowledge

For the use of this technology template, you should be familiar with STEP 7 and the application of technology objects and technology function calls in the integrated technology of the technology CPU.

This documentation is not an introduction to these topics and focuses on the specifications for use of this technology template.

1.1.3 Technical environment

This technology template can be used unaltered only in connection with the Technology CPU:

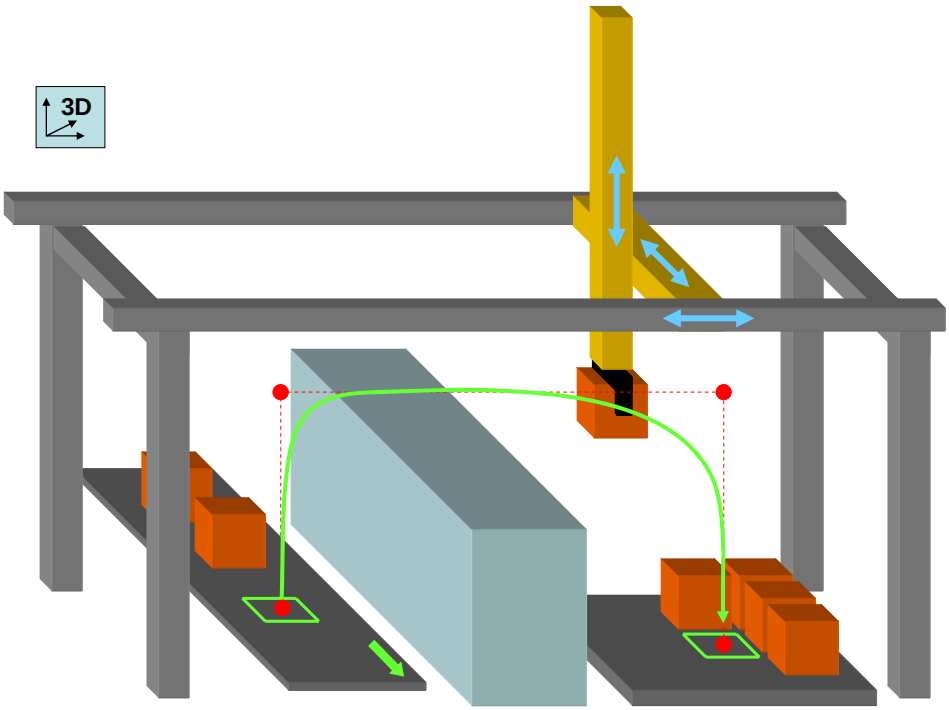
- Technology CPU 317T-2 DP
- Technology CPU 315T-2 DP (6ES7315-6TH13-0AB0)

1.2 Objective and purpose of this technology template

1.2.1 Task

A simple three-dimensional spatial motion with constant path velocity is to be executed with the technology CPU, the trajectory is specified via interpolation points in an interpolation table.

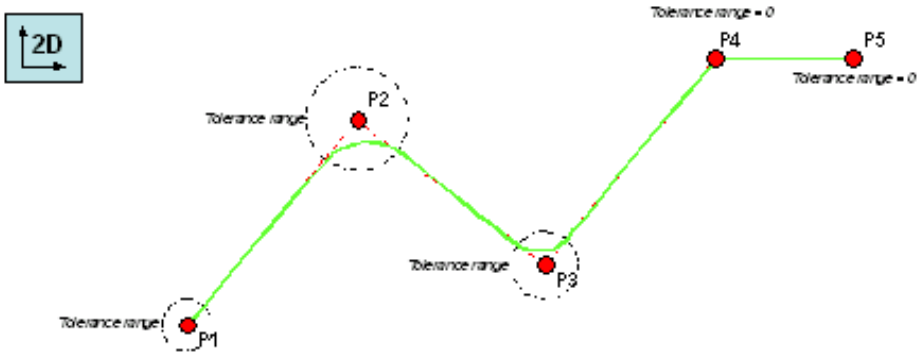
Figure 1-1 Example of a three-dimensional spatial motion



The motion of the axes connected to the technology CPU is to be generated via a cam disc synchronism. The required cam discs for synchronizing the individual axes are to be generated from a specified interpolation table. This requires that the interpolation table is available prior to the start of the motion for generating the required cam discs.

The trajectory between two interpolation points is to be in a straight line. A tolerance range can be defined around the interpolation points within which the trajectory may deviate from the straight line. This enables a smooth motion of the axes and a short-time standstill of the axes at the interpolation points can be avoided.

Figure 1-2 Trajectory defined via interpolation points



1.2.2 Advantages of this technology template

Using this technology template offers the following advantages to the user:

Quick program generation

Using the technology template, an interpolated motion with constant path velocity can quickly and easily be integrated into an application to be created or an already existing application.

The blocks contained in the technology template can be applied to an application by simple copying. Additionally required configuration steps are comprehensively explained in this documentation on the technology template.

Adaptation options

The technology template includes the blocks FB 505 “Move3D” and FB 508 “MoveCam” in commented form. This ensures that this technology template can quickly and easily be expanded by own functions or adapted to a specific application.

This documentation also includes an explanation of the program flow.

Test program

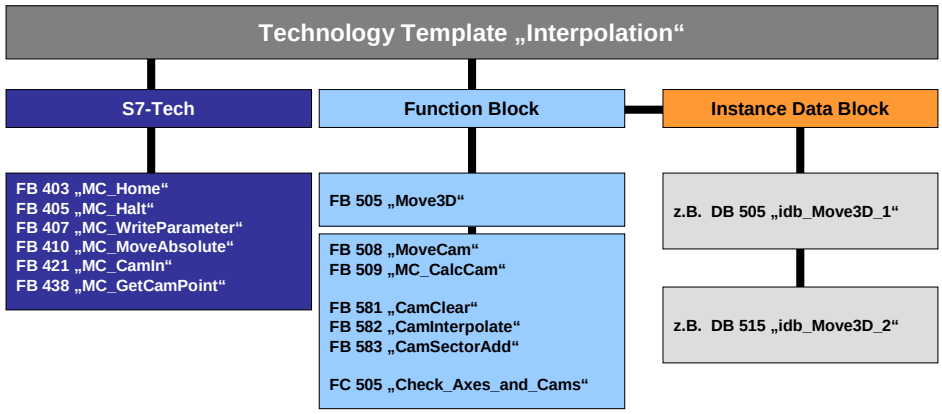
The delivery of the technology template also includes a test program with which you can test the control of the blocks contained in the template and the reactions of the template to different parameters and controls.

1.3 Components included in the technology template

The technology template is a software package which contains all STEP 7 blocks required for the realization of an interpolated motion with constant path velocity.

This ensures that the technology template can be integrated quickly and easily into self-created user projects.

Figure 1-3 Components contained in the technology template



The complete functionality of an interpolated motion with constant path velocity is contained in block FB 505 “Move3D” of the technology template. Via this block, a trajectory defined via an interpolation table can be interpolated and followed using the technology CPU.

Block FB 505 “Move3D” uses the blocks FB 509 “MC_CalcCam” for generating the cam discs and FB 508 “MoveCam” for controlling the axes using the generated cam discs.
For generating the cam discs with FB 509 “MC_CalcCam” the function blocks FB 581 “CamClear“ to delete the cam discs, FB 582 “CamInterpolate“ to interpolate the trajectory between the interpolation points and FB 583 “CamSectorAdd“ to add another sector to a cam disc. These function blocks are also included in this technology template to be autonomous of the version of S7-Technology for generating the cam discs with the function block FB 509 “MC_CalcCam”.

In the other blocks, technology function blocks of the S7-Technology software package are used to realize the control of the motion control functions of the technology CPU.

2 Application Options of the Technology Template

2.1 Applications

2.1.1 Authorized and required hardware and software components

Hardware components

Figure 2-1 Hardware components

Component	No.	MLFB / Order Number	Note
CPU 317T-2 DP	1	6ES7317-6TJ10-0AB0 or 6ES7317-6TK13-0AB0 Firmware: V2.6 / V4.1.1	The CPU processes the user program and the technological functions.
Micro Memory Card 4MB	1	6ES7953-8LM11-0AA0	The S7 program is stored on the MMC.

or alternatively

Figure 2-2 Hardware components

Component	No.	MLFB / Order Number	Note
CPU 315T-2 DP	1	6ES7315-6TH13-0AB0 Firmware: V2.6 / V4.1.1	The CPU processes the user program and the technological functions.
Micro Memory Card 4MB	1	6ES7953-8LM11-0AA0	The S7 program is stored on the MMC.

Standard software components

Table 2-3 Standard software components

Component	No.	MLFB / Order Number	Note
STEP 7	1	6ES7810-4CC08-0YA7 Version: V5.4	STEP 7 is the basic package for all optional software packages and it is used for programming the SIMATIC S7.
S7-Technology	1	6ES7864-1CC41-0YX0 Version: V4.1	Tool for parameterizing and programming the technology objects of the technology CPU

Software components required for the test program

Table 2-4 Software components required for the test program

Component	No.	MLFB / Order Number	Note
WinCC flexible Runtime	1	6AV6613-1DA51-3CA0 Version: 2008	The Runtime software of WinCC flexible is required for operating the HMI of the test program.
WinCC flexible	1	6AV6613-0AA51-3CA5 Version: 2008	The engineering software of WinCC flexible is only required if the HMI of the test program is to be modified.

Example files and projects

The following list includes all files and archives used in this technology template.

Table 2-5 Files and STEP 7 archives of the technology template

Component	Note
21364022_Move3D_CODE_v41.zip	This STEP 7 archive contains only the blocks associated to the technology template for integration into a user program.
21364022_CPU315T-6TH13_ Move3D_CODE_EXP_v41.zip 21364022_CPU317T-6TJ10_ Move3D_CODE_EXP_v41.zip 21364022_CPU317T-6TK13_ Move3D_CODE_EXP_v41.zip	This STEP 7 archive contains the blocks associated to the technology template for integration into a user program as well as a test program for checking the parameterization options and functions of the technology template.
21364022_Move3D_DOKU_v41_e.pdf	This document.

Required PLC-Open blocks from the “S7-Tech V4.1” library

The list below includes all PLC-Open blocks from the “S7-Tech V4.1” library used for technology function calls in this technology template. The “S7-Tech V4.1” library is included in the “S7-Technology” software component listed above.

Table 2-6 Required PLC-Open blocks

PLC-Open blocks	Function
FB 403 “MC_Home”	Homing axes or defined setting of position values.
FB 405 “MC_Halt”	Stopping axis motions or releasing cam disc synchronizations.
FB 407 “MC_WriteParameter”	Writing system parameters of the technology objects, e.g. of the velocity override.
FB 410 “MC_MoveAbsolute”	Absolute positioning of axes to a defined position.
FB 421 “MC_CamIn”	Activating the cam disc synchronization between two axes for controlling a slave axis via a master axis.
FB 438 “MC_GetCamPoint”	Reading a slave position at a defined master position or a master position at a defined slave position of a cam disc.

2.1.2 Tasks which can be solved with the technology template

The technology template can directly be used for generating an interpolated motion, the trajectory to be followed is specified via an interpolation table.

The interpolation table is transferred to the technology template and the template subsequently takes over the generation of the required cam discs and the following of the resulting interpolated trajectory.

Simple interpolating motions with path velocity mainly occur in the following applications:

- Handling machines…
  … for exact movement of workpieces or tools on specified paths in a smooth motion at constant velocity.
- Pick and place machines…
  … for careful transport of workpieces from a pick up position to a defined destination position which may require to bypass existing obstacles.
- Palletizing machines…
  … for palletizing workpieces according to a specified palletizing strategy, the workpieces have to be moved on a defined path between pick up position and destination position.

The main field of application of the technology template for simple interpolating motions is probably the field of packaging machines.

2.1.3 Properties of this technology template

The following properties were considered during the realization of the technology template and can be used in a user program when using the template:

- **Processing of up to 32 interpolation points**
  Via the interpolation table, trajectories with up to32 interpolation points

can be defined for each interpolating motion. An individual tolerance range can be defined for each interpolation point within which the interpolated trajectory may deviate from the actual path to avoid velocity and acceleration overloads of individual axes.

- **Processing of sections of the interpolation table**
  More points can be stored in the interpolation table than to be used for the interpolation. The start and the end of the interpolation section in the interpolation table can be specified by a start and an end index in the interpolation table.
- **Free definition of the axes involved in the interpolation**
  The axes involved in the interpolation can be freely defined. Up to three axes can be used for the interpolation. Axes which are not used can easily be deactivated which also enables motions in the two-dimensional range.
- **Interpolated path with and without acceleration limitation**
  The interpolated trajectory can be followed with and without acceleration limitation. To limit the maximum velocity, the template generates an additional cam disc which can be included in the cam disc group via the template if required.
- **Checking the current axis position before the start of the motion**
  For the start of the interpolated motion, a tolerance limit can be defined within which the current position of the axes has to be located to start the interpolated motion. If the axes are outside this tolerance range, a message is output and the axes have to be moved to the also displayed starting position outside the technology template.
  However, the function for manual motion of the axes is not included in this template. A separate “MoveJog” technology template is available for this function (see: Chapter 11.2).
- **Option of stopping the interpolated motion**
  Following an interpolated trajectory can be stopped via an input at the function block of the template at any time. The axes are decelerated to standstill on the trajectory on a defined basis. If the axes have been brought a standstill the option exists of manually moving the axes independently of one another or of removing the release of the axes without interrupting the execution of the template. After the interruption, the travel motion can be continued via a further input of the template.
- **Changing direction on the trajectory**
  Before starting the travel motion of the interpolated trajectory as well as after stopping the motion, the direction of motion of the axes can be newly specified on the trajectory. Consequently, the option exists to pass the interpolation table in ascending and descending order or to interrupt an active travel motion and to return to the starting point on the same trajectory.

2.2 Constraints

The properties listed below were not considered during the realization of the technology template.

- **No ensuring and monitoring of the path accuracy**
  The technology template does not monitor the compliance with the specified trajectory during the travel motion. Particularly when the dynamic restrictions of the axes are not complied with, deviations from the specified trajectory may occur.
- **No following of specific contours**
  With the technology template, it is not possible to follow contours composed of circular arcs and straight lines as known from the field of CNC-machines. The trajectory for the technology template is exclusively specified via an interpolation table.
- **No tool offset**
  Active tool offset during the generation of the interpolated trajectory and automatic consideration of this offset in the travel motion of the cam is also not possible.

2.3 Environment

The technology template was especially developed for use with Cartesian kinematics, i.e. three orthogonal linear axes X, Y, Z can be controlled.

Figure 2-1 Example of Cartesian kinematics

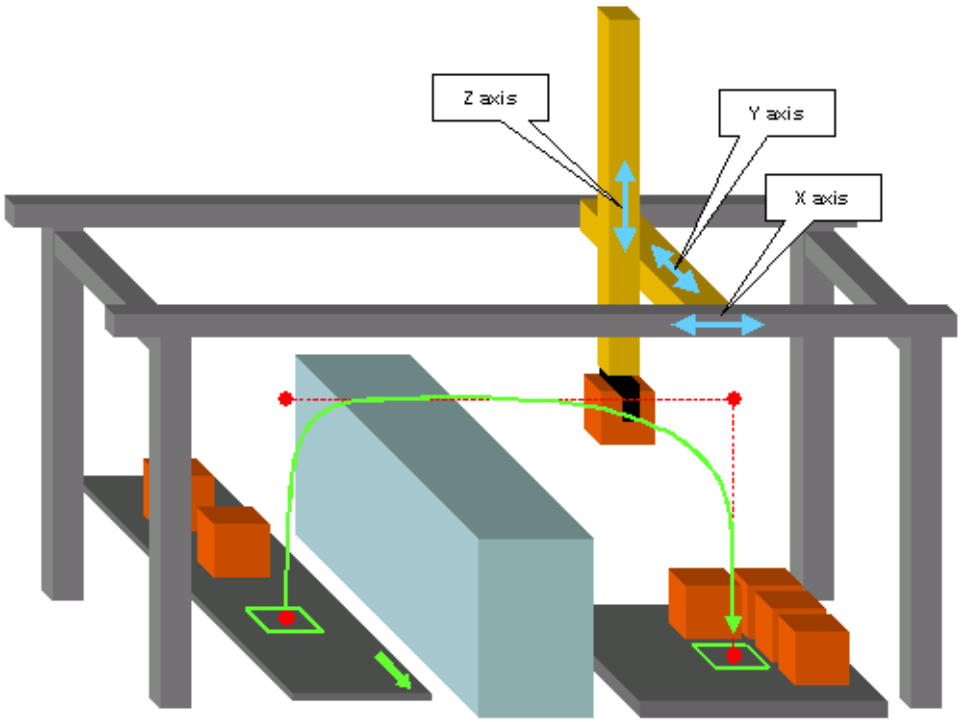
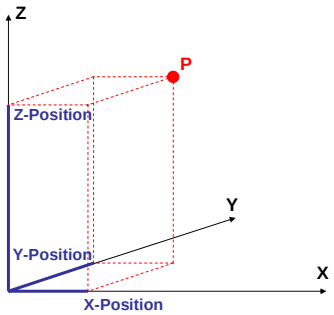


Figure 2-2 Locating a point in Cartesian kinematics



In addition, all axes used for the technology template must use the same system of units and the Cartesian axes have to be designed in such a way that the set limits are not reached by the motion.

Table 2-7 Possible systems of units

Variable	System of units 1	System of units 2
Position	mm	m
Velocity	mm/s	m/s
Acceleration	mm/s^2	m/s^2

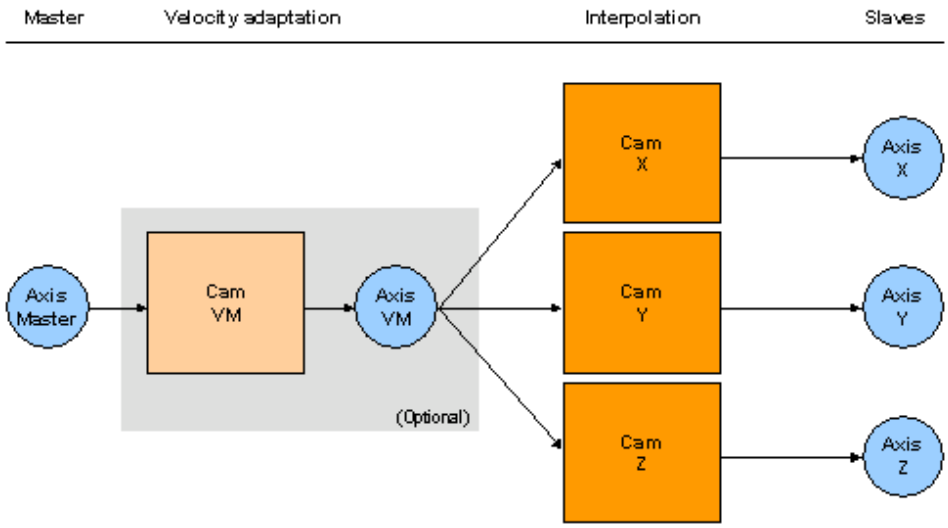
3 Structure and Function

3.1 Structure of the technology template

The technology template for simple 3D interpolation using cam discs is based on a unique synchronization of axes and cam discs in the integrated technology of the technology CPU.

Three real axes, the three Cartesian axes X, Y and Z of the machine and two virtual axes, as master axes for the cam disc synchronization, as well as up to four cam discs for synchronizing the individual axes are required.

Figure 3-1 Configuration of the axis synchronization via cam discs



The Cartesian axes **Axis X**, **Axis Y** and **Axis Z** of the machine are controlled via individual cam discs **Cam X**, **Cam Y** and **Cam Z** in which the respective part of the Cartesian axis in the desired interpolated motion is stored. A virtual axis in the integrated technology of the CPU is used as master for all three cam discs.

The virtual axis **Axis Master** is the master for the complete arrangement for the three-dimensional interpolated motion. It is moved from a starting point to an end point at constant velocity and consequently makes available the necessary input value for the cam discs.

If it is not required to limit the acceleration of the axes during the interpolated motion, the **Axis Master** axis can be synchronized directly to the cam discs **Cam X**, **Cam Y** and **Cam Z** of the three Cartesian axes. If, however, a motion with limited acceleration is desired, an additional cam disc and an additional virtual axis have to be included in the cam disc synchronization. Cam disc **Cam VM** is responsible for adapting the input values specified by **Axis Master** and makes these values available to the cam discs **Cam X**, **Cam Y** and **Cam Z** via the virtual axis **Axis VM** for the interpolated motion.

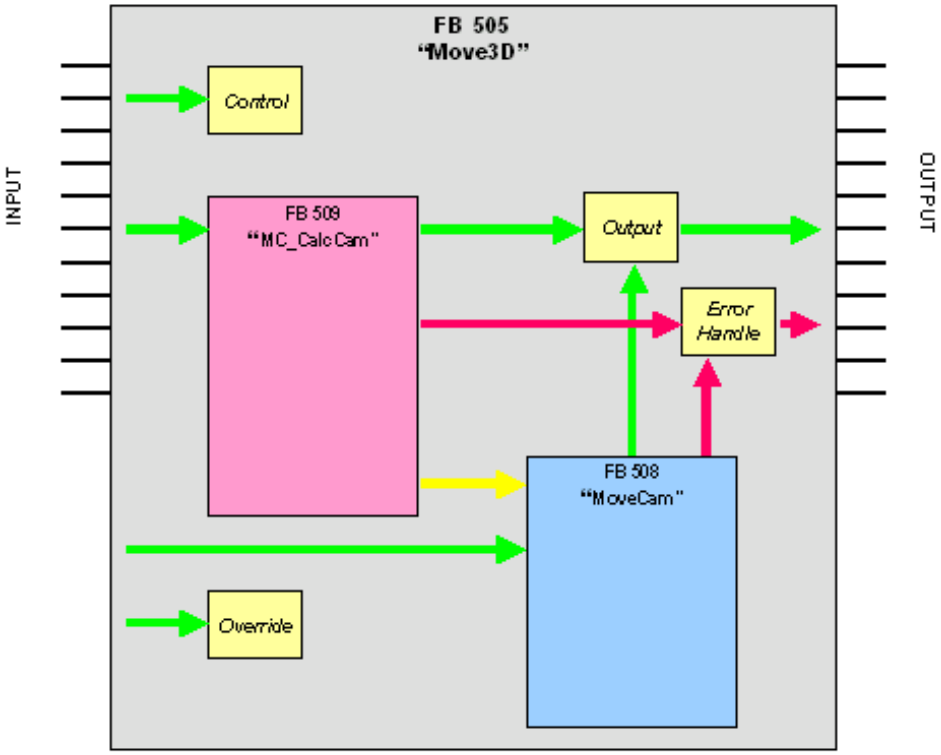
The following information on the technology template assumes that the respective interpolated motion is to be performed with limited acceleration.

3.2 Function principle of the technology template

All functions for executing an interpolated motion with limited acceleration on a trajectory defined via an interpolation table are integrated in block **FB 505 “Move3D”** of the template.

Block **FB 505 “Move3D”** is responsible for the complete function process, initiates the generation of the required cam discs and subsequently starts the travel motion using the generated cam discs.

Figure 3-2 General structure of block FB 505 “Move3D”



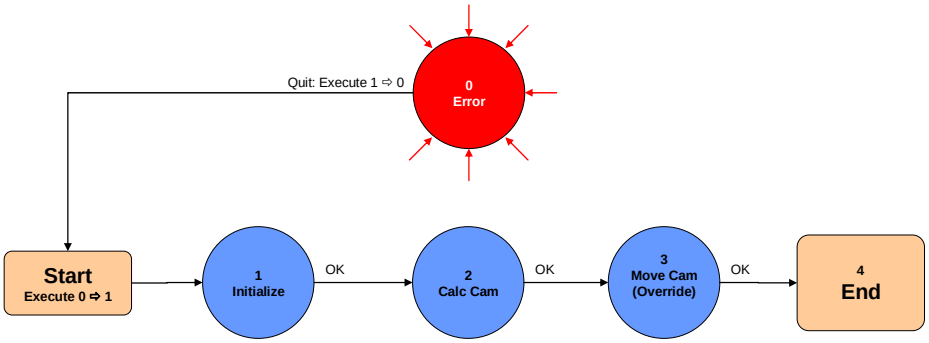
FB 505 “Move3D” uses additional functions realized in independent function blocks. The blocks **FB 509 “MC_CalcCam”** for generating the required cam discs from the specified interpolation table and **FB 508 “MoveCam”** for executing the actual axis motion using the generated cam discs are called in this block.

FB 505 “Move3D” is responsible for the complete coordination of the individual block calls.

3.3 Possible statuses

To execute an interpolated motion on a trajectory defined via an interpolation table, block **FB 505 "Move3D"** gradually executes several functions successively, which are displayed in the graphic below.

Figure 3-3 Possible statuses of FB 505 "Move3D"



The individual steps of the block have the following function:

Table 3-1 Description of the statuses of FB 505 "Move3D"

Step / Status	Function
0 – Error	If an error occurs during executing the individual functions of the block, the block branches into this status and outputs an error code for exact localization of the cause of the error.
1 – Initialize	During this step the internal variables of the block and the functions called in the block are set to defined values and the input parameters of the block are checked.
2 – Calc Cam	During this step the cam discs required for the interpolated motion are generated from the specified interpolation table in the integrated technology of the CPU.
3 – Move Cam (Override)	During this step the synchronization of the real and virtual axes is performed via the just generated cam discs and the travel motion of the interpolated trajectory is executed.
4 – End	After successful processing of all functions and execution of all travel motions, the block branches into this step and no longer executes functions in this step until the block is terminated or called again.

Block **FB 505 "Move3D"** is completely processed for each interpolated motion.

Determining the current status of the block

The current status of the block or the current step in which block **FB 505 “Move3D”** is located can be determined via the integer variable **Sequencer** in the instance data block of **FB 505 “Move3D”** (see **Chapter 4.2.3)**.

Note

The instance data block of **FB 505 “Move3D”** contains the variables **MoveCam.Sequencer** and **Sequencer**!

The **Sequencer** variable of the **multi-instance “MoveCam”** represents the current status/step of block **FB 508 “MoveCam”**.

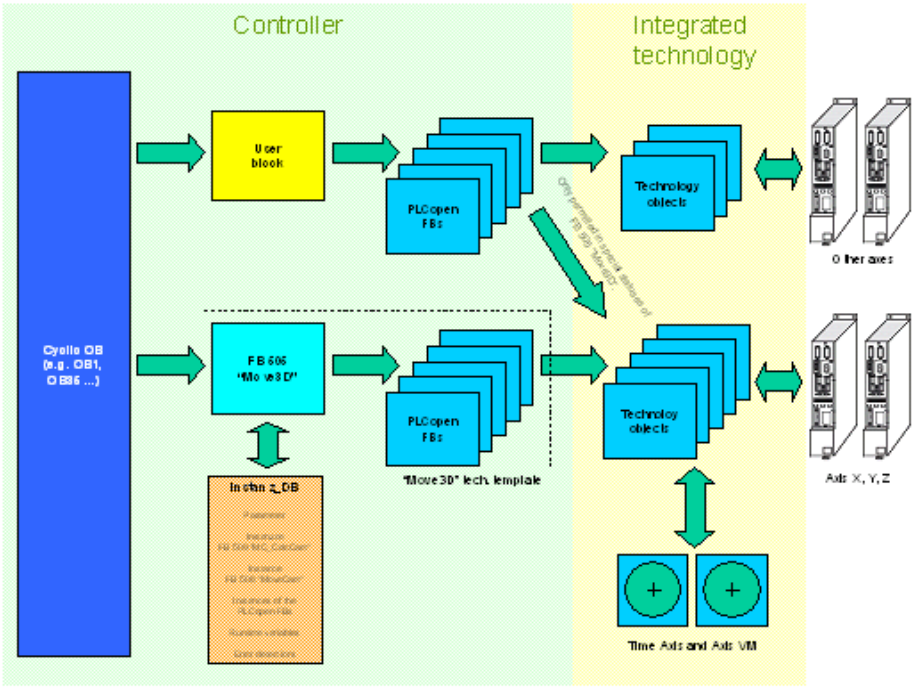
In contrast, the static variable **Sequencer** in the associated instance data block of **FB 505 “Move3D”** displays the current status/step of this block.

4 Program Environment and Interfaces

4.1 Call environment

Block **FB 505 “Move3D”** of the technology template has to be called cyclically in the user program. It can be called directly in an OB or within a cyclically processed FB.

Figure 4-1 Call environment of the technology template



The technology objects influenced by block **FB 505 “Move3D”** must, while **FB 505 “Move3D”** is active, only be influenced by the user program in defined statuses of the block without generating an error or an abort of the block.

External influencing of the axes of the technology template

If the block is in the following statuses, the axes assigned to the technology template may also be influenced by PLC-Open function blocks outside the technology template.

- **Position out of Tolerance**
  The axes X, Y, Z are not within the defined tolerance range for the start of the interpolated motion. For this reason, the travel motion cannot be started.
  In this status, the axes can be moved to the required starting position without terminating or replacing block **FB 505 “Move3D”**.

- **Master stopped**
  The interpolated motion was stopped via the Master_Stop input at block **FB 505 “Move3D”**. If the axes are stopped, the cam disc synchronization is released.
  In this status, the axes can also be manually moved or the release of the axes can be disabled without terminating or replacing block **FB 505 “Move3D”**.

If an error occurs in the block by access to a technology object or by replacing a technology function, the interpolated motion is aborted with an error message and the technology template no longer has access to the axes involved.

4.2 Interfaces

4.2.1 Structure of the interfaces

Block **FB 505 “Move3D”** can be parameterized and influenced via several parameters and interfaces which are divided into the following sections:

- **Block interface**
  Input and output variables of block **FB 505 “Move3D”**. At this interface, the parameter values for direct influencing of the desired interpolated motion are transferred.
- **User interface of the instance data block**
  Via a special area of the instance data block for block **FB 505 “Move3D”**, mainly parameters are set which do not change during the entire operation of the block, such as e.g. the numbers of the technology data blocks of the axes.
- **Parameterization of the technology objects**
  The basic settings of the technology objects required for block **FB 505 “Move3D”** have to be preset via the S7T-Config configuration software in STEP 7.

4.2.2 Block interface

For control of the interpolated motion by block **FB 505 “Move3D”**, the following interfaces are available at the block:

Danger

The “Master_Stop” input is only used for the interruption of an <u>already active</u> motion.

If the input is set before block FB 505 “Move3D” is started, an axis motion may still occur during the cam disc synchronization!

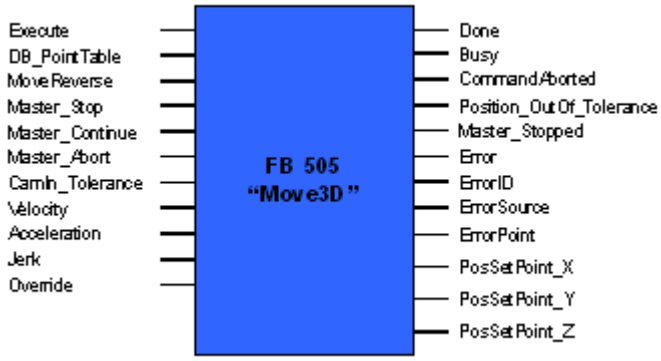


Table 4-1 Block interface

Parameter	Data type	Initial value	Description
Input parameters			
Execute	BOOL	False	Initiation of a new interpolated motion, from generating the cam discs from the interpolation table to executing the motion. If this input is reset, output signals are no longer output at the block.
DB_PointTable	INT	0	Number of the data block containing the interpolation table. The interpolation table has to be structured according to the specifications of **UDT 509**.
MoveReverse	BOOL	False	Reversal of the direction of motion. If the signal is set, the interpolation table is processed from end to start. The signal is newly interpreted before the start of the block or after stopping the travel motion.
Master_Stop	BOOL	False	If the signal is set during the travel motion, the axes are decelerated on the contour and the cam disc synchronization of the axes is released after stopping the axes.
Master_Continue	BOOL	False	Continuation of the template if the CamIn_Tolerance tolerance range is exceeded or in case of motion after stopping the travel motion. This requires that the Master_Stop is no longer set.

Parameter	Data type	Initial value	Description
Master_Abort	BOOL	False	Terminating the block if the CamIn_Tolerance tolerance range is exceeded or after stopping the travel motion.
CamIn_Tolerance	REAL	0.000	Tolerance range (spherical in 3D) in which the axes X, Y and Z have to be located around the starting point of the contour for starting the block. The parameter is processed as absolute value without observing the sign.
Velocity	REAL	0.000	Maximum velocity. An exact assignment of this parameter is available at the end of the table.
Acceleration	REAL	0.000	Maximum acceleration. An exact assignment of this parameter is available at the end of the table.
Jerk	REAL	0.000	Maximum jerk. An exact assignment of this parameter is available at the end of the table.
Override	REAL	100.000	Percentage value on the influencing of the traversing velocity during the interpolated motion (0…200%).
Output parameters			
Done	BOOL	False	Processing the block is completed. The travel motion was completely executed or the block was terminated via the Master_Abort input.
Busy	BOOL	False	The block is being processed.
CommandAborted	BOOL	False	The technology functions used in the block and thus the block itself were replaced by a technology function outside the block. Consequently, the block no longer controls the axes provided for the interpolated motion!

Parameter	Data type	Initial value	Description
Position_OutOf_Tolerance	BOOL	False	The position of the axes X, Y and Z is outside the defined tolerance range around the starting point of the motion during the start of the block or during the continuation of a stopped travel motion.
Master_Stopped	BOOL	False	The travel motion was stopped upon request and the cam disc synchronization was released.
Error	BOOL	False	An error has occurred during processing the block. Further information on the localization of the cause of the error is made available via the outputs ErrorID, ErrorSource and ErrorPoint.
ErrorID	WORD	0	Error code of the block or of a technology function called internally. The error location in the block can additionally be read via the ErrorSource output.
ErrorSource	WORD	0	Indication of an additional error code for localization of the cause of the error in the block.
ErrorPoint	INT	0	Index of the incorrect point in the interpolation table during generation of the cam discs using block FB 509 “MC_CalcCam”.
PosSetPoint_X	REAL	0.000	If the position of the axes X, Y and Z is outside the tolerance range, the required position for the start or the continuation of the motion for axis X is output.
PosSetPoint_Y	REAL	0.000	If the position of the axes X, Y and Z is outside the tolerance range, the required position for the start or the continuation of the motion for axis Y is output.
PosSetPoint_Z	REAL	0.000	If the position of the axes X, Y and Z is outside the tolerance range, the required position for the start or the continuation of the motion for axis Z is output.

Assignment of the parameters “Velocity”, “Acceleration” and “Jerk”

The parameters “Velocity”, “Acceleration” and “Jerk” are used differently in the subordinate function blocks **FB 509 “MC_CalcCam”** and **FB 508 “MoveCam”** of block **FB 505 “Move3D”**. The table below explains the assignment of the parameters to the individual functions:

Table 4-2 Parameter assignment “Velocity”, “Acceleration” and “Jerk”

Function block	Description / Function
“Velocity”	
FB 509 “MC_CalcCam”	Maximum path velocity of the interpolated motion which is considered during the generation of the cam discs required for the travel motion.
FB 508 “MoveCam”	Maximum velocity of the individual axes during the compensation of the position tolerance between current axis position and starting position of the travel motion when synchronizing the axes within the tolerance range. Maximum velocity when moving **Axis Master** for setpoint generation for the interpolated motion.
“Acceleration”	
FB 509 “MC_CalcCam”	Maximum acceleration of the interpolated motion which is considered during the generation of the cam discs required for the travel motion. However, the compliance with the acceleration is only considered if **Axis VM** and **Cam VM** are activated for the interpolated motion and if **Axis Master** is not moved quicker than specified at the **Velocity** parameter for the cam disc calculation.
FB 508 “MoveCam”	Maximum acceleration of the individual axes during the compensation of the position tolerance between current axis position and starting position of the travel motion when synchronizing the axes within the tolerance range. Maximum acceleration when moving **Axis Master** for setpoint generation for the interpolated motion. Maximum acceleration when stopping **Axis Master** in case of interruption of the interpolated motion.
“Jerk”	
FB 509 “MC_CalcCam”	The maximum jerk is not considered during the generation of the cam discs.
FB 508 “MoveCam”	Maximum jerk of the individual axes during the compensation of the position tolerance between current axis position and starting position of the travel motion when synchronizing the axes within the tolerance range. Maximum jerk when moving **Axis Master** for setpoint generation for the interpolated motion. Maximum jerk when stopping **Axis Master** in case of interruption of the interpolated motion.

Note If values larger than 100% are set for the Override parameter, the maximum values listed here may be exceeded.

4.2.3 Structure of the instance data block

The structure of the instance data block is described below, the user may only change the data block in specific areas.

Setting the axes involved in the interpolation

The axes involved in the interpolating motion are set via the user interface of the instance data block of **FB 505 "Move3D"**.

Note For an interpolating motion via the FB 505 "Move3D" technology template, at least two Cartesian axes have to be activated.

Figure 4-2 Structure of the instance data block

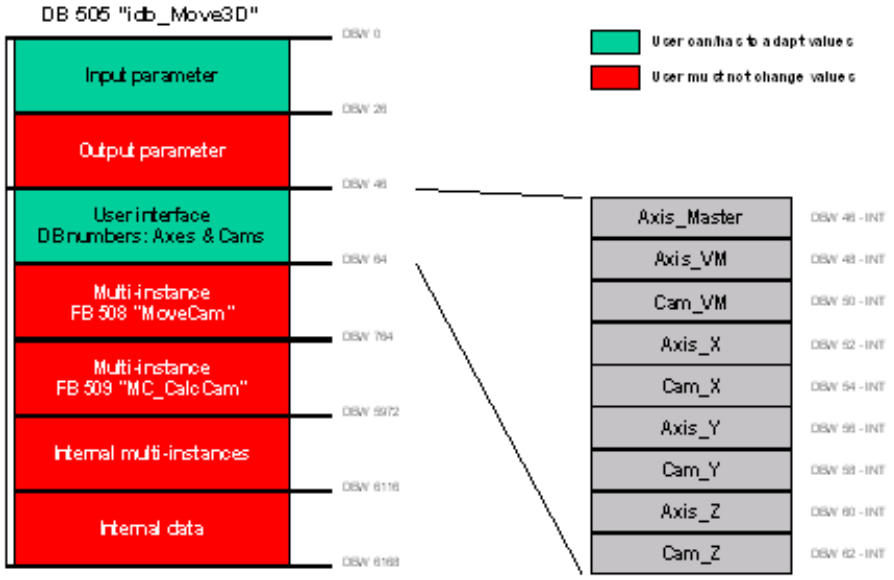


Table 4-3 Parameters of the instance data block – user interface

Parameter	Data type	Initial value	Description
Axis_Master	INT	0	Virtual master axis for generating the setpoints for the control of the respective cam discs.
Axis_VM	INT	0	Virtual slave axis for considering the velocity adaptation for generating the setpoints for the respective cam disc of the Cartesian axes.

Parameter	Data type	Initial value	Description
Cam_VM	INT	0	Cam disc for considering the velocity adaptation.
Axis_X	INT	0	Real Cartesian axis of the machine in X direction.
Cam_X	INT	0	Cam disc with the part of the interpolated motion in X direction.
Axis_Y	INT	0	Real Cartesian axis of the machine in Y direction.
Cam_Y	INT	0	Cam disc with the part of the interpolated motion in Y direction.
Axis_Z	INT	0	Real Cartesian axis of the machine in Z direction.
Cam_Z	INT	0	Cam disc with the part of the interpolated motion in Z direction.

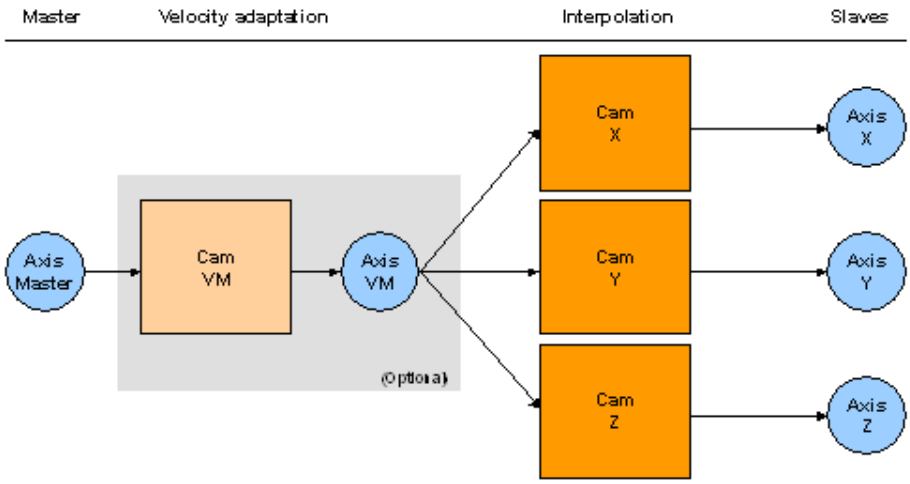
Deactivating the velocity adaptation

If the velocity adaptation is not to be activated, the value **0** is to be assigned to the **Axis_VM** parameter.

The assignment of the cam disc via the **Cam_VM** parameter is not relevant and any value can be assigned. The value of this parameter is not checked during the start of the block as soon as the velocity adaptation has been deactivated.

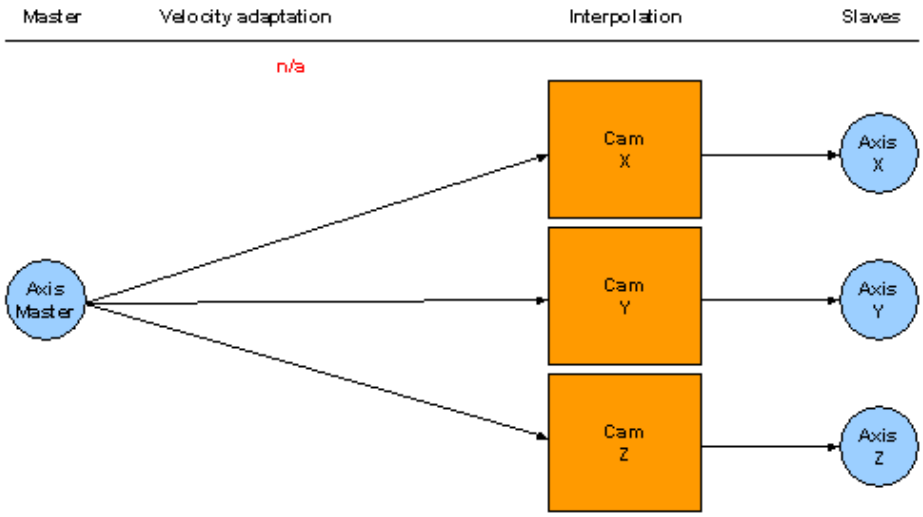
If the velocity adaptation is activated with a value **≠0** via the **Axis_VM** parameter, a valid value **≠0**, which is checked, also has to entered for the cam disc at the **Cam_VM** parameter.

Figure 4-3 Axis synchronization **with** velocity adaptation



...becomes...

Figure 4-4 Axis synchronization **without** velocity adaptation



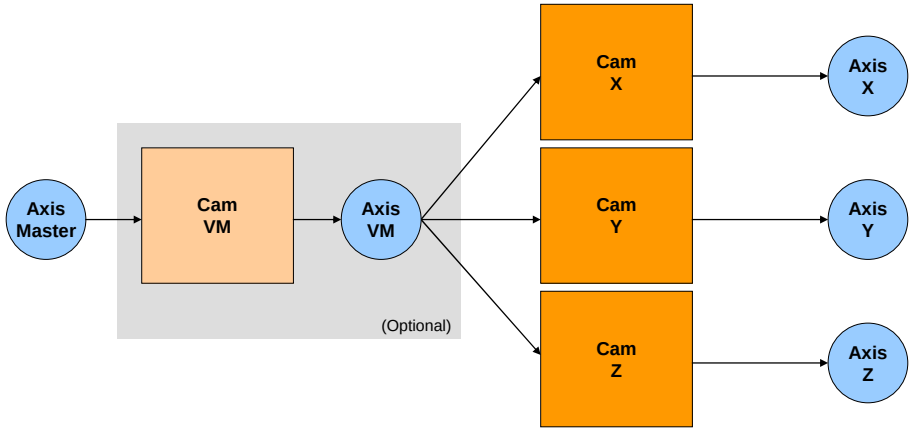
Deactivating individual Cartesian axes

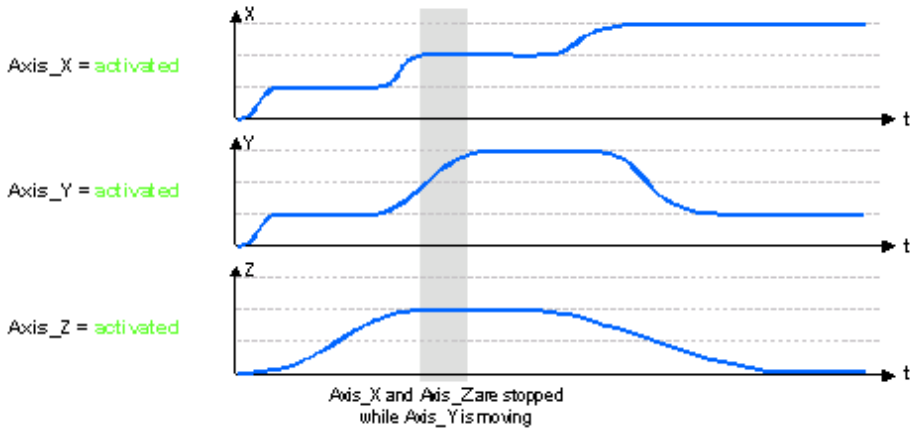
If individual axes are to be excluded from the interpolated motion, the value **0** is to be assigned to the respective parameter of the Cartesian axes **Axis_X**, **Axis_Y** and/or **Axis_Z**.

If different position values for a deactivated axis are listed in the interpolation table, these values are considered during the interpolation of the interpolation table via block **FB 509 "MC_CalcCam"**, however, they are not moved by the deactivated axis. But all other axes, which are not deactivated, react as if the deactivated axis participated in the interpolated motion.

Example 1: All Cartesian axes are activated:

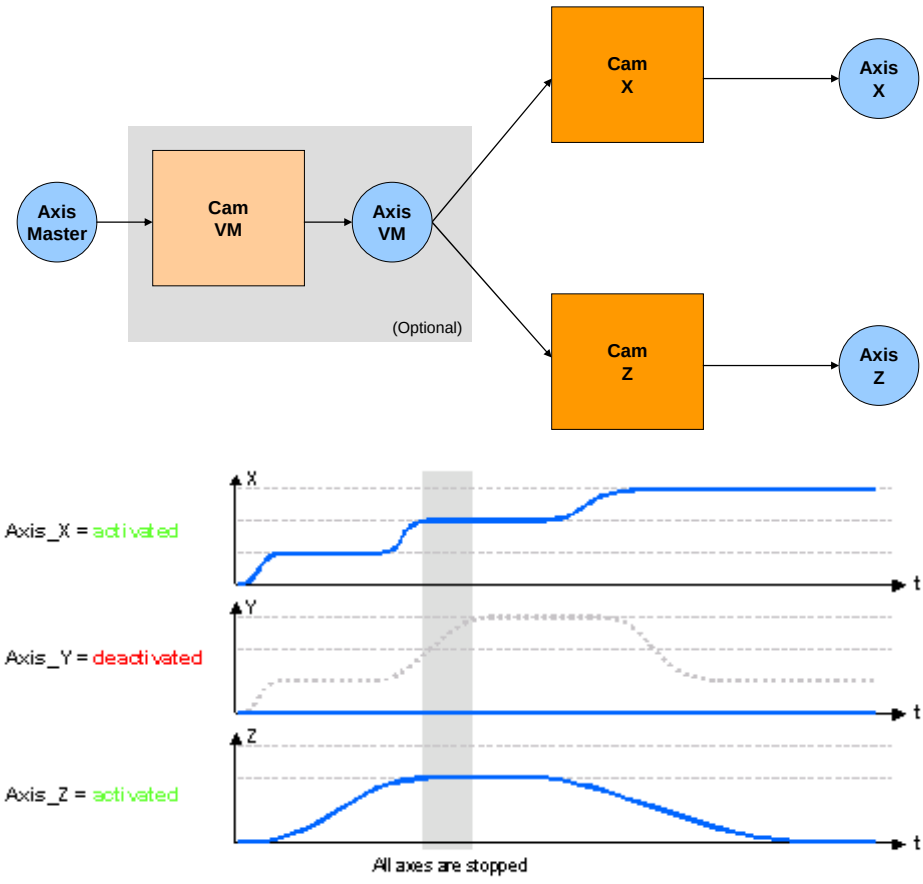
Figure 4-5 Axis synchronization for three-dimensional motions (X, Y, Z)





Example 2: Cartesian axis Y was deactivated:

Figure 4-6 Axis synchronization for motions in the plane (X, Z)



Normally, different position values should not be specified for axes which are not used so that they do not affect the interpolated motion.

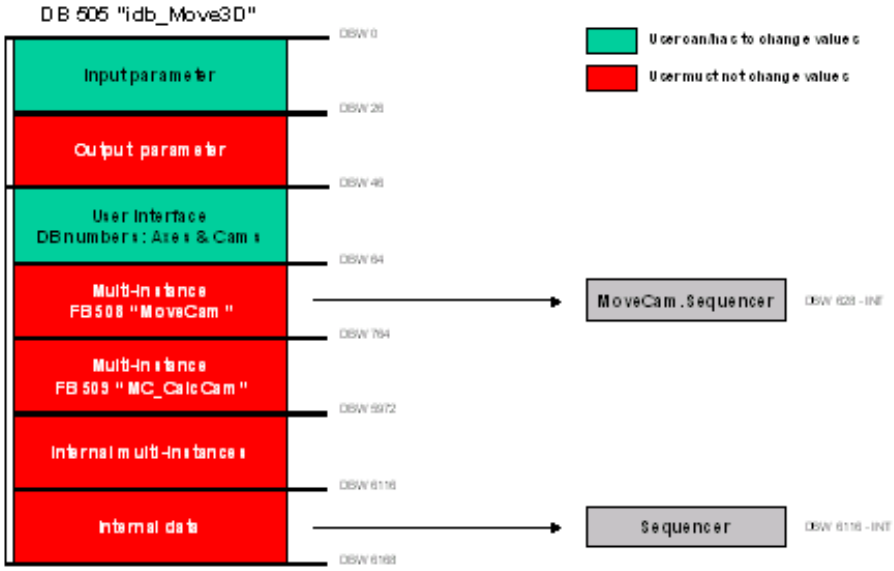
Checking the block status

The current status of the blocks **FB 505 "Move3D"** and **FB 508 "MoveCam"** can be checked via the **Sequencer** variable of the respective block.

The **Sequencer** variable of block **FB 505 "Move3D"** is located directly in the instance data block of **FB 505 "Move3D"** as static variable.

However, the **Sequencer** variable of block **FB 508 "MoveCam"** is located in the instance data block of **FB 505 "Move3D"** as multi-instance of **FB 508 "MoveCam"**.

Figure 4-7 Checking the block statuses via the sequencer variables



4.2.4 Structure of the interpolation table

The interpolation table is the basis of the interpolated motion. In this table, up to 32 spatial points can be stored for defining a trajectory. The interpolation table is stored in the technology CPU as data block based on the user-defined data type **UDT 509**.

Structure of UDT 509

The structure of **UDT 509** is shown in the figure below:

Figure 4-8 Structure of UDT 509

Adresse	Name	Typ	Anfangswert	Kommentar
0.0		STRUCT		
+0.0	StartIndex	INT	1	index of the first valid point
+2.0	EndIndex	INT	32	index of the last valid point
+4.0	Point	ARRAY[1..32]		points with radius
*0.0		STRUCT		
+0.0	X	REAL	0.000000e+000	X-Axis
+4.0	Y	REAL	0.000000e+000	Y-Axis
+8.0	Z	REAL	0.000000e+000	Z-Axis
+12.0	R	REAL	0.000000e+000	radius
=16.0		END_STRUCT		
=516.0		END_STRUCT		

Data block in the interpolation table according to UDT 509

If a data block is generated according to **UDT 509** shown above, the structure of the data block is as follows:

- One array element exists for each spatial point.
- Input boxes for the spatial coordinates X, Y and Z are available for each spatial point.
- For each spatial point, a tolerance range can be defined within which the interpolated trajectory may be adapted in such a way that smooth motion control without standstill of individual axes or without exceeding dynamic limits is enabled.

Figure 4-9 Structure of the data block of the interpolation table (according to UDT 509)

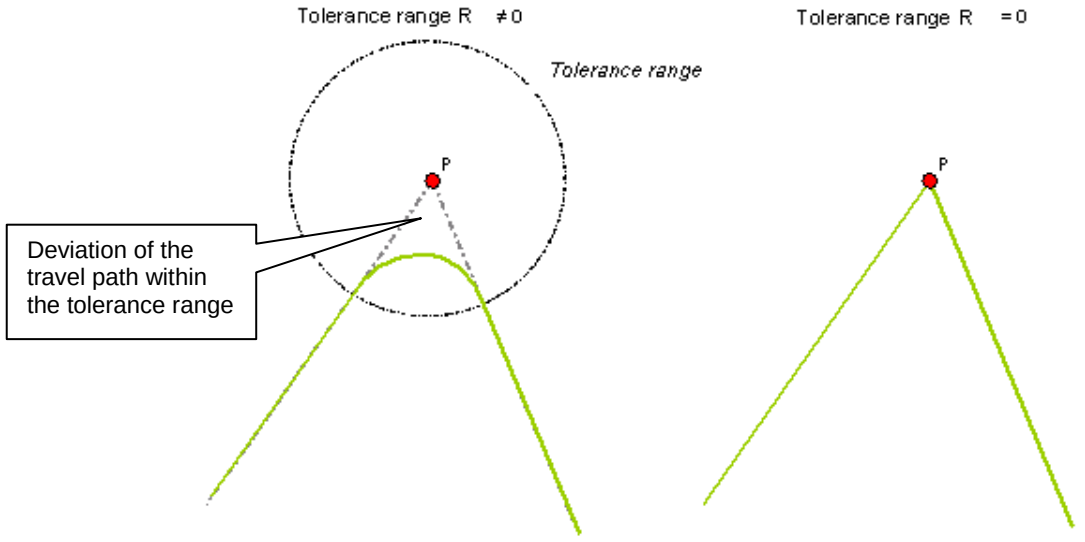
	Adresse	Name	Typ	Anfangswert	Aktualwert	Kommentar
1	0.0	StartIndex	INT	1	1	index of the first valid point
2	2.0	EndIndex	INT	32	5	index of the last valid point
3	4.0	Point[1].X	REAL	0.000000e+000	0.000000e+000	X-Axis
4	8.0	Point[1].Y	REAL	0.000000e+000	0.000000e+000	Y-Axis
5	12.0	Point[1].Z	REAL	0.000000e+000	0.000000e+000	Z-Axis
6	16.0	Point[1].R	REAL	0.000000e+000	0.000000e+000	radius
7	20.0	Point[2].X	REAL	0.000000e+000	0.000000e+000	X-Axis
8	24.0	Point[2].Y	REAL	0.000000e+000	0.000000e+000	Y-Axis
9	28.0	Point[2].Z	REAL	0.000000e+000	1.000000e+002	Z-Axis
10	32.0	Point[2].R	REAL	0.000000e+000	3.000000e+001	radius
11	36.0	Point[3].X	REAL	0.000000e+000	2.000000e+002	X-Axis
12	40.0	Point[3].Y	REAL	0.000000e+000	2.000000e+002	Y-Axis
13	44.0	Point[3].Z	REAL	0.000000e+000	1.000000e+002	Z-Axis
14	48.0	Point[3].R	REAL	0.000000e+000	3.000000e+001	radius
15	52.0	Point[4].X	REAL	0.000000e+000	2.000000e+002	X-Axis

Characteristic features of the interpolation table

In the interpolation table, the following characteristic features are available for influencing the interpolation of the trajectory:

- Via the definition of the **tolerance range R** in the interpolation table, the cam control can be influenced at any point.

Figure 4-10 Cam control in the tolerance range R



The larger the tolerance range around a spatial point is selected, the larger can be the distance between the interpolated trajectory and the specified points.

The specified **tolerance ranges R** are ignored for the starting point and the end point of the trajectory since these points have to be approached very exactly.

- **Start index** and **end index** of the interpolation table make available the option to release only sections of the interpolation table for interpolation of the trajectory by **FB 509 "MC_CalcCam"**.

  The following has to apply to start index and end index:

  1 ≤ start index < end index ≤ 32

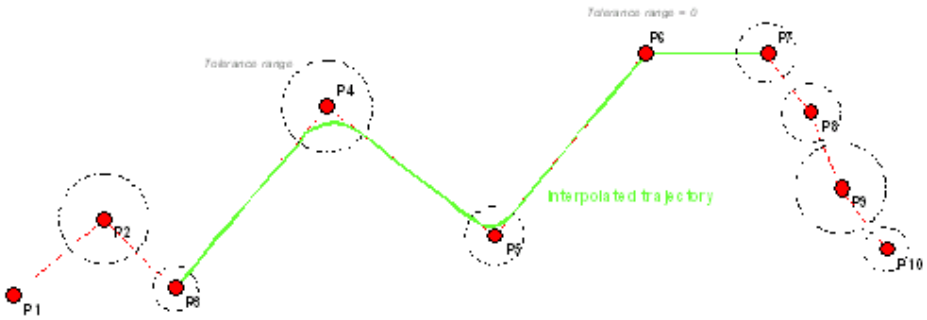
Example of a partial interpolation of an interpolation table:

Size of the interpolation table = 10 interpolation points

Start index = 3
End index = 7

For the interpolation of the trajectory from the interpolation table, the spatial points with the indices 3, 4, 5, 6 and 7 are used. The defined tolerance ranges R are ignored at the points 3 and 7 since these points are the start and the end of the trajectory.

Figure 4-11 Example of the partial interpolation of an interpolation table



Integration of the Technology Template

Content

This part of the documentation provides detailed information on the procedures for integrating this technology template into new or already existing projects and on the control of the technology template by a user program.

It is required to read this part if you want to integrate this technology template into your own application.

5 Integration of the Technology Template

You are provided with information on…

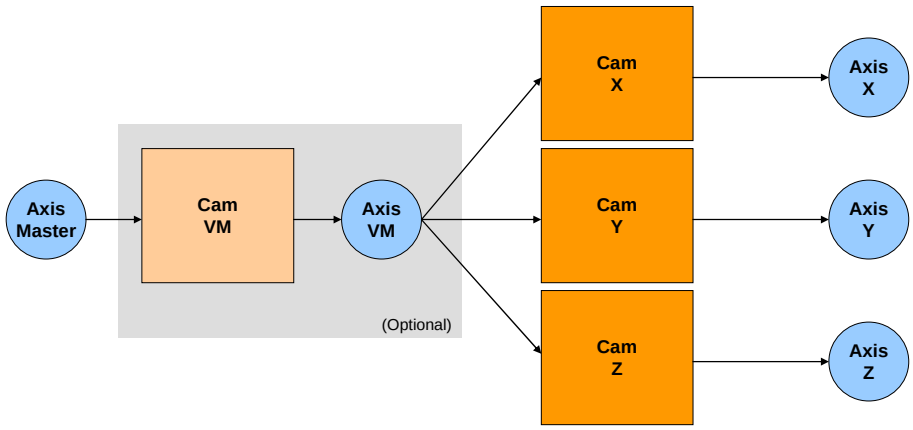
How you can integrate this template into a new or already existing project.

5.1 Requirements

To be able to integrate the technology template into your STEP 7 project, the required technology objects, such as axes and cam discs, have to be created in the technology CPU via the S7T-Config configuration software from the “S7-Technology” software package.

The following relationships have to apply:

Figure 5-1 Required relationships for the axis synchronization for interpolation



This results in the following settings for the virtual and real axes displayed in the overview below:

Table 5-1 Settings axes

Axis	Axis technology			Axis type	Modulo	Drive	
	Speed	Position	Synchronism			Real	Virtual
Master	-	✓	✓	Linear	-	-	✓
VM	-	-	✓	Linear	-	-	✓
X	-	-	✓	Linear	-	✓	✓
Y	-	-	✓	Linear	-	✓	✓
Z	-	-	✓	Linear	-	✓	✓

The synchronization of axes via cam discs requires that the following relationships apply:

Table 5-2 Synchronization relationships between axes and cam discs

Axis	Possible cam discs				Possible master values (axes)				
	VM	X	Y	Z	Master	VM	X	Y	Z
Master	-	-	-	-	-	-	-	-	-
VM	✓	-	-	-	✓	-	-	-	-
X	-	✓	-	-	✓	✓	-	-	-
Y	-	-	✓	-	✓	✓	-	-	-
Z	-	-	-	✓	✓	✓	-	-	-

The creation of the required technology objects will be explained in detail in the following chapters.

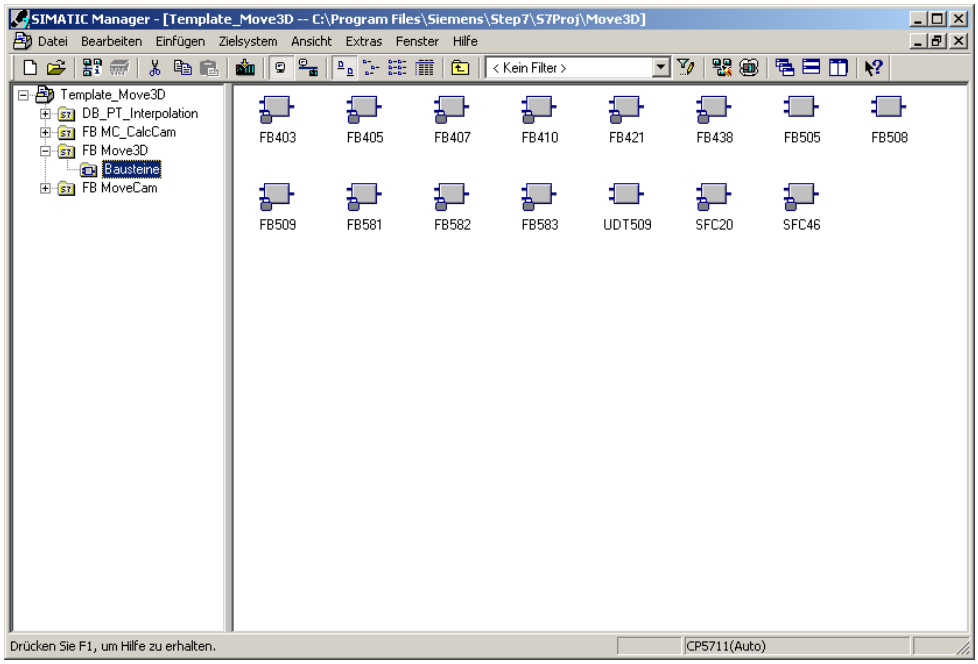
5.2 Preparations

5.2.1 Retrieving the technology template

The technology template is delivered as STEP 7 archive. To use the template, it is required to first retrieve this archive via STEP 7.

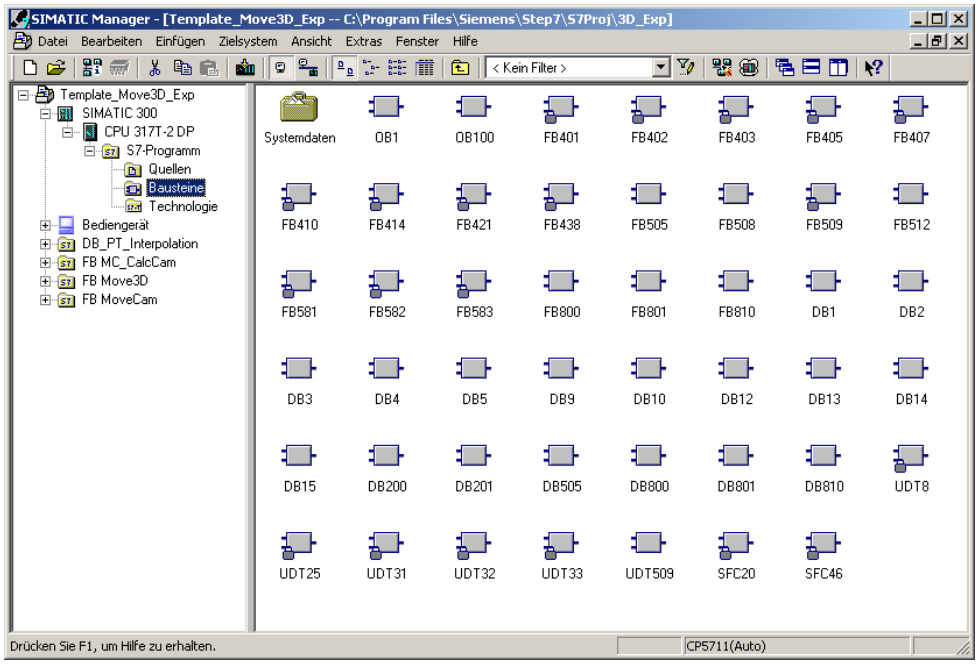
You can use the STEP 7 archive of the technology template which only contains the blocks required for the integration of the template into a user program…

Figure 5-2 Blocks of the technology template (without test program)



… or choose the STEP 7 archive which contains a test program in addition to the blocks of the template.

Figure 5-3 Blocks of the test program for the technology template (incl. template)

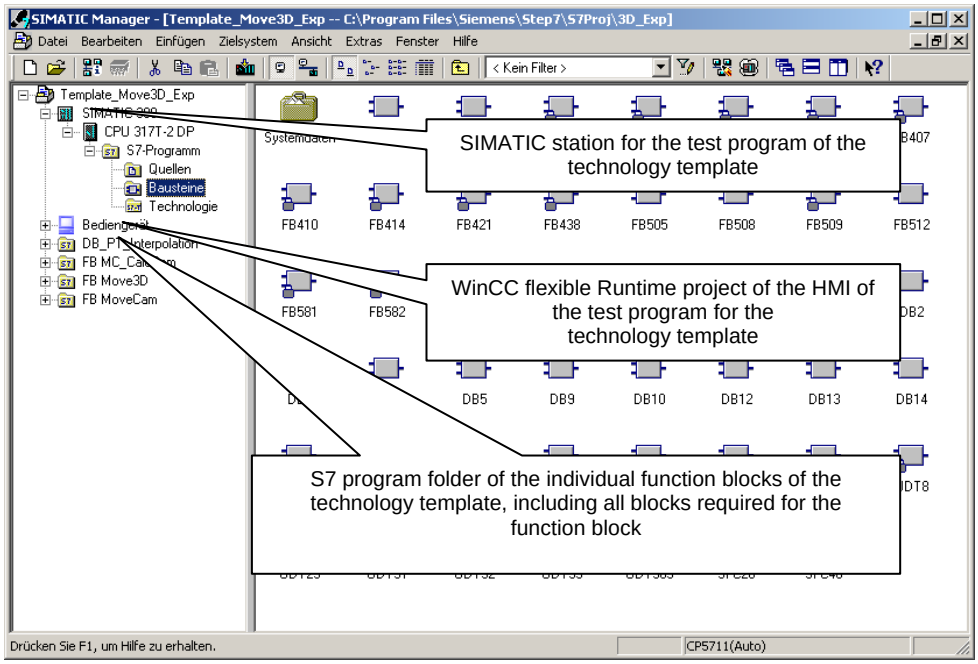


Content and structure of the STEP 7 archives

Each of these STEP 7 projects contains several S7 program folders which include all necessary elements for the use of the technology template.

- **FB Move3D:**
  Complete technology template including all blocks listed in the following.
- **FB MC_CalcCam / FB MoveCam / FC Check_Axes_and_Cams:**
  Individual function blocks or functions of the technology template with all blocks required for the use of the function blocks or functions detached from the technology template.

Figure 5-4 Content and structure of the STEP 7 archive (incl. test program)



In addition to the S7 program folders, the STEP 7 archive with the test program for the technology template contains a SIMATIC station for the Technology CPU 317T-2 DP which contains the test program including all required blocks of the technology template.

5.2.2 Integration of the technology template into your STEP 7 project

For easy and quick transfer of the technology template to your STEP 7 project, you should proceed as described below.

Transfer of the complete S7 program folder

Copy the complete S7 program folder from the STEP 7 archive of the technology template to the root directory of your STEP 7 project. Now all blocks required for the technology template are directly available in your user program.

Integration of the elements of the technology template into your STEP 7 project

To integrate the elements of the technology template, you now only have to copy the individual blocks of the template from the copied S7 program folder to the block folder of your application.

Subsequently, you can use the technology template in your user program by a simple call of block **FB 505 "Move3D"**.

5.3 Creation of the required technology objects

Operation of the technology template additionally requires that the technology objects listed below are created in the integrated technology of the technology CPU and that the objects are configured via the S7T-Config configuration software and interconnected.

5.3.1 Virtual master axis "Axis_Master"

The virtual axis **Axis_Master** has to be created as follows:

Configuration

Table 5-3 Configuration "Axis_Master"

Parameter	Setting	Note
Technology	Position axis	Alternatively, a synchronization axis can be used.
Axis type	Linear	
Units		All axes should be set to the same system of units.
Modulo	Inactive	
Drive assignment	None ⇨ virtual axis	It is mandatory that Axis_Master is created as virtual axis.

Presetting

The presetting of **Axis_Master** determines the dynamic properties of the axis in case of changes of the velocity override.

For acceleration and jerk, the desired values for the implementation of override changes have to be entered via **Axis_Master** using the mechanical conditions at the axes X, Y and Z.

To ensure that the setting for the jerk takes effect, it is required to set a **"Smooth acceleration characteristic"** for the velocity profile at **Axis_Master**.

Limitations

For the settings of the limitations for velocity, acceleration and jerk, the following relations apply:

- Velocity ≥ Maximum path velocity
- Acceleration ≥ Maximum path velocity / 1ms
- Jerk ≥ 10 000 s-1 * acceleration

Example:

Maximum path velocity: v = 250 mm/s
Acceleration: a = 250 mm/s / 0.001 s = 250 000 mm/s^2
Jerk: J = 10 000 s^{-1} * 250 000 mm/s^2 = 2,5 * 10^9 mm/s^3

This means: The maximum acceleration is reached within 0.1 ms. The maximum path velocity is reached within 1.1 ms (due to the jerk limitation).

5.3.2 Virtual axis for velocity adaptation "Axis_VM"

The virtual axis for velocity adaptation **Axis_VM** has to be created as follows:

Configuration

Table 5-4 Configuration "Axis_VM"

Parameter	Setting	Note
Technology	Synchronization axis	Required for the cam disc synchronization as slave axis
Axis type	Linear	
Units		All axes should be set to the same system of units.
Modulo	Inactive	
Drive assignment	None ⇨ virtual axis	It is mandatory that Axis_VM is created as virtual axis.

Presetting

The settings in the presetting of the axis are irrelevant for the use of **Axis_VM** since these settings cannot be accessed in the technology template.

Consequently, it is not necessary to change the default values of S7T-Config when creating the axis.

Limitations

For setting the limitations of **Axis_VM**, the same values as for **Axis_Master** are to be selected (see **Chapter 5.3.1**).

5.3.3 Real Cartesian axes “Axis_X”, “Axis_Y” and “Axis_Z”

The real Cartesian axes have to be created as described below:

Configuration

Table 5-5 Configuration Cartesian axes “Axis_X”, “Axis_Y” and “Axis_Z”

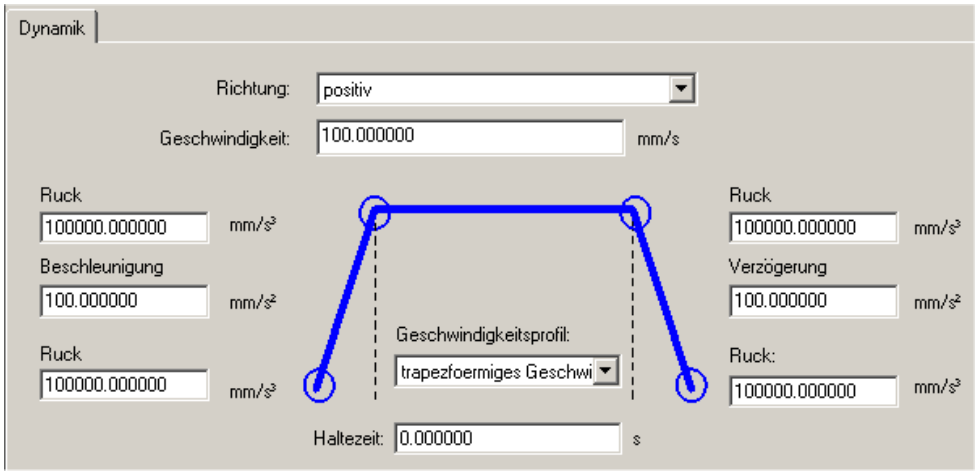
Parameter	Setting	Note
Axis technology	Synchronization axis	Required for the cam disc synchronization as slave axis
Axis type	Linear	
Units		All axes should be set to the same system of units.
Modulo axis	Inactive	
Drive assignment	Drive module ⇨ real axis	Alternatively, the Cartesian axes can also be operated as virtual axes (see test program).

Presetting

If the Cartesian axes are in motion when block **FB 505 “Move3D”** is called, these axes are stopped by the technology template to create a defined initial status.

The dynamic values defined in the presetting are used to stop the axes in this status.

Figure 5-5 Example of the dynamic response of the Cartesian axes

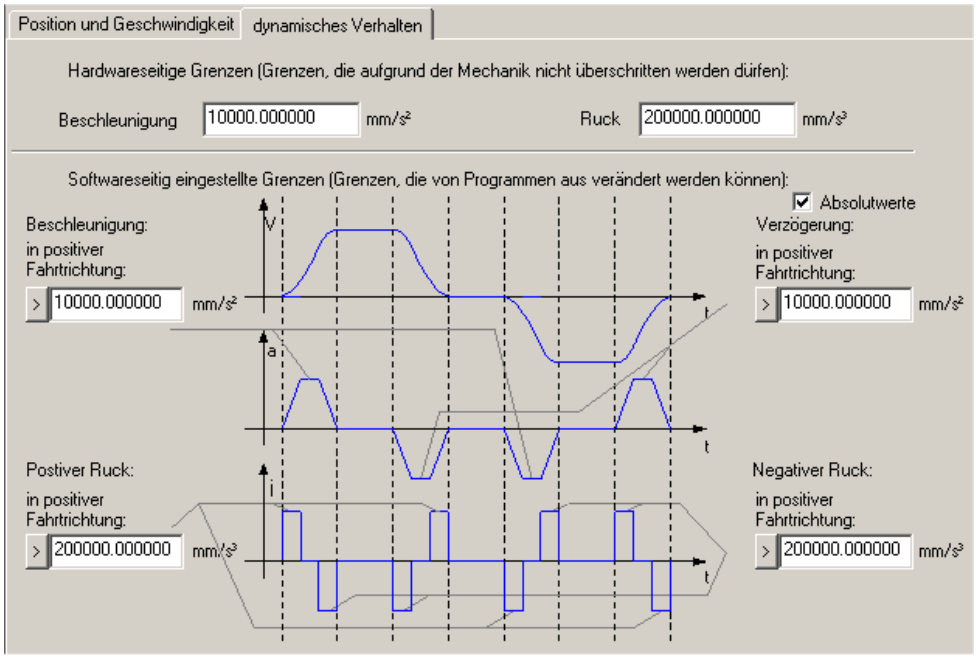


The settings are to be selected depending on the application and do not influence the behavior of the axes during the interpolated motion.

Limitations

The settings for the limitations of acceleration and jerk are, provided that the mechanical conditions allow it, to be selected at least twice as large as the maximum acceleration and the maximum jerk during the interpolated motion.

Figure 5-6 Example of the dynamic limitations of the Cartesian axes



Danger

If the motion of at least one axis is limited, the interpolated travel path can be left. For this reason, it should be ensured that the limitations of the Cartesian axes are not reached during the interpolated motion.

5.3.4 Cam discs “Cam_VM”, “Cam_X”, “Cam_Y” and “Cam_Z”

The cam discs only have to be created via the S7T-Config configuration software. The actual cam discs are defined “online” when calling the technology template via **FB 509 “MC_CalcCam”** using the interpolation table in which the desired trajectory is stored.

Inserting cam disc

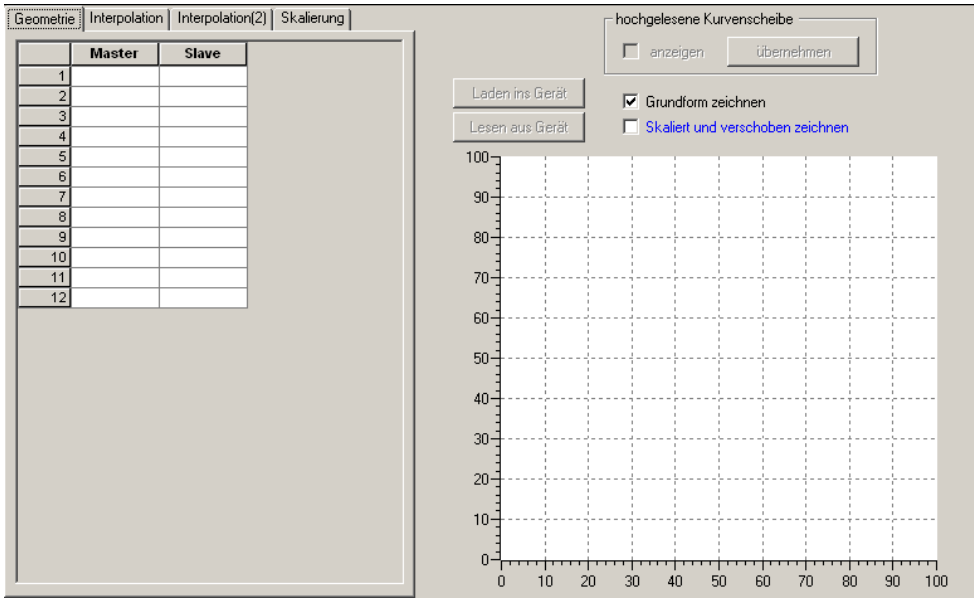
Table 5-6 Configuration of the cam discs

Parameter	Setting	Note
Type	Interpolation table or polynomial	The cam disc is generated by block FB 509 “MC_CalcCam”.

Geometry, interpolation and scaling

It is not required to make further settings for the cam discs in S7T-Config since the cam disc is generated and interpolated by block **FB 509 "MC_CalcCam"**.

Figure 5-7 Example of creating the cam discs



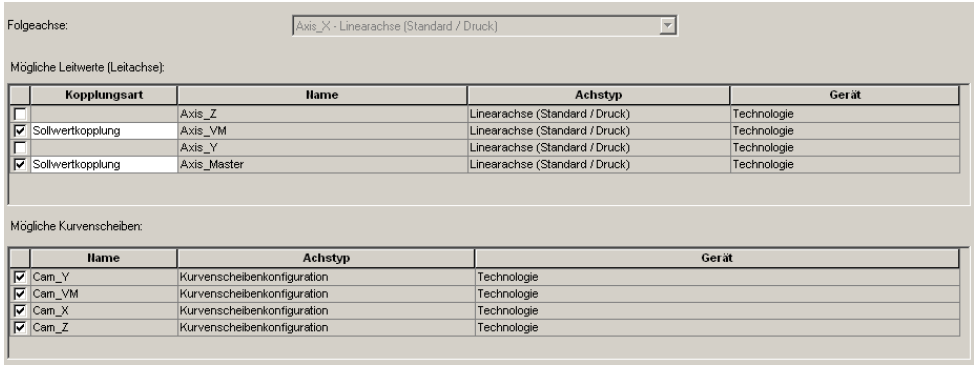
5.3.5 Parameterization of the synchronism conditions of the axes

Configuration

The interconnection between master axis and cam disc for each axis is to be performed as described in the table listed in **Chapter 5.1 Requirements**.

The coupling type between master axis and slave axis to be selected is **Setpoint coupling**.

Figure 5-8 Configuration synchronism (using the example of Axis_X)



Presetting – synchronization cam

Via the presetting on the synchronization of the axis to the cam disc it is determined how the axis reacts in case of request of the cam disc synchronization.

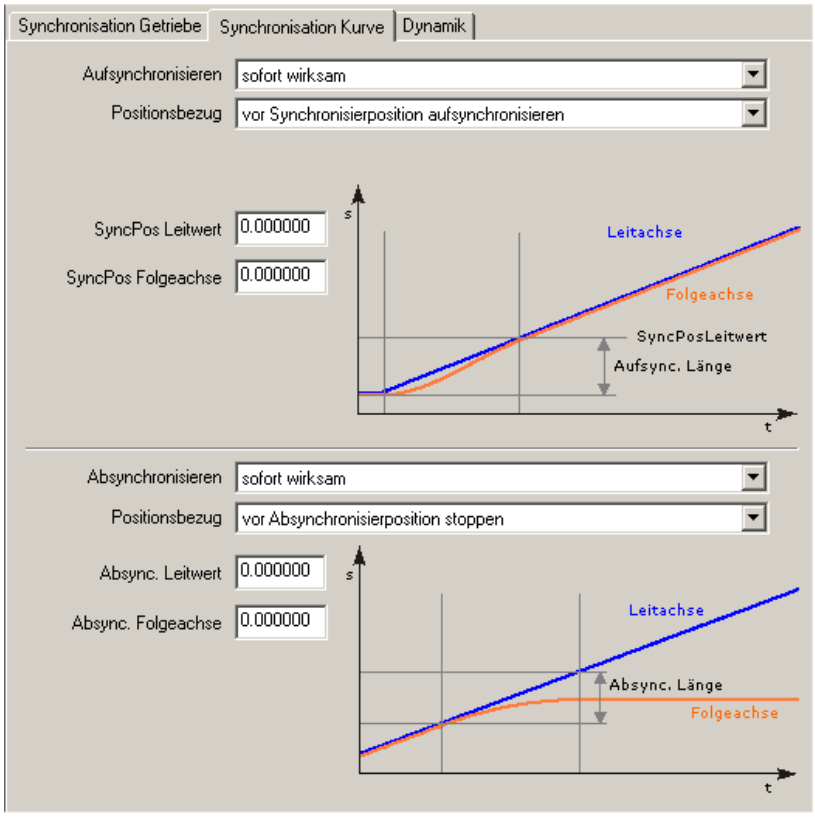
The request of the cam disc synchronization is generated in the technology template via the **FB 421 "MC_CamIn"** technology function.

Table 5-7 Presetting of the synchronism conditions of the axes

Parameter	Setting	Note
Synchronization	Effective immediately	As a result, all further settings for the synchronization are ineffective.
Desynchronization	Effective immediately	As a result, all further settings for the synchronization are ineffective.

The **"Effective immediately"** setting ensures that the synchronization or desynchronization process is started immediately upon request of the cam disc synchronization.
The actual synchronization process takes place according to the dynamic presettings of the cam disc synchronization.

Figure 5-9 Example of the presetting of the synchronization conditions of the axes

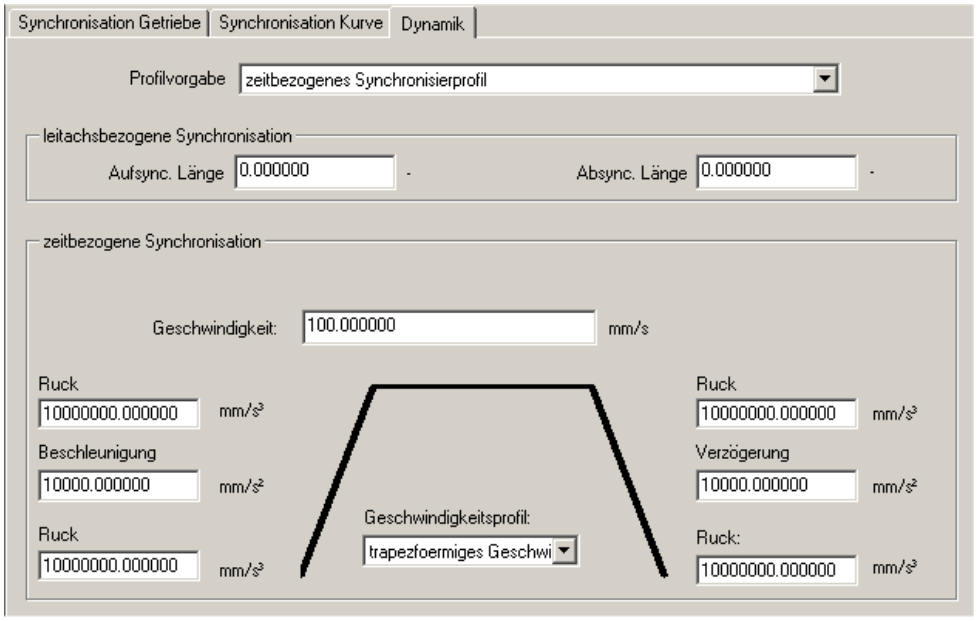


Presetting – dynamics

Table 5-8 Presetting of the dynamics for the synchronism conditions of the axes

Parameter	Setting	Note
Profile setting	Time-related synchronization profile	Synchronization and desynchronization is performed according to the specified dynamic values.
Velocity		The values entered here are not relevant for the use of the technology template since the values specified at the block input of FB 505 “Move3D” are used for cam disc synchronization in the template.
Jerk		
Acceleration		
Deceleration		
Velocity profile	Trapezoidal velocity profile	

Figure 5-10 Example of presetting the dynamics for the synchronism conditions



A time-related synchronization profile means that the synchronization of the axes via cam discs does not, as in the master axis-related synchronization profile, depend on the position of the master axis but that the synchronization is performed via the set dynamic values after calling the **FB 421** “**MC_CamIn**” technology function. For the synchronization of the axes, the slave axis moves to the position which is specified by the current position of the master axis via the cam disc.

In the technology template, the dynamic values defined in the **FB 421 "MC_CamIn"** technology function are used and not the values from S7T-Config shown in the graphic.

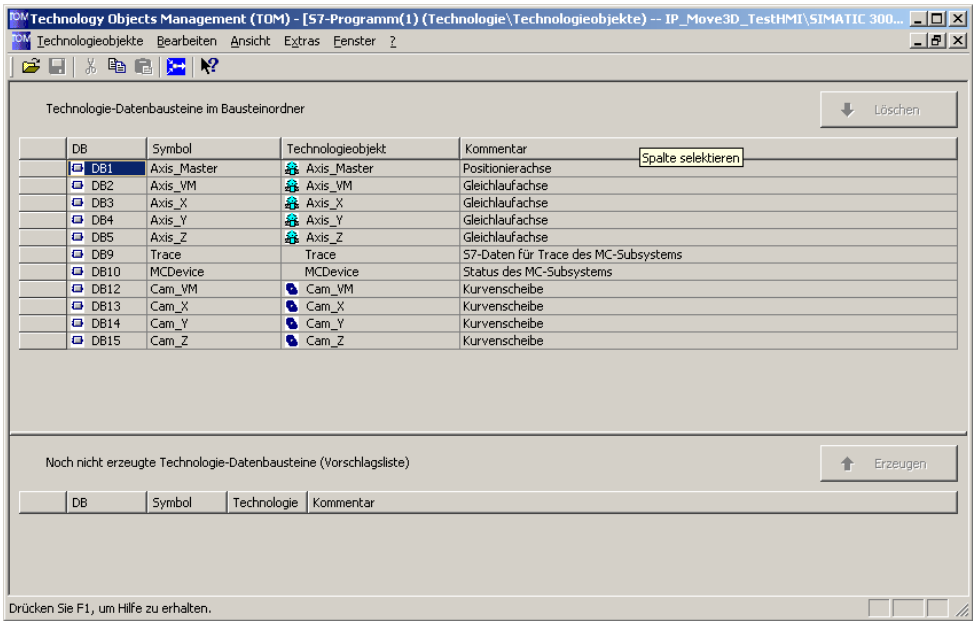
5.3.6 Saving-compiling and creating the technology objects

If all settings have been made in the S7T-Config configuration software, the settings have to be saved and compiled. Subsequently, S7T-Config can be terminated.

Creating the technology data blocks via the Technology Objects Manager

Finally, it is required to integrate the created technology objects into the STEP 7 program via the Technology Objects Manager (TOM).

Figure 5-11 Creation of the data blocks of the technology objects



Via the Technology Objects Manager (TOM), the DB numbers of the technology blocks can be specified or changed and the data blocks of the technology objects are created in the S7 program folder of your STEP 7 user program after clicking the **Create** button.

5.4 Integration of the technology template into your application

After transferring all blocks included in the delivery of the technology template to your STEP 7 project and after creating the required technology objects in the integrated technology of the technology CPU, you can now use the functions provided by the technology template in your user program.

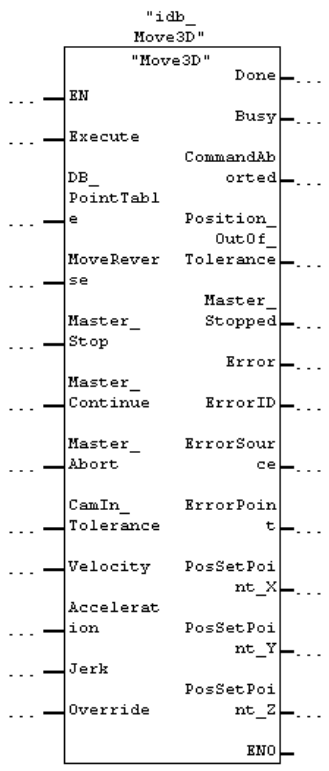
5.4.1 Call of block FB 505 “Move3D” in the user program

The function block **FB 505 “Move3D”** of the technology template can easily be called in your STEP 7 project in the user program.

Call of the function block in STL and FBD

The call of the function block **FB 505 “Move3D”** of the technology template in the programming languages STL and FBD is shown below as an example:

Table 5-9 Call of the function block of the technology template

	STL	FBD
FB 505 “Move3D”	CALL "Move3D" , "idb_Move3D" Execute := DB_PointTable := MoveReverse := Master_Stop := Master_Continue := Master_Abort := CamIn_Tolerance := Velocity := Acceleration := Jerk := Override := Done := Busy := CommandAborted := Position_OutOf_Tolerance:= Master_Stopped := Error := ErrorID := ErrorSource := ErrorPoint := PosSetPoint_X := PosSetPoint_Y := PosSetPoint_Z :=	

Assignment of the instance data block

For <u>each</u> interpolated motion with up to three axes which is to be executed simultaneously to another interpolated motion and which is also generated using **FB 505 “Move3D”**, a separate instance data block or an area in a multi-instance data block has to be assigned to the function block **FB 505 “Move3D”**.

The axes and cam discs used for the interpolated motion are also defined in this instance data block.

5.4.2 Integration of FB 505 “Move3D” into the processing sequence

The function block **FB 505 “Move3D”** of the technology template is integrated into the processing sequence of the user program by a simple block call and the transfer of the required parameters. The block has to be called in a cyclically starting OB or FB. A timer interrupt-controlled processing (e.g in OB 35) is not necessary but it is possible.

6 Use of the Technology Template

6.1 General information

Block **FB 505 "Move3D"**, which executes the complete interpolated motion based on an interpolation table, is the most important element of the technology template. To use the technology template in your application, this block has to be called and parameterized in your user program.

Generating and executing an interpolated motion

For the generation of the cam discs required for the interpolated motion and for the execution of the interpolated motion, block **FB 505 "Move3D"** calls further blocks. For instance block **FB 509 "MC_CalcCam"** is responsible for generating the cam discs and block **FB 508 "MoveCam"** is responsible for the interpolated motion using the generated cam discs.

Table 6-1 Function blocks for subfunctions of the technology template

Function block	Function
FB 509 "MC_CalcCam"	Generating the cam discs **Cam X**, **Cam Y**, **Cam Z** and **Cam VM** from a specified interpolation table indicating the maximum path velocity.
FB 508 "MoveCam"	Executing an interpolated motion using the cam discs **Cam X**, **Cam Y**, **Cam Z** and **Cam VM** and the real and virtual axes **Axis X**, **Axis Y**, **Axis Z**, **Axis VM** and **Time Axis**.

Basically, these blocks can also be used individually in your user program. However, this documentation does not include an explicit description of the individual use of the blocks in your user program.

Management of the axes and cam discs

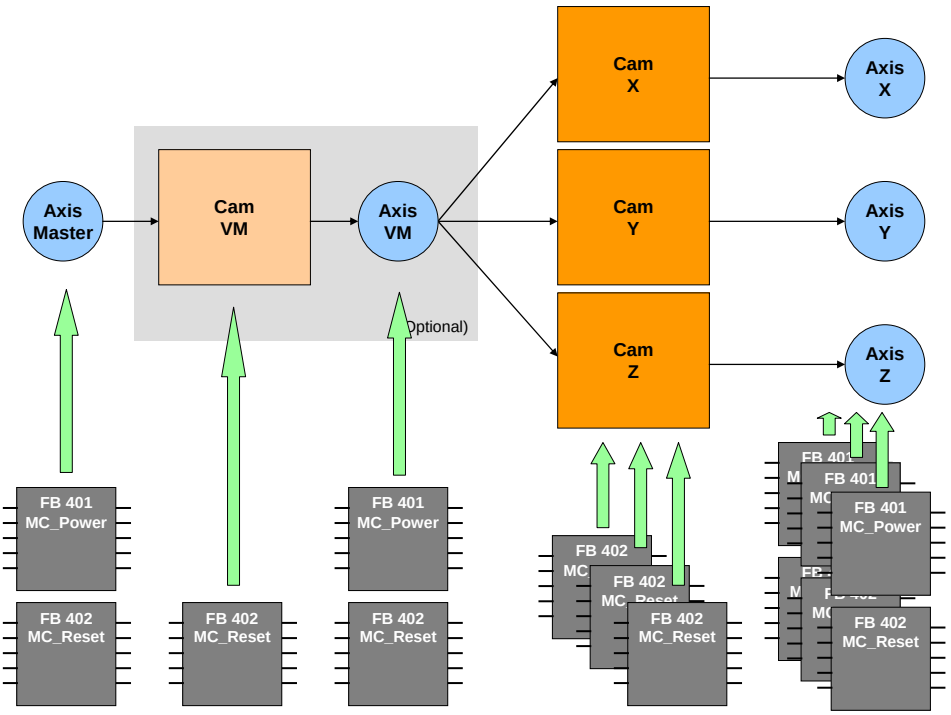
Merely the complete control of the axes and cam discs required for the interpolated motion is performed from block **FB 505 "Move3D"**. You have to manage the axes (release, acknowledgement of errors) in your user program in which block **FB 505 "Move3D"** is called.

For the management of the axes and cam discs, the following technology functions in the user program are to be used:

- Release of the axes via **"MC_Power"**
- Acknowledgement of errors of the axes via **"MC_Reset"**
- Acknowledgement of errors of the cam discs via **"MC_Reset"**

This ensures that the user program has authority over all axes and cam discs and that it can start and implement specific measures in case of emergency (e.g. emergency stop, disabling the axis release or similar measures).

Figure 6-1 Management of the axes and cam discs



6.2 Control of the technology template

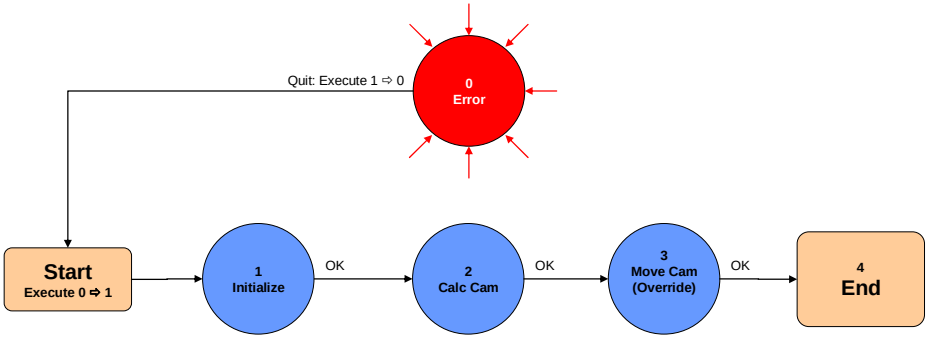
The technology template for executing an interpolated motion is controlled via block **FB 505 “Move3D”**. This block manages all processes required for this motion and calls further function blocks, which are also contained in the template, for the individual functions.

6.2.1 Execution of an interpolated motion (Move3D)

The interpolated motion is influenced via the inputs of block **FB 505 “Move3D”**. During the execution of the interpolated motion, the block is in different statuses displayed in the graphic below.

The technology template can only be influenced in the individual status “Generation of the cam discs” (status 2 – “Calc Cam”) and “Execution of the interpolated motion” (status 3 – “Move Cam”) via block **FB 505 “Move3D”**.

Figure 6-2 State machine of FB 505 “Move3D”



In status 2 – “Calc Cam”, function block **FB 509 “MC_CalcCam”** for generating the cam discs from the specifications of the interpolation table is called. **Chapter 6.2.2** provides detailed information on the options for influencing.

In status 3 – “Move Cam”, function block **FB 508 “MoveCam”** is called and the generated cam discs are moved. **Chapter 6.2.3** provides detailed information on the options for influencing.
In addition, this status, when executing the interpolated motion, includes the option to influence the velocity of the travel motion during the motion via the **Override**.

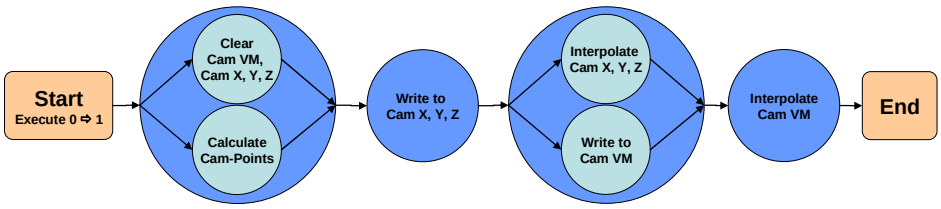
6.2.2 Generation of the cam discs (Calc Cam)

The generation of the cam discs can only be influenced by specifying the respective interpolation table, the maximum path velocity and the desired acceleration.

A travel motion with acceleration adaptation can be achieved especially by activating axis **Axis_VM**. If **Axis_VM** is activated, cam disc **Cam_VM** is additionally generated and cam disc **Cam_VM** and axis **Axis_VM** are included in the control of the cam discs for X, Y and Z axis by the timing axis **Axis_Master**.

The cam discs are generated according to the following principle:

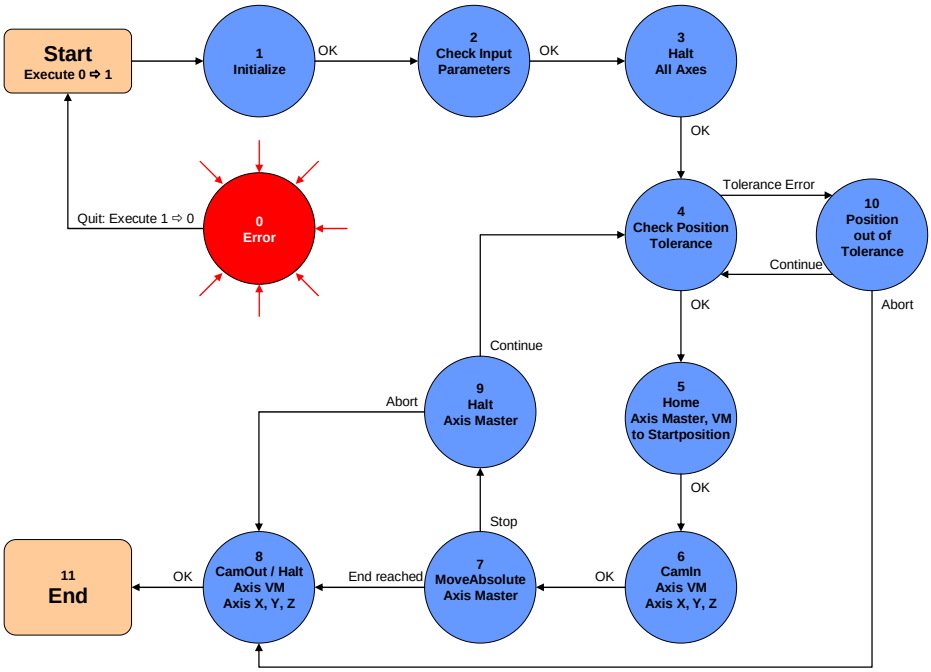
Figure 6-3 Function principle of FB 509 “MC_CalcCam”



6.2.3 Execution of the interpolated motion (Move Cam)

The execution of the interpolated motion can basically be influenced by parameters and signals at block **FB 505 "Move3D"**. The principle of the execution of the interpolated motion is shown in the figure below:

Figure 6-4 State machine of FB 508 "MoveCam"



The following options for influencing are available:

- **Definition of a tolerance range for the cam disc synchronization:**
  If the axes X, Y and Z are outside the defined tolerance range, the axes are not automatically moved to the starting point of the interpolated motion and the cam disc synchronization is not performed. The block reports **"Position out of Tolerance"** and the required position of the axes is displayed so that the axes can be manually moved to the starting position. The block is not interrupted.
  The option to manually move the axes X, Y and Z is not integrated in block **FB 505 "Move3D"** and has to be realized by the user in the user program.

- **Stopping the interpolated motion:**
  During the interpolated motion, the motion can be interrupted without terminating the block. The axes stop, the cam disc synchronization is released and the block reports **"Master stopped"**. In this status, the individual axes can be manually moved or the release of the axes can be removed.
  If the axes have been stopped, the motion can still be continued, which includes a tolerance check or the interpolated motion can be finally aborted.

6.3 Executing an interpolated motion

To be able to execute an interpolated motion, you have to proceed as follows:

6.3.1 Control of the required technology objects

Before calling block **FB 505 "Move3D"** for executing an interpolated motion, it is required to release all axes involved (**FB 401 "MC_Power"**) and to eliminate and acknowledge errors present at the axes and cam discs (**FB 402 "MC_Reset"**). It is required that the cam discs are not being used.

The following technology objects are to be considered:

- **FB 401 "MC_Power":**
  Real axes: "Axis X", "Axis Y", "Axis Z"
  Virtual axes: "Axis Master", "Axis VM"
- **FB 402 "MC_Reset":**
  Real axes: "Axis X" "Axis Y", "Axis Z"
  Virtual axes: "Axis Master" , "Axis VM"
  Cam discs: "Cam_VM", "Cam_X", "Cam_Y", "Cam_Z"

6.3.2 Control of the function block FB 505 "Move3D"

If all axes and cam discs are ready for the calculation of the cam discs and for the execution of the interpolated motion, proceed step by step as described in the table below to operate block **FB 505 "Move3D"**:

Figure 6-2 Control of the function block FB 505 "Move3D"

Step	Action	Note
Preparations		
1	Defining axes	Enter the numbers of the technology data blocks of the axes and cam discs to be used in the instance data block of FB 505 "Move3D".
2	Transferring parameters	Set the parameters for tolerance range, maximum velocity, acceleration and maximum jerk. Deactivate the override by setting the parameter to the value 100.
3	Defining direction of travel	Via the **MoveReverse** input, the travel motion can be started in reverse direction to the interpolation table.

Step	Action	Note
4	Transferring interpolation table	Set the number of the data block containing the interpolation table for the travel motion.
Starting execution of the block		
5	Setting **Execute** input	Start the generation of the cam discs and the execution of the interpolated motion via the **Execute** input.
Position out of tolerance (optional – otherwise Step 8)		
6	Moving axes to the starting point of the travel motion.	If the current position of the axes is outside the defined tolerance range, the axes can now be manually moved to the starting position of the travel motion output by the block at the outputs **SetPoint_X**, **SetPoint_Y** and **SetPoint_Z**.
7	Setting **MasterContinue** input	As soon as the axes are in the tolerance range, the execution of block FB 505 “Move3D” can be continued via the **MasterContinue** input.
Interrupting and continuing travel motion (optional – otherwise Step 13)		
8	Setting **MasterStop** input	The travel motion is stopped on the trajectory and the cam disc synchronization is disabled. The successful interruption of the travel motion is displayed at the **Master_stopped** output.
9	Defining direction of travel	After an interruption of the travel motion, the direction of travel can be newly defined. By switching the **MoveReverse** input, the travel motion on the trajectory can be started back to the starting point.
10	Defining tolerance range	To continue the travel motion, a new tolerance range can be defined within which the axes have to be located.
11	Resetting **MasterStop** input	The travel motion can only be continued if the **MasterStop** input is not set.
12	Setting **MasterContinue** input	A tolerance check is performed to continue the motion. If necessary, the axes have to be moved to the respective positions as described in steps 6 and 7.

Step	Action	Note
Terminating block		
13	---	If the trajectory has been completely followed, the block is automatically set to the “Ready” status. This is indicated via the **Done** output of the block.
14	Resetting **Execute** input	After successful execution of the function block, the **Execute** input can be reset which terminates the output of information at the outputs of the block.

6.3.3 Reactions of the function block FB 505 “Move3D”

At the outputs of block **FB 505 “Move3D”**, the following reactions are detectable during operation:

Table 6-3 Possible reactions of FB 505 “Move3D”

Reaction / Output	Note
Done	Block FB 505 “Move3D” was successfully executed. The generation of the cam discs from the interpolation table was successful and the interpolated motion was completely executed or the block was specifically terminated via the **Master_Abort** input.
Busy	Block FB 505 “Move3D” is currently being processed. Additional information on the current status of the block is provided by evaluating the outputs **Position_OutOf_Tolerance** and **Master_Stopped**.
CommandAborted	Block FB 505 “Move3D” was replaced by calling a technology function outside the block. If this output is set, block FB 505 “Move3D” has completely given up the control of the axes involved in the interpolated motion. The axes can no longer be influenced by FB 505 “Move3D”!
Position_OutOf_Tolerance	The position of the axes X, Y and Z is outside the defined tolerance range for the starting point of the interpolated motion. As long as the output is set, the position of the starting point of the interpolated motion is output at the outputs **SetPoint_X**, **SetPoint_Y** and **SetPoint_Z** for the respective axis. If this output is set, the axes X, Y and Z can be manually moved by a function from the user program (e.g. via the “MoveJOG” technology template) without interrupting or replacing block FB 505 “Move3D”.

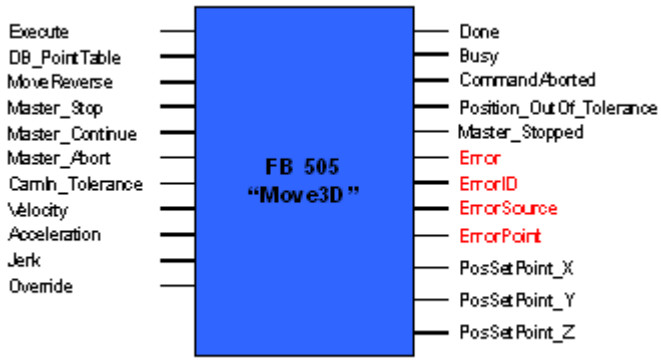
Reaction / Output	Note
Master_Stopped	The interpolated motion was stopped and the cam disc synchronization between the axes was released. As long as the output is set, the axes can be manually moved or the release of the axes can be reset and set without interrupting or replacing block FB 505 “Move3D”. This function can be used especially for safety functions, such as e.g. safety doors with interruption of the axis release.
Error	An error has occurred during executing block FB 505 “Move3D”. The cause of the error can be located in FB 505 “Move3D”, in a subordinate block or in a technology function. For localization of the exact cause of the error, error codes are additionally output at the outputs **ErrorID**, **ErrorSource** and **ErrorPoint**.

6.4 Warning and error messages

6.4.1 Display of the warning and error messages

Via the outputs **Error**, **ErrorID**, **ErrorSource** and **ErrorPoint** of block FB 505 “Move3D”, errors and warnings within the block are signaled.

Figure 6-5 Interfaces for warning and error messages at FB 505 “Move3D”



Via these interfaces, information on the occurred events can be transferred to the user program and appropriate measures can be taken if required.

6.4.2 Error concept

The display of error and warning messages is based on the following concept:

- Output **Error**:
  If this output is set, the occurred event is an error. The cause of the error can be read at the outputs **ErrorID**, **ErrorSource** and **ErrorPoint**.

If this output is not set, there is either no error event or it is a warning and a warning code is output at the outputs **ErrorID**, **ErrorSource** and **ErrorPoint**.

- Output **ErrorID**:
  The error code assigned to the error or the warning is output at this output. The possible output error codes are listed in the following:
  - **Error at a technology function:**
    If an error occurs in the block during the use of a technology function, the error code of the technology function (ErrorID) is directly transferred to the output of block FB 505 “Move3D”.
    The exact cause of the error can then be determined via the error codes on the technology functions of the technology CPU.
  - **Error in block FB 509 “MC_CalcCam”:**
    If an error occurs in block FB 509 “MC_CalcCam”, which was not caused by using a technology function, an error code is output in the **90xx$_{HEX}$** form.
  - **Error in block FB 508 “MoveCam”:**
    If an error occurs in block FB 508 “MoveCam”, which was not caused by using a technology function, the **9030$_{HEX}$** error code is output.
  - **Error in block FB 505 “Move3D”:**
    If an error occurs in block FB 505 “Move3D”, which was not caused by using a technology function, the **9031$_{HEX}$** error code is output.

  For exact localization of the error in the blocks or the cause of the error, the outputs **ErrorSource** and **ErrorPoint** of block **FB 505 “Move3D”** can be used.
- Output **ErrorSource**:
  At this output, an additional error code depending on the **ErrorID** output is output for exact localization of the cause of the error.
  The following rules apply to the interpretation of the additional error code at this output:
  - ErrorSource-Code **00**01$_{HEX}$ to **00**FF$_{HEX}$:
    The signaled error has occurred in block **FB 509 “MC_CalcCam”**.
  - ErrorSource-Code **01**01$_{HEX}$ to **0A**FF$_{HEX}$:
    The signaled error has occurred in block **FB 508 “MoveCam”.**
  - ErrorSource-Code **FF**01$_{HEX}$ to **FF**FF$_{HEX}$:
    The signaled error has occurred in block **FB 505 “Move3D”.**
- Output **ErrorPoint**:
  If an error has occurred in block **FB 509 “MC_CalcCam”** during generating the cam discs from the interpolation table, the index of the incorrect point in the interpolation table is displayed at this output.

Program Description of the Technology Template

Content

This part provides detailed information on the structure and the setup of the technology template enabling you to individually adapt this technology template to your application.

7 Description of important Program Elements

7.1 Program structure

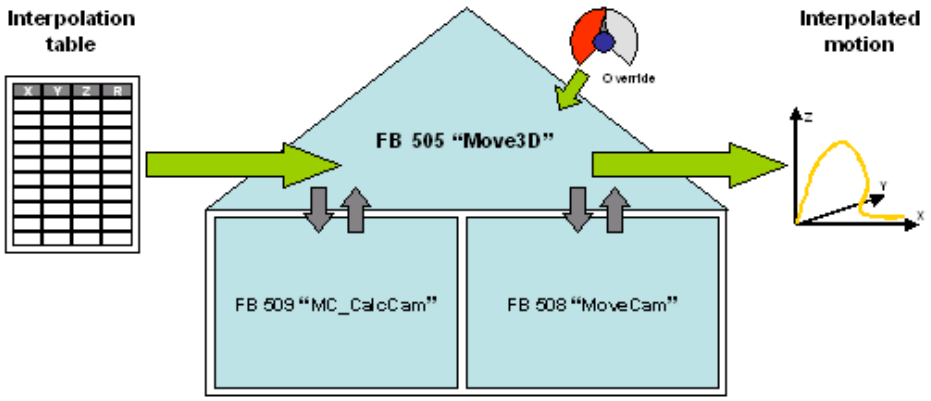
7.1.1 General information on the block structure

The complete technology template consists of three function blocks and each function block executes a specific function.

The tasks of the individual function blocks are listed in the following:

- **FB 509 “MC_CalcCam”:**
  From an interpolation table available according to the **UDT 509** data format, this block generates three cam discs for the Cartesian axes of the interpolated motion and if required a cam disc for the velocity adaptation for generation of a three-dimensional interpolated motion.
- **FB 508 “MoveCam”:**
  This block is responsible for the actual axis motion. It manages the synchronization of the axes and cam discs and provides the execution of the interpolated motion with and without velocity adaptation.
  To execute block **FB 508 “MoveCam”**, it is required that the cam discs generated by block **FB 509 “MC_CalcCam”** are already available.
  In addition, this block offers different options enabling the operator to intervene, such as stopping the motion, continuing the motion and defining a tolerance range for the start or the continuation of the interpolated motion.
- **FB 505 “Move3D”:**
  As calling block, this block is at a higher level than the two already mentioned function blocks and manages the consistent call of the individual blocks for generating an interpolated motion directly from an interpolation table.
  In addition, this block also offers the use of the override function of the integrated technology for influencing the traversing velocity of the interpolated motion.

Figure 7-1 Sequence of an interpolated motion via the technology template



Except for block **FB 505 "Move3D"**, all blocks existing in the template can also be used individually in a self-created user program.

Basic structure of the function blocks

The individual blocks are realized as independent state machines. This means that the steps necessary in the blocks are performed successively and that the sequence of the steps is in accordance with specific definitions. These definitions can depend on operator interventions and on the results of the individual functionalities.

The advantage of this technology is the fact that only one step is active at a time and that consequently the error finding and the reproducibility of the block function are considerably facilitated.

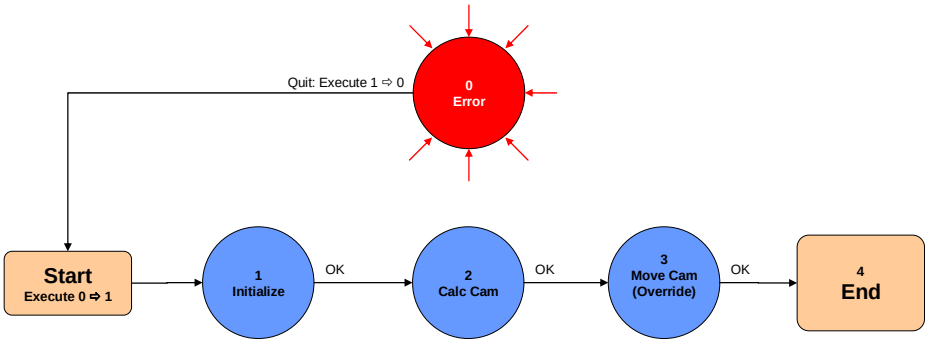
The sequence of the individual steps can be reproduced using the state graphs available for the individual blocks.

The currently active step in the respective block can be determined via the **Sequencer** variable of the corresponding block. (see also **Chapter 4.2.1**)

7.1.2 Block FB 505 "Move3D"

Block **FB 505 "Move3D"** is based on the following state machine:

Figure 7-2 State machine of FB 505 "Move3D"



The individual statuses of the block have the following meaning:

Table 7-1 Description of the statuses of FB 505 “Move3D”

Status	Action	Note
0	Error	If an error has occurred in the block or if a technology function has been replaced, branching into the error status takes place. The respective outputs at the block are set and the execution of the function block is stopped in status 0.
1	Initialization	The internal variables and the technology functions and function calls of the block are set to a defined status.
2	Cam disc calculation	**FB 509 “MC_CalcCam”** is initiated and the cam discs are calculated using the interpolation table.
3	Execution of the interpolated motion	**FB 508 “MoveCam”** is called and the interpolated motion is executed using the generated cam discs. Via inputs of the block, the execution of the interpolated motion can be influenced. In addition, this status makes available the option to influence the velocity of the interpolated motion via the override of the integrated technology.
4	End of the block	If the block was correctly terminated, the block remains in this status until the next call.

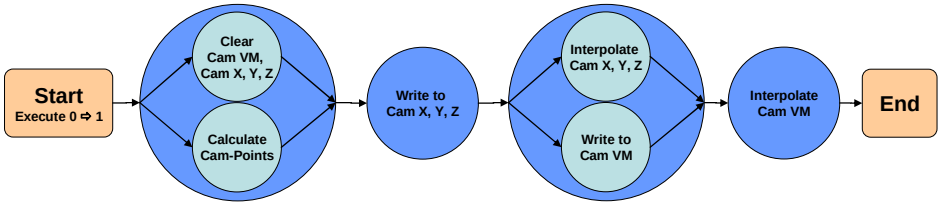
7.1.3 Block FB 509 “MC_CalcCam”

Block **FB 509 “MC_CalcCam”** is a special block in this technology template.

The functionality for generating the cam discs from an interpolation table exists as protected block in the technology template. This block can be used freely for the generation of cam discs, however, the source code of the block cannot be viewed and it can consequently not be changed or adapted by the user.

The basic sequence of block **FB 509 “MC_CalcCam”** is shown in the figure below but it is not a state machine as in the other blocks of the template:

Figure 7-3 Function principle of FB 509 “MC_CalcCam”



If the block is started, the specified cam discs for the interpolation are cleared and simultaneously the cam disc points are calculated using the trajectory specified via the interpolation table.

During the next step the calculated points are written into the respective cam disc.

Subsequently, the created cam discs have to be interpolated for the use for cam disc synchronization while the cam disc for velocity adaptation is written simultaneously. The latter depends on the motions of the individual Cartesian axes.

During the last step the cam disc for the velocity adaptation is interpolated before the block is terminated and before the individual cam discs are available for the execution of the interpolated motion.

7.1.4 Block FB 508 “MoveCam”

Block **FB 508 “MoveCam”** is based on the following state machine:

Figure 7-4 State machine of FB 508 “MoveCam”

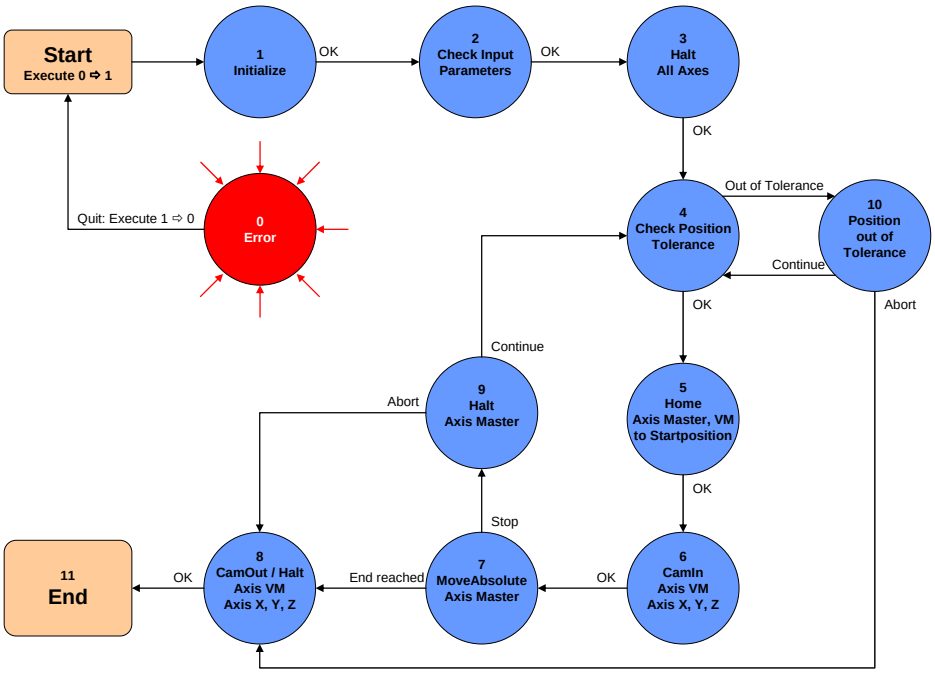


Table 7-2 Description of the statuses of FB 508 “MoveCam”

Status	Action	Note
0	Error	If an error has occurred in the block or if a technology function has been replaced, branching into the error status takes place. The respective outputs at the block are set and the execution of the function block is stopped in status 0.
1	Initialization	The internal variables and the technology functions and function calls of the block are set to a defined status.
2	Checking the input parameters	The assignment of the axes and cam discs and the input parameters are checked. In case of incorrect input parameters or assignments an error message is output and the block branches into the error status.
3	Stopping all axes	To achieve a defined status for executing the block, all axes involved in the interpolated motion (real and virtual) are stopped and possibly existing cam disc synchronizations are released.
4	Checking the tolerance range	Checking whether the current position of the axes X, Y and Z is within the specified tolerance range on the starting point of the interpolated motion. If the current position of the axes is outside the tolerance range, branching into **status 10** takes place.
5	Moving virtual axes to starting position	Prior to the start of the motion, the virtual axes are set to the respective starting position depending on whether the interpolation table is to be passed in ascending or descending direction.

Status	Action	Note
6	Executing cam disc synchronization	If the virtual axes are in the correct position, the axes are synchronized using the cam discs and a possibly existing deviation between the current position of the axes X, Y and Z and the starting position of the motion is moved.
7	Executing interpolated motion	The virtual axis **Axis Master** is started so that the interpolated motion of the axes X, Y and Z is executed via the synchronized cam discs. In this status, the motion can be interrupted by an operator intervention via the inputs of the block and a branching into **status 9** of the state machine takes place.
8	Releasing cam disc synchronization	If the interpolated motion was completely executed, all axes are stopped and the cam disc synchronization of the axes is released. From this time on, all axes can be moved and influenced individually and independently of one another.
9	Stopping interpolated motion	If the travel motion is stopped via the input of the block, the virtual axis **Axis Master** is stopped and the other axes are also stopped via the cam disc synchronization. They follow the specified contour. If all axes are stopped, the cam disc synchronization is additionally released ensuring that the axes can now be moved individually and independently of one another. In this status, it is also possible to remove the release of the axes without interrupting the block or causing an error message. In this status, the interpolated motion can be continued (**status 4**) or finally aborted (**status 8**) by an operator intervention.

Status	Action	Note
10	The axes are outside the tolerance range	If the current position of the axes X, Y, and Z is outside the tolerance range, branching into this status takes place. It is possible to manually move the individual axes to the correct position and subsequently to continue the execution of the block with a renewed check of the tolerance range.
11	End of the block	If the block was correctly terminated, the block remains in this status until the next call.

7.2 Options for influencing the technology template

The basic sequence of the technology template is specified by block **FB 505 "Move3D"**. Intervening in the initialization of the block and the generation of the cam discs from the interpolation table is only possible to a limited extent.

Interpolation table

Via the parameters **StartIndex** and **EndIndex** in the interpolation table, it is only possible to define the section of the interpolation table to be used for the interpolation. Via the **tolerance range R** around the individual interpolation points of the table, the cam of the interpolated motion can be influenced in addition.

Cam disc generation

When generating the cam discs, it can be defined which cam discs are to be generated by specifying the numbers of the data blocks.

By indicating the number for cam disc **Cam VM**, it can additionally be selected whether a velocity adaptation (by **Cam VM**) is to be provided or not provided for the interpolated motion.

Executing the interpolated motion

The largest number of options for influencing is available for the execution of the travel motion. The following actions can be performed:

- Definition of a tolerance range for the start of the travel motion or the continuation of an interrupted travel motion.
- Interruption or abort of the active travel motion.
- Change of the direction of motion prior to the start of the motion or after an interruption of the active travel motion.
- Specification of velocity, acceleration and jerk for the travel motion. If the travel motion is executed with velocity adaptation, the desired

velocity and acceleration is already considered during the generation of the cam discs.

7.3 Description of special functions of the technology template

For the execution of an interpolated motion in block **FB 505 "Move3D"** and in the subordinate blocks, the technology template provides a number of special functions which will be explained in detail in the following chapter.

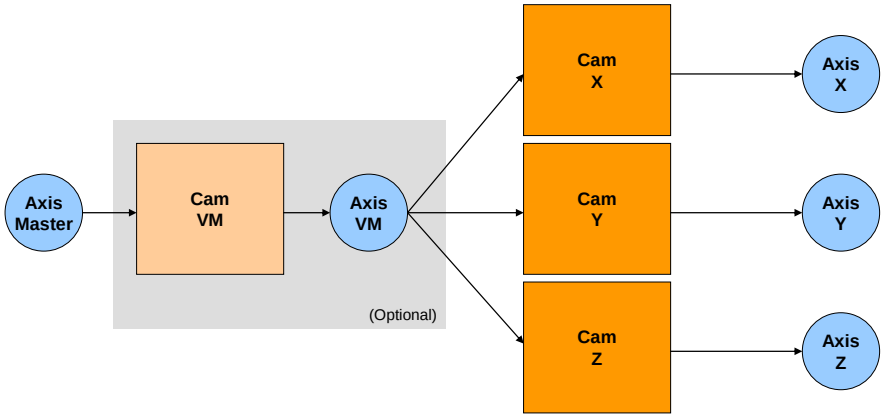
7.3.1 Checking the input parameters

The data blocks of the technology objects axes and cam discs are checked during checking the input parameters of block **FB 505 "Move3D"**. The data blocks of the axes and cam discs have to comply with the following criteria:

- Via the number of the data block, it is defined whether the respective axis and/or cam disc participates in the interpolated motion.
  - **DB number = 0:** The axis/cam disc does not participate in the interpolating motion.
  - **DB number ≠ 0:** The axis/cam disc does participate in the interpolating motion.

  A characteristic feature is the fact that the participation of cam disc and axis can only be activated and deactivated via the DB number of the axis. If an axis is activated and if the associated cam disc is deactivated an error is output.

  Figure 7-5 Interpolated motion with velocity adaptation



  An interpolated motion without velocity adaptation is executed by transferring the DB number of **Axis VM** with the value **0**.

  For **Axis Master** as master axis for the entire interpolated motion, it is always required to specify a valid DB number. If the number is invalid, an error message is output.

- It is required that data blocks for the specified numbers exist in the memory of the CPU. Non-existing blocks are not automatically created.

7.3.2 Performing the tolerance check

The tolerance check is performed before the start of the synchronization of the axes in block **FB 508 "MoveCam"**. This ensures that an uncontrolled motion of the axes during synchronizing the axes via the cam discs is avoided.

The procedure of the tolerance check realized in block **FB 508 "MoveCam"** is described in the following:

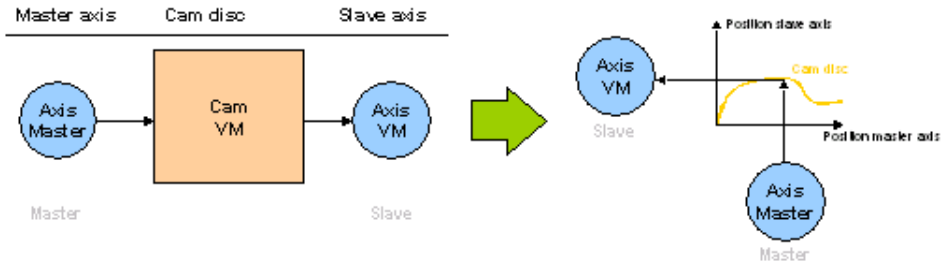
- Reading the specified value for the tolerance range.
  The tolerance range is spherically (in case of 3D motions) located around the starting point of the interpolated motion.
- Defining the start and target position for the virtual axis **Axis Master** which supplies the master value for the cam disc synchronization.
  It has to be considered whether the motion was restarted or whether an interrupted motion is to be continued. Furthermore, the direction of motion for restarted motions is also evaluated according to or contrary to the points in the interpolation table.
- If the velocity adaptation is active, the required position of **Axis VM** is determined using the **FB 438 "MC_GetCamPoint"** technology function via the position of **Axis Master** and cam disc **Cam VM**.
- Now the setpoint positions of **Axis X, Axis Y** and **Axis Z** are determined via the cam discs **Cam X, Cam Y** and **Cam Z**. This is again done with the **FB 438 "MC_GetCamPoint"** technology function and either **Axis VM** (with velocity adaptation) or **Axis Master** (without velocity adaptation) is directly used as master value for the axes X, Y and Z.
- Now the current actual positions of the axes (**DBD 68**) are read from the technology data blocks of the axes **Axis X, Axis Y** and **Axis Z**.
- Finally, the distance between setpoint and actual position is created for each axis and the distance between the two points in three-dimensional space (3D) is determined.

If the calculated distance between the two points in three-dimensional space exceeds the defined tolerance range, the result of the tolerance check is negative and the execution of the interpolated motion is not started. For this, the state machine of **FB 508 "MoveCam"** branches into **status 10**.

7.3.3 Synchronization of the axes via the cam discs

If two axes are synchronized via a cam disc, one axis is defined as master axis while the second axis, the slave axis, follows the master axis via the mapping specification of the cam disc.

Figure 7-6 Synchronization of axes via a cam disc



In block **FB 508 "MoveCam"**, the axes are synchronized via the cam discs according to the following procedure:

- Assignment of the master axis for the cam discs **Cam X**, **Cam Y** and **Cam Z**. If the velocity adaptation is activated, **Axis VM** is the master axis for the named cam discs. Otherwise the cam discs are directly controlled by **Axis Master**.
- Synchronization of the axes **Axis X, Axis Y, Axis Z, Axis VM** and **Axis Master** via the cam discs **Cam X, Cam Y, Cam Z** and **Cam VM**. During the cam disc synchronization of the individual axes, possibly still existing deviations between the actual position of the axes **Axis X**, **Axis Y** and **Axis Z** and the setpoint position of these axes are removed. The axes are moved to the required setpoint position independently of one another by the **FB 421 "MC_CamIn"** technology function.

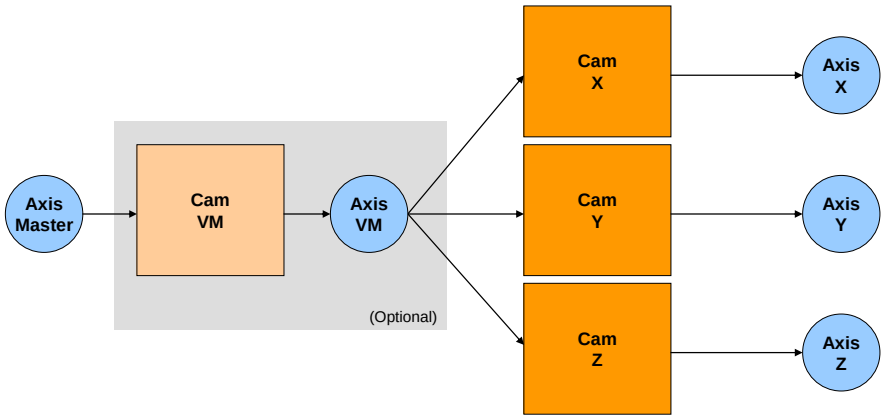
The interpolated motion can only be executed after successful synchronization of the axes via the cam discs.

7.3.4 Executing the interpolated motion

If the axes are connected to each other via the cam discs, the interpolated motion can directly be executed and influenced via the control of the virtual axis **Axis Master**.

The interpolated motion with or without velocity adaptation can be executed alone by controlling **Axis Master**.

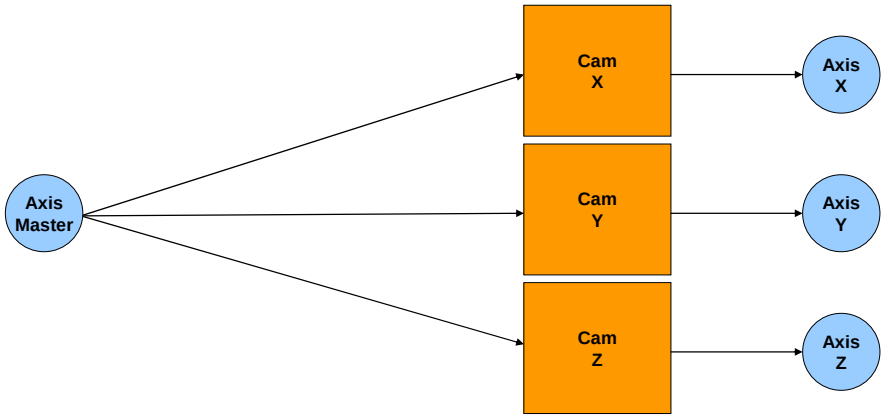
Figure 7-7 Control of the axes via “Axis_Master” (with “Cam_VM”)



If the interpolated motion is to be executed with velocity adaptation **(Axis VM** is active), **Axis Master** provides the master value for cam disc **Cam VM** and by that controls the position of the slave axis **Axis VM**. This slave axis in turn provides the master value for the cam discs of the individual Cartesian axes and by that controls the actual three-dimensional interpolated motion (3D).

If, however, the travel motion is executed without velocity adaptation, Axis Master directly operates as master axis for the cam discs of the Cartesian axes **Axis X**, **Axis Y** and **Axis Z**.

Figure 7-8 Control of the axes via “Axis_Master” (without “Cam_VM”)

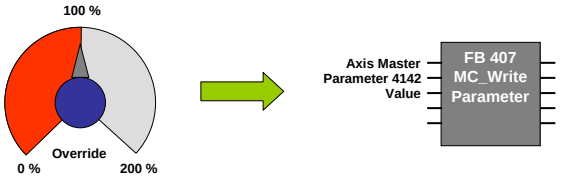


7.3.5 Override function

The integrated technology of the technology CPU provides the option of influencing the velocity of individual axes via an override function in the range of 0…200% of the set velocity during the motion.

This requires that the set override value is written to **Parameter 4142** of the desired axis via the **FB 407 "MC_WriteParameter"** technology function.

Figure 7-9 Control of the override function of the integrated technology



To be able to influence the velocity of the axes **Axis X**, **Axis Y** and **Axis Z** during the interpolated motion without leaving the interpolated trajectory, the override function is to be used for **Axis Master**. This ensures that the set override value simultaneously influences all axes via the cam disc synchronization.

Note

Settings below 0% and above 200% are ignored by the override function. The current valid override setting is retained.

8 Adaptation of the Technology Template

8.1 Notes and warnings

Before changing this technology template, you should observe the notes and warnings listed in the following:

Principle of operation of the components

Before changing the components included in this technology template, you should have familiarized with the principle of operation and the relationships of the individual components.

Uncontrolled changes of the technology template can cause danger to life and limb!

Support restrictions

Support services in the scope of the Customer Support can only be provided for the unaltered technology template.

If the code is changed it is no longer possible to provide support for the technology template.

The same applies to the suggested changes and adaptations described in this chapter.

8.2 Possible adaptations

For individual adaptation to special requirements and rating classes, the following changes of the components included in the technology template are useful.

8.2.1 Optimization of the function blocks

For better understanding of the processes and for easier adaptation of the blocks to special changes or expansions, the individual function blocks of the template are provided with sufficient comments and constant function structures.

If an execution of the block optimized with regard to time is desired or if the memory requirement of the blocks is to be reduced, the program code of the individual blocks can be functionally adapted and optimized. Particularly some **NOP instructions** can be removed from the block, however, a consistent positioning of possibly existing jump targets has to be observed.

8.2.2 Use of several sets of cam discs

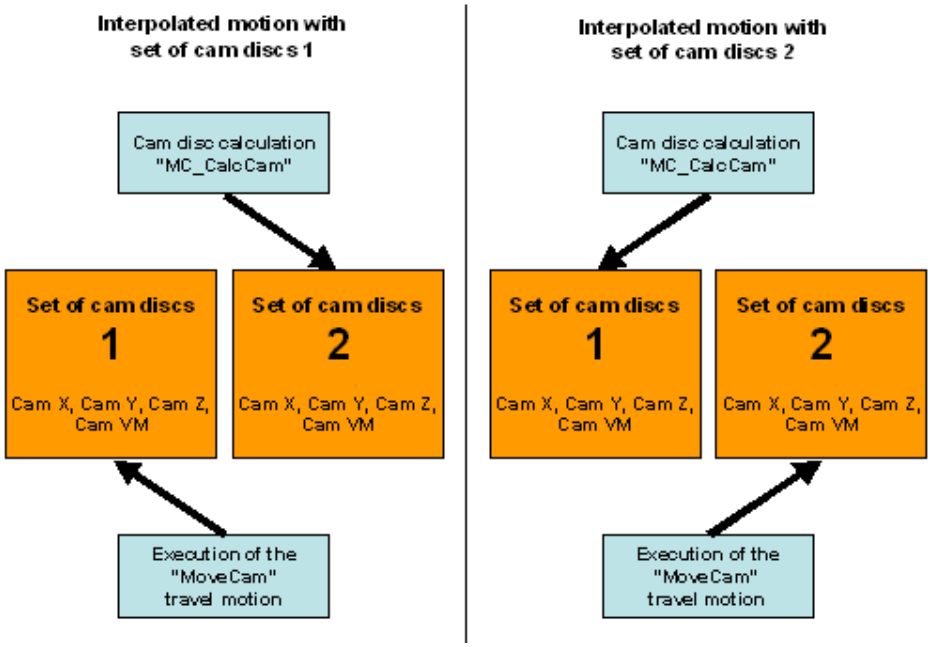
The use of two parallel sets of cam discs during generating interpolated motions is also used to increase the performance.

This offers the option of parallel execution of the individual functions of the template, such as cam disc generation by **FB 509 “MC_CalcCam”** and following the interpolated trajectory by **FB 508** “**MoveCam”**. If the

interpolated motion is executed using a set of cams, the other set of cams can already be prepared for the subsequent travel motion.

After completing the motion, the sets of cam discs are switched over and the respective other set of cam discs is calculated or moved.

Figure 8-1 Use of two sets of cam discs



This procedure is especially suitable for pick and place applications for the reduction of cycle times: While the motion to and from the position is executed with one set of cam discs, the set of cam discs for the next position can already be calculated.

Appendix and Literature

9 Warning and Error Messages

9.1 Signalling of warning and error events

9.1.1 Interfaces

If warnings or errors occur at the technology template, they are displayed at the block interface as follows:

- Output **Error**:
  This outputs is set in case of an error event. The cause of the error can be read at the outputs **ErrorID**, **ErrorSource** and **ErrorPoint**.
  If this output is not set, it is a warning and only a warning code is output at the outputs **ErrorID**, **ErrorSource** and **ErrorPoint**.
- Output **ErrorID**:
  Output of the error code associated to the error event or of a warning code.
- Output **ErrorSource**:
  More detailed specification of the warning or error code displayed at the ErrorID output for easier localization of the cause of the error.
- Output **ErrorPoint**:
  Display of the index of the incorrect point in the interpolation table if an error has occurred during cam disc generation.

9.1.2 Assignment of the warning and error codes at the ErrorID outpout

The warning and error codes displayed at the **ErrorID** output can be assigned as follows:

- Code **00**xx_{HEX}:
  Warning message of a **technology function** called in the technology template.
- Code **8**xxx_{HEX}:
  Error message of a **technology function** called in the technology template.
- Code **90**xx_{HEX}:
  Error in block **FB 509 "MC_CalcCam"** which was not caused by the use of a technology function.
- Code **9030**$_{HEX}$:
  Error in block **FB 508 "MoveCam"** which was not caused by the use of a technology function.

- Code **9031**$_{HEX}$:
  Error in block **FB 505 "Move3D"** which was not caused by the use of a technology function.

9.1.3 Assignment of the codes at the ErrorSource outpout

The codes displayed at the **ErrorSource** output can be assigned as follows:

- ErrorSource-Code **00**01$_{HEX}$ to **00**FF$_{HEX}$:
  The cause of the error is connected with the cam disc generation in block **FB 509 "MC_CalcCam"**.
- ErrorSource-Code **01**01$_{HEX}$ to **0A**FF$_{HEX}$:
  The cause of the error is connected with the interpolated motion in block **FB 508 "MoveCam"**.
- ErrorSource-**FF**01$_{HEX}$ to **FF**FF$_{HEX}$:
  The cause of the error is connected with the calling block **FB 505 "Move3D"**.

9.2 Error codes at the "ErrorID" output

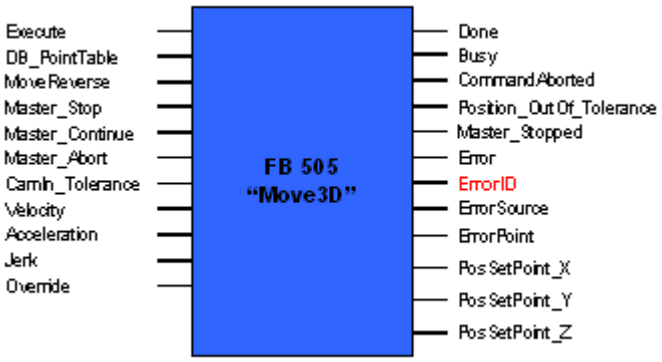


Table 9-1 Error codes at the "ErrorID" output

ErrorID [HEX]	Meaning	Note
0000	No error	
FB 509 "MC_CalcCam"		
9001	Invalid start or end index in the interpolation table for definition of the trajectory.	The following applies to start and end index: 1 ≤ start index ≤ end index ≤ 32
9002	The tolerance radius of an interpolation point is less than 0.	The index of the incorrect interpolation point can be read at the **ErrorPoint** output.

ErrorID [HEX]	Meaning	Note
9003	Two neighboring points of the interpolation table are identical or too close to each other.	The following has to apply to the distance between two points: Distance ≥ MinDist
9004	The tolerance ranges of two neighboring interpolation points touch or overlap.	This error can be avoided with the **autoCorrect** = *true* setting since the tolerance ranges are then automatically reduced.
9005	The DB number of one or several cam discs required for the cam disc generation was defined ≤ 0.	
9006	Minimum distance between points **MinDist** invalid.	The following has to apply to the **MinDist** parameter: **MinDist** > 0
9007	Maximum path velocity for interpolation invalid.	The following has to apply to the **vMaxMaster** parameter: **vMaxMaster** > 0
9008	Maximum acceleration for interpolation invalid.	The following has to apply to the **Acceleration** parameter: **Acceleration** > 0
9009	Internal error. The required dynamics limitation cannot be complied with.	The point in the interpolation table is affected of which the index can be read at the **ErrorPoint** output and its successor.
900A	The data block of the interpolation table is invalid.	The data block of the interpolation has to comply with the **UDT 509** template.
FB 508 "MoveCam"		
9030	Internal error of block FB 508	See error code at **ErrorSource** output for a detailed error analysis.
FB 505 "Move3D"		
9031	Internal error of block FB 505	See error code at **ErrorSource** output for a detailed error analysis.

9.3 Error codes at the “ErrorSource” output

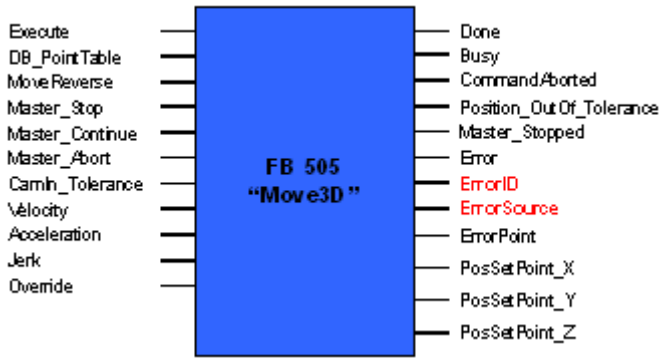


Table 9-2 Error codes at the “ErrorSource” output

ErrorSource [HEX]	Meaning	Note
0000	No error	
FB 509 “MC_CalcCam”		
0001	General error during clearing the cams from the cam discs	FB 581 “CamClear“
0002	Error during clearing the cam from cam disc **Cam X**.	FB 581 “CamClear“
0003	Error during clearing the error from cam disc **Cam Y**.	FB 581 “CamClear“
0004	Error during clearing the error from cam disc **Cam Z**.	FB 581 “CamClear“
0005	Error during clearing the cam from cam disc **Cam VM**.	FB 581 “CamClear“
0006	General error during inserting cam segments into the cam discs.	FB 583 “CamSectorAdd“
0007	Error during inserting cam segments into cam disc **Cam X**.	FB 583 “CamSectorAdd“
0008	Error during inserting cam segments into cam disc **Cam Y**.	FB 583 “CamSectorAdd“
0009	Error during inserting cam segments into cam disc **Cam Z**.	FB 583 “CamSectorAdd“
000A	Error during inserting cam segments into cam disc **Cam VM**.	FB 583 “CamSectorAdd“
000B	Error during interpolating the cam of cam disc **Cam X**.	FB 582 “CamInterpolate“
000C	Error during interpolating the cam of cam disc **Cam Y**.	FB 582 “CamInterpolate“
000D	Error during interpolating the cam of cam disc **Cam Z**.	FB 582 “CamInterpolate“
000E	Error during interpolating the cam of cam disc **Cam VM**.	FB 582 “CamInterpolate“

ErrorSource [HEX]	Meaning	Note
000F	Error during plausibility check or calculation of the cams.	
FB 508 "MoveCam" – Axis X		
0101	**Axis X** activated (DB number ≠ 0) but no cam disc **Cam X** defined for **Axis X**.	
0108	Error during disabling the cam disc synchronization of **Axis X**.	MC_Halt
0109	The technology function for disabling the cam disc of **Axis X** was replaced. (CommandAborted)	MC_Halt
010A	Error during interrupting the travel motion of **Axis X**.	MC_Halt
010B	The technology function for interrupting the travel motion of **Axis X** was replaced. (CommandAborted)	MC_Halt
010C	Error during stopping **Axis X**.	MC_Halt
010D	The technology function for stopping **Axis X** was replaced. (CommandAborted)	MC_Halt
FB 508 "MoveCam" – Axis Y		
0201	**Axis Y** activated (DB number ≠ 0) but no cam disc **Cam Y** defined for **Axis Y**.	
0208	Error during disabling the cam disc synchronization of **Axis Y**.	MC_Halt
0209	The technology function for disabling the cam disc synchronization of **Axis Y** was replaced. (CommandAborted)	MC_Halt
020A	Error during interrupting the travel motion of **Axis Y**.	MC_Halt
020B	The technology function for interrupting the travel motion of **Axis Y** was replaced. (CommandAborted)	MC_Halt
020C	Error during stopping **Axis Y**.	MC_Halt
020D	The technology function for stopping **Axis Y** was replaced. (CommandAborted)	MC_Halt
FB 508 "MoveCam" – Axis Z		
0301	**Axis Z** activated (DB number ≠ 0) but no cam disc **Cam Z** defined for **Axis Z**.	
0308	Error during disabling the cam disc synchronization of **Axis Z**.	MC_Halt

ErrorSource [HEX]	Meaning	Note
0309	The technology function for disabling the cam disc synchronization of **Axis Z** was replaced. (CommandAborted)	MC_Halt
030A	Error during interrupting the travel motion of **Axis Z**.	MC_Halt
030B	The technology function for interrupting the travel motion of **Axis Z** was replaced. (CommandAborted)	MC_Halt
030C	Error during stopping **Axis Z**.	MC_Halt
030D	The technology function for stopping **Axis Z** was replaced. (CommandAborted)	MC_Halt
FB 508 "MoveCam" – Axis VM		
0401	**Axis VM** activated (DB number ≠ 0) but no cam disc **Cam VM** defined for **Axis VM**.	
0404	Error during homing **Axis VM**.	MC_Home
0405	The technology function for homing **Axis VM** was replaced. (CommandAborted)	MC_Home
0408	Error during disabling the cam disc synchronization of **Axis VM**.	MC_Halt
0409	The technology function for disabling the cam disc synchronization of **Axis VM** was replaced. (CommandAborted)	MC_Halt
040A	Error during interrupting the travel motion of **Axis VM**.	MC_Halt
040B	The technology function for interrupting the travel motion of **Axis VM** was replaced. (CommandAborted)	MC_Halt
040C	Error during stopping **Axis VM**.	MC_Halt
040D	The technology function for stopping **Axis VM** was replaced. (CommandAborted)	MC_Halt
FB 508 "MoveCam" – Axis Master		
0501	**Axis Master** not activated (DB number = 0)	
0504	Error during homing **Axis Master**.	MC_Home
0505	The technology function for homing **Axis Master** was replaced. (CommandAborted)	MC_Home

ErrorSource [HEX]	Meaning	Note
0506	Error during moving **Axis Master**.	MC_MoveAbsolute
0507	The technology function for moving **Axis Master** was replaced. (CommandAborted)	MC_MoveAbsolute
050A	Error during interrupting the travel motion of **Axis Master**.	MC_Halt
050B	The technology function for interrupting the travel motion of **Axis Master** was replaced. (CommandAborted)	MC_Halt
050C	Error during stopping **Axis Master**.	MC_Halt
050D	The technology function for stopping **Axis Master** was replaced. (CommandAborted)	MC_Halt
FB 508 "MoveCam" – Cam X		
0604	Cam disc point in **Cam X** could not be determined.	MC_GetCamPoint
0605	**Cam X** is not interpolated and cannot be used.	
0606	Error during synchronizing cam disc **Cam X**.	MC_CamIn
0607	The technology function for synchronizing cam disc **Cam X** was replaced. (CommandAborted)	MC_CamIn
FB 508 "MoveCam" – Cam Y		
0704	Cam disc point in **Cam Y** could not be determined.	MC_GetCamPoint
0705	**Cam Y** is not interpolated and cannot be used.	
0706	Error during synchronizing cam disc **Cam Y**.	MC_CamIn
0707	The technology function for synchronizing cam disc **Cam Y** was replaced. (CommandAborted)	MC_CamIn
FB 508 "MoveCam" – Cam Z		
0804	Cam disc point in **Cam Z** could not be determined.	MC_GetCamPoint
0805	**Cam Z** is not interpolated and cannot be used.	
0806	Error during synchronizing cam disc **Cam Z**.	MC_CamIn

ErrorSource [HEX]	Meaning	Note
0807	The technology function for synchronizing cam disc **Cam Z** was replaced. (CommandAborted)	MC_CamIn
FB 508 "MoveCam" – Cam VM		
0904	Cam disc point in **Cam VM** could not be determined.	MC_GetCamPoint
0905	**Cam VM** is not interpolated and cannot be used.	
0906	Error during synchronizing cam disc **Cam VM**.	MC_CamIn
0907	The technology function for synchronizing cam disc **Cam VM** was replaced. (CommandAborted)	MC_CamIn
FB 508 "MoveCam" – general error		
0A01	**PathLength** parameter incorrect	The following has to apply: PathLength ≥ 0
0A02	**PathLenMaster** parameter incorrect	The following has to apply: PathLenMaster ≥ 0
0A03	Error during exponentiation (SQR) and root extraction (SQRT).	
FB 505 "Move3D"		
FF01	Error during writing the set override value for **Axis Master.**	MC_WriteParameter
FF11	Error during stopping **Axis Master**.	MC_Halt
FF12	The technology function for stopping **Axis Master** was replaced. (CommandAborted)	MC_Halt
FF13	Error during stopping **Axis VM**.	MC_Halt
FF14	The technology function for stopping **Axis VM** was replaced. (CommandAborted)	MC_Halt
FF15	Error during stopping **Axis X**.	MC_Halt
FF16	The technology function for stopping **Axis X** was replaced. (CommandAborted)	MC_Halt
FF17	Error during stopping **Axis Y**.	MC_Halt
FF18	The technology function for stopping **Axis Y** was replaced. (CommandAborted)	MC_Halt
FF19	Error during stopping **Axis Z**.	MC_Halt

ErrorSource [HEX]	Meaning	Note
FF1A	The technology function for stopping **Axis Z** was replaced. (CommandAborted)	MC_Halt

10 Test program for the Technology Template

10.1 Tasks of the test program

For the first tests prior to the integration of the technology template into a user program, a test program is available which offers the option to supply the interfaces of block **FB 505 "Move3D"** with values and consequently to extensively test the reactions and options of the template via an operator-friendly HMI. In addition, the input and output assignments of the blocks **FB 509 "MC_CalcCam"** and **FB 508 "MoveCam"** can be monitored and the current configuration of axes and cam discs can be visualized.

No real machine axes are required for the test program. The program is immediately runnable on a technology CPU and the required axes are simulated as virtual axes in the controller for the test.

Attention

The test program is used to familiarize with the principle of operation and the reactions of the technology template.

This program is not intended for use in real machines and consequently not released.

The test program is available as independent STEP 7 archive with all required technology objects and STEP 7 blocks.

10.2 Requirements for running the test program

To start up the test program, the following requirements have to be met:

- The STEP 7 project of the test program was correctly loaded to the technology CPU.
- The CPU is in RUN and no error message is present.
- The technology CPU and the programming device are connected via an MPI connection (with a transmission rate of 12 MBaud via a PROFIBUS line).
- WinCC flexible Runtime 2008 is installed and runnable.

Warning

Before changing the interface speed, check the maximum speed of your used CP or adapter.

If the maximum speed is not 12 Mbit/s and if you load the application to the CPU without prior changes, you can no longer access the CPU!

For this reason, it is required to set the baud rate of all MPI busses in the project to the maximum transmission rate possible before downloading the application.

10.3 HMI of the test program

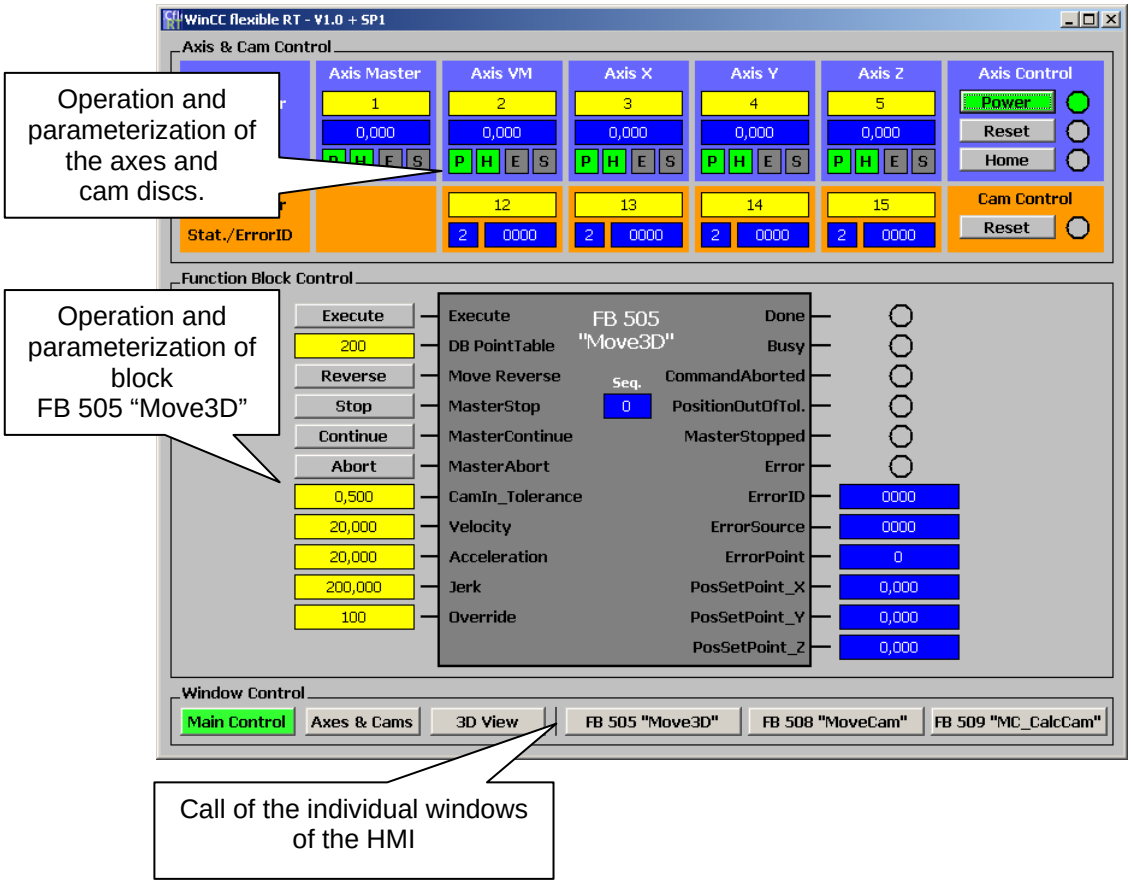
10.3.1 Overview

Via the HMI of the test program for the technology template, the functions listed below can be executed and tested in a convenient way:

- Setting up different axis and cam disc configurations.
- Releasing, resetting and homing the axes as well as resetting the cam discs.
- Parameterizing the function block **FB 505 "Move3D"**.
- Controlling the function block and influencing the travel motions of the axes via different block inputs.
- Monitoring the block reactions and block outputs.
- Checking the axis and cam disc configuration via a graphical display of the configuration image.
- Manual moving of the individual Cartesian axes via a JOG function.
- Monitoring the interpolated motions in a three-dimensional display of the current position.
- Monitoring the statuses and reactions of the other blocks contained in the technology template.

For these tests, different operator displays, in which the respective functions of the technology template can be activated via input boxes and buttons, are available on the HMI of the test program.

Figure 10-1 Test program “Main Control”



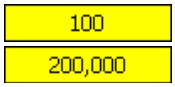
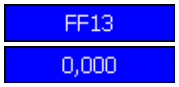
Display elements and output boxes display the current status of the output interface of block **FB 505 “Move3D”** and of the cam discs and axes involved in the interpolated motion.

10.3.2 General functions of the controls and display elements

The controls and display elements available on the HMI of the test program have the following meaning:

Table 10-1 Controls and display elements of the test program

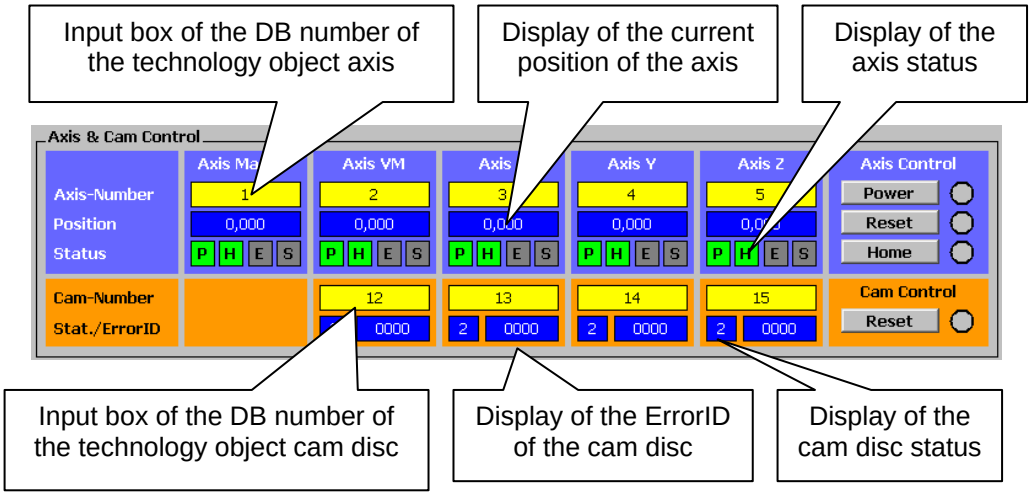
Element	Function	Description
Reverse Reverse	Setting and resetting boolean inputs.	The status of a boolean input is displayed by the color of the control. If the control is green, the input is set (True), otherwise the input is not set (False).

Element	Function	Description
	Status display for boolean outputs.	The status of a boolean output is displayed by the color of the control. Green or red signals that the bit is set (True). Gray indicates that the bit is not set (False).
	Input boxes	Parameter values can be entered in these boxes.
	Output boxes	Output values are displayed in these boxes.

10.3.3 Operation and parameterization of the axes and cam discs

Via the “Axis and Cam Control” section on the “Main Control” page of the HMI, the axes and cam discs involved in the interpolated motion can be parameterized and monitored.

Figure 10-2 Operation and parameterization of the axes and cam discs



Status axes

Via the status display of the axes, the following status can be read:

Table 10-2 Status display axes

Status display	Status	Note
P	Power	Pulse enable of the drive is active. In virtual axes, this display is always True!
H	Homed	The axis was homed.

Status display	Status	Note
E	Error	An error has occurred at the axis.
S	Synchronized	The axis is operated in synchronism as slave axis and synchronized to a master axis via a cam disc.

Status cam discs

Via the status display of the cam discs, the following statuses of the cam discs can be read:

Table 10-3 Status display cam discs

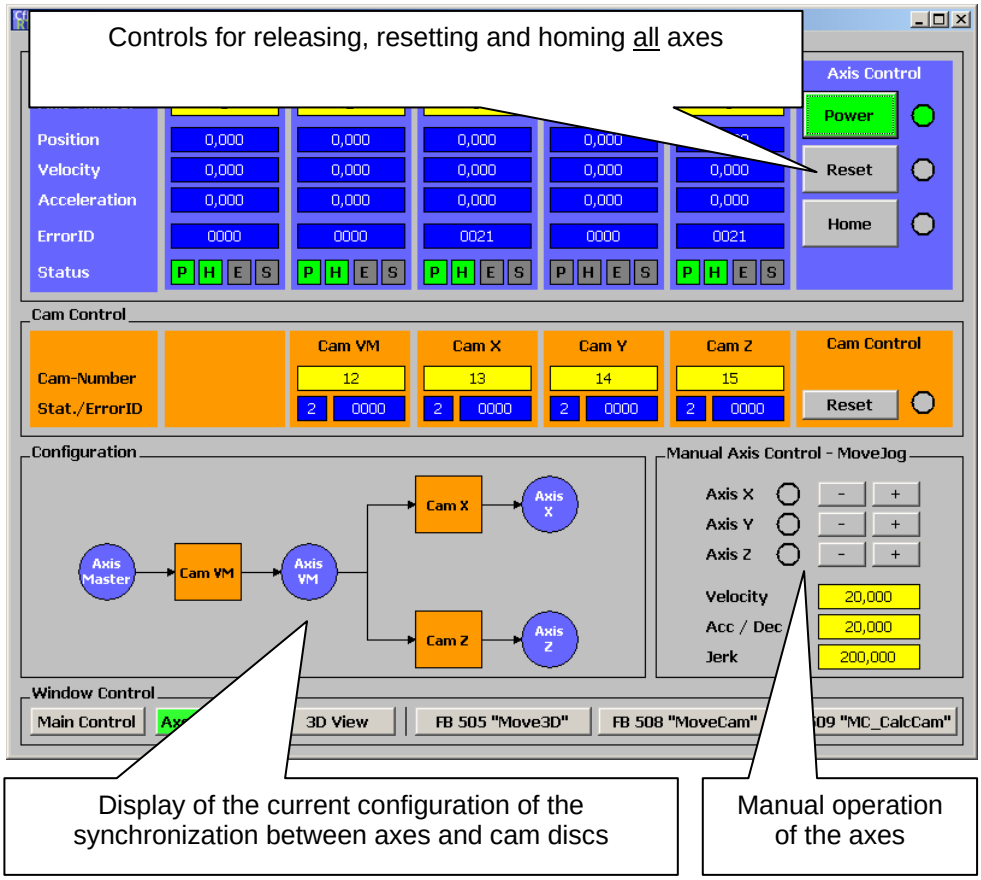
Status number	Status	Note
0	Cleared	The cam does not include points or segments.
1	Added Points / Segments	The cam does include points or segments.
2	Interpolated	The cam is interpolated and can be used for the cam disc synchronization.
3	Error	There is an error.

Configuration and synchronization the of axes and cam discs

In addition, the “Axes & Cams” page of the HMI is available for the comprehensive monitoring of the axes and cam discs and for the display of the current configuration.

On this page, the current position, velocity and acceleration can be read for each axis. Furthermore, the axes can be manually moved using the MoveJOG function.

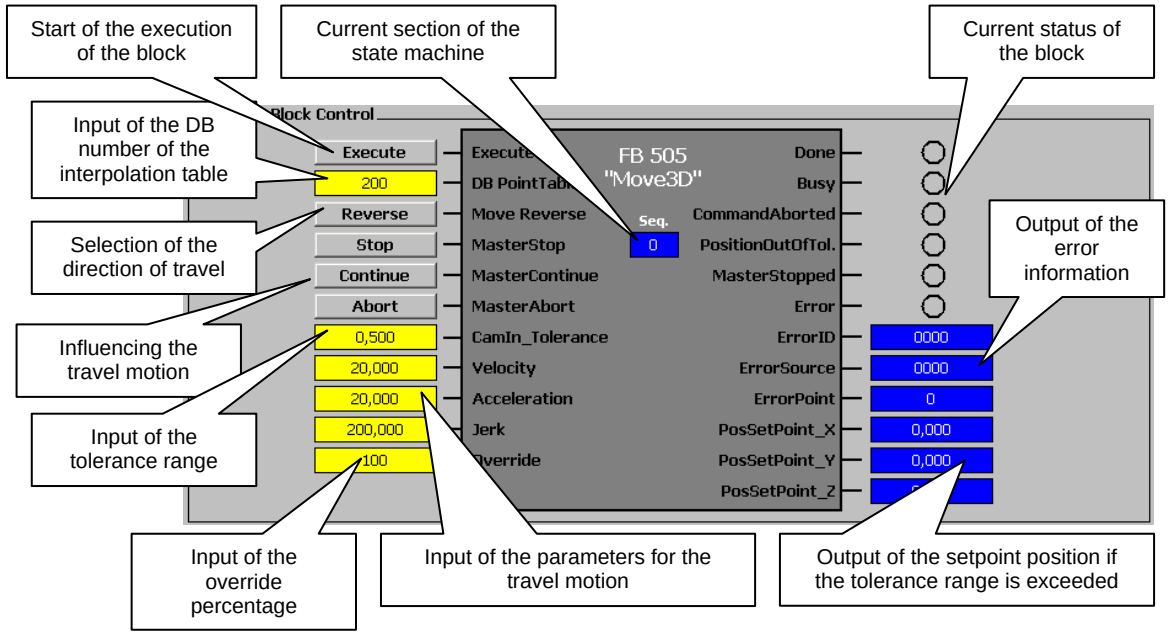
Figure 10-3 Test program “Axes & Cams”



10.3.4 Operation and parameterization of block FB 505 “Move3D”

The inputs and outputs of block **FB 505 “Move3D”** can be parameterized and monitored via the block symbol of the HMI of the test program.

Figure 10-4 Operation and parameterization of block FB 505 “Move3D”



10.3.5 Monitoring the three-dimensional motions (3D)

On the “3D View” page of the HMI, the interpolated motion of the axes by block **FB 505 “Move3D”** can be monitored during the motion.

The current position of the axes is output via a point in three-dimensional space at which additionally the values of the individual axis positions are recorded.

Figure 10-5 Display of the three-dimensional travel motion (3D)

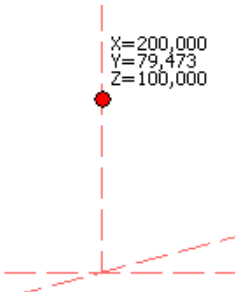
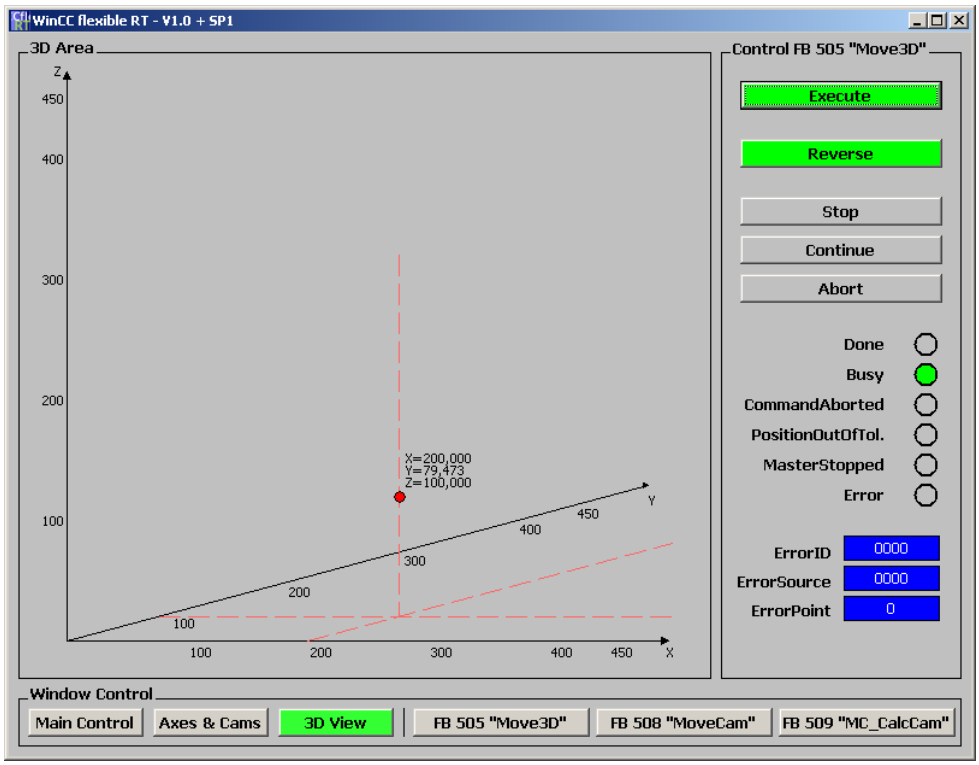


Figure 10-6 Test program “3D View”



On the right side, additionally the operating options and the status displays of **FB 505 “Move3D”** are available so that interpolated motions can directly be started, influenced and monitored.

10.3.6 Monitoring the blocks FB 505, FB 508 and FB 509

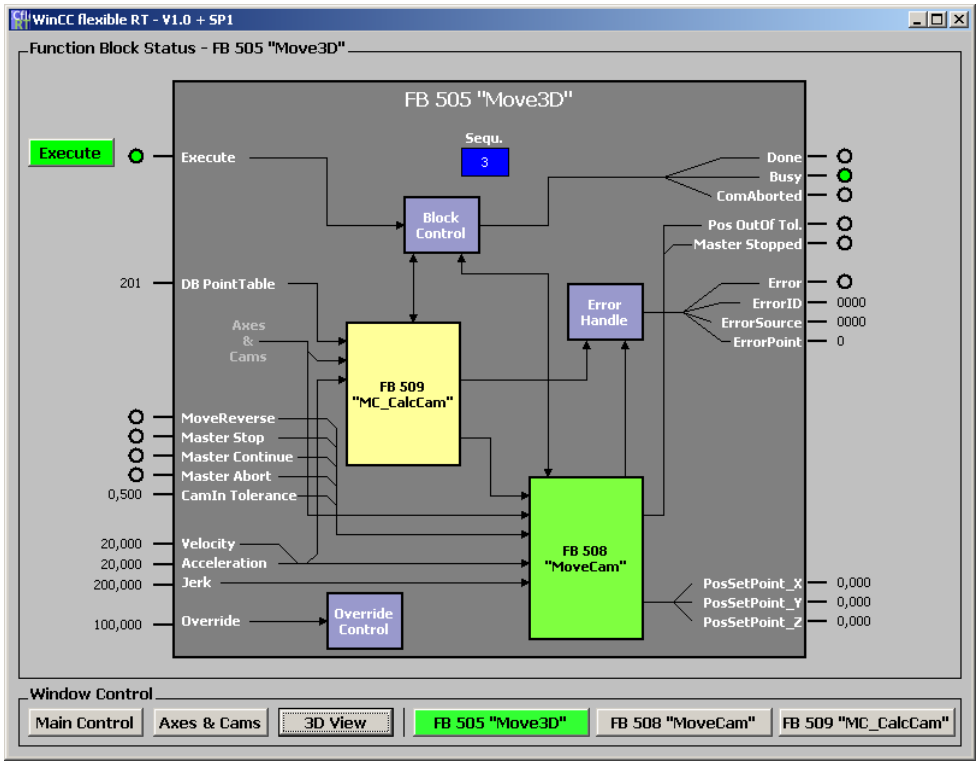
The blocks of the technology template **FB 505 “Move3D”**, **FB 508 “MoveCam”** and **FB 509 “MC_CalcCam”** can be monitored via individual pages of the HMI. Direct operation of the blocks is not possible. The blocks are addressed via the calling block **FB 505 “Move3D”** and the displayed status is only valid during the active execution of the block in **FB 505 “Move3D”**.

FB 505 “Move3D”

The assignment of the inputs and outputs of block **FB 505 “Move3D”** to the individual statuses of the block and to the subordinate blocks **FB 508 “MoveCam”** and **FB 509 “MC_CalcCam”** is displayed on this page.

In addition, this page displays the current state of the function block. The respective active function block of the block or the active subordinate block is displayed in green.

Figure 10-7 Test program “Move3D”



For operation of the block, only one button for setting and resetting the **Execute** input is available on this page so that status changes in the block can be monitored directly. Block **FB 505 “Move3D”** is to be parameterized on the “Main Control” page of the HMI.

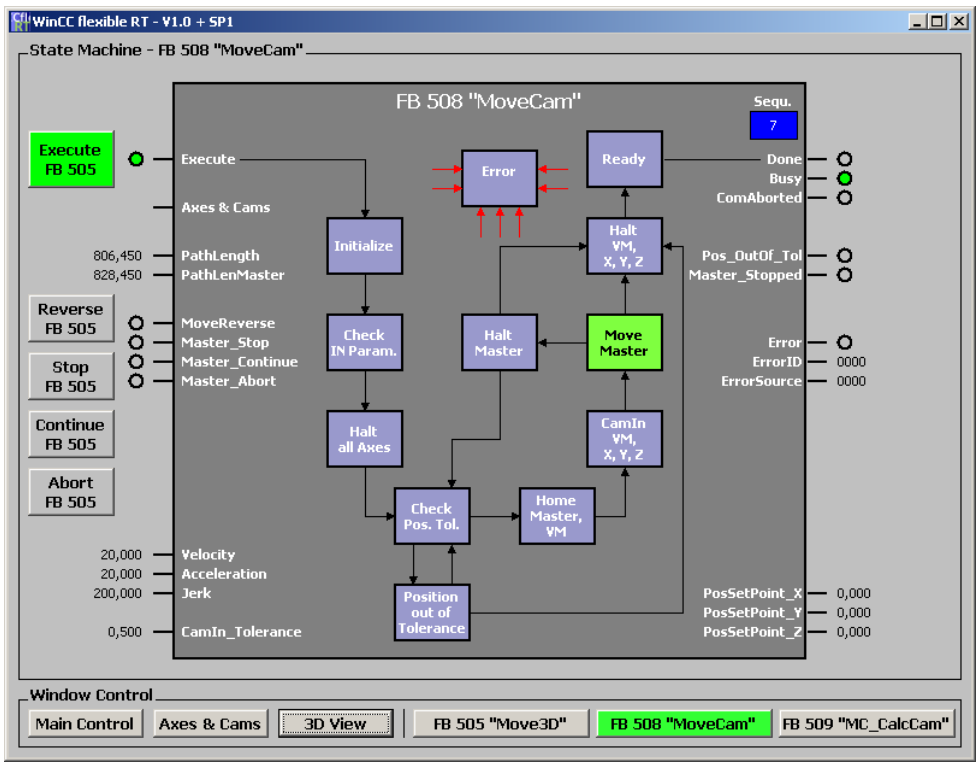
FB 508 “MoveCam”

This page displays the sequence of the individual function blocks of the state machine of block **FB 508 “MoveCam”**. The respective active status is displayed in green. However, the block is only active as long as it is controlled by the calling block **FB 505 “Move3D”**.

Direct control of the inputs of the block is not possible. But this page of the HMI includes buttons for control of the inputs of block **FB 505 “Move3D”** which affect block **FB 508 “MoveCam”**. This enables to influence the execution of the interpolated motion and to directly monitor the effects on the state machine of block **FB 508 “MoveCam”**.

This page of the HMI displays the respective current statuses and values of the other input and output parameters of the block. These values are to be parameterized on the “Main Control” page.

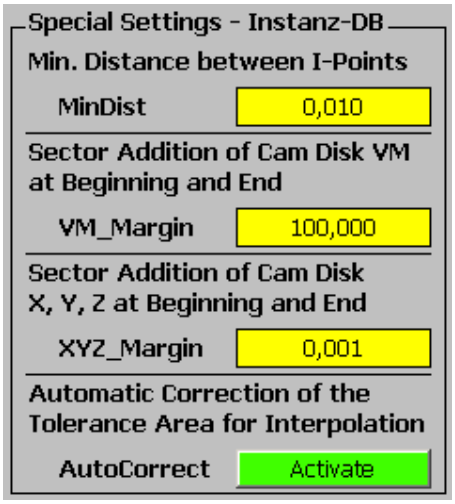
Figure 10-8 Test program “MoveCam”



FB 509 “MC_CalcCam”

This page displays the function principle of block **FB 509 “MC_CalcCam”** and the current status of the input and output parameters. In addition, the option exists to write special parameters in the instance DB of **FB 509 “MC_CalcCam”** which influence the cam disc generation by **FB 509 “MC_CalcCam”**.

Figure 10-9 Special settings of FB 509 “MC_CalcCam”



The special parameters of **FB 509 „MC_CalcCam“** for cam disc generation available here have the following function:

Table 10-4 Special settings of FB 509 “MC_CalcCam”

Parameter	Function	Note
MinDist	Minimum distance between two interpolation points.	If the distance between two interpolation points is less than the minimum distance, an error message is output at the block.
VM_Margin	Extension of cam disc **Cam VM**.	Start and end of cam disc **Cam VM** are extended by the value specified here to avoid requests of points outside the cam disc due to rounding errors of the master position.
XYZ_Margin	Extension of the cam discs **Cam X**, **Cam Y** and **Cam Z**.	Start and end of the cam discs **Cam X**, **Cam Y** and **Cam Z** are extended by the value specified here to avoid requests of points outside the cam disc due to rounding errors of the master position.
AutoCorrect	Automatic adaptation of the tolerance ranges of neighboring interpolation points.	If the tolerance ranges of two neighboring points defined in the interpolation table touch or overlap, an error message is output. If the **AutoCorrect** parameter is set, the overlapping tolerance ranges are automatically reduced so that the ranges no longer touch.

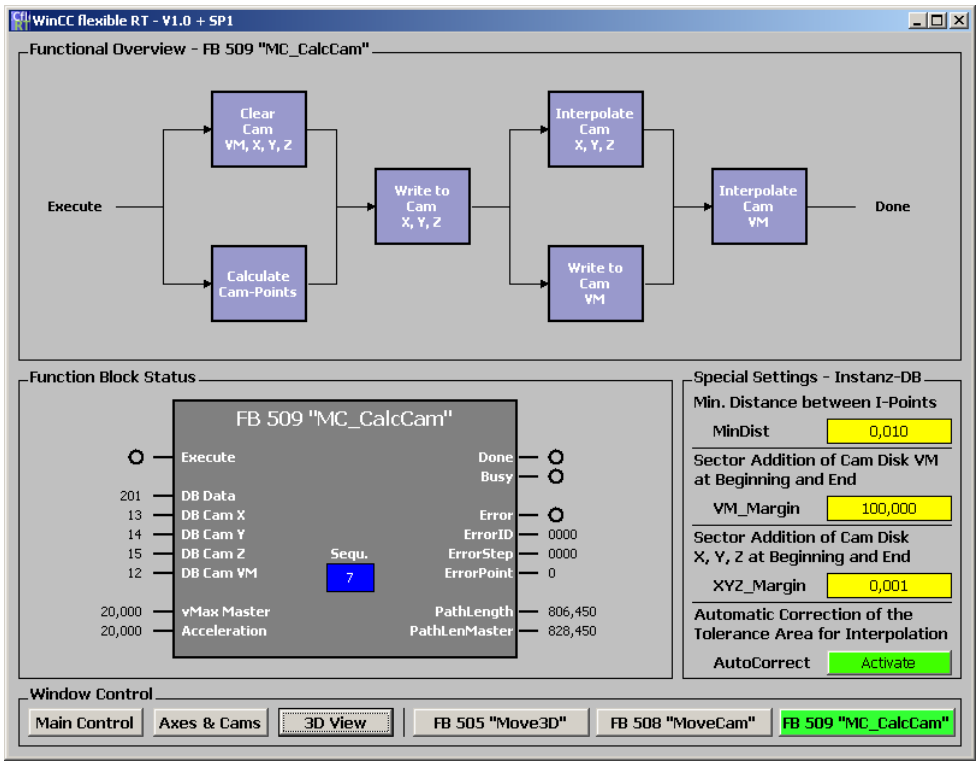
Direct control of block **FB 509 “MC_CalcCam”** is not available on this page.

Danger

If the value set for the “XYZ_Margin” parameter is too low, uncontrolled motions of the axes during synchronizing the axes may occur.

Check the synchronization behavior of the axes and select a suitable value for the “XYZ_Margin” parameter.

Figure 10-10 Test program “MC_CalcCam”



10.3.7 Technology objects available for the test program

The following technology objects (axes and cam discs) and interpolation tables have already been created for the test program, are available and can be used for the operation of the technology template.

Axes and cam discs

Table 10-5 Technology objects – axes and cam discs

Technology object	Function	Note
Axes		
DB 1 “Axis_Master”	Positioning axis	This axis can only be used as master.
DB 2 “Axis_VM”	Synchronization axis	Synchronization possible with all cam discs listed below.
DB 3 “Axis_X”	Synchronization axis	
DB 4 “Axis_Y”	Synchronization axis	
DB 5 “Axis_Z”	Synchronization axis	
Cam discs		
DB 12 “Cam_VM”	Cam disc	
DB 13 “Cam_X”	Cam disc	
DB 14 “Cam_Y”	Cam disc	
DB 15 “Cam_Z”	Cam disc	

Interpolation tables

The following interpolation tables are already included in the delivery for the test of the technology template:

- **DB 200 “PT_Interpol_1”**
  Interpolation table with 21 points which represents a simple line in three-dimensional space (3D).

Figure 10-11 Interpolation table in DB 200 “PT_Interpol_1”

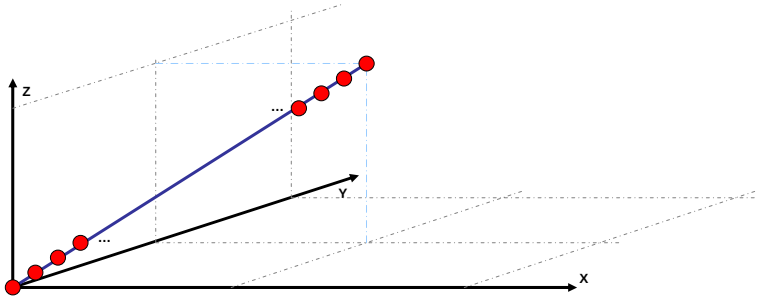


Table 10-6 Value table for interpolation table in DB 200 “PT_Interpol_1”

Interpolation point index	X	Y	Z	R
1	0.000	0.000	0.000	0.000
2	5.000	5.000	5.000	1.000
3	10.000	10.000	10.000	1.000
…	…	…	…	…
20	95.000	95.000	95.000	1.000
21	100.000	100.000	100.000	0.000

- **DB 201 “PT_Interpol_2”**
  Interpolation table with 5 points which represents a defined travel path in a three-dimensional space with defined tolerance ranges.

Figure 10-12 Interpolation table in DB 201 “PT_Interpol_2”

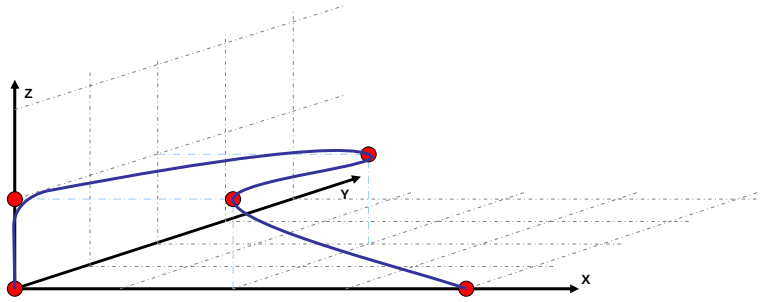
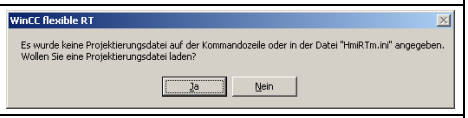
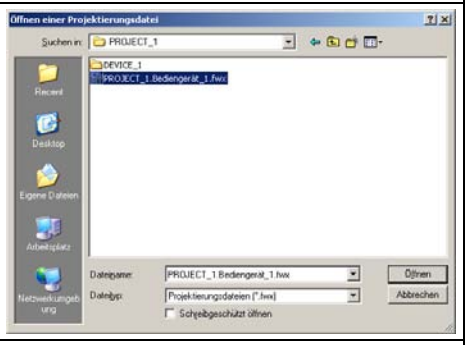
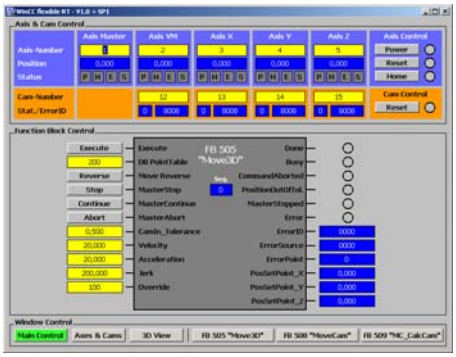


Table 10-7 Value table for interpolation table in DB 201 “PT_Interpol_2”

Interpolation point index	X	Y	Z	R
1	0.000	0.000	0.000	0.000
2	0.000	0.000	100.000	30.000
3	200.000	200.000	100.000	30.000
4	200.000	0.000	100.000	30.000
5	400.000	0.000	0.000	0.000

10.4 Starting the test program

Table 10-8 Starting the test program

No.	Instruction	Note
1	Start **WinCC flexible Runtime** via the Windows start bar.	
2	Answer the query whether you want to load the configuration file with **Yes**.	
3	In the **Project directory** of STEP 7, select the desired project and double-click the **HmiEs** directory. **Note:** The **S7Proj** standard project directory is located in the STEP 7 program directory.	
4	In the **PROJECT_1** directory, select the file **PROJECT_1.Bediengerät_1.fwx** and click the **Open** button.	
5	The HMI of the test program is opened in WinCC flexible Runtime and, if required, a connection to the technology CPU is immediately established provided that an active MPI connection to the CPU exists.	

Note

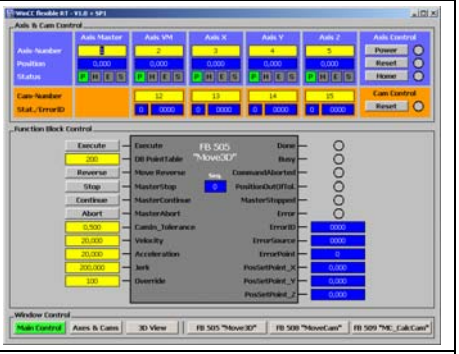
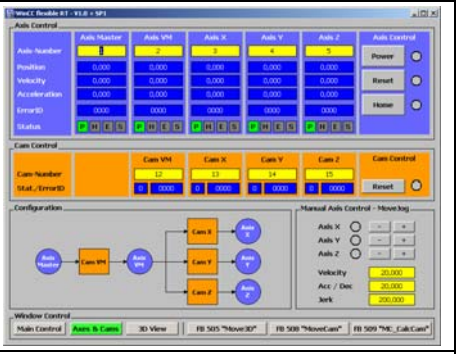
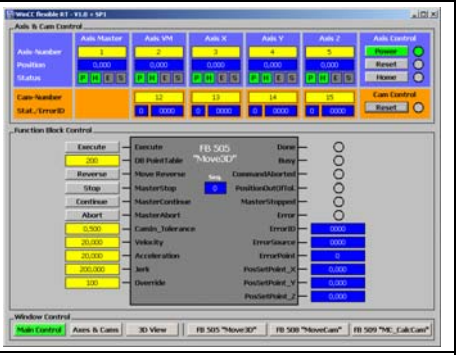
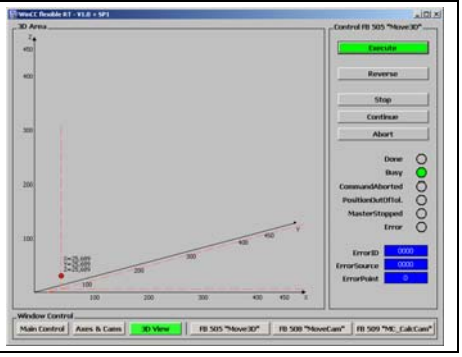
To avoid problems during operating the HMI and the connection to the technology CPU, the PG/PC interface for the MPI connection should be set to **AUTO** mode.

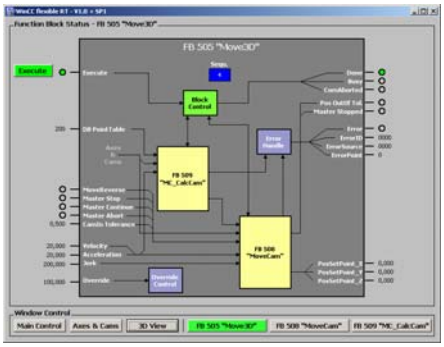
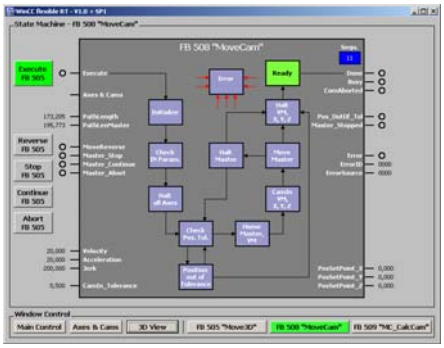
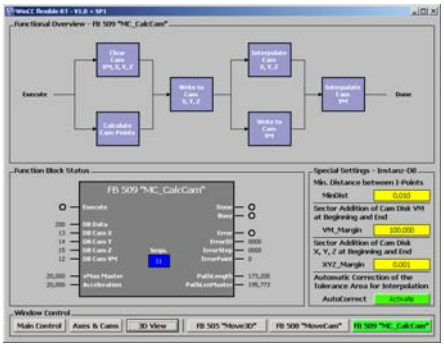
If an MPI adapter is used which is not suitable for a transmission rate of 12 Mbaud, the baud rate for the MPI connection has to be reduced in the STEP 7 project.

10.5 Operation of the test program

To test block **FB 505 “Move3D”** using the test program, proceed as follows:

Table 10-9 Operation of the test program

No.	Instruction	HMI
1	Load the test program to the controller and set the controller to RUN. Start the HMI using WinCC flexible Runtime.	
2	Check the current axis configuration on the “Axes & Cams” page and release the axes using the **Power** button. If necessary, reset all axes and cam discs using the **Reset** button. If required, home the axes using the **Home** button.	
3	Check the transfer parameters of block FB 505 “Move3D” on the “Main Control” page. Set the **Override** parameter to the value 100%.	
4	Open page “3D View” and start block FB 505 „Move3D“ using the **Execute** button. Monitor the travel motion in the “3D Area” section.	

5	Monitor the current status of block FB 505 “Move3D” on the respective page. You can restart the block using the **Execute** button. It may be required to additionally change the direction of travel using the **Reverse** button on the “Main Control” page or the axes have to be homed using the **Home** button.	
6	Monitor the current status of block FB 508 “MoveCam” on the respective page.	
7	Monitor the current status of FB 509 “MC_CalcCam” on the respective page or change the special settings of the block for cam disc generation.	

11 Literature

11.1 Bibliographic references

This list is by no means complete and only gives a selection of appropriate sources.

Table 11-1 Literature

	Topic	Title
/1/	STEP 7	Automating with STEP7 in STL and SCL Hans Berger Publicis MCD Verlag - 3rd edition 2005 ISBN 3-89578-243-2
/2/	STEP 7	SIMATIC – Programming with STEP 7 V5.4 Siemens Manual Edition 03/2006 MLFB: 6ES7810-4CA08-8BW0
/3/	STEP 7	SIMATIC – System Software for S7-300/400 System and Standard Functions Siemens Reference Manual Edition 03/2006 MLFB: 6ES7810-4CA08-8BW1
/4/	STEP 7	SIMATIC – Statement List (STL) for S7-300/400 Siemens Reference Manual Edition 03/2006 MLFB: 6ES7810-4CA08-8BW1
/5/	Technology CPU	SIMATIC – S7-300 CPU 31xT Siemens Manual Edition 03/2008 MLFB: A5E01672599-01
/6/	Technology CPU	SIMATIC – S7 Technology Siemens Manual Edition 03/2008 MLFB: A5E00251798-06

11.2 Internet links

This list is by no means complete and only gives a selection of appropriate sources.

Table 11-2 Internet links

	Topic	Title / link
\1\	Reference to the entry	http://support.automation.siemens.com/WW/view/en/21364022

	Topic	Title / link
\2\	Automation & Drives “Service & Support”	http://www.automation.siemens.com/support
\3\	“MoveJog” technology template	http://support.automation.siemens.com/WW/view/en/21365191
\4\	Manual Technology-CPU	http://www.automation.siemens.com/support Select „Product Support“ Open the following directories in the Product Information tree: • Automation systems • SIMATIC Industrial Automation Systems • PLC • SIMATIC S7 • S7-300/S7-300F • CPUs Click the **Manual** tab to open a list with related documents or click the following links: http://support.automation.siemens.com/WW/view/en/10805161/133300 S7-Technology: http://support.automation.siemens.com/WW/view/en/30119663 CPU-Data 317T-2 DP: http://support.automation.siemens.com/WW/view/en/21362915 CPU-Data 315T-2 DP: http://support.automation.siemens.com/WW/view/en/21362915

12 History

Table 12-1 History

Version	Date	Modification
V1.0	09/14/2005	First edition
V3.0	05/29/2006	Adaption of the Technology Template to the editions V2.0 and V3.0 of S7-Technology
V3.1	03/18/2008	Correction of the Override handling in the Technology Template
V4.1	09/30/2008	Adaption of the Technology Template to the edition V4.1 of S7-Technology
V4.11	03/04/2009	Removal of the UDT check from the function blocks of the Technology Template