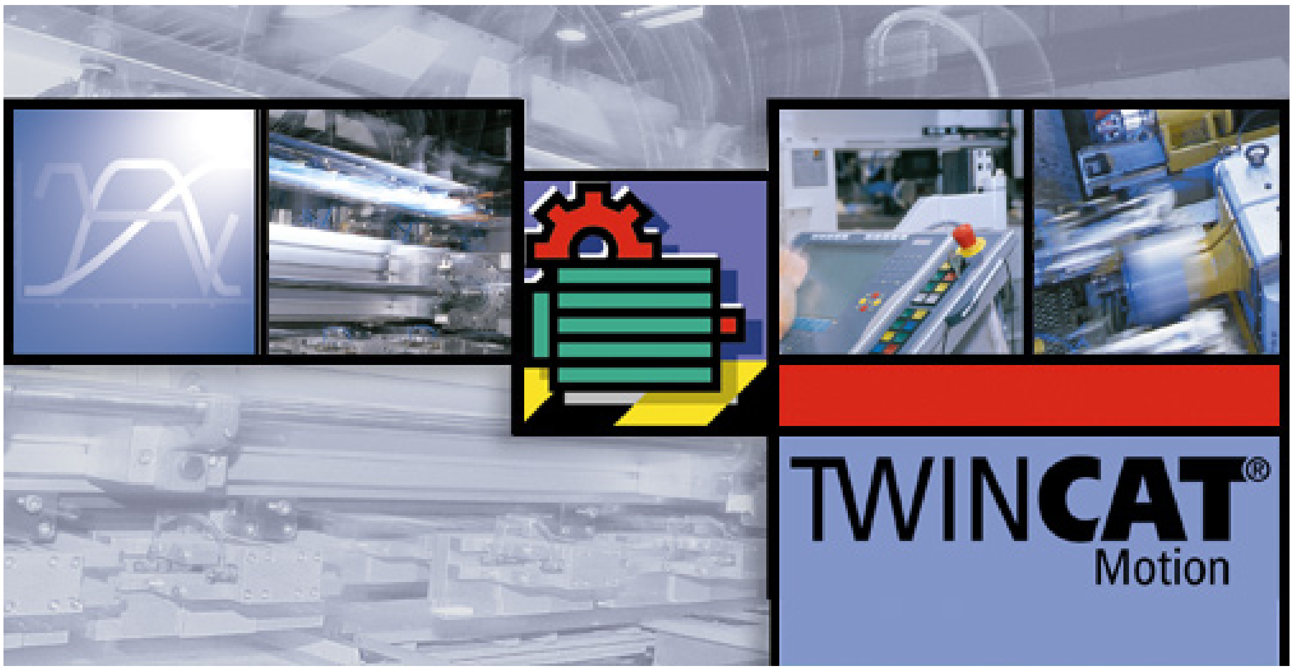

Manual

PLC Library Hydraulics

TwinCAT

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BECKHOFF

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1 Foreword

1.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

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

Personnel qualification

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

Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

⚠ **DANGER**	**Serious risk of injury!** Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.
⚠ **WARNING**	**Risk of injury!** Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.
⚠ **CAUTION**	**Personal injuries!** Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.
! **Attention**	**Damage to the environment or devices** Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.
i **Note**	**Tip or pointer** This symbol indicates information that contributes to better understanding.

2 Introduction to hydraulics

Hydraulics vs electromechanics: a technology comparison

Hydraulic drives differ from electric drives in that they have a fundamentally different design, so that their behavior is only comparable to a limited degree. This special behavior and the distinctly different fields of application require adapted control and monitoring mechanisms. The following table provides an overview of these differences.

The electromechanical axes controlled by TwinCAT NC/NCI/CNC typically consist of an AX servo drive and an AM synchronous motor with integrated position measuring system. The differences mainly relate to the design, since linear or asynchronous motors can also be traced back to this basic principle. The servo drive generates a rotating or moving magnetic field through the currents it controls, which is followed by the moving part of the motor. The strength, speed and angular/rotational speed difference of this magnetic field to the rotor is controlled in such a way that the desired movement is achieved. With appropriate design, a configuration is created that can be easily modeled. Since the basic structure is constant, this basically also applies to the model.

Hydraulic axes are a much more varied in terms of their design. In addition to the various variants of linear cylinders (plungers, synchronous, differential, area-switchable cylinders etc.), several rotary drives (swivel cylinders, rotary cylinders, various types of hydraulic motors) are available as actuators. The velocity can be defined through continuous valves or primary or secondary controlled pumps. In addition, there are various hydraulic circuits in which further components influencing the amount of oil or pressure are added. Most of these have a non-linear or situation-dependent behavior.

Ultimately, these differences mean that applications which can be achieved by a precisely defined and then precisely executed movement are nowadays largely realized electromechanically. The more complex, less standardized and difficult to handle hydraulic axes are used for tasks in which their particular strengths can be exploited. For example, they are ideally suited for applying large forces and energies over long periods or in applications where space is limited. In many cases, the behavior they are used to controlled is atypical for electromechanical drives, such as limiting or relieving pressure or force control. The plastics industry and metal forming are just two examples.

Overview of differences

The differences in design described above have a considerable effect on the operating behavior of hydraulic and electric drives. An overview of these effects is presented below.

- Typical natural frequencies of electromechanical axes are in the range >80 Hz. Values below 20 Hz are not uncommon for hydraulic axes. In both technologies, axes with >200 Hz can be realized, but for technical and/or calculation reasons they are only used when necessary. The natural frequency has a direct influence on controllability, since it limits the usable kP of the position controller. The controllability of electromechanical axes is a prerequisite for standard NCs.
- For hydraulic axes, differential cylinders with just one piston rod are preferred. This makes the feed constant (here defined as travel per oil quantity) direction-dependent. Standard NCs do not take this behavior into account, because there is no such effect with electromechanical axes.
- The asymmetrical working surfaces of a differential cylinder require an asymmetrical pressure distribution on the surfaces for a standstill in force equilibrium. If the axis starts in the opposite direction, a different pressure distribution must be established. For this purpose, an amount of oil has to be transported through the valves, which are initially only slightly opened, without any movement taking place. This leads to a delayed startup. A comparable but much fiercer phenomenon occurs if the axis has built up a pressing force beforehand. Standard NCs do not take this behavior into account, because there is no such effect with electromechanical axes.
- Hydraulic actuators rely on seals to separate their workspaces from each other and from ambient. These seals, which in some cases have long circumferential edges, are in contact with metal surfaces and must slide on them. Above all, the transition from standstill to movement is accompanied by pronounced changes in adhesion/sliding friction. The comparable effects with electromechanical axes are several orders of magnitude smaller and are usually negligible. In the case of hydraulic axes, they play a key role in determining the behavior on startup, when approaching the target and when moving at low speeds.

- Hydraulic axes use continuously adjustable valves or pumps as actuators. These components are always more or less non-linear. The system gain to be taken into account by the controller and the feed constant to be used by the pilot control are dependent on the operating point. Compromises in motion control can be reduced through linearization, but not completely avoided. Standard NCs do not take this behavior into account, because there is no such effect with electromechanical axes.
- A dead range around the zero point of several 10 % of full scale is not uncommon for valves. Even with linearization, position control at standstill is then only possible to a limited extent. Standard NCs do not take this behavior into account, because there is no such effect with electromechanical axes.
- The output value sent to the valve defines the slider position and thus, via a non-linear mechanical function, the openings for the oil flow. However, the pressure drop across the opening has a strong influence on the actual oil quantity and thus on the cylinder speed. Fluctuations in the supply pressure or cylinder pressure (resulting from the process force) have a strong influence on the axis velocity.
- It is not easily possible to use of an I component in the controller. In combination with the adhesion/ sliding friction changes, low-frequency oscillations can easily occur, which are difficult to control. The cylinder oscillates periodically around positions determined by the working cycle, resulting in damage to seals and surfaces in the medium term.

It may be possible to operate a hydraulic axis with a standard NC. The higher the quality of the component selection and configuration, the easier it is to do this. However, expectations regarding the behavior then offer little room for compromise. Conventional hydraulic axis configurations usually require adapted solutions, which are provided by Beckhoff Automation in the hydraulic library.

Motion Control in a different way

The key function of a Motion Control solution is the set value generator. It calculates or resolves instantaneous set values for position, velocity, acceleration and possibly jerk. The time-controlled mode of operation of the NC is well known in this context. However, there is an often overlooked alternative that is of particular interest for hydraulic axes. Its derivation and the differences are described below.

A set value generator can operate either as a function of or independently of the variables of another axis. The former is the case if the values for a cam plate coupling are derived from the values of another axis via a table or, in the case of a gear coupling, via a calculation formula. This requires a position controller that is active during the motion. Both the hydraulics library and, above all, the NC offer various options here.

If the values are calculated independently of other axes, a distinction must be made between time-based and displacement-based generation. Like practically all current MC systems, TwinCAT NC/NCI/CNC works on a time-controlled basis. The core technology of the hydraulic library is path-controlled, although here, too, time-controlled operation is possible. The differences are shown below.

A time-controlled Motion Control solution uses equations in which the motion profile runs on a time basis. This is shown below for an accelerated movement:

V := A * t

P := ½ * A * t^2

If the first equation is squared and then both equations are resolved to t^2 and equated, the following equation is obtained:

V := SQRT(2 * A * P)

If the absolute value of the remaining distance s to a target position is used for P and the sign is restored, a suitable braking ramp results.

V := ± SQRT(2 * A * ABS(s))

It should be noted that the time as the controlling variable has been replaced by the path. Combining this braking ramp with a ramp for the acceleration phase and a constant phase provides the basis for a simple but particularly robust Motion Control solution that is characterized by the following features:

- Delayed axis responses at the start of a motion are ignored. The valve is not initially opened excessively and without effect by a position controller, only to be controlled back down again to a standstill once the cylinder springs into action.

- No position control takes place even during the active motion. If the axis does not move at the correct velocity or at varying velocity, this is automatically compensated for by a premature or delayed initiation of the brake phase.
- Counter forces generated by the process slow down the axis. However, this inevitably leads to an increase in pressure even without a reaction from the control unit, possibly up to the supply pressure and thus to the maximum available force. If this is not sufficient for a further movement, it would not be affected by a controller either. Even without position control, there is no risk of the axis stopping.
- When approaching the target position, the velocity is adjusted according to the remaining distance. This adjustment happens continuously and thus compensates for inaccurate braking.
- Non-linearities are also compensated. However, they can appear as interfering irregularities in the acceleration. In this case, the behavior can be improved by a more precise linearization.
- The permanently active position controller, which is inevitable with the time-controlled principle, increases the tendency to oscillate and generates undesirable changes in the speeds. With electromechanical axes, this effect is less pronounced and can be tolerated. Hydraulic axes are subjected to considerably more excitation sources, and they have lower frequency and are less attenuated. The effect is distinct and often rather troublesome.
- The accuracy at the target does not depend on the method used. In the time-controlled "vertical" principle, a deviation of the axis behavior from the ideal is compensated by an added controller output. With the displacement-based principle, the reaction takes place by "horizontal" stretching or compressing of the profile.
- With the time-based principle, two axes that are operated with the same parameters and started simultaneously with the same commands will move as if they were mechanically connected. Both axes move at the right time in the right place and at the right velocity. The deviation is limited to the (typically small) lag errors and is not integrated.
- With the displacement-based principle, influences from the process or even manufacturing tolerances of the components are not compensated. Deviations are integrated within a movement. There is no definitive expectation of a link between two axes that are operated with the same parameters and started simultaneously with the same commands. They are positioned in the target with the achievable accuracy, but do not necessarily arrive there at exactly the same time.

Structure of the library

In contrast to the NC, the library functions work entirely in the PLC runtime. This has several consequences, which are listed below.

- Internal function blocks are usually also visible. This makes the online view less transparent. On the other hand, local variables can be used for an analysis.
- All parameters and even runtime variables are visible and accessible. This creates opportunities for specific manipulations. It should be obvious why this should be done with the utmost care.
- Nothing is done without a corresponding function block being called directly or indirectly. In contrast to the NC, the internal operation of the Motion Control is very transparent. This is particularly true for:
    - Loading and saving of parameters.
    - Recording of actual values.
    - Setpoint generator.
    - Regulation.
    - Output adjustment.
- In contrast to NC, there are no "finished" axes. This increases the initial effort, but also offers opportunities for realizing adapted properties.
- Since the axis is configured in the PLC application, it is easily possible that unexpected and difficult to comprehend effects are created by an incorrect sequence or combination of the called function blocks. It is highly advisable to follow the examples.
- Since the function blocks are called by the PLC, the Motion Control also works with the cycle time of the PLC task. A task with a typical NC cycle time of considerably less than 10 ms should be used.

In order to make the projects more transparent, the most important function blocks are implemented according to the PLCopen standards. Among other things, this standard specifies that the function blocks are linked to an axis via a reference named AxisRef. Since there is no hidden task level in the library, all data (parameters, runtime values) required for the axis are integrated in this structure. The communication of the function blocks of an axis is based on shared use of this reference. The only exceptions are the signals defined by PLCopen. The Execute input can be controlled by the Done output of another function block, for example, in order to create a desired sequence.

Structure of an application

In a PLC application realized with the hydraulics library, a distinction should be made between three different types of function block:

- System function blocks related to all axes. This includes communication with the PlcMcManager IBN tool or handling of message recording. Regardless of the number of axes, these function blocks must be instantiated exactly once per project and called up exactly once per cycle. This should obviously be done from the Main() routine of a program.
- Function blocks used for the configuration of an axis. These include, for example, the encoder function block and the set value generator etc. Exactly one instance of these function blocks must be created for each axis. The call should be made exactly once per cycle.
- Function blocks related to an axis. These include, for example, the MC_MoveAbsolute_BkPlcMc function block and the MC_Stop_BkPlcMc function block etc. More than one instance of these function blocks can be created for each axis. As a rule, the call must be made exactly once per cycle.

If the application has only one axis, this difference is less clear, but must still be considered.

System function blocks

The system function blocks include the following:

- MC_AxAdsCommServer_BkPlcMc()

This function block provides an joint ADS connection for the PlcMcManager for all axes. If this function block is not called cyclically, no connection is established.

- MC_AxRtLoggerSpool_BkPlcMc() or MC_AxRtLoggerDespool_BkPlcMc

This function block manages the message buffer. If exactly one of these function blocks is not called cyclically, the message buffer overflows, and subsequent messages are lost.

As you can see, the system function blocks require access to all affected structures. At the same time, the axis-related function blocks also require access. This can be easily ensured by creating the structures as VAR_GLOBAL. This is shown in the examples and applies especially to:

- The axis references. They should be created as ARRAY[1... number of axes] OF Axis_Ref_BkPlcMc.
    - This means that it is not possible to distribute the axis references in modules of the application.
    - There is an alternative method that works with POINTER lists. Special care is required in his case. This method is therefore not recommended for general use.
- The message buffer of type ST_TcPlcMcLogBuffer. The buffer is shared by all axes, and the management function block therefore cannot be assigned to an axis.

Function blocks for the structure of an axis

These always include:

- The initialization function block MC_AxUtiStandardInit_BkPlcMc().
- The function blocks of the actual value acquisition. These always include a function block of type MC_AxRtEncoder_BkPlcMc() and one or more function blocks for determining pressures or forces, as required. Filtering can be used, if necessary.
- A function block of type MC_AxRuntime_BkPlcMc() for setpoint generation. This function block contains a standard position controller.
- A function block of type MC_AxAxRtFinish_BkPlcMc() or MC_AxRtFinishLinear_BkPlcMc. Various output parameters are combined here, and a section-by-section or characteristic curve-controlled output linearization is carried out.
- A function block of type MC_AxRtDrive_BkPlcMc() that adapts to the I/O variables of the output hardware.

If necessary, this minimum structure must be supplemented by function blocks that give the axis additional capabilities. These include, for example, function blocks for controlling pressures or forces, as an alternative position controller or for automatic measurement of characteristic curves. To be effective, the calls of these function blocks must be inserted at the correct position between the above-mentioned function blocks.

The transparency of the application can be improved by combining these function blocks into an axis block with general interfaces.

Axis-related function blocks

These include the usual function blocks for configuring the working cycle of an axis.

- MC_Power_BkPlcMc
- MC_MoveAbsolute_BkPlcMc
- MC_Stop_BkPlcMc
- MC_Reset_BkPlcMc
- MC_Home_BkPlcMc
- MC_GearIn_BkPlcMc
- MC_GearOut_BkPlcMc
- etc.

Since the behavior of these function blocks corresponds to the PLCopen definitions, they can largely be used like the corresponding function blocks of the TC_MC libraries. However, the function blocks of these libraries only send commands to the NC driver and observe its reactions and feedback. Various function blocks of the hydraulic library contain essential parts of the functionality and must be called continuously and in every cycle. This must be taken into account when creating the application.

3 General structure

3.1 The hydraulics library

Special control algorithms are required to meet the requirements of the hydraulic systems. The PLC libraries TcPlcHydraulics_30 (for TC2) and TC2_Hydraulic (for TC3) contain a number of blocks and functions for hydraulic axes and the data types used in them. They extend support for this drive technology by enabling the operation of axes whose properties (limit frequency, scattering behavior) make them unsuitable for position control, or whose tasks differ from those of electrical servo axes.

The product presented here includes:

- the software library "TcPlcHydraulics.lib" or "Tc2_Hydraulics.compiled-library"
- the commissioning tool "PlcMcManager.exe"

To simplify the use of the library, the function blocks are designed based on specifications by the IEC61131 user organization (PLCopen) and certified accordingly.

NOTE! The documentation for version V2.1 will continue to be available.

Library topics:

- Evaluation of encoders [▶ 135]
- Evaluation of pressure cells
- Various filter functions
    - Pt1 filter
    - Moving average [▶ 191]
    - Rise limitation [▶ 190]
- Full access to internal parameters
- Motion control
- Controllers for
    - Pressure/force
    - Position
    - Velocity
    - Possibility of in-house controller development
- Synchronization of hydraulic and electric axes
- Adaptation of control values to output devices
- Full handling of complex devices

- Message logging
- Parameter handling
    - Storage and loading routines
    - Autosave
- Characteristic curve linearization
    - Section by section
    - Characteristic compensation curve [▸ 192]

The following motion controllers are supported:

1. Time-based motion control:
    - The controlling parameter for the profile generation is time.
    - The generator does not “know” the axis.
    - Only the pre-controlled position controller establishes the connection.
2. Displacement-based motion control:
    - The controlling parameter for the profile generation is the residual path.
    - The generator “knows” the axis.
    - During motion no position control is possible/required.
3. Dependent motion control:
    - The set values are calculated from the values of another axis, based on a mapping rule (gear formula, curve table).
    - The generator does not “know” the axis.
    - Only the pre-controlled position controller establishes the connection.

Displacement- and time-based motion control:

Time-based motion control uses time reference variable. The basic equations are

v=a*t and

s=0.5*a*t*t.

The set value generator provides a velocity and a position, which are evaluated by the position and velocity controller and offset against the current position.

During displacement-controlled positioning, in contrast to time-controlled the control value for the axis is calculated as a function of the residual path. Rearranging the above equations results in

v=sqrt(2*a*s).

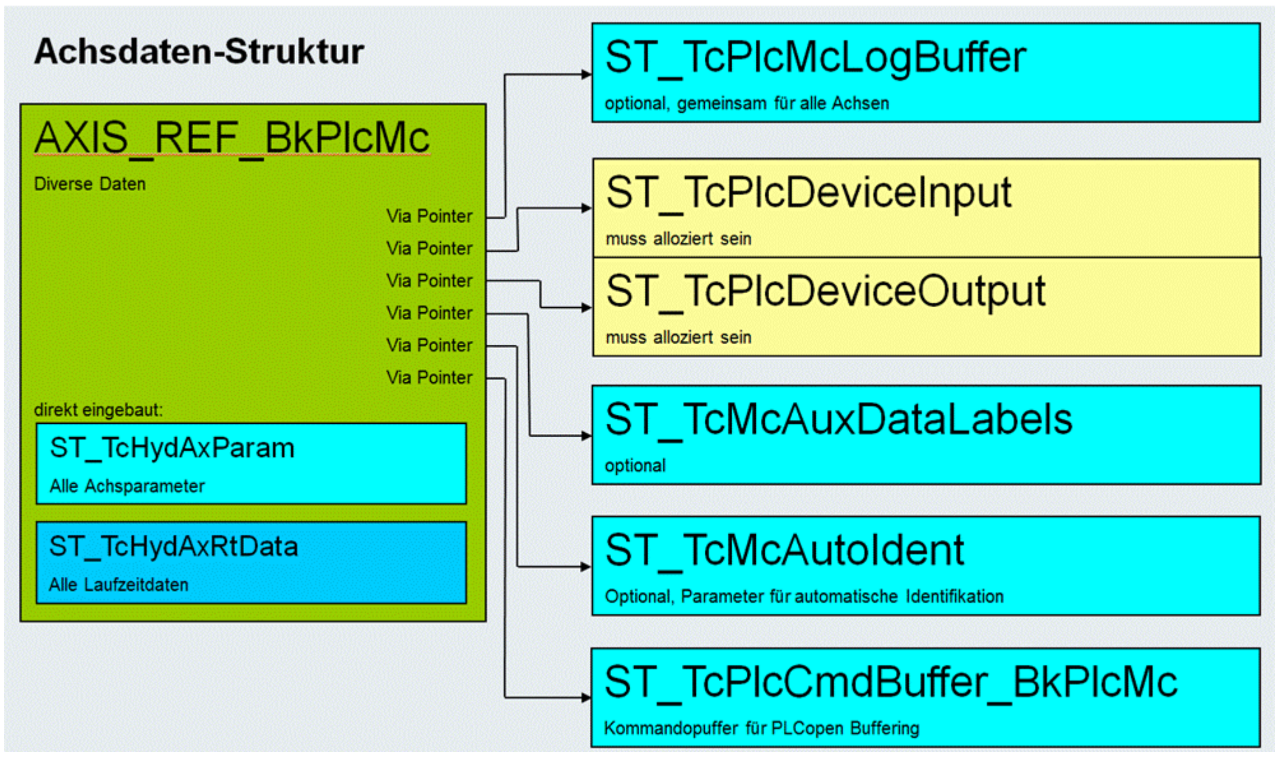
Both methods have advantages and disadvantages.

- Time-controlled require closed-loop control, particularly for acceleration and deceleration processes. The feedback is essential to enable the velocity controller to generate the correct output value. However, such a control loop reacts strongly to stick/slip effects or supply pressure fluctuations, which can cause the system to start oscillating.
- Displacement-controlled axes do not have to be operated in closed-loop control. This method is therefore significantly more robust against external interference.
- Since displacement-control of axes is based on the displacement, not on the time, a velocity is provided, but not readjusted. This makes the positioning of hydraulic axes very robust.

Both methods are supported by the hydraulics library and can also be used in combination.

3.2 Structure of the documentation

Each axis consists of an axis structure under the name "Axis_ref_BkPlcMc", which is composed of different external structures. This axis structure contains all the data (runtime data and parameter data) for this axis.



Certain function blocks have to be present in each application, to enable an axis to move. These function blocks include:

- MC_AxUtiStandardInit_BkPlcMc [▸ 182]**:** Initialization and monitoring of the different axis components. Such an FB should be called cyclically. Blocks such as **MC_Power_BkPlcMc,** etc. may only be called after successful initialization.
- MC_Power_BkPlcMc [▸ 26]**:** The function block is used to control an external actuator. The function block issues release notifications to valve output stages or frequency converters, for example.
- MC_AxStandardBody_BkPlcMc [▸ 181]**:** In each case the function block calls a function block of type
  MC_AxRtEncoder_BkPlcMc [▸ 135]: Determination of the actual position of the axis from the input information of a hardware module.
  MC_AxRuntime_BkPlcMc [▸ 167]: Deals with profile generation.
  MC_AxRtFinish_BkPlcMc [▸ 175]: Adaptation of the control value to the special characteristics of the axis (characteristic curve linearization)
  MC_AxRtDrive_BkPlcMc [▸ 125]: The function block performs preparation of the control value for the axis for it to be output on a hardware module.
- MC_AxAdsCommServer_BkPlcMc [▸ 198]**:** Establishes the connection to PlcMcManager and monitors it. This block must be called independent of the initialization, in order to enable commissioning without existing parameters.

Optional useful function blocks are:

- MC_AxRtLoggerSpool_BkPlcMc [▸ 187]**:** The function block prevents overflowing of the LogBuffer of the library.
- MC_AxParamDelayedSave_BkPlcMc**:** Performs an auto-save of the axis parameters.

The so-called "PlcMcManager" is provided for commissioning. This tool consolidates setting parameters and is intended to facilitated commissioning of the system.

The first example is intended to illustrate the "first steps".

Function groups	Description
Management functions [▶ 19]	Functions for management and monitoring of axes, parameter access and states.
Single axis motion functions [▶ 19]	Triggering and monitoring of active movements for individual axes.
Axis group motion functions [▶ 20]	Triggering and monitoring of active movements for axis groups.
Drive adjustments [▶ 20]	Function blocks for preparing axis control values for output on output devices (terminals, actuators etc.) in the periphery.
Encoder adjustments [▶ 20]	Function blocks for evaluating actual position data, which were read by input devices (terminals, encoders etc.) in the periphery.
Parameter handling [▶ 21]	Function blocks for saving, reading and communicating parameters.
Motion generators [▶ 20]	Control value generators for active axis movements
Controller [▶ 21]	Controllers for various state variables: position, velocity, pressure.
Table functions [▶ 22]	Table functions for non-linear mappings and cam plates
Message logging [▶ 22]	Message recording.
Runtime functions [▶ 23]	Various runtime functions.
Data types	Enumerations [▶ 24] and structures [▶ 25] used in the library

3.3 Functions, function blocks and types (from V3.0)

NOTE! All the functions, function blocks and data types present in the library are listed here.
You will find answers to frequently asked questions and notes on the use of the library, setting up, problem analysis and example projects in the Knowledge Base [▶ 218].

Some of the components listed here are not intended to be used by an application. Their presence, interface and behavior is therefore not guaranteed. Because, however, a TwinCAT PLC library is strictly open, it is not possible to hide these internal components. It is, nevertheless, essential to avoid calling these components, identified with (internal use only) or (not recommended), directly from an application. If one of these components would, in practice, be useful for you, please make contact with our Support Department. We will then examine the possibility of making the function block available to you, independently of the library, and for you to then take the responsibility for using it.

If the library contains function blocks, types or constants that are not listed in the documentation, then these are elements that have not yet been approved, and are the subject of current software maintenance and development work. These elements must never be directly used in an application, because they are, as a general rule, not yet tested.

NOTE! The hydraulic library only offers a restricted range of functions, even in connection with electrical drives. TwinCAT NC PTP, NC I and CNC offer a significantly broader spectrum and more comprehensive support for commissioning and diagnosis.

NOTE! A number of libraries are available, which deal with a typical axis configuration or special functionalities. These libraries require the TcPlcHydraulics library and have to be ordered separately.

Name	Description
TcPlcLibHydraulics_30_2R2Vgantry.LIB	in preparation
TcPlcLibHydraulics_30_4R3Vgantry.LIB	in preparation

PLC open Motion Control

The function blocks listed here are oriented towards:

Technical Specification

PLCopen - Technical Committee 2 - Task Force

Function blocks for motion control

Part 1 Version 1.1 and Part 2 Version 0.99F (definition not yet finalized)

The names of these function blocks begin with MC_ and end with _BkPlcMc.

NOTE! Parts of the PLCopen definitions have not yet been finalized. Future versions of the library may be subject to modifications.
Such modifications may relate to

- Names, behavior or even existence of functions, function blocks or derived data types
- Names, behavior, types or existence of input or output signals

Administrative Function blocks

Name	Description
MC_CamTableSelect_BkPlcMc [▸ 46]	The function block initializes a variable of type ST_TcPlcMcCamId, thereby preparing a cam plate for the coupling of two axes.
MC_Power_BkPlcMc [▸ 26]	Function block to control an external actuator.
MC_ReadActualPosition_BkPlcMc [▸ 28]	The actual position of an axis is determined.
MC_ReadActualTorque_BkPlcMc [▸ 29]	The actual force or the actual pressure of an axis is determined.
MC_ReadActualVelocity_BkPlcMc [▸ 30]	The actual velocity of an axis is determined.
MC_ReadAxisError_BkPlcMc [▸ 30]	The current error code of an axis is found.
MC_ReadBoolParameter_BkPlcMc [▸ 31]	The boolean parameters of an axis are read.
MC_ReadDigitalOutput_BkPlcMc [▸ 32]	The current state of a digital output of a cam controller is determined.
MC_ReadParameter_BkPlcMc [▸ 33]	The non-boolean parameters of an axis are read.
MC_ReadStatus_BkPlcMc [▸ 34]	The state of the axis is decoded.
MC_Reset_BkPlcMc [▸ 36]	The axis is placed in a state ready for operation.
MC_ResetAndStop_BkPlcMc [▸ 36]	The axis is placed in a state ready for operation and is stationary.
MC_SetOverride_BkPlcMc [▸ 37]	The axis override is set.
MC_SetPosition_BkPlcMc [▸ 39]	The actual position of the axis is set.
MC_SetReferenceFlag_BkPlcMc [▸ 40]	The referencing flag of the axis is defined. (Function is not defined by PLCopen)
MC_WriteBoolParameter_BkPlcMc [▸ 41]	The boolean parameters of an axis are written.
MC_WriteDigitalOutput_BkPlcMc [▸ 42]	The current state of a digital output of a cam controller is defined.
MC_WriteParameter_BkPlcMc [▸ 43]	The non-boolean parameters of an axis are written.

Motion Function blocks, Single Axis

Name	Description
MC_DigitalCamSwitch_BkPlcMc [▸ 48]	Generation of software cams as a function of position, direction of travel and velocity of an axis.
MC_EmergencyStop_BkPlcMc [▸ 50]	Stopping a movement without reaching the target position. (Function is not defined by PLCopen)
MC_Halt_BkPlcMc [▸ 56]	Stopping a movement without reaching the target position.
MC_Home_BkPlcMc [▸ 57]	Initiation and monitoring of a reference travel.
MC_ImediateStop_BkPlcMc [▸ 59]	Stopping a movement without reaching the target position. (Function is not defined by PLCopen)
MC_MoveAbsolute_BkPlcMc [▸ 60]	Start and monitoring of a positioning process at a specifiable velocity to absolutely stated target co-ordinates.
MC_MoveJoySticked_BkPlcMc [▸ 62]	Starting and controlling of an axis movement with a proportional control unit. (Function is not defined by PLCopen)
MC_MoveRelative_BkPlcMc [▸ 63]	Start and monitoring of a positioning process at a specifiable velocity over an absolutely stated distance.
MC_MoveVelocity_BkPlcMc [▸ 64]	Start and monitoring of a positioning process at a specifiable velocity but with no specified target.
MC_Stop_BkPlcMc [▸ 66]	Stopping a movement without reaching the target position.

Motion Function blocks, Multiple Axis

Name	Description
MC_CamIn_BkPlcMc [▸ 44]	The function block starts and monitors a cam plates coupling between two axes.
MC_CamOut_BkPlcMc [▸ 45]	The function block releases a cam plate coupling between two axes.
MC_GearIn_BkPlcMc [▸ 51]	Start and monitoring of the gear coupling of two axes.
MC_GearInPos_BkPlcMc [▸ 53]	On-the-fly gear coupling of two axes.
MC_GearOut_BkPlcMc [▸ 55]	Cancelling the gear coupling of two axes.

System Function blocks

Name	Description
MC_AxRtDrive_BkPlcMc [▸ 125]	Preparation of the control value of the axis for output on a hardware module, mapping information.
MC_AxRtEncoder_BkPlcMc [▸ 135]	Determination of the actual position of the axis from the input information of a hardware module, mapping information.
MC_AxRtFinish_BkPlcMc [▸ 175]	Adaptation of the generated control value to the special features of the axis.
MC_AxRtFinishLinear_BkPlcMc [▸ 176]	Adjustment of the generated control value to the special features of the axis, taking into account a characteristic curve.
MC_AxRuntime_BkPlcMc [▸ 167]	Control value generation for the axis.

System function blocks, other actual values

Name	Description
MC_AxRtReadForceDiff_BkPlcMc [▸ 152]	Determination of the differential actual force of an axis.
MC_AxRtReadForceSingle_BkPlcMc [▸ 154]	Determination of the one-sided actual force of an axis.
MC_AxRtReadPressureDiff_BkPlcMc [▸ 156]	Determination of the differential actual pressure of an axis.
MC_AxRtReadPressureSingle_BkPlcMc [▸ 158]	Determination of the one-sided actual pressure of an axis.

System Function blocks, Parameter

Name	Description
MC_AxAdsCommServer_BkPlcMc [▶ 198]	The application is given the capacity to function as an ADS server.
MC_AxAdsReadDecoder_BkPlcMc [▶ 200]	The function block decodes ADS read accesses for an ADS server.
MC_AxAdsWriteDecoder_BkPlcMc [▶ 201]	The function block decodes ADS write accesses for an ADS server.
MC_AxAdsPtrArrCommServer_BkPlcMc [▶ 199]	The application is given the capacity to function as an ADS server.
MC_AxParamAuxLabelsLoad_BkPlcMc [▶ 202]	Loading the label texts for the client-specific axis parameters from a file.
MC_AxParamLoad_BkPlcMc [▶ 203]	Load the parameters for an axis from a file.
MC_AxParamSave_BkPlcMc [▶ 204]	Write the parameters for an axis into a file.
MC_AxUtiReadCoeDriveTerm_BkPlcMc [▶ 204]	Reading the contents of a register from the EL terminal, which is used as drive interface for the axis.
MC_AxUtiReadCoeEncTerm_BkPlcMc [▶ 206]	Reading the contents of a register from the EL terminal, which is used as encoder interface for the axis.
MC_AxUtiReadRegDriveTerm_BkPlcMc [▶ 207]	Reading the contents of a register from the KL terminal, which is used as drive interface for the axis.
MC_AxUtiReadRegEncTerm_BkPlcMc [▶ 208]	Reading the contents of a register from the KL terminal, which is used as encoder interface for the axis.
MC_AxUtiUpdateRegDriveTerm_BkPlcMc [▶ 209]	Writing a parameter set into the register of a KL terminal, which is used as drive interface for the axis.
MC_AxUtiUpdateRegEncTerm_BkPlcMc [▶ 211]	Writing a parameter set into the register of a KL terminal, which is used as encoder interface for the axis.
MC_AxUtiWriteCoeDriveTerm_BkPlcMc [▶ 212]	Writing the contents of a register into the EL terminal, which is used as drive interface for the axis.
MC_AxUtiWriteCoeEncTerm_BkPlcMc [▶ 213]	Writing the contents of a register into the EL terminal, which is used as encoder interface for the axis.
MC_AxUtiWriteRegDriveTerm_BkPlcMc [▶ 215]	Writing the contents of a register into the KL terminal, which is used as drive interface for the axis.
MC_AxUtiWriteRegEncTerm_BkPlcMc [▶ 216]	Writing the contents of a register into the KL terminal, which is used as encoder interface for the axis.
MC_LinTableExportToAsciFile_BkPlcMc	in preparation
MC_LinTableExportToBinFile_BkPlcMc	in preparation
MC_LinTableImportFromAsciFile_BkPlcMc	in preparation
MC_LinTableImportFromBinFile_BkPlcMc	in preparation

System Function blocks, Controllers

Name	Description
MC_AxCtrlAutoZero_BkPlcMc [▶ 109]	Automatic zero balance.
MC_AxCtrlPressure_BkPlcMc [▶ 115]	Controller for pressure build-up control.
MC_AxCtrlPressureCompensation_BkPlcMc	Adjustment of the output values of an axis to the valve pressure drop.
MC_AxCtrlPullbackOnPressure_BkPlcMc	Controller for pressure displacement control.
MC_AxCtrlSlowDownOnPressure_BkPlcMc [▶ 119]	Controller for pressure relief control.
MC_AxCtrlStepperDeStall_BkPlcMc [▶ 121]	Monitoring the movement of a stepper motor axis.
MC_AxCtrlVelocity_BkPlcMc	Controller for the axis velocity.
MC_AxCtrlVeloMoving_BkPlcMc	Controller for the axis velocity.

System Function blocks, TableFunctions

Name	Description
MC_AxTableFromAsciFile_BkPlcMc [▸ 166]	Reading the content of table from a text file.
MC_AxTableFromBinFile_BkPlcMc [▸ 165]	Reading the content of table from a binary file.
MC_AxTableReadOutNonCyclic_BkPlcMc [▸ 164]	Function block for determining the slave values assigned to a master value with the aid of a table.
MC_AxTableToAsciFile_BkPlcMc [▸ 162]	Writing the contents of a table to text file.
MC_AxTableToBinFile_BkPlcMc [▸ 161]	Writing the contents of a table to a binary file.

System Function blocks, Message Logging

Name	Description
MC_AxRtLogAxisEntry_BkPlcMc [▸ 184]	An axis-related message is entered in the LogBuffer of the library.
MC_AxRtLogClear_BkPlcMc [▸ 185]	Clear and initialize all entries in the LogBuffer.
MC_AxRtLogEntry_BkPlcMc [▸ 185]	A message is entered in the LogBuffer of the library.
MC_AxRtLoggerDespool_BkPlcMc [▸ 186]	Ensure the minimum number of free messages in the LogBuffer of the library.
MC_AxRtLoggerRead_BkPlcMc [▸ 186]	Reading a message from the LogBuffer of the library.
MC_AxRtLoggerSpool_BkPlcMc [▸ 187]	Transferring messages from the LogBuffer of the library into the Windows event viewer.

System function blocks, runtime functions

Name	Description
MC_AxRtCheckSyncDistance_BkPlcMc [▶ 174]	Monitoring of the distance between the referencing cam and zero pulse.
MC_AxRtCmdBufferExecute_BkPlcMc	in preparation
MC_AxRtCommandsLocked_BkPlcMc [▶ 187]	in preparation
MC_AxRtGoErrorState_BkPlcMc [▶ 178]	(not recommended) The axis is placed into an error state.
MC_AxRtMoveChecking_BkPlcMc [▶ 178]	Monitoring the movement of an axis.
MC_AxRtSetDirectOutput_BkPlcMc [▶ 179]	Direct output of a control value.
MC_AxRtSetExtGenValues_BkPlcMc [▶ 180]	Supplying an axis with command variables, which do not originate from the axis' own generator.
MC_AxStandardBody_BkPlcMc [▶ 181]	Calls the usual sub-components for an axis (encoder, generator, finish, drive).
MC_AxUtiAutoIdent_BkPlcMc [▶ 192]	Automatic determination of axis parameters.
MC_AxUtiAutoIdentSlave_BkPlcMc	in preparation: Automatic determination of slave axis parameters.
MC_AxUtiAverageDerivative_BkPlcMc [▶ 188]	Determination of the derivative of value through numeric differentiation over than one cycle.
MC_AxUtiPT1_BkPlcMc [▶ 189]	Calculation of a first-order low-pass.
MC_AxUtiPT2_BkPlcMc [▶ 190]	Calculation of a second-order low-pass.
MC_AxUtiSlewRateLimitter_BkPlcMc [▶ 190]	Generation of a rise-limited ramp.
MC_AxUtiSlidingAverage_BkPlcMc [▶ 191]	Determination of a moving average.
MC_AxUtiStandardInit_BkPlcMc [▶ 182]	Initialization and monitoring of axis components.
MC_FunctionGeneratorFD_BkPlcMc [▶ 159]	A function generator.
MC_FunctionGeneratorSetFrq_BkPlcMc [▶ 160]	Updates the operating frequency of a time base for one or several function generators.
MC_FunctionGeneratorTB_BkPlcMc [▶ 161]	Updates a time base for one or several function generators.

Data types: Enumerations

Name	Description
E_TcMcCurrentStep [▶ 71]	This enumeration returns codes for the internal states of the control value generators.
E_TcMcDriveType [▶ 72]	The constants in this enumeration are used to identify the hardware used to output the control values for an axis.
E_TcMcEncoderType [▶ 75]	The constants in this enumeration are used to identify the hardware used to acquire the actual values for an axis.
E_TcMCFbState [▶ 78]	This enumeration supplies codes for the current state of an axis.
E_TcMcHomingType [▶ 79]	This enumeration supplies codes for the referencing method used by an axis.
E_TcMCParameter [▶ 79]	The constants listed here are used for numbering parameters.
E_TcMcPressureReadingMode [▶ 89]	The constants in this list determine which actual value in the ST_TcHydAxRtData structure of the axis is to be updated with the result of a pressure or force measurement.
E_TcMcProfileType [▶ 88]	The constants listed here are used for identifying control value generators.
E_TcPlcBufferedCmdType_BkPlcMc [▶ 69]	In preparation: The constants in this list are used to identify buffered axis commands.
MC_BufferMode_BkPlcMc [▶ 89]	The constants in this list are used for controlling blending according to PLC Open.
MC_Direction_BkPlcMc [▶ 90]	This enumeration supplies codes for the direction of movement if this information is not contained in other data or cannot be in determined on the basis of the situation.
MC_HomingMode_BkPlcMc [▶ 91]	This enumeration returns codes for specification of the referencing method.
MC_StartMode_BkPlcMc [▶ 91]	The constants in this list are used for identifying the modes during axis startups.

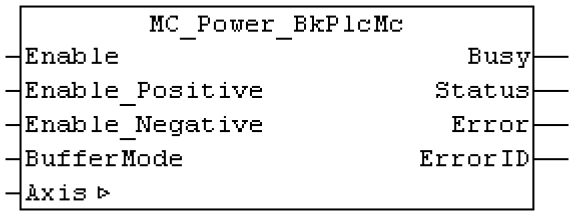
Data types: Structures

Name	Description
Axis_Ref_BkPlcMc [▸ 67]	A variable of this type contains all the necessary variables or pointers to variables that are associated with an axis.
CAMSWITCH_REF_BkPlcMc [▸ 69]	A variable of this type is transferred to an MC_DigitalCamSwitch_BkPlcMc [▸ 48] function block.
MC_CAM_ID_BkPlcMc [▸ 90]	A variable of this type contains the description of a cam plate prepared for coupling.
MC_CAM_REF_BkPlcMc [▸ 90]	A variable of this type contains the description of a provided cam plate.
OUTPUT_REF_BkPlcMc [▸ 92]	A variable of this type contains output data of an MC_DigitalCamSwitch_BkPlcMc [▸ 48] function block.
ST_FunctionGeneratorFD_BkPlcMc [▸ 92]	A variable of this type contains parameters for defining the output signals of a function generator.
ST_FunctionGeneratorTB_BkPlcMc [▸ 92]	A variable of this type contains parameter for defining a time base for a function generator.
ST_TcMcAutoIdent [▸ 93]	A variable of this type contains the parameters for an MC_AxUtiAutoIdent_BkPlcMc [▸ 192] function block.
ST_TcMcAuxDataLabels [▸ 103]	A variable of this type contains label texts for the client-specific axis parameters.
ST_TcHydAxParam [▸ 93]	A variable of this type contains all the parameters for an axis.
ST_TcHydAxRtData [▸ 99]	A variable of this type contains the runtime data for an axis.
ST_TcPlcMcLogBuffer [▸ 107]	A variable with this structure forms the LogBuffer of the library.
ST_TcPlcMcLogEntry [▸ 108]	A variable with this structure contains a message of the LogBuffer of the library.
ST_TcPlcDeviceInput [▸ 104]	This structure contains the input image variables of an axis.
ST_TcPlcDeviceOutput [▸ 106]	This structure contains the output image variables of an axis.
ST_TcPlcRegDataItem [▸ 108]	This structure contains a parameter set for a KL terminal.
ST_TcPlcRegDataTable [▸ 109]	This structure contains a parameter for a KL terminal.
TRACK_REF_BkPlcMc [▸ 109]	In preparation.

4 PLCopen Motion Control

4.1 Administrative

4.1.1 MC_Power_BkPlcMc (from V3.0)



The function block is used to control an external actuator. Further information on this topic can be found under FAQ #9 [▶ 227].

```
VAR_INPUT
    Enable:             BOOL;
    Enable_Positive:    BOOL;
    Enable_Negative:    BOOL;
    BufferMode:         MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;  (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Status:     BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A TRUE at this input activates an external actuator of an axis.

Enable_Positive: A TRUE at this input activates the directional enable of an external actuator of an axis for movements in a positive direction.

Enable_Negative: A TRUE at this input activates the directional enable of an external actuator of an axis for movements in a negative direction.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Status: Readiness for operation is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded error message is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

This function block is used to control external actuators. These can be modules for valve control (the valve's onboard output stage or switch cabinet assembly), frequency converters or servoamplifiers. These devices usually require a digital signal to enable the output of energy through a power stage. Depending on the design of the device, it is also possible for the "positive" and "negative" movement directions to be individually activated.

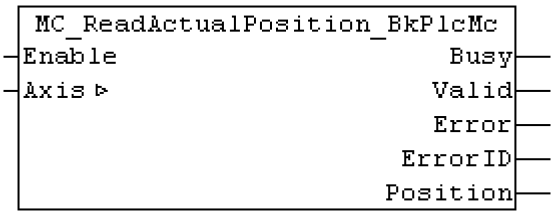
The function block's input signals are passed on through the interface to the peripheral device. **Enable** also activates error monitoring.

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems can be detected and reported during this process:

- If the value iTcMc_DriveAx2000_XXXXX is set under nDrive_Type in pStAxParams, the following procedure is applied:
    - If one of the pointers pStDeviceOutput or pStDeviceInput in Axis_Ref_BkPlcMc [▶ 67] is not initialized, the block responds with E**rror** and **ErrorID**:=dwTcHydErrCdPtrPlcDriveIn or dwTcHydErrCdPtrPlcDriveOut. **Status** is then FALSE.
    - If an error is detected in the communication with the AX device or an error message occurs in the pStDeviceInput interface of the AX device, the function block responds with **Error** and an **ErrorID**, which is defined in the global constants [▶ 241] of the library. **Status** is then FALSE, and the axis is set to an error state with the axis error dwTcHydErrCdDriveNotReady.
    - Otherwise, the value of **Enable** is returned as the **Status**.
- If the value iTcMc_DriveKL2531 or iTcMc_DriveKL2541 is set under nDrive_Type in pStAxParams, the following procedure is applied:
    - The pointers pStDeviceOutput and or pStDeviceInput Axis_Ref_BkPlcMc [▶ 67] are checked. **I**f these pointers have not been initialised, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcDriveIn or dwTcHydErrCdPtrPlcDriveOut. **Status** is then FALSE.
    - If an error is detected in the communication with the I/O terminal or an error message occurs in the pStDeviceInput interface of the terminal, the function block responds with **Error** and an **ErrorID**, which is defined in the in global constants [▶ 241] of the library. **Status** is then FALSE, and the axis is set to an error state with the axis error dwTcHydErrCdDriveNotReady.
    - **Enable** is used to activate the terminal output stage through a bit in pStDeviceOutput.bTerminalCtrl. The ready signal in bTerminalCtrl.bTerminalState is returned as **Status**.
    - If the drive interface is operating without error, the value of **Enable_Positive** is entered with the mask dwTcHydDcDwFdPosEna in the nDeCtrlDWord of pStAxRtData.
    - If the drive interface is operating without error, the value of **Enable_Negative** is entered with the mask dwTcHydDcDwFdNegEna in the nDeCtrlDWord of pStAxRtData.
- Otherwise the pointers pStDeviceInput and pStDeviceOutput in Axis_Ref_BkPlcMc [▶ 67] are checked. If these pointers have not been initialised, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcDriveIn or dwTcHydErrCdPtrPlcDriveOut. **Status** is then FALSE.
    - Otherwise, the value of bPowerOk from pStDeviceInput is returned as the **Status**.
- If the drive interface is operating without error, the value of **Enable** is entered with the mask dwTcHydDcDwCtrlEnable in the nDeCtrlDWord of pStAxRtData.
- If the drive interface is operating without error, the value of **Enable_Positive** is entered with the mask dwTcHydDcDwFdPosEna in the nDeCtrlDWord of pStAxRtData.
- If the drive interface is operating without error, the value of **Enable_Negative** is entered with the mask dwTcHydDcDwFdNegEna in the nDeCtrlDWord of pStAxRtData.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.2 MC_ReadActualPosition_BkPlcMc (from V3.0)



The function block determines the current position of an axis.

```
VAR_INPUT
    Enable:     BOOL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Valid:      BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    Position:   LREAL;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: Updating of the position value is initiated by a positive edge at this input.

Busy: Indicates that a command is being processed.

Valid: Successful determination of the actual position is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Position: [mm] The actual position.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

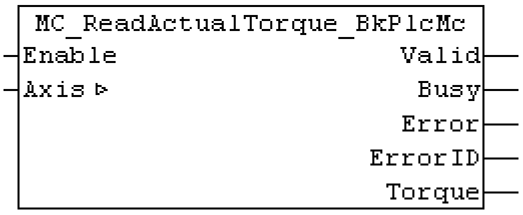
- If the axis is already in a fault state, and if the cause lies with an encoder problem, it responds with **Error** and **ErrorID**:=the encoder's error code.

The actual position is determined and reported with **Valid** if these checks can be carried out without problems.

A negative edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.3 MC_ReadActualTorque_BkPlcMc (from V3.0)



The function block determines the current actual force or actual pressure of an axis.

```
VAR_INPUT
    Enable:     BOOL;
END_VAR
VAR_OUTPUT
    Valid:      BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    Torque:     LREAL;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A rising edge at this input triggers an update of the actual value.

Valid: This indicates successful determination of the actual value.

Busy: This output TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Torque: The actual force or actual pressure.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

The function block is activated by a rising edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

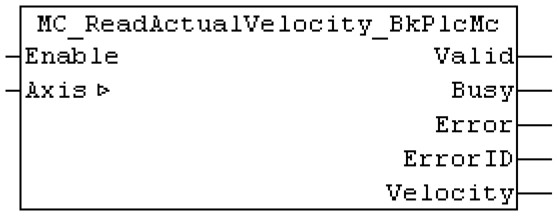
- If the axis is already in a fault state, and if the cause lies with an encoder problem, it responds with **Error** and **ErrorID**:=the encoder's error code.

If these checks were completed without problem, the actual force or the actual pressure is determined, and **Valid** is reported.

A falling edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.4 MC_ReadActualVelocity_BkPlcMc (from V3.0)



The function block determines the current velocity of an axis.

```
VAR_INPUT
    Enable:     BOOL;
END_VAR
VAR_OUTPUT
    Valid:      BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    Velocity:   LREAL;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A positive edge at this input triggers an update of the velocity value.

Valid: This indicates successful determination of the velocity.

Busy: This output is TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Velocity: [mm/s] The actual velocity.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

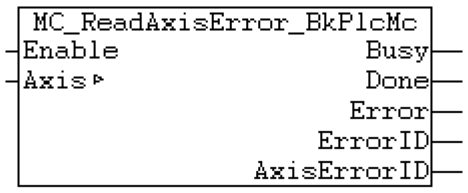
- If the axis is already in a fault state, and if the cause lies with an encoder problem, it responds with **Error** and **ErrorID**:=the encoder's error code.

The velocity is determined and reported with **Valid** if these checks can be carried out without problems.

A negative edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.5 MC_ReadAxisError_BkPlcMc (from V3.0)



This function block determines the current error code of an axis.

```
VAR_INPUT
    Enable:     BOOL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    AxisErrorID:UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: TRUE at this input triggers an update of the error code.

Busy: Indicates that a command is being processed.

Done: Successful determination of the actual position is indicated here.

Error: Indicates TRUE, if the function block was unable to execute the required function.

ErrorID: Provides a coded cause of error, if the function block was unable to execute the required function.

AxisErrorID: Provides the current error code [▶ 236] of the axis.

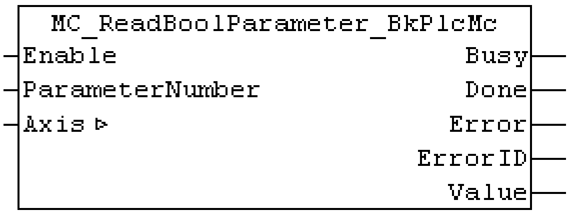
Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

If **Enable** is TRUE, the function block checks the transferred axis interface. The current error code is reported as **AxisErrorID**. If **Enable** is FALSE, the function block cancels all pending output signals.

NOTE! This function block requires no time and no preconditions for executing its tasks. The outputs Error and Busy will never assume the value TRUE and only exist for compatibility reasons.

4.1.6 MC_ReadBoolParameter_BkPlcMc (from V3.0)



This function block reads the boolean parameters of an axis. The function block MC_ReadParameter_BkPlcMc [▶ 33] is available for non-boolean parameters.

```
VAR_INPUT
    Enable:             BOOL;
    ParameterNumber:    INT;
END_VAR
VAR_OUTPUT
    Busy:               BOOL;
    Done:               BOOL;
    Error:              BOOL;
    ErrorID:            UDINT;
    Value:              BOOL;
END_VAR
VAR_INOUT
    Axis:               Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A reading process is initiated by a rising edge at this input.

ParameterNumber: This code number specifies the parameter that is to be read. Only named constants from E_TcMCParameter [▶ 79] should be used.

Busy: Indicates that a command is being processed.

Done: Successful execution of the reading process is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Value: The value of the parameter is made available here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

The function block is activated by a rising edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

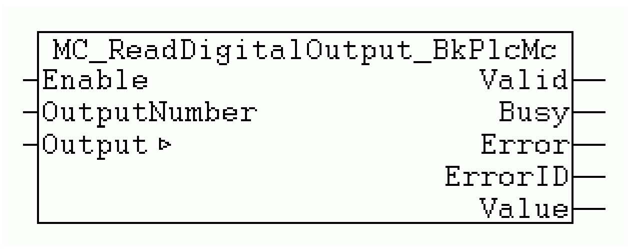
- If an unsupported value is given to **ParameterNumber** the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

The desired parameter value is made available at **Value**, and **Done** is asserted if these checks can be carried out without problems.

A falling edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.7 MC_ReadDigitalOutput_BkPlcMc (from V3.0)



The function block determines the current state of a digital output of a cam controller.

```
VAR_INPUT
    Enable:          BOOL;
    OutputNumber:    INT;
END_VAR
VAR_OUTPUT
    Done:        BOOL;
    Busy:        BOOL;
    Error:       BOOL;
    ErrorID:     UDINT;
    Value:       BOOL;
END_VAR
VAR_INOUT
    Output:      OUTPUT_REF_BkPlcMc;
END_VAR
```

Enable: A rising edge at this input triggers an update of the state.

OutputNumber: The number of the output to be determined.

Valid: This indicates successful determination of the state.

Busy: This output TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Value: The state of the digital output.

Output: Here, the address of a variable of type OUTPUT_REF_BkPlcMc [▶ 92] should be transferred.

Behavior of the function block:

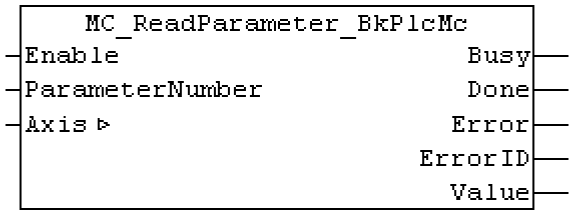
If **Enable** is TRUE, the function block checks the transferred parameters. During this process, a problem may be detected and reported:

- If the value of **OutputNumber** is not within the permissible range [0..31], the response is **Error** with **ErrorID**:=dwTcHydErrCdIllegalOutputNumber.

If these checks were carried out without problems, the state of the digital output is determined, and **Valid** is reported.

A falling edge at **Enable** clears all the pending output signals.

4.1.8 MC_ReadParameter_BkPlcMc (from V3.0)



This function block reads the non-boolean parameters of an axis. The function block MC_ReadBoolParameter_BkPlcMc [▶ 31] is available for boolean parameters.

```
VAR_INPUT
    Enable:             BOOL;
    ParameterNumber:    INT;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    Value:      LREAL;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A reading process is initiated by a rising edge at this input.

ParameterNumber: This code number specifies the parameter that is to be read. Only named constants from E_TcMCParameter [▶ 79] should be used.

Busy: Indicates that a command is being processed.

Done: Successful execution of the reading process is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Value: The value of the parameter is made available here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

The function block is activated by a rising edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

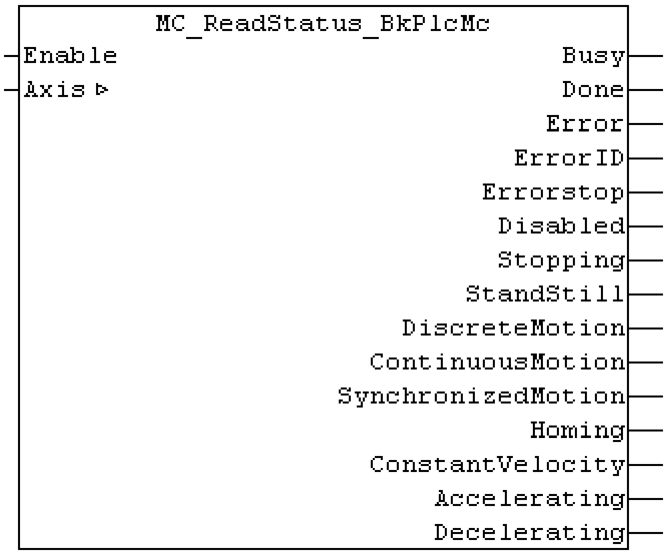
- If an unsupported value is given to **ParameterNumber** the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

The desired parameter value is made available at **Value**, and **Done** is asserted if these checks can be carried out without problems.

A falling edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.9 MC_ReadStatus_BkPlcMc (from V3.0)



The function block determines the current state of an axis.

```
VAR_INPUT
    Enable:                BOOL;
END_VAR
VAR_OUTPUT
    Busy:                 BOOL;
    Done:                 BOOL;
    Error:                BOOL;
    ErrorID:              UDINT;
    Errorstop:            BOOL;
    Disabled:             BOOL;
    Stopping:             BOOL;
    StandStill:           BOOL;
    DiscreteMotion:       BOOL;
    ContinousMotion:      BOOL;
    SynchronizedMotion:   BOOL;
    Homing:               BOOL;
    ConstantVelocity:     BOOL;
    Accelerating:         BOOL;
    Decelerating:         BOOL;
END_VAR
VAR_INOUT
    Axis:                 Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A TRUE state at this input causes the function block to update.

Busy: Indicates that a command is being processed.

Done: Successful determination of the actual position is indicated here.

Error: This output reports any problems relating to the function of the function block.

ErrorID: Provides a coded cause of error, if the function block was unable to execute the required function.

Errorstop: This signal indicates that the axis associated with an error has been placed in a state in which it is not able to operate. This state can only be cleared by activating either a MC_Reset_BkPlcMc [▸ 36] or a MC_ResetAndStop_BkPlcMc [▸ 36] function block.

Disabled: This signal indicates whether the axis is enabled or disabled by its MC_Power_BkPlcMc [▸ 26] function block.

Stopping: This signal indicates that an active movement of the axis is being stopped by a MC_Stop_BkPlcMc [▸ 66] or by a MC_ResetAndStop_BkPlcMc [▸ 36] function block. This signal is cleared as soon as the axis is stationary.

StandStill: This signal indicates that the axis is neither in a fault state nor is it active.

DiscreteMotion: This signal indicates that the axis is executing an autonomous movement (not resulting from a coupling) with a defined target.

ContinousMotion: This signal indicates that the axis is executing an autonomous movement (not resulting from a coupling) with a defined velocity but not with a specified target.

SynchronizedMotion: This signal indicates that the axis is being controlled by a gear coupling.

Homing: This signal indicates that the axis is executing a reference travel.

ConstantVelocity: This signal indicates that the axis is being moved with constant velocity.

Accelerating: This signal indicates that the velocity of an axis is reaching a specified value.
🛈 **NOTE! This does not always mean that the velocity is increasing: when an axis that is already in movement is started, it can happen that the axis accelerates in the direction opposite the current movement in order to achieve a specified velocity in the other direction. From the point of view of the original movement this is a deceleration, although from the point of the current (new) movement it is still an acceleration.**

Decelerating: This signal indicates that the axis is reducing its velocity in order to continue a movement with a velocity lower than the current velocity, or in order to end it.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

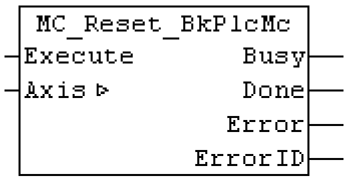
If **Enable** is TRUE, the function block examines the transferred axis interface and decodes the internal state information. A FALSE state at **Enable** clears all the pending output signals.

🛈 **NOTE! This function block requires no time and no preconditions for executing its tasks. The outputs Error and Busy will never assume the value TRUE and only exist for compatibility reasons.**

Note	**Observe outputs** The outputs **Error** and **ErrorID** indicate the state of the function block, **not** that of the axis.

To read the current error code of the axis, an MC_ReadAxisError_BkPlcMc() [▸ 30] function block should be used.

4.1.10 MC_Reset_BkPlcMc (from V3.0)



The function block eliminates an error state and puts the axis in an operational state.

```
VAR_INPUT
    Execute:    BOOL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Execute: An axis reset is initiated by a rising edge at this input.

Busy: Indicates that a command is being processed.

Done: Successful execution of the axis reset is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

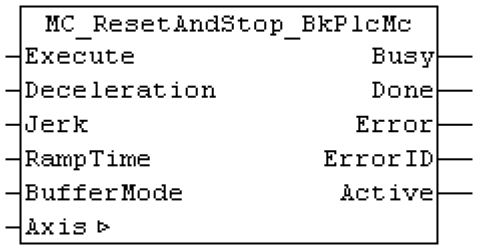
Behavior of the function block:

A rising edge at **Execute** triggers an axis reset. This puts the axis in an operational state, as far as possible, and **Done** is reported. If this is not possible, the function block reacts with **Error** and **ErrorID**:= the ErrorCode of the axis.

A falling edge at **Execute** clears all the pending output signals.

NOTE! In some drive types, signal exchange with an external device is required, in order to rectify certain errors. During the time required for this, the function block is unable to report a final result (Done or Error). Instead, Busy is used to indicate that the function is in progress.

4.1.11 MC_ResetAndStop_BkPlcMc (from V3.0)



The function block puts a faulty axis in an operational state. If the axis is processing a travel command, this is aborted, and the associated required stop operation is monitored.

```
VAR_INPUT
    Execute:        BOOL;
    Deceleration:   LREAL;  (ab/from V3.0.5)
    Jerk:           LREAL;  (ab/from V3.0.5)
    RampTime:       LREAL;  (ab/from V3.0.5)
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;  (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input triggers an axis reset and a stop operation.

Deceleration: [mm/s^2] The deceleration to be applied.

Jerk: [mm/s^3] The jerk to be applied.

RampTime: [s] The required stopping time.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: Successful execution of the axis reset is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

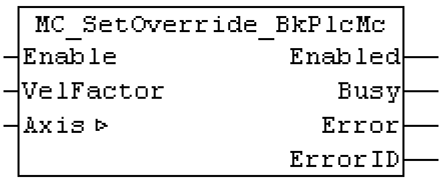
- If it is not possible to successfully clear an existing fault state for an axis through a reset operation, the function block reacts with **Error** and **ErrorID**:= the ErrorCode for the axis.
- If the axis is placed into an error state in the course of a stop operation that may have been necessary, the function block reacts with **Error** and **ErrorID**:= the ErrorCode for the axis.

Successful completion of both operations is reported with **Done**. The axis is then without error and stationary.

A negative edge at **Execute** clears all the pending output signals.

NOTE! If the axis is executing a motion, it is decelerated until it stops. In some drive types, signal exchange with an external device is required, in order to rectify certain errors. During the time required for this, the function block is unable to report a final result (Done or Error). Instead, Busy is used to indicate that the function is in progress.

4.1.12 MC_SetOverride_BkPlcMc (from V3.0)



The function block sets the override of an axis.

NOTE! This function block only takes effect if the profile type iTcMc_ProfileCtrlBased is used.

```
VAR_INPUT
    Enable:     BOOL;
    VelFactor:  LREAL;
END_VAR
VAR_OUTPUT
    Enabled:    BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: An active state at this input sets the override of the axis.

VelFactor: [1] The new override of the axis.

Enabled: This indicates the active state of the function block.

Busy: This output is TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

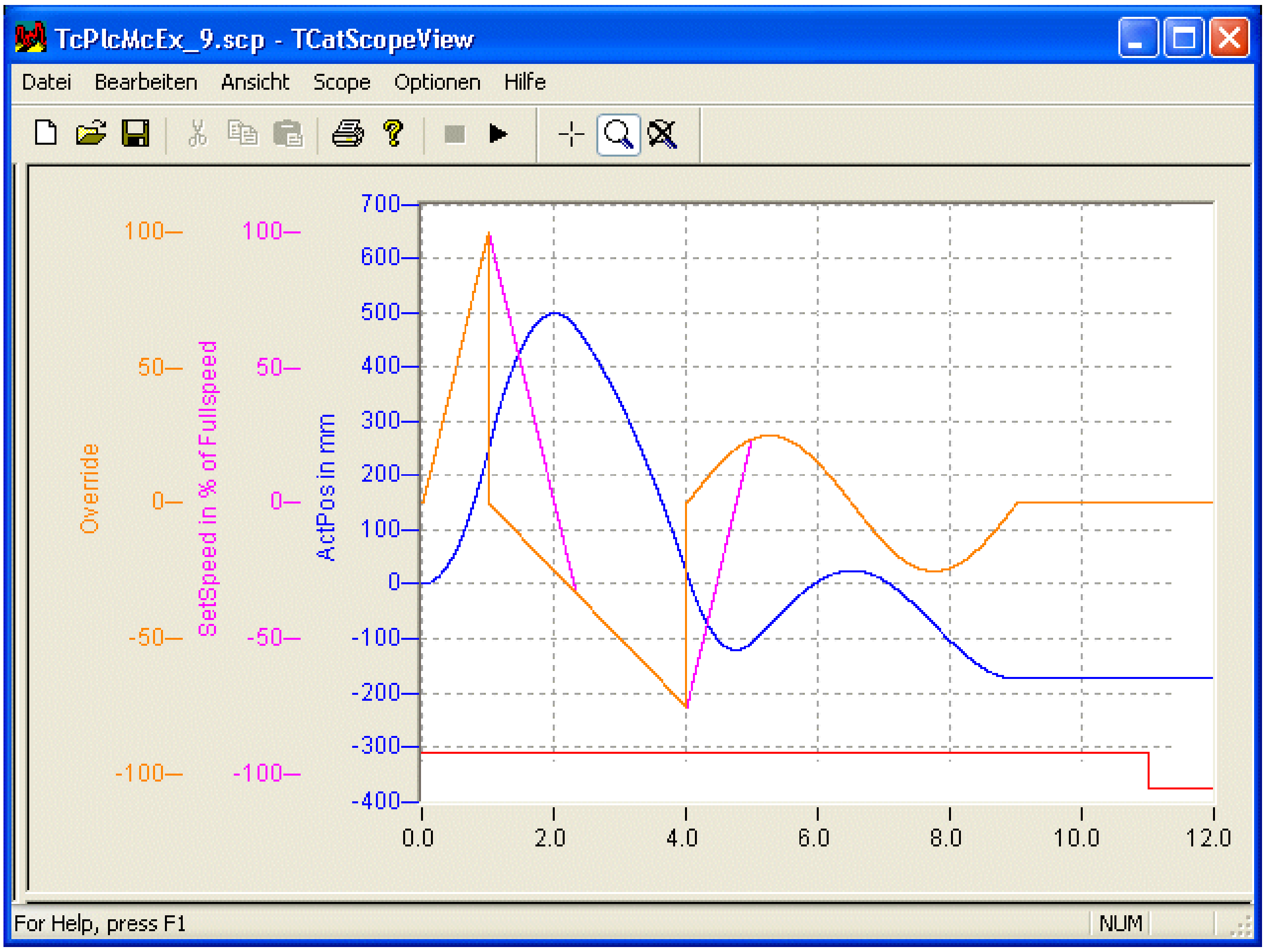
ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

If the **Enable** state is active, the value transferred as **VelOverride** is limited to the range 0.0 to 1.0 and entered in **Axis.pStAxParams^.fOverride**. **Enabled** is set to TRUE.

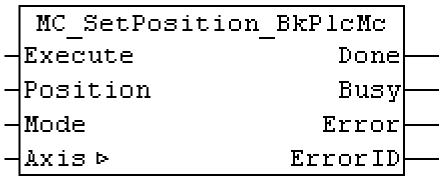
A negative edge at **Enable** clears all outputs.



All velocity changes caused by an override change are limited according to the maximum permitted accelerations and decelerations.

NOTE! In order to ensure reproducible behavior during the target approach, the override only reduces the travel speed to pStAxParams.fCreepSpeed. Therefore, it is not possible to stop the axis movement through an override of 0.0.

4.1.13 MC_SetPosition_BkPlcMc (from V3.0)



The function block sets the actual position of an axis.

```
VAR_INPUT
    Execute:    BOOL;
    Position:   LREAL;
    Mode:       BOOL;
END_VAR
VAR_OUTPUT
    Done:       BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
```

```
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input sets the actual position of the axis.

Position: [mm] The new actual position of the axis.

Mode: This parameter specifies the operating mode. If **Mode** = TRUE, the actual position is changed by **Position**, if **Mode** = FALSE, the actual position is set to **Position.**

Done: This indicates successful processing of the command.

Busy: This output is TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

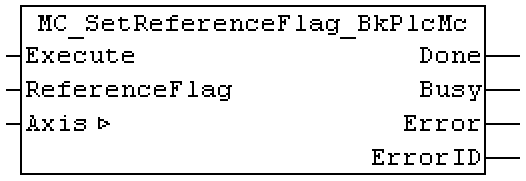
The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- Depending on the encoder type specified in **Axis.pStAxParams^.nEnc_Type**, either ST_TcHydAxRtData.fEnc_RefShift or ST_TcHydAxParam.fEnc_ZeroShift is updated such that the actual position of the axis assumes the required value. If the encoder types is unknown or the encoder does not permit the actual value to be set, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdEncType.
- If ST_TcHydAxParam.fEnc_ZeroShift changes recognizable during this process, Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxRtData [▸ 99].bParamsUnsave is set.

NOTE! This function block may cause the actual position and/or the target position of the currently processed motion to be moved after an active software limit switch. This is not monitored by the function block.

If these checks could be performed without problem, all other affected elements in ST_TcHydAxRtData are automatically updated. This function block can therefore also be activated for axes, which perform an active motion. The successful execution of the function is indicated with **Done**. A negative edge at **Execute** clears all the pending output signals.

4.1.14 MC_SetReferenceFlag_BkPlcMc (from V3.0)



(Function is not defined by PLCopen) The function block defines the referencing flag of the axis.

```
VAR_INPUT
    Execute:        BOOL;
    ReferenceFlag:  BOOL;
END_VAR
VAR_OUTPUT
    Done:       BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
```

```
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input sets the referencing flag of the axis.

ReferenceFlag: The new state of the referencing flag of the axis.

Done: This indicates successful processing of the command.

Busy: This output TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

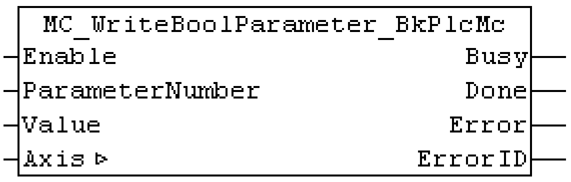
ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

A rising edge at **Execute** causes the referencing flag in ST_TcHydAxRtData.nStateDWord [▸ 235] to be updated. To this end, the respective bit is cleared or set with dwTcHydNsDwReferenced, depending on **ReferenceFlag**. The successful execution of the function is indicated with **Done**. A falling edge at **Execute** clears all the pending output signals.

4.1.15 MC_WriteBoolParameter_BkPlcMc (from V3.0)



This function block writes the boolean parameters of an axis. The MC_WriteParameter_BkPlcMc [▸ 43] function block is available for non-boolean parameters.

```
VAR_INPUT
    Enable:             BOOL;
    ParameterNumber:    INT;
    Value:              BOOL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A write process is initiated by a rising edge at this input.

ParameterNumber: This code number specifies the parameter that is to be read. Only named constants from E_TcMCParameter [▸ 79] should be used.

Value: The value of the parameter is to be provided here.

Busy: Indicates that a command is being processed.

Done: Successful execution of the writing process is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

The function block is activated by a rising edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

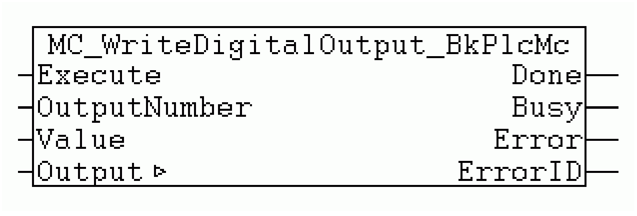
- If an unsupported value is given to **ParameterNumber** the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

If these checks could be performed without problems, **Value** is entered in the required parameter value, and **Done** is reported. If the parameter is changed during this process, Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxRtData [▶ 99].bParamsUnsave is set.

A falling edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.1.16 MC_WriteDigitalOutput_BkPlcMc (from V3.0)



The function block determines the current state of a digital output of a cam controller.

```
VAR_INPUT
    Execute:        BOOL;
    OutputNumber:   INT;
    Value:          BOOL;
END_VAR
VAR_OUTPUT
    Done:       BOOL;
    Busy:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Output:     OUTPUT_REF_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input triggers an update of the state.

OutputNumber: The number of the output to be determined.

Value: The state of the digital output.

Done: This indicates successful determination of the state.

Busy: This output TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Output: Here, the address of a variable of type OUTPUT_REF_BkPlcMc [▶ 92] should be transferred.

Behavior of the function block:

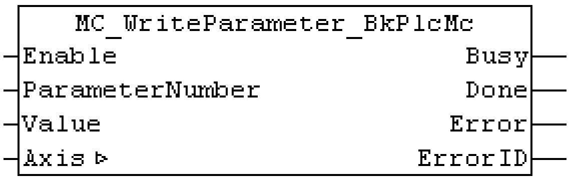
A rising edge at **Execute** causes the function block to examine the transferred parameters. During this process, a problem may be detected and reported:

- If the value of **OutputNumber** is not within the permissible range [0..31], the response is **Error** with **ErrorID**:=dwTcHydErrCdIllegalOutputNumber.

If these checks could be performed without problems, the state of the digital output is defined according to the value of **Value,** and **Done** is reported.

A falling edge at **Execute** clears all the pending output signals.

4.1.17 MC_WriteParameter_BkPlcMc (from V3.0)



This function block writes the non-boolean parameters of an axis. The MC_WriteBoolParameter_BkPlcMc [▸ 41] function block is available for boolean parameters .

```
VAR_INPUT
    Enable:             BOOL;
    ParameterNumber:    INT;
    Value:              LREAL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Enable: A write process is initiated by a rising edge at this input.

ParameterNumber: This code number specifies the parameter that is to be read. Only named constants from E_TcMCParameter [▸ 79] should be used.

Value: The value of the parameter is to be provided here.

Busy: Indicates that a command is being processed.

Done: Successful execution of the writing process is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

The function block is activated by a rising edge at **Enable**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If an unsupported value is given to **ParameterNumber** the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

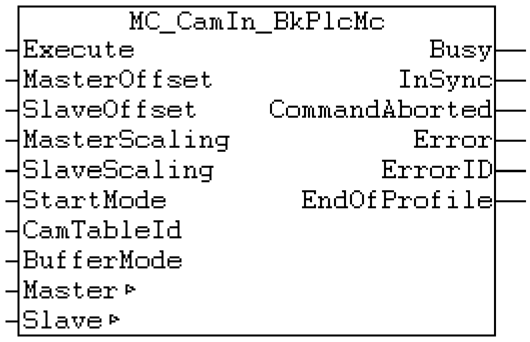
If these checks could be performed without problems, **Value** is entered in the required parameter value, and **Done** is reported. If the parameter is clearly changed during this process, Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxRtData [▸ 99].bParamsUnsave is set.

A falling edge at **Enable** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.2 Motion

4.2.1 MC_CamIn_BkPlcMc (from V3.0)



The function block starts and monitors a cam plate coupling between two axes. To release the coupling, an MC_CamOut_BkPlcMc [▶ 45] function block should be used.

```
VAR_INPUT
    Execute:        BOOL;
    MasterOffset:   LREAL:=0.0;
    SlaveOffset:    LREAL:=0.0;
    MasterScaling:  LREAL:=0.0;
    SlaveScaling:   LREAL:=0.0;
    StartMode:      MC_StartMode_BkPlcMc:=MC_StartMode_Absolute;
    CamTableId:     MC_CAM_ID_BkPlcMc;
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    InSync:         BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
    EndOfProfile:   BOOL;
END_VAR
VAR_INOUT
    Master:         Axis_Ref_BkPlcMc;
    Slave:          Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input starts the coupling.

MasterOffset, MasterScaling: [mm, 1] These values are offset against with the actual position of the master, before the resulting value is looked up in the master column of the table.

SlaveOffset, **SlaveScaling**: [mm, 1] These values are offset against the slave position from the table.

StartMode: A value from MC_StartMode_BkPlcMc [▶ 91], which specifies the behavior of the slave axis when the coupling is activated.

CamTableId: Here, a variable of type MC_CAM_ID_BkPlcMc [▶ 90] should be transferred, which was initialized by a function block of type MC_CamTableSelect_BkPlcMc [▶ 46].

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

InSync: This indicates the first successful synchronization of the axes. The signal the remains active, even if the synchronization subsequently fails temporarily or permanently.

CommandAborted: This indicates abortion of the coupling.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

EndOfProfile: This is indicates whether the master has reached the end of the defined range.

Master, Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If **CamTableId**.bValidated was not set by a function block of type MC_CamTableSelect_BkPlcMc, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblNoInit.
- If either the master or the slave are not in idle state, the system responds with **Error** and **ErrorID:=dwTcHydErrCdNotStartable.**
- If the value MC_StartMode_RampIn is specified as **StartMode**, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

If these checks could be performed without problem, the coupling is initiated. Depending on **StartMode**, the reference position for **Slave** is either set to 0.0 or to the current actual position of **Slave**. The axis is now in state McState_Synchronizedmotion [▶ 78], and the function block starts calculating and monitoring the coupling.

The set position and set velocity of **Slave** are calculated depending on the actual position and the set velocity of the master and the table.

When the velocity required by the coupling is reached for the first time while the slave axis coupling is active, this is indicated at output InGear. Since the coupling can currently only be activated at standstill, this is the case immediately. If the slave axis is unable to follow the specifications for some reason while the coupling is active, InGear remains unchanged.

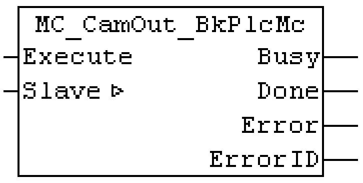
If an error code occurs in the motion generator while the coupling is active, the system responds with **Error** and **ErrorID**:=motion algorithm error code.

A negative edge at **Execute** neither aborts the calculation nor the monitoring of the coupling. This is only brought about if the coupling is activated through an MC_CamOut_BkPlcMc function block or if an error occurs. Only then are all pending output signals cleared.

NOTE! This function block temporarily deals with setpoint generation. To indicate this, Busy is not only TRUE up to the transition to synchronicity, but remains TRUE until the coupling is released.

Note	**Function block call** It is therefore imperative that this function block is called cyclically, if **Busy** is TRUE. Subsequently, the function block should be called at least once with **Execute**:=FALSE.

4.2.2 MC_CamOut_BkPlcMc (from V3.0)



The function block releases a cam plate coupling between two axes, which was started through an MC_CamIn_BkPlcMc [▶ 44] function block.

```
VAR_INPUT
    Execute:        BOOL;
ND_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Slave:          Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the coupling.

Busy: Indicates that a command is being processed.

Done: This indicates successful processing of the command.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block:

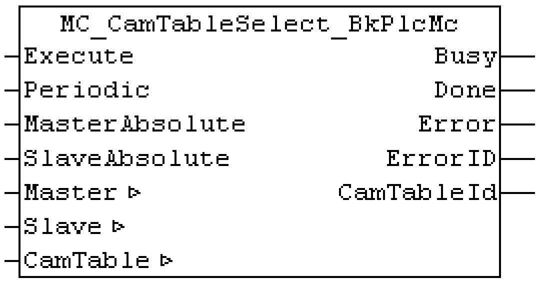
The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the pointer pStAxParams in Axis_Ref_BkPlcMc [▶ 67] is not initialized, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the pointer pStAxRtData in Axis_Ref_BkPlcMc [▶ 67] is not initialized, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrMcPlc.
- If the axis is not coupled, the function block responds with **Done**, without further checks or activities.
- If the current set velocity of the axis is smaller than the velocity specified by pStAxParams.fCreepSpeed, the axis immediately assumes McState_Standstill and dissipates the residual velocity. **Done** is indicated, and no further checks or activities take place.

If these checks could be performed without problem and **Done** is not already indicated for one of the reasons mentioned, the motion controlled by the cam plate coupling is converted to a continuous motion with the same velocity and direction, which is independent of the master. **Done** is indicated if this conversion was executed successfully, otherwise the system responds with **Error** and **ErrorID**:=error code.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.2.3 MC_CamTableSelect_BkPlcMc (from V3.0)



The function block initializes a variable of type MC_CAM_ID_BkPlcMc [▸ 90], thereby preparing a cam plate for the coupling of two axes.

```
VAR_INPUT
    Execute:            BOOL;
    Periodic:           BOOL;
    MasterAbsolute:     BOOL;
    SlaveAbsolute:      BOOL;
ND_VAR
VAR_OUTPUT
    Busy:               BOOL;
    Done:               BOOL;
    Error:              BOOL;
    ErrorID:            UDINT;
    CamTableId:         MC_CAM_ID_BkPlcMc;
END_VAR
VAR_INOUT
    Master:             Axis_Ref_BkPlcMc;
    Slave:              Axis_Ref_BkPlcMc;
    CamTable:           MC_CAM_REF_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the command.

Periodic: Not supported: FALSE should be transferred at present.

MasterAbsolute: Not supported: TRUE should be transferred at present.

SlaveAbsolute: Not supported: TRUE should be transferred at present.

Busy: Indicates that a command is being processed.

Done: This indicates successful initialization of CamTableId.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

CamTableId: Returns a variable of type MC_CAM_ID_BkPlcMc [▸ 90], which can be passed on to a function block of type MC_CamIn_BkPlcMc [▸ 44].

Master, Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

CamTable: A variable of type MC_CAM_REF_BkPlcMc [▸ 90] should be transferred here.

Behavior of the function block:

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

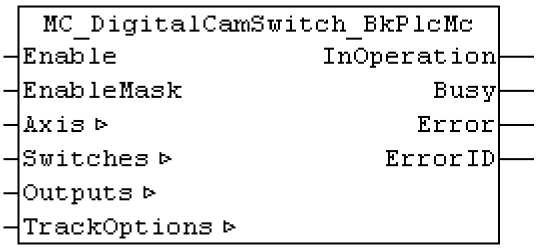
- If **CamTable**.pTable is not initialized, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If **CamTable**.nLastIdx is not greater than **CamTable**.nFirstIdx, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblEntryCount.
- If **CamTable**.nFirstIdx and **CamTable**.nLastIdx define a table with more than 100 rows, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblLineCount.
- If **MasterAbsolute** or **SlaveAbsolute** are not set or **Periodic** is set, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.

If these checks could be performed without problem, **CamTableId** is initialized. The data from **CamTable** and the input data of function block are used for this purpose. **CamTableId** is marked as valid and modified. **Done** is used to report execution of the command.

A falling edge at **Execute** clears all the pending output signals.

NOTE! This function block requires no time for executing its tasks. The output Busy will never assume the value TRUE and only exists for compatibility reasons.

4.2.4 MC_DigitalCamSwitch_BkPlcMc (from V3.0)



The function block generates software cams depending on the position, direction of travel and velocity of an axis.

```
VAR_INPUT
    Enable:         BOOL;
    EnableMask:     DWORD;
END_VAR
VAR_OUTPUT
    InOperation:    BOOL;
    Busy:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
    Switches:       CAMSWITCH_REF_BkPlcMc;
    Outputs:        OUTPUT_REF_BkPlcMc;
    TrackOptions:   TRACK_REF_BkPlcMc;
END_VAR
```

Enable: This input controls all activities of the function block.

EnableMask: A mask with bits that specify the activation of the outputs in **Outputs**.

InOperation: This indicates whether the function block is active.

Busy: This output TRUE while the command is being processed.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Switches: Here, an array of type CAMSWITCH_REF_BkPlcMc [▸ 69] should be transferred.

Outputs: Here, the address of a variable of type OUTPUT_REF_BkPlcMc [▸ 92] should be transferred.

TrackOptions: Here, an array of type TRACK_REF_BkPlcMc [▸ 109] should be transferred.

Behavior of the function block

Cam signals (switches) are switched based on the actual position of an axis. The available options are position-controlled (with start and end position) and time-controlled (with trigger position and duration). The direction of travel of the axis can be taken into account.

The cam signals are assigned to tracks with parameter sable properties. The time response can be specified through a switch-on and switch-off delay. Predictive signalling can be achieved through negative values. A hysteresis enables suppression of undesirable signalling, if the axis is near a switching points and the actual position is not entirely constant.

Example

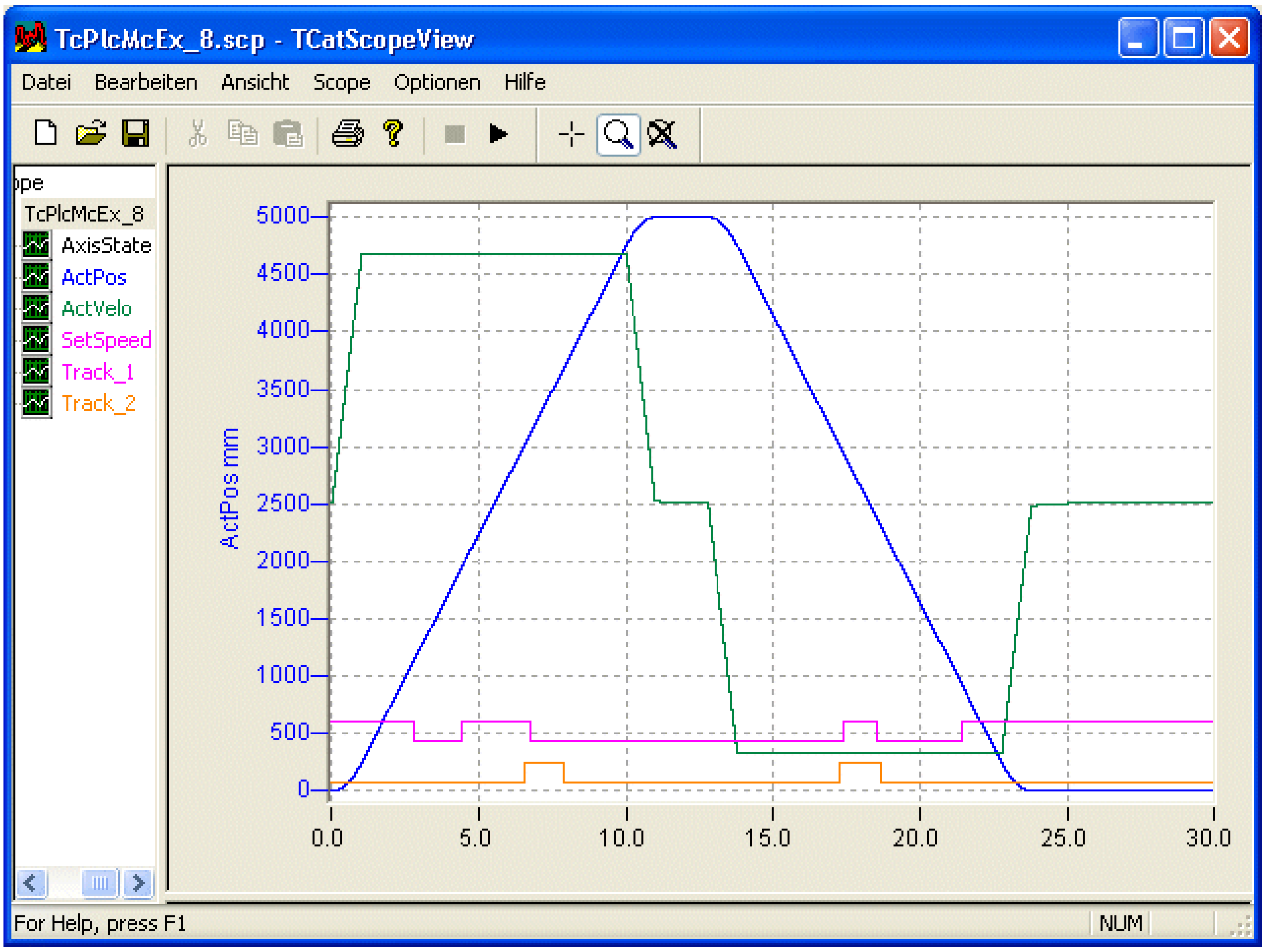
CAMSWITCH_REF_BkPlcMc [▸ 69] used:

Parameter	Switch[1]	Switch[2]	Switch[3]	Switch[4]	...	Switch[n]
TrackNumber	1	1	1	2		
FirstOnPosition	2000.0	2500.0	-1000.0	3000.0		
LastOnPosition	3000.0	3000.0	1000.0			
AxisDirection	1	2	0	0		
CamSwitchMode	0	0	0	1		
Duration				1.35		
.....						

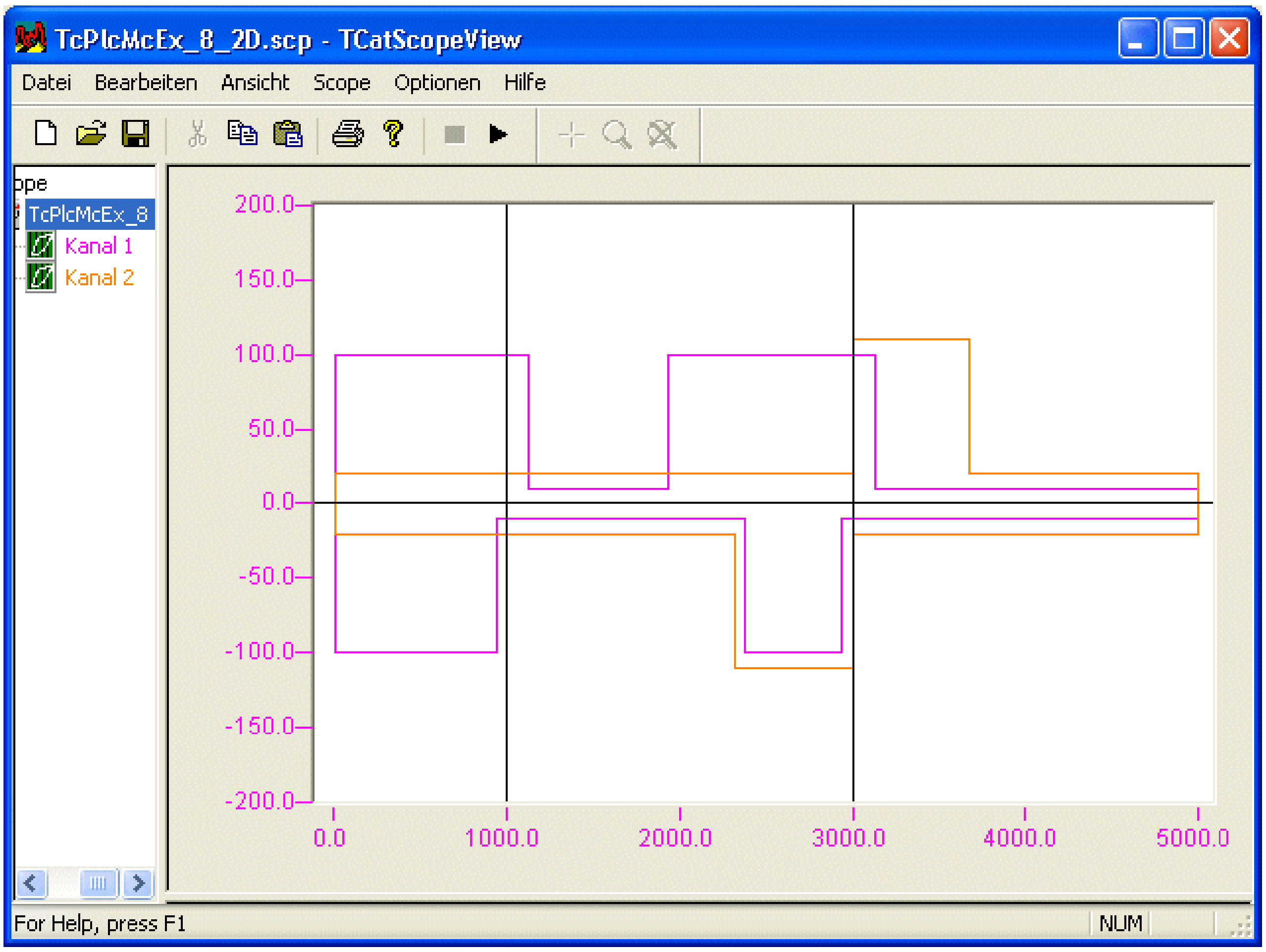
TRACK_REF_BkPlcMc [▶ 109] used:

Parameter	Track[1]	Track[2]	...	Track[n]
OnCompensation	-0.125	0.0		
OffCompensation	0.250	0.0		
Hysteresis	0.0	0.0		

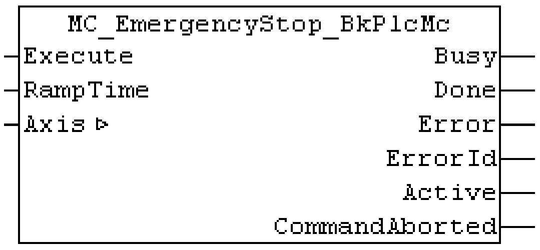
Signal curves during axis motion from 0.0 to 5000.0 and back:



The following diagram shows the signal curves over the position. For positive direction of travel the signals are shown normally (upwards), for negative direction of travel they are shown negative, i.e. 'downwards'. The vertical cursor lines indicate the positions 1000 and 3000 mm.



4.2.5 MC_EmergencyStop_BkPlcMc (from V3.0.5)



The function block cancels a current axis motion and monitors the emergency stop operation.

```
VAR_INPUT
    Execute:        BOOL;
    RampTime:       LREAL;   (ab/from V3.0.5)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
    Active:         BOOL;
    CommandAborted: BOOL;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input ends a movement being carried out by the axis.

RampTime: [s] The required stopping time.

Busy: Indicates that a command is being processed.

Done: This indicates successful processing of the operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that a command is being processed.

CommandAborted: Indicates that processing of this command was canceled by another command.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

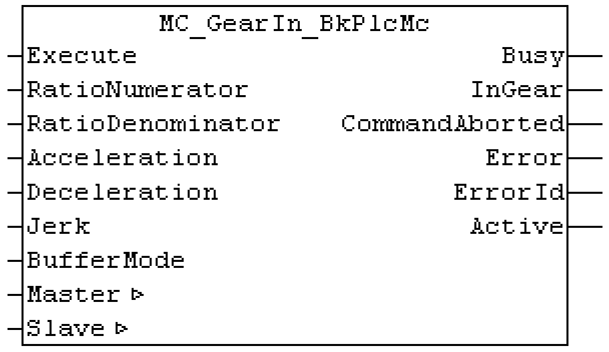
The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- The stop can only be executed if the axis is actively carrying out a movement. If it is stationary, the function block immediately asserts the **Done** signal.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If the axis is in a state, in which it is controlled by a coupling with another axis or a comparable mechanism, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.

The Stop operation begins if these checks can be carried out without problems. **RampTime** is used to calculate a deceleration, taking into account the reference speed. **MaxJerk** is used if a jerk-limiting control value generator is selected. If no value is specified for **RampTime**, which is recognizably greater than 0, the axis parameter fEmergencyRamp is used.

An MC_Stop_BkPlcMc [▶ 66] function block is used internally for slowing down the axis. Once the control value output is reduced to 0, all control or regulating voltage outputs are suppressed, as long as **Execute** is set to TRUE.

4.2.6 MC_GearIn_BkPlcMc (from V3.0)



The function block starts and monitors a coupling between two axes. To release the coupling, an MC_GearOut_BkPlcMc [▶ 55] function block should be used.

```
VAR_INPUT
    Execute:                BOOL;
    RatioNumerator:         INT;
    RatioDenominator:       INT;
    Acceleration:           LREAL;
    Deceleration:           LREAL;
    Jerk:                   LREAL;  (ab/from V3.0.5)
    BufferMode:             MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
```

```
VAR_OUTPUT
    Busy:            BOOL;
    InGear:          BOOL;
    CommandAborted:  BOOL;
    Error:           BOOL;
    ErrorID:         UDINT;
    Active:          BOOL;
END_VAR
VAR_INOUT
    Master:          Axis_Ref_BkPlcMc;
    Slave:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input starts the coupling.

RatioNumerator, RatioDenominator: [1, 1] These parameters describe the coupling factor in the form of a gear unit.

Acceleration: [mm/s^2] The acceleration permitted for the synchronization in actual value units of the axis per square second.

Deceleration: [mm/s^2] The deceleration permitted for the synchronization in actual value units of the axis per square second.

Jerk: [mm/s^3] The jerk to be applied.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

InGear: This indicates the first successful synchronization of the axes. The signal the remains active, even if the synchronization subsequently fails temporarily or permanently.

CommandAborted: This indicates abortion of the coupling.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that a command is being processed.

Master, Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- Next, the system checks whether **RatioDenominator** is 0. In this case the function block will react by asserting **Error** with **ErrorID**:=dwTcHydErrCdIllegalGearFactor.
- Currently, the coupling can only be activated if both the master and the slave are at standstill. Otherwise the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotStartable.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If the movement algorithm is already indicating an error code, the function block responds with **Error** and **ErrorID**:= the movement algorithm's error code.

If these checks could be performed without problem, the coupling is initiated. The axis is now in state McState_Synchronizedmotion [▸ 78], and the function block starts monitoring the coupling.

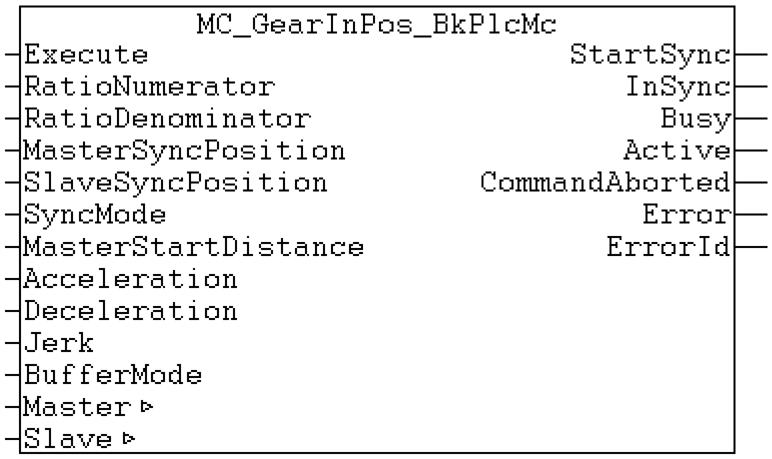
When the velocity required by the coupling is reached for the first time while the slave axis coupling is active, this is indicated at output InGear. Since the coupling can currently only be activated at standstill, this is the case immediately. If the slave axis is unable to follow the specifications for some reason while the coupling is active, InGear remains unchanged.

If an error code occurs in the motion generator while the coupling is active, the system responds with **Error** and **ErrorID**:=motion algorithm error code.

A negative edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the coupling is still active, the existing coupling remains unaffected and active.

NOTE! The output Active is currently identical to the output Busy.

4.2.7 MC_GearInPos_BkPlcMc (from V3.0.33)



The function block starts and monitors an on-the-fly coupling between two axes. To release the coupling, an MC_GearOut_BkPlcMc [▶ 55] function block should be used.

```
VAR_INPUT
     Execute:                 BOOL;
     RatioNumerator:          INT;
     RatioDenominator:        INT;
     MasterSyncPosition:      LREAL;
     SlaveSyncPosition:       LREAL;
     SyncMode:                INT;
     MasterStartDistance:     LREAL;
     Acceleration:            LREAL;
     Deceleration:            LREAL;
     Jerk:                    LREAL;    (ab/from V3.0.5)
     BufferMode:              MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;
END_VAR
VAR_OUTPUT
     StartSync:          BOOL;
     InSync:             BOOL;
     Busy:               BOOL;
     Active:             BOOL;
     CommandAborted:     BOOL;
     Error:              BOOL;
     ErrorID:            UDINT;
END_VAR
VAR_INOUT
     Master:        Axis_Ref_BkPlcMc;
     Slave:         Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input starts the coupling.

RatioNumerator, RatioDenominator: [1, 1] These parameters describe the coupling factor in the form of a gear unit.

MasterSyncPosition: [mm] The coupling is fully active from this master position.

SlaveSyncPosition: [mm] The coupling is fully active from this slave position.

SyncMode: Currently not supported.

MasterStartDistance: [mm] This is the master distance over which the coupling is established.

Acceleration: [mm/s^2] The acceleration permitted for the synchronization in actual value units of the axis per square second.

Deceleration: [mm/s^2] The deceleration permitted for the synchronization in actual value units of the axis per square second.

Jerk: [mm/s^3] The jerk to be applied.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

StartSync: Indicates the transition phase between idle state and fully active coupling.

InSync: This indicates the first successful synchronization of the axes. The signal the remains active, even if the synchronization subsequently fails temporarily or permanently.

Busy: Indicates that a command is being processed.

Active: Indicates that a command is being processed.

CommandAborted: This indicates abortion of the coupling.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Master, Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- Next, the system checks whether **RatioDenominator** is 0. In this case the function block will react by asserting **Error** with **ErrorID**:=dwTcHydErrCdIllegalGearFactor.
- **If RatioDenominator** is less than 0, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotSupport.
- The coupling can only be activated if the slave is at standstill. Otherwise the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotStartable.
- If the absolute value of the **MasterStartDistance** is too small, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdCannotSynchronize.
- If the actual position of the master is not between **MasterSyncPosition** and the end of the synchronization distance specified by **MasterStartDistance,** the system responds with **Error** and **ErrorID**:=dwTcHydErrCdCannotSynchronize.

If these checks could be performed without problem, the coupling is initiated. The slave axis initially continues to be in state McState_Standstill [▸ 78]. Only when the master axis reaches the start of the synchronization distance for the first time does the slave axis report McState_Synchronizedmotion [▸ 78] and indicate **StartSync,** and the function block starts monitoring the coupling. As soon as the axis reaches the end the synchronization distance for the first time, the slave axis indicates **InSync**. Should the master axis later pass the start of the synchronization distance backwards, the coupling is not released.

If an error code occurs in the motion generator while the coupling is active, the system responds with **Error** and **ErrorID**:=motion algorithm error code.

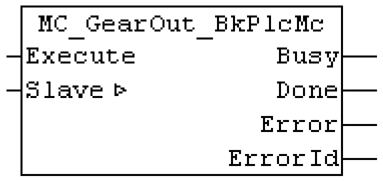
A negative edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the coupling is still active, the existing coupling remains unaffected and active.

An example is available under #103 [▸ 255].

CAUTION! The function block does not support the functionality of TwinCAT NC.

NOTE! The output Active is currently identical to the output Busy.

4.2.8 MC_GearOut_BkPlcMc (from V3.0)



The function block releases a coupling between two axes. This coupling must have been established with an MC_GearIn_BkPlcMc [▶ 51] or an MC_GearInPos_BkPlcMc [▶ 53] function block.

```
VAR_INPUT
    Execute:         BOOL;
END_VAR
VAR_OUTPUT
    Busy:            BOOL;
    Done:            BOOL;
    Error:           BOOL;
    ErrorID:         UDINT;
END_VAR
VAR_INOUT
    Slave:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input releases the coupling.

Busy: Indicates that a command is being processed.

Done: Successful processing of the movement is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Slave: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

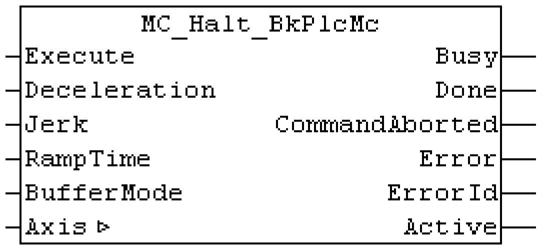
Behavior of the function block:

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is not operated in a gear coupling, the function block immediately indicates **Done** and omits all further checks or activities.
- If the current set velocity of the axis is smaller than the velocity specified by pStAxParams.fCreepSpeed, the axis immediately assumes McState_Standstill and dissipates the residual velocity. **Done** is indicated, and no further checks or activities take place.

If these checks could be performed without problem and **Done** is not already indicated for one of the reasons mentioned, the motion controlled by the gear coupling is converted to a continuous motion with the same velocity and direction, which is independent of the master. **Done** is indicated if this conversion was executed successfully, otherwise the system responds with **Error** and **ErrorID**:=error code.

4.2.9 MC_Halt_BkPlcMc (from V3.0)



The function block cancels a current axis motion and monitors the stop operation.

NOTE! The stop operation initiated by this function block can be interrupted by other function blocks. An MC_Stop_BkPlcMc function block can be used to prevent the axis from restarting during a stop operation.

```
VAR_INPUT
    Execute:        BOOL;
    Deceleration:   LREAL;  (ab/from V3.0.5)
    Jerk:           LREAL;  (ab/from V3.0.5)
    RampTime:       LREAL;  (ab/from V3.0.5)
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
    Active:         BOOL;
    CommandAborted: BOOL;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input ends a movement being carried out by the axis.

Deceleration: [mm/s^2] The deceleration to be applied.

Jerk: [mm/s^3] The jerk to be applied.

RampTime: [s] The required stopping time.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: This indicates successful processing of the operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that a command is being processed.

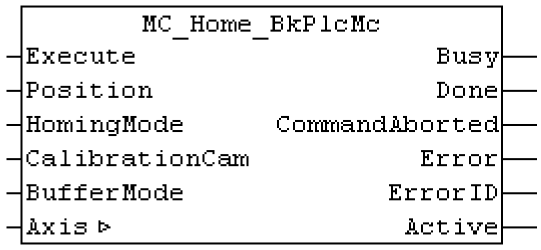
CommandAborted: Indicates that processing of this command was canceled by another command.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The behavior of the function block is identical to that of the MC_Stop_BkPlcMc [▶ 66]() function block. The only difference is that processing of the command can be canceled by other function blocks.

4.2.10 MC_Home_BkPlcMc (from V3.0)



This function block starts and monitors the homing of an axis.

```
VAR_INPUT
    Execute:        BOOL;
    Position:       LREAL;
    HomingMode:     MC_HomingMode_BkPlcMc;
    CalibrationCam: BOOL;
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The homing is initiated by a positive edge at this input.

Position: [mm] The reference position.

HomingMode: Specifies the method [▶ 91] to be used.

CalibrationCam: This can be used for direct transfer of the referencing index (cam).

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: Successful processing of the homing is indicated here.

CommandAborted: Abortion of homing is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- Homing can only be started from a stationary condition without errors. If that is not the case, the function block will react by asserting **Error** with **ErrorID**:=dwTcHydErrCdNotStartable or with the error code that is passed to it.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If one of the velocities stated in the axis parameters is too small (less than 1% of the reference velocity) the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdSetVelo.

Homing begins if these checks are carried out without problems. The exact sequence is specified by HomingMode [▸ 91]. If the movement algorithm reports an error code while homing is being executed, the function block responds with **Error** and **ErrorID**:=the movement algorithm's error code. If completion of homing is prevented by the activity of another function block, the function block responds with **CommandAborted**. Successful completion of homing is reported with **Done**.

A negative edge at **Execute** clears all the pending output signals. If, while homing is still active, **Execute** is set to FALSE, execution of homing that had started continues unaffected. The signals provided at the end of the movement (**Error**, **ErrorID, CommandAborted**, **Done**) are made available for one cycle.

CAUTION! fEnc_DefaultHomePosition in pStAxParams is provided for circumstances in which the application does not itself specify a reference position and a value saved with the machine data is to be loaded for use instead. If different values are required, depending on the situation, use should be made of fCustomerData[] in pStAxParams.

If iTcMc_EncoderSim is set as encoder type, the mode MC_Direct_BkPlcMc takes effect, irrespective of **HomingMode** and Axis_Ref_BkPlcMc [▸ 67].stAxParams.nEnc_HomingType.

MC_DefaultHomingMode_BkPlcMc

The referencing method is not specified by the application, but through Axis_Ref_BkPlcMc [▸ 67].stAxParams.nEnc_HomingType. The following rules apply:

nEnc_HomingType	MC_HomingMode_BkPlcMc
iTcMc_HomingOnBlock	MC_Block_BkPlcMc
iTcMc_HomingOnIndex	MC_AbsSwitch_BkPlcMc
iTcMc_HomingOnSync	MC_RefPulse_BkPlcMc
iTcMc_HomingOnExec	MC_Direct_BkPlcMc

MC_AbsSwitch_BkPlcMc

The axis is moved with Axis_Ref_BkPlcMc [▸ 67].stAxParams.fEnc_RefIndexVelo in the direction specified by bEnc_RefIndexPositive. The axis stops if **CalibrationCam** becomes TRUE or if the reference cam (bit 5, dwTcHydDcDwRefIndex) is detected in Axis_Ref_BkPlcMc [▸ 67].stAxRtData.nDeCtrlDWord. The axis is then moved with fEnc_RefSyncVelo in the direction specified by bEnc_RefSyncPositive, until the reference cam is exited. The actual value for the axis is set to the value of the reference position.

MC_LimitSwitch_BkPlcMc

Not currently supported.

MC_RefPulse_BkPlcMc

The axis is moved with Axis_Ref_BkPlcMc [▸ 67].stAxParams.fEnc_RefIndexVelo in the direction specified by bEnc_RefIndexPositive. The axis stops if **CalibrationCam** becomes TRUE or if the reference cam (bit 5, dwTcHydDcDwRefIndex) is detected in Axis_Ref_BkPlcMc [▸ 67].stAxRtData.nDeCtrlDWord. The axis is then moved with fEnc_RefSyncVelo in the direction specified by bEnc_RefSyncPositive, until the reference cam is exited. The encoder's hardware latch is then activated, and the axis is moved on until the latch becomes valid. After the axis has stopped, the actual value for the axis is set to a value that is calculated from the reference position and from the distance covered since the encoder's sync pulse was detected.

MC_Direct_BkPlcMc

The actual value of the axis is immediately set to the value of the reference position.

MC_Absolute_BkPlcMc

Not currently supported.

MC_Block_BkPlcMc

The axis is moved with Axis_Ref_BkPlcMc [▶ 67].stAxParams.fEnc_RefIndexVelo in the direction specified by bEnc_RefIndexPositive. If no movement is detected over a period of 2 seconds, the fixed stop (block) is considered to have been reached. The actual value for the axis is set to the value of the reference position.

From version 3.0.41 of 12 October 2017 it is possible to change the time period for the function block detection. See ST_TcHydAxRtData [▶ 99].fBlockDetectDelay.

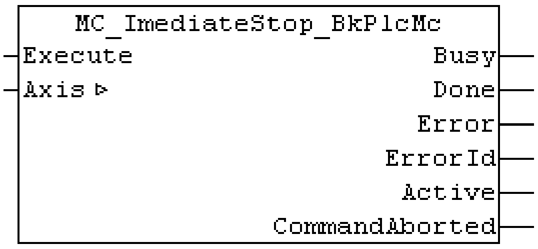
MC_FlyingSwitch_BkPlcMc

Not currently supported.

MC_FlyingRefPulse_BkPlcMc

Not currently supported.

4.2.11 MC_ImediateStop_BkPlcMc (from V3.0.5)



The function block cancels a current axis motion.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
    Active:         BOOL;
    CommandAborted: BOOL;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input ends a movement being carried out by the axis.

Busy: Indicates that a command is being processed.

Done: This indicates successful processing of the operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that a command is being processed.

CommandAborted: Indicates that processing of this command was cancelled by another command.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

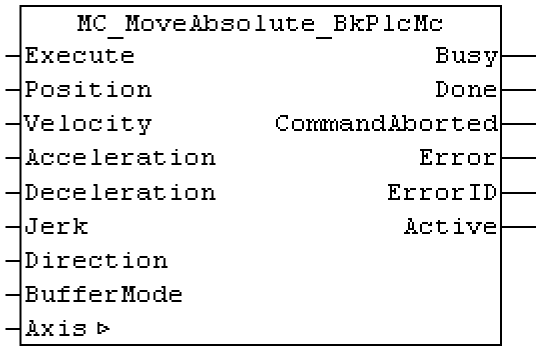
Behavior of the function block:

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- The stop can only be executed if the axis is actively carrying out a movement. If it is stationary, the function block immediately asserts the **Done** signal.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If the axis is in a state, in which it is controlled by a coupling with another axis or a comparable mechanism, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.

The Stop operation begins if these checks can be carried out without problems. The control value of the axis is immediately set to 0, without any ramp. All outputs of control or regulation voltages are then suppressed, as long as **Execute** is set to TRUE.

4.2.12 MC_MoveAbsolute_BkPlcMc (from V3.0)



This function block starts and monitors the movement of an axis.

```
VAR_INPUT
    Execute:        BOOL;
    Position:       LREAL;
    Velocity:       LREAL;
    Acceleration:   LREAL;
    Deceleration:   LREAL;
    Jerk:           LREAL;
    Direction:      MC_Direction_BkPlcMc:=MC_Shortest_Way_BkPlcMc;   (ab/from V3.0.8)
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;        (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The movement is initiated by a positive edge at this input.

Position: [mm] The target position of the movement in actual value units of the axis.

Velocity: [mm/s] The required motion velocity in actual value units of the axis per second.

Acceleration: [mm/s^2] The required acceleration in actual value units of the axis per square second. If this parameter is 0.0, it is replaced by a default value from the axis parameters.

Deceleration: [mm/s^2] The required deceleration in actual value units of the axis per square second. If this parameter is 0.0, it is replaced by a default value from the axis parameters.

Jerk: [mm/s^3] reserved.

Direction: Reserved. This input was only amended for compatibility reasons and either should not be assigned, or the constant MC_Shortest_Way_BkPlcMc should be assigned to it. (from V3.0.8)

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: Successful processing of the movement is indicated here.

CommandAborted: Abortion of the movement is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

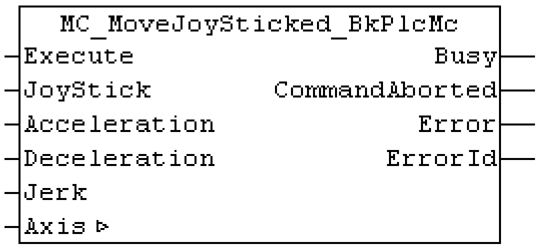
- The possibility that **Position** is located behind an active software limit switch is checked next. In this case the function block will react by asserting **Error** with **ErrorID**:=dwTcHydErrCdSoftEnd.
- Depending on the movement algorithm specified in **Axis.pStAxParams^.nProfile** the axis may either only be able to begin the movement initiated here when stationary, or may be able to begin from another movement that has not yet been completed. If it is unable at the present time to accept this new order, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotStartable.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Velocity** is too small (less than 1% of the reference velocity) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdSetVelo.
- If **Acceleration** is too small (the **Velocity** cannot be reached within 100 seconds) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdAcc.
- If **Deceleration** is too small (the **Velocity** cannot be reached within 100 seconds) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdDec.
- If the movement algorithm is already indicating an error code, the function block responds with **Error** and **ErrorID**:= the movement algorithm's error code.

The movement begins if these checks can be carried out without problems. This is done by limiting the parameters **Position, Velocity, Acceleration** and **Deceleration** to the maximum permissible values and passing them to the movement algorithm. The axis is now in the McState_DiscreteMotion [▸ 78] state, and the function block begins to monitor the movement.

If the movement algorithm reports an error code while the movement is being executed, the function block responds with **Error** and **ErrorID**:=the movement algorithm's error code. If completion of the movement is prevented by the activity of another function block, the function block responds with **CommandAborted**. If the movement algorithm achieves the target conditions for the axis, the function block reacts with **Done**.

A negative edge at **Execute** clears all the pending output signals. If, while the movement is still active, **Execute** is set to FALSE, execution of the movement that had started continues unaffected. The signals provided at the end of the movement (**Error**, **ErrorID, CommandAborted**, **Done**) are made available for one cycle.

4.2.13 MC_MoveJoySticked_BkPlcMc (from V3.0)



This function block starts and monitors the movement of an axis.

NOTE! This function is currently only supported by axes, which are controlled by a function block of type MC_AxRuntimeCtrlBased_BkPlcMc (in preparation: MC_AxRunTimeTimeRamp_BkPlcMc). Such a function block is selected by specifying the corresponding constant from E_TcMcProfileType under nProfileType in ST_TcHydAxParam.

```
VAR_INPUT
    Execute:        BOOL;
    JoyStick:       LREAL;
    Acceleration:   LREAL;
    Deceleration:   LREAL;
    Jerk:           LREAL;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The movement is initiated by a positive edge at this input.

JoyStick: [1] The velocity specified via the control unit, normalized to the range ±1.0.

Acceleration: [mm/s^2] The required acceleration in actual value units of the axis per square second.

Deceleration: [mm/s^2] The required deceleration in actual value units of the axis per square second.

Jerk: [mm/s^3] reserved.

Busy: Indicates that a command is being processed.

CommandAborted: Abortion of the movement is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

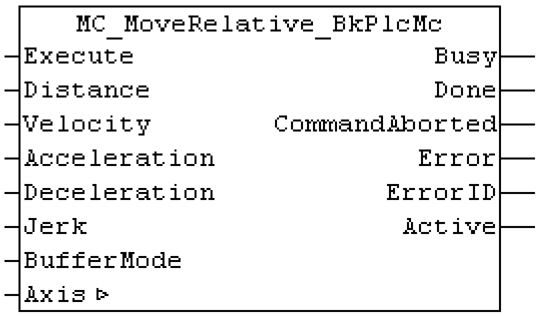
The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If the movement algorithm is already indicating an error code, the function block responds with **Error** and **ErrorID**:= the movement algorithm's error code.
- Next, the system checks whether the generator of the axis supports the required function. If this is not the case, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.

The movement begins if these checks can be carried out without problems. To this end the motion algorithm is set to state iTcHydStateExtGenerated and the axis to state McState_Synchronizedmotion. The axis velocity is specified through **JoyStick** and ST_TcHydAxParam [▸ 93].fRefVelo. Changes in velocity are accompanied by ramp limitation to ST_TcHydAxParam [▸ 93].fMaxAcc. If the axis moves towards an active software limit switch, the velocity is limited, depending on the remaining distance, such that the limit switch is approached correctly.

A falling edge at **Execute** offset puts motion algorithm in state iTcHydStateTcDecP or iTcHydStateTcDecM and the axis in state McState_Standstill. If the axis is in motion at this point in time, it is decelerated with a stop ramp and assumes state iTcHydStateIdle.

4.2.14 MC_MoveRelative_BkPlcMc (from V3.0)



This function block starts and monitors the movement of an axis.

```
VAR_INPUT
    Execute:        BOOL;
    Distance:       LREAL;
    Velocity:       LREAL;
    Acceleration:   LREAL;
    Deceleration:   LREAL;
    Jerk:           LREAL;
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;     (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The movement is initiated by a positive edge at this input.

Distance: [mm] The distance to the target position of the movement in actual value units of the axis.

Velocity: [mm/s] The required motion velocity in actual value units of the axis per second.

Acceleration: [mm/s^2] The required acceleration in actual value units of the axis per square second.

Deceleration: [mm/s^2] The required deceleration in actual value units of the axis per square second.

Jerk: [mm/s^3] reserved.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: Successful processing of the movement is indicated here.

CommandAborted: Abortion of the movement is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

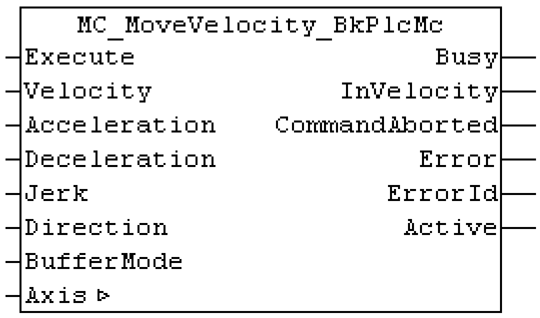
- The possibility that moving through **Distance** will lead to a conflict with an active software limit switch is checked next. In this case the function block will react by asserting **Error** with **ErrorID**:=dwTcHydErrCdSoftEnd.
- Depending on the movement algorithm specified in **Axis.pStAxParams^.nProfile** the axis may either only be able to begin the movement initiated here when stationary, or may be able to begin from another movement that has not yet been completed. If it is unable at the present time to accept this new order, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotStartable.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Velocity** is too small (less than 1% of the reference velocity) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdSetVelo.
- If **Acceleration** is too small (the **Velocity** cannot be reached within 100 seconds) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdAcc.
- If **Deceleration** is too small (the **Velocity** cannot be reached within 100 seconds) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdDec.
- If the movement algorithm is already indicating an error code, the function block responds with **Error** and **ErrorID**:= the movement algorithm's error code.

The movement begins if these checks can be carried out without problems. This is done by limiting the parameters **Distance, Velocity, Acceleration** and **Deceleration** to the maximum permissible values and passing them to the movement algorithm. The axis is now in the McState_DiscreteMotion [▶ 78] state, and the function block begins to monitor the movement.

If the movement algorithm reports an error code while the movement is being executed, the function block responds with **Error** and **ErrorID**:=the movement algorithm's error code. If completion of the movement is prevented by the activity of another function block, the function block responds with **CommandAborted**. If the movement algorithm achieves the target conditions for the axis, the function block reacts with **Done**.

A negative edge at **Execute** clears all the pending output signals. If, while the movement is still active, **Execute** is set to FALSE, execution of the movement that had started continues unaffected. The signals provided at the end of the movement (**Error**, **ErrorID, CommandAborted**, **Done**) are made available for one cycle.

4.2.15 MC_MoveVelocity_BkPlcMc (from V3.0)



This function block starts and monitors the movement of an axis.

```
VAR_INPUT
    Execute:        BOOL;
    Velocity:       LREAL;
    Acceleration:   LREAL;
    Deceleration:   LREAL;
    Direction:      MC_Direction_BkPlcMc;
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    InVelocity:     BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The movement is initiated by a positive edge at this input.

Velocity: [mm/s] The required motion velocity in actual value units of the axis per second.

Acceleration: [mm/s^2] The required acceleration in actual value units of the axis per square second.

Deceleration: [mm/s^2] The required deceleration in actual value units of the axis per square second.

Direction: A direction specification, coded according to MC_Direction_BkPlcMc [▶ 90].

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

InVelocity: This output becomes TRUE when the axis reaches the required velocity for the first time.

CommandAborted: Abortion of the movement is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

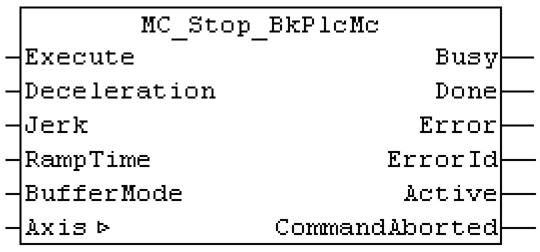
- Depending on the movement algorithm specified in **Axis.pStAxParams^.nProfile** the axis may either only be able to begin the movement initiated here when stationary, or may be able to begin from another movement that has not yet been completed. If it is unable at the present time to accept this new order, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdNotStartable.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Velocity** is too small (less than 1% of the reference velocity) the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdSetVelo.
- If the movement algorithm is already indicating an error code, the function block responds with **Error** and **ErrorID**:= the movement algorithm's error code.

The movement begins if these checks can be carried out without problems. This is done by selecting a value for the target position depending on **Direction** and the parameters for the software limit switches. The parameters **Velocity, Acceleration** and **Deceleration** are then limited to the maximum permissible values and are passed to the movement algorithm. The axis is now in the McState_Continuousmotion [▶ 78] state, and the function block begins to monitor the movement.

If the movement algorithm reports an error code while the movement is being executed, the function block responds with **Error** and **ErrorID**:=the movement algorithm's error code. If completion of the movement is prevented by the activity of another function block, the function block responds with **CommandAborted**. **InVelocity** is set when the motion algorithm reaches the required velocity.

A negative edge at **Execute** clears all the pending output signals. If, while the movement is still active, **Execute** is set to FALSE, execution of the movement that had started continues unaffected. The signals provided at the end of the movement (**Error**, **ErrorID, CommandAborted, InVelocity**) are made available for one cycle.

4.2.16 MC_Stop_BkPlcMc (from V3.0)



The function block cancels a current axis motion and monitors the stop operation.

NOTE! The stop operation initiated by this function block cannot be interrupted by other function blocks. A function block MC_Halt_BkPlcMc should be used to enable an axis restart during a stop operation.

```
VAR_INPUT
    Execute:        BOOL;
    Deceleration:   LREAL;  (ab/from V3.0.5)
    Jerk:           LREAL;  (ab/from V3.0.5)
    RampTime:       LREAL;  (ab/from V3.0.5)
    BufferMode:     MC_BufferMode_BkPlcMc:=Aborting_BkPlcMc;    (ab/from V3.0.8)
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
    Active:         BOOL;
    CommandAborted: BOOL;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input ends a movement being carried out by the axis.

Deceleration: [mm/s^2] The deceleration to be applied.

Jerk: [mm/s^3] The jerk to be applied.

RampTime: [s] The required stopping time.

BufferMode: Reserved. This input is provided in preparation for a future build. It should currently either not be assigned or assigned the constant Aborting_BkPlcMc. (from V3.0.8)

Busy: Indicates that a command is being processed.

Done: This indicates successful processing of the operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that a command is being processed.

CommandAborted: Indicates that processing of this command was canceled by another command.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

The function block is activated by a positive edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- The stop can only be executed if the axis is actively carrying out a movement. If it is stationary, the function block immediately asserts the **Done** signal.
- If the axis is already in a fault state, or if it is in the process of carrying out a stop operation, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If the axis is in a state, in which it is controlled by a coupling with another axis or a comparable mechanism, it responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.

The Stop operation begins if these checks can be carried out without problems. **Deceleration** is used, if this parameter is recognizably greater than 0. Otherwise **RampTime** is used to calculate a deceleration, taking into account the reference speed. If a jerk-limiting control value generator is selected, **Jerk** is used if this parameter is recognizably greater than 0. If none of the mentioned parameters is recognizably greater than 0, the axis parameter MaxDec and MaxJerk are used.

The next reachable position is determined and used as new target position, taken into account the current set velocity and the currently valid parameters. Once this position has been reached, the axis assumes its regular behavior in idle state.

NOTE! The RampTime specifies the time during which the axis is to be decelerated from its reference speed to standstill. If the axis moves with a different velocity, the braking time reduces accordingly. If control value generators with creep mode are used, the corresponding time is added to the braking time.

If the movement algorithm reports an error code while the movement is being executed, the function block responds with **Error** and **ErrorID**:=the movement algorithm's error code. If completion of the process is prevented by the activity of another function block, the function block responds with **CommandAborted**. Successful completion of the operation is reported with **Done**.

A negative edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the operation is still active, the initiated stop continues unaffected. The signals provided at the end of the movement (**Error**, **ErrorID, Done**) are made available for one cycle.

NOTE! The output Active is currently identical to the output Busy.

4.3 Data types

4.3.1 Axis_Ref_BkPlcMc (from V3.0)

The variables in this structure consolidate the subcomponents of the axis. A variable of this type is transferred to most function blocks of the library. This type therefore corresponds to the AXIS_REF data type of PLCopen.

```
TYPE Axis_Ref_BkPlcMc:
STRUCT
    sAxisName:           STRING(83) := 'NoName';
    pStAxLogBuffer:      POINTER TO ST_TcMcLogBuffer:=0;
    pStDeviceInput:      POINTER TO ST_TcPlcDeviceInput:=0;
    pStDeviceOutput:     POINTER TO ST_TcPlcDeviceOutput:=0;
    pStAxAuxLabels:      POINTER TO ST_TcMcAuxDataLabels:=0;
    pStAxAutoParams:     POINTER TO ST_TcMcAutoIdent:=0;
    pStAxCommandBuf:     POINTER TO ST_TcPlcCmdBuffer_BkPlcMc:=0;
    nActiveRequest:     UDINT := 0;
    nNextRequest:       UDINT := 1;
    bParamsEnable:      BOOL:=FALSE;
    nState:             E_TcMCFbState:=McState_Standstill;
    nInitState:         INT:=0;
    nInitError:         DINT:=0;
    nInterfaceType:     UINT := 16#FFFF;
    nDeviceInType:      UINT := 16#FFFF;
    nDeviceOutType:     UINT := 16#FFFF;
    nRtDataType:        UINT := 16#FFFF;
    nParamType:         UINT := 16#FFFF;
    nLogBufferType:     UINT := 16#FFFF;
    nAxAutoIdentType:   UINT := 16#FFFF;
    nCmdBufferType:     UINT := 16#FFFF;
    nLogLevel:          DINT := 0;
    nDebugTag:          UDINT := 16#00000000;
    stAxParams:         ST_TcHydAxParam;
    stAxRtData:         ST_TcHydAxRtData;
END_STRUCT
END_TYPE
```

sAxisName: The text name of the axes.

pStAxLogBuffer: The address of a variable of type ST_TcMcLogBuffer [▸ 107]. This variable contains the LogBuffer of the library.

pStDeviceInput: The address of a variable of type ST_TcPlcDeviceInput [▸ 104]. This variable contains all input interfaces of the axis.

pStDeviceOutput: The address of a variable of type ST_TcPlcDeviceOutput [▸ 106]. This variable contains all output interfaces of the axis.

pStAxAuxLabels: The address a variable of type ST_TcMcAuxDataLabels [▸ 103]. This variable optionally contains the application parameter IDs in ST_TcHydAxParam:fCustomerData[..].

pStAxAutoParams: The address a variable of type ST_TcMcAutoIdent [▸ 93]. This variable optionally contains the parameters for an MC_AxUtiAutoIdent_BkPlcMc [▸ 192] function block.

pStAxCommandBuf: From V3.0.8, the input **BufferMode** is available in various function blocks, as defined by PLCopen. The functionality that can be controlled with this is currently in preparation. In this context this command buffer was amended.

nActiveRequest: Every function block sets a code here that starts a function on this axis. After this, the function block monitors this variable to see if it is changed by another function block that is taking over control through another function. In this way any function block can tell whether a function that it has started has been interrupted by another function block, and can generate appropriate signals.

nNextRequest: Reserved. Used for generating new values for **nActiveRequest**.

bParamsEnable: This variable is only TRUE if the parameters have been placed into a valid state by being loaded from the file. Saving the parameters will also assert this signal, because this also ensures consistency between the data in the parameter structure and in the file. The axis is not ready to operate while this variable is not TRUE.

NOTE! At run-time, write accesses to the parameter structure temporarily set this variable to FALSE, after which it is returned to its previous state.

nState: The current state of the axis is stored here, encoded in accordance with E_TcMCFbState [▸ 78].

nInitState: The current state of the initialization.

nInitError: Any error code detected during initialization.

nInterfaceType: The type code of the currently valid Axis_Ref_BkPlcMc variable type.

nDeviceInType: The type code of the currently valid ST_TcPlcDeviceInput [▸ 104] variable type.

nDeviceOutType: The type code of the currently valid ST_TcPlcDeviceOutput [▸ 106] variable type.

nRtDataType: The type code of the currently valid ST_TcHydAxRtData [▸ 99] variable type.

nParamType: The type code of the currently valid ST_TcHydAxParam [▸ 93] variable type.

nLogBufferType: The type code of the currently valid ST_TcMcLogBuffer [▸ 107] variable type.

nAxAutoIdentType: The type code of the currently valid ST_TcMcAutoIdent [▸ 93] variable type.

nCmdBufferType: Reserved. The type code of the currently valid command buffer variable type.

nLogLevel: The message level [▸ 244], from which entries in the logging buffer are to be made.

nDebugTag: Many library blocks enter a debug ID here for the duration of their execution.

stAxParams: This variable of type ST_TcHydAxParam [▸ 93] contains the axis parameters.

stAxRtData: This variable of type ST_TcHydAxRtData [▸ 99] contains the runtime data of the axis.

Note	In order to make the data structures of the library independent of the CPU architecture (I86, Strong ARM), it is necessary to change the order of data or insert placeholders in some places. These placeholders contain a name in the form "bAlign_1"; the number has no purpose. Neither existence, name, type or dimensioning are guaranteed.

4.3.2 CAMSWITCH_REF_BkPlcMc (from V3.0)

A variable of this type is transferred to an MC_DigitalCamSwitch_BkPlcMc [▸ 48] function block.

```
TYPE CAMSWITCH_REF_BkPlcMc:
STRUCT
    Switch:     ARRAY [ciBkPlcMc_CamSwitchRef_MinIdx..ciBkPlcMc_CamSwitchRef_MaxIdx] OF CAM-
SWITCH_REFTYPE_BkPlcMc;
END_STRUCT
END_TYPE
```

```
TYPE CAMSWITCH_REFTYPE_BkPlcMc:
STRUCT
    TrackNumber:      INT;
    FirstOnPosition:  LREAL;
    LastOnPosition:   LREAL;
    AxisDirection:    INT;
    CamSwitchMode:    INT;
    Duration:         LREAL;
    (* private members, do not touch *)
    nCurrentState:    SINT:=0;
    bTriggered:       BOOL:=FALSE;
    fTimer:           LREAL;
    (**)
END_STRUCT
END_TYPE
```

TrackNumber: This is an index in an ARRAY [ciBkPlcMc_TrackRef_MinIdx..ciBkPlcMc_TrackRef_MaxIdx] OF TRACK_REF_BkPlcMc [▸ 109], which is transferred to a function block of type MC_DigitalCamSwitch_BkPlcMc [▸ 48].

FirstOnPosition: [mm] The start of the cam track. For time-controlled cams, this is the trigger position.

LastOnPosition: [mm] The end of the cam track. Has no effect for time-controlled cams.

AxisDirection: Specifies in which direction of travel the cam becomes active: 0 = both directions, 1 = positive direction, 2 = negative direction.

CamSwitchMode: The operating mode of the cam: For displacement-controlled cams enter 0, for time-controlled cams enter 1.

Duration: [s] For time-controlled cams enter the switch-on time in seconds.

nCurrentState, **bTriggered**, **fTimer**: These elements are runtime variables and must not be influenced or used by the application.

4.3.3 E_TcPlcBufferedCmdType_BkPlcMc

The constants in this list are used to identify buffered axis commands. See MC_BufferMode_BkPlcMc [▸ 89].

```
TYPE E_TcPlcBufferedCmdType_BkPlcMc : (
(* last modification: xx.xx.2009 *)
iBufferedCmd_NoOperation,
iBufferedCmd_MoveAbsolute,
iBufferedCmd_MoveRelative,
iBufferedCmd_MoveVelocity,
(**)
iBufferedCmd_Stop,
iBufferedCmd_ResetAndStop,
iBufferedCmd_Halt,
iBufferedCmd_CamIn,
iBufferedCmd_GearIn,
iBufferedCmd_Power,
iBufferedCmd_Home,
iBufferedCmd_StepAbsSwitch,
iBufferedCmd_StepLimitSwitch,
iBufferedCmd_StepBlock,
iBufferedCmd_StepDirect,
iBufferedCmd_FinishHoming,
(**)
iBufferedCmdEx_Jerk:=100,
iBufferedCmdEx_Acc,
iBufferedCmdEx_Velo,
iBufferedCmdEx_Creep,
(**)
iBufferedCmd_
);
END_TYPE
```

iBufferedCmd_NoOperation: This constant is used as initial value for call parameters of function blocks and in variables.

iBufferedCmd_MoveAbsolute: The cached command was entered by an MC_MoveAbsolute_BkPlcMc block. See note #1.

iBufferedCmd_MoveRelative: The cached command was entered by an MC_MoveRelative_BkPlcMc block. See note #1.

iBufferedCmd_MoveVelocity: The cached command was entered by an MC_MoveVelocity_BkPlcMc block. See note #1.

iBufferedCmd_Stop: reserved, not implemented.

iBufferedCmd_ResetAndStop: reserved, not implemented.

iBufferedCmd_Halt: reserved, not implemented.

iBufferedCmd_CamIn: reserved, not implemented.

iBufferedCmd_GearIn: reserved, not implemented.

iBufferedCmd_Power: reserved, not implemented.

iBufferedCmd_Home: reserved, not implemented.

iBufferedCmd_StepAbsSwitch: reserved, not implemented.

iBufferedCmd_StepLimitSwitch: reserved, not implemented.

iBufferedCmd_StepBlock: reserved, not implemented.

iBufferedCmd_StepDirect: reserved, not implemented.

iBufferedCmd_FinishHoming: reserved, not implemented.

iBufferedCmdEx_Jerk: The command component associated with constant-jerk motion was entered by a function block. See note #2.

iBufferedCmdEx_Acc: The command component associated with constant acceleration or deceleration was entered by a function block. See note #2.

iBufferedCmdEx_Velo: The command component associated with constant-velocity motion was entered by a function block. See note #2.

iBufferedCmdEx_Creep: reserved, not implemented.

NOTE! #1 If the axis uses a set value generator type without look-ahead, complete commands are entered as a buffer element.

NOTE! #2 If the axis uses a set value generator type with look-ahead, commands are split into sections and entered as a package typically consisting of seven buffer elements (jerk, acceleration, jerk, velocity, jerk, deceleration, jerk).

4.3.4 E_TcMcCurrentStep (from V3.0)

The constants in this list are used for identifying the internal states of the control value generators.

NOTE! Not all of these states are used by all control value generators.

```
TYPE E_TcMcCurrentStep :(
iTcHydStateIdle,
iTcHydStateTcAccP,
iTcHydStateTcAccM,
iTcHydStatePcAccP,
iTcHydStatePcAccM,
iTcHydStateConstVeloP,
iTcHydStateConstVeloM,
iTcHydStatePcDecP,
iTcHydStatePcDecM,
iTcHydStateCreepVeloP,
iTcHydStateCreepVeloM,
iTcHydStateTcDecP,
iTcHydStateTcDecM,
iTcHydStateFeedStopPos,
iTcHydStateFeedStopNeg,
iTcHydStateDoBrake,
iTcHydStateCoupling := 1000,
iTcHydStateCoupled,
iTcHydStateExtCoupled,
iTcHydStateExtGenerated := 2000,
iTcHydStateEmergencyBreak := 9000,
iTcHydStateFault := 9999
);
END_TYPE
```

iTcHydStateIdle: The axis is not actively moving. Its behavior is controlled by ST_TcHydAxParam.fLagAmp, ST_TcHydAxParam.fTargetClamping and ST_TcHydAxParam.fReposDistance.

iTcHydStateTcAccP: The axis establishes a positive control value according to ST_TcHydAxRtData.fDestAcc. This value is set by one of the start function blocks according to the data of the travel command. This state is assumed when the control value reaches the specified motion control value. If the system detects that the braking process for the target approach has to be initiated, the state is changed to **iTcHydStatePcDecP**. In the absence of feed enable, the state is changed to **iTcHydStateFeedStopPos**.

iTcHydStateTcAccM: The axis establishes a negative control value according to ST_TcHydAxRtData.fDestAcc. This value is set by one of the start function blocks according to the data of the travel command. This state is assumed when the control value reaches the specified motion control value. If the system detects that the braking process for the target approach has to be initiated, the state is changed to **iTcHydStatePcDecM**. In the absence of feed enable, the state is changed to **iTcHydStateFeedStopNeg**.

iTcHydStatePcAccP: The axis is in the displacement-controlled acceleration phase of a travelling motion in positive direction. The control value is set to a value specified by the travel command according to ST_TcHydAxRtData.fDestAcc. The state then changes to **iTcHydStateConstVeloP**.

iTcHydStatePcAccM: The axis is in the displacement-controlled acceleration phase of a travelling motion in negative direction. The control value is set to a value specified by the travel command according to ST_TcHydAxRtData.fDestAcc. The state then changes to **iTcHydStateConstVeloM**.

iTcHydStateConstVeloP: The axis travels in positive direction with constant control value. The control value is specified by the travel command.

iTcHydStateConstVeloM: The axis travels in negative direction with constant control value. The control value is specified by the travel command.

iTcHydStatePcDecP: The axis is in the displacement-controlled brake phase of a travelling motion in positive direction. The control value is reduced to ST_TcHydAxParam.fCreepSpeed. The state then changes to **iTcHydStateCreepVeloP**.

iTcHydStatePcDecM: The axis is in the displacement-controlled brake phase of a travelling motion in negative direction. The control value is reduced to ST_TcHydAxParam.fCreepSpeed. The state then changes to **iTcHydStateCreepVeloM**.

iTcHydStateCreepVeloP: The axis travels in positive direction with constant control value. The control value is specified by ST_TcHydAxParam.fCreepSpeed.

iTcHydStateCreepVeloM: The axis travels in negative direction with constant control value. The control value is specified by ST_TcHydAxParam.fCreepSpeed.

iTcHydStateTcDecP: The axis executes a regular stop, starting from a travelling motion in positive direction. The control value is reduced with ST_TcHydAxParam.fStopRamp. The state then changes to **iTcHydStateIdle**.

iTcHydStateTcDecM: The axis executes a regular stop, starting from a travelling motion in negative direction. The control value is reduced with ST_TcHydAxParam.fStopRamp. The state then changes to **iTcHydStateIdle**.

iTcHydStateFeedStopPos: The axis executes an intermediate stop, due to lack of feed enable in positive direction (dwTcHydDcDwFdPosEna is not set in ST_TcHydAxRtData.nDeCtrlDWord). The control value is reduced with ST_TcHydAxParam.fStopRamp. The axis then waits for a feed enable.

iTcHydStateFeedStopNeg: The axis executes an intermediate stop, due to lack of feed enable in negative direction (dwTcHydDcDwFdNegEna is not set in ST_TcHydAxRtData.nDeCtrlDWord). The control value is reduced with ST_TcHydAxParam.fStopRamp. The axis then waits for a feed enable.

iTcHydStateDoBrake: The axis executes a waiting time. This is necessary, if switching is required due to a brake or a switching valve.

iTcHydStateCoupling: The axis is in transition to state **iTcHydStateCoupled**.

iTcHydStateCoupled: The control value of the axis is derived from the control value of another axis based on the principle of electronic gearing.

iTcHydStateExtCoupled: The control value of the axis is calculated based on the principle of continuously variable transmission.

iTcHydStateExtGenerated: The control value of the axis is generated by an external block. This may be a library block or an application-specific block.

iTcHydStateEmergencyBreak: The axis executes an emergency stop. The control value is reduced with ST_TcHydAxParam.fEmergencyRamp. The system then checks whether the axis is in an error state (ST_TcHydAxRtData.nErrorCode not equal 0). If yes, the state is changed to **iTcHydStateFault**, otherwise **iTcHydStateIdle**.

iTcHydStateFault: The axis is in an error state. It does not carry out actively control movements and does not accept motion commands. To put the axis back in an undisturbed state, call a function block of type MC_Reset_BkPlcMc or MC_ResetAndStop_BkPlcMc.

4.3.5 E_TcMcDriveType (from V3.0)

The constants listed here are used to identify the hardware used to output the control values for an axis.

```
TYPE E_TcMcDriveType :(
(*
The sequence below must not be changed!
New types have to be added at the end.
In case a type becomes obsolete it has to be replaced by a dummy
to ensure the numerical meaning of the other codes.
*)
(*
Die bestehende Reihenfolge darf nicht veraendert werden.
Neue Typen muessen am Ende eingefuegt werden.
Wenn ein Typ wegfallen sollte, muss er durch einen Dummy
ersetzt werden, um die numerische Zuordnung zu garantieren.
*)
(* last modification: 26.02.2016 *)
iTcMc_Drive_Customized,
iTcMc_DriveLowCostStepper,
iTcMc_DriveKL2521,
iTcMc_DriveKL4032,
iTcMc_DriveAx2000_B900R,
iTcMc_DriveM2400_D1,
iTcMc_DriveM2400_D2,
iTcMc_DriveM2400_D3,
iTcMc_DriveM2400_D4,
iTcMc_DriveLowCostStepperHS,
iTcMc_DriveLowCostStepperFS,
iTcMc_DriveIx2512_1Coil,
iTcMc_DriveIx2512_2Coil,
iTcMc_DriveKL2531,
iTcMc_DriveKL2541,
iTcMc_DriveEL4132,
iTcMc_DriveAx2000_B200R,
iTcMc_DriveAx2000_B110R,
iTcMc_DriveKL2532,
iTcMc_DriveKL2552,
iTcMc_DriveKL2535_1Coil,
iTcMc_DriveKL2535_2Coil,
iTcMc_DriveKL2545_1Coil,
iTcMc_DriveKL2545_2Coil,
iTcMc_DriveLowCostInverter,
iTcMc_Drive_CoE_DS408,
iTcMc_DriveAx2000_B110A,
iTcMc_DriveAx5000_B110A,
iTcMc_DriveAx2000_B750A,
iTcMc_Drive_CoE_DS402,
iTcMc_DriveAx5000_B110SR,
iTcMc_DriveEL4x22,
iTcMc_DriveEL2521,
iTcMc_DrivePumpEtcIO,
iTcMc_DriveEL2535_1Coil,
iTcMc_DriveEL2535_2Coil,
iTcMc_DriveEL7201,
iTcMc_DriveEL7037,
iTcMc_DriveEL7047,
iTcMc_DriveEM8908,
iTcMc_DriveAx5000_B110INC,
iTcMc_Drive_TestOnly:=1000
);
END_TYPE
```

iTcMc_Drive_Customized: The control value for the drive has not been prepared for output on any particular hardware. This process must be carried out by the PLC application itself.

iTcMc_DriveAx2000_B110A: The control value for the drive is processed for output on an AX2000 actuator at an absolute multi-turn encoder motor at the EtherCAT fieldbus.

iTcMc_DriveAx2000_B110R: The control value for the drive is processed for output on an AX2000 actuator at a resolver motor at the EtherCAT fieldbus.

iTcMc_DriveAx2000_B200R: The control value for the drive is processed for output on an AX2000 actuator at a resolver motor at the Beckhoff II/O fieldbus.

iTcMc_DriveAx2000_B750A: The control value for the drive is processed for output on an AX2000 actuator at an absolute multi-turn encoder motor at the Sercos fieldbus.

iTcMc_DriveAx2000_B900R: The control value for the drive is processed for output on an AX2000 actuator at a resolver motor at the Beckhoff RealTime Ethernet fieldbus.

iTcMc_DriveAx5000_B110A: The control value for the drive is processed for output on an AX5000 actuator at an absolute multi-turn encoder motor at the EtherCAT fieldbus.

iTcMc_DriveAx5000_B110SR: The control value for the drive is processed for output on an AX5000 actuator at an absolute single-turn encoder or resolver motor at the EtherCAT fieldbus.

iTcMc_DriveAx5000_B110INC: The control value for the drive is processed for output on an AX5000 actuator at an incremental encoder at the EtherCAT fieldbus.

iTcMc_DriveEL2521:The control value for the drive has been appropriately processed for output on a KL2521 Pulse Train terminal.

iTcMc_DriveEL2535_1Coil: The control value for the drive is processed for output on an EL2535 PWM motor output stage terminal.

iTcMc_DriveEL2535_2Coil: The control value for the drive is processed for output on an EL2535 PWM motor output stage terminal.

iTcMc_DriveEL4132: The control value for the drive has been appropriately processed for output on a ±10 V EL4132 analog output terminal.

iTcMc_DriveEL4x22: In preparation.

iTcMc_DriveEL7031: The control value for the drive is processed for output on an EL7031 stepper motor output stage terminal.

iTcMc_DriveEL7037: The control value for the drive is processed for output on an EL7037 stepper motor output stage terminal.

iTcMc_DriveEL7041: The control value for the drive is processed for output on an EL7041 stepper motor output stage terminal.

iTcMc_DriveEL7047: The control value for the drive is processed for output on an EL7047 stepper motor output stage terminal.

iTcMc_DriveEL7201: The control value for the drive is processed for output on an EL7201 servo terminal.

iTcMc_DriveEM8908: Reserved for sector-specific packet.

iTcMc_DriveIx2512_1Coil: The control value for the drive is processed for output on a Fieldbus Box IP/IE2512. The rules for valves with one coil apply.

iTcMc_DriveIx2512_2Coil: The control value for the drive is processed for output on a Fieldbus Box IP/IE2512. The rules for valves with two coils apply.

iTcMc_DriveKL2521: The control value for the drive has been appropriately processed for output on a KL2521 Pulse Train terminal.

iTcMc_DriveKL2531: The control value for the drive is processed for output on a KL2531 stepper motor output stage terminal.

iTcMc_DriveKL2532: The control value for the drive is processed for output on a KL2532 DC motor output stage terminal.

iTcMc_DriveKL2535_1Coil: The control value for the drive is processed for output on a KL2535 PWM motor output stage terminal.

iTcMc_DriveKL2535_2Coil: The control value for the drive is processed for output on a KL2535 PWM motor output stage terminal.

iTcMc_DriveKL2541: The control value for the drive is processed for output on a KL2541 stepper motor output stage terminal.

iTcMc_DriveKL2542: The control value for the drive is processed for output on a KL2542 DC motor output stage terminal.

iTcMc_DriveKL2545_1Coil: The control value for the drive is processed for output on a KL2545 PWM motor output stage terminal.

iTcMc_DriveKL2545_2Coil: The control value for the drive is processed for output on a KL2545 PWM motor output stage terminal.

iTcMc_DriveKL4032: The set value for the drive has been appropriately processed for output on a ±10 V KL4032 analog output terminal.

iTcMc_DriveLowCostInverter: The control value for the drive is processed for output in the form of digital output signals for a frequency converter with programmed fixed frequencies.

iTcMc_DriveLowCostStepper: The incremental set position changes are generated as a digital output signals for a directly controlled stepper motor. This code continues to be supported for reasons of compatibility, and has the same meaning as **iTcMc_DriveLowCostStepperHS**.

iTcMc_DriveLowCostStepperHS: The incremental set position changes are generated as a digital output signals for a directly controlled stepper motor. Half-stepping is being used.

iTcMc_DriveLowCostStepperFS: The incremental set position changes are generated as a digital output signals for a directly controlled stepper motor. Full-stepping is being used.

iTcMc_DriveM2400_D1: The control value for the drive has been appropriately processed for output on the first channel of an M2400 Box on the Beckhoff II/O.

iTcMc_DriveM2400_D2: The control value for the drive has been appropriately processed for output on the second channel of an M2400 Box on the Beckhoff II/O.

iTcMc_DriveM2400_D3: The control value for the drive has been appropriately processed for output on the third channel of an M2400 Box on the Beckhoff II/O.

iTcMc_DriveM2400_D4: The control value for the drive has been appropriately processed for output on the fourth channel of an M2400 Box on the Beckhoff II/O.

iTcMc_Drive_CoE_DS402: In preparation.

iTcMc_Drive_CoE_DS408: The control value for the drive is processed for output on a proportional valve at the EtherCAT fieldbus.

iTcMc_DrivePumpEtcIO: reserved

iTcMc_Drive_TestOnly: reserved for internal testing; do not use.

4.3.6 E_TcMcEncoderType (from V3.0)

The constants listed here are used to identify the hardware used to acquire the actual values for an axis.

```
TYPE E_TcMcEncoderType :(
(*
The sequence below must not be changed!
New types have to be added at the end.
In case a type becomes obsolete it has to be replaced by a dummy
to ensure the numerical meaning of the other codes.
*)
(*
Die bestehende Reihenfolge darf nicht veraendert werden.
Neue Typen muessen am Ende eingefuegt werden.
Wenn ein Typ wegfallen sollte, muss er durch einen Dummy
ersetzt werden, um die numerische Zuordnung zu garantieren.
*)
(* last modification: 17.01.2013 *)
iTcMc_EncoderSim,
iTcMc_EncoderDigIncrement,
iTcMc_EncoderLowCostStepper,
iTcMc_EncoderKL2521,
iTcMc_EncoderKL3042,
iTcMc_EncoderKL5001,
iTcMc_EncoderKL5101,
iTcMc_EncoderAx2000_B900R,
iTcMc_EncoderDigCam,
iTcMc_EncoderIx5009,
iTcMc_EncoderM2510,
iTcMc_EncoderKL3002,
iTcMc_EncoderKL2531,
iTcMc_EncoderKL5111,
iTcMc_EncoderAbs32,
iTcMc_EncoderM3120,
iTcMc_EncoderKL2541,
iTcMc_EncoderEL3102,
iTcMc_EncoderEL3142,
iTcMc_EncoderEL5001,
iTcMc_EncoderEL5101,
iTcMc_EncoderEL5111,
iTcMc_EncoderKL3062,
iTcMc_EncoderKL3162,
iTcMc_EncoderAx2000_B200R,
iTcMc_EncoderAx2000_B110R,
iTcMc_EncoderEL3162,
iTcMc_EncoderKL2542,
iTcMc_EncoderKL2545,
iTcMc_EncoderAx2000_B110A,
iTcMc_EncoderAx5000_B110A,
iTcMc_EncoderAx2000_B750A,
iTcMc_EncoderCoE_DS406,
iTcMc_EncoderCoE_DS402SR,
iTcMc_EncoderAx5000_B110SR,
iTcMc_EncoderCoE_DS402A,
iTcMc_EncoderEL2521,
iTcMc_EncoderAbs32Etc,
iTcMc_EncoderEL7201SR,
iTcMc_EncoderDigPulseCount,
iTcMc_EncoderEL3255,
iTcMc_EncoderEL7047,
iTcMc_DriveEM8908A,
iTcMc_DriveEM8908C,
iTcMc_EncoderCoE5001,
iTcMc_EncoderEL7201A,
iTcMc_DriveAx5000_B110INC,
iTcMc_EncoderEL5032,
iTcMc_EncoderEL5021,
iTcMc_Encoder_TestOnly:=1000
);
END_TYPE
```

iTcMc_EncoderAbs32: The absolute actual position is generated from the 32-bit value of a general electronic input system.

iTcMc_EncoderAbs32Etc: The absolute actual position is generated from the 32-bit value of a general EtherCAT electronic input system. Profile support is not a precondition.

iTcMc_EncoderAx2000_B110R: The incremental actual position is determined from the counter value of an AX2000 actuator at a resolver motor at the EtherCAT fieldbus.

iTcMc_EncoderAx2000_B110A: The absolute actual position is determined from the counter value of an AX2000 actuator at an absolute multi-turn encoder motor at the EtherCAT fieldbus.

iTcMc_EncoderAx2000_B200R: The incremental actual position is determined from the counter value of an AX2000 actuator at a resolver motor at the Beckhoff II/O fieldbus.

iTcMc_EncoderAx2000_B750A: The absolute actual position is determined from the counter value of an AX2000 actuator at an absolute multi-turn encoder motor at the Sercos fieldbus.

iTcMc_EncoderAx2000_B900R: The incremental actual position is determined from the counter value of an AX2000 actuator at a resolver motor at the Beckhoff RealTime Ethernet fieldbus.

iTcMc_EncoderAx5000_B110A: The absolute actual position is determined from the counter value of an AX5000 actuator at an absolute multi-turn encoder motor at the EtherCAT fieldbus.

iTcMc_EncoderAx5000_B110SR: The incremental actual position is determined from the counter value of an AX5000 actuator at a single turn encoder motor at the EtherCAT fieldbus.

iTcMc_EncoderAx5000_B110INC: The incremental actual position is determined from the counter value of an AX5000 actuator at an incremental encoder at the EtherCAT fieldbus.

iTcMc_EncoderDigCam: The position cam byte is generated from four digital input bits.

iTcMc_EncoderDigPulseCount: Counts the edges (positive and negative) of pulses. The direction of rotation is determined via the drive output. **NOTE! Only one pulse can be detected per PLC cycle.**

iTcMc_EncoderDigIncrement: The incremental actual value of the axis is generated by evaluating two digital input bits. These represent the A and B tracks of an incremental encoder, and are evaluated, in accordance with the principle of a quadrature decoder, using quadruple evaluation. **NOTE! Only one of the input bits may change its state in each PLC cycle. This means that the maximum velocity is one increment per TCycle.**

iTcMc_EncoderEL2521: The incremental actual position is generated from the pulse counter of an EL2521 Pulse Train terminal.

iTcMc_EncoderEL3102: The absolute actual position is generated from the ADW value of a ±10V EL3102 analog input terminal.

iTcMc_EncoderEL3142: The absolute actual position is generated from the ADW value of a 0..20 mA EL3142 analog input terminal.

iTcMc_EncoderEL3162: The absolute actual position is generated from the ADW value of a 0..10V EL3162 analog input terminal.

iTcMc_EncoderEL3255: In preparation.

iTcMc_EncoderEL5021: The absolute actual position is generated from the counter value of an EL5021 sin/cos input terminal.

iTcMc_EncoderEL5032: The absolute actual position is generated from the counter value of an EL5032 EnDat-2.2 input terminal.

iTcMc_EncoderEL5001: The absolute actual position is generated from the counter value from an EL5001 SSI input terminal.

iTcMc_EncoderEL5101: The incremental actual position is generated from the counter value from an EL5101 input terminal.

iTcMc_EncoderEL5111: The incremental actual position is generated from the counter value from an EL5111 input terminal.

iTcMc_EncoderEL7041: The incremental actual position is generated from the pulse counter (motor pulse or encoder) of an EL7041 stepper motor terminal.

iTcMc_EncoderEL7201SR: The incremental actual position is generated from the counter value from an EL7201 servo terminal.

iTcMc_EncoderCoE_DS402A: In preparation.

iTcMc_EncoderCoE_DS402SR: In preparation.

iTcMc_EncoderCoE_DS406: An encoder with CoE_406 support at the EtherCAT fieldbus.

iTcMc_EncoderIx5009: The absolute actual position is generated from the counter value of an SSI IP/IE5009 Fieldbus Box.

iTcMc_EncoderKL2521: The incremental actual position is generated from the pulse counter of a KL2521 Pulse Train terminal.

iTcMc_EncoderKL2531: The incremental actual position is generated from the pulse counter of a KL2531 stepper motor terminal.

iTcMc_EncoderKL2541: The incremental actual position is generated from the pulse counter (motor pulse or encoder) of a KL2541 stepper motor terminal.

iTcMc_EncoderKL2542: The incremental actual position is generated from the counter value from a KL2542 input terminal.

iTcMc_EncoderKL2545: The incremental actual position is generated from the counter value from a KL2542 input terminal.

iTcMc_EncoderKL3002: The absolute actual position is generated from the ADW value of a ±10V KL3002 analog input terminal.

iTcMc_EncoderKL3042: The absolute actual position is generated from the ADW value of a 0..20 mA KL3042 analog input terminal.

iTcMc_EncoderKL3062: The absolute actual position is generated from the ADW value of a 0..10 V KL3062 analog input terminal.

iTcMc_EncoderKL3162: The absolute actual position is generated from the ADW value of a 0..10V KL3162 analog input terminal.

iTcMc_EncoderKL5001: The absolute actual position is generated from the counter value from a KL5001 SSI input terminal.

iTcMc_EncoderKL5101: The incremental actual position is generated from the counter value from a KL5101 input terminal.

iTcMc_EncoderKL5111: The incremental actual position is generated from the counter value from a KL5111 input terminal.

iTcMc_EncoderLowCostStepper: Incremental changes to the actual position are generated from the output signals for a digitally operated stepper motor.

iTcMc_EncoderM2510: The absolute actual position is generated from the ADW value of a ±10V M2510 analog input box.

iTcMc_EncoderM3120: The incremental actual position is generated from the counter value of an M3120 Lightbus module.

iTcMc_EncoderSim: The virtual actual position of the axis is a copy of the set position.

Attention	**iTcMc_EncoderSim** On a real machine this type must only be used for virtual axes. Otherwise the axis will carry out uncontrolled and unpredictable movements.

iTcMc_Encoder_TestOnly: reserved for internal testing; do not use.

4.3.7 E_TcMCFbState (from V3.0)

The constants listed here are used to identify the runtime states of the axes.

```
TYPE E_TcMCFbState :
(
McState_Standstill := 0,
McState_DiscreteMotion,
McState_Continousmotion,
McState_Synchronizedmotion,
McState_Stopping,
McState_Errorstop,
McState_Homing,
McState_Disabled
);
END_TYPE
```

McState_Standstill: The axis does not have a transport instruction. Active position control, repositioner monitoring, the output of a press control value or none of these will be carried out, depending on the parameterization.

McState_DiscreteMotion: The axis executes a movement with a defined destination position and velocity.

McState_Continousmotion: The axis executes a movement without any defined destination position. Only the velocity is specified.

McState_Synchronizedmotion: The axis performs a movement, which is derived from the movement of another axis.

McState_Stopping: The axis is carrying out a stop.

McState_Errorstop: The axis has been stopped because of a problem. It cannot at present be started, and requires a reset before it will be in a condition from which it can start.

McState_Homing: The axis is homing.

McState_Disabled: The controller enable of the axis is FALSE.

4.3.8 E_TcMcHomingType (from V3.0)

The constants listed here are used to identify the referencing method of the axes.

```
TYPE E_TcMcHomingType :(
iTcMc_HomingOnBlock,
iTcMc_HomingOnIndex,
iTcMc_HomingOnSync,
iTcMc_HomingOnMultiSync,
iTcMc_HomingOnExec
);
END_TYPE
```

iTcMc_HomingOnBlock: The axis is moved in the direction specified by ST_TcHydAxParam.bEnc_RefIndexPositive with ST_TcHydAxParam.fEnc_RefIndexVelo. If no movement is detected over a period of 2 seconds, the fixed stop (block) is considered to have been reached. The actual value for the axis is set to the value of the reference position.

iTcMc_HomingOnIndex: The axis is moved in the direction specified by ST_TcHydAxParam.bEnc_RefIndexPositive with ST_TcHydAxParam.fEnc_RefIndexVelo. The axis is stopped if the reference cam (bit 5, dwTcHydDcDwRefIndex) is detected in ST_TcHydAxRtData.nDeCtrlDWord. It is then moved with ST_TcHydAxParam.fEnc_RefSyncVelo in the direction specified by ST_TcHydAxParam.bEnc_RefSyncPositive until the reference cam has again been left. The actual value for the axis is set to the value of the reference position.

iTcMc_HomingOnSync: The axis is moved in the direction specified by ST_TcHydAxParam.bEnc_RefIndexPositive with ST_TcHydAxParam.fEnc_RefIndexVelo. The axis is stopped if the reference cam (bit 5, dwTcHydDcDwRefIndex) is detected in ST_TcHydAxRtData.nDeCtrlDWord. It is then moved with ST_TcHydAxParam.fEnc_RefSyncVelo in the direction specified by ST_TcHydAxParam.bEnc_RefSyncPositive until the reference cam has again been left. The encoder's hardware latch is then activated, and the axis is moved on until the latch becomes valid. After the axis has stopped, the actual value for the axis is set to a value that is calculated from the reference position and from the distance covered since the encoder's sync pulse was detected.

iTcMc_HomingOnExec: The actual value of the axis is immediately set to the value of the reference position.

iTcMc_HomingOnMultiSync: The hardware latch of the encoder is activated. The axis is moved with ST_TcHydAxParam.fEnc_RefSyncVelo in the direction specified by ST_TcHydAxParam.bEnc_RefIndexPositive, until the latch has become valid twice. If the end of path is detected before two sync pulses were detected, the process is repeated in the opposite direction. If this does not succeed either, the homing is aborted. Otherwise the current actual position is determined from the distance of the sync pulses and the fEnc_BaseDistance.

4.3.9 E_TcMCParameter (from V3.0)

The constants listed here are used for numbering parameters.

```
TYPE E_TcMCParameter :
(
(*
===================================================================== A T T E N T I O N =
=====================================================================
= These Codes are also used to identify parameters in files. =
= Any change of the meaning of any code here will make any file =
= incompatible without notice and may even cause a crash of =
= the control system! =
=====================================================================
= CONSEQUENCE: Only adding new codes is allowed! =
=====================================================================
= These codes are also used for ADS communication =
=====================================================================
*)
(*
=====================================================================
A C H T U N G =
=====================================================================
= Diese Codes werden auch zur Kennzeichnung von Parametern =
= in den Dateien verwendet. Eine Veraenderung der Codes wuerde
= die Dateien (nicht erkennbar) inkompatibel machen und koennte =
= zum Systemabsturz fuehren! =
=====================================================================
= ALSO: Es duerfen nur neue Codes dazugefuegt werden! =
=====================================================================
= Diese Codes werden ebenfalls fuer die ADS-Kommunikation benutzt =
=====================================================================
*)
McPara_CommandedPosition:=1,
McPara_SWLimitPos,
McPara_SWLimitNeg,
McPara_EnableLimitPos,
McPara_EnableLimitNeg,
McPara_EnablePosLagMonitoring,
McPara_MaxPositionLag,
McPara_MaxVelocitySystem,
McPara_MaxVelocityAppl,
McPara_ActualVelocity,
McPara_CommandedVelocity,
McPara_MaxAccelerationSystem,
McPara_MaxAccelerationAppl,
McPara_MaxDecelerationSystem,
McPara_MaxDecelerationAppl,
McPara_MaxJerk,
(* ============================================================== *)
McPara_BkPlcMc_ProfilType:=1000,
McPara_BkPlcMc_EnvCycletime,
McPara_BkPlcMc_AxName,
McPara_BkPlcMc_TimeBased,
McPara_BkPlcMc_JerkEnabled,
McPara_BkPlcMc_LogLevel,
McPara_BkPlcMc_CycleDivider,
McPara_BkPlcMc_ParamFileName,
McPara_BkPlcMc_EncoderType:=1100,
McPara_BkPlcMc_EncoderHomingType,
McPara_BkPlcMc_EncoderZeroShift,
McPara_BkPlcMc_EncoderIncWeighting,
McPara_BkPlcMc_EncoderIncInterpolation,
McPara_BkPlcMc_EncoderRefIndexVelo,
McPara_BkPlcMc_EncoderRefIndexPositive,
McPara_BkPlcMc_EncoderRefSyncVelo,
McPara_BkPlcMc_EncoderRefSyncPositive,
McPara_BkPlcMc_EncoderDefaultHomePosition,
McPara_BkPlcMc_EncoderReversed,
McPara_BkPlcMc_EncoderBaseDistance,
McPara_BkPlcMc_EncoderModuloBase,
McPara_BkPlcMc_EncoderEnableLatch,
McPara_BkPlcMc_EncoderLatchedPos,
McPara_BkPlcMc_EncoderRefShift,
McPara_BkPlcMc_EncoderRefFlag,
McPara_BkPlcMc_EncoderPotiRgToRl,
McPara_BkPlcMc_EncoderOverrunMask,
McPara_BkPlcMc_EncoderPositionMask,
McPara_BkPlcMc_EncoderZeroSwap,
McPara_BkPlcMc_ValveOverlapCompP:=1200,
McPara_BkPlcMc_ValveBendPointVelo,
McPara_BkPlcMc_ValveBendPointOutput,
McPara_BkPlcMc_ValveResponseTime,
McPara_BkPlcMc_ValveOverlapCompM,
McPara_BkPlcMc_CylinderArreaA:=1280,
McPara_BkPlcMc_CylinderArreaB,
McPara_BkPlcMc_DriveType:=1300,
McPara_BkPlcMc_AreaRatio,
McPara_BkPlcMc_DriveReversed,
McPara_BkPlcMc_DriveDefaultPowerOk
McPara_BkPlcMc_DriveAbsoluteOutput,
McPara_BkPlcMc_DriveIncWeighting,
McPara_BkPlcMc_DriveIncInterpolation,
McPara_BkPlcMc_StartRamp:=1400,
McPara_BkPlcMc_obsolete_1,
McPara_BkPlcMc_obsolete_2,
McPara_BkPlcMc_StopRamp:=1500,
McPara_BkPlcMc_EmergencyRamp,
McPara_BkPlcMc_BrakeOn,
McPara_BkPlcMc_BrakeOff,
McPara_BkPlcMc_BrakeSafety,
McPara_BkPlcMc_CreepSpeedP:=1600,
McPara_BkPlcMc_CreepDistanceP,
McPara_BkPlcMc_BrakeDistanceP,
McPara_BkPlcMc_BrakeDeadTimeP,
McPara_BkPlcMc_CreepSpeedM,
McPara_BkPlcMc_CreepDistanceM,
McPara_BkPlcMc_BrakeDistanceM,
McPara_BkPlcMc_BrakeDeadTimeM,
McPara_BkPlcMc_AsymetricalTargeting,
McPara_BkPlcMc_LagAmp:=1700,
McPara_BkPlcMc_LagAmpAdaptLimit,
McPara_BkPlcMc_LagAmpAdaptFactor,
McPara_BkPlcMc_ZeroCompensation,
McPara_BkPlcMc_TargetClamping,
McPara_BkPlcMc_ReposDistance,
McPara_BkPlcMc_AutoBrakeDistance,
McPara_BkPlcMc_EnableControlLoopOnFault,
McPara_BkPlcMc_LagAmpDx,
McPara_BkPlcMc_LagAmpTi,
McPara_BkPlcMc_LagAmpWuLimit,
McPara_BkPlcMc_LagAmpOutLimit,
McPara_BkPlcMc_VeloAmp,
McPara_BkPlcMc_VeloAmpDx,
McPara_BkPlcMc_VeloAmpTi,
McPara_BkPlcMc_VeloAmpWuLimit,
McPara_BkPlcMc_VeloAmpOutLimit,
McPara_BkPlcMc_FeedForward,
McPara_BkPlcMc_LagAmpTd,
McPara_BkPlcMc_LagAmpTdd,
McPara_BkPlcMc_LagAmpCfb_tA,
McPara_BkPlcMc_LagAmpCfb_kA,
McPara_BkPlcMc_LagAmpCfb_tV,
McPara_BkPlcMc_LagAmpCfb_kV,
McPara_BkPlcMc_MonPositionRange:=1800,
McPara_BkPlcMc_MonTargetRange,
McPara_BkPlcMc_MonTargetFilter,
McPara_BkPlcMc_MonPositionLagFilter,
McPara_BkPlcMc_MonDynamicLagLimit,
McPara_BkPlcMc_MonPehEnable,
McPara_BkPlcMc_MonPehTimeout,
McPara_BkPlcMc_DigInputReversed,
McPara_PFW_EnableLimitPos:=1898,
McPara_PFW_EnableLimitNeg:=1899,
McPara_BkPlcMc_JogVeloFast:=1900,
McPara_BkPlcMc_JogVeloSlow,
McPara_BkPlcMc_CustomerData:=2000,
McPara_BkPlcMc_AutoId_EnaEoT:=3000,
McPara_BkPlcMc_AutoId_EnaOvl,
McPara_BkPlcMc_AutoId_EnaZadj,
McPara_BkPlcMc_AutoId_EnaAratio,
McPara_BkPlcMc_AutoId_EnaLinTab,
McPara_BkPlcMc_AutoId_EoT_N:=3100,
McPara_BkPlcMc_AutoId_EoT_P,
McPara_BkPlcMc_AutoId_EoI_N,
McPara_BkPlcMc_AutoId_EoI_P,
McPara_BkPlcMc_AutoId_EoTlim_N,
McPara_BkPlcMc_AutoId_EoTlim_P,
McPara_BkPlcMc_AutoId_DecFactor,
McPara_BkPlcMc_AutoId_EoVlim_N,
McPara_BkPlcMc_AutoId_EoVlim_P,
McPara_BkPlcMc_AutoId_LastIdent_N,
McPara_BkPlcMc_AutoId_LastIdent_P,
McPara_BkPlcMc_AutoId_TblCount:=3150,
McPara_BkPlcMc_AutoId_TblLowEnd,
McPara_BkPlcMc_AutoId_TblHighEnd,
McPara_BkPlcMc_AutoId_TblRamp,
McPara_BkPlcMc_AutoId_TblSettling,
McPara_BkPlcMc_AutoId_TblRecovery,
McPara_BkPlcMc_AutoId_TblMinCycle,
McPara_BkPlcMc_AutoId_LinTblAvailable,
McPara_BkPlcMc_AutoId_TblValveType,
McPara_BkPlcMc_AutoId_LinTab_1:=3200,
McPara_BkPlcMc_AutoId_LinTab_2:=3400,
 (* ---------------------------------------------------------- *)
McRtData_BkPlcMc_ActualPosition:=10000,
McRtData_BkPlcMc_ActualAcceleration,
McRtData_BkPlcMc_PosError,
McRtData_BkPlcMc_DistanceToTarget,
McRtData_BkPlcMc_ActPressure,
McRtData_BkPlcMc_ActPressureA,
McRtData_BkPlcMc_ActPressureB,
McRtData_BkPlcMc_ActForce,
McRtData_BkPlcMc_ValvePressure,
McRtData_BkPlcMc_SupplyPressure,
McRtData_BkPlcMc_SetPosition,
McRtData_BkPlcMc_SetVelocity,
McRtData_BkPlcMc_SetAcceleration,
McRtData_BkPlcMc_SetPressure,
McRtData_BkPlcMc_SetOverride,
McRtData_BkPlcMc_LatchPosition,
McRtData_BkPlcMc_CtrlOutLag,
McRtData_BkPlcMc_CtrlOutClamping,
McRtData_BkPlcMc_CtrlOutOverlapComp,
McRtData_BkPlcMc_TargetPosition,
McRtData_BkPlcMc_NSDW:=11000,
McRtData_BkPlcMc_DCDW,
McRtData_BkPlcMc_ErrCode,
McRtData_BkPlcMc_FbState,
McRtData_BkPlcMc_CurStep,
McRtData_BkPlcMc_ParamsUnsave,
McRtData_BkPlcMc_RawPosition,
McRtData_BkPlcMc_ActPosCams,
McRtData_BkPlcMc_ReloadParams,
McRtData_BkPlcMc_EncoderMinPos,
McRtData_BkPlcMc_EncoderMaxPos,
McRtData_BkPlcMc_BufferedEntries,
 (* ---------------------------------------------------------- *)
 (**)
McPara_BkPlcMc_
 (**)
McPara_BkPlcMc_FileMarkComplete:=32767  (* Ax.Params.bLinTabAvailable AutoIdent: .. / Au-
toIdent: .. *)
);
END_TYPE
```

McPara_ActualVelocity: The actual axis velocity.

McPara_BkPlcMc_AreaRatio: The direction-dependent velocity ratio.

McPara_BkPlcMc_AsymmetricalTargeting: Enable for the asymmetric target approach.

McPara_BkPlcMc_AutoID_EnaAratio: Automatic identification: Determining direction-related velocity ratio.

McPara_BkPlcMc_AutoID_DecFactor: Automatic identification: Factor for weighting the deceleration.

McPara_BkPlcMc_AutoID_EnaEoI_N: Automatic identification: Determined negative hard stop of the cylinder in increments.

McPara_BkPlcMc_AutoID_EnaEoI_P: Automatic identification: Determined positive hard stop of the cylinder in increments.

McPara_BkPlcMc_AutoID_EnaEoT: Automatic identification: Determining the hard stops of the cylinders.

McPara_BkPlcMc_AutoID_EnaLinTab: Automatic identification: Determining the characteristic curve.

McPara_BkPlcMc_AutoID_EnaOvl: Automatic identification: Determining the valve overlap.

McPara_BkPlcMc_AutoID_EnaZadj: Automatic identification: Determining the offsets.

McPara_BkPlcMc_AutoID_EoTlim_N: Automatic identification: Determined negative hard stop of the cylinder.

McPara_BkPlcMc_AutoID_EoTlim_P: Automatic identification: Determined positive hard stop of the cylinder.

McPara_BkPlcMc_AutoID_EoT_N: Automatic identification: Hard stop of the cylinder in negative direction.

McPara_BkPlcMc_AutoID_EoT_P: Automatic identification: Hard stop of the cylinder in positive direction.

McPara_BkPlcMc_AutoID_EoVlim_N: Automatic identification: Velocity limitation of the characteristic curves determination in negative direction.

McPara_BkPlcMc_AutoID_EoVlim_P: Automatic identification: Velocity limitation of the characteristic curves determination in positive direction.

McPara_BkPlcMc_AutoID_LastIdent_N: Automatic identification: The output value of the last successful measurement in negative direction.

McPara_BkPlcMc_AutoID_LastIdent_P: Automatic identification: The output value of the last successful measurement in positive direction.

McPara_BkPlcMc_AutoID_LinTab_1: Automatic identification: Points of the characteristic curve, relative velocity.

McPara_BkPlcMc_AutoID_LinTab_2: Automatic identification: Points of the characteristic curve, relative output.

McPara_BkPlcMc_AutoID_LinTblAvailable: This signal is set to TRUE at the end of a successful characteristic curve measurement.

McPara_BkPlcMc_AutoID_MinCycle: Automatic identification: Minimum measuring distance.

McPara_BkPlcMc_AutoID_TblCount: Automatic identification: The number of required table points. Since the zero point is counted but is only present once, this parameter must always be an odd number. Values between 3 and 99 are accepted. A value of less than 11 is not recommended.

McPara_BkPlcMc_AutoID_TblHighEnd: Automatic identification: Upper end of the designated measuring section.

McPara_BkPlcMc_AutoID_TblLowEnd: Automatic identification: Lower end of the designated measuring section.

McPara_BkPlcMc_AutoID_TblRamp: Automatic identification: Ramp for establishing the measuring output. The specified time refers a change from zero to full scale. Smaller output changes are applied in a proportion of the time.

McPara_BkPlcMc_AutoID_TblRecovery: Automatic characteristic curve identification: Delay time in the event of a change of direction.

McPara_BkPlcMc_AutoID_TblSettling: Automatic identification: Delay time between establishment of the measuring output and the start of the measurement.

McPara_BkPlcMc_AutoID_TblValveType: Automatic identification: The expected characteristic curve type.

McPara_BkPlcMc_BrakeDeadTimeM: The brake dead time in negative direction.

McPara_BkPlcMc_BrakeDeadTimeP: The brake dead time in positive direction.

McPara_BkPlcMc_Auto_BrakeDistance: The enable for automatic calculation of the braking distance.

McPara_BkPlcMc_BrakeDistanceM: For asymmetric target approach: The braking distance time in negative direction.

McPara_BkPlcMc_BrakeDistanceP: The braking distance time in positive direction. For symmetric target approach: The braking distance time in negative direction.

McPara_BkPlcMc_BrakeOff: A delay between the active axis motion and the signal for activating a brake.

McPara_BkPlcMc_BrakeOn: A delay between the signal for releasing a brake and the active axis motion.

McPara_BkPlcMc_BrakeSafety: A delay between the active axis motion in one direction and active motion in the opposite direction.

McPara_BkPlcMc_CreepDistanceM: For asymmetric target approach: The creep distance in negative direction.

McPara_BkPlcMc_CreepDistanceP: The creep distance in positive direction. For symmetric target approach: The creep distance in negative direction.

McPara_BkPlcMc_CreepSpeedM: For asymmetric target approach: The creep speed in negative direction.

McPara_BkPlcMc_CreepSpeedP: The creep speed in positive direction. For symmetric target approach: The creep speed in negative direction.

McPara_BkPlcMc_CustomerData: A field with parameters that can be used freely by an application. These parameter are stored and loaded with the axis parameters.

McPara_BkPlcMc_CycleDevider: reserved, not implemented.

McPara_BkPlcMc_CylinderArreaA: The cylinder area of the cylinder side pushing in positive direction.

McPara_BkPlcMc_CylinderArreaB: The cylinder area of the cylinder side pushing in negative direction.

McPara_BkPlcMc_DigInputsReversed: Enable for inversion of the input signals of an axis with digital position sensors.

McPara_BkPlcMc_DriveAbsoluteOutput: Enable for absolute value formation during output adjustment.

McPara_BkPlcMc_DriveDefaultPowerOk: Drive power is assumed to be available adopted; no hardware signal required.

McPara_BkPlcMc_DriveIncInterpolation: Interpolation of the output adjustment.

McPara_BkPlcMc_DriveIncWeighting: Weighting of the output adjustment.

McPara_BkPlcMc_DriveReversed: Enable for inverted output adjustment.

McPara_BkPlcMc_DriveType: Type of drive adjustment.

McPara_BkPlcMc_EmergencyRamp: In the event of an emergency stop: The time for braking from maximum velocity to standstill.

McPara_BkPlcMc_EnableControlLoopOnFaults: Enable for position control in the event of axis errors.

McPara_BkPlcMc_EncoderBaseDistance: Reserved for distance-coded encoders.

McPara_BkPlcMc_EncoderDefaultHomePosition: Axes with incremental distance measuring system: A default value for homing.

McPara_BkPlcMc_EncoderEnableLatch: Enable for the latch function of an encoder hardware.

McPara_BkPlcMc_EncoderHomingType: Axes with incremental distance measuring system: The default homing method.

McPara_BkPlcMc_EncoderIncInterpolation: The increment interpolation of the encoder evaluation.

McPara_BkPlcMc_EncoderIncWeighting: The increment weighting of the encoder evaluation.

McPara_BkPlcMc_EncoderModuloBase: reserved, not implemented.

McPara_BkPlcMc_EncoderLatchedPosition: The latched position during homing.

McPara_BkPlcMc_EncoderOverrunMask: A mask for detecting an encoder overflow.

McPara_BkPlcMc_EncoderPositionMask: A mask for isolating the valid bits within the mapped variables.

McPara_BkPlcMc_EncoderPotiRgToRl: For potentiometer encoders: The ratio of total potentiometer resistance to load resistance (input resistance of the terminal).

McPara_BkPlcMc_EncoderRefFlag: The homing status of the axis.

McPara_BkPlcMc_EncoderRefIndexPositive: Axes with incremental distance measuring system: During homing the system looks for the index (cam) in positive direction.

McPara_BkPlcMc_EncoderRefIndexVelo: Axes with incremental distance measuring system: During homing the system looks for the index (cam) with this velocity.

McPara_BkPlcMc_EncoderRefShift: Axes with incremental distance measuring system: Zero shift of the encoder evaluation.

McPara_BkPlcMc_EncoderRefSyncPositive: Axes with incremental distance measuring system: During homing the system looks for the homing signal in positive direction.

McPara_BkPlcMc_EncoderRefSyncVelo: Axes with incremental distance measuring system: During homing the system looks for the homing signal with this velocity.

McPara_BkPlcMc_EncoderReversed: Enable for inverted encoder evaluation.

McPara_BkPlcMc_EncoderType: Type of encoder evaluation.

McPara_BkPlcMc_EncoderZeroShift: Axes with absolute distance measuring system: Zero shift of the encoder evaluation.

McPara_BkPlcMc_EncoderZeroSwap: Block-by-block shifting of the counting range of the encoder evaluation.

McPara_BkPlcMc_EnvCycleTime: The cycle time of the task in which the core blocks (encoder, setpoint generator, etc.) of the axis are called.

McPara_BkPlcMc_FeedForward: Pre-control weighting of the axis.

McPara_BkPlcMc_JerkEnabled: The control word for jerk limitation.

McPara_BkPlcMc_JogVeloFast: A default value for a fast jog velocity.

McPara_BkPlcMc_JogVeloSlow: A default value for a slow jog velocity.

McPara_BkPlcMc_LagAmp: Gain factor for the proportional component in the position controller.

McPara_BkPlcMc_LagAmpAdaptFactor: Reserved.

McPara_BkPlcMc_LagAmpAdaptLimit: Reserved.

McPara_BkPlcMc_LagAmpCfb_tA: Reserved.

McPara_BkPlcMc_LagAmpCfb_kA: Reserved.

McPara_BkPlcMc_LagAmpCfb_tV: Reserved.

McPara_BkPlcMc_LagAmpCfb_kV: Reserved.

McPara_BkPlcMc_LagAmpDx: Threshold value for the integrating component of the position controller.

McPara_BkPlcMc_LagAmpTd: Reserved.

McPara_BkPlcMc_LagAmpTdd: Reserved.

McPara_BkPlcMc_LagAmpTi: Time constant for the integrating component of the position controller.

McPara_BkPlcMc_LagAmpOutLimit: Output limitation for the position controller.

McPara_BkPlcMc_LagAmpWuLimit: Limitation (wind-up limit) for the integrating component of the position controller.

McPara_BkPlcMc_LogLevel: Threshold value for message logging.

McPara_BkPlcMc_MonDynamicLagLimit: Tolerance for dynamic position lag monitoring.

McPara_BkPlcMc_MonPehEnable: Enable for monitoring of the ready message at the target.

McPara_BkPlcMc_MonPehTimeout: Filter time for monitoring of the ready message at the target.

McPara_BkPlcMc_MonPositionLagFilter: Filter time for position lag monitoring.

McPara_BkPlcMc_MonPositionRange: Tolerance for the position window.

McPara_BkPlcMc_MonTargetFilter: Filter time for the target window.

McPara_BkPlcMc_MonTargetRange: Tolerance for the target window.

McPara_BkPlcMc_obsolete_XYZ: Placeholder for parameters that are no longer supported. These parameter codes must not be reused for new parameters. To ensure this, such numerical values are assigned names of this form.

McPara_BkPlcMc_ParamFileName: Name of the parameter file.

McPara_BkPlcMc_ProfilType: Type of set value generation.

McPara_BkPlcMc_ReposDistance: Threshold value for automatic repositioning.

McPara_BkPlcMc_StartRamp: Only for certain set value generators: Acceleration ramp.

McPara_BkPlcMc_StopRamp: Only for certain set value generators: Braking ramp.

McPara_BkPlcMc_TargetClamping: Default output value for the terminal function.

McPara_BkPlcMc_TimeBased: Switching of setpoint generator: Time-based or displacement-based.

McPara_BkPlcMc_ValveBendPointOutput: Valve output for compensation of the characteristic curve bend.

McPara_BkPlcMc_ValveBendPointVelo: Velocity for compensation of the characteristic curve bend.

McPara_BkPlcMc_ValveOverlapCompM: Compensation of the valve overlap for the negative direction.

McPara_BkPlcMc_ValveOverlapCompP: Compensation of the valve overlap for the positive direction.

McPara_BkPlcMc_ValveResponseTime: Compensation of the valve response time.

McPara_BkPlcMc_VeloAmp: Gain factor for the proportional component in the velocity controller.

McPara_BkPlcMc_VeloAmpDx: Threshold value for the integrating component of the velocity controller.

McPara_BkPlcMc_VeloAmpTi: Time constant for the integrating component of the velocity controller.

McPara_BkPlcMc_VeloAmpOutLimit: Output limitation for the velocity controller.

McPara_BkPlcMc_VelopWuLimit: Limitation (wind-up limit) for the integrating component of the velocity controller.

McPara_BkPlcMc_ZeroCompensation: Offset compensation of the output.

McPara_CommandedPosition: The last commanded target position of the axis.

McPara_CommandedVelocity: The last commanded velocity of the axis.

McPara_EnableLimitNeg: Enable for the software limit switch in negative direction.

McPara_EnableLimitPos: Enable for the software limit switch in positive direction.

McPara_MaxAccelerationAppl: The maximum acceleration that can be commanded by the application.

McPara_MaxAccelerationSystem: The upper limit set by the system for the maximum acceleration that can be commanded by the application.

McPara_MaxDecelerationAppl: The maximum deceleration that can be commanded by the application.

McPara_MaxDecelerationSystem: The upper limit set by the system for the maximum deceleration that can be commanded by the application.

McPara_MaxJerk: The upper limit set by the system for the maximum jerk that can be commanded by the application.

McPara_MaxPositionLag: Threshold value for position lag monitoring.

McPara_MaxVelocityAppl: The maximum velocity that can be commanded by the application.

McPara_MaxVelocitySystem: The upper limit set by the system for the maximum velocity that can be commanded by the application.

McPara_PFW_Xyz: These parameters are reserved for a sector-specific solution.

McPara_SWLimitNeg: Software limit switch in negative direction.

McPara_SWLimitPos: Software limit switch in positive direction.

McRtData_BkPlcMc_ActForce: The actual force.

McRtData_BkPlcMc_AxName: The text-based name of the axis.

McRtData_BkPlcMc_ActPosCams: For axes with digital position sensors: The sensor signals.

McRtData_BkPlcMc_ActPressure: The actual differential pressure at the valve.

McRtData_BkPlcMc_ActPressureA: The actual pressure in the A-chamber of the cylinder.

McRtData_BkPlcMc_ActPressureB: The actual pressure in the B-chamber of the cylinder.

McRtData_BkPlcMc_ActualAcceleration: The actual acceleration.

McRtData_BkPlcMc_ActualPosition: The actual position.

McRtData_BkPlcMc_BufferedEntries: For axes with a command buffer: The number of buffered commands.

McRtData_BkPlcMc_CtrlOutOverlapComp: The current output component of the overlap compensation.

McRtData_BkPlcMc_CtrlOutClamping: The current value of the terminal output.

McRtData_BkPlcMc_CtrlOutLag: The current output of the position controller.

McRtData_BkPlcMc_CurStep: The current (internal) axis step. See also E_TcMcCurrentStep.

McRtData_BkPlcMc_DCDW: The control word of the axis with the enables (and other parameters). **NOTE! There is no relationship with the control word of an external device.**

McRtData_BkPlcMc_DistanceToTarget: The remaining distance to the target.

McRtData_BkPlcMc_EncoderMaxPos: Reserved.

McRtData_BkPlcMc_EncoderMinPos: Reserved.

McRtData_BkPlcMc_ErrCode: The current error code of the axis.

McRtData_BkPlcMc_FbState: The current axis step (defined by PLCopen). See also E_TcMCFbState.

McRtData_BkPlcMc_FileMarkComplete: In a parameter file: The logical end identifier.

McRtData_BkPlcMc_LatchPosition: The (offset) reference position. This is the position at which the actual position was finally set during homing.

McRtData_BkPlcMc_NSDW: The axis status word with the operating states. **NOTE! There is no relationship with the status word of an external device.**

McRtData_BkPlcMc_ParamsUnsave: A TRUE here indicates that a parameter was changed significantly, but the parameter file was not yet written again **NOTE! . This signal cannot be issued by the library, if the parameter was changed directly (without the write function blocks).**

McRtData_BkPlcMc_PosError: The lag error.

McRtData_BkPlcMc_SetAcceleration: The current acceleration set value.

McRtData_BkPlcMc_SetOverride: The current override value.

McRtData_BkPlcMc_SetPosition: The current position set value.

McRtData_BkPlcMc_SetPressure: The set value for pressure or force regulators.

McRtData_BkPlcMc_SetVelocity: The current velocity set value.

McRtData_BkPlcMc_SupplyPressure: The actual supply pressure value.

McRtData_BkPlcMc_RawPosition: The actual position, which was not manipulated through an zero shift.

McRtData_BkPlcMc_ReloadParams: For parameter changes through the runtime: A request to the PlcMcManager to re-read the parameters.

McRtData_BkPlcMc_TargetPos: The last commanded target position of the axis. **NOTE! This position is not changed by a Stop command.**

McRtData_BkPlcMc_ValvePressure: The pressure drop at the valve.

4.3.10 E_TcMcProfileType (from V3.0)

The constants listed here are used to identify the rules used to generate the control value for an axis.

```
TYPE E_TcMcProfileType :
(
(*
The sequence below must not be changed!
New types have to be added at the end.
In case a type becomes obsolete it has to be replaced by a dummy
to ensure the numerical meaning of the other codes.
*)
(*
Die bestehende Reihenfolge darf nicht veraendert werden.
Neue Typen muessen am Ende eingefuegt werden.
Wenn ein Typ wegfallen sollte, muss er durch einen Dummy
ersetzt werden, um die numerische Zuordnung zu garantieren.
*)
iTcMc_ProfileConstAcc,
iTcMc_ProfileTimePosCtrl,
iTcMc_ProfileCosine,
iTcMc_ProfileCtrlBased,
iTcMc_ProfileTimeRamp,
iTcMc_ProfileJerkBased,
iTcMc_ProfileBufferedJerk,
iTcMc_ProfileSwitchedVelo,
iTcMc_Profile_TestOnly:=100
);
END_TYPE
```

iTcMc_ProfileConstAcc: Only present for compatibility reasons; has been replaced by **iTcMc_ProfileCtrlBased**.

iTcMc_ProfileTimePosCtrl: Only present for compatibility reasons; no longer supported.

iTcMc_ProfileCosine: Only present for compatibility reasons; no longer supported.

iTcMc_ProfileCtrlBased: The control value for the drive is assembled from sections of constant acceleration and deceleration. Time (acceleration, change of velocity, stop) and distance (positioning) function as controlling values.

NOTE! This generator type can optionally operate in purely time-controlled mode with continuously closed position controller.

iTcMc_ProfileTimeRamp: The control value for the drive is generated with time-controlled ramps for accelerations and decelerations. The controlling parameters are time (acceleration, velocity change, stop) and path (braking, stopping).

NOTE! This generator type is intended for axes, which only have digital cams instead of an encoder.

iTcMc_ProfileJerkBased: The control value for the drive is assembled from sections of constant acceleration and deceleration. The deceleration is reduced with limited jerk towards the target. Optionally, the acceleration can be increased with limited jerk. Time (acceleration, change of velocity, stop) and distance (positioning) function as controlling values.

NOTE! Some functions are not supported by this generator type, or not fully.

NOTE! This generator type can optionally operate in purely time-controlled mode with continuously closed position controller.

iTcMc_ProfileBufferedJerk: Reserved.

iTcMc_ProfileSwitchedVelo: Reserved for sector-specific packet.

iTcMc_Profile_TestOnly: This type is only intended for internal testing of function block prototypes, which have not yet been released. It cannot be set via the PlcMcManager.

4.3.11 E_TcMcPressureReadingMode (from V3.0)

The constants in this list are transferred to function blocks for logging actual force or pressure values [▸ 20]. They determine which actual value should be updated in the ST_TcHydAxRtData [▸ 99] structure with the result of the evaluation.

```
TYPE E_TcMcPressureReadingMode :
(
    iTcHydPressureReadingDefault,
    iTcHydPressureReadingActPressure,
    iTcHydPressureReadingActPressureA,
    iTcHydPressureReadingActPressureB,
    iTcHydPressureReadingActForce,
    iTcHydPressureReadingSupplyPressure,
    iTcHydPressureReadingValvePressure
);
END_TYPE
```

iTcHydPressureReadingDefault: The target variable depends on the function block being used.

iTcHydPressureReadingActPressure: The target variable is **fActPressure**. Some function blocks automatically update **fActPressureA** and **fActPressureB**.

iTcHydPressureReadingActPressureA: The target variable is **fActPressureA**.

iTcHydPressureReadingActPressureB: The target variable is **fActPressureA**.

iTcHydPressureReadingActForce: The target variable is **fActForce**. Some function blocks automatically update **fActPressure,fActPressureA** and **fActPressureB**.

iTcHydPressureReadingSupplyPressure: The target variable is **fSupplyPressure**.

iTcHydPressureReadingValvePressure: The target variable is **fValvePressure**.

4.3.12 MC_BufferMode_BkPlcMc (from V3.0)

The constants in this list are used for controlling blending according to PLC Open.

```
TYPE MC_BufferMode_BkPlcMc :
(
Aborting_BkPlcMc := 0,
Buffered_BkPlcMc,
BlendingLow_BkPlcMc,
BlendingPrevious_BkPlcMc,
BlendingNext_BkPlcMc,
BlendingHigh_BkPlcMc
);
END_TYPE
```

Aborting_BkPlcMc: The default case: The new command becomes active immediately and cancels any other command that may already be active. The function block monitoring the aborted command will respond with **CommandAborted**.

Buffered_BkPlcMc: For axes with command buffer: This command is started automatically once all previous commands have been fully processed.

BlendingLow_BkPlcMc: For axes with command buffer: This command follows the previous command without intermediate stop. If possible, the transition point is passed with the lower velocity of the commands involved.

BlendingPrevious_BkPlcMc: For axes with command buffer: This command follows the previous command without intermediate stop. If possible, the transition point is passed with the commanded velocity of the previous command.

BlendingNext_BkPlcMc: For axes with command buffer: This command follows the previous command without intermediate stop. If possible, the transition point is passed with the commanded velocity of the new command.

BlendingHigh_BkPlcMc: For axes with command buffer: This command follows the previous command without intermediate stop. If possible, the transition point is passed with the higher velocity of the commands involved.

4.3.13 MC_CAM_ID_BkPlcMc (from V3.0)

(internal use only).

```
TYPE MC_CAM_ID_BkPlcMc:
STRUCT
    stCamRef:        MC_CAM_REF_BkPlcMc;
    bValidated:      BOOL:=FALSE;
    bPeriodic:       BOOL:=FALSE;
    bMasterAbs:      BOOL:=FALSE;
    bSlaveAbs:       BOOL:=FALSE;
    bIsChanged:      BOOL:=TRUE;
END_STRUCT
END_TYPE
```

stCamRef: A copy of the MC_CAM_REF_BkPlcMc [▶ 90] structure.

bValidated: Here this structure is identified as valid, if was initialized by a function block of type MC_CamTableSelect_BkPlcMc [▶ 46].

bPeriodic: Reserved.

bMasterAbs: Specifies whether the data of the master column are absolute or refer to the master position at the time of the coupling.

bSlaveAbs: Specifies whether the data of the slave column are absolute or refer to the slave position at the time of the coupling.

bIsChanged: Reserved.

4.3.14 MC_CAM_REF_BkPlcMc (from V3.0)

(internal use only).

```
TYPE MC_CAM_REF_BkPlcMc:
STRUCT
    pTable:         POINTER TO LREAL:=0;
    nFirstIdx:      UDINT:=1;
    nLastIdx:       UDINT:=1;
    bEquiDistant:   BOOL:=FALSE;
END_STRUCT
END_TYPE
```

pTable: The address of the curve table.

nFirstIdx: The index of the first table row.

nLastIdx: The index of the last table row.

bEquiDistant: Reserved.

4.3.15 MC_Direction_BkPlcMc (from V3.0)

The constants listed here are used to identify the direction in which axes are moving.

```
TYPE MC_Direction_BkPlcMc:
(
MC_Positive_Direction_BkPlcMc := 1,
MC_Shortest_Way_BkPlcMc,
MC_Negative_Direction_BkPlcMc,
MC_Current_Direction_BkPlcMc,
MC_SwitchPositive_Direction_BkPlcMc,
MC_SwitchNegative_Direction_BkPlcMc
);
END_TYPE
```

MC_Positive_Direction_BkPlcMc: The movement is in the direction of rising values of position.

MC_Shortest_Way_BkPlcMc: The direction of movement is selected so that the distance covered is as short as possible.

MC_Negative_Direction_BkPlcMc: The movement is in the direction of falling values of position.

MC_Current_Direction_BkPlcMc: The movement is in the same direction as the most recently executed movement.

MC_SwitchPositive_Direction_BkPlcMc: not supported.

MC_SwitchNegative_Direction_BkPlcMc: not supported.

4.3.16 MC_HomingMode_BkPlcMc (from V3.0)

The constants in this list are used for identifying the modes during axis homing.

```
TYPE MC_HomingMode_BkPlcMc:
(
    MC_DefaultHomingMode_BkPlcMc,
    MC_AbsSwitch_BkPlcMc,
    MC_LimitSwitch_BkPlcMc,
    MC_RefPulse_BkPlcMc,
    MC_Direct_BkPlcMc,
    MC_Absolute_BkPlcMc,
    MC_Block_BkPlcMc,
    MC_FlyingSwitch_BkPlcMc,
    MC_FlyingRefPulse_BkPlcMc
);
END_TYPE
```

MC_DefaultHomingMode_BkPlcMc: The referencing method specified in the axis parameters is used.

MC_AbsSwitch_BkPlcMc: The method iTcMc_HomingOnIndex is used.

MC_LimitSwitch_BkPlcMc: not supported.

MC_RefPulse_BkPlcMc: The method iTcMc_HomingOnSync is used.

MC_Direct_BkPlcMc: The method iTcMc_HomingOnExec is used.

MC_Absolute_BkPlcMc: not supported.

MC_Block_BkPlcMc: The method iTcMc_HomingOnBlock is used.

MC_FlyingSwitch_BkPlcMc: not supported.

MC_FlyingRefPulse_BkPlcMc: not supported.

4.3.17 MC_StartMode_BkPlcMc (from V3.0)

The constants in this list are used for identifying the modes during axis startups.

```
TYPE MC_StartMode_BkPlcMc:
(
    MC_StartMode_Absolute:=1,
    MC_StartMode_Relative,
    MC_StartMode_RampIn
);
END_TYPE
```

MC_StartMode_Absolute: The set slave position determined by MC_CamIn_BkPlcMc is regarded as absolute value.

MC_StartMode_Relative: The set slave position determined by MC_CamIn_BkPlcMc function blocks is regarded as distance from the location of the coupling.

MC_StartMode_RampIn: Not supported.

4.3.18 OUTPUT_REF_BkPlcMc (from V3.0)

A structure of this type is transferred to function blocks of types MC_ReadDigitalOutput_BkPlcMc() [▸ 32], MC_WriteDigitalOutput_BkPlcMc() [▸ 42] and MC_DigitalCamSwitch_BkPlcMc() [▸ 48].

```
TYPE OUTPUT_REF_BkPlcMc:
STRUCT
    OutputBits: UDINT:=0;
END_STRUCT
END_TYPE
```

OutputBits: The outputs addressed via this structure.

4.3.19 ST_FunctionGeneratorFD_BkPlcMc (from V3.0.31)

This structure consolidates parameter for the definition of the output signals of a function generator. A structure of this type is transferred to MC_FunctionGeneratorFD_BkPlcMc [▸ 159]() function blocks.

```
TYPE ST_FunctionGeneratorFD_BkPlcMc :
STRUCT
     Sin_Amplitude:    LREAL:=0.0;
     Sin_Phase:        LREAL:=0.0;
     Sin_Offset:       LREAL:=0.0;

     Cos_Amplitude:    LREAL:=0.0;
     Cos_Phase:        LREAL:=0.0;
     Cos_Offset:       LREAL:=0.0;

     Rect_Amplitude:   LREAL:=0.0;
     Rect_Phase:       LREAL:=0.0;
     Rect_Ratio:       LREAL:=0.5;
     Rect_Offset:      LREAL:=0.0;

     Saw_Amplitude:    LREAL:=0.0;
     Saw_Phase:        LREAL:=0.0;
     Saw_Ratio:        LREAL:=0.5;
     Saw_Offset:       LREAL:=0.0;

END_STRUCT
END_TYPE
```

Sin_Amplitude, Cos_Amplitude, Rect_Amplitude, Saw_Amplitude: The peak value of the signals.

Sin_Phase, Cos_Phase, Rect_Phase, Saw_Phase: The phase shift of the signals.

Sin_Offset, **Cos_Offset**, **Rect_Offset, Saw_Offset:** The zero point offset of the signals.

Rect_Ratio, **Saw_Ratio**: The duty factor of the square or sawtooth signal.

4.3.20 ST_FunctionGeneratorTB_BkPlcMc (from V3.0.31)

This structure consolidates parameters for the time base of one or several function generators. A structure of this type is transferred to MC_FunctionGeneratorTB_BkPlcMc [▸ 161](), MC_FunctionGeneratorFD_BkPlcMc [▸ 92]() and MC_FunctionGeneratorSetFrq_BkPlcMc [▸ 160]() function blocks.

```
TYPE ST_FunctionGeneratorTB_BkPlcMc :
STRUCT
     Frequency:        LREAL:=0.000001;
     Freeze:           BOOL:=FALSE;

     CycleCount:       DINT:=0;
     CurrentTime:      LREAL:=0.0;
     CurrentRatio:     LREAL:=0.0;
END_STRUCT
END_TYPE
```

Frequency: The operating frequency of the time base generated by an MC_FunctionGeneratorTB_BkPlcMc [▸ 161]() function block in Hertz.

Freeze: If this variable is set to TRUE, a MC_FunctionGeneratorTB_BkPlcMc [▸ 161]() function block will not evaluate the structure.

CycleCount: The number of fully generated signal sequences.

CurrentTime: The time elapsed since the currently created signal sequence.

CurrentRatio: The normalized progress since the start of the currently generated signal sequence.

4.3.21 ST_TcMcAutoIdent (from V3.0.4)

In this structure the parameters for an MC_AxUtiAutoIdent_BkPlcMc [▸ 192] function block are stored. It contains further information about the purpose of the individual elements.

```
TYPE ST_TcMcAutoIdent :
(* last modification: 15.05.2015 *)
STRUCT
     EndOfTravel_Negativ:         LREAL:=0.0;
     EndOfTravel_Positiv:         LREAL:=0.0;
     EndOfTravel_NegativLimit:    LREAL:=0.0;
     EndOfTravel_PositivLimit:    LREAL:=0.0;
     DecelerationFactor:          LREAL:=1.0;
     EndOfVelocity_NegativLimit: LREAL:=0.0;
     EndOfVelocity_PositivLimit: LREAL:=0.0;
     EndOfTravel_LastIdent_P:     LREAL:=0.0;
     EndOfTravel_LastIdent_M:     LREAL:=0.0;
     ValveCharacteristicLowEnd:  LREAL:=0.0;
     ValveCharacteristicHighEnd: LREAL:=0.0;
     ValveCharacteristicRamp:    LREAL:=0.0;
     ValveCharacteristicSettling:LREAL:=0.0;  (* starting with V3.0.32 *)
     ValveCharacteristicRecovery:LREAL:=0.0;
     ValveCharacteristicMinCycle:LREAL:=0.0;

     ValveCharacteristicTable:   ARRAY[1..100,1..2] OF LREAL;

     EndOfIncrements_Negativ:    DINT:=0;
     EndOfIncrements_Positiv:    DINT:=0;

     ValveCharacteristicType:    INT:=0;  (* starting with V3.0.33 *)
     ValveCharacteristicTblCount:INT:=0;

     EnableEndOfTravel:           BOOL:=FALSE;
     EnableOverlap:               BOOL:=FALSE;
     EnableZeroAdjust:            BOOL:=FALSE;
     EnableArreaRatio:            BOOL:=FALSE;
     EndOfTravel_PositivDone:     BOOL:=FALSE;
     EndOfTravel_NegativDone:     BOOL:=FALSE;
     EnableValveCharacteristic:   BOOL:=FALSE;
     EnableNoUturn: BOOL:=FALSE;
END_STRUCT
END_TYPE
```

4.3.22 ST_TcHydAxParam (from V3.0)

This structure contains all axis parameters. Under Setup (partly in preparation), suitable procedures for axis commissioning are presented.

NOTE! The order of the parameters is not guaranteed.

```
TYPE ST_TcHydAxParam :
(* last modification: 27.06.2017 *)
STRUCT
    (* ==================================================================
    this section isn't saved / dieser Bereich wird nicht gesichert
    ================================================================== *)
    sParamFileName: STRING(255) := 'DefAxParmFile.dat';
    (* ================================================================
    from this point all parameters are saved /
von hier an werden alle Parameter gesichert
    ================================================================= *)
    fAcc: LREAL := 2000.0;
    fAreaRatio: LREAL := 1.0;
    fBrakeDeadTimeM: LREAL := 0.0;
    fBrakeDeadTimeP: LREAL := 0.0;
    fBrakeDistanceM: LREAL := 0.1;
    fBrakeDistanceP: LREAL := 0.1;
    fBrakeOffDelay: LREAL := 0.0;
    fBrakeOnDelay: LREAL := 0.0;
    fBrakeSafetyDelay: LREAL := 0.0;
    fCreepDistanceM: LREAL := 1.0;
    fCreepDistanceP: LREAL := 1.0;
    fCreepSpeedM: LREAL := 80.0;
    fCreepSpeedP: LREAL := 80.0;
    fCustomerData: ARRAY [1..iTcHydfCustDataMaxIdx] OF LREAL;
    fCycletime: LREAL := 0.010;
    fCylinder_ArreaA: LREAL := 1.0;
    fCylinder_ArreaB: LREAL := 1.0;
    fCylinder_Mass: LREAL := 1.0;
    fCylinder_Stroke: LREAL := 1.0;
    fDec: LREAL := 2000.0;
    fDrive_IncInterpolation: LREAL := 1.0;
    fDrive_IncWeighting: LREAL := 0.001;
    fEmergencyRamp: LREAL := 0.1;
    fEnc_BaseDistance: LREAL := 0.001;
    fEnc_DefaultHomePosition: LREAL := 0.0;
    fEnc_IncInterpolation: LREAL := 1.0;
    fEnc_IncWeighting: LREAL := 0.001;
    fEnc_ModuloBase: LREAL := 0.001;
    fEnc_PotiRgToRl: LREAL := 0.0;
    fEnc_RefIndexVelo: LREAL := 0.1;
    fEnc_RefSyncVelo: LREAL := 0.1;
    fEnc_ZeroShift: LREAL := 0.0;
    fJogVeloFast: LREAL := 100.0;
    fJogVeloSlow: LREAL := 25.0;
    fFeedForward: LREAL := 1.0;
    fLagAmp: LREAL := 0.05;
    fLagAmpDx: LREAL := 0.0;
    fLagAmpTi: LREAL := 0.0;
    fLagAmpOutL: LREAL := 0.0;
    fLagAmpWuL: LREAL := 0.0;
    fLagAmpTd: LREAL := 0.0;
    fLagAmpTdd: LREAL := 0.0;
    fLagAmpCfb_kV: LREAL := 0.0;
    fLagAmpCfb_tV: LREAL := 0.0;
    fLagAmpCfb_kA: LREAL := 0.0;
    fLagAmpCfb_tA: LREAL := 0.0;
    fMaxAcc: LREAL := 500.0;
    fMaxDec: LREAL := 500.0;
    fMaxDynamicLag: LREAL := 0.0;
    fMaxJerk: LREAL := 1000.0;
    fMaxLag: LREAL := 0.0;
    fMaxLagFilter: LREAL := 0.0;
    fMaxVelo: LREAL := 500.0;
    fMonPositionRange: LREAL := 1.0;
    fMonTargetFilter: LREAL := 1.0;
    fMonTargetRange: LREAL := 1.0;
    fPEH_Timeout: LREAL := 0.0;
    fRefVelo: LREAL := 500.0;
    fReposDistance: LREAL := 0.0;
    fSoftEndMax: LREAL := 10000.0;
    fSoftEndMin: LREAL := 0.0;
    fStartAccDistance: LREAL := 1.0;
    fStartRamp: LREAL := 1.0;
    fStopRamp: LREAL := 1.0;
    fTargetClamping: LREAL := 0.0;
    fVeloAmp: LREAL := 0.0;
    fVeloAmpDx: LREAL := 0.0;
    fVeloAmpTi: LREAL := 0.0;
    fVeloAmpOutL: LREAL := 0.0;
    fVeloAmpWuL: LREAL := 0.0;
    fValve_BendPointOutput: LREAL := 0.0;
    fValve_BendPointVelo: LREAL := 0.0;
    fValve_OverlapCompM: LREAL := 0.0;
    fValve_OverlapCompP: LREAL := 0.0;
    fValve_ResponseTime: LREAL := 0.0;
    fZeroCompensation: LREAL := 0.0;

    nEnc_OverrunMask: DWORD := 0;
    nEnc_PositionMask: DWORD := 0;
    nEnc_ZeroSwap: DINT := 0;
    nDigInReversed: DINT := 0;

    nCycleDivider: INT := 1;
    nDrive_Type: E_TcMcDriveType:=iTcMc_Drive_Customized;
    nEnc_HomingType: E_TcMcHomingType:=iTcMc_HomingOnBlock;
   nEnc_Type: E_TcMcEncoderType:=iTcMc_EncoderSim;

    nJerkEnabled: WORD := 16#0101;
    nProfileType: E_TcMcProfileType:=iTcMc_ProfileCtrlBased;

    bAsymetricalTargeting: BOOL := FALSE;
    bDrive_AbsoluteOutput: BOOL := FALSE;
    bDrive_DefaultPowerOk: BOOL := FALSE;
    bDrive_Reversed: BOOL := FALSE;
    bEnableAutoBrakeDistance: BOOL := FALSE;
    bEnableControlLoopOnFault: BOOL := FALSE;
    bEnc_RefIndexPositive: BOOL := FALSE;
    bEnc_RefSyncPositive: BOOL := FALSE;
    bEnc_Reversed: BOOL := FALSE;
    bMaxLagEna: BOOL := FALSE;
    bPEH_Enable: BOOL := FALSE;
    bPosCtrlAccEna: BOOL := FALSE;
    bSoftEndMaxEna: BOOL := FALSE;
    bSoftEndMinEna: BOOL := FALSE;
    bTimeBased: BOOL := FALSE;
    bLinTabAvailable: BOOL := FALSE;
    (*------------------------------------------------------------------*)
END_STRUCT
END_TYPE
```

bAsymetricalTargeting: From V3.0.8: If this parameter is TRUE, direction-dependent parameters take effect during target approach and overlap compensation.

bDrive_AbsoluteOutput: If this parameter is TRUE, control values outputs are always positive, irrespective of the direction.

bDrive_DefaultPowerOk: If this parameter is set, the PowerOk feedback in the ST_TcPlcDeviceInput [▶ 104] structure of the axis is ignored.

bDrive_Reversed: If this parameter is set, the control value output is negated.

bEnableAutoBrakeDistance: In preparation: If this parameter is TRUE, **fCreepDistanceM** and **fCreepDistanceP** are calculated automatically from **fCreepSpeedM** or **fCreepSpeedP** and fLagAmp.

bEnableControlLoopOnFault: In preparation: If this parameter is TRUE, the standstill position controller of the axis also becomes active in the event of an error. **Requirement**: Its parameter are suitable for this, and the axis is in a suitable state.

bEnc_RefIndexPositive: If this parameter is set, while searching for the reference index (cam) during homing a positive control value is output, otherwise a negative value.

bEnc_RefSyncPositive: If this parameter is set, while searching for the reference pulse (sync pulse, zero pulse) during homing a positive control value is output, otherwise a negative value.

bEnc_Reversed: If this parameter is set, the actual position value is evaluated in negated form.

bLinTabAvailable: TRUE here means that each pointer was associated with a linearization table during initialization, which contains a successfully determined characteristic curve.

bMaxLagEna: This parameter activates lag monitoring.

bPEH_Enable: This parameter is used to active PEH monitoring.

bPosCtrlAccEna: obsolete, will be removed in the near future.

bSoftEndMaxEna: This parameter activates the upper software limit switch.

bSoftEndMinEna: This parameter activates the lower software limit switch.

bTimeBased: If this parameter is TRUE, the profile calculations are time-controlled. The position controller is always active.

fAcc: [mm/s^2] The absolute acceleration limitation of the axis.

fAreaRatio: [1] This parameter can be used to compensate the directionality of the velocity.

fBrakeDistance: [mm] Up to V3.0.7: At this not direction-dependent distance from the target, active profile-controlled control value generation ceases; optionally a standstill position controller or a different mechanism that applies at target is activated.

fBrakeDistanceM: [mm] From V3.0.8: If **bAsymetricalTargeting** is TRUE, at this negative distance from the target active profile-controlled control value generation ceases; optionally a standstill position controller or a different mechanism that applies at target is activated.

fBrakeDistanceP: [mm] From V3.0.8: At this not direction-dependent or (if **bAsymetricalTargeting** is TRUE) positive distance from the target, active profile-controlled control value generation ceases; optionally a standstill position controller or a different mechanism that applies at target is activated.

fBrakeDeadTime: [s] Up to V3.0.7:

fBrakeDeadTimeM: [s] From V3.0.0.8:

fBrakeDeadTimeP: [s] From V3.0.0.8:

fBrakeOffDelay: [s] If this parameter is set to a value greater than 0, the control value generator observes a delay time between the positive edge at ST_TcPlcDeviceOutput [▸ 106].bBrakeOff and the start of the acceleration phase.

fBrakeOnDelay: [s] If this parameter is set to a value greater than 0, the control value generator observes a delay time between the end of the active profile generation and the negative edge at ST_TcPlcDeviceOutput [▸ 106].bBrakeOff.

fBrakeSafetyDelay: [s] If this parameter is set to a value greater than 0, the control value generator at the negative edge at ST_TcPlcDeviceOutput [▸ 106].bBrakeOff observes a delay time between the end of an active profile generation and the positive edge of the next travel command.

fCreepSpeed: [mm/s] Up to V3.0.7: This velocity is used, in non-direction-dependent mode, for the last phase of the profile-controlled control value generation.

fCreepSpeedM: [mm/s] From V3.0.8: If **bAsymetricalTargeting** is TRUE and the direction of travel is negative, this velocity is used for the last phase of the profile-controlled control value generation.

fCreepSpeedP: [mm/s] From V3.0.8: This velocity is used, in non-direction-dependent mode, or (if **bAsymetricalTargeting** is TRUE) if the direction of travel is positive, for the last phase of the profile-controlled control value generation.

fCreepDistance: [mm] Up to V3.0.7: From this non-direction-dependent distance from the target, **fCreepSpeed** is used as control value for the last phase of the profile-controlled control value generation.

fCreepDistanceM: [mm] From V3.0.8: If **bAsymetricalTargeting** is TRUE, from this negative distance from the target **from fCreepSpeedM** is used as control value for the last phase of the profile-controlled control value generation.

fCreepDistanceP: [mm] From V3.0.8: From this non-direction-dependent or (if **bAsymetricalTargeting** is TRUE) positive distance from the target, **fCreepSpeedP** is used as control value for the last phase of the profile-controlled control value generation.

fCustomerData: 20 LREAL parameters are available for use by the application, as required. They are loaded and stored together with the other axis parameters. Library function blocks do not use these parameters independently, by the application can instruct to use them based on the type of call.

fCycletime: [s] The cycle time of the PLC task, from which the library function blocks are called. This value is determined automatically by an MC_AxUtiStandardInit_BkPlcMc [▸ 182]() function block and may be used but **not be changed** by the application.

fCylinder_ArreaA: [mm^2] The active area of the cylinder, which is under pressure during a motion in positive direction.

fCylinder_ArreaB: [mm^2] The active area of the cylinder, which is under pressure during a motion in negative direction.

fCylinder_Mass: Reserved.

fCylinder_Stroke: Reserved.

fDec: [mm/s^2] The absolute deceleration limitation of the axis.

fDrive_IncInterpolation: This parameter is used in some output devices for internal conversion of the velocity control value.

fDrive_IncWeighting: This parameter is used in some output devices for internal conversion of the velocity control value.

fEmergencyRamp: [s] This parameter specifies the time required for deceleration from **fRefVelo** to standstill. It is used by different control value generators in response to unscheduled emergency stop requests (lack of controller enable, fault condition, function block call).

fEnc_BaseDistance: [mm] This parameter is used for the evaluation of encoders with distance-coded zero marks.

fEnc_DefaultHomePosition: [mm] This parameter can be used to store a position, which can be transferred as reference position to an MC_Home_BkPlcMc [▸ 57]() function block. If homing is triggered by the PlcMcManager, the value stored here is used in this way. If this is also intended to be the case if homing is triggered by the PLC application, this parameter should be transferred when the used function block is called.

fEnc_IncInterpolation: [mm/n] This parameter specifies the resolution with which the actual position of the axis is determined.

fEnc_IncWeighting: [1] This parameter specifies the resolution with which the actual position of the axis is determined.

fEnc_PotiRgToRl: [1] It is used by some function blocks for linearization of simple potentiometer displacement transducer, which are subject to load from the input resistance of the interface electronics.

fEnc_RefIndexVelo: [1] This parameter specifies the control value as a proportion of **fRefVelo**, which is output during a search for the reference index (cam) during homing.

fEnc_RefSyncVelo: 81] This parameter specifies the control value as a proportion of **fRefVelo**, which is output during a search for the reference pulse (sync pulse, zero pulse) during homing.

fEnc_ZeroShift: [mm] This parameter shifts the zero point of the actual value determination of the axis.

fJogVeloFast: [mm/s] Set velocity for fast manual travel.

fJogVeloSlow: [mm/s] Set velocity for slow manual travel.

fLagAmp: [mm/s per mm $\rightarrow$ 1/s] The Kp amplification of the standstill position controller.

fLagAmpCfb_kA: [1] Optional: Weighting factor of the actual acceleration activation in the condition feedback of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpCfb_kV: : [1] Optional: Weighting factor of the actual velocity activation in the condition feedback of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpCfb_tA: [1] Optional: Filter time of the actual acceleration activation in the condition feedback of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpCfb_tV: : [1] Optional: Filter time of the actual velocity activation in the condition feedback of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpDx: [mm] In preparation: The response window of the standstill position controller.

fLagAmpTd: [1] Optional: Rate time of the differential component of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpTdd: [s] Optional: Damping time of the differential component of the position controller. **Note**: This parameter is only used by MC_AxRtPosPiControllerEx_BkPlcMc().

fLagAmpTi: In preparation: The integration time of the standstill position controller.

fLagAmpOutL: In preparation: The output limitation of the standstill position controller.

fLagAmpWuL: In preparation: The limitation of the I component of the standstill position controller.

fMaxAcc: [mm/s^2] The axis acceleration limitation applicable to the function blocks. This value is limited to **fAcc**.

fMaxDec: [mm/s^2] The axis deceleration limitation applicable to the function blocks. This value is limited to **fDec**.

fMaxDynamicLag: [s] This parameter specifies one of the limit values for the lag monitoring.

fMaxJerk: [mm/s^3] The axis jerk limitation applicable to the function blocks. This value is used if **iTcMc_ProfileJerkBased** is set as profile type.

fMaxLag: [mm] This parameter specifies one of the limit values for the lag monitoring.

fMaxLagFilter: [s] This parameter specifies one of the limit values for the lag monitoring.

fMaxVelo: [mm/s] The maximum velocity that can be used by function blocks. If a function block tries to use a higher value, the value is generally limited accordingly without an error message. **NOTE! This parameter is limited to fRefVelo.**

fMonPositionRange: [mm] This parameter is used for target window monitoring.

fMonTargetFilter: [s] This parameter is used for target window monitoring.

fMonTargetRange: [mm] This parameter is used for target window monitoring.

fPEH_Timeout: [s] This parameter specifies the limit value for PEH monitoring.

fRefVelo: [mm/s] This parameter specifies the maximum absolute axis velocity.

fReposDistance: [mm] If this parameter is greater than 0 and the axis has moved beyond the target by more than this distance, target positioning is automatically applied again.

fSoftEndMax: [mm] The upper (positive) software limit switch.

fSoftEndMin: [mm] The lower (negative) software limit switch.

fStartAccDistance: obsolete, will be removed in the near future.

fStartRamp: [s] This parameter specifies the time required in profile type **iTcMc_ProfileTimeRamp** to accelerate to **fRefVelo**.

fStopRamp: [s] This parameter specifies the time required for deceleration from **fRefVelo** to standstill. It is used in profile type **iTcMc_ProfileTimeRamp** for the target approach, and also by control value generators in response to unscheduled stop requests (lack of feed enable, fault condition, function block call).

fTargetClamping: [v] If this parameter is set to a value greater than zero, this control value is output with the correct sign when a target is reached. A position control is suppressed.

fValve_BendPointOutput: [1] In valves with a bend in the characteristic curve, this parameter can be used for simple linearization.

fValve_BendPointVelo: [1] In valves with a bend in the characteristic curve, this parameter can be used for simple linearization.

fValve_OverlapComp: [1] Up to V3.0.7: Compensation of a non-direction-dependent valve overlap.

fValve_OverlapCompM: [1] From V3.0.0.8: Compensation (if **bAsymetricalTargeting** = TRUE) for of a valve overlap used for the negative direction.

fValve_OverlapCompP: [1] From V3.0.0.8: Compensation of a non-direction-dependent valve overlap or (if **bAsymetricalTargeting** = TRUE) a valve overlap used for the positive direction.

fValve_ResponseTime: [s] This parameter can be used for dead time compensation of the actuator.

fVeloAmp: In preparation: The Kp gain of the subordinate velocity controller.

fVeloAmpDx: In preparation: The response window of the subordinate velocity controller.

fVeloAmpTi: In preparation: The integration time of the subordinate velocity controller.

fVeloAmpOutL: In preparation: The output limitation of the subordinate velocity controller.

fVeloAmpWuL: In preparation: Limitation of the I component of the subordinate velocity controller.

fZeroCompensation: [V] This parameter can be used to compensate an analog offset of the velocity output.

nCycleDivider: Reserved.

nDrive_Type: Specifies the drive type [▶ 72].

nEnc_Type: Specifies the encoder type [▶ 75].

nEnc_HomingType: Used to specify the referencing method, which an MC_Home_BkPlcMc [▶ 57]() function block uses if MC_DefaultHomingMode_BkPlcMc [▶ 91] is transferred as **HomingMode**.

nEnc_ZeroSwap: Reserved.

nJerkEnabled: This bit mask determines at which transitions in the profile jerk limitation is to be applied. This value is used if **iTcMc_ProfileJerkBased** is set as profile type.

nProfileType: Specifies the control value generator [▶ 88].

sParamFileName: This file name is used for storing the axis parameter as a DAT file.

Notes on setting up an axis can be found under Setup.

4.3.23 ST_TcHydAxRtData (from V3.0)

The variables in this structure indicate the runtime state of the axis.

NOTE! The order of the data is not guaranteed.

```
TYPE ST_TcHydAxRtData :
(* last modification: 12.10.2017 *)
STRUCT
(*-------------------------------*)
fActForce:           LREAL := 0.0;
fActiveOverlap:      LREAL := 0.0;
fActPos:             LREAL := 0.0;
fActPosDelta:        LREAL := 0.0;
fActPosOffset:       LREAL := 0.0;
fActPressure:        LREAL := 0.0;
fActPressureA:       LREAL := 0.0;
fActPressureB:       LREAL := 0.0;
fActVelo:            LREAL := 0.0;
fBrakeOffTimer:      LREAL := 0.0;
fBrakeOnTimer:       LREAL := 0.0;
fBrakeSafetyTimer:   LREAL := 0.0;
fClampingOutput:     LREAL := 0.0;
fDestAcc:            LREAL := 0.0;
fDestCreepDistanceM: LREAL := 0.0;
fDestCreepDistanceP: LREAL := 0.0;
fDestCreepSpeedM:    LREAL := 0.0;
fDestCreepSpeedP:    LREAL := 0.0;
fDestDec:            LREAL := 0.0;
fDestJerk:           LREAL := 0.0;
fDestPos:            LREAL := 0.0;
fDestRampEnd:        LREAL := 0.0;
fDestSpeed:          LREAL := 0.0;
fDistanceToTarget:   LREAL := 0.0;
fEnc_RefShift:       LREAL := 0.0;
```

```
fEnc_ZeroSwap:        LREAL := 0.0;
fGearActive:          LREAL := 0.0;
fGearSetting:         LREAL := 0.0;
fLagCtrlOutput:       LREAL := 0.0;
fLatchedPos:          LREAL := 0.0;
fOilRequirred_A:      LREAL := 0.0;
fOilRequirred_B:      LREAL := 0.0;
fOilUsed_A:           LREAL := 0.0;
fOilUsed_B:           LREAL := 0.0;
fOutput:              LREAL := 0.0;
fOverride:            LREAL := 1.0;
fParamAccTime:        LREAL := 0.0;
fPosError:            LREAL := 0.0;
fSetAcc:              LREAL := 0.0;
fSetPos:              LREAL := 0.0;
fSetPressure:         LREAL := 0.0;
fSetSpeed:            LREAL := 0.0;
fSetSpeedOld:         LREAL := 0.0;
fSetVelo:             LREAL := 0.0;
fStartPos:            LREAL := 0.0;
fStartRamp:           LREAL := 0.0;
fStartRampAnchor:     LREAL := 0.0;
fSupplyPressure:      LREAL := 0.0;
fTargetPos:           LREAL := 0.0;
fTimerPEH:            LREAL := 0.0;
fTimerTPM:            LREAL := 0.0;
fValvePressure:       LREAL := 0.0;
fVeloError:           LREAL := 0.0;
fBlockDetectDelay: LREAL := 2.0;
(*-------------------------------------------------------*)
nAxisState:           DWORD := 0;
nCalibrationState:    DWORD := 0;
nDeCtrlDWord:         DWORD := 0;
nErrorCode:           DWORD := 0;
nStateDWord:          DWORD := 0;
udiAmpErrorCode:      UDINT;
(*-------------------------------------------------------*)
iCurrentStep: E_TcMcCurrentStep;
wEncErrMask:          WORD:=0;
wEncErrMaskInv:       WORD:=0;
nDrvWcCount:          INT:=0;
(**)
nEncWcCount:          INT:=0;
nDrvDeviceState:      UINT:=0;
nEncDeviceState:      INT:=0;
(*-------------------------------------------------------*)
bActPosCams:          BYTE := 0;
bBrakeOff:            BOOL := FALSE;
bBrakeOffInverted:    BOOL := FALSE;
bControllable:        BOOL := FALSE;
bCountedCycles:       BYTE := 1;
bCycleCounter:        BYTE := 0;
bDriveResponse:       BOOL := FALSE;
bEncDoLatch:          BOOL := FALSE;
(**)
bEncoderResponse:     BOOL := FALSE;
bEncLatchValid:       BOOL := FALSE;
bLocked_Estop:        BOOL := FALSE;
bParamsUnsave:        BOOL := FALSE;
bReloadParams:        BOOL := FALSE;
bTargeting:           BOOL := FALSE;
bUnalignedOverlap:    BOOL := FALSE;
bActPosOffsetEnable:  BOOL := FALSE;  (* starting with 09.03.2015 *)
(**)
bDriveStartup:        BOOL := FALSE;
bEncAlignRefShift:    BOOL := FALSE;
bDrvWcsError:         BOOL := FALSE;
bEncWcsError:         BOOL := FALSE;
bFirstWcs:            BOOL := FALSE;
bChangeCount:         BYTE := 0;
bStartAutoIdent:      BOOL := FALSE;
bParamFileComplete:   BOOL := FALSE;
(*-------------------------------------------------------*)
pMasterRtData:        POINTER TO BYTE;
pMasterParam:         POINTER TO BYTE;
(*-------------------------------------------------------*)
udiSercDeviceID:      UDINT := 0;
uiSercBoxAddr:        UINT := 0;
uiSercPort:           UINT := 0;
(*-------------------------------------------------------*)
```

```
stPosCtrlr: stbkplcinternal_cplxctrl;
stVeloCtrlr: stbkplcinternal_cplxctrl;
(*-------------------------------------------------------*)
sTopBlockName:        STRING(83) := '';
(*-------------------------------------------------------*)
END_STRUCT
END_TYPE
```

bActPosCams: The current position cam of the axis. This value is only used, if iTcMc_EncoderDigCam is set as encoder type.

bActPosOffsetEnable: A TRUE in this variable activates actual value influencing. See also under **fActPosOffset**.

bBrakeOff: The control signal for an external brake. An output variable of the profile generators.

bBrakeOffInverted: The inverted **bBrakeOff** signal.

bChangeCount: This value is incremented with each parameter change.

bEncAlignRefShift: Reserved.

bEncDoLatch: This signal is used for communication by the MC_Home_BkPlcMc [▸ 57] and MC_AxRtEncoder_BkPlcMc [▸ 135] function blocks of the axis during homing.

bEncLatchValid: This signal is used for communication by the MC_Home_BkPlcMc [▸ 57] and MC_AxRtEncoder_BkPlcMc [▸ 135] function blocks of the axis during homing.

bLocked_Estop: A TRUE in this variable prevents the control value generators from exiting the state iTcHydStateEmergencyBreak / McState_Errorstop, despite the fact that the drive outputs are reduced to 0. Used by MC_EmergencyStop_BkPlcMc [▸ 50] and MC_ImediateStop_BkPlcMc [▸ 59].

bParamFileComplete: This flag is set if a corresponding identifier was found at the end of the file when the parameters were loaded and the CRC check was successful.

bParamsUnsave: The function blocks MC_WriteParameter_BkPlcMc [▸ 43] and MC_WriteBoolParameter_BkPlcMc [▸ 41] set this flag if they change a parameter value. An MC_AxParamSave_BkPlcMc [▸ 204] function block clears the flag when the parameters are successfully saved. In online mode of the PlcMcManager [▸ 252], this flag is used for the status display.

bStartAutoIdent:

bUnalignedOverlap: The characteristic of the overlap compensation is defined here.

fActForce: [N, kN] Actual force of the cylinder. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

fActiveOverlap: [1] The current output of the overlap compensation. An output variable of the profile generators.

fActPos: [mm] The current actual position of the axis. This value is usually determined by an encoder function block.

fActPosOffset: [mm] The offset used to influence the actual value. If **bActPosOffsetEnable** is TRUE, this offset is added to **fActPos**. If **fActPosOffset** changes, **fActVelo** is unaffected.

If **bActPosOffsetEnable** is TRUE, **fActPosOffset** takes effect immediately and without ramp.

NOTE! If actual value influencing is active during homing, bActPosOffset is taken into account when the actual position is set.

Example: If the reference position is 100.0 mm and the offset is 1.0 mm, the actual position at the point of the zero pulse is set to 101.0 mm. If influencing is subsequently deactivated or set to 0.0, the actual position at the point of the zero pulse shows the value 100.0, just like it would have done during homing without influencing.

NOTE! This function is only implemented for the following encoder types: iTcMc_EncoderCoE_DS406, iTcMc_EncoderEL3255, iTcMc_EncoderSim, iTcMc_EncoderEL5101, iTcMc_EncoderKL5101, iTcMc_EncoderKL5111, iTcMc_EncoderEL5001, iTcMc_EncoderKL5001, iTcMc_EncoderKL3002, iTcMc_EncoderEL3102, iTcMc_EncoderKL3042, iTcMc_EncoderKL3062, iTcMc_EncoderEL3142, iTcMc_EncoderEM8908_A, iTcMc_EncoderEL3162, iTcMc_EncoderKL3162.

NOTE! If one of the types listed is set for an for an I/O device that is compatible with one of these types, the function described is also realized.

fActPosDelta: [mm] The change of the actual position relative to the previous cycle.

fActPressure: [bar] Actual pressure in the cylinder. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

fActPressureA: [bar] Actual pressure on the A-side of the cylinder. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

fActPressureB: [bar] Actual pressure on the B-side of the cylinder. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

fActVelo: [mm/s] The current actual velocity of the axis. This value is usually determined by an encoder function block.

fBlockDetectDelay: [s] The delay time for the detection of the function block during homing on block. This value is initialized with 2.0 seconds to reflect the default behavior of previous versions. If a different time is required, it must be updated before homing commences. If a value of less than the cycle time is detected when homing commences, the default value of 2.0 seconds is entered automatically. This value is not saved as a parameter. This variable has been available under TC2 in V3.0.41 from 12 October 2017.

fClampingOutput: [V] An output variable of the profile generators.

fDestAcc: [mm/s^2] The acceleration specified by the current or last executed motion command.

fDestCreepDistance: [mm] Up to V3.0.7: The creep distance.

fDestCreepSpeed: [mm/s] Up to V3.0.7: The creep speed.

fDestCreepDistanceP: [mm] From V3.0.8: The creep distance in positive direction.

fDestCreepSpeedP: [mm/s] From V3.0.8: The creep speed in positive direction.

fDestCreepDistanceM: [mm] From V3.0.8: The creep distance in negative direction.

fDestCreepSpeedM: From V3.0.8: The creep speed in negative direction.

fDestDec: [mm/s^2] The deceleration specified by the current or last executed motion command.

fDestJerk: [mm/s^3] The jerk specified by the current or last executed motion command.

fDestPos: [mm] The currently active target position.

fDestSpeed: [mm/s] The velocity specified by the current or last executed motion command.

fDistanceToTarget: [mm] The current remaining distance of the axis. This value is usually determined by a generator function block.

fEnc_RefShift: [mm] The offset between the converted (perhaps internal extended) counter value of an incremental encoder input terminal and the actual position of the axis. This offset is determined through homing, e.g. with an MC_Home_BkPlcMc [▸ 57] function block, or manipulated with an MC_SetPosition_BkPlcMc [▸ 39] function block.

fLatchedPos: [mm] The position (taking into account current offsets) at which homing took place or where the components of the actual value acquisition (encoder, I/O electronics) were switched on.

fLagCtrlOutput: [1] The normalized output of the position controller. An output variable of the profile generators.

fOilRequirred_A: [l/min] The oil consumption on the A-side, calculated taking into account the set velocity.

fOilRequirred_B: [l/min] The oil consumption on the B-side, calculated taking into account the set velocity.

fOilUsed_A: [l/min] The oil consumption on the A-side, calculated taking into account the actual velocity.

fOilUsed_B: [l/min] The oil consumption on the B-side, calculated taking into account the actual velocity.

fOutput: [1] The control value to be output. This variable is used for communication between the MC_AxRtFinish_BkPlcMc [▸ 175] and MC_AxRtDrive_BkPlcMc [▸ 125] function blocks.

fOverride: [1] The current axis velocity override.

fPosError: [mm] The current position error of the axis.

fSetPos: [mm] The current position command value of the axis.

fSetSpeed: [mm/s] The normalized set velocity of the axis. An output variable of the profile generators.

fSetAcc: [mm/s^2] The current acceleration control value. An output variable of the profile generators.

fSetPressure: [bar] The set value for an optional pressure or force control must be stored here.

fStartPos: [mm] The start position of the current or last processed motion command.

fSupplyPressure: [bar] Supply pressure. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

fTargetPos: [mm] The target position specified by the current or last processed motion command.

fValvePressure: [bar] Pressure drop at the valve. This value is usually determined by an acquisition function block for acquisition of actual force or pressure values [▸ 20].

iCurrentStep: The internal state of the control value generators. Values from E_TcMcCurrentStep [▸ 71].

nAxisState: The motion state of the axis.

nCalibrationState: The current homing state.

nDeCtrlDWord: The control signals [▸ 236] of the axis.

nErrorCode: The current error code [▸ 236] of the axis.

nStateDWord: The status signals [▸ 235] of the axis.

sTopBlockName: Most of the library function blocks called directly by application enter a debug ID here.

wEncErrMask:

wEncErrMaskInv:

All other elements of this structure are reserved for internal use. They are not guaranteed and must not be used or modified by the application.

4.3.24 ST_TcMcAuxDataLabels (from V3.0)

This structure is used for storing the label texts for the customer-specific axis parameters. A structure of this type can be linked with the axis through an MC_AxUtiStandardInit_BkPlcMc [▸ 182] via a pointer in the Axis_Ref_BkPlcMc [▸ 67] structure.

```
TYPE ST_TcMcAuxDataLabels:
STRUCT
    stLabel:        ARRAY [1..20] OF STRING(20);
END_STRUCT
END_TYPE
```

stLabel: The label texts.

4.3.25 ST_TcPlcDeviceInput (from V3.0)

This structure contains the input image variables of an axis.

```
TYPE ST_TcPlcDeviceInput :
STRUCT
    uiCount:          UINT:=0;
    uiLatch:          UINT:=0;
    usiStatus:        USINT:=0;

    uiPZDL_RegDaten:  UINT:=0;
    uiPZDH:           UINT:=0;
    usiRegStatus:     USINT:=0;

    udiCount:         UDINT:=0;
    uiStatus:         UINT:=0;

    bTerminalState:   BYTE:=0;
    uiTerminalData:   WORD:=0;
    uiTerminalState2:WORD:=0;

    bDigInA:          BOOL:=FALSE;
    bDigInB:          BOOL:=FALSE;

    bDigCamMM:        BOOL:=FALSE;
    bDigCamM:         BOOL:=FALSE;
    bDigCamP:         BOOL:=FALSE;
    bDigCamPP:        BOOL:=FALSE;

    DriveError:       UDINT:=0;
    ActualPos:        ARRAY [0..1] OF UINT:=0;
    DriveState:       ARRAY [0..3] OF BYTE:=0;

    S_iReserve:       INT:=0;
    S_DiReserve:      ARRAY [1..9] OF DINT:=0;

    CiA_Reserve:      ARRAY [1..8] OF UINT:=0;

    bPowerOk:         BOOL:=FALSE;
    bEnAck:           BOOL:=FALSE;

    wDriveDevState:   WORD:=0;
    wDriveWcState:    BYTE:=0;
    wEncDevState:     WORD:=0;
    wEncWcState:      BYTE:=0;
    uiDriveBoxState:  UINT:=0;
    uiEncBoxState:    UINT:=0;

    sEncAdsAddr:      ST_TcPlcAdsAddr;
    nEncAdsChannel:   BYTE:=0;
    sDrvAdsAddr:      ST_TcPlcAdsAddr;
    nDrvAdsChannel:   BYTE:=0;

    nReserve:         ARRAY [1..20] OF BYTE;
END_STRUCT
END_TYPE
```

uiCount: Used for position detection. Used for **iTcMc_EncoderEL3102**, **iTcMc_EncoderEL3142**, **iTcMc_EncoderEL5101**, **iTcMc_EncoderKL2521**, **iTcMc_EncoderKL2531**, **iTcMc_EncoderKL2541**, **iTcMc_EncoderKL3002**, **iTcMc_EncoderKL3042**, **iTcMc_EncoderKL3062**, **iTcMc_EncoderKL3162**, **iTcMc_EncoderKL5101**, **iTcMc_EncoderKL5111**, **iTcMc_EncoderM2510**, **iTcMc_EncoderM3120**, **iTcMc_DriveKL2531**, **iTcMc_DriveKL2541**.

uiLatch: Used for position detection. Used for **iTcMc_EncoderEL5101**, **iTcMc_EncoderKL5101**, **iTcMc_EncoderKL5111**.

usiStatus: Used for device state information. Used for **iTcMc_EncoderEL5101**, **iTcMc_EncoderKL3002**, **iTcMc_EncoderKL3042**, **iTcMc_EncoderKL3062**, **iTcMc_EncoderKL3162**, **iTcMc_EncoderKL5101**, **iTcMc_EncoderKL5111**, **iTcMc_EncoderM3120**.

uiPZDL_RegDaten: Used for position detection and parameter communication. Used for **iTcMc_EncoderKL5001**.

uiPZDH: Used for position detection. Used for **iTcMc_EncoderKL5001**.

usiRegStatus: Used for device state information. Used for **iTcMc_EncoderEL5001**, **iTcMc_EncoderKL5001**.

udiCount: Used for position detection. Used for **iTcMc_EncoderEL5001**.

uiStatus: Used for device state information. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

bTerminalState: Used for parameter communication. Used for **iTcMc_EncoderKL2521**, **iTcMc_EncoderKL2531**, **iTcMc_EncoderKL2541**, **iTcMc_DriveEL4132**, **iTcMc_DriveKL2521**, **iTcMc_DriveKL2531**, **iTcMc_DriveKL2541**, **iTcMc_DriveKL4032**.

uiTerminalData: Reserved.

uiTerminalState2: Used for position detection. Used for **iTcMc_EncoderKL2541**.

bDigInA: Used for position detection. Used for **iTcMc_EncoderDigIncrement**.

bDigInB: Used for position detection. Used for **iTcMc_EncoderDigIncrement**.

bDigCamMM: Used for position detection. Used for **iTcMc_EncoderDigCam**.

bDigCamM: Used for position detection. Used for **iTcMc_EncoderDigCam**.

bDigCamP: Used for position detection. Used for **iTcMc_EncoderDigCam**.

bDigCamPP: Used for position detection. Used for **iTcMc_EncoderDigCam**.

DriveError: Used for device state information. Used for **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

ActualPos: Used for position detection. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

DriveState: Used for device state information. Used for **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

nReserve: Reserved.

S_iReserve: Reserved.

S_DiReserve: Reserved.

CiA_Reserve: Reserved.

bPowerOk: Optionally used for monitoring of a mains contactor. Used for **iTcMc_DriveAx2000_B110**, **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

bEnAck: Reserved.

wDriveDevState: Reserved.

wDriveWcState: Used for monitoring the connection to the actuator. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

wEncDevState: Reserved.

wEncWcState: Used for monitoring the connection to the encoder. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**, **iTcMc_EncoderEL3102**, **iTcMc_EncoderEL3142**, **iTcMc_EncoderEL5001**, **iTcMc_EncoderEL5101**.

uiDriveBoxState: Used for monitoring the connection to the actuator. Used for **iTcMc_DriveAx2000_B200**, **iTcMc_DriveAx2000_B900**.

uiEncBoxState: Used for monitoring the connection to the encoder. Used for **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

sEncAdsAddr: Used for parameter communication. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**, **iTcMc_EncoderEL3102**, **iTcMc_EncoderEL3142**, **iTcMc_EncoderEL5001**, **iTcMc_EncoderEL5101**.

nEncAdsChannel: Used for parameter communication. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

sDrvAdsAddr: Used for parameter communication. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

nDrvAdsChannel: Used for parameter communication. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

nReserve: Reserved.

4.3.26 ST_TcPlcDeviceOutput (from V3.0)

This structure contains the output image variables of an axis.

```
TYPE ST_TcPlcDeviceOutput :
STRUCT
    nDacOut:          INT:=0;
    bDigOutAp:        BOOL:=FALSE;
    bDigOutAn:        BOOL:=FALSE;
    bDigOutBp:        BOOL:=FALSE;
    bDigOutBn:        BOOL:=FALSE;
    uiCount:          UINT:=0;
    uiDacOutA:        UINT:=0;
    uiDacOutB:        UINT:=0;
    bMovePos:         BOOL:=FALSE;
    bMoveNeg:         BOOL:=FALSE;
    bBrakeOff:        BOOL:=FALSE;
    bBrakeOffInverted:BOOL:=FALSE;
    DriveCtrl:        ARRAY [0..3] OF BYTE:=0;
    NominalVelo:      DINT:=0;
    uiDriveCtrl:      UINT:=0;
    S_iReserve:       ARRAY [1..2] OF INT:=0;
    S_DiReserve:      ARRAY [1..7] OF DINT:=0;
    CiA_Reserve:      ARRAY [1..7] OF UINT:=0;
    bPowerOn:         BOOL:=FALSE;
    bEnable:          BOOL:=FALSE;
    bEnablePos:       BOOL:=FALSE;
    bEnableNeg:       BOOL:=FALSE;
    nResetState:      BYTE:=0;
    usiCtrl:          USINT:=0;
    uiTerminalData:   WORD:=0;
    bTerminalCtrl:    BYTE:=0;
    uiTerminalCtrl2:  WORD:=0;
    nReserve:         ARRAY [1..20] OF BYTE;
END_STRUCT
END_TYPE
```

nDacOut: Used for control value outputs or parameter communication. Used for **iTcMc_EncoderKL2531**, **iTcMc_EncoderKL2541**, **iTcMc_DriveEL4132**, **iTcMc_DriveKL2521**, **iTcMc_DriveKL2531**, **iTcMc_DriveKL2541**, **iTcMc_DriveKL4032**, **iTcMc_DriveM2400_Dn**.

bDigOutAp: Used for control value output. Used for **iTcMc_DriveLowCostStepper**.

bDigOutAn: Used for control value output. Used for **iTcMc_DriveLowCostStepper**.

bDigOutBp: Used for control value output. Used for **iTcMc_DriveLowCostStepper**.

bDigOutBn: Used for control value output. Used for **iTcMc_DriveLowCostStepper**.

uiCount: Reserved.

uiDacOutA: Used for control value output. Used for **iTcMc_EncoderIx2512_1Coil**, **iTcMc_EncoderIx2512_2Coil**.

uiDacOutB: Used for control value output. Used for **iTcMc_EncoderIx2512_2Coil**.

bMovePos : Reserved.

bMoveNeg : Reserved.

bBrakeOff: Reserved.

bBrakeOffInverted: Reserved.

DriveCtrl: Used for device control signals. Used for **iTcMc_EncoderAx2000_B200**, **iTcMc_DriveAx2000_B200**, **iTcMc_EncoderAx2000_B900**, **iTcMc_DriveAx2000_B900**.

NominalVelo: Used for control value output. Used for **iTcMc_DriveAx2000_B110**, **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

uiDriveCtrl: Used for device control signals. Used for **iTcMc_EncoderAx2000_B110**, **iTcMc_DriveAx2000_B110**.

S_iReserve: Reserved.

S_DiReserve: Reserved.

CiA_Reserve: Reserved.

bPowerOn: Optionally used for controlling a mains contactor. Used for **iTcMc_DriveAx2000_B110**, **iTcMc_EncoderAx2000_B200**, **iTcMc_EncoderAx2000_B900**.

bEnable: Reserved.

bEnablePos: Reserved.

bEnableNeg: Reserved.

nResetState: Reserved.

usiCtrl: Used for device control signals or parameter communication. Used for **iTcMc_EncoderEL5101**, **iTcMc_EncoderKL3002**, **iTcMc_EncoderKL3042**, **iTcMc_EncoderKL3062**, **iTcMc_EncoderKL3162**, **iTcMc_EncoderKL5101**, **iTcMc_EncoderKL5111**, **iTcMc_EncoderM3120**.

uiTerminalData: Used for parameter communication. Used for **iTcMc_EncoderKL2521**, **iTcMc_EncoderKL5001**, **iTcMc_EncoderKL5101**, **iTcMc_EncoderKL5111**, **iTcMc_DriveEL4132**, **iTcMc_DriveKL2521**, **iTcMc_DriveKL4032**.

bTerminalCtrl: Used for parameter communication. Used for **iTcMc_EncoderKL2521**, **iTcMc_EncoderKL2531**, **iTcMc_EncoderKL2541**, **iTcMc_DriveEL4132**, **iTcMc_DriveKL2521**, **iTcMc_DriveKL2531**, **iTcMc_DriveKL2541**, **iTcMc_DriveKL4032**.

uiTerminalCtrl2: Used for device control signals. Used for **iTcMc_EncoderKL2541**, **iTcMc_DriveKL2531**, **iTcMc_DriveKL2541**.

nReserve: Reserved.

4.3.27 ST_TcPlcMcLogBuffer (from V3.0)

A variable with this structure forms the LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

Note	The data in this structure must not be modified by the application.

```
TYPE ST_TcMcLogBuffer:
STRUCT
    ReadIdx:        INT:=0;
    WriteIdx:       INT:=0;
    MessageArr:     ARRAY [0..19] OF ST_TcPlcMcLogEntry;
END_STRUCT
END_TYPE
```

ST_TcPlcMcLogEntry [▸ 108]

ReadIdx: The read index of the buffer.

WriteIdx: The write index of the buffer.

MessageArr: The currently stored messages.

4.3.28 ST_TcPlcMcLogEntry (from V3.0)

A variable with this structure contains a message of the LogBuffer of the library. Used as a component in ST_TcPlcMcLogBuffer [▸ 107]. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

Note	The data in this structure must not be modified by the application.

```
TYPE ST_TcPlcMcLogEntry:
STRUCT
    TimeLow:     UDINT:=0;
    TimeHigh:    UDINT:=0;
    LogLevel:    DWORD:=0;
    Source:      DWORD:=0;
    Msg:         STRING(255);
    ArgType:     INT:=0;
    diArg:       DINT:=0;
    lrArg:       LREAL:=0;
    sArg:        STRING(255);
END_STRUCT
END_TYPE
```

TimeLow, **TimeHigh**: The timestamp of the message. Records the time at which the message was generated.

LogLevel: Indicates the urgency of the message. Only values from a specified pool of numbers [▸ 244] should appear here.

Source: Indicates the source of the message. Only values from a specified pool of numbers [▸ 244] should appear here.

Msg: The message text with an optional placeholder for a variable component.

ArgType: The type of the optional component.

diArg: If an optional component of type DINT is used, its value can be found here.

lrArg: If an optional component of type LREAL is used, its value can be found here.

sArg: If an optional component of type STRING is used, its value can be found here.

4.3.29 ST_TcPlcRegDataItem (from V3.0.7)

This structure contains a parameter for a KL terminal. An ARRAY of elements of this type forms the type ST_TcPlcRegDataTable [▸ 109].

```
TYPE ST_TcPlcRegDataItem :
STRUCT
    Access:      INT:=0;
    Select:      INT:=-1;
    RegData:     WORD:=0;
END_STRUCT
END_TYPE
```

Access: The type of the operation to be executed is coded here. Details can be found under MC_AxUtiUpdateRegDriveTerm_BkPlcMc [▸ 209] or MC_AxUtiUpdateRegEncTerm_BkPlcMc [▸ 211].

Select: The address of the register in the terminal.

RegData: The parameters to be used for the operation to be executed.

4.3.30 ST_TcPlcRegDataTable (from V3.0.7)

This structure contains a parameter set for a KL terminal. Such a table is processed by the MC_AxUtiUpdateRegDriveTerm_BkPlcMc [▸ 209] or MC_AxUtiUpdateRegEncTerm_BkPlcMc [▸ 211] function blocks.

```
TYPE ST_TcPlcRegDataTable :
STRUCT
    RegDataItem:    ARRAY [1..64] OF ST_TcPlcRegDataItem;
END_STRUCT
END_TYPE
```

4.3.31 TRACK_REF_BkPlcMc (from V3.0)

```
TYPE TRACK_REF_BkPlcMc:
STRUCT
    Track:          ARRAY [ciBkPlcMc_TrackRef_MinIdx..ciBkPlcMc_Track-
Ref_MaxIdx] OF TRACK_REFTYPE_BkPlcMc;
END_STRUCT
END_TYPE

TYPE TRACK_REFTYPE_BkPlcMc:
STRUCT
    OnCompensation: LREAL;
    OffCompensation:LREAL;
    Hysteresis:     LREAL;
END_STRUCT
END_TYPE
```

OnCompensation: The switch-on dead time to be compensated in seconds.

OffCompensation: The switch-off dead time to be compensated in seconds.

Hysteresis: The axis must have moved away from the switching point by this distance before reaching of the switching point is evaluated again.

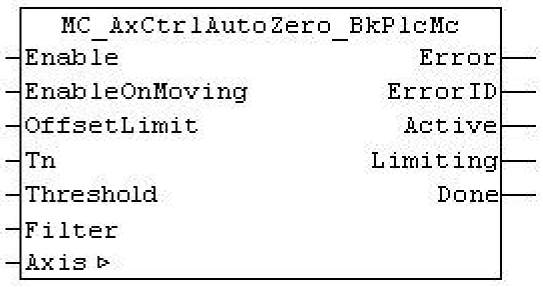
If a positive value is specified as dead time compensation, signaling is delayed. A negative value leads to leading signalling.

NOTE! The time cannot be adhered to precisely, if the controlling parameter changes with a fluctuating rate. If this controlling parameter is an actual axis position, the actual axis velocity must be constant.

4.4 System

4.4.1 Controller

4.4.1.1 MC_AxCtrlAutoZero_BkPlcMc (from V3.0)



The function block executes an automatic zero balance. This function block may only be used for zero overlap valves.

```
VAR_INPUT
    Enable:         BOOL:=FALSE;
    EnableOnMoving: BOOL:=FALSE;
    OffsetLimit:    LREAL:=0.0;
    Tn:             LREAL:=0.0;
    Threshold:      LREAL:=0.1;
    Filter:         LREAL:=0.1;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:          BOOL;
    ErrorID:        UDINT;
    Active:         BOOL;
    Limiting:       BOOL;
    Done:           BOOL;
END_VAR
```

Enable: This input controls the activity of the compensation.

EnableOnMoving: This input controls the activity of the compensation.

Tn: [s] The integral action time of the compensation. This is the time for a change by 10 V. Values greater than 100 s are recommended.

Threshold: [V] Parameter for the **Done** signal.

Filter: [s] Parameter for the **Done** signal.

OffsetLimit: [V] The value in fZeroCompensation is limited to this value.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Active: Indicates that the function block actively adjusts the value of fZeroCompensation in ST_TcHydAxParam [▸ 93].

Limiting: Indicates that the value of fZeroCompensation in ST_TcHydAxParam [▸ 93] has reached the limit specified by OffsetLimit.

Done: Indicates leveling out of the offset compensation.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Purpose of the function block

If a hydraulic cylinder is drifting when the position controller is switched off (kP=0.0), or if there is a permanent lag error relative to the target when the position controller is active, this can be corrected by using a zero overlap valve with offset compensation.

A hydraulic cylinder stops when it is in equilibrium of forces. In the simplest case (cylinder with identical surfaces, no external forces by gravity or a process) this equilibrium is fulfilled, if the same pressure acts on both surfaces. For a differential cylinder, the pressures must be proportional to the inverse of the surfaces. Any external forces must be included. In order to achieve the required pressure conditions, a proportion of the system pressure is required as pressure difference. In the case of a zero overlap valve, this is defined by the pressure gain characteristic.

Another possible reason for an offset is a difference between the hydraulic zero point of the valve and the logical zero point of the output hardware. These are unavoidable manufacturing tolerances.

Therefore, a small valve excitation with up to ±0.5 V is required. Refer to the data sheets provided by the valve and hardware manufacturers for further information.

Behavior of the function block: Enable logic

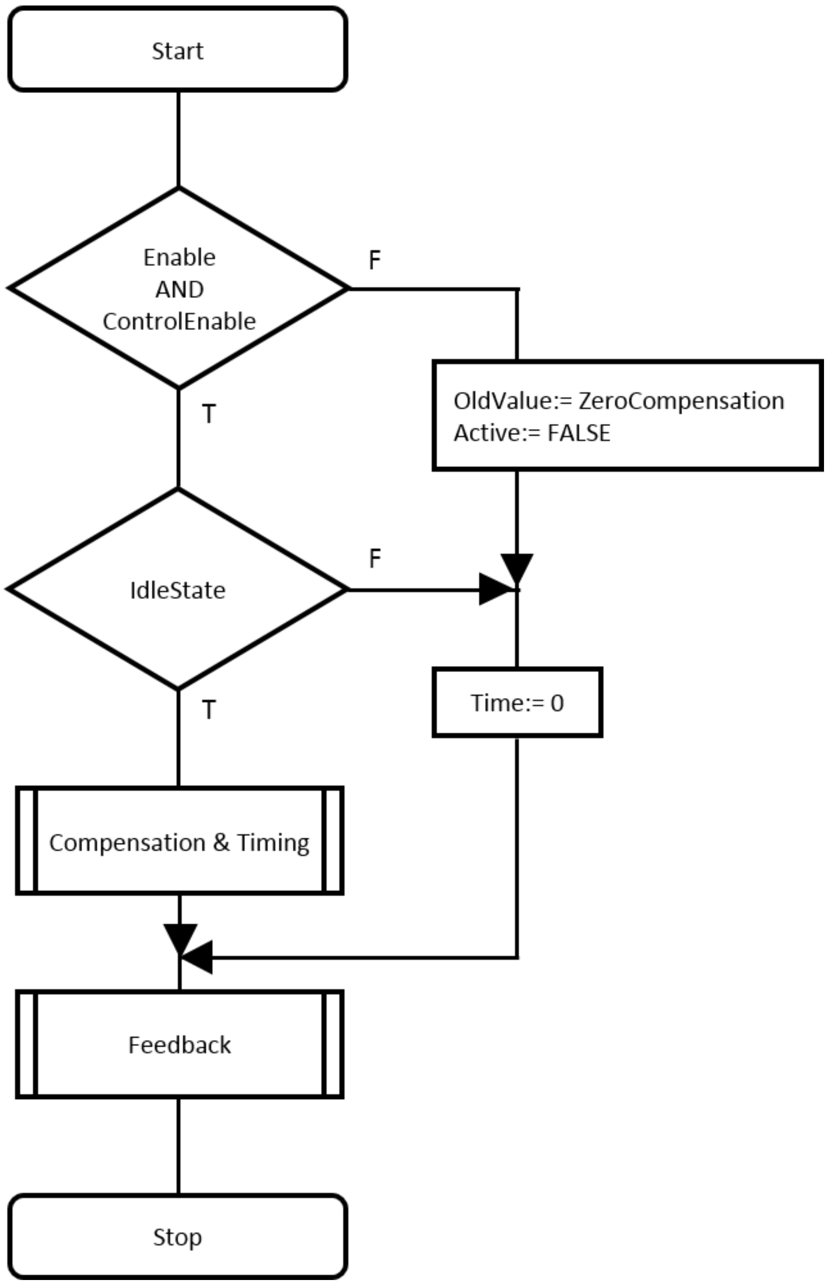
As long as **Enable** for the function block or the axis controller is FALSE, the function block does not become **Active**. The comparison value for monitoring the compensation is initialized and the time measurement for the **Done** message is reset.

If the enable conditions are met and the axis is not in idle state (i.e. it is in motion), the time measurement for the **Done** message is also reset.

If the enable conditions are met and the axis is in idle state, the function block 'Compensation&Timing' is processed.

Irrespective of these preconditions, the function block' Feedback' is processed.

Enable logic:



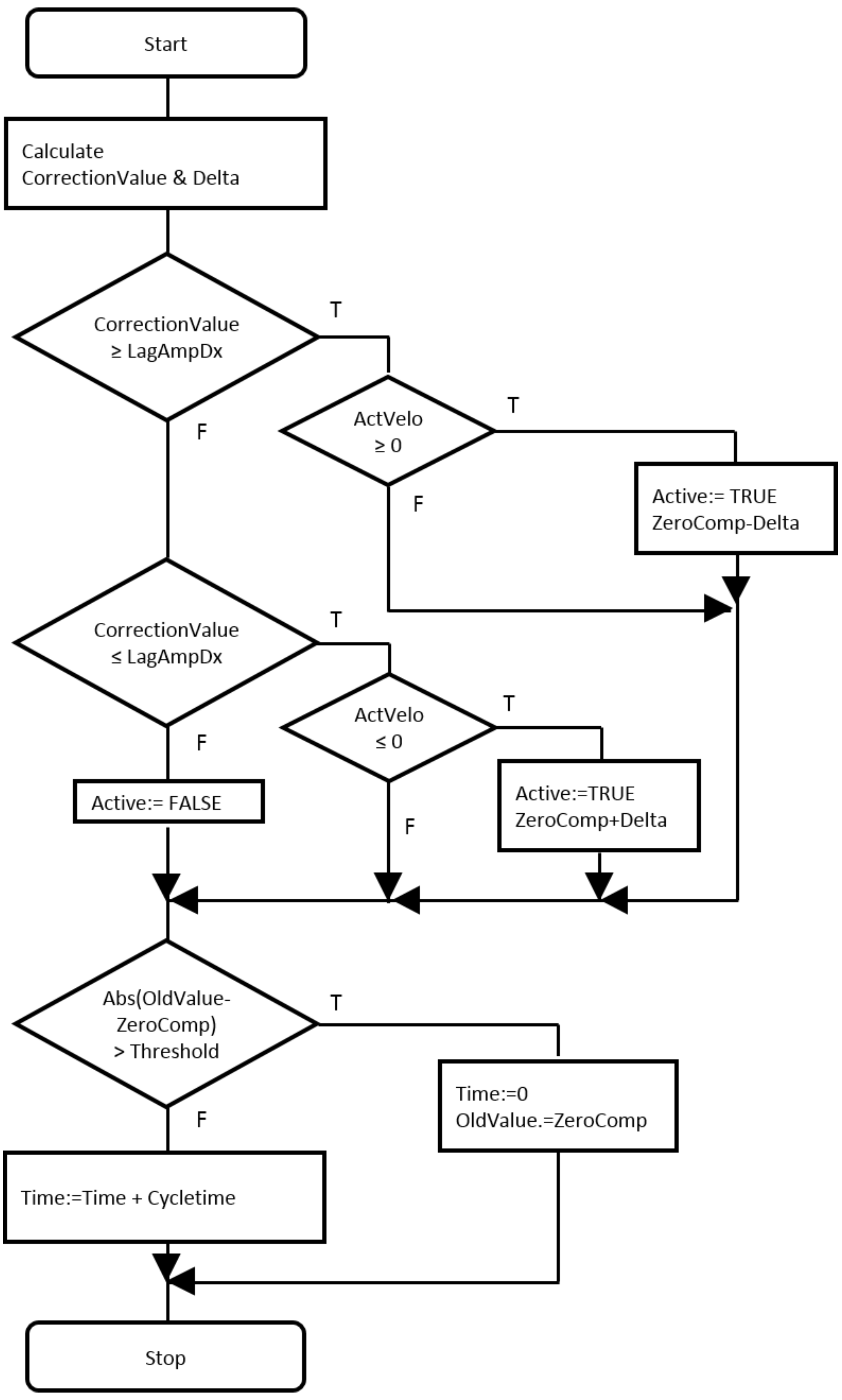
Behavior of the function block: Compensation&Timing

A correction value is formed from the lag error and the response of the controller. The bandwidth of the possible axis controller parameterization is taken into account. A delta value (maximum change in **zero compensation** per cycle) is formed from this correction value and **Tn**. **Tn** defines a ramp time for an increase by 10 V. The delta value is limited such that this ramp slope is not exceeded. In this way an excessively fast change, during which the correction would become unstable, can be avoided. Values greater than 100 seconds are recommended.

A tolerance threshold is used for compensation. In this case **LagAmpDx** (threshold value of the I component in the position controller) is used.
If the correction value is greater than or equal to the tolerance threshold and the actual velocity is greater than or equal to zero (i.e. the remaining correction value is not already reduced), the **Active** function block is used and the compensation is reduced in each cycle by the delta value described.
If the correction value is less than or equal to the tolerance threshold and the actual velocity is less than or equal to zero (i.e. the remaining correction value is not already reduced), the **Active** function block is used and the compensation is reduced in each cycle by the delta value described.
If the magnitude of the correction value is smaller than the tolerance threshold, **Active** becomes FALSE.

If the compensation differs by more than the **Threshold** from the OldValue comparison value, the time measurement is reset and the current compensation is updated as a new comparison value. Otherwise, the time measurement is increased with the cycle time. In this way, the time required to accumulate a change in compensation by at least the **Threshold** is logged.

Compensation&Timing:

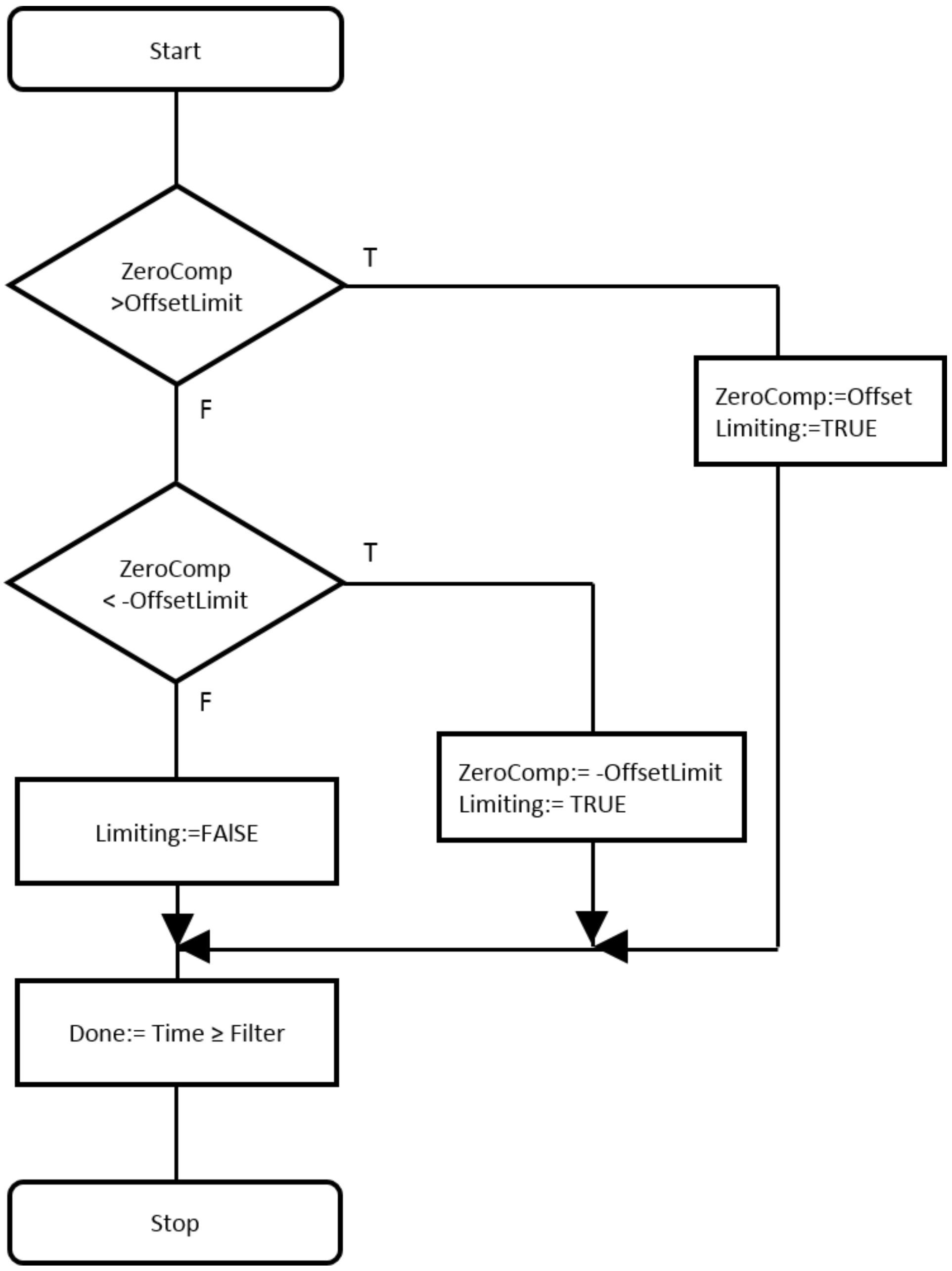

Start
Calculate CorrectionValue & Delta
CorrectionValue ≥ LagAmpDx
T
F
ActVelo ≥ 0
T
F
Active:= TRUE ZeroComp-Delta
CorrectionValue ≤ LagAmpDx
T
F
ActVelo ≤ 0
T
F
Active:=TRUE ZeroComp+Delta
Active:= FALSE
Abs(OldValue-ZeroComp) > Threshold
T
F
Time:=0 OldValue.=ZeroComp
Time:=Time + Cycletime
Stop

Behavior of the function block: Feedback

The compensation is limited to ±**OffsetLimit** and signaled to **Limiting**.

Done is reported when the function block is active and the time measurement reaches the time set in **Filter**. Example: If **Threshold** is set to 0.05 and **Filter** to 2.0, **Done** is reported if the compensation has been readjusted by less than 0.05 V within the last 2 seconds.

Feedback



NOTE! The limitation to the range specified by OffsetLimit applies even if the function block is not active. The Limiting output is updated.

The value **OffsetLimit** and ST_TcHydAxParam [▶ 93].**fZeroCompensation** are regarded as offset voltage. The value 10.0 therefore corresponds to full scale control. In general, a value between 0.1 and 1.0 makes sense for **OffsetLimit,** depending on the application.

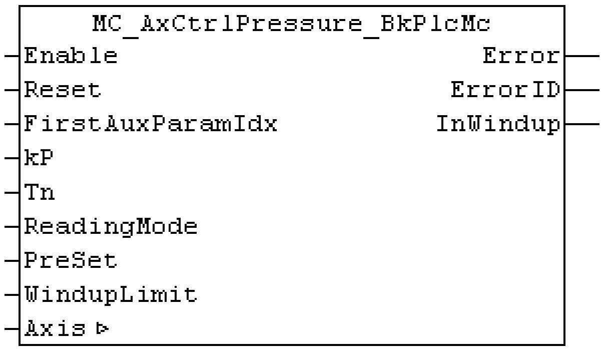
Integration of the function block in the application

In the call sequence for the function blocks of an axis, an MC_AxCtrlAutoZero_BkPlcMc function block should appear immediately before the MC_AxRtFinish_BkPlcMc [▶ 175]. If an MC_AxStandardBody_BkPlcMc [▶ 181] function block is called instead of the individual function blocks, MC_AxCtrlAutoZero_BkPlcMc should be called before this function block.

Attention	**Dangerous axis movement** If situations occur during axis operation, in which the axis has a controller enable pending but does not display its normal motion behavior, the MC_AxCtrlAutoZero_BkPlcMc function block must be disabled. Possible causes for such a situation including function block startup with or without transition to pressure control or reduction of or switch-off of the supply. If this is not taken into account, the value of fZeroCompensation in ST_TcHydAxParam [▸ 93] may run in any direction until the specified limit is reached. As soon as the axis is responsive again at a later stage, a dangerous motion may be unavoidable. In this case the positioning behavior will be severely affected. If the function block is called without **EnableOnMoving,** it may no longer be able to automatically correct the shifted offset. In this case the axis will stop outside the target window and never report the motion as complete, or only after a long time.

In combination with an MC_AxStandardBody_BkPlcMc [▸ 181] function block, all responses of the MC_AxCtrlAutoZero_BkPlcMc function block are delayed by one PLC cycle. Usually this is no problem. If this offset does cause problems, the individual function blocks for encoder etc. should be used, and the MC_AxCtrlAutoZero_BkPlcMc function block should be called immediately before the MC_AxRtFinish_BkPlcMc [▸ 175] function block.

4.4.1.2 MC_AxCtrlPressure_BkPlcMc (from V3.0)



The function block controls the pressure applied to an axis such that a specified default value is established and maintained in the actual value selected by **ReadingMode**.

In most cases the actual pressure can be logged with function blocks of type MC_AxRtReadPressureSingle_BkPlcMc [▸ 158] or MC_AxRtReadPressureDiff_BkPlcMc [▸ 156].

```
VAR_INPUT
    Enable:      BOOL:=FALSE;
    Reset:       BOOL:=TRUE;
    FirstAuxParamIdx: INT:=0;
    kP:          LREAL:=0.0;
    Tn:          LREAL:=0.0;
    ReadingMode:E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
    PreSet:      LREAL:=0.0;
    WindupLimit:LREAL:=0.0;
END_VAR
VAR_INOUT
    Axis:        Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:       BOOL;
    ErrorID:     UDINT;
    InWindup:    UDINT;
END_VAR
```

Enable: TRUE at this input activates the controller.

Reset: TRUE at this input resets the controller. The memory of the I component is cleared.

FirstAuxParamIdx: Here a range in the Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxParam [▶ 93].fCustomerData can be activated as parameter interface.

InWindup: This output becomes TRUE if the I component is limited by **WindupLimit**.

kP: The gain factor of the P component.

Tn: The integral action time of the I component.

ReadingMode: The actual value to be controlled can be specified here. Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxRtData [▶ 99].**fActPressure** is selected as default value.

PreSet: Here you can specify a default value for calculating an initial value for the I component of the controller. The I component is preloaded with this value on activation.

WindupLimit: Here you can specify a limit value for the I component. Such a limitation prevents extreme behavior of the I component in situations where the path does not respond to controller outputs.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block:

The function block investigates the axis interface that has been passed to it every time it is called. TRUE at **Reset** puts the function block in an idle state, irrespective of the other control signals. Both the P component and the I component are then deleted. **Enable** can be used to specified whether the function block assumes the active state.

The input **ReadingMode** determines which variable is assigned the parameter to be controlled in the stAxRtData structure.

- iTcHydPressureReadingDefault, iTcHydPressureReadingActPressure: fActPressure is controlled.
- iTcHydPressureReadingActForce: fActForce is controlled.
- Any other value deactivates the controller.

NOTE! The set value has to be specified in fSetPressure in the stAxRtData structure of the axis.

First, the function block determines whether it has to assume or quit the active state. To this end the **Enable** signal is evaluated. A rising edge causes the I component to be initialized with **PreSet**. If the output value matching ST_TcHydAxRtData [▶ 99].in fSetPressure is known, it can be utilized for reaching the compensated state more quickly. A P component is then calculated with **kP,** an I component with **Tn**. The sum of these controller components is output as control value in ST_TcHydAxRtData [▶ 99].fSetSpeed. Since this controller assumes the function of a control value generator, it cancels ST_TcHydAxRtData [▶ 99].fLagCtrlOutput. The MC_AxRtFinish_BkPlcMc [▶ 175] function block to be positioned after the controller function block then considers the response automatically.

The transition to the inactive state results in deletion of the controller components.

Integration of the function block in the application

A function block of this type must be called after the actual value and actual pressure acquisition. It handles the full control of the axis and replaces any function block for control value generation that may be present.

A program example [▶ 219] #15 is available.

NOTE! If a function block for control value generation and an MC_AxCtrlPressure_BkPlcMc function block are present, these function blocks should either be called alternatively, or the MC_AxCtrlPressure_BkPlcMc function block must follow after the control value function block, so that it overwrites the outputs of this function block. Not all generator types allow both options.

NOTE! A value greater than 0 in FirstAuxParamIdx can be used to instruct the function block to use three consecutive values in the fCustomerData of the parameter structure as Tn, kP and PreSet. If the address of a suitable ARRAY[..] OF STRING() is entered in Axis.pStAxAuxLabels, the parameters are automatically assigned a name.

Commissioning

The four parameters **kP**, **Tn**, **PreSet** and **WindupLimit** enable the controller to be adapted to a range of different tasks.

Attention	**Control oscillations** During commissioning the axis may be subjected to the full system pressure, or damped or undamped vibrations in a wide frequency range may occur. Appropriate measures must be taken, if there is a risk for the axis or its surroundings. In any case, measures should be taken to enable fast deactivation of the controls.

Initially 0.0 should be entered for **Tn** and **Preset** and 1.0 for **WindupLimit**. The controller now operates as a pure P controller. Once a function block has started up and the controller is activated (Enable:=TRUE, Reset:=FALSE, **SetPressure**:=set value), the maximum applicable value for **kP** can be determined. Increase the value step-by-step, until an oscillation tendency becomes apparent. Use repeated deactivation and activation to check whether the controller is actually stable. In practice the value will be between around 0.1 and 0.5.

The next parameter to be set is **Tn**. Initially, a relatively large value should be specified, e.g. 0.5. The actual pressure should now be regulated to the set value with large inertia, but fairly precisely. Now determine the maximum possible setting through step-by-step reduction. Again, use repeated deactivation and activation to check whether the controller is actually stable. If there is a tendency to damped oscillation during activation, **Tn** is already set too low.

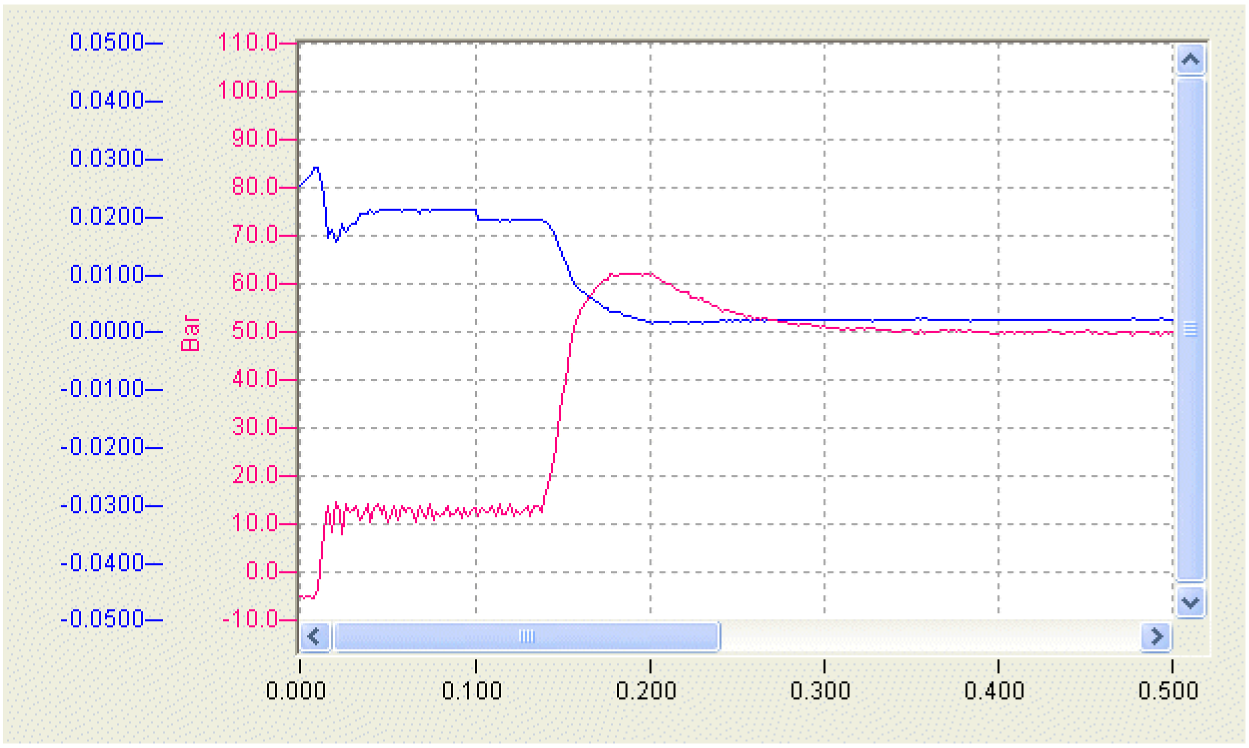
The setting of **WindupLimit** does not directly influence the behavior of the controller. Rather, this parameter is used to influence the transition behavior. If the controller is able to build up the pressure immediately because the axis does not have to travel, the value of **WindupLimit** should be chosen such that the I component is not greater than three to four times the value that is required according to valve characteristics. In this way the pressure regulation can be achieved significantly more quickly. If the axis still has some way to travel, a low value for this parameter will determine the motion of the axis until the working position is reached. If the parameter is chosen too low, the axis will move very slowly or even stop. On the other hand, a value that is too large will cause the axis to reach the working position with a rather high velocity, resulting in steep pressure increase. The resulting peak pressure can be significant.

NOTE! If possible, activation of a pressure controller should be avoided, unless the axis is very close to its working position.

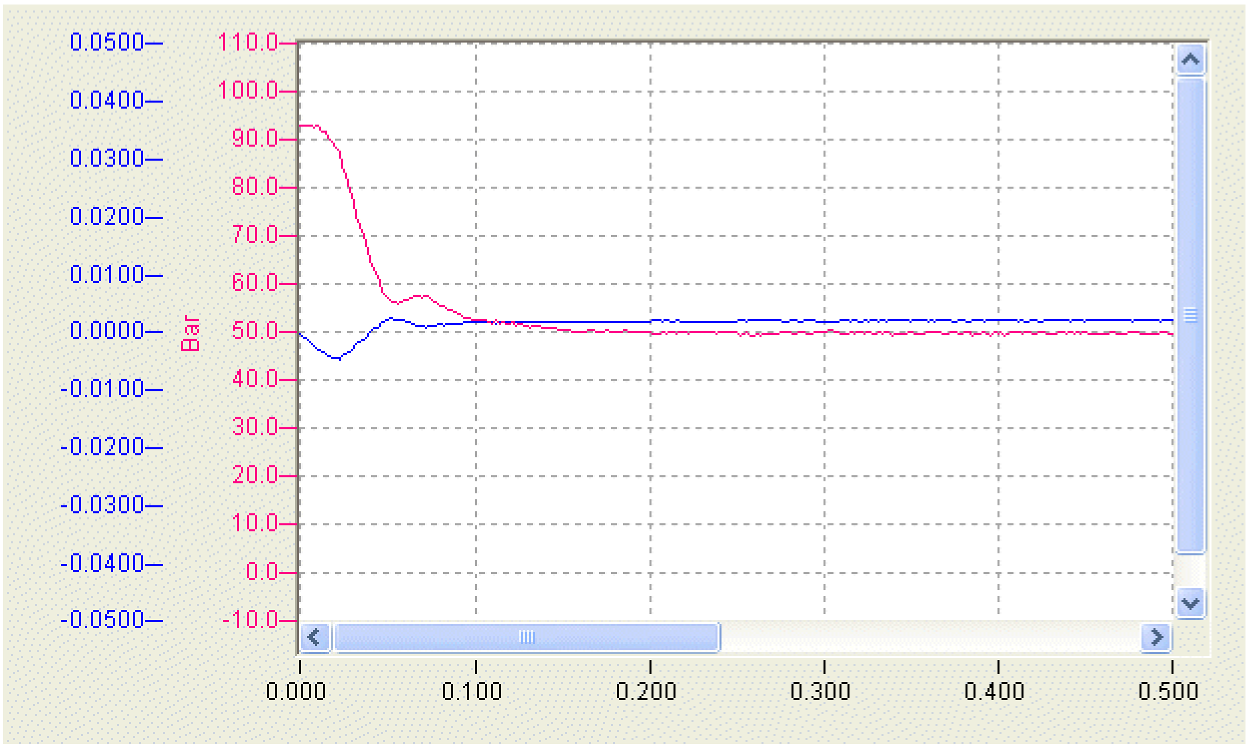
The value for **PreSet** can be used for two procedures. If the pressure regulator should continue the control value of another function block continuously, its control value can be specified for the calculation of **PreSet**. In this way it is possible to reduce or avoid step changes in the control value during activation of the controller.

If the control value to be generated by the controller is known, a value that is close to this value can be specified as **PreSet**. In this way it is possible to reduce the time, which the I component requires to establish the control value. Since the P component is also active, a value should be set that is higher than the exact value.

NOTE! The ultimate aim when setting these parameters is to find a set of values that is appropriated for the task by making small changes and assessing the controller characteristics.

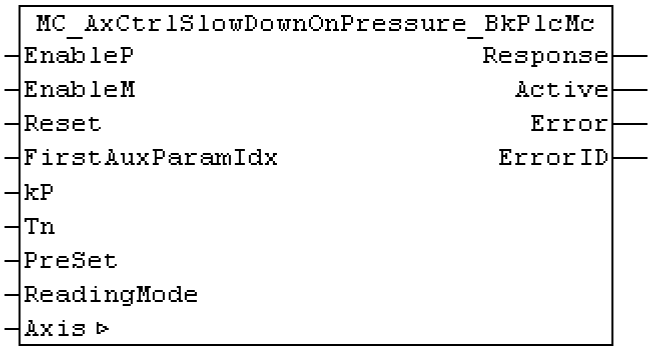


Example for the behavior of the controller, if the axis first has to travel some distance before it can build up the required pressure.



Example for the controller behavior, if the axis is able to build up the required pressure immediately.

4.4.1.3 MC_AxCtrlSlowDownOnPressure_BkPlcMc (from V3.0)



The function block decelerates an axis such that a certain default value is not exceeded in the actual value selected through **ReadingMode**. The rules of substitutional pressure control apply.

In most cases the actual pressure can be logged with function blocks of type MC_AxRtReadPressureSingle_BkPlcMc [▸ 158] or MC_AxRtReadPressureDiff_BkPlcMc [▸ 156].

```
VAR_INPUT
    EnableP:          BOOL:=FALSE;
    EnableM:          BOOL:=FALSE;
    Reset:            BOOL:=TRUE;
    FirstAuxParamIdx: INT:=0.0;
    kP:               LREAL:=0.0;
    Tn:               LREAL:=0.0;
    PreSet:           LREAL:=0.0;
    ReadingMode:      E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
END_VAR
```

E_TcMcPressureReadingMode [▸ 89]

```
VAR_INOUT
    Axis:             Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Response:         LREAL;
    Active:           BOOL;
    Error:            BOOL;
    ErrorID:          UDINT;
END_VAR
```

EnableP: TRUE at this input enables the controller to influence the output value during a motion in positive direction.

EnableM: TRUE at this input enables the controller to influence the output value during a motion in negative direction.

Reset: TRUE at this input resets the controller. The memory of the I component is cleared.

FirstAuxParamIdx: Here a range in the Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxParam [▸ 93].fCustomerData can be activated as parameter interface.

kP: The gain factor of the P component.

Tn: The integral action time of the I component.

PreSet: Here you can specify a default value for calculating an initial value for the I component of the controller. The I component is preloaded with this value on activation.

Response: The output value of a pressure regulator.

ReadingMode: The actual value to be controlled can be specified here. Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxRtData [▸ 99].**fActPressure** is selected as default value.

Active: TRUE at this output indicates that the function block generates a response in order to take over the pressure control.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

TRUE at **Reset** puts the function block in an idle state, irrespective of the other control signals. **Active** is then FALSE and **Response** := 0.0, since both the P component and the I component are deleted.

The input **ReadingMode** determines which variable is assigned the parameter to be controlled in the stAxRtData structure.

- iTcHydPressureReadingDefault, iTcHydPressureReadingActPressure: fActPressure is controlled.
- iTcHydPressureReadingActForce: fActForce is controlled.
- Any other value deactivates the controller.

NOTE! The set value has to be specified in fSetPressure in the stAxRtData structure of the axis.

During active operation the behavior of the function block is determined by the inputs **EnableP** and **EnableM**. They determine whether the function block should intervene in positive or negative direction during a motion. Note that the function block is tasked to counteract an active travelling motion. **EnableP** should therefore be set if travelling motion in positive direction should not exceed a specified pressure. In opposite direction of travel **EnableM** enables a pressure-limiting controller response in positive direction.

First, the function block determines whether it has to assume or quit the active state. To this end the signals **EnableP**, **EnableM**, the sign of ST_TcHydAxRtData [▸ 99].fSetSpeed and the difference between **SetPressure** and the selected actual value are evaluated.

During transition to the active state the I component is initialized with **PreSet**. It is loaded with a starting value, which in combination with ST_TcHydAxRtData [▸ 99].fSetSpeed results in the value of **PreSet**. If the output value matching **fSetPressure** is known, it can be utilized for reaching the compensated state more quickly. In practice, the choice of this parameter should be made dependent on the behavior of the controlled system. This is mainly influenced by the flexibility of the pressed in object, but also by the selected velocity. If the increase is rather slow compared with the **Tn** used, the current control value from ST_TcHydAxRtData [▸ 99].fSetSpeed should be used as preset value. If the actual pressure responds with a rapid increase, it is advisable to use a value, which takes into account the set pressure and the pressure amplification of the valve.

A P component is then calculated with **kP,** an I component with **Tn**. The sum of these controller components is output as **Response,** and the state of the controller is indicated as TRUE at **Active**.

The transition to the inactive state results in deletion of the controller components and is indicated with FALSE at **Active**.

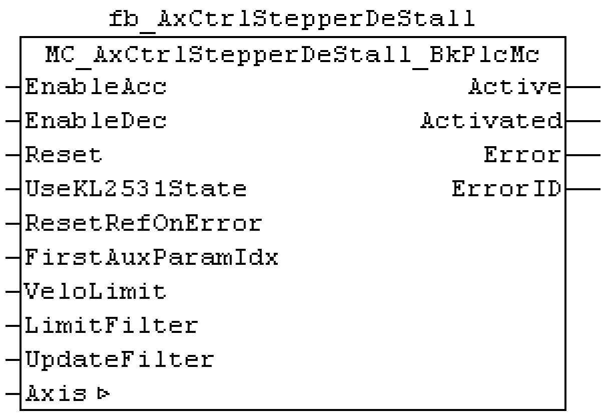
Integration of the function block in the application

A function block of this type must be called after the actual value and actual pressure acquisition, and after the control value generation. If function blocks are called for velocity or position control, these must also be positioned before the pressure regulator function block, or the responses of the controllers should be coordinated with due diligence.

Although the pressure regulator calculates a response, it is not entered in the ST_TcHydAxRtData [▸ 99] structure. This is done by the application, depending on **Active** and taking into account signals of other controllers. Usually, **Response** is assigned to the variable ST_TcHydAxRtData [▸ 99].fLagCtrlOutput. The MC_AxRtFinish_BkPlcMc [▸ 175] function block to be positioned after the controller function block then considers the response automatically.

NOTE! A value greater than 0 in FirstAuxParamIdx can be used to instruct the function block to use three consecutive values in the fCustomerData of the parameter structure as Tn, kP and PreSet. If the address of a suitable ARRAY[..] OF STRING() is entered in Axis.pStAxAuxLabels, the parameters are automatically assigned a name.

4.4.1.4 MC_AxCtrlStepperDeStall_BkPlcMc



The function block monitors the motion of a stepper motor axis, which is operated with an encoder.

NOTE! It is essential to use a real encoder (not an encoder emulation based on pulse counting of an output terminal) in order to ensure correct function of this function block.

NOTE! The application of such a function block can result in stalling (torque discontinuity). It therefore cannot be assumed that the velocity is constant.

```
VAR_INPUT
    EnableAcc:        BOOL:=FALSE;
    EnableDec:        BOOL:=FALSE;
    Reset:            BOOL:=FALSE;
    UseKL2531State:   BOOL:=FALSE;
    ResetRefOnError:  BOOL:=FALSE;
    FirstAuxParamIdx:INT:=0;
    VeloLimit:        LREAL:=0.0;
    LimitFilter:      LREAL:=0.0;
    UpdateFilter:     LREAL:=0.0;
END_VAR
VAR_INOUT
    Axis:             Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Active:           BOOL;
    Activated:        BOOL;
    Error:            BOOL;
    ErrorID:          UDINT;
END_VAR
```

EnableAcc, EnableDec: These inputs determine whether the monitoring may intervene during the acceleration and braking phases.

Reset: This input controls the activity of the controller.

UseKL2531State: If TRUE is transferred here, the function block evaluates ST_TcPlcDeviceInput [▶ 104].bTerminalState.

ResetRefOnError: If TRUE is transferred here, the function block clears the reference flag of the axis.

FirstAuxParamIdx: Here a range in the Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxParam [▶ 93].fCustomerData can be activated as parameter interface.

VeloLimit: The threshold for the velocity deviation, from which the stall situation is detected.

LimitFilter: The time over which an excessive velocity deviation must be present continuously for the stall situation to be detected.

UpdateFilter: The time constant, with which the velocity control value in the function block is adjusted to the actual velocity.

Active: Indicates that a stall situation was detected.

Activated: Indicates that a stall situation was detected since the last start of an active axis movement.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

During each call the function block checks whether it has to change the state. It goes in the active state if the internal motion phase permits this under the rules of **EnableAcc, EnableDec** and the velocity error continuously exceeds the value of **VeloLimit** for at least **LimitFilter**. **EnableAcc** enables the function block to intervene during phases with constant phases or phases with rising magnitude. **EnableDec** enables the activity of the function block for phases with falling magnitude or constant velocity. **Active** and **Activated** are set during the transition to the active state.

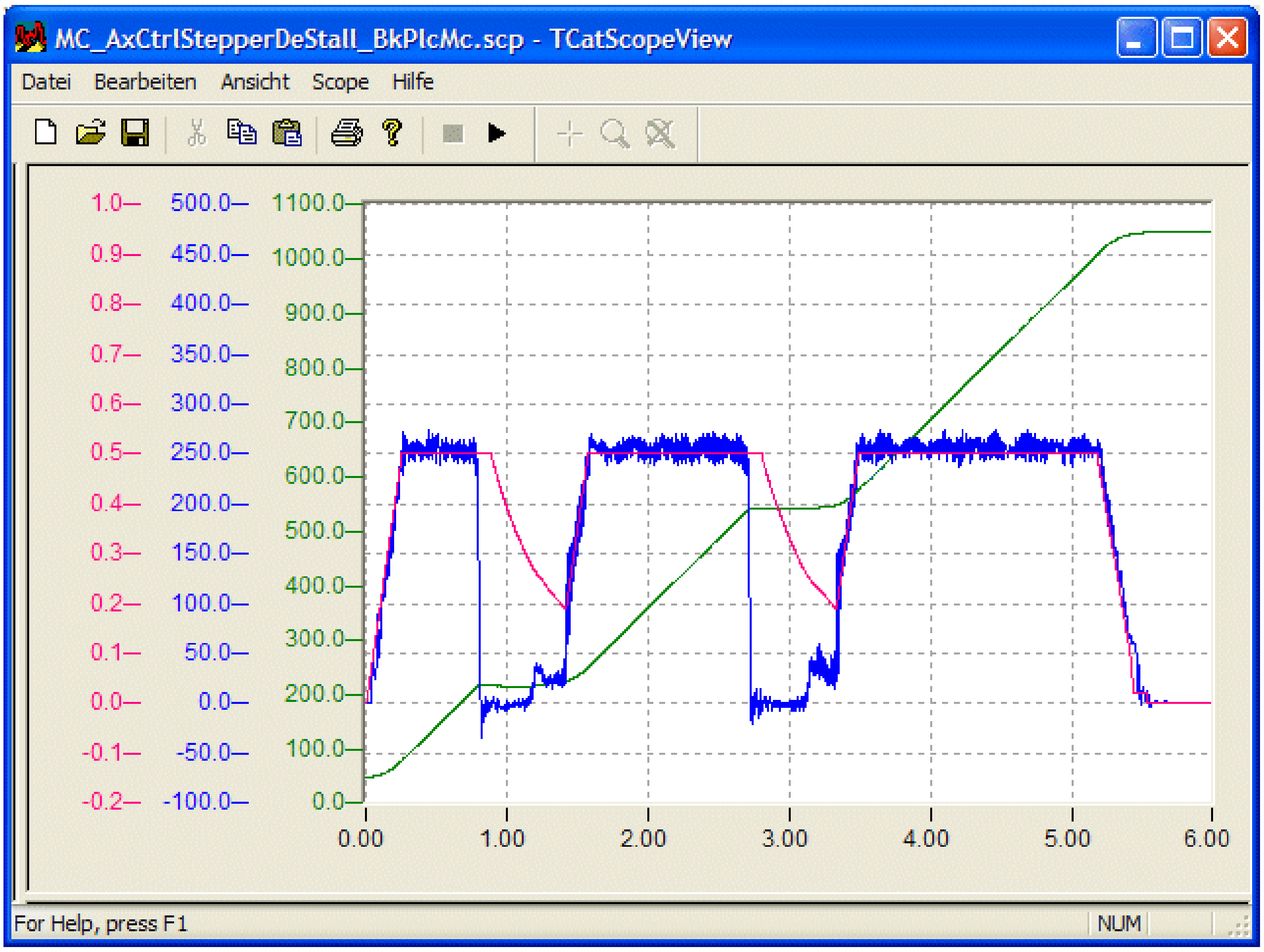
The function block changes to inactive state if the velocity error was reduced to half the value of **VeloLimit**. **Active** is cancelled during the transition to the inactive state.

In active state the control value is adjusted to the actual velocity with the time constant **UpdateFilter**. If the time constant is set to 0.0, the actual velocity is applied directly.

In inactive state **Activated** is cancelled, if the axis leaves the idle state and starts an active motion.

NOTE! Since the function block evaluates the difference between set and actual velocity, it is important to set the reference velocity correctly when this function block is used. Imprecise setting of this parameter can result in unnecessary intervention by the function block in the motion.

The following Scope View shows a positioning, during which an obstacle was encountered twice. In each case the axis stopped completely.

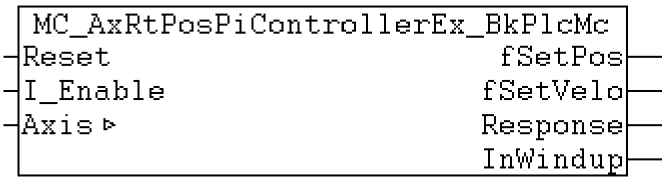


Integration of the function block in the application

A function block of this type must be called after the actual value acquisition and control value generation. The function block superimposes its response with that of the control value generator and enters it in the ST_TcHydAxRtData [▸ 99]. The MC_AxRtFinish_BkPlcMc [▸ 175] function block to be positioned after the controller function block then considers the response automatically.

NOTE! A value greater than 0 in FirstAuxParamIdx can be used to instruct the function block to use three consecutive values in the fCustomerData of the parameter structure as VeloLimit, LimitFilter and UpdateFilter. If the address of a suitable ARRAY[..] OF STRING() is entered in Axis.pStAxAuxLabels, the parameters are automatically assigned a name.

4.4.1.5 MC_AxRtPosPiControllerEx_BkPlcMc (ab V3.0.40)



The function block can be used as an alternative to the default position controller. It is called after the MC_AxRuntime_BkPlcMc() function block (setpoint generator and default position controller). This arrangement overwrites the responses of the default position controller.

```
VAR_INPUT
    Reset:          BOOL:=FALSE;
    I_Enable:       BOOL:=FALSE;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    SetPos:         LREAL;
    SetVelo:        LREAL;
    Response:       LREAL;
    InWindup:       BOOL;
END_VAR
```

Reset: This input deletes all internal and external controller responses.

I_Enable: This input controls the activity of the I component.

SetPos: [mm] The set position that becomes effective at the internal controller.

SetVelo: [mm/s] The set velocity that becomes effective at the internal controller.

Response: [mm/s] The controller response.

InWindup: Here, the limitation of the I component that has become active is signaled.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Purpose of the function block

The default position controller integrated in the MC_AxRuntime_BkPlcMc() [▸ 167] function block cannot meet the control requirements of some applications, due to its simple structure. The MC_AxRtPosPiControllerEx_BkPlcMc() function block is available for such applications. It supports the following control components:

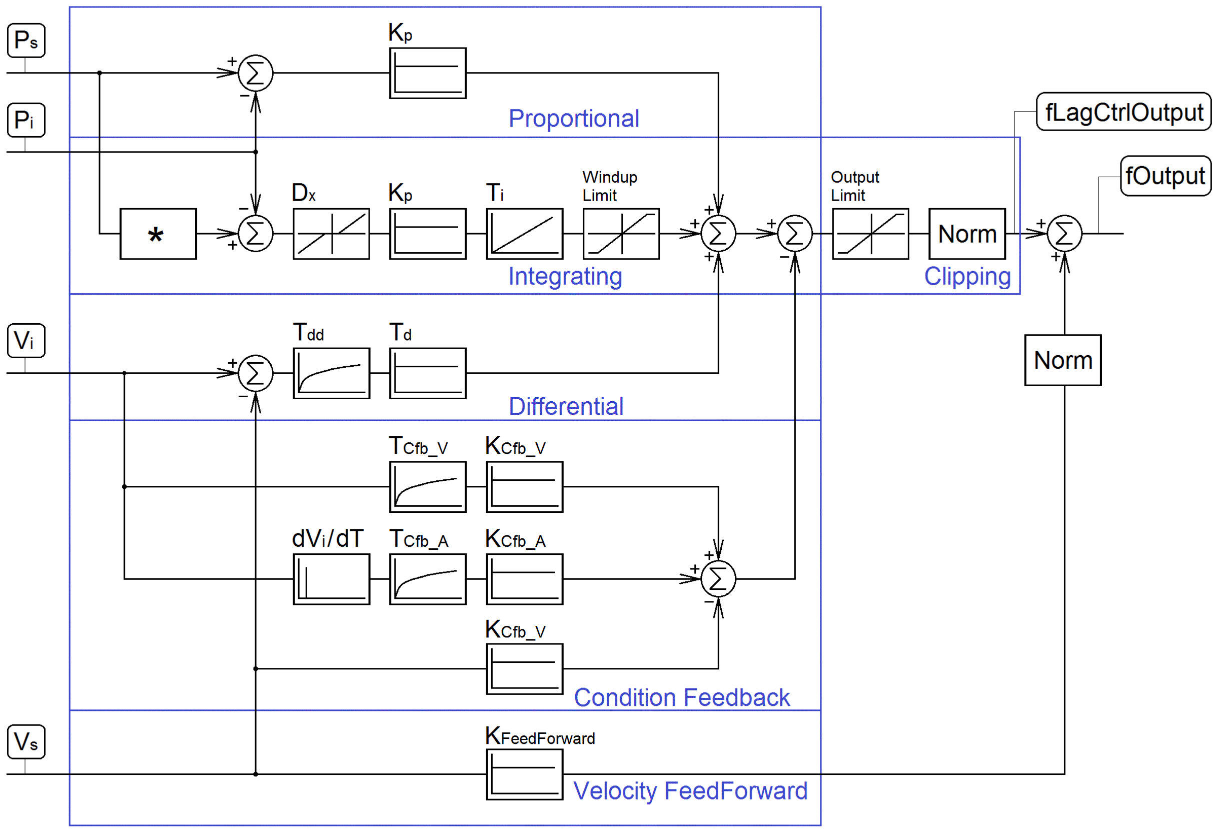
- Position P controller
- Position I controller with threshold and Windup limit
- Position D controller (realized as velocity P controller) with attenuation time
- Condition feedback for the actual velocity

- Condition feedback for the actual acceleration
- Compensation of the static effect of the condition feedback for the actual velocity

Velocity pre-control is activated after the controller. The same applies to any activated linearizations.

NOTE! The controller is enabled with V3.0.40. The extended parameters are supported by the PlcMcManager released with this version.

Structure of the controller



The component marked with an asterisk * prepares the set value for the I component of the controller when the setpoint generator is path-controlled. This is necessary because the set position provided by the setpoint generator jumps to the target position when the braking distance is reached. With time-controlled setpoint generator, the component is transparent.

NOTE! Not shown here: TRUE on Reset, or a missing controller enable of the axis deletes both the I component and the controller output.

The I component has a threshold value Dx, which prevents a response to small deviations. For technical reasons, this parameter is limited to at least 2/3 incremental weighting of the encoder. If the I component is to be inactive, set Ti to zero.

The implementation of the D component takes advantage of the fact that the differentiated set position is provided by the setpoint generator. An actual velocity is determined by differentiating the actual position. Under this condition, the differentiation time constant Td acts as a proportionality factor. If the D component is to be inactive, set the time constant Td to zero.

Three branches are implemented in the condition feedback:

- Velocity activation: The actual velocity is filtered and activated with a weighting factor. As it is subtracted, it has an attenuating effect. If the connection is to be inactive, set K_{Cfb_V} to zero.
- Acceleration activation: The actual velocity is differentiated, filtered and activated with a weighting factor. As it is subtracted, it has an attenuating effect. If the connection is to be inactive, set K_{Cfb_A} to zero.

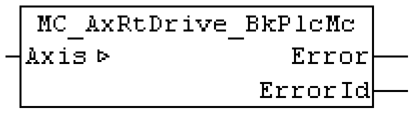
- A velocity activation generates a statically effective reduction of the velocity pre-control. In the case of path-controlled positioning, this generates a noticeable velocity deviation. With time-controlled positioning, this effect is compensated, as far as possible, by the continuously active position control. This undesirable side-effect of velocity feedback is eliminated by automatic adjustment of the pre-control. Deactivating the velocity activation also deactivates this compensation.

Velocity pre-control is activated after the controller. The weighting is fixed at 1.0 when the setpoint generator is path-controlled and cannot be reduced.

If linearization is activated, it takes place after the controller and is not shown here.

4.4.2 Drive

4.4.2.1 MC_AxRtDrive_BkPlcMc (in V3.0)



The function block performs preparation of the control value for the axis for it to be output on a hardware module. To this end a function block is called depending on the value set as nDrive_Type in **Axis**.ST_TcHydAxParam [▸ 93], which takes into account the special features of the hardware module.

```
VAR_OUTPUT
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems can be detected and reported during this process:

- If nDrive_Type in pStAxParams is set to an unacceptable value, the function block reacts with **Error** and **ErrorID**:=dwTcHydErrCdDriveType. If the pointer pStAxRtData for the axis has been initialized, it is placed into a fault state.
- If one of the specific sub-function-blocks detects a problem, it will (if possible) place the axis into a fault state. This error is then echoed at the outputs of the MC_AxRtDrive_BkPlcMc.

If it is possible to carry out these checks without encountering any problems, the control value for the axis is processed appropriately for the nDrive_Type [▸ 72] in **Axis**.ST_TcHydAxParam [▸ 93].

Information about the necessary linking of I/O components with the input and output structures of the axis may be found in the Knowledge Base [▸ 218] under FAQ #7.

If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc [▸ 181] should be used for simplicity.

The function blocks MC_AxUtiReadRegDriveTerm_BkPlcMc [▸ 207] and MC_AxUtiWriteRegDriveTerm_BkPlcMc [▸ 215] are available for asynchronous data exchange with I/O devices of the KL series.

iTcMc_DriveAx2000_B110A

The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus. This assumes that the connected motor is equipped with an absolute encoder. If a motor is operated with a resolver, **iTcMc_DriveAx2000_B110R** should be set.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this suggestion.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderAX2000_B110A [▶ 136].

iTcMc_DriveAx2000_B110R

The function block handles the processing of the axis control value for output on an AX2000 servo drive at the EtherCAT fieldbus.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderAx2000_B110R [▶ 137].

iTcMc_DriveAx2000_B200R, iTcMc_DriveAx2000_B900R

The function block handles the processing of the axis control value for output on an AX2000 servo drive at the Beckhoff Lightbus (B200) or RtEthernet fieldbus (B900).

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderAx2000_B200R [▶ 138].

iTcMc_DriveAx2000_B750A

The function block handles (from V3.0.26) processing of the control value of the axis for output at an AX2000 servo actuator at the Sercos fieldbus. The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderAX2000_B750A [▶ 139].

Note a number of special features. Further information can be found in the Knowledge Base.

iTcMc_DriveAx5000_B110A, iTcMc_DriveAx5000_B110SR

The function block handles the processing of the axis control value for output on an AX5000 servo actuator at the EtherCAT fieldbus. The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus. If motor is operated with a resolver, **iTcMc_EncoderAx5000_B110SR** should be set.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this suggestion.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderAX5000_B110A [▶ 139].

A list of successfully tested compatible devices can be found under iTcMc_EncoderAX5000_B110A [▶ 139].

Note a number of special characteristics. Further information can be found in the Knowledge Base.

iTcMc_DriveCoE_DS402

The function block handles the evaluation of the actual values of a servo actuator with CoE DS402 profile at the EtherCAT fieldbus.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this suggestion.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the encoder function block and described there. See also iTcMc_EncoderCoE_DS402A [▶ 141] and iTcMc_EncoderCoE_DS402SR [▶ 141].

A list of successfully tested compatible devices can be found under iTcMc_EncoderCoE_DS402SR [▶ 141].

NOTE! Currently only drives with resolver or single-turn encoders are supported.

iTcMc_Drive_CoE_DS408

The function block handles the processing of the axis control value for output to a proportional valve at the EtherCAT fieldbus. The valve must support the CiA DS408 profile.

I/O variable	Interface.Variable	Use
see note	ST_TcPlcDeviceInput.nDacOut	Output of the velocity signal.
see note	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
see note	ST_TcPlcDeviceInput.uiStatus	Device status
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Monitoring of online status
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Automatic identification.

NOTE! The names of the process data exchanged with the device are specified via the XML file of the manufacturer.

The valve must support the following Index.SubIndex combinations.

Index	Subindex	Meaning
1000	0	Identification
1008	0	Device name (optional)
1018	1	Manufacturer ID
1018	2	Device type

The following list of compatible devices is naturally incomplete. It is not a recommendation but is merely intended for information. Beckhoff cannot guarantee trouble-free operation of the listed devices. If a manufacturer or one of their devices is not listed, trouble-free operation may well be possible, but is not guaranteed.

Manufacturer	Type	Description
Moog	D638Exxx	Proportional valve
Parker	DxxFP /DxxFE /TDP /TPQ	Proportional valve

x: Represents a placeholder for different characters.

iTcMc_DriveIx2512_1Coil

The function block deals with processing of the axis control value for output on an IP2512 PWM fieldbus module.

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.uiDacOutA	Output of the PWM factor.

iTcMc_DriveIx2512_2Coil

The function block deals with processing of the axis control value for output on an IP2512 PWM fieldbus module.

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.uiDacOutA	Output of the PWM factor for coil 1.
Data out	ST_TcPlcDeviceOutput.uiDacOutB	Output of the PWM factor for coil 2.

iTcMc_DriveEL2535

The function block prepares the control value of the axis for output on a current-controlled PWM output terminal. This terminal provides two independent output stages and can be used for the following valve types:

Proportional valve with spring center position and two coils without permanent magnets:

nDrive_Type = iTcMc_DriveEL2535_2Coil

Both channels are required for one valve. The terminal cannot be used for another valve at the same time.

With this type of valve, a proportion of the full current in the directionally active coil with currentless countercoil is required to move the slider to the desired position. For -100% .. 0% .. +100% control, the terminal block generates the output values 0 .. 0 .. 32767 in uiDacOutA and 32767 .. 0 .. 0 in uiDacOutB.

I/O variable	Interface.Variable	Use
Channel1.PWM Output	ST_TcPlcDeviceOutput.uiDacOutA	Output of the PWM factor for coil 1.
Channel2.PWM Output	ST_TcPlcDeviceOutput.uiDacOutB	Output of the PWM factor for coil 2.
	ST_TcPlcDeviceOutput.nDacOut	DO NOT USE!
Channel1.Status	ST_TcPlcDeviceInput.uiStatus	Status of the first device channel
Channel2.Status	ST_TcPlcDeviceInput.uiTerminalState2	Status of the second device channel
Channel1.Control	ST_TcPlcDeviceOutput.uiDriveCtrl	Control of the first device channel
Channel2.Control	ST_TcPlcDeviceOutput.uiTerminalCtrl2	Control of the second device channel
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Automatic identification, parameterization.

Proportional valve with spring end position and coil without permanent magnets:

nDrive_Type = iTcMc_DriveEL2535_1Coil

Only one channel is required here. The terminal can also be used for another valve. The I/O variables of the second channel must be used for this purpose.

With this type of valve, 50% of the full power supply is required to move the slider to the center position. The terminal module generates the output values 0 .. 16384 .. 32767 for -100% .. 0% .. +100% control.

I/O variable	Interface.Variable	Use
	ST_TcPlcDeviceOutput.uiDacOutA	DO NOT USE!
	ST_TcPlcDeviceOutput.uiDacOutB	DO NOT USE!
Channel1.PWM Output	ST_TcPlcDeviceOutput.nDacOut	Output of the PWM factor.
Channel1.Status	ST_TcPlcDeviceInput.uiStatus	Device status
Channel1.Control	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Automatic identification, parameterization.

Proportional valve with spring center position and a coil with permanent magnets:

nDrive_Type = iTcMc_DriveEL2535_1Coil

Only one channel is required here. The terminal can also be used for another valve. The I/O variables of the second channel must be used for this purpose.

This type of valve requires a bipolar current supply, which corresponds to the operating principle of a ±10 V terminal. The output value generated by the terminal block is to be adjusted as follows AFTER the drive function block has been called by the application:

ST_TcPlcDeviceOutput.nDacOut := 2 * (ST_TcPlcDeviceOutput.nDacOut - 16384);

I/O variable	Interface.Variable	Use
	ST_TcPlcDeviceOutput.uiDacOutA	DO NOT USE!
	ST_TcPlcDeviceOutput.uiDacOutB	DO NOT USE!
Channel1.PWM Output	ST_TcPlcDeviceOutput.nDacOut	Output of the PWM factor.
Channel1.Status	ST_TcPlcDeviceInput.uiStatus	Device status
Channel1.Control	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Automatic identification, parameterization.

iTcMc_DriveEL4132

The function block deals with processing of the axis control value for output on a ±10 V output terminal.

I/O variable	Interface.Variable	Use
Output	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.

iTcMc_DriveEL7031

The function block deals with processing of the axis control value for output on an EL7031 stepper motor output stage terminal.

I/O variable	Interface.Variable	Use
STM Velocity.Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal.
STM Control.Control	ST_TcPlcDeviceOutput.uiDriveCtrl	Operation: Control of the output stage.
STM Status.Status	ST_TcPlcDeviceInput.uiStatus	Operation: Status of the output stage.
WcState.WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Communication.

iTcMc_DriveEL7041

The function block deals with processing of the axis control value for output on an EL7041 stepper motor output stage terminal.

I/O variable	Interface.Variable	Use
STM Velocity.Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal.
STM Control.Control	ST_TcPlcDeviceOutput.uiDriveCtrl	Operation: Control of the output stage.
STM Status.Status	ST_TcPlcDeviceInput.uiStatus	Operation: Status of the output stage.
ENC Status.Counter Value	ST_TcPlcDeviceInput.uiCount	Operation: Read the actual position.
ENC Status.Latch Value	ST_TcPlcDeviceInput.uiLatch	Operation: Reading the latch position.
ENC Status.Status	ST_TcPlcDeviceInput.uiTerminalState2	Operation: Status of the encoder interface.
ENC Control.Control	ST_TcPlcDeviceOutput.uiTerminalCtrl2	Operation: Control of the encoder interface.
WcState.WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Communication.

iTcMc_DriveEL7201

The function block prepares the control value of the axis for output to an EL7201 servo terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the encoder function block. See also iTcMc_EncoderEL7201.

I/O variable	Interface.Variable	Use
Target velocity	ST_TcPlcDeviceOutput.NominalVelo	Operation: Output of the velocity signal.
Controlword	ST_TcPlcDeviceOutput.uiDriveCtrl	Operation: Control of the output stage.
Position actual value	ST_TcPlcDeviceInput.udiCount	Operation: Read the actual position.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
Statusword	ST_TcPlcDeviceInput.uiStatus	Operation: Status of the output stage.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring, condition monitoring.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Communication

iTcMc_DriveKL2521

The function block deals with processing of the axis control value for output on a KL2521 pulse output terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the encoder function block. See also iTcMc_EncoderKL2521 [▸ 147].

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication [▸ 233]: Interface for read data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Register communication
Status	ST_TcPlcDeviceInput.bTerminalState	Register communication
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. Register communication: Interface for written data.

iTcMc_DriveKL2531

The function block deals with processing of the axis control value for output on a KL2531 stepper motor output stage terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the encoder function block. See also iTcMc_EncoderKL2531 [▸ 148].

I/O variable	Interface.Variable	Use
Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▸ 233]: Interface for written data.
Position	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Ctrl	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.
ExtStatus	ST_TcPlcDeviceInput.uiTerminalState2	Diagnosis of output stage and motor

iTcMc_DriveKL2532

The function block deals with processing of the axis control value for output on a KL2532 DC motor output stage terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiTerminalData	For register communication [▸ 233]: Interface for read data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Register communication
Data out	ST_TcPlcDeviceOutput.nDacOut	Register communication

iTcMc_DriveKL2535_1Coil, iTcMc_DriveKL2535_2Coil

The function block deals with processing of the axis control value for output on a KL2535 PWM output stage terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiTerminalData	Register communication [▸ 233]
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Register communication
Data out	ST_TcPlcDeviceOutput.nDacOut	Register communication

iTcMc_DriveKL2541

The function block deals with processing of the axis control value for output on a KL2541 stepper motor output stage terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the encoder function block. See also iTcMc_EncoderKL2541 [▸ 148].

I/O variable	Interface.Variable	Use
Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▸ 233]: Interface for written data.
Position	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Ctrl	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.
ExtCtrl	ST_TcPlcDeviceOutput.uiTerminalCtrl2	Latch control during homing with the synchronous pulse of the encoder
ExtStatus	ST_TcPlcDeviceInput.uiTerminalState2	Diagnosis of output stage and motor, latch status during homing with the synchronous pulse of the encoder

iTcMc_DriveKL2542

The function block deals with processing of the axis control value for output on a KL2542 DC motor output stage terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the encoder function block. See also iTcMc_EncoderKL2542 [▸ 149].

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▸ 233]: Interface for written data.
Data in	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.

iTcMc_DriveKL4032

The function block deals with processing of the axis control value for output on a ±10 V output terminal.

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▸ 233]: Interface for written data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Register communication
Status	ST_TcPlcDeviceInput.bTerminalState	Register communication
Data in	ST_TcPlcDeviceOutput.uiTerminalData	Register communication: Interface for read data.

iTcMc_DriveLowCostStepper

The function block deals with processing of the axis control value for output on digital output terminals. For emulation of an actual position, a pulse counter is updated, which can be evaluated with an iTcMc_EncoderLowCostStepper [▸ 151] encoder.

I/O variable	Interface.Variable	Use
Output	ST_TcPlcDeviceOutput.nDigOutAp	Non-inverted control of the A phase.
Output	ST_TcPlcDeviceOutput.nDigOutAn	Inverted control of the A phase.
Output	ST_TcPlcDeviceOutput.nDigOutBp	Non-inverted control of the B phase.
Output	ST_TcPlcDeviceOutput.nDigOutBn	Inverted control of the B phase.

iTcMc_DriveLowCostInverter

The function block deals with processing of the axis control value for output on digital output terminals for operation of a pole reversing contactor configuration or a frequency inverter with fixed frequencies. If this drive type is used, a number of special characteristics must be taken into account. For linking, a distinction has to be made between two options:

Brake, enable, direction and velocity level

After the MC_AxRtFinish_BkPlcMc [▸ 175] or MC_AxStandardBody_BkPlcMc [▸ 181]function block of the axis has been called, four decoded signals are available. In order to generate the required signals, the following consolidations of the direction-specific signals are required after the function block call.
Sample:
stAxDeviceOut.bDigOutAp:=stAxDeviceOut.bDigOutAp OR stAxDeviceOut.bDigOutBp;

stAxDeviceOut.bDigOutAn:=stAxDeviceOut.bDigOutAn OR stAxDeviceOut.bDigOutBn;

NOTE! From V3.0.11 the output of an absolute value can be activated on the valve tab. In this case, the signal consolidation shown above is applied internally.

I/O variable	Interface.Variable	Use
Output	ST_TcPlcDeviceOutput.nDigOutAp	Selection of the fixed frequency for rapid traverse.
Output	ST_TcPlcDeviceOutput.nDigOutAn	Selection of the fixed frequency for slow traverse.
Output	ST_TcPlcDeviceOutput.bMovePos	Specifies the direction of travel: Positive.
Output	ST_TcPlcDeviceOutput.bMoveNeg	Specifies the direction of travel: Negative.
Output	ST_TcPlcDeviceOutput.bPowerOn	Enabling the power stage.
Output	ST_TcPlcDeviceOutput.bBrakeOff	Activation of the brake.
Input	ST_TcPlcDeviceInput.bPowerOk	Status of the converter: Ready for operation.

Brake, enable and direction-coded velocity level

I/O variable	Interface.Variable	Use
Output	ST_TcPlcDeviceOutput.nDigOutAp	Selection of the fixed frequency for rapid traverse in positive direction of travel.
Output	ST_TcPlcDeviceOutput.nDigOutAn	Selection of the fixed frequency for slow traverse in positive direction of travel.
Output	ST_TcPlcDeviceOutput.nDigOutBn	Selection of the fixed frequency for slow traverse in negative direction of travel.
Output	ST_TcPlcDeviceOutput.nDigOutBp	Selection of the fixed frequency for rapid traverse in negative direction of travel.
Output	ST_TcPlcDeviceOutput.bPowerOn	Enabling the power stage.
Output	ST_TcPlcDeviceOutput.bBrakeOff	Activation of the brake.
Input	ST_TcPlcDeviceInput.bPowerOk	Status of the converter: Ready for operation.

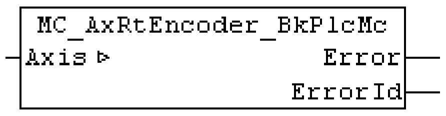
iTcMc_DriveM2400_Dn

The function block performs preparation of the control value for the axis so that it can be output on one of the four channels of a ±10 V M2400 output box.

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal.

4.4.3 Encoder

4.4.3.1 MC_AxRtEncoder_BkPlcMc (from V3.0)



This function block determines the actual position of the axis from the input information of a hardware module. To this end a function block is called depending on the value set as **nEnc_Type** in **Axis**.ST_TcHydAxParam [▸ 93], which takes into account the special features of the hardware module.

```
VAR_OUTPUT
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems can be detected and reported during this process:

- If **nEnc_Type** in pStAxParams is set to an unacceptable value, the function block responds with **Error** and **ErrorID**:=dwTcHydErrCdEncType. The axis is set to an error state.
- If one of the specific sub-function-blocks detects a problem, it will (if possible) place the axis into a fault state. This error is then echoed at the outputs of the **MC_AxRtEncoder_BkPlcMc**.

If it is possible to carry out these checks without encountering any problems, the actual value of the axis is determined by calling a type-specific function block corresponding to the nEnc_Type [▸ 75] in **Axis**.ST_TcHydAxParam [▸ 93].

Information about the necessary linking of I/O components with the input and output structures of the axis may be found in the Knowledge Base under FAQ #4 [▸ 222].

If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc [▸ 181] should be used for simplicity.

The function blocks MC_AxUtiReadRegEncTerm_BkPlcMc [▸ 208] and MC_AxUtiWriteRegEncTerm_BkPlcMc [▸ 216] are available for asynchronous data exchange with I/O devices of the KL series.

iTcMc_EncoderAx2000_B110A

The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus. This assumes that the connected motor is equipped with an absolute encoder. If a motor is operated with a resolver, **iTcMc_EncoderAx2000_B110R** should be set.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveAX2000_B110R [▸ 126].

I/O variable	Interface.Variable	Use
Position actual value	ST_TcPlcDeviceInput.ActualPos[0..1]	Determines the actual position.
Status word	ST_TcPlcDeviceInput.uiStatus	Device status, encoder emulation.
Control word	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
Velocity demand value	ST_TcPlcDeviceOutput.NominalVelo	Output of the velocity control value.
WcState (see note)	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring for actual value acquisition.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring for the drive.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Monitoring of online status
InfoData.AdsAddr (see note)	ST_TcPlcDeviceInput.sEncAdsAddr	Parameter communication.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Control of real-time status, parameter communication.
Chn0 (see note)	ST_TcPlcDeviceInput.nEncAdsChannel	Parameter communication.
Chn0	ST_TcPlcDeviceInput.nDrvAdsChannel	Control of real-time status, parameter communication.
Output (on a DO terminal)	ST_TcPlcDeviceOutput.PowerOn	Optional control of the mains contactor. A digital output terminal is required for this purpose.
Input (on a DI terminal)	ST_TcPlcDeviceInput.PowerOk	Optional evaluation of the mains contactor. A digital input terminal is required for this purpose.

NOTE! In order to simplify the establishment of the I/O link, the linking of ST_TcPlcDeviceInput.sEncAdsAddr, ST_TcPlcDeviceInput.nEncAdsChannel and ST_TcPlcDeviceInput.wEncWcState can be avoided, if the actual value acquisition takes place via the same device, as usual. In this case, the function blocks for parameter communication and encoder evaluation use the corresponding variables of the drive link.

iTcMc_EncoderAx2000_B110R

The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus. This assumes that the connected motor is equipped with a resolver. If a motor is operated with an absolute encoder, **iTcMc_EncoderAx2000_B110A** must be set.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveAX2000_B110R [▶ 126].

I/O variable	Interface.Variable	Use
Position actual value	ST_TcPlcDeviceInput.ActualPos[0..1]	Determines the actual position.
Status word	ST_TcPlcDeviceInput.uiStatus	Device status, encoder emulation.
Control word	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
Velocity demand value	ST_TcPlcDeviceOutput.NominalVelo	Output of the velocity control value.
WcState (see note)	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring for actual value acquisition.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring for the drive.
uiDriveBoxState	ST_TcPlcDeviceInput.InfoData.State	Monitoring of online status
InfoData.AdsAddr (see note)	ST_TcPlcDeviceInput.sEncAdsAddr	Parameter communication.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Parameter communication.
Chn0 (see note)	ST_TcPlcDeviceInput.nEncAdsChannel	Parameter communication.
Chn0	ST_TcPlcDeviceInput.nDrvAdsChannel	Parameter communication.
Output (on a DO terminal)	ST_TcPlcDeviceOutput.PowerOn	Optional control of the mains contactor. A digital output terminal is required for this purpose.
Input (on a DI terminal)	ST_TcPlcDeviceInput.PowerOk	Optional evaluation of the mains contactor. A digital input terminal is required for this purpose.

NOTE! In order to simplify the establishment of the I/O link, the linking of ST_TcPlcDeviceInput.sEncAdsAddr, ST_TcPlcDeviceInput.nEncAdsChannel and ST_TcPlcDeviceInput.wEncWcState can be avoided, if the actual value acquisition takes place via the same device, as usual. In this case, the function blocks for parameter communication and encoder evaluation use the corresponding variables of the drive link.

iTcMc_EncoderAx2000_B200R, iTcMc_EncoderAx2000_B900R

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

The function block deals with evaluation of the actual values of an AX2000 servo actuator with Lightbus (B200) or RealtimeEthernet (B900).

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveAX2000_B200R [▸ 126].

I/O variable	Interface.Variable	Use
ActualPos[0..1]	ST_TcPlcDeviceInput.ActualPos[0..1]	Determines the actual position.
DriveError	ST_TcPlcDeviceInput.DriveError	Device status.
DriveState[0..3]	ST_TcPlcDeviceInput.DriveState[0..3]	Device status.
BoxState	ST_TcPlcDeviceInput.uiDriveBoxState	Connection monitoring.
DriveCtrl0	ST_TcPlcDeviceOutput.DriveCtrl[0]	Device control.
DriveCtrl1	ST_TcPlcDeviceOutput.DriveCtrl[1]	Device control.
DriveCtrl2	ST_TcPlcDeviceOutput.DriveCtrl[2]	Device control.
DriveCtrl3	ST_TcPlcDeviceOutput.DriveCtrl[3]	Device control.
NominalVelo	ST_TcPlcDeviceOutput.NominalVelo	Output of the velocity control value.
Output (on a DO terminal)	ST_TcPlcDeviceOutput.PowerOn	Optional control of the mains contactor. A digital output terminal is required for this purpose.
Input (on a DI terminal)	ST_TcPlcDeviceInput.PowerOk	Optional evaluation of the mains contactor. A digital input terminal is required for this purpose.

iTcMc_EncoderAx2000_B750A

The function block handles (from V3.0.26) the evaluation of the actual values of an AX2000 servo actuator at the Sercos fieldbus. The function block handles the evaluation of the actual values of an AX2000 servo actuator at the EtherCAT fieldbus.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this suggestion.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveAX2000_B750A [▸ 126].

I/O variable	Interface.Variable	Use
Drive status word	ST_TcPlcDeviceInput.uiStatus	Device status.
Actual position value encoder 1	ST_TcPlcDeviceInput.udiCount	Determines the actual position.
Master control word	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
Velocity command value	ST_TcPlcDeviceOutput.NominalVelo	Output of the velocity control value.
SystemStatus (from Sercos master)	ST_TcPlcDeviceInput.uiDriveBoxState	Monitoring of the Sercos phase. **Note**: This variable is provided by the Sercos master (e.g. FC7501).
Output (on a DO terminal)	ST_TcPlcDeviceOutput.PowerOn	Optional control of the mains contactor. A digital output terminal is required for this purpose.
Input (on a DI terminal)	ST_TcPlcDeviceInput.PowerOk	Optional evaluation of the mains contactor. A digital input terminal is required for this purpose.

Note a number of special characteristics. Further information can be found in the Knowledge Base [▸ 218].

iTcMc_EncoderAx5000_B110A, iTcMc_EncoderAx5000_B110SR

The function block handles the evaluation of the actual values of an AX5000 servo actuator at the EtherCAT fieldbus. This assumes that the connected motor is equipped with an absolute encoder. If a motor is operated with a resolver, **iTcMc_EncoderAx5000_B110SR** should be set.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveAX5000_B110A [▸ 126].

I/O variable	Interface.Variable	Use
Position feedback 1 value	ST_TcPlcDeviceInput.udiCount	Determines the actual position.
Drive status word	ST_TcPlcDeviceInput.uiStatus	Device status.
Master control word	ST_TcPlcDeviceOutput.uiDriveCtrl	Device control.
Velocity command value	ST_TcPlcDeviceOutput.NominalVelo	Output of the velocity control value.
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring for the drive.
WcState (see note)	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring for actual value acquisition.
InfoData.State	ST_TcPlcDeviceInput. uiDriveBoxState	Monitoring of online status
InfoData.AdsAddr	ST_TcPlcDeviceInput.sDrvAdsAddr	Control of real-time status, parameter communication.
InfoData.AdsAddr (see note)	ST_TcPlcDeviceInput.sEncAdsAddr	Parameter communication.
Chn0 (see note 2)	ST_TcPlcDeviceInput.nDrvAdsChannel	For single devices or the first drive of a dual device: Control of real-time status, parameter communication.
Chn0 (see notes 1,2)	ST_TcPlcDeviceInput.nEncAdsChannel	For single devices or the first drive of a dual device: Parameter communication.
Chn1 (see note 2)	ST_TcPlcDeviceInput.nDrvAdsChannel	Only for the second drive of a dual device: Control of real-time status, parameter communication.
Chn1 (see notes 1,2)	ST_TcPlcDeviceInput.nEncAdsChannel	Only for the second drive of a dual device: Parameter communication.
Output (on a DO terminal)	ST_TcPlcDeviceOutput.PowerOn	Optional control of the mains contactor. A digital output terminal is required for this purpose.
Input (on a DI terminal)	ST_TcPlcDeviceInput.PowerOk	Optional evaluation of the mains contactor. A digital input terminal is required for this purpose.

The following list of compatible devices is naturally incomplete. It is not a recommendation but is merely intended for information. Beckhoff cannot guarantee trouble-free operation of the listed devices. If a manufacturer or one of their devices is not listed, trouble-free operation may well be possible, but is not guaranteed.

Manufacturer	Type	Description
Baumüller	b-maxx	Servo controller with single-turn absolute encoder

NOTE! In order to simplify the establishment of the I/O link, the linking of ST_TcPlcDeviceInput.sEncAdsAddr, ST_TcPlcDeviceInput.nEncAdsChannel and ST_TcPlcDeviceInput.wEncWcState can be avoided, if the actual value acquisition takes place via the same device, as usual. In this case, the function blocks for parameter communication and encoder evaluation use the corresponding variables of the drive link.

NOTE! The variables Chn0 and Chn2 are used for distinguishing the channels of a dual unit. Connect Chn0 for the first drive of the device and Chn1 for the second. For single devices proceed as for the first channel of a dual device.

NOTE! Note a number of special characteristics. Further information can be found in the Knowledge Base.

iTcMc_EncoderCoE_DS402A

The function block handles the evaluation of the actual values of a servo actuator with CoE DS402 profile at the EtherCAT fieldbus. This assumes that the connected motor is equipped with a multi-turn absolute encoder.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this suggestion.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveCoE_DS402 [▶ 127].

I/O variable	Interface.Variable	Use
see note	ST_TcPlcDeviceInput.udiCount	Determines the actual position.
	ST_TcPlcDeviceInput.uiStatus	
	ST_TcPlcDeviceOutput.uiDriveCtrl	
	ST_TcPlcDeviceOutput.NominalVelo	
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Monitoring of online status
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Automatic identification.

NOTE! The names of the process data exchanged with the device are specified via the XML file of the manufacturer.

A list with compatible devices can be found below

iTcMc_EncoderCoE_DS402SR

The function block handles the evaluation of the actual values of a servo actuator with CoE DS402 profile at the EtherCAT fieldbus. This assumes that the connected motor is equipped with a resolver or a single-turn absolute encoder.

NOTE! During manual insertion or automatic detection of a drive actuator the TwinCAT System Manager will suggest to insert an NC axis in the project and connect it with this actuator. If this actuator is to be controlled with the hydraulic system library, it is essential to decline this proposition.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions overlap with those of the drive function block. See also iTcMc_DriveCoE_DS402 [▶ 127].

I/O variable	Interface.Variable	Use
see note	ST_TcPlcDeviceInput.udiCount	Determines the actual position.
	ST_TcPlcDeviceInput.uiStatus	
	ST_TcPlcDeviceOutput.uiDriveCtrl	
	ST_TcPlcDeviceOutput.NominalVelo	
WcState	ST_TcPlcDeviceInput.wDriveWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiDriveBoxState	Monitoring of online status
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Automatic identification.

NOTE! The names of the process data exchanged with the device are specified via the XML file of the manufacturer.

The encoder must support the following Index.SubIndex combinations.

Index	Subindex	Meaning
1000	0	Identification
1008	0	Device name (optional)
1018	1	Manufacturer ID
1018	2	Device type
6080	0	Maximum speed in RPM (optional; if this object is not supported, the reference speed must be entered manually).
608F	1	Number of encoder increments per motor revolution.
6090	1	Number of increments per motor revolution used for control value output.

The following list of compatible devices is naturally incomplete. It is not a recommendation but is merely intended for information. Beckhoff cannot guarantee trouble-free operation of the listed devices. If a manufacturer or one of their devices is not listed, trouble-free operation may well be possible, but is not guaranteed.

Manufacturer	Type	Description
LTi DRiVES GmbH		Servo controller with single-turn absolute encoder

iTcMc_EncoderCoE_DS406

The function block handles the evaluation of encoders with direct EtherCAT connection. The encoder must support the CiA DS406 profile.

I/O variable	Interface.Variable	Use
see note	ST_TcPlcDeviceInput.udiCount	Determines the actual position.
see notes	ST_TcPlcDeviceInput.wEncDevState	Monitoring the device status.
WcState	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxState	Monitoring of online status.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Automatic identification.

NOTE! The names of the process data exchanged with the device are specified via the XML file of the manufacturer.

NOTE! Monitoring of the device status is not guaranteed for all devices from all manufacturers. For some devices an 8-bit status is provided. This kind of information should be mapped on the lower 8 bits of the wEncDevState element.

The encoder must support the following Index.SubIndex combinations.

Index	Subindex	Meaning
1000	0	Identification
1008	0	Device name (optional)
1018	1	Manufacturer ID
1018	2	Device type
6001	0	Rotational encoders: increments per revolution (obligatory)
6002	0	Rotational encoders: Total counting range (option A, alternatively: index 6502) Linear encoders: Total counting range (obligatory)
6005	1	Linear encoders: Resolution (option A, alternatively: index 6501)
6501	0	Linear encoders: Resolution (option B, alternatively: index 6005)
6502	0	Rotational encoders: Number of counted revolutions (option B, alternatively: index 6002)
650A	2	Linear encoders: lower limit of the intended working area (option)
650B	3	Linear encoders: upper limit of the intended working area (option)

The following list of compatible devices is naturally incomplete. It is not a recommendation but is merely intended for information. Beckhoff cannot guarantee trouble-free operation of the listed devices. If a manufacturer or one of their devices is not listed, trouble-free operation may well be possible, but is not guaranteed.

Certain parameters can be determined automatically, depending on the support of the listed objects. This applies to the counting range, the overflow detection and (for linear encoders) the resolution. If the respective objects are not provided or not in a supported combination, this is not possible. In such a case, operation may be possible. However, the parameters must then be set manually during commissioning.

Manufacturer	Type	Description
Fritz Kübler GmbH	58x8	Multi-turn absolute encoder.
IVO GmbH & Co. KG	GXMMW_H	Multi-turn absolute encoder.
MTS	Temposonics R	Linear absolute encoder.
TR Electronic GmbH:	LMP	Linear absolute encoder.
TWK-Electronic GmbH	CRKxx12R12C1xx	Multi-turn absolute encoder.

iTcMc_EncoderDigCam

The function block handles the evaluation of four digital inputs as position cams.

I/O variable	Interface.Variable	Use
Input	ST_TcPlcDeviceInput.bDigCamPP	Determines the actual position: Positive target cam.
Input	ST_TcPlcDeviceInput.bDigCamP	Determines the actual position: Positive brake cam.
Input	ST_TcPlcDeviceInput.bDigCamM	Determines the actual position: Negative brake cam.
Input	ST_TcPlcDeviceInput.bDigCamMM	Determines the actual position: Negative target cam.

iTcMc_EncoderDigIncrement

The function block handles the evaluation of two digital inputs for the emulation of an incremental encoder evaluation.

I/O variable	Interface.Variable	Use
Input	ST_TcPlcDeviceInput.bDigInA	Determines the actual position.
Input	ST_TcPlcDeviceInput.bDigInB	Determines the actual position.

iTcMc_EncoderEL3102

The function block handles the evaluation of data from an EL3102 analog input terminal.

I/O variable	Interface.Variable	Use
Value	ST_TcPlcDeviceInput.uiCount	Read the actual position.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Optional: Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring.

iTcMc_EncoderEL3142

The function block handles the evaluation of data from an EL3142 analog input terminal. The mapping is similar to the interface-compatible EL3102.

iTcMc_EncoderEL3162

The function block handles the evaluation of data from an EL3162 analog input terminal. The mapping is similar to the interface-compatible EL3102.

iTcMc_EncoderEL3255

The function block handles the evaluation of data from an EL3255 analog input terminal.

I/O variable	Interface.Variable	Use
AI Standard Channel x.Value	ST_TcPlcDeviceInput.uiCount	Read the actual position.
AI Standard Channel x.Status	ST_TcPlcDeviceInput.wEncDevSta te	Evaluation of the fault signal of the encoder.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAdd r	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxSta te	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcStat e	Connection monitoring.

NOTE! The terminal supports up to five encoders. The variables InfoData.AdsAddr, InfoData.State and WcState should be distributed to all axes involved through multiple mapping.

iTcMc_EncoderEL5001

The function block handles the evaluation of data from an EL5001 SSI encoder terminal.

I/O variable	Interface.Variable	Use
Value	ST_TcPlcDeviceInput.udiCount	Read the actual position.
Status	ST_TcPlcDeviceOutput.usiRegStat us	Evaluation of the fault signal of the encoder.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAdd r	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxSta te	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcStat e	Connection monitoring.

iTcMc_EncoderEL5021

The function block handles the evaluation of data from an EL5021 sin/cos encoder terminal.

I/O variable	Interface.Variable	Use
ENC Status.Counter value	ST_TcPlcDeviceInput.udiCount	Read the actual position.
ENC Status.Status	ST_TcPlcDeviceInput.usiRegStatu s	Evaluation of the fault signal of the encoder.
ENC Status.Latch value	ST_TcPlcDeviceInput.udiLatch	For homing using the synchronous pulse of the encoder.
ENC Control.Control	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAdd r	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxSta te	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcStat e	Connection monitoring.

iTcMc_EncoderEL5032 (ab V3.0.40)

The function block handles the evaluation of data from an EL5032 ENDAT encoder terminal.

The EL5032 terminal provides a 32-bit or 64-bit counter, depending on its setting. This means that the highest value that can be displayed is either $2^{32} – 1$ or $2^{64} – 1$. Multiplied with the encoder resolution, this results in the evaluable path. At 10 nm resolution results in a value of 42949 mm. This is sufficient for most applications, which is why it is usually OK to use the terminal in 32-bit mode. To do this, only the mapping to udiCount is required. Otherwise, the 64-bit mode of the terminal must be activated and the complete mapping to udiCount and S_DiReserve[1] must be configured.

Note	**Note the supply voltage** To prevent damage to the connected device, check the supply voltage set in the EL5032 before connecting the device.

When a fieldbus is started and an axis error is reset, certain parameters of the connected device are read. The device type is included in the logging. Only absolute linear scales and absolute multi-turn encoders are accepted. With linear scales, the resolution is automatically updated in the encoder weighting and interpolation.

I/O variable	Interface.Variable	Use
Position (DWORD or lower part of ULINT)	ST_TcPlcDeviceInput.udiCount	Read the actual position.
Position (upper part of ULINT)	ST_TcPlcDeviceInput.S_DiReserve[1]	Optional: Reading of the actual position under TC2.
Position (upper part of ULINT)	ST_TcPlcDeviceInput.udiLatch	Optional: Reading of the actual position under TC3.
Status	ST_TcPlcDeviceInput.uiEncDevState	Evaluation of the fault signal of the encoder.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring.

iTcMc_EncoderEL5101

The function block handles the evaluation of data from an EL5101 incremental encoder terminal.

I/O variable	Interface.Variable	Use
Value	ST_TcPlcDeviceInput.uiCount	Operation: Read the actual position.
Latch	ST_TcPlcDeviceInput.uiLatch	For homing using the synchronous pulse of the encoder.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function etc.
Status	ST_TcPlcDeviceInput.usiStatus	Status of the encoder, of the latch function.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring.

iTcMc_EncoderEL5111

The function block handles the evaluation of data from an EL5111 incremental encoder terminal.

I/O variable	Interface.Variable	Use
Value	ST_TcPlcDeviceInput.uiCount	Operation: Read the actual position.
Latch	ST_TcPlcDeviceInput.uiLatch	For homing using the synchronous pulse of the encoder.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function etc.
Status	ST_TcPlcDeviceInput.usiStatus	Status of the encoder, of the latch function.
InfoData.AdsAddr	ST_TcPlcDeviceInput.sEncAdsAddr	Address information for parameter communication via CoE.
InfoData.State	ST_TcPlcDeviceInput.uiEncBoxState	Connection monitoring, condition monitoring.
WcState	ST_TcPlcDeviceInput.wEncWcState	Connection monitoring.

iTcMc_EncoderEL7041

The function block handles the evaluation of data from an EL7041 stepper motor output terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveEL7041 [▶ 130].

iTcMc_EncoderEL7201

The function block handles the evaluation of data from an EL7201 servo output terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveEL7201.

iTcMc_EncoderIx5009

The function block handles the evaluation of data from an IP5009 SSI encoder box.

I/O variable	Interface.Variable	Use
PZDL_RegDaten	ST_TcPlcDeviceInput.uiPZDL_RegDaten	Operation: Read the actual position. For register communication [▶ 233]: Interface for read data.
PZDH	ST_TcPlcDeviceInput.uiPZDH	Read the actual position.
RegStatus	ST_TcPlcDeviceInput.usiRegStatus	Miscellaneous status information.

iTcMc_EncoderKL2521

The function block handles the evaluation of data from a KL2521 pulse output terminal. The output pulses are counted and used for an encoder emulation.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveKL2521 [▶ 131].

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication [▸ 233]: Interface for read data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Register communication
Status	ST_TcPlcDeviceInput.bTerminalState	Register communication
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. Register communication: Interface for written data.

iTcMc_EncoderKL2531

The function block handles the evaluation of data from a KL2531 pulse output terminal. The output pulses are counted and used for an encoder emulation.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveKL2531 [▸ 131].

I/O variable	Interface.Variable	Use
Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▸ 233]: Interface for written data.
Position	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Ctrl	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.
ExtStatus	ST_TcPlcDeviceInput.uiTerminalState2	Diagnosis of output stage and motor

iTcMc_EncoderKL2541

The function block handles the evaluation of data from a KL2541 pulse output terminal. The output pulses are counted and used for an encoder emulation.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveKL2541 [▸ 132].

I/O variable	Interface.Variable	Use
Velocity	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▶ 233]: Interface for written data.
Position	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Ctrl	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.
ExtCtrl	ST_TcPlcDeviceOutput.uiTerminalCtrl2	Latch control during homing with the synchronous pulse of the encoder
ExtStatus	ST_TcPlcDeviceInput.uiTerminalState2	Diagnosis of output stage and motor, latch status during homing with the synchronous pulse of the encoder

iTcMc_EncoderKL2542

The function block handles the evaluation of data from a KL2542 motor output stage terminal.

This I/O device belongs to a group of devices, which are used for the control value output as well as actual value determination. The required mapping definitions, particularly for parameter communication, overlap with those of the drive function block. See also iTcMc_DriveKL2542 [▶ 133].

I/O variable	Interface.Variable	Use
Data out	ST_TcPlcDeviceOutput.nDacOut	Operation: Output of the velocity signal. For register communication [▶ 233]: Interface for written data.
Data in	ST_TcPlcDeviceInput.uiTerminalData	Operation: Read the actual position. For register communication: Interface for read data.
Control	ST_TcPlcDeviceOutput.bTerminalCtrl	Control the output stage, register communication.
Status	ST_TcPlcDeviceInput.bTerminalState	Status of the output stage, register communication.

iTcMc_EncoderKL3002

The function block handles the evaluation of data from a KL3002 analog input terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiCount	Read the actual position.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Register communication.

iTcMc_EncoderKL3042

The function block handles the evaluation of data from a KL3042 analog input terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiCount	Read the actual position.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Register communication.

iTcMc_EncoderKL3062

The function block handles the evaluation of data from a KL3062 analog input terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiCount	Read the actual position.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Register communication.

iTcMc_EncoderKL3162

The function block handles the evaluation of data from a KL3162 analog input terminal.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiCount	Read the actual position.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Register communication.

iTcMc_EncoderKL5001

The function block handles the evaluation of data from a KL5001 SSI encoder terminal.

I/O variable	Interface.Variable	Use
PZDL_RegDaten	ST_TcPlcDeviceInput.uiPZDL_RegDaten	Operation: Read the actual position. For register communication [▶ 233]: Interface for read data.
PZDH	ST_TcPlcDeviceInput.uiPZDH	Read the actual position.
RegStatus	ST_TcPlcDeviceInput.usiRegStatus	Miscellaneous status information.
RegDaten	ST_TcPlcDeviceOutput.bTerminalData	Register communication.

iTcMc_EncoderKL5101

The function block handles the evaluation of data from a KL5101 incremental encoder terminal.

I/O variable	Interface.Variable	Use
Counter	ST_TcPlcDeviceInput.uiCount	Operation: Read the actual position. For register communication: Interface for read data.
Latch	ST_TcPlcDeviceInput.uiLatch	For homing using the synchronous pulse of the encoder.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function etc., register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Miscellaneous status information.
RegDaten	ST_TcPlcDeviceOutput.bTerminalData	Register communication.

iTcMc_EncoderKL5111

The function block handles the evaluation of data from a KL5111 incremental encoder terminal.

I/O variable	Interface.Variable	Use
Counter	ST_TcPlcDeviceInput.uiCount	Operation: Read the actual position. For register communication: Interface for read data.
Latch	ST_TcPlcDeviceInput.uiLatch	For homing using the synchronous pulse of the encoder.
Ctrl	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function etc., register communication [▶ 233]
Status	ST_TcPlcDeviceInput.usiStatus	Miscellaneous status information.
RegDaten	ST_TcPlcDeviceOutput.bTerminal Data	Register communication.

iTcMc_EncoderLowCostStepper

If the value iTcMc_DriveLowCostStepper [▶ 134] is entered as nDrive_Type, the half steps that are output are counted in ST_TcPlcDeviceOutput.uiCount. The result is used to calculate the actual position. Mapping is not required for the encoder.

NOTE! This encoder type can only be used in combination with an iTcMc_DriveLowCostStepperdrive.

iTcMc_EncoderM2510

The function block handles the evaluation of data from an M2510 analog input box.

I/O variable	Interface.Variable	Use
Data in	ST_TcPlcDeviceInput.uiCount	Read the actual position.

iTcMc_EncoderM3120

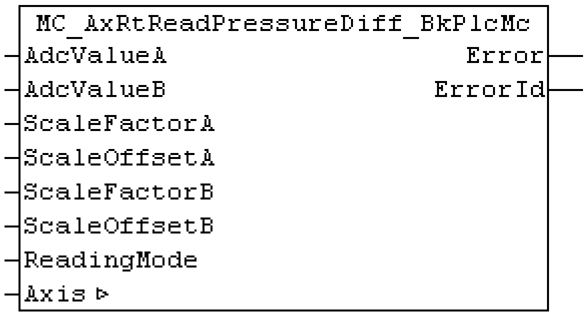
The function block handles the evaluation of data from an M3120 incremental encoder box.

I/O variable	Interface.Variable	Use
Value_N	ST_TcPlcDeviceInput.uiCount	Read the actual position.
State_N	ST_TcPlcDeviceInput.usiStatus	Miscellaneous status information.
Ctrl_N	ST_TcPlcDeviceOutput.usiCtrl	Control of the latch function etc.

iTcMc_EncoderSim

A simulation encoder calculates the actual position through integration of the set velocity. No mapping is required.

4.4.3.2 MC_AxRtReadForceDiff_BkPlcMc (from V3.0)



The function block handles determination of the actual force of the axis from the input data of two analog input terminals. The actual pressure on the A- and B-sides is converted to the force acting on the load, taking into account the areas and the sliding friction.

NOTE! If only one input signal is available, a function block of type MC_AxRtReadForceSingle_BkPlcMc [▶ 154] should be used. If the actual pressure is to be determined, a function block of type MC_AxRtReadPressureDiff_BkPlcMc [▶ 156] should be used.

```
VAR_INPUT
    AdcValueA:      INT:=0;
    AdcValueB:      INT:=0;
    ScaleFactorA:   LREAL:=0.0;
    ScaleOffsetA:   LREAL:=0.0;
    ScaleFactorB:   LREAL:=0.0;
    ScaleOffsetB:   LREAL:=0.0;
    SlippingOffset: LREAL:=0.0;
    ReadingMode:    E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
END_VAR
```

E_TcMcPressureReadingMode [▶ 89]

```
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

AdcValueA, **AdcValueB**: These parameters are used to transfer the input data of the analog terminals.

ScaleFactorA, **ScaleFactorB**: [N/ADC_INC] This value represents the weighting. It determines which pressure increase corresponds to a stage of the AD converter.

ScaleOffsetA, **ScaleOffsetB**: [N/ADC_INC] This offset is used to correct the zero point of the pressure scale.

SlippingOffset: [N] If the function block is used for calculating the active force, the force required to overcome the sliding friction can be entered here.

ReadingMode: The actual value to be determined can be specified here. Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxRtData [▶ 99].**fActPressure** is selected as default target.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block:

The function block determines the actual pressure and the actual force of the axis by evaluating the variables **AdcValueA** and **AdcValueB**. The result is entered in ST_TcHydAxRtData [▶ 99].fActPressure.

NOTE! The parameters assigned to an axis can be saved in ST_TcHydAxParam.fCustomerData[...], for example. This ensures that the data are loaded, saved and backed up together with the standard parameters of the axis and are also exported and imported, as required.

Determining a differential actual pressure

Commissioning is usually done in one of three ways.

Commissioning option A (preferred for ±10V)

In this case, no movement of the axis is required. The achievable accuracy is sufficient for high-quality pressure sensors in most cases.

- The rated pressure of the pressure sensors divided by **AdcValueA**$_{MAX}$ or **AdcValueB**$_{MAX}$ should be entered as **ScaleFactorA** and **ScaleFactorB**.
- If the function block is used for determining the actual pressure, the parameters **ScaleArreaA** and **ScaleArreaB** should be set to 1.0. Otherwise these parameters should be specified for an actual force in N (= Newton) in mm^2.

Commissioning option B

For this option it is necessary that a function block can be approached with full system pressure in both directions. A genuine movement of the axis is not required. Approaching of the end stops can be modeled by limiting the axis movement through provisional limits or even complete mechanical fixing.

- All function blocks, which respond to the value of ST_TcHydAxRtData [▶ 99].fActPressure, must be deactivated.
- First, slowly approach the lower function block (in the direction of decreasing actual position). The values for **AdcValueA** and **AdcValueB** are determined and logged. The system pressure should now be present on the A-side and the tank pressure – and therefore the ambient pressure – on the B-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement.
- Then, slowly approach the upper function block (in the direction of increasing actual position). The values for **AdcValueA** and **AdcValueB** are again determined and logged. Now measure the pressures again.
- The parameters to be entered can then be calculated as follows:

  ScaleFactorA := (PressureA$_{MAX}$ - PressureA$_{MIN}$) / (**AdcValueA**$_{MAX}$ - **AdcValueA**$_{MIN}$);

  ScaleFactorB := (PressureB$_{MAX}$ - PressureB$_{MIN}$) / (**AdcValueB**$_{MAX}$ - **AdcValueB**$_{MIN}$);

  ScaleOffsetA := PressureA$_{MIN}$ - **ScaleFactorA** * **AdcValueA;**$_{MIN}$

  ScaleOffsetB := PressureB$_{MIN}$ - **ScaleFactorB** * **AdcValueB;**$_{MIN}$

Commissioning option C

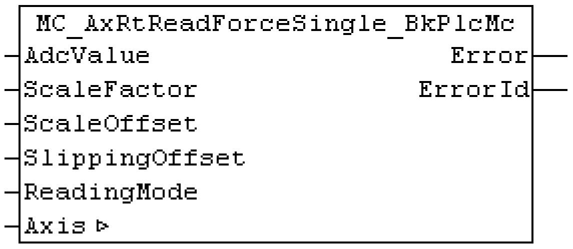
Alternatively, commissioning can be carried out without axis control. However, the accuracy that can be achieved in this way is much lower.

- First, the axis should be made pressure-free. To this end, switch off the compressor and relieve the pressure in the accumulator.
- Ensure that the axis does not build up pressure. To this end, an axis that is subject to external forces (gravity etc.) should be supported mechanically. Open the valve several times in both directions, either manually or electrically.
- Now determine and log the values for **AdcValueA** and **AdcValueB**. The tank pressure – and therefore the ambient pressure – should be present both on the A-side and on the B-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement. Use the values found in this way as **MIN** values in the equations mentioned above.
- Take the pressure for the upper limit of the electrical signal (10 V, 20 mA) from the data sheet specifications for the pressure sensors. Use the upper limit value for the converted electrical value as **AdcValueA** and **AdcValueB**. Use these values as **MAX** values in the equations mentioned above.
- The parameters to be entered can then be calculated as described above.

Determining an active force

To determine an active force, first determine the actual pressure, as described above. Entering the active areas under **ScaleArreaA** and **ScaleArreaA** causes the function block to convert the pressures on both sides into forces, taking into account the areas.

4.4.3.3 MC_AxRtReadForceSingle_BkPlcMc (from V3.0)



The function block handles determination of the actual force of the axis from the input data of an analog input terminal. The actual pressure on the A- or B-sides is converted to the force acting on the load, taking into account the area and the sliding friction.

Note	If only one input signal is available, a function block of type MC_AxRtReadForceDiff_BkPlcMc [▸ 152] should be used. If the actual pressure is to be determined, a function block of type MC_AxRtReadPressureDiff_BkPlcMc [▸ 156] should be used.

```
VAR_INPUT
    AdcValueA:      INT:=0;
    AdcValueB:      INT:=0;
    ScaleFactorA:   LREAL:=0.0;
    ScaleOffsetA:   LREAL:=0.0;
    ScaleFactorB:   LREAL:=0.0;
    ScaleOffsetB:   LREAL:=0.0;
    SlippingOffset: LREAL:=0.0;
    ReadingMode:    E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

AdcValueA, **AdcValueB**: These parameters are used to transfer the input data of the analog terminals.

ScaleFactorA, **ScaleFactorB**: [N/ADC_INC] This value represents the weighting. It determines which pressure increase corresponds to a stage of the AD converter.

ScaleOffsetA, **ScaleOffsetB**: [N/ADC_INC] This offset is used to correct the zero point of the pressure scale.

SlippingOffset: [N] If the function block is used for calculating the active force, the force required to overcome the sliding friction can be entered here.

ReadingMode: The actual value to be determined can be specified here. Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxRtData [▸ 99].**fActPressure** is selected as default target.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

The function block determines the actual pressure and the actual force of the axis by evaluating the variables **AdcValueA**. The result is entered in ST_TcHydAxRtData [▸ 99].fActPressure.

The parameters assigned to an axis can be saved in ST_TcHydAxParam [▸ 93].fCustomerData[...], for example. This ensures that the data are loaded, saved and backed up together with the standard parameters of the axis and are also exported and imported, as required.

Determining a differential actual pressure

If the function block is used to determine the actual pressure, the parameters **ScaleArreaA** and **ScaleArreaA** should be set to 1.0 and **SlippingOffset** to 0.0.

Commissioning option A

In this case, no movement of the axis is required. The achievable accuracy is sufficient for high-quality pressure sensors in most cases.

- Enter the rated pressure of the pressure sensors divided by **AdcValueA**$_{MAX}$ as **ScaleFactorA**.

Commissioning option B

For this option it is necessary that a function block can be approached with full system pressure in both directions. A genuine movement of the axis is not required. Approaching of the end stops can be modeled by limiting the axis movement through provisional limits or even complete mechanical fixing.

- All function blocks, which respond to the value of ST_TcHydAxRtData [▸ 99].fActPressure, must be deactivated.
- First, slowly approach the lower function block (in the direction of decreasing actual position). The values for **AdcValueA** and **AdcValueB** are determined and logged. The system pressure should now be present on the A-side and the tank pressure – and therefore the ambient pressure – on the B-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement.
- Then, slowly approach the upper function block (in the direction of increasing actual position). The values for **AdcValueA** and **AdcValueB** are again determined and logged. Now measure the pressures again.
- The parameters to be entered can then be calculated as follows:

  ScaleFactorA := (PressureA$_{MAX}$ - PressureA$_{MIN}$) / (**AdcValueA**$_{MAX}$ - **AdcValueA**$_{MIN}$);

  ScaleFactorB := (PressureB$_{MAX}$ - PressureB$_{MIN}$) / (**AdcValueB**$_{MAX}$ - **AdcValueB**$_{MIN}$);

  ScaleOffsetA := PressureA$_{MIN}$ - **ScaleFactorA** * **AdcValueA;**$_{MIN}$

  ScaleOffsetB := PressureB$_{MIN}$ - **ScaleFactorB** * **AdcValueB;**$_{MIN}$

Commissioning option C

Alternatively, commissioning can be carried out without axis control. However, the accuracy that can be achieved in this way is much lower.

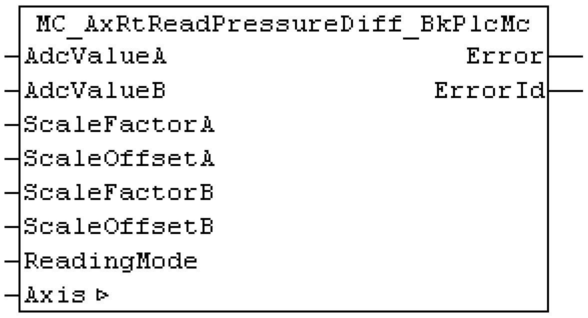
- First, the axis should be made pressure-free. To this end, switch off the compressor and relieve the pressure in the accumulator.
- Ensure that the axis does not build up pressure. To this end, an axis that is subject to external forces (gravity etc.) should be supported mechanically. Open the valve several times in both directions, either manually or electrically.
- Now determine and log the values for **AdcValueA** and **AdcValueB**. The tank pressure – and therefore the ambient pressure – should be present both on the A-side and on the B-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement. Use the values found in this way as **MIN** values in the equations mentioned above.
- Take the pressure for the upper limit of the electrical signal (10 V, 20 mA) from the data sheet specifications for the pressure sensors. Use the upper limit value for the converted electrical value as **AdcValueA** and **AdcValueB**. Use these values as **MAX** values in the equations mentioned above.

- The parameters to be entered can then be calculated as described above.

Determining an active force

To determine an active force, first determine the actual pressure, as described above. Entering the active area under **ScaleArreaA** causes the function block to convert the single-sided pressure to a force, taking into account the area.

4.4.3.4 MC_AxRtReadPressureDiff_BkPlcMc (from V3.0)



The function block handles determination of the actual pressure of the axis from the input data of two analog input terminals.

Note	If only one input signal is available, a function block of type MC_AxRtReadPressureSingle_BkPlcMc [▸ 158] should be used. If the force is to be determined, instead of the pressure, a function block of type MC_AxRtReadForceDiff_BkPlcMc [▸ 152] should be used.

```
VAR_INPUT
    AdcValueA:      INT:=0;
    AdcValueB:      INT:=0;
    ScaleFactorA:   LREAL:=0.0;
    ScaleOffsetA:   LREAL:=0.0;
    ScaleFactorB:   LREAL:=0.0;
    ScaleOffsetB:   LREAL:=0.0;
    ReadingMode:    E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

AdcValueA, **AdcValueB**: These parameters are used to transfer the input data of the analog terminals.

ScaleFactorA, **ScaleFactorB**: [bar/ADC_INC] This value represents the weighting. It determines which pressure increase corresponds to a stage of the AD converter.

ScaleOffsetA, **ScaleOffsetB**: [bar] This offset is used to correct the zero point of the pressure scale.

ReadingMode: This parameter is used to specify where the result of the evaluation is to be stored.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block:

The function block investigates the axis interface that has been passed to it every time it is called. During this process, a problem may be detected and reported:

- If the pointer pStAxRtData in Axis_Ref_BkPlcMc [▸ 67] is not initialized, the function block reacts with an **Error** and **ErrorID**:=dwTcHydErrCdPtrMcPlc. In this case, the axis cannot be placed into a fault state.

If these checks could be performed without problem, the actual pressure of the axis is determined by evaluating the variables **AdcValueA** and **AdcValueB**. The result is entered in ST_TcHydAxRtData [▸ 99].fActPressure.

The parameters assigned to an axis can be saved in ST_TcHydAxParam [▸ 93].fCustomerData[...], for example. This ensures that the data are loaded, saved and backed up together with the standard parameters of the axis and are also exported and imported, as required.

Commissioning option A

In this case, no movement of the axis is required. The achievable accuracy is sufficient for high-quality pressure sensors in most cases.

- The rated pressure of the pressure sensors divided by **AdcValueA**$_{MAX}$ or **AdcValueB**$_{MAX}$ should be entered as **ScaleFactorA** and **ScaleFactorB**.

Commissioning option B

In this case, no movement of the axis is required. The achievable accuracy is sufficient for high-quality pressure sensors in most cases.

- The rated pressure of the pressure sensors divided by **AdcValueA**$_{MAX}$ or **AdcValueB**$_{MAX}$ should be entered as **ScaleFactorA** and **ScaleFactorB**.

Commissioning option C

For this option it is necessary that a function block can be approached with full system pressure in both directions. A genuine movement of the axis is not required. Approaching of the end stops can be modeled by limiting the axis movement through provisional limits or even complete mechanical fixing.

- All function blocks, which respond to the value of ST_TcHydAxRtData [▸ 99].fActPressure, must be deactivated.
- First, slowly approach the lower function block (in the direction of decreasing actual position). The values for **AdcValueA** and **AdcValueB** are determined and logged. The system pressure should now be present on the B-side and the tank pressure – and therefore the ambient pressure – on the A-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement.
- Then, slowly approach the upper function block (in the direction of increasing actual position). The values for **AdcValueA** and **AdcValueB** are again determined and logged. Now measure the pressures again.
- The parameters to be entered can then be calculated as follows:

  ScaleFactorA := (PressureA$_{MAX}$ - PressureA$_{MIN}$) / (**AdcValueA**$_{MAX}$ - **AdcValueA**$_{MIN}$);

  ScaleFactorB := (PressureB$_{MAX}$ - PressureB$_{MIN}$) / (**AdcValueB**$_{MAX}$ - **AdcValueB**$_{MIN}$);

  ScaleOffsetA := PressureA$_{MIN}$ - **ScaleFactorA** * **AdcValueA;**$_{MIN}$

  ScaleOffsetB := PressureB$_{MIN}$ - **ScaleFactorB** * **AdcValueB;**$_{MIN}$

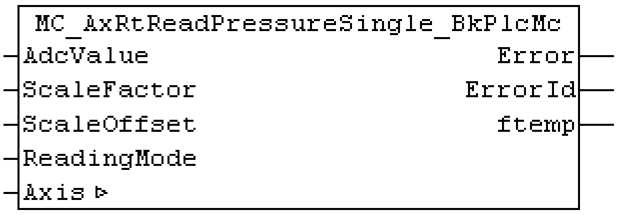
Commissioning option D

Alternatively, commissioning can be carried out without axis control. However, the accuracy that can be achieved in this way is much lower.

- First, the axis should be made pressure-free. To this end, switch off the compressor and relieve the pressure in the accumulator.
- Ensure that the axis does not build up pressure. To this end, an axis that is subject to external forces (gravity etc.) should be supported mechanically. Open the valve several times in both directions, either manually or electrically.

- Now determine and log the values for **AdcValueA** and **AdcValueB**. The tank pressure – and therefore the ambient pressure – should be present both on the A-side and on the B-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement. Use the values found in this way as **MIN** values in the equations mentioned above.
- Take the pressure for the upper limit of the electrical signal (10 V, 20 mA) from the data sheet specifications for the pressure sensors. Use the upper limit value for the converted electrical value as **AdcValueA** and **AdcValueB**. Use these values as **MAX** values in the equations mentioned above.
- The parameters to be entered can then be calculated as described above.

4.4.3.5 MC_AxRtReadPressureSingle_BkPlcMc (from V3.0)



The function block handles determination of the actual pressure of the axis from the input data of an analog input terminal.

Note If separate input signals are available for the A- and B-sides, a function block of type MC_AxRtReadPressureDiff_BkPlcMc [▶ 156] should be used.

```
VAR_INPUT
    AdcValue:        INT:=0;
    ScaleFactor:     LREAL:=0.0;
    ScaleOffset:     LREAL:=0.0;
    ReadingMode:     E_TcMcPressureReadingMode:=iTcHydPressureReadingDefault;
END_VAR
VAR_INOUT
    Axis:            Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Error:           BOOL;
    ErrorID:         UDINT;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

AdcValue: These parameters are used to transfer the input data of the analog terminal.

ScaleFactor: [bar/ADC_INC] This value represents the weighting. It determines which pressure increase corresponds to a stage of the AD converter.

ScaleOffset: [bar] This offset is used to correct the zero point of the pressure scale.

ReadingMode: The actual value to be determined can be specified here. Axis_Ref_BkPlcMc [▶ 67].ST_TcHydAxRtData [▶ 99].**fActPressure** is selected as default value.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block:

The function block investigates the axis interface that has been passed to it every time it is called. During this process, a problem may be detected and reported:

- If the pointer pStAxRtData in Axis_Ref_BkPlcMc [▶ 67] is not initialised, the function block reacts with an **Error** and **ErrorID**:=dwTcHydErrCdPtrMcPlc. In this case, the axis cannot be placed into a fault state.

If these checks could be performed without problem, the actual pressure of the axis is determined by evaluating the variables **AdcValue**. The result is entered in ST_TcHydAxRtData [▶ 99].fActPressure.

Note

The parameters assigned to an axis can be saved in ST_TcHydAxParam [▶ 93].fCustomerData[...], for example. This ensures that the data are loaded, saved and backed up together with the standard parameters of the axis and are also exported and imported, as required.

Commissioning option A

For this option it is necessary that a function block can be approached with full system pressure in both directions. A genuine movement of the axis is not required. Approaching of the end stops can be modeled by limiting the axis movement through provisional limits or even complete mechanical fixing.

- All function blocks, which respond to the value of ST_TcHydAxRtData [▶ 99].fActPressure, must be deactivated.
- First, slowly approach the lower function block (in the direction of decreasing actual position). The value for **AdcValue** is determined and logged. The system pressure should now be present on the B-side and the tank pressure – and therefore the ambient pressure – on the A-side. Should this not be the case for some reason, the pressures on the A- and B-side should be determined through measurement.
- Then, slowly approach the upper function block (in the direction of increasing actual position). The value for **AdcValue** is determined and logged again. Now measure the pressures again.
- The parameters to be entered can then be calculated as follows:

  ScaleFactor := (Pressure$_{MAX}$ - Pressure$_{MIN}$) / (**AdcValue**$_{MAX}$ - **AdcValue**$_{MIN}$);

  ScaleOffset := Pressure$_{MIN}$ - **ScaleFactor** * **AdcValue;**$_{MIN}$

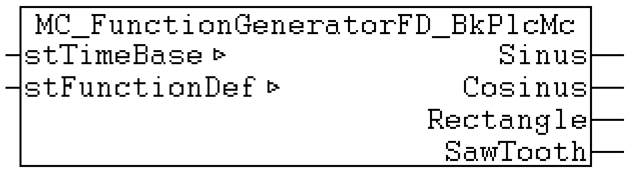
Commissioning option B

Alternatively, commissioning can be carried out without axis control. However, the accuracy that can be achieved in this way is much lower.

- First, the axis should be made pressure-free. To this end, switch off the compressor and relieve the pressure in the accumulator.
- Ensure that the axis does not build up pressure. To this end, an axis that is subject to external forces (gravity etc.) should be supported mechanically. Open the valve several times in both directions, either manually or electrically.
- Now the value for **AdcValue** is determined and logged. The tank pressure – and therefore the ambient pressure – should be present both on the A-side and on the B-side. If this is not the case for some reason, the pressure on the A-side should be determined through measurement. Use the values found in this way as **MIN** values in the equations mentioned above.
- Take the pressure for the upper limit of the electrical signal (10 V, 20 mA) from the data sheet specifications for the pressure sensors. Use the upper limit value for the converted electrical value as **AdcValue**. Use these values as **MAX** values in the equations mentioned above.
- The parameters to be entered can then be calculated as described above.

4.4.4 FunctionGenerator

4.4.4.1 MC_FunctionGeneratorFD_BkPlcMc (from V3.0.31)



The function block calculates the signals of a function generator.

```
VAR_OUTPUT
    Sinus:          LREAL;
    Cosinus:        LREAL;
    Rectangle:      LREAL;
    SawTooth:       LREAL;
END_VAR
VAR_INOUT
    stTimeBase:     ST_FunctionGeneratorTB_BkPlcMc;
    stFunctionDef:  ST_FunctionGeneratorFD_BkPlcMc;
END_VAR
```

Sinus, Cosinus, Rectangle, **SawTooth**: The output signals of the function generator.

stTimeBase: A structure with the parameters of the time base of this function generator.

stFunctionDef: A structure with the definitions of the output signals of a function generator.

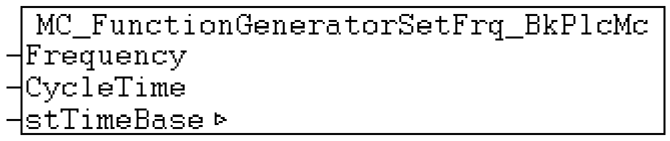
Behaviour of the function block

The output signals are determined from **stTime base.CurrentRatio** and the parameters in stFunctionDef [▶ 92].

The time base in **stTimeBase** should be updated with an MC_FunctionGeneratorTB_BkPlcMc [▶ 161]() function block.

To change the operating frequency, an MC_FunctionGeneratorSetFrq_BkPlcMc [▶ 160]() function block should be used.

4.4.4.2 MC_FunctionGeneratorSetFrq_BkPlcMc (from V3.0.31)



The function block updates the operating frequency of a time base for one or several function generators [▶ 159].

```
VAR_INPUT
    Frequency:      LREAL;
    CycleTime:      LREAL;
END_VAR
VAR_INOUT
    stTimeBase:     ST_FunctionGeneratorTB_BkPlcMc;
END_VAR
```

Frequency: The operating frequency to be used.

CycleTime: The cycle time of the calling task.

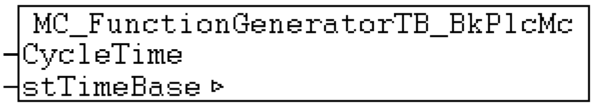
stTimeBase: A structure with the parameters of the time base of one or several function generators [▶ 92].

Behaviour of the function block

The function block sets **stTimeBase.Frequency** to the transferred value. **stTimeBase.CurrentTime** is adjusted, if required.

The function block uses **stTimeBase.Freeze** to prevent a collision with MC_FunctionGeneratorTB_BkPlcMc [▶ 161]() function blocks. Thus, it can also be called from another task.

4.4.4.3 MC_FunctionGeneratorTB_BkPlcMc (from V3.0.31)



The function block updates a time base for one or several function generators [▶ 159].

```
VAR_INPUT
    CycleTime:       LREAL;
END_VAR
VAR_INOUT
    stTimeBase:      ST_FunctionGeneratorTB_BkPlcMc;
END_VAR
```

CycleTime: The cycle time of the calling task.

stTimeBase: A structure with the parameters of the time base of one or several function generators [▶ 92].

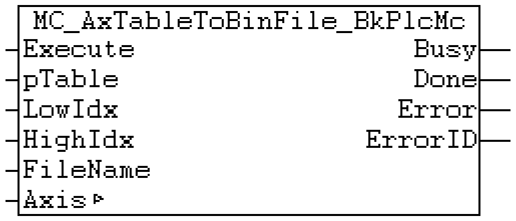
Behaviour of the function block

If **stTimeBase.Freeze** is not set, **stTimeBase.CurrentTime** is updated with **CycleTime** and **stTimeBase.CurrentRatio** is determined. **stTimeBase.Frequency** is taken into account.

To change the operating frequency, an MC_FunctionGeneratorSetFrq_BkPlcMc [▶ 160]() function block should be used.

4.4.5 TableFunctions

4.4.5.1 MC_AxTableToBinFile_BkPlcMc (from V3.0)



The function block writes the contents of a table to a binary file.

```
VAR_INPUT
    Execute:    BOOL:=FALSE;
    pTable:     POINTER TO LREAL:=0;
    LowIdx:     INT:=0;
    HighIdx:    INT:=0;
    FileName:   STRING(255):='';
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

pTable: This parameter is used to transfer the address of an ARRAY[nFirstIdx..nLastIdx.1..2].

LowIdx: This parameter is used to transfer the lower index of the ARRAY, whose address is transferred as **pTable**.

HighIdx: This parameter is used to transfer the upper index of the ARRAY, whose address is transferred as **pTable**.

FileName: This parameter can be used to specify a file name.

Busy: Indicates that a command is being processed.

Done: Successful processing of the reference travel is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

A rising edge at **Execute** causes the function block to examine the transferred parameters. A number of problems can be detected and reported during this process:

- If **LowIdx** is negative, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **pTable**=0, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **LowIdx** and **HighIdx** describe a table with fewer than five rows, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.

If these checks were performed without problems, the write operation is started. **Busy** is TRUE for the duration of the operation. This can lead to some further problems, which are indicated by various error codes. Successful writing of the file is indicated with **Done**.

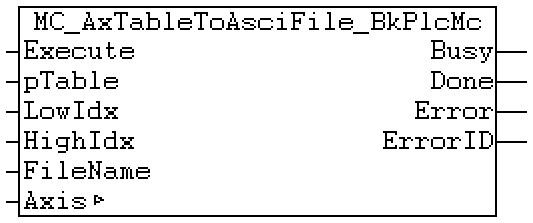
A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the operation is still active, the initiated operation continues unaffected. The signals at the end of the operation (**Error**, **ErrorID, Done**) apply for one cycle.

If a **FileName** is specified, it must be complete (including the drive letter and the path, if applicable, always including the file type), since it is used by function block without any further modification or amendment.

If no **FileName** is specified, the function block uses the path and the file name, which were specified through the MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block. File type TBL is used here, to distinguish from the parameter file with file type DAT.

NOTE! The file contents cannot be read or modified with an ASCII editor.

4.4.5.2 MC_AxTableToAsciFile_BkPlcMc (from V3.0)



The function block writes the contents of a table to a text file.

```
VAR_INPUT
    Execute:    BOOL:=FALSE;
    pTable:     POINTER TO LREAL:=0;
    LowIdx:     INT:=0;
    HighIdx:    INT:=0;
    FileName:   STRING(255):='';
END_VAR
```

```
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

pTable: This parameter is used to transfer the address of an ARRAY[nFirstIdx..nLastIdx.1..2].

LowIdx: This parameter is used to transfer the lower index of the ARRAY, whose address is transferred as **pTable**.

HighIdx: This parameter is used to transfer the upper index of the ARRAY, whose address is transferred as **pTable**.

FileName: This parameter can be used to specify a file name.

Busy: Indicates that a command is being processed.

Done: Successful processing of the reference travel is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

A rising edge at **Execute** causes the function block to examine the transferred parameters. A number of problems can be detected and reported during this process:

- If **LowIdx** is negative, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **pTable**=0, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **LowIdx** and **HighIdx** describe a table with fewer than five rows, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.

If these checks were performed without problems, the write operation is started. **Busy** is TRUE for the duration of the operation. This can lead to some further problems, which are indicated by various error codes. Successful writing of the file is indicated with **Done**.

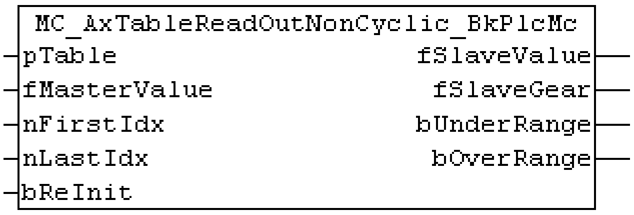
A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the operation is still active, the initiated operation continues unaffected. The signals at the end of the operation (**Error**, **ErrorID, Done**) apply for one cycle.

If a **FileName** is specified, it must be complete (including the drive letter and the path, if applicable, always including the file type), since it is used by function block without any further modification or amendment.

If no **FileName** is specified, the function block uses the path and the file name, which were specified through the MC_AxUtiStandardInit_BkPlcMc [▶ 182] function block. File type TXT is used here, to distinguish from the parameter file with file type DAT.

NOTE! The file contents can be read or modified with an ASCII editor. Changes of the content can make correct reading or the intended use impossible or change the effect of the table in a way that is difficult to trace. Manual changes should therefore be implemented very carefully, if at all, and only by competent persons.

4.4.5.3 MC_AxTableReadOutNonCyclic_BkPlcMc (from V3.0)



The function block determines the slave values assigned to a master value with the aid of a table.

NOTE! This function block is a component of cam plates or similar non-linear couplings. It is generally not called direct by an application.

```
VAR_INPUT
    pTable:         POINTER TO LREAL:=0;
    fMasterValue:   LREAL:=0.0;
    nFirstIdx:      UDINT:=1;
    nLastIdx:       UDINT:=1;
    bReInit:        BOOL:=FALSE;
END_VAR
VAR_OUTPUT
    fSlaveValue:    LREAL:=0.0;
    fSlaveGear:     LREAL:=0.0;
    bUnderRange:    BOOL;
    bOverRange:     BOOL;
END_VAR
```

pTable: This parameter is used to transfer the address of an ARRAY[nFirstIdx..nLastIdx.1..2].

Attention	**Crash of the PLC application** An incorrect specification at this point causes the **PLC application to crash** through triggering of serious runtime errors (**Page Fault Exception**).

fMasterValue: This parameter is used to transfer the master value, for which the corresponding slave values are to be determined.

nFirstIdx: This parameter is used to transfer the lower index of the ARRAY, whose address is transferred as **pTable**.

Attention: An incorrect specification at this point causes the **PLC application to crash** through triggering of serious runtime errors (**Page Fault Exception**).

nLastIdx: This parameter is used to transfer the upper index of the ARRAY, whose address is transferred as **pTable**.

Attention	**Crash of the PLC application** An incorrect specification at this point causes the **PLC application to crash** through triggering of serious runtime errors (**Page Fault Exception**).

bReInit: This input indicates to the function block that the search procedure should start at the top of the table.

fSlaveValue: This parameter is used to output the slave value belonging to **fMasterValue**.

fSlaveGear: This parameter is used to output the local slope of the slave values at the point in the table specified by the master.

bUnderRange: This output becomes TRUE, if the master value reaches the bottom of the table or falls below it.

bOverRange: This output becomes TRUE, if the master value reaches the top of the table or exceeds it.

Behaviour of the function block

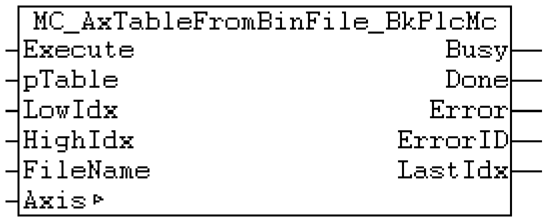
The function block searches inside the transferred table for a master pair of values, which matches or includes the transferred **fMasterValue**. Within the found intervals a linear intermediate interpolation is calculated. The result is output as **fSlaveValue**. The local slope determined in this calculation is output as **fSlaveGear**.

If **fMasterValue** is below the value range described by the table, **bUnderRange** is indicated. The value output as **fSlaveValue** is the value allocated to the lowest point of the table. 0.0 is returned as **fSlaveGear**.

If **fMasterValue** is above the value range described by the table, **bOverRange** is indicated. The value output as **fSlaveValue** is the value allocated to the highest point of the table. 0.0 is returned as **fSlaveGear**.

The return value **fSlaveGear** represents the ratio of the first derivatives of **fMasterValue** and **fSlaveValue**. If **fMasterValue** represents a position or a virtual time, the multiplication of master progress velocity and **fSlaveGear** returns the set slave velocity. This can be used to generate a pilot-control velocity. An MC_AxRtSetExtGenValues_BkPlcMc [▶ 180] function block is preferable for this purpose.

4.4.5.4 MC_AxTableFromBinFile_BkPlcMc (from V3.0)



The function block reads the contents of a table from a binary file.

```
VAR_INPUT
    Execute:    BOOL:=FALSE;
    pTable:     POINTER TO LREAL:=0;
    LowIdx:     INT:=0;
    HighIdx:    INT:=0;
    FileName:   STRING(255):='';
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    LastIdx:    INT:=0;
END_VAR
```

Execute: A rising edge at this input starts the read process.

pTable: This parameter is used to transfer the address of an ARRAY[nFirstIdx..nLastIdx.1..2].

LowIdx: This parameter is used to transfer the lower index of the ARRAY, whose address is transferred as **pTable**.

HighIdx: This parameter is used to transfer the upper index of the ARRAY, whose address is transferred as **pTable**.

FileName: This parameter can be used to specify a file name.

Busy: Indicates that a command is being processed.

Done: Successful processing of the reference travel is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

LastIdx: This parameter is used to indicate the index of the last table row defined by the read operation.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

A rising edge at **Execute** causes the function block to examine the transferred parameters. A number of problems can be detected and reported during this process:

- If **LowIdx** is negative, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **pTable**=0, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- f **LowIdx** and **HighIdx** describe a table with fewer than five rows, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.

If these checks were performed without problems, the read operation is started. **Busy** is TRUE for the duration of the operation. This can lead to some further problems, which are indicated by various error codes. Successful reading of the file is indicated with **Done**.

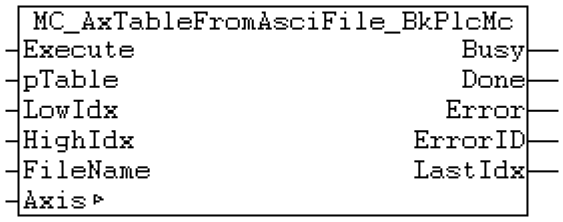
A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the operation is still active, the initiated operation continues unaffected. The signals at the end of the operation (**Error**, **ErrorID, Done**) apply for one cycle.

If a **FileName** is specified, it must be complete (including the drive letter and the path, if applicable, always including the file type), since it is used by function block without any further modification or amendment.

If no **FileName** is specified, the function block uses the path and the file name, which were specified through the MC_AxUtiStandardInit_BkPlcMc [▶ 182] function block. File type TBL is used here, to distinguish from the parameter file with file type DAT.

NOTE! The file contents cannot be read or modified with an ASCII editor.

4.4.5.5 MC_AxTableFromAsciFile_BkPlcMc (from V3.0)



The function block reads the contents of a table from a text file.

```
VAR_INPUT
    Execute:    BOOL:=FALSE;
    pTable:     POINTER TO LREAL:=0;
    LowIdx:     INT:=0;
    HighIdx:    INT:=0;
    FileName:   STRING(255):='';
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
    LastIdx:    INT:=0;
END_VAR
```

Execute: A rising edge at this input starts the read process.

pTable: This parameter is used to transfer the address of an ARRAY[nFirstIdx..nLastIdx.1..2].

LowIdx: This parameter is used to transfer the lower index of the ARRAY, whose address is transferred as **pTable**.

HighIdx: This parameter is used to transfer the upper index of the ARRAY, whose address is transferred as **pTable**.

FileName: This parameter can be used to specify a file name.

Busy: Indicates that a command is being processed.

Done: Successful processing of the reference travel is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

LastIdx: This parameter is used to indicate the index of the last table row defined by the read operation.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

A rising edge at **Execute** causes the function block to examine the transferred parameters. A number of problems can be detected and reported during this process:

- If **LowIdx** is negative, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **pTable**=0, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.
- If **LowIdx** and **HighIdx** describe a table with fewer than five rows, the system responds with **Error** and **ErrorID**=dwTcHydErrCdTblEntryCount.

If these checks were performed without problems, the read operation is started. **Busy** is TRUE for the duration of the operation. This can lead to some further problems, which are indicated by various error codes. Successful reading of the file is indicated with **Done**.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the operation is still active, the initiated operation continues unaffected. The signals at the end of the operation (**Error**, **ErrorID, Done**) apply for one cycle.

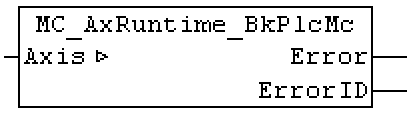
If a **FileName** is specified, it must be complete (including the drive letter and the path, if applicable, always including the file type), since it is used by function block without any further modification or amendment.

If no **FileName** is specified, the function block uses the path and the file name, which were specified through the MC_AxUtiStandardInit_BkPlcMc [▶ 182] function block. File type TXT is used here, to distinguish from the parameter file with file type DAT.

NOTE! The file contents can be read or modified with an ASCII editor. Changes of the content can make correct reading or the intended use impossible or change the effect of the table in a way that is difficult to trace. Manual changes should therefore be implemented very carefully, if at all, and only by competent persons.

4.4.6 Generators

4.4.6.1 MC_AxRuntime_BkPlcMc (from V3.0)



This function block performs the task of a set value generator. To this end a profile-specific function block is called, depending on the value set as nProfileType in **Axis**.ST_TcHydAxParam [▶ 93].

```
VAR_OUTPUT
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems can be detected and reported during this process:

- If one of the pointers has not been initialised the function block reacts with **Error** and with **ErrorID**:=dwTcHydErrCdPtrPlcMc or dwTcHydErrCdPtrMcPlc.

If it is possible to carry out these checks without encountering any problems, the set value generation is executed by calling an appropriate function block corresponding to the nProfileType in **Axis**.ST_TcHydAxParam [▸ 93].

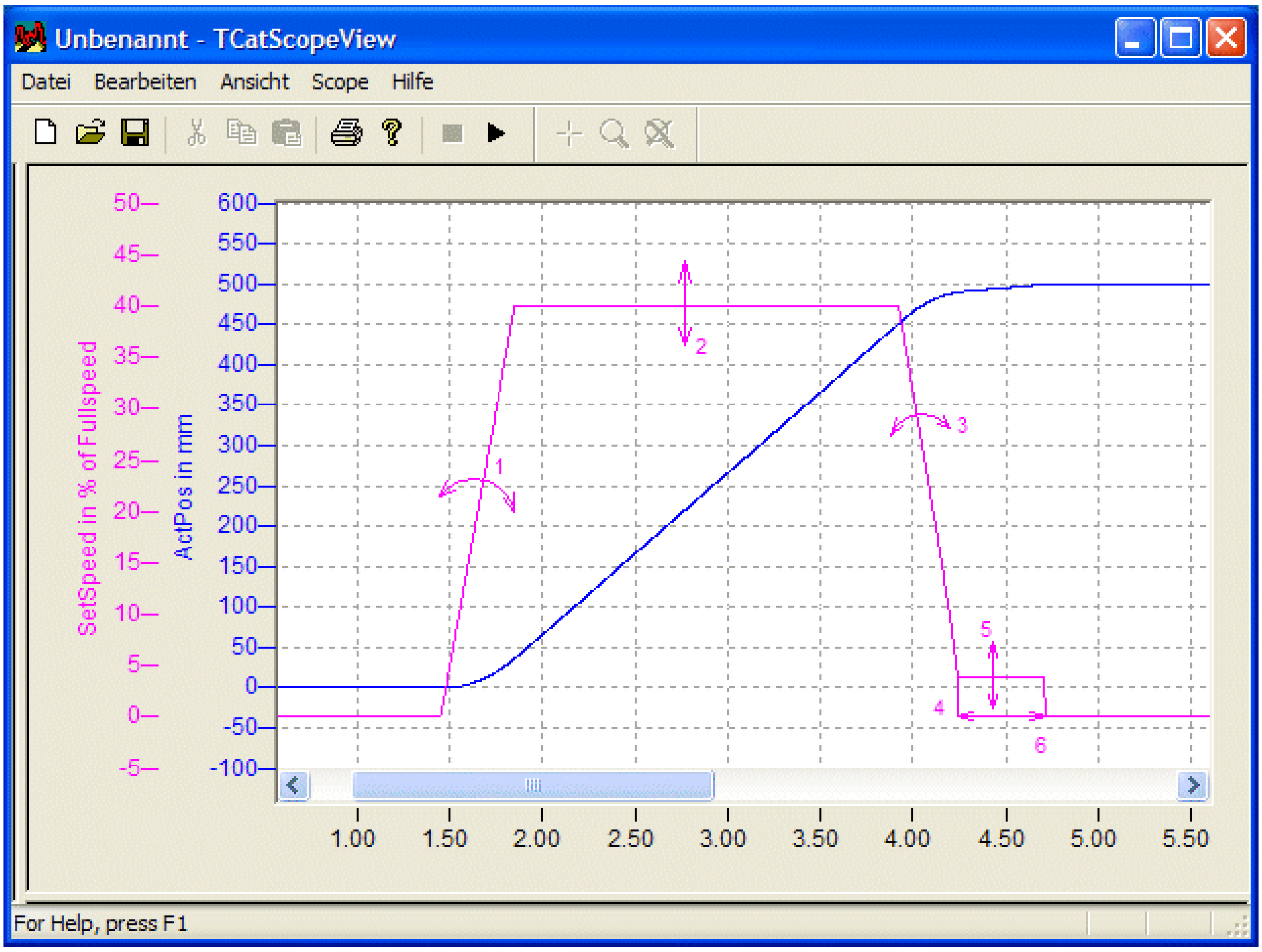
The following generators are presently available:

nProfileType	Description
iTcMc_ProfileCtrlBased [▶ 170]	**Standard profile**: Single-stage time-referenced acceleration, displacement-referenced (square root) braking ramp, target approach at creep velocity, selectable behavior when stationary. An axis in motion can be restarted at any time (new target, new velocity etc.), except in error state or in a state with dependent control value generation. **Note:** Overshooting the new target can happen even if the axis is in front of the target position at the time of the start. **Note**: The function block can be parameterized such that it starts automatically and assumes an active motion state under certain conditions, which are defined through its parameters. **Note**: This generator type can optionally operate in purely time-controlled mode with continuously closed position controller.
iTcMc_ProfileJerkBased	**Standard profile**: Single- or two-stage time-controlled acceleration through optional jerk limitation, displacement-controlled (square root generator) braking ramp, target approach with jerk limitation, selectable behavior in idle state. An axis in motion can be restarted at any time (new target, new velocity etc.), except in error state or in a state with dependent control value generation. **Note**: Overshooting the new target can happen even if the axis is in front of the target position at the time of the start. **Note**: The function block can be parameterized such that it starts automatically and assumes an active motion state under certain conditions, which are defined through its parameters. **Note**: This generator type can optionally operate in purely time-controlled mode with continuously closed position controller. **Note:** Some functions are not supported by this generator type, or not fully.
iTcMc_ProfileTimePosCtrl	**Note:** Only present for compatibility reasons; will shortly no longer be supported. **Special profile**: Two stage acceleration (initially time-referenced, then displacement-referenced following square root curve), displacement-referenced (square root) braking ramp, target approach at creep velocity, selectable behavior when stationary. It is not possible to execute a start for an axis that is already travelling (new target, new velocity etc.).
iTcMc_ProfileCosine	**Note:** Only present for compatibility reasons; will shortly no longer be supported. **Special profile**: Two stage acceleration (initially time-referenced, then displacement-referenced following cosine curve), displacement-referenced (cosine) braking ramp, target approach at creep velocity, selectable behavior when stationary. It is not possible to execute a start for an axis that is already travelling (new target, new velocity etc.).
iTcMc_ProfileTimeRamp [▶ 172]	**Special profile**: Single-stage time-controlled acceleration, time-controlled braking ramp, target approach with creep speed, conditionally selectable behavior in idle state. The generator uses position cams instead of an encoder. An axis in motion can be restarted (new target, new velocity etc.), except in error state. **Note**: This generator type is intended for axes, which only have digital cams instead of an encoder.

If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc [▶ 181] should be used for simplicity.

iTcMc_ProfileCtrlBased

A profile is generated with a time-controlled acceleration phase, a displacement-controlled braking phase based on the square root generator principle, and a target approach with creep speed.



The arrows on the profile of the control value suggest how the shape of the curve can be affected through the parameters of the move order or of the axis. To begin with, a time-controlled ramp function "1" is used to accelerate to the required travel velocity "2". This control value is maintained until a point is reached that was recalculated at the start. After this point, a displacement-referenced ramp "3" is followed to brake down from the main travel velocity to the creep velocity "5"; this control value is reached at a specified distance, "4", from the target. This control value is retained until the target has been approached to within a specified remaining distance "6". The axis is then switched to its idle behavior.

Parameters active in the travel profile

Start ramp "1": The smallest of the following values is the effective one: **fMaxAcc** and **fAcc** in **Axis**.ST_TcHydAxParam [▸ 93]**, Acceleration** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Travel phase "2": The smallest of the following values is the effective one: **fRefVelo** and **fMaxVelo** in **Axis**.ST_TcHydAxParam [▸ 93], **Velocity** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Braking ramp "3": The smallest of the following values is the effective one: **fMaxDec** and **fDec** in **Axis**.ST_TcHydAxParam [▸ 93]**, Deceleration** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Creep phase "4", "5": The values of **fCreepSpeed** and **fCreepDistance** in **Axis**.ST_TcHydAxParam [▸ 93] have an effect.

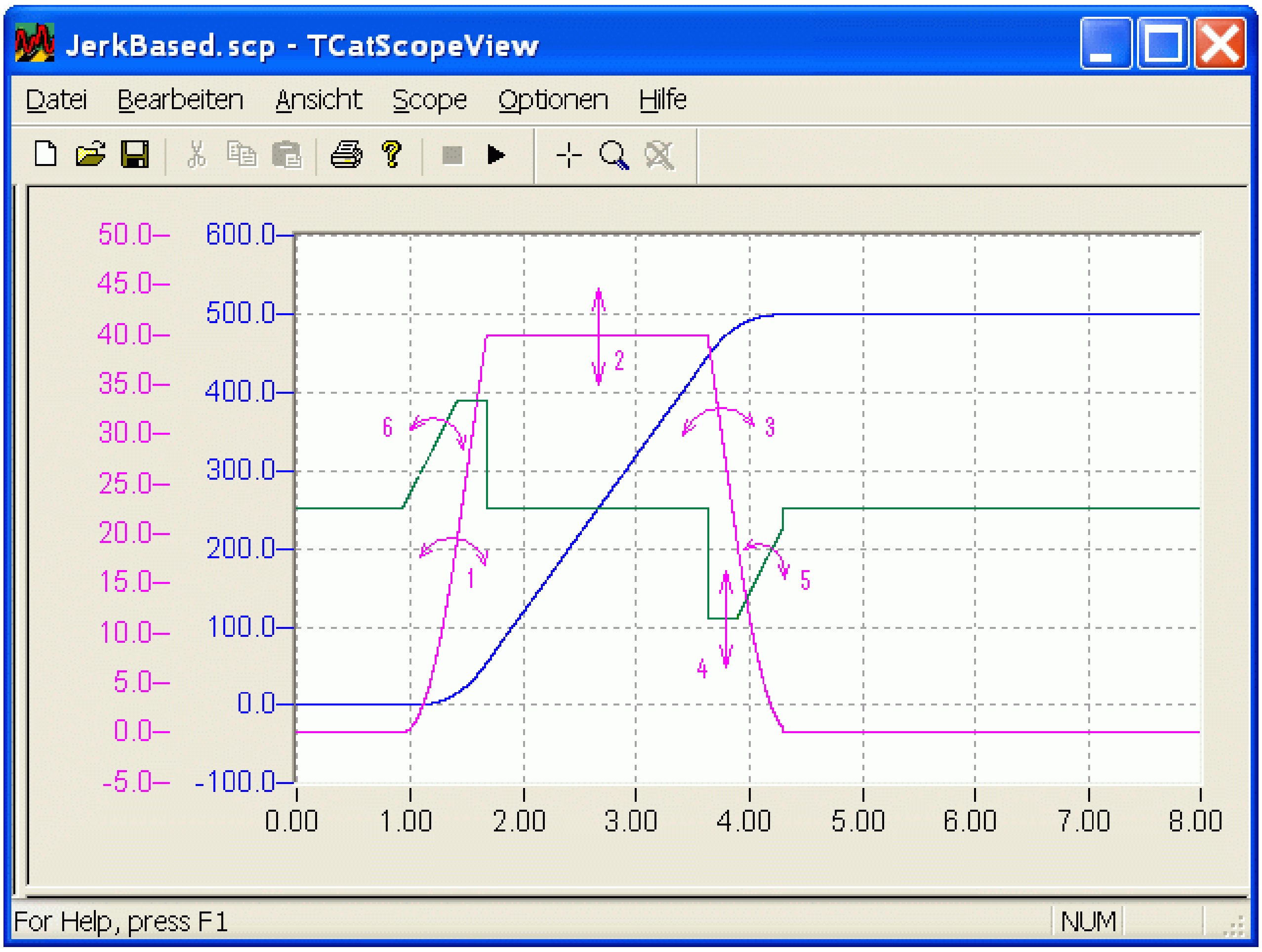
Transfer to target "6": The **fBrakeDistance** and/or **fBrakeDeadTime** in **Axis**.ST_TcHydAxParam [▸ 93] have an effect.

Automatic starting of the axis

If the difference between the actual position and the current target position exceeds the value in **Axis**.ST_TcHydAxParam [▸ 93].fReposDistance, an automatic start is triggered.

iTcMc_ProfileJerkBased

A profile is generated with a time-controlled acceleration phase (with optional jerk limitation), a displacement-controlled braking ramp based on the square root generator principle, and a target approach with jerk limitation.



The arrows on the profile of the control value suggest how the shape of the curve can be affected through the parameters of the move order or of the axis. To begin with, a time-controlled ramp function "1" is used to accelerate to the required travel velocity "2". The optional jerk limitation "6" can take effect. The travel speed is maintained until a point is reached that was recalculated at the start. At this point a displacement-controlled braking ramp "3" is applied, until the distance to the target has reduced to the residual distance. The deceleration "4" is reduced with limited jerk "5" towards the target. The axis is then switched to its idle behavior.

Parameters active in the travel profile

Start ramp "1": The smallest of the following values is the effective one: **fMaxAcc** and **fAcc** in **Axis**.ST_TcHydAxParam [▸ 93], **Acceleration** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Travel phase "2": The smallest of the following values is the effective one: **fRefVelo** and **fMaxVelo** in **Axis**.ST_TcHydAxParam [▸ 93], **Velocity** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Braking ramp "3", "4": The smallest of the following values is the effective one: **fMaxDec** and **fDec** in **Axis**.ST_TcHydAxParam [▸ 93]**, Deceleration** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Transfer to target "5": fMaxJerk in **Axis**.ST_TcHydAxParam [▸ 93] and **fJerk** of the function block used on axis start take effect (example: MC_MoveAbsolute_BkPlcMc [▸ 60]) and **fBrakeDistance** and/or **fBrakeDeadTime** in **Axis**.ST_TcHydAxParam [▸ 93].

iTcMc_ProfileTimePosCtrl

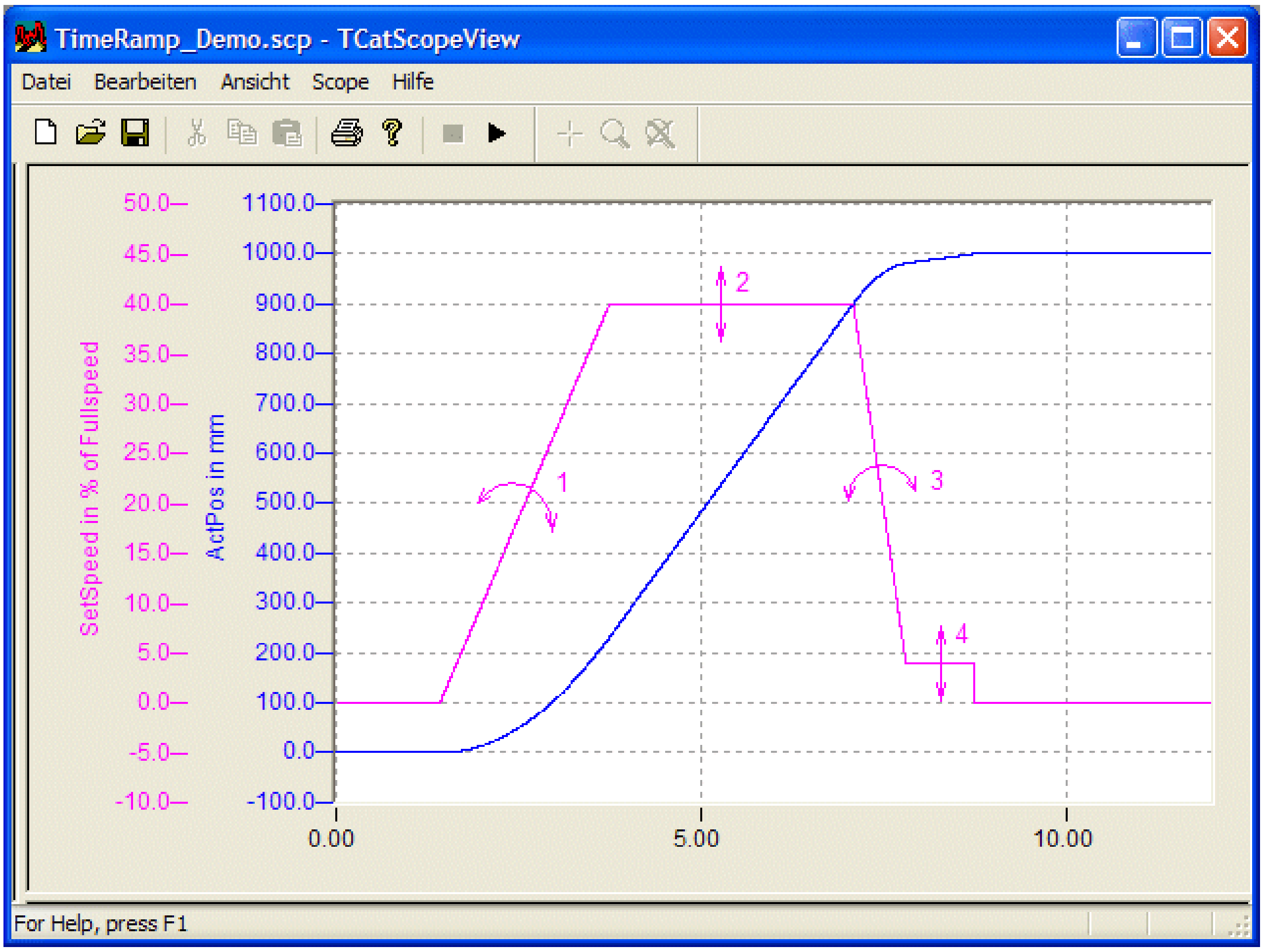
NOTE! Only present for compatibility reasons; will shortly no longer be supported. It should not be used for new projects and should be replaced when existing projects are revised, if possible.

iTcMc_ProfileCosine

NOTE! Only present for compatibility reasons; will shortly no longer be supported. It should not be used for new projects and should be replaced when existing projects are revised, if possible.

iTcMc_ProfileTimeRamp

A profile is generated with a time-controlled acceleration phase, a time-controlled braking phase and a target approach with creep speed.



The arrows on the profile of the control value suggest how the shape of the curve can be affected through the parameters of the move order or of the axis. To begin with, a time-controlled ramp function "1" is used to accelerate to the required travel velocity "2". This control value is maintained until the direction-specific target window cam is detected. From here, a time-controlled ramp "3" is applied to decelerate from the set motion value to the set creep value "5". This control value is maintained until the direction-specific target cam is detected. The axis is then switched to its idle behavior.

Parameters active in the travel profile

Start ramp "1": fStartRamp has an effect in **Axis**.ST_TcHydAxParam [▸ 93].

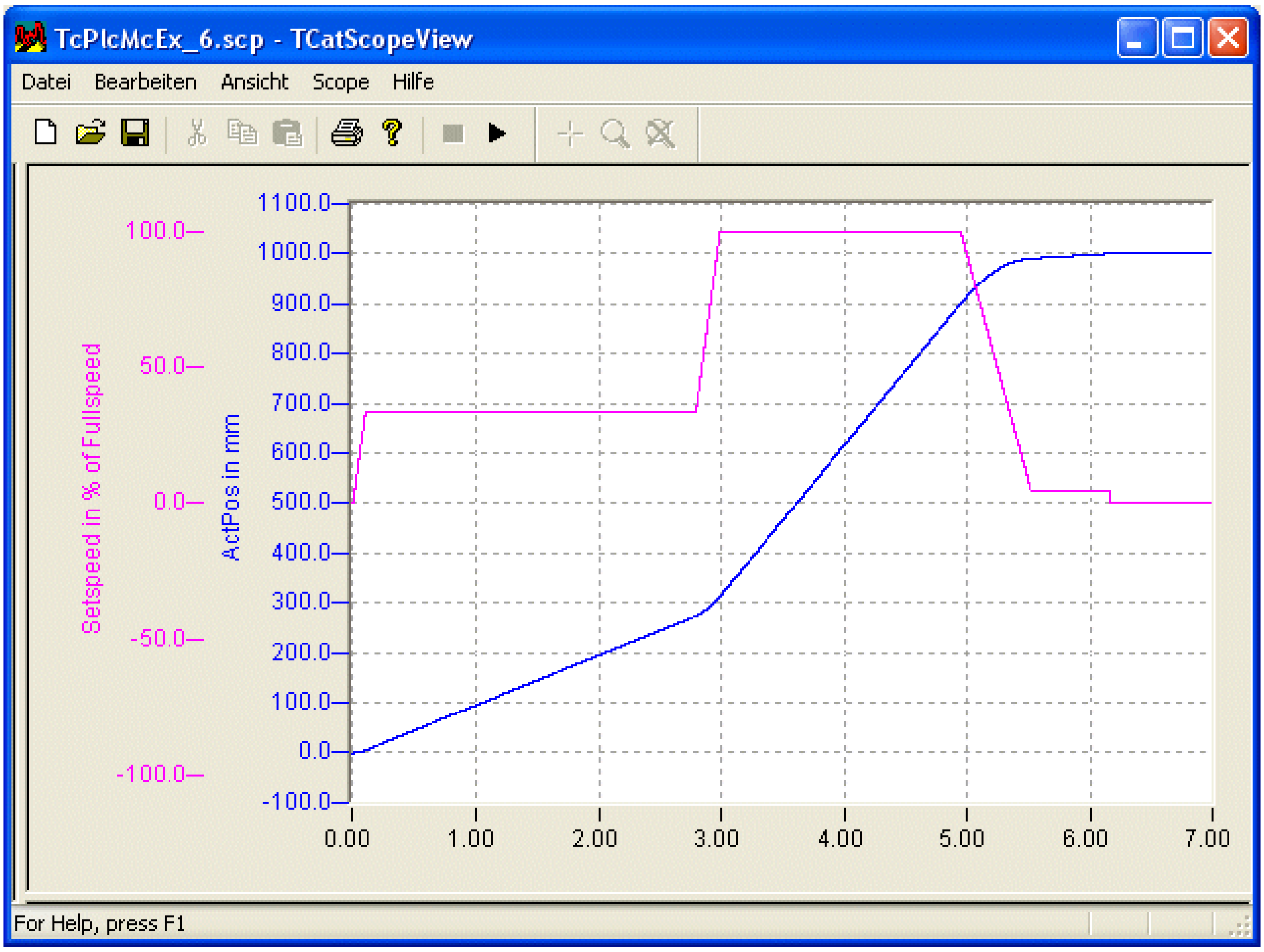
Travel phase "2": The smallest of the following values is the effective one: **fRefVelo** and **fMaxVelo** in **Axis**.ST_TcHydAxParam [▸ 93], **Velocity** of the function block used to start the axis (for example: MC_MoveAbsolute_BkPlcMc [▸ 60]).

Braking ramp "3": fStopRamp has an effect in **Axis**.ST_TcHydAxParam [▸ 93].

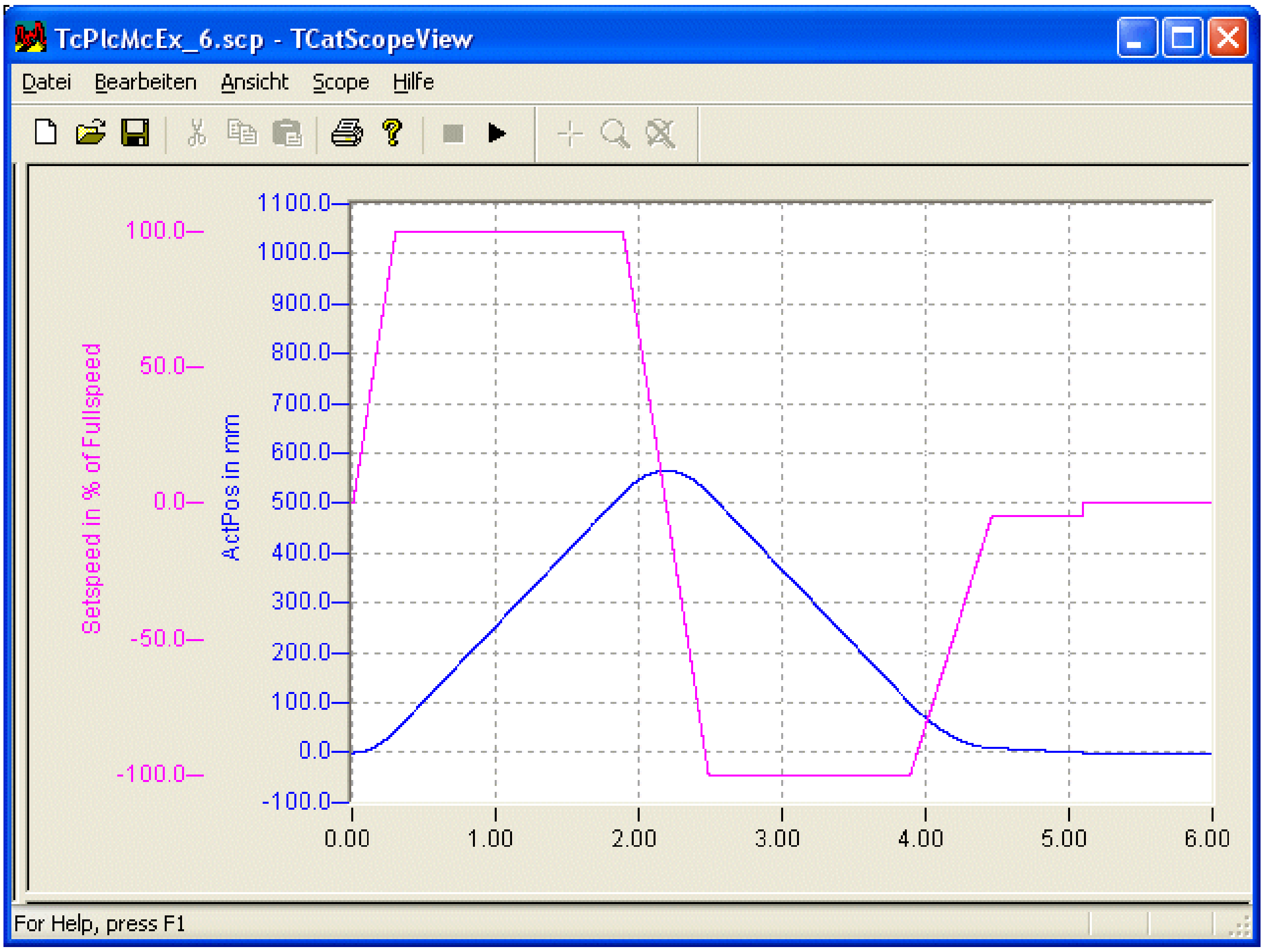
Creep phase "4": fCreepSpeed has an effect in **Axis**.ST_TcHydAxParam [▸ 93].

Behavior of the function block on restart during a motion

If a further start command is issued during an active motion, a distinction has to be made between two cases.



This profile is created on restart in the same direction with a different velocity (higher in this case).

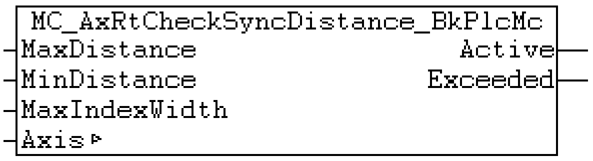


This profile is created on restart in the opposite direction, in this case with the same velocity.

This profile type can only be used in a meaningful manner in combination with the encoder type iTcMc_EncoderDigCam [▶ 144]. See also Special case: digital position cams.

4.4.7 Runtime

4.4.7.1 MC_AxRtCheckSyncDistance_BkPlcMc (from V3.0)



The function block checks for an invalid path (distance) after leaving the cam during homing.

```
VAR_INPUT
    MaxDistance:     LREAL;
    MinDistance:     LREAL;
    MaxIndexWidth:   LREAL;
END_VAR
VAR_INOUT
    Axis:            Axis_Ref_BkPlcMc;
END_VAR
VAR_OUTPUT
    Active:          BOOL;
    Exceeded:        BOOL;
END_VAR
```

MaxDistance: [mm] This parameter is used to specify the maximum permitted distance that may be traveled between the referencing cam and reaching of the zero pulse.

MinDistance: [mm] This parameter is used to specify the minimum distance that must be traveled between the referencing cam and reaching of the zero pulse.

MaxIndexWidth: [mm] This parameter is used to specify the minimum distance that must be traveled to leave the referencing cam. (from V3.0.20)

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Exceeded: Indicates that the axis has travelled more than **MaxDistance** after leaving the cam, without detection of the zero pulse of the encoder.

Active: Indicates that the axis has left the cam has and expects the zero pulse of the encoder.

Behavior of the function block

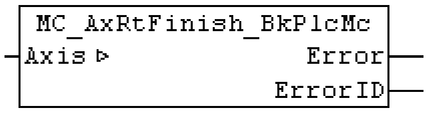
The function block detects the part of the homing, in which the axis searches for the zero pulse of encoder, thereby monitoring the distance travelled. Two problems can be detected during this process:

- The axis travels **MaxIndexWidth**, without that the falling edges of the referencing cam being detected.
- The axis travels **MaxDistance**, without a zero pulse being detected.
- The zero pulse is detected, before the axis has traveled **MinDistance**.

Any problems that are detected are indicated with **Exceeded**. If this is to lead to an axis error, the application must specify a corresponding change of state. An MC_AxRtGoErrorState_BkPlcMc [▶ 178] function block and a coded Error Code [▶ 236] should be used here.

NOTE! Monitoring for MinDistance and MaxDistance can be suppressed by setting the respective parameter to 0.0.

4.4.7.2 MC_AxRtFinish_BkPlcMc (from V3.0)



This function block adapts the control value that has been generated to the special features of the particular axis. An MC_AxRtFinishLinear_BkPlcMc [▶ 176] function block should be used if a characteristic curve linearisation is required.

```
VAR_OUTPUT
    Error:       BOOL;
    ErrorID:     UDINT;
END_VAR
VAR_INOUT
    Axis:        Axis_Ref_BkPlcMc;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems can be detected and reported during this process:

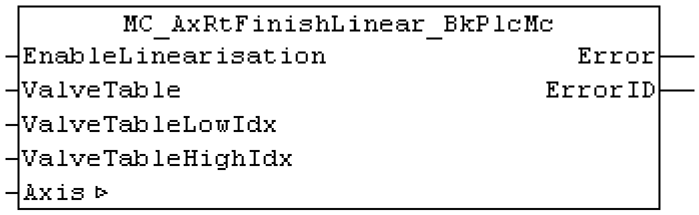
- If one of the pointers has not been initialised the function block reacts with **Error** and with **ErrorID**:=dwTcHydErrCdPtrPlcMc or dwTcHydErrCdPtrMcPlc.

If these checks could be performed without problem, the control value for the axis is adapted according to the values in **Axis**.ST_TcHydAxParam [▸ 93].

- The control value for the advance and the positional control reaction are combined to form the output control value.
- Area compensation is taken into account.
- Compensation is applied for a bend in the characteristic curve.
- The overlap compensation, the terminal control value and the offset compensation are included in the calculation.

If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc [▸ 181] should be used for simplicity.

4.4.7.3 MC_AxRtFinishLinear_BkPlcMc (from V3.0.16)



The function block deals with the adjustment of the generated control value to the special features of the axis, taking into account a characteristic curve.

```
VAR_INPUT
    EnableLinearisation:   BOOL;
    ValveTable:            POINTER TO LREAL:=0;
    ValveTableLowIdx:      INT:=0;
    ValveTableHighIdx:     INT:=0;
END_VAR
VAR_OUTPUT
    Error:                 BOOL;
    ErrorID:               UDINT;
END_VAR
VAR_INOUT
    Axis:                  Axis_Ref_BkPlcMc;
END_VAR
```

EnableLinearisation: TRUE at this input activates the linearisation.

ValveTable: The address of the linearisation table should be transferred here. If possible, this should be the ValveCharacteristicTable of an ST_TcMcAutoIdent [▸ 93] linked to the axis.

ValveTableLowIdx: The index of the first point in the linearisation table.

ValveTableHighIdx: The index of the last point in the linearisation table. If possible, this should be the ValveCharacteristicTblCount of an ST_TcMcAutoIdent [▸ 93] linked to the axis.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

The function block investigates the axis interface that has been passed to it every time it is called. A number of problems may be detected:

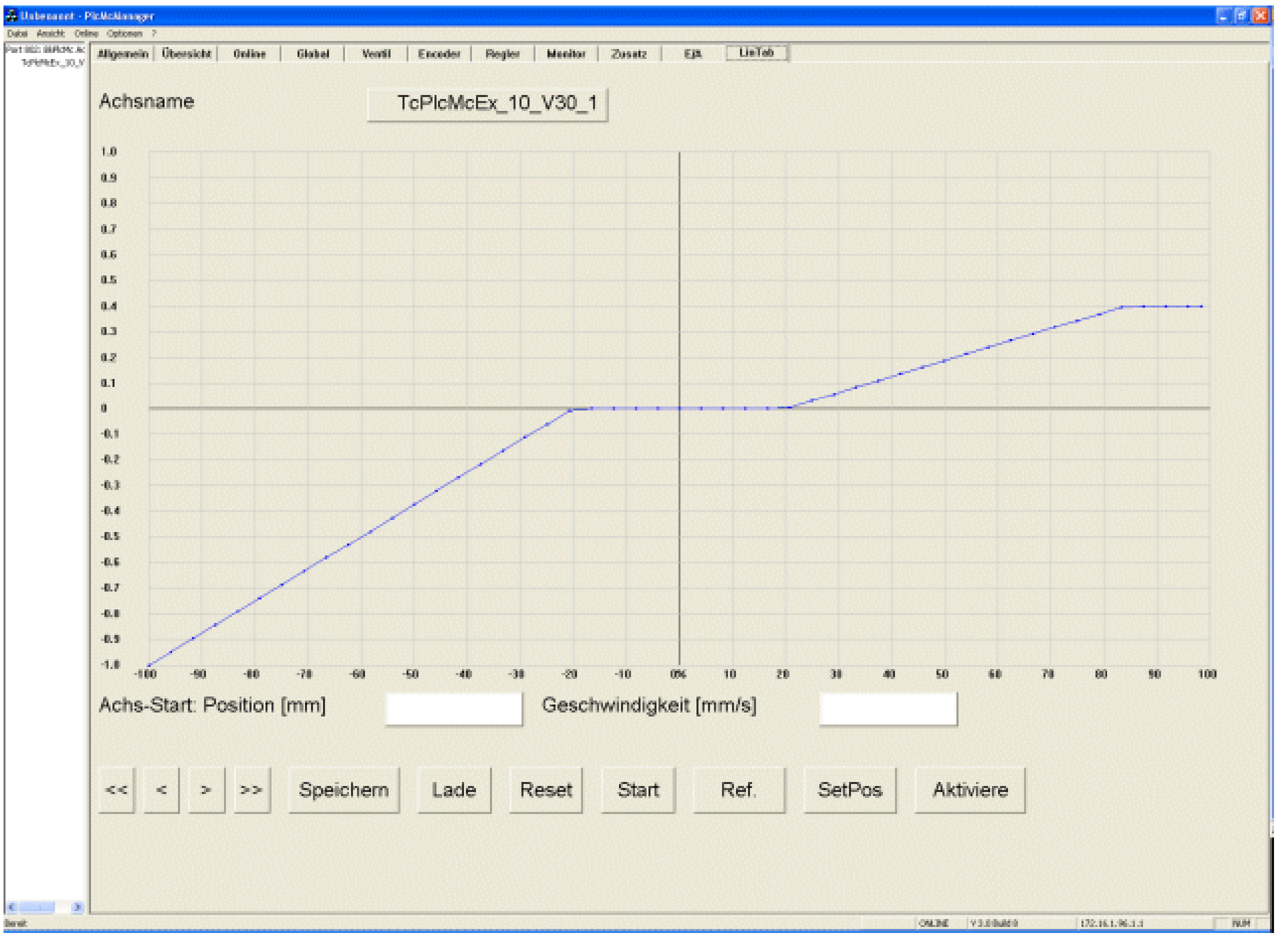
- **EnableLinearisation** is FALSE.
- The pointer **ValveTable** is not initialised.
- **ValveTableLowIdx** is less than 0.

- **ValveTableHighIdx** is less than or equal to **ValveTableLowIdx**.

In these cases an MC_AxRtFinish_BkPlcMc [▸ 175] function block is called internally, and its outputs are passed on. Otherwise the table linearisation for the axis is performed. Note the following special characteristics:

- The parameter for compensating the directionality (area ratio, gravity etc.) of the axis velocity has no effect. This compensation should be taken into account in the table.
- The parameters for compensating a kink in the characteristic curve have no effect. This compensation should be taken into account in the table.
- The parameter for the overlap compensation has no effect. This compensation should be taken into account in the table.
- A pressing power output or an offset compensation cannot be realized through a linearization. The corresponding parameters are active.

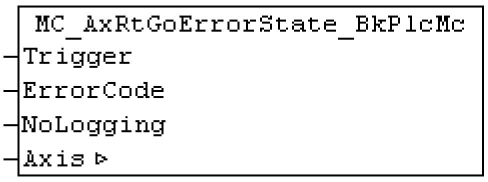
Sample: Display of a linearisation in the PlcMcManager:



The linearisation tables can be loaded from a text file [▸ 233] with an MC_AxTableFromAsciFile_BkPlcMc [▸ 166] or MC_AxTableFromBinFile_BkPlcMc [▸ 165] function block.

A sample program can be found in the SampleList [▸ 255] of the Knowledge Base [▸ 218]. Demonstrates automatic determination of a characteristic curve with an MC_AxUtiAutoIdent_BkPlcMc [▸ 192] function block.

4.4.7.4 MC_AxRtGoErrorState_BkPlcMc (from V3.0)



(not recommended) This function block places the axis into a fault state.

```
VAR_INPUT
    Trigger:        BOOL;
    ErrorID:        UDINT;
    NoLogging:      BOOL;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Trigger: A rising edge at this input places the axis in a fault state.

ErrorCode: An encoded indication of the cause of the error is provided here.

NoLogging: TRUE at this input suppresses the output of a message.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

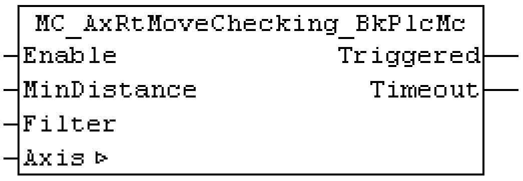
The axis is placed into a fault state by a rising edge at the **Trigger** input.

Requirements:

- The value at the **ErrorCode** input is not equal to 0.
- The axis is not already in a fault state.

NOTE! If NoLogging is FALSE (default state), message containing information on the affected axis and the ErrorCode is generated during the transition of the axis to the error state. This default message should be replaced with a message that is meaningful for the application. In this case the default message should be suppressed by setting NoLogging to TRUE.

4.4.7.5 MC_AxRtMoveChecking_BkPlcMc (from V3.0)



The function block monitors the response of an axis.

```
VAR_INPUT
     Enable:        BOOL;
     MinDistance:   LREAL;
     Filter:        LREAL;
END_VAR
VAR_OUPUT
     Triggered:     BOOL;
     Timeout:       BOOL;
END_VAR
```

```
VAR_INOUT
     Axis:          Axis_Ref_BkPlcMc;
END_VAR
```

Enable: TRUE at this input activates the monitoring.

MinDistance: [mm] The required minimum distance must be transferred here.

Filter: [s] The measuring time must be specified here.

Triggered: This output indicates that the axis was set to error state.

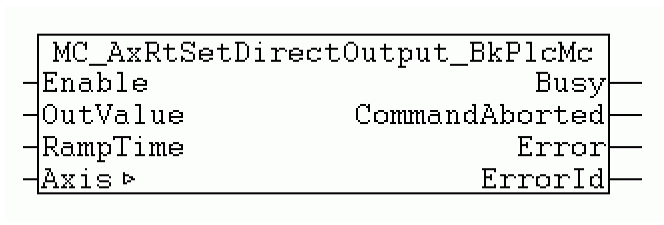
Timeout: This output indicates that monitoring was triggered.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block continuously checks whether the axis has travelled at least a **MinDistance** within **Filter** in the direction that matches the required motion. If this is not the case, **timeout** is indicated. If **Enable** is TRUE, the axis is set to error state **dwTcHydErrCdNotMoving** = 16#435D = 17245. This is indicated through **Triggered**.

4.4.7.6 MC_AxRtSetDirectOutput_BkPlcMc (from V3.0)



The function block issues a control value, regardless of a profile generation.

```
VAR_INPUT
     Enable:            BOOL;
     OutValue:          LREAL;
     RampTime:          LREAL;
END_VAR
VAR_OUPUT
     Busy:              BOOL;
     CommandAborted:    BOOL;
     Error:             BOOL;
     ErrorID:           UDINT;
END_VAR
VAR_INOUT
     Axis:              Axis_Ref_BkPlcMc;
END_VAR
```

Enable: **TRUE** at this input activates the output.

OutValue: The control value to be output should be transferred here.

RampTime: [s] Here, the time should be specified in which the control value would reach full scale.

Busy: Indicates that a command is being processed.

CommandAborted: This indicates abortion of the function.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

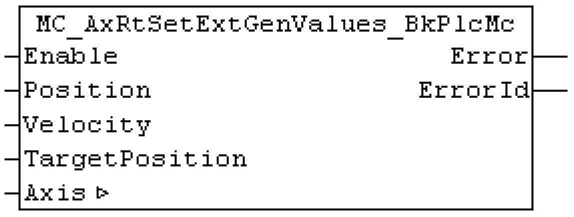
Behavior of the function block

A positive edge at **Enable** activates the function. The axis is put into states McState_Continousmotion [▶ 78] and iTcHydStateExtGenerated [▶ 71], and **Busy** becomes **TRUE**. The control value of the axis is updated with OutValue. The rate of change is specified through **RampTime**.

If **Enable** is set to **FALSE,** the control value is brought to 0.0 using **RampTime**, and the function is terminated. Only then does **Busy** become **FALSE**.

If another function block takes over control of the axis while the **MC_AxRtSetDirectOutput_BkPlcMc** is active, the function block terminates its function and indicates **CommandAborted**.

4.4.7.7 MC_AxRtSetExtGenValues_BkPlcMc (from V3.0)



The function block supplies an axis with command variables, which do not originate from the axis' own generator.

```
VAR_INPUT
    Enable:             BOOL;
    Position:           LREAL:=0.0;
    Velocity:           LREAL:=0.0;
    TargetPosition:     LREAL:=0.0;
END_VAR
VAR_OUTPUT
    Error:              BOOL;
    ErrorID:            UDINT;
END_VAR
VAR_INOUT
    Axis:               Axis_Ref_BkPlcMc;
END_VAR
```

Enable: TRUE at this input activates the transfer of the command variables provided.

Position: [mm] Set position value to be transferred cyclically.

Velocity: [mm/s] Set velocity value to be transferred cyclically.

TargetPosition: [mm] Target position value for the current motion to be transferred cyclically.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behavior of the function block

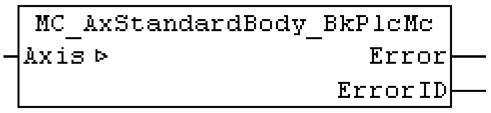
The function block investigates the axis interface that has been passed to it every time it is called. If a positive edge is detected at **Execute**, the axis is put in state **McState_Synchronizedmotion** and **iTcHydStateExtGenerated**.

If Execute is TRUE, the values of **Position, Velocity** and **TargetPosition** are entered in the runtime variables of the axis. The purpose is to model the behavior of the generator function block for a comparable motion, as far as possible.

If a negative edge is detected at Execute, the function block puts the axis in state **McState_Standstill**. If the axis is not at standstill at this time, it is stopped via the time-controlled ramp set in fStopRamp.

NOTE! The generator function block of the axis should still be called cyclically. It deals with position control and updates further internal variables.

4.4.7.8 MC_AxStandardBody_BkPlcMc (V3.0)



This function bllock calls a function block of each of the following types: MC_AxRtEncoder_BkPlcMc [▶ 135], MC_AxRuntime_BkPlcMc [▶ 167], MC_AxRtFinish_BkPlcMc [▶ 175] and MC_AxRtDrive_BkPlcMc [▶ 125].

```
VAR_OUTPUT
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

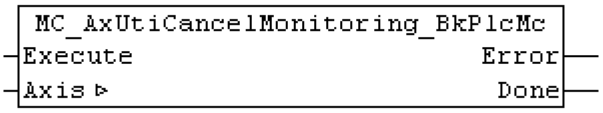
Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

The usual components of the axis are called, depending on the value in ST_TcHydAxParam [▶ 93]. If one of the called function blocks reports an **Error** it is echoed, together with its **ErrorID**, at the outputs of this function block.

NOTE! In the event of multiple problems, they are prioritized according to the following sequence: encoder, generator, finish, drive.

4.4.7.9 MC_AxUtiCancelMonitoring_BkPlcMc (from V3.0)



Monitoring of a function is aborted.

NOTE! Many function blocks can still be activated based on the PLCopen definitions, even if an activity was already started for the axis by the same or another function block. In most cases this behavior can be utilized, and the monitoring does not have to be aborted.

Note	**A number of function blocks require the option of monitoring for correct and full processing of their function. Monitoring may only be aborted in function blocks for which this possibility is explicitly stated.**

```
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
VAR_INPUT
    Execute:    BOOL;
END_VAR
```

```
VAR_OUTPUT
    Error:      BOOL;
    Done:       BOOL;
END_VAR
```

Execute: A rising edge at this input stops the monitoring.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Error: The occurrence of an error is indicated here.

Done: This indicates successful abortion.

Behaviour of the function block

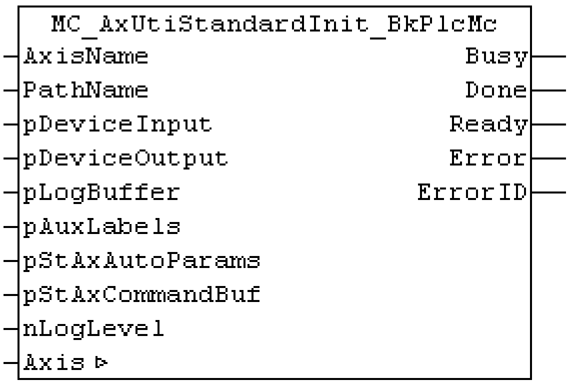
A rising edge at **Execute** causes the function block to manipulate the transferred **Axis** interface such that other function blocks interpret it as the start of a function. If a different function block is monitoring the processing of a function started by it, it will abort this and set the signal **CommandAborted** at its output.

NOTE! Currently no error causes are known. The Error output is always FALSE.

NOTE! The function block function requires no processing time. The output Done will immediately match the input Execute when the function block is called.

A list of function blocks, for which such an abortion of monitoring is permitted, can be found in the Knowledge Base [▸ 218].

4.4.7.10 MC_AxUtiStandardInit_BkPlcMc (from V3.0)



The function block handles the initialization and monitoring of axis components.

```
VAR_INPUT
    AxisName:           STRING(255);
    PathName:           STRING(255);
    pDeviceInput:       POINTER TO ST_TcPlcDeviceInput:=0;
    pDeviceOutput:      POINTER TO ST_TcPlcDeviceOutput:=0;
    pLogBuffer:         POINTER TO ST_TcPlcMcLogBuffer:=0;
    pStAxAuxLabels:     POINTER TO ST_TcMcAuxDataLabels:=0;
    pStAxAutoParams:    POINTER TO ST_TcMcAutoIdent;
    pStAxCommandBuf:    POINTER TO ST_TcPlcCmdBuffer_BkPlcMc:=0;    (* ab/from V3.0.8 *)
    nLogLevel:          DINT:=0;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Ready:      BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

AxisName: Here, the text-based name of the axis (example: 'Axis_1') should be transferred.

PathName: Here, the text-based path name (example: 'C:\TwinCAT\Project\'), under which the axis parameters are to be saved, should be transferred.

pDeviceInput: This parameter is used to transfer the address of a variable of type ST_TcPlcDeviceInput [▸ 104].

pDeviceOutput: This parameter is used to transfer the address of a variable of type ST_TcPlcDeviceOutput [▸ 106].

pLogBuffer: Here, the address of a variable of type ST_TcPlcMcLogBuffer [▸ 107] can be transferred.

pAuxLabels: Here, the address of an ST_TcMcAuxDataLabels [▸ 103] structure with label texts for customer-specific axis parameters can be transferred.

pStAxAutoParams: Here, the address of a variable of type ST_TcMcAutoIdent [▸ 93] can be transferred.

pStAxCommandBuf: From V3.0.8, the input **BufferMode** is available in various function blocks, as defined by PLCopen. The functionality that can be controlled with this is currently in preparation. In this context this command buffer was amended.

Note	The input **pStAxCommandBuf** must currently not be supplied, or only with the value 0.

nLogLevel: Here, a coded value [▸ 244] should be transferred, which specifies the threshold value for recording of messages.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

With each call the function block examines the transferred axis interface and the transferred pointers. If a change is detected, the function block indicates in the transferred Axis_Ref_BkPlcMc [▸ 67] structure that the axis has to be reinitialised. The MC_AxParamLoad_BkPlcMc [▸ 203] function block used by the function block will now automatically load the axis parameters from the file. If **pAuxLabels** is supplied, an MC_AxParamAuxLabelsLoad_BkPlcMc [▸ 202] function block is then used to load the label texts for the customer-specific axis parameters.

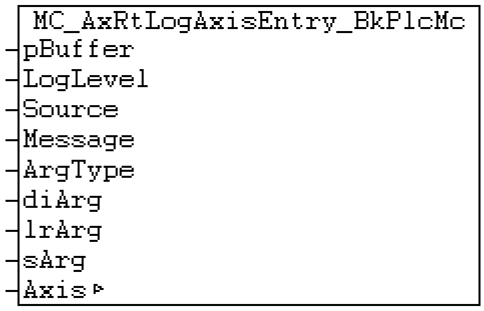
NOTE! The strings transferred as AxisName and PathName must not contain spaces or special characters, which would make them unsuitable for generating a file name. The file name is generated by concatenating the transferred strings and adding the extension '.dat'. The file name for the label texts of the customer-specific axis parameter is generated in the same way, but with the extension '.txt'.

NOTE! The parameters pDeviceInput and pDeviceOutput should be supplied for all axes, which use an I/O hardware for position sensing. If virtual axes are used, these parameters should not be assigned or assigned 0.

Note	The input **pStAxCommandBuf** must currently not be supplied, or only with the value 0.

4.4.8 Message logging

4.4.8.1 MC_AxRtLogAxisEntry_BkPlcMc (from V3.0)



The function block enters an axis-related message in the LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▶ 218].

NOTE! All axis-related library function blocks use this function block for message outputs.

```
VAR_INOUT
    Axis:           POINTER TO Axis_Ref_BkPlcMc;
END_VAR
VAR_INPUT
    Execute:        BOOL:=FALSE;
    pBuffer:        POINTER TO ST_TcPlcMcLogBuffer;
    LogLevel:       DWORD:=0;
    Source:         DWORD:=0;
    Message:        STRING(255);
    ArgType:        INT:=0;
    diArg:          DINT:=0;
    lrArg:          LREAL:=0;
    sArg:           STRING(255);
END_VAR
```

Execute: The function block is activated by a rising edge at this input.

pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▶ 107].

LogLevel: A coded specification of the message type. A Logger Levels [▶ 244] value from the Global Constants [▶ 235] should be used.

Source: A coded specification of the message source. A logger sources [▶ 244] value from the Global Constants [▶ 235] should be used.

Message: The message text.

ArgType: The type of the optional argument.

diArg: The value of the optional argument, if it is of type DINT.

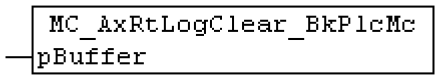
lrArg: The value of the optional argument, if it is of type LREAL.

sArg: The value of the optional argument, if it is of type STRING.

Behaviour of the function block

The only difference between the function block and MC_AxRtLogEntry_BkPlcMc [▶ 185] is that the axis name appears before the message.

4.4.8.2 MC_AxRtLogClear_BkPlcMc (from V3.0)



The function block deletes a LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

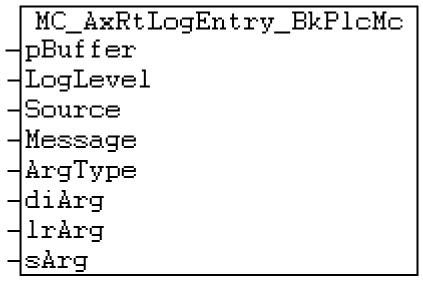
```
VAR_INOUT
    pBuffer:        POINTER TO ST_TcPlcMcLogBuffer;
END_VAR
```

pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▸ 107].

Behavior of the function block:

All entries in the LogBuffer are deleted and initialized.

4.4.8.3 MC_AxRtLogEntry_BkPlcMc (from V3.0)



The function block enters a message in the LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

```
VAR_INPUT
    Execute:        BOOL:=FALSE;
    pBuffer:        POINTER TO ST_TcPlcMcLogBuffer;
    LogLevel:       DWORD:=0;
    Source:         DWORD:=0;
    Message:        STRING(255);
    ArgType:        INT:=0;
    diArg:          DINT:=0;
    lrArg:          LREAL:=0;
    sArg:           STRING(255);
END_VAR
```

Execute: The function block is activated by a rising edge at this input.

pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▸ 107].

LogLevel: A coded specification of the message type. A Logger Levels [▸ 244] value from the Global Constants [▸ 235] should be used.

Source: A coded specification of the message source. A logger sources [▸ 244] value from the Global Constants [▸ 235] should be used.

Message: The message text.

ArgType: The type of the optional argument.

diArg: The value of the optional argument, if it is of type DINT.

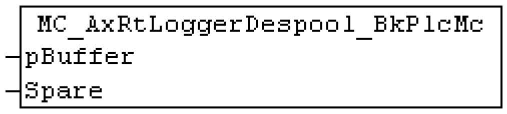
lrArg: The value of the optional argument, if it is of type LREAL.

sArg: The value of the optional argument, if it is of type STRING.

Behaviour of the function block

If **pBuffer** was supplied correctly and points to an ST_TcPlcMcLogBuffer [▸ 107], which has capacity for at least one further message, the transferred message data are complemented with local time information and entered in the message buffer.

4.4.8.4 MC_AxRtLoggerDeSpool_BkPlcMc (from V3.0)



The function block prevents overflowing of the LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

```
VAR_INPUT
    Spare:      INT;
END_VAR
VAR_INOUT
    pBuffer:    POINTER TO ST_TcPlcMcLogBuffer;
END_VAR
```

Spare: The required number of free messages in the LogBuffer.

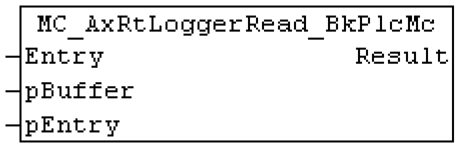
pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▸ 107].

Behaviour of the function block

With each call the function block removes a message from the LogBuffer, if the number of free messages is smaller than the minimum number transferred in **Spare**. An MC_AxRtLoggerSpool_BkPlcMc [▸ 187] function block should be used to include the whole history in the Windows Event Viewer.

NOTE! Using this function block makes sense whenever a write-restricted mass storage medium is used (typically a FLASH DISK). As a minimum, a limited history of 10 to 15 messages is enabled.

4.4.8.5 MC_AxRtLoggerRead_BkPlcMc (from V3.0)



The function block reads a message from the LogBuffer of the library. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▸ 218].

NOTE! This function block is used by diagnostics tools via ADS. A direct call from the PLC application generally makes no sense.

```
VAR_INOUT
    Entry:      INT:=0;
    pBuffer:    POINTER TO ST_TcPlcMcLogBuffer;
    pEntry:     POINTER TO ST_TcPlcMcLogEntry;
END_VAR
VAR_OUTPUT
    Result:     DWORD:=0;
END_VAR
```

Entry: The number of the message to be read.

pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▶ 107].

pEntry: Here, the address of a variable of type ST_TcPlcMcLogEntry [▶ 108] should be transferred as target.

Result: Here, a coded cause of error is provided.

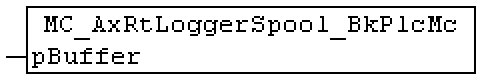
Behaviour of the function block

The function block checks the transferred input values with each call. Two problems can be detected during this process:

- If **Entry** is not in the valid range (1..20), the function block returns dwTcHydAdsErrInvalidIdxOffset as **Result**.
- If **pBuffer** or **pEntry** are not defined, the function block returns dwTcHydAdsErrNotReady as **Result**.

If no problem was detected during the check, the function block copies the message selected by **Entry** from the LogBuffer **pBuffer** into the message structure addressed with **pEntry**. Entry is regarded as relative age indication: Use Entry:=1 to select the message that was entered last, with Entry:=2 the next older message, etc. If the requested message is not available, an empty message is provided.

4.4.8.6 MC_AxRtLoggerSpool_BkPlcMc (from V3.0)



The function block deals with transferring messages from the LogBuffer of the library into the Windows Event Viewer. Further information about creating a log buffer can be found under FAQ #10 in the Knowledge Base [▶ 218].

```
VAR_INOUT
    pBuffer:        POINTER TO ST_TcPlcMcLogBuffer;
END_VAR
```

pBuffer: This parameter is used to transfer the address of a variable of type ST_TcPlcMcLogBuffer [▶ 107].

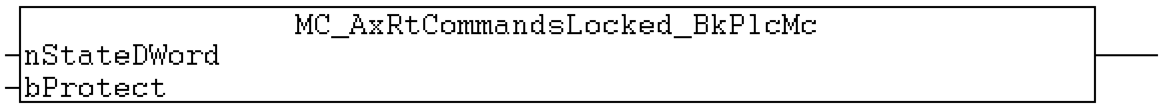
Behaviour of the function block

With each call the function block removes a message from the LogBuffer and transfers it to the Windows Event Viewer.

If the computer uses a write-restricted mass storage medium (typically FLASH DISK), it makes no sense to use the Windows Event Viewer. An MC_AxRtLoggerDespool_BkPlcMc [▶ 186] function block can be used to generate a history in any case.

4.4.9 Utilities

4.4.9.1 MC_AxRtCommandsLocked_BkPlcMc : DWORD



The function simplifies setting and deleting of a protective function in the status double word of an axis.

```
VAR_INPUT
     nStateDWord:  DWORD:=0;
     bProtect:     BOOL:=FALSE;
END_VAR
```

nStateDWord: The current state of the status double word.

bProtect: The required state of the protective function.

Behaviour of the function

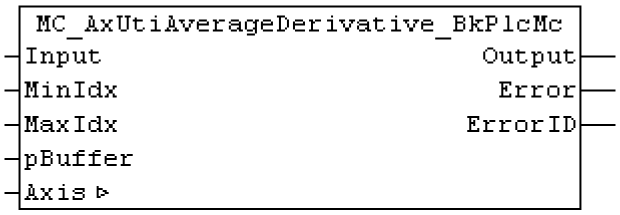
The function shows the status bit of the protective function in the transferred status double word, depending on **bProtect**.

NOTE! The application must assign the result of the function to the status double word of the axis.

An https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/pro/1599851275.pro is available.

4.4.9.2 Filters

4.4.9.2.1 MC_AxUtiAverageDerivative_BkPlcMc (from V3.0)



The function block determines the derivative of a value through numeric differentiation over more than one cycle.

```
VAR_INPUT
    Input:      LREAL:=0.0;
    MinIdx:     DINT:=0;
    MaxIdx:     DINT:=0;
    pBuffer:    POINTER TO LREAL:=0;
END_VAR
VAR_OUTPUT
    Output:     LREAL:=0.0;
    Error:      BOOL:=FALSE;
    ErrorID:    UDINT:=0;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Input: The raw value of the parameter to be filtered.

MinIdx: The index of the first filter buffer element to be used.

MaxIdx: The index of the last filter buffer element to be used.

pBuffer: The address of the first filter buffer element.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Output: The filtered value.

Error: This output indicates problems with the transferred parameters.

ErrorID: In the event of an error, coded information about the type of problem is reported here.

Behaviour of the function block

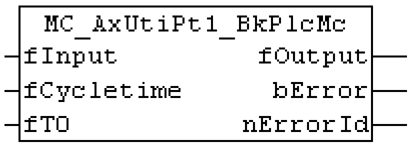
With each call the function block checks the address of the filter buffer **pBuffer** and the indices of the elements **MinIdx** and **MaxIdx** to be used. **If the transferred values are obviously nonsensical, the system responds with Error** and coded information in ErrorID. Otherwise, with each call **Input** is entered in the filter buffer, and the average value of the modification over the set of values available in the buffer is formed and returned as **Output**.

NOTE! The set of values for averaging contains (MaxIdx - MinIdx + 1) values. The measuring time is determined by multiplication of this number with the cycle time.

NOTE! The principle of sliding averaging leads to a delay amounting to half the measuring time. If the filtered parameter can be used in a control loop, the resulting frequency-dependent phase shift can lead to restrictions for the parameter selection.

The function block has no way to fully check the transferred values of pBuffer, MinIdx and MaxIdx. The user must ensure that these values can be used safely. Otherwise may behave in an unpredictable manner (overwriting of memory) or abortion of the PLC operation.

4.4.9.2.2 MC_AxUtiPT1_BkPlcMc (from V3.0)



The function block calculates a first-order low-pass.

```
VAR_INPUT
     fInput:        LREAL:=0.0;
     fCycletime:    LREAL:=0.001;
     fT0:           LREAL:=1.0;
END_VAR
VAR_OUTPUT
     fOutput:       LREAL;
     bError:        BOOL;
     nErrorId:      UDINT;
END_VAR
```

fInput: The raw value of the parameter to be filtered.

fCycletime: [s] The cycle time of the calling PLC task.

fT0: [s] The filter time constant.

fOutput: The filtered value.

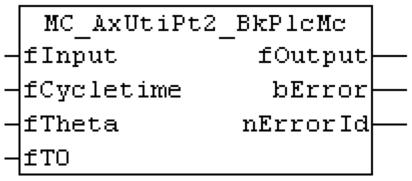
bError: This output indicates problems with the transferred parameters.

nErrorId: In the event of an error, coded information about the type of problem is reported here.

Behavior of the function block

With each call the function block checks the transferred parameters. If an invalid value is detected, the function block responds with **bError** and a corresponding value in **nErrorId**. Otherwise, the internal variables are updated with **fInput,** and the filtered value is returned as **fOutput**.

4.4.9.2.3 MC_AxUtiPT2_BkPlcMc (from V3.0)



The function block calculates a second-order low-pass.

```
VAR_INPUT
     fInput:        LREAL:=0.0;
     fCycletime:    LREAL:=0.001;
     fTheta:        LREAL:=1.0;
     fT0:           LREAL:=1.0;
END_VAR
VAR_OUTPUT
     fOutput:       LREAL;
     bError:        BOOL;
     nErrorId:      UDINT;
END_VAR
```

fInput: The raw value of the parameter to be filtered.

fCycletime: [s] The cycle time of the calling PLC task.

fTheta: The attenuation.

fT0: The filter time constant.

fOutput: The filtered value.

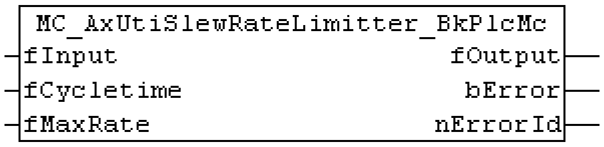
bError: This output indicates problems with the transferred parameters.

nErrorId: In the event of an error, coded information about the type of problem is reported here.

Behavior of the function block

With each call the function block checks the transferred parameters. If an invalid value is detected, the function block responds with **bError** and a corresponding value in **nErrorId**. Otherwise, the internal variables are updated with **fInput,** and the filtered value is returned as **fOutput**.

4.4.9.2.4 MC_AxUtiSlewRateLimitter_BkPlcMc (from V3.0)



The function block generates a rise-limited ramp.

```
VAR_INPUT
    fInput:        LREAL:=0.0;
    fCycletime:    DINT:=0;
    fMaxRate:      DINT:=0;
END_VAR
VAR_OUTPUT
    fOutput:       LREAL:=0.0;
    bError:        BOOL:=FALSE;
    nErrorId:      UDINT:=0;
END_VAR
```

fInput: The raw value of the parameter to be filtered.

fCycletime: [s] The cycle time of the calling PLC task in seconds.

fMaxRate: The magnitude of the maximum permitted rate of change at the output as change per second.

fOutput: [1/s] The filtered value.

bError: This output indicates problems with the transferred parameters.

nErrorId: In the event of an error, coded error information is output here.

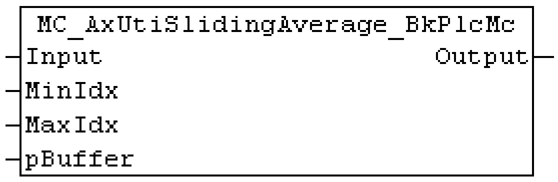
Behavior of the function block

With each call the function block checks the transferred values for **fCycletime** and **fMaxRate**. If the values are incorrect, the system responds with **bError** and coded information in **nErrorId**. Otherwise, the difference between **Input** and **Output** is determined with each call. If the magnitude of this difference is less than or equal to **fMaxRate * fCycletime**, the value of **Input** is used directly as **fOutput**. Otherwise, **fOutput** is changed by **fMaxRate * fMaxRate**. The sign is selected automatically.

NOTE! The value for fCycletime must be ≥ 0.001. Negative values are not permitted for fMaxRate.

Input will usually be a value, which is determined and filtered based on the cycle of the axis blocks. Axis_Ref_BkPlcMc [▸ 67].ST_TcHydAxParam [▸ 93].fCycletime can be used for **fCycletime** here.

4.4.9.2.5 MC_AxUtiSlidingAverage_BkPlcMc (from V3.0)



The function block determines a moving average.

```
VAR_INPUT
    Input:      LREAL:=0.0;
    MinIdx:     DINT:=0;
    MaxIdx:     DINT:=0;
    pBuffer:    POINTER TO LREAL:=0;
END_VAR
VAR_OUTPUT
    Output:     LREAL:=0.0;
END_VAR
```

Input: The raw value of the parameter to be filtered.

MinIdx: The index of the first filter buffer element to be used.

MaxIdx: The index of the last filter buffer element to be used.

pBuffer: The address of the first filter buffer element.

Output: The filtered value.

Behaviour of the function block

With each call the function block checks the address of the filter buffer **pBuffer** and the indices of the elements **MinIdx** and **MaxIdx** to be used. If the transferred values are obviously nonsensical, **Input** is output as **Output**. Otherwise, with each call **Input** is entered in the filter buffer, and the average value of the set of values available in the buffer is formed and returned as **Output**.

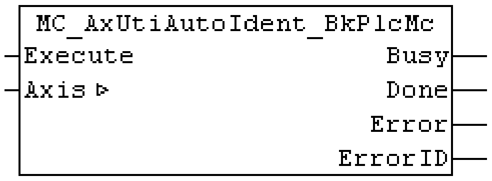
Note	The set of values for averaging contains **(MaxIdx - MinIdx + 1)** values. The filter time is determined by multiplication of this number with the cycle time.

NOTE! The principle of sliding averaging leads to a delay amounting to half the filter time. If the filtered parameter can be used in a control loop, the resulting frequency-dependent phase shift can lead to restrictions for the parameter selection.

NOTE! The function block has no way to fully check the transferred values of pBuffer, MinIdx and MaxIdx. The user must ensure that these values can be used safely. Otherwise may behave in an unpredictable manner (overwriting of memory) or abortion of the PLC operation.

4.4.9.3 Identification

4.4.9.3.1 MC_AxUtiAutoIdent_BkPlcMc (from V3.0.28)



The function block automatic determines a number of axis parameters.

```
VAR_INPUT
    Execute:    BOOL;
END_VAR
VAR_OUTPUT
    Busy:       BOOL;
    Done:       BOOL;
    Error:      BOOL;
    ErrorID:    UDINT;
END_VAR
VAR_INOUT
    Axis:       Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A positive edge at this input triggers the identification.

Busy: Indicates that a command is being processed.

Done: This indicates successful identification.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behavior of the function block

The function block checks whether the pointer Axis_Ref_BkPlcMc [▸ 67].pStAxAutoParams was initialized. If this is the case, it performs a number of initializations when a positive edge is detected at the **Execute** input and then commences the parameter identification. The individual steps of the identification are determined by the values in ST_TcMcAutoIdent [▸ 93].

EnableEndOfTravel: If this boolean parameter is set, the mechanical travel limits are determined automatically. First, the system ensures that the axis can move freely or is at the positive function block. The axis is now moved with a negative control voltage until it has reached the function block. The axis is then operated with a positive control voltage until the positive function block has been detected. The control voltage is limited to **EndOfTravel_NegativLimit** and **EndOfTravel_PositivLimit**. If the positive travel limit falls below the negative limit, the values are swapped, and Axis.stAxParams.bDrive_Reversed is inverted.

EnableOverlap, EnableZeroAdjust: If one of these boolean parameter is set, the cover or the offset voltage of the valve is determined. **NOTE! Thus operation is influenced by EndOfTravel_Negative and EndOfTravel_Positive.**

First, the axis is moved into a position window that is located in the middle between **EndOfTravel_Positive** and **EndOfTravel_Negative**. The width of the window is 80% of the area defined by these parameters. The output polarity of the drive is inverted, if required. Now, the output voltage is determined, at which the axis starts moving in positive direction. Then, the corresponding negative voltage is determined. By offsetting these parameter, both the cover and the offset voltage are determined. The type of entry in the axis parameter is controlled through **EnableOverlap** and **EnableZeroAdjust**.

EnableArreaRatio: If this boolean parameter is set, the direction-dependent velocity ratio is determined. First, the axis is moved into a position window, which is located in the middle between pStAxAutoParams. **EndOfTravel_Positiv** and pStAxAutoParams. **EndOfTravel_Negativ**. The width of the window is 80% of the area defined by these parameters. Then, the axis is moved in positive and negative direction for one second with a control voltage of 1 V. The velocities determined during this movement are divided, in order to determine the velocity ratio.

EndOfTravel_Negativ: [mm] If determination of the travel limits is activated, this value is determined by the function block. If it is disabled, the application must specify the value here. **NOTE! This parameter influences the determination of the offset voltage and the area ratio.**

EndOfTravel_Positiv: [mm] If determination of the travel limits is activated, this value is determined by the function block. If it is disabled, the application must specify the value here. **NOTE! This parameter influences the determination of the offset voltage and the area ratio.**

EndOfIncrements_Negativ: [1] If determination of the travel limits is activated, this value is determined by the function block. It then matches **EndOfTravel_Negativ**, but it is the raw encoder value in increments.

EndOfIncrements_Positiv: [1] If determination of the travel limits is activated, this value is determined by the function block. It then matches **EndOfTravel_Positiv**, but it is the raw encoder value in increments.

EndOfTravel_NegativLimit: [V] This parameter limits negative output voltages.

EndOfTravel_PositivLimit: [V] This parameter limits positive output voltages.

EndOfTravel_PositivDone: This signal is set by the function block, if determination of the travel limits is disabled or the positive travel limit was determined.

EndOfTravel_NegativDone: This signal is set by the function block, if determination of the travel limits is disabled or the negative travel limit was determined.

EndOfVelocity_NegativLimit: [mm/s] This parameter limits negative velocities. If this velocity is reached or exceeded during the measurement, the current measurement is completed, but no further measurement in this direction is performed.

EndOfVelocity_PositivLimit: [mm/s] This parameter limits positive velocities. If this velocity is reached or exceeded during the measurement, the current measurement is completed, but no further measurement in this direction is performed.

DecelerationFactor: [1] After the measuring stroke, the axis is moved to the end of the measuring path for the next measuring stroke. The regular axis parameter **fMaxAcc** and **fMaxDec,** which are weighted with this factor, are used.

EnableValveCharacteristic: If this boolean parameter is set, the characteristic velocity curve is determined automatically.

ValveCharacteristicTable: This ARRAY[1..2,1..100] contains the value pairs of the linearization table. ValveCharacteristicTable[nnn,1] is the normalized velocity value, ValveCharacteristicTable[nnn,2] is the normalized output value. Within the table, the value pairs with increasing index have increasing values for the velocity value and the output value. The first value pair therefore describes the fastest negative point, the last active value pair the fastest positive point. During automatic determination, the control voltage is limited to **EndOfTravel_NegativLimit** and **EndOfTravel_PositivLimit** and the velocity to **EndOfVelocity_NegativLimit** and **EndOfVelocity_PositivLimit.** The further points of the table are determined through extrapolation from the last two data points.

ValveCharacteristicType: Reserved.

ValveCharacteristicTblCount: This parameter specifies the number of value pairs to be determined in **ValveCharacteristicTable**. The value must be odd and between 3 and 99 (including).

ValveCharacteristicLowEnd: [mm] The lower end position of the range permitted for determining the characteristic curve.

ValveCharacteristicHighEnd: [mm] The upper end position of the range permitted for determining the characteristic curve.

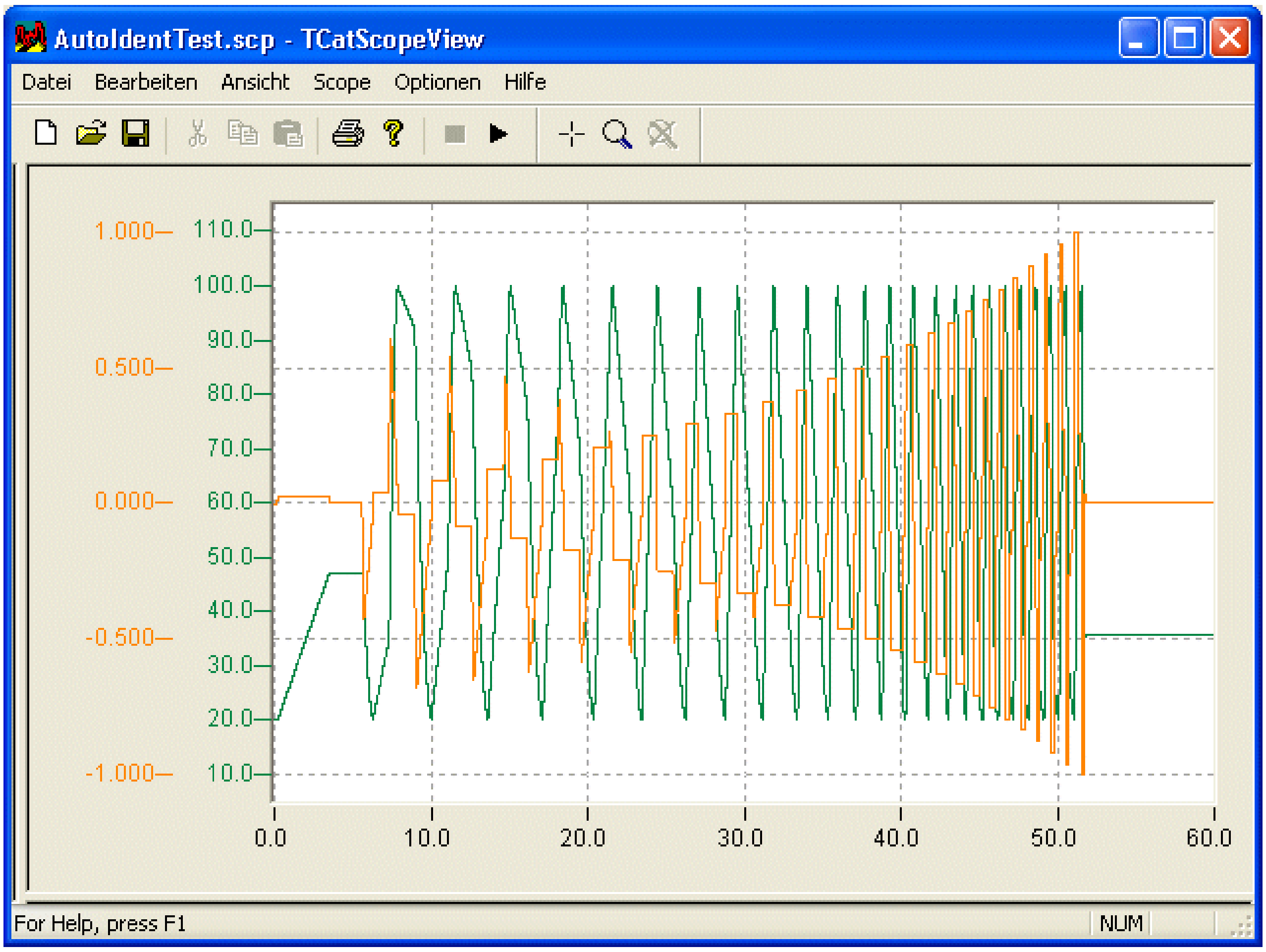
ValveCharacteristicRamp: [s] This parameter specifies the ramp for establishing the measuring voltage for the characteristic curve determination. During the specified time the voltage is increased to 10 V. Since the actual voltages are generally lower, less time is usually required to establish the voltage.

ValveCharacteristicSettling: [s] Once the control value has been ramped up to the test level for the measurement, the starting of the measurement can be delayed through this parameter.

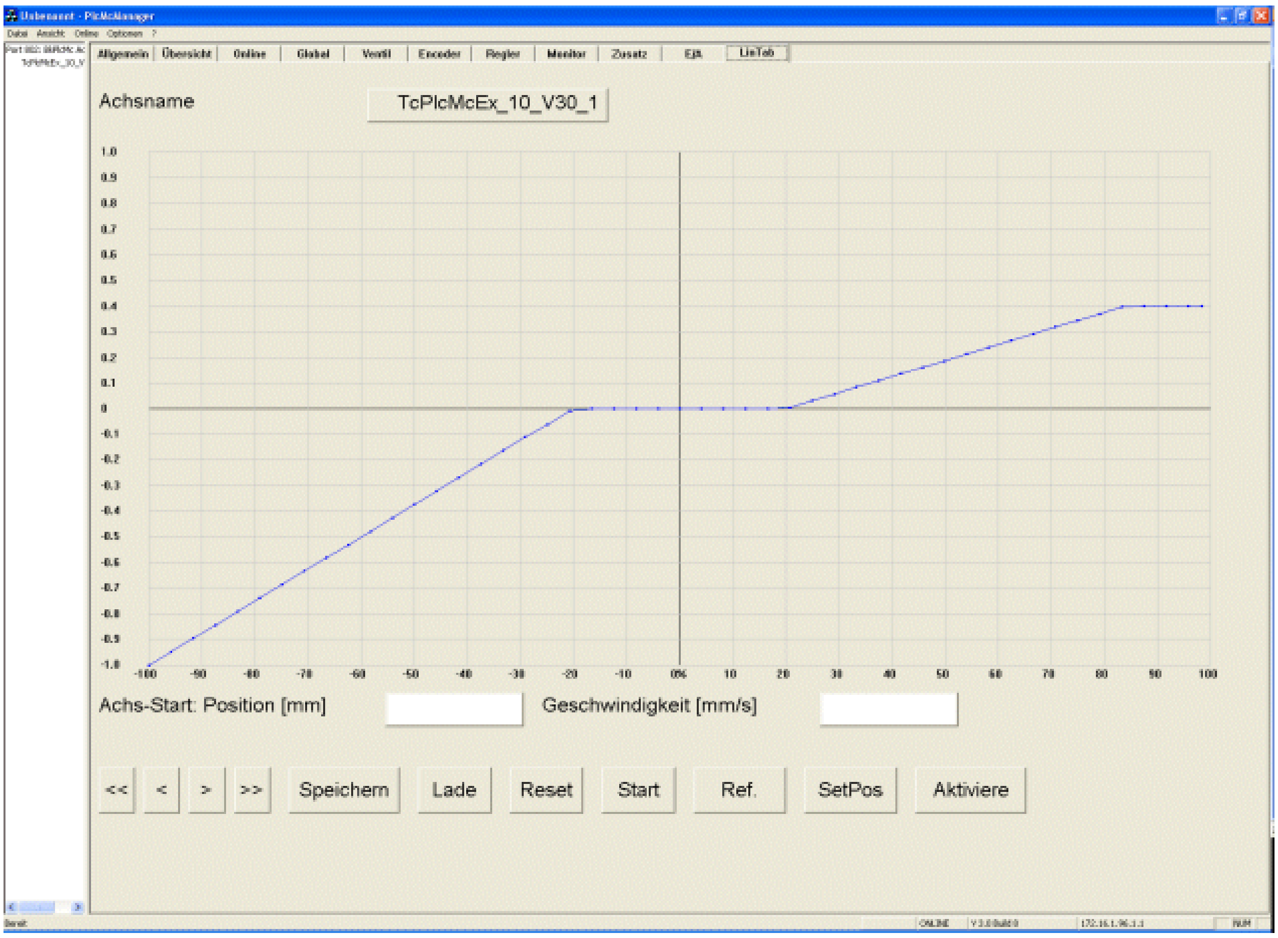
ValveCharacteristicRecovery: [s] This parameter defines a dwell time, which is adhered to before the measurement travel. This enables the supply to compensate a pressure drop that may have been caused by the previous measurement travel. **NOTE! During this time the axis is not controlled.**

ValveCharacteristicMinCycle: [mm] The measurement travel is only valid if the measuring voltage was established before the axis has moved towards the center of the measuring distance defined by **ValveCharacteristicHighEnd** and **ValveCharacteristicLowEnd** by less than the half of this value. Otherwise the effective measuring distance (without ramps) is less than this distance, and this measurement and all further measurements in this direction are replaced by a value calculated using the reference speed of the axis.

Example: Diagram of a characteristic curve determination in TwinCAT ScopeView:



Example: Display of a linearization in the PlcMcManager:



Achsname TcPlcMcEx_10_V30_1

Achs-Start: Position [mm]

Geschwindigkeit [mm/s]

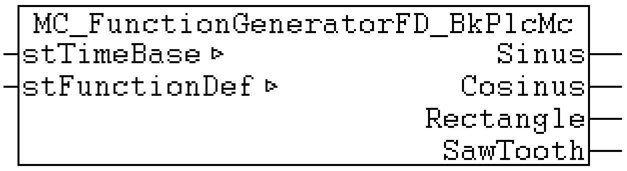
NOTE! The characteristic curve determined in this way can be used with an MC_AxRtFinishLinear_BkPlcMc function block for linearization at runtime.

NOTE! The characteristic curve is stored in the parameter file of the axis and automatically read on system startup.

NOTE! It is possible to export the characteristic curve to a text file with an MC_AxTableToAsciFile_BkPlcMc function block or to a binary file with an MC_AxTableToBinFile_BkPlcMc function block. It is also possible to import a characteristic curve from such a file.

4.4.9.4 Function generator

4.4.9.4.1 MC_FunctionGeneratorFD_BkPlcMc (from V3.0.31)



The function block calculates the signals of a function generator.

```
VAR_OUTPUT
    Sinus:          LREAL;
    Cosinus:        LREAL;
    Rectangle:       LREAL;
    SawTooth:        LREAL;
END_VAR
VAR_INOUT
    stTimeBase:      ST_FunctionGeneratorTB_BkPlcMc;
    stFunctionDef:   ST_FunctionGeneratorFD_BkPlcMc;
END_VAR
```

Sinus, Cosinus, Rectangle, **SawTooth**: The output signals of the function generator.

stTimeBase: A structure with the parameters of the time base of this function generator.

stFunctionDef: A structure with the definitions of the output signals of a function generator.

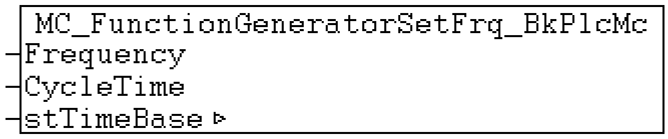
Behaviour of the function block

The output signals are determined from **stTime base.CurrentRatio** and the parameters in stFunctionDef [▸ 92].

The time base in **stTimeBase** should be updated with an MC_FunctionGeneratorTB_BkPlcMc [▸ 161]() function block.

To change the operating frequency, an MC_FunctionGeneratorSetFrq_BkPlcMc [▸ 160]() function block should be used.

4.4.9.4.2 MC_FunctionGeneratorSetFrq_BkPlcMc (from V3.0.31)



The function block updates the operating frequency of a time base for one or several function generators [▸ 159].

```
VAR_INPUT
    Frequency:       LREAL;
    CycleTime:       LREAL;
END_VAR
VAR_INOUT
    stTimeBase:      ST_FunctionGeneratorTB_BkPlcMc;
END_VAR
```

Frequency: The operating frequency to be used.

CycleTime: The cycle time of the calling task.

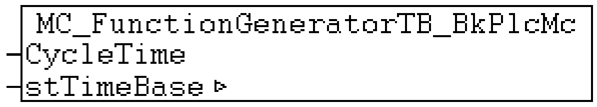
stTimeBase: A structure with the parameters of the time base of one or several function generators.

Behaviour of the function block

The function block sets **stTimeBase.Frequency** to the transferred value. **stTimeBase.CurrentTime** is adjusted, if required.

The function block uses **stTimeBase.Freeze** to prevent a collision with MC_FunctionGeneratorTB_BkPlcMc [▸ 161]() function blocks. Thus, it can also be called from another task.

4.4.9.4.3 MC_FunctionGeneratorTB_BkPlcMc (from V3.0.31)



The function block updates a time base for one or several function generators [▸ 159].

```
VAR_INPUT
    CycleTime:      LREAL;
END_VAR
VAR_INOUT
    stTimeBase:     ST_FunctionGeneratorTB_BkPlcMc;
END_VAR
```

CycleTime: The cycle time of the calling task.

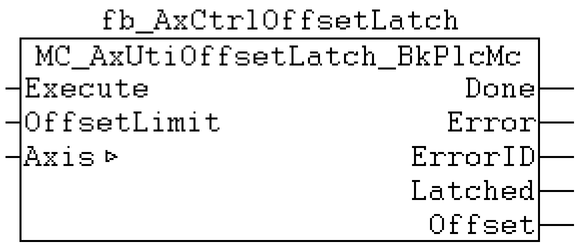
stTimeBase: A structure with the parameters of the time base of one or several function generators.

Behaviour of the function block

If **stTimeBase.Freeze** is not set, **stTimeBase.CurrentTime** is updated with **CycleTime** and **stTimeBase.CurrentRatio** is determined. **stTimeBase.Frequency** is taken into account.

To change the operating frequency, an MC_FunctionGeneratorSetFrq_BkPlcMc [▸ 160]() function block should be used.

4.4.9.5 MC_AxUtiOffsetLatch_BkPlcMc (ab V3.0.40)



The function block updates the offset compensation.

```
VAR_INPUT
     Execute:      BOOL;
     OffsetLimit:  LREAL:=0.5;
END_VAR
VAR_OUTPUT
     Done:       BOOL;
     Error:        BOOL;
     ErrorId:      UDINT;
     Latched:      BOOL;
     Offset:       LREAL;
END_VAR
VAR_IN_OUT
     Axis:       AXIS_REF_BkPlcMc;
END_VAR
```

Execute: A positive edge triggers the update.

OffsetLimit: [V] The maximum permissible value range for the offset compensation.

Done: A successful update is indicated here.

Error: This output indicates any problems that may have occurred.

ErrorId: In the event of an error, coded information about the type of problem is reported here.

Latched: This output signals that the update was successfully completed.

Offset: [V] This output reports the offset value. It is only accepted as a new compensation when **Done**.

Behavior of the function block

With a positive edge at **Execute**, **Offset** is updated with the current output of the position controller.

Before accepting this value as compensation, the function block checks for several possible errors:

- The axis must have a controller enable and must not be in an active motion state or error state (Axis.stAxRtData.iCurrentStep=iTcHydStateIdle). (error code dwTcHydAdsErrBusy)
- The detected controller output must not be outside ±**OffsetLimit**. (error code dwTcHydAdsErrIllegalValue)

If one of the errors has occurred, **Error** is reported and **ErrorId** is assigned the specified error code. In this case, the compensation remains unchanged.

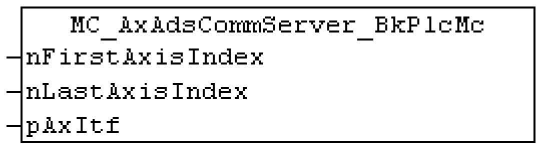
Otherwise, **offset** is applied as the new compensation value. Since from this point in time the part of the output value previously provided by the position controller is taken over by the compensation, the output of the controller must be canceled. The following steps are carried out once only:

- The set and current target positions are updated with the actual position.
- The position error (lag error) is set to zero.
- The position controller output is set to zero.
- The I component of the default position controller is wiped.
- If a position controller other than the default position controller is used, its I component must be deleted by the application.

All outputs are set to the idle state with a negative edge at **Execute**.

4.5 Parameter

4.5.1 MC_AxAdsCommServer_BkPlcMc (from V3.0)



The function block gives the application the capacity to function as an ADS server. Calls function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▶ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▶ 201] as required. The ADS codes [▶ 242] are listed in the Knowledge Base.

```
VAR_INPUT
    nFirstAxisIndex:    INT;
    nLastAxisIndex:     INT;
END_VAR
VAR_INOUT
    pAxItf:             POINTER TO Axis_Ref_BkPlcMc;
END_VAR
```

nFirstAxisIndex, **nLastAxisIndex**: This parameter is used to specify the dimensioning of the Axis_Ref_BkPlcMc [▶ 67] array.

Attention	**Crash of the PLC application** An incorrect specification at this point excludes some of the axes from the communication or results in a **crash of the PLC application** by triggering serious runtime errors (**Page Fault Exception**).

pAxItf: Here, the address of a variable or an array of variables of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

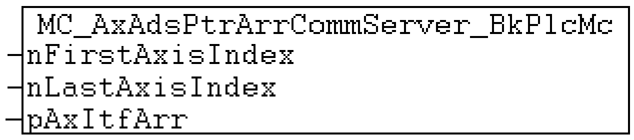
Behaviour of the function block

Through cyclic calling of this function block in the PLC application, the application assumes the character of an ADS server and responds to ADS read and ADS write-access like any other ADS server. This includes the decoding of IdxGroup/IdxOffset addressing. Function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▸ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▸ 201] are called as required.

NOTE! This function block must not be used if the PLC application already is an ADS server.

In this case the function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▸ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▸ 201] should be called from the existing ADS server function block of the application.

4.5.2 MC_AxAdsPtrArrCommServer_BkPlcMc



The function block gives the application the capacity to function as an ADS server. Calls function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▸ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▸ 201] as required. The ADS codes [▸ 242] are listed in the Knowledge Base.

NOTE! For most applications an MC_AxAdsCommServer_BkPlcMc is adequate and preferable. (MC_AxAdsCommServer_BkPlcMc [▸ 198])

```
VAR_INPUT
     nFirstAxisIndex:  INT;
     nLastAxisIndex:   INT;
END_VAR
VAR_INOUT
     pAxItfArr:        POINTER TO DWORD;
END_VAR
```

nFirstAxisIndex, **nLastAxisIndex**: This parameter is used to specify the dimensioning of the Axis_Ref_BkPlcMc [▸ 67] array.

Attention	**Crash of the PLC application** An incorrect specification at this point excludes some of the axes from the communication or results in a **crash of the PLC application** by triggering serious runtime errors (**Page Fault Exception**).

pAxItfArr: Here, the address of a variable of type ARRAY [ncnstFirstAxId..ncnstLastAxId] OF POINTER TO Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Attention	**Crash of the PLC application** An incorrect specification at this point causes the PLC application to crash inevitably through triggering of serious runtime errors (Page Fault Exception).

Behaviour of the function block

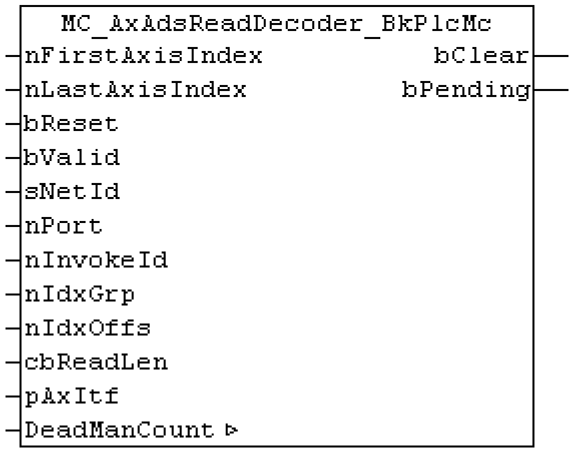
Through cyclic calling of this function block in the PLC application, the application assumes the character of an ADS server and responds to ADS read and ADS write-access like any other ADS server. This includes the decoding of IdxGroup/IdxOffset addressing. Function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▸ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▸ 201] are called as required.

NOTE! This function block must not be used if the PLC application already is an ADS server.

In this case the function blocks of type MC_AxAdsReadDecoder_BkPlcMc [▸ 200] and MC_AxAdsWriteDecoder_BkPlcMc [▸ 201] should be called from the existing ADS server function block of the application.

A program example [▸ 219] #16 is available.

4.5.3 MC_AxAdsReadDecoder_BkPlcMc (from V3.0)



The function block decodes ADS read accesses. The ADS codes [▸ 242] are listed in the Knowledge Base.

```
VAR_INPUT
    nFirstAxisIndex:    INT;
    nLastAxisIndex:     INT;
    bReset:             BOOL;
    bValid:             BOOL;
    sNetId:             STRING(80);
    nPort:              UINT;
    nInvokeId:          UDINT;
    nIdxGroup:          UDINT;
    nIdxOffs:           UDINT;
    cbReadLen:          UDINT;
    pAxItf:             POINTER TO Axis_Ref_BkPlcMc:=0;
END_VAR
VAR_INOUT
    DeadManCount:       UDINT;
END_VAR
VAR_OUTPUT
    bClear:             BOOL;
    bPending:           BOOL;
END_VAR
```

nFirstAxisIndex, **nLastAxisIndex**: This parameter is used to specify the dimensioning of the Axis_Ref_BkPlcMc [▸ 67] array.

CAUTION! An incorrect specification at this point excludes some of the axes from the communication or results in a crash of the PLC application by triggering serious runtime errors (Page Fault Exception).

bReset, **bValid**: The signals are used to co-ordinate the decoder with the ADS server.

sNetId, **nPort**, **nInvokeId**: These values are required in order to generate the ADS response. They are supplied by an ADS server's ADS indication function block.

nIdxGroup, **nIdxOffs**, **cbReadLen**: These values are required in order to decode the access. They are supplied by an ADS server's ADS indication function block.

pAxItf: Here, the address of a variable or an array of variables of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

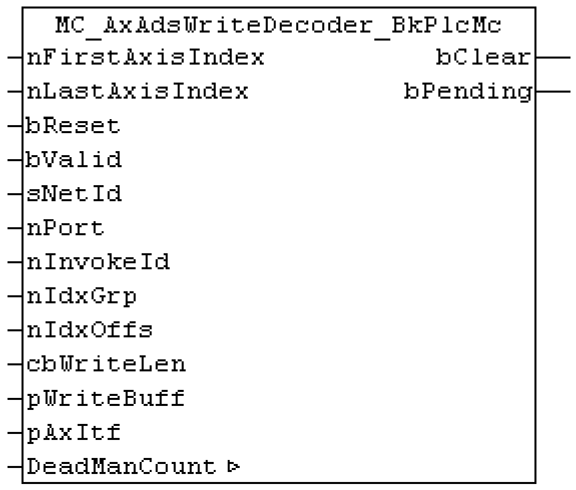
bClear: Indicates that an ADS access indicated with bValid should be acknowledged.

bPending: Indicates that an ADS access indicated with bValid is being processed.

Behaviour of the function block

If, when the bValid signal is present, the function block indicates neither bClear nor bPending it has not decoded the combination of nIdxGroup and nIdxOffs, and has not generated a response. In such a case, the ADS server (if there is one) must call another decoder, or must generate a response with the appropriate error code.

4.5.4 MC_AxAdsWriteDecoder_BkPlcMc (from V3.0)



The function block decodes ADS write accesses. The ADS codes [▸ 242] are listed in the Knowledge Base.

```
VAR_INPUT
    nFirstAxisIndex:    INT;
    nLastAxisIndex:     INT;
    bReset:             BOOL;
    bValid:             BOOL;
    sNetId:             STRING(80);
    nPort:              UINT;
    nInvokeId:          UDINT;
    nIdxGroup:          UDINT;
    nIdxOffs:           UDINT;
    cbWriteLen:         UDINT;
    pWriteBuff:         DWORD;
    pAxItf:             POINTER TO Axis_Ref_BkPlcMc:=0;
END_VAR
VAR_INOUT
    DeadManCount:       UDINT;
END_VAR
VAR_OUTPUT
    bClear:             BOOL;
    bPending:           BOOL;
END_VAR
```

nFirstAxisIndex, **nLastAxisIndex**: This parameter is used to specify the dimensioning of the Axis_Ref_BkPlcMc [▸ 67] array.

CAUTION! An incorrect specification at this point excludes some of the axes from the communication or results in a crash of the PLC application by triggering serious runtime errors (Page Fault Exception).

bReset, **bValid**: The signals are used to co-ordinate the decoder with the ADS server.

sNetId, **nPort**, **nInvokeId**: These values are required in order to generate the ADS response. They are supplied by an ADS server's ADS indication function block.

nIdxGroup, **nIdxOffs**, **cbWriteLen**: These values are required in order to decode the access. They are supplied by an ADS server's ADS indication function block.

pAxItf: Here, the address of a variable or an array of variables of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

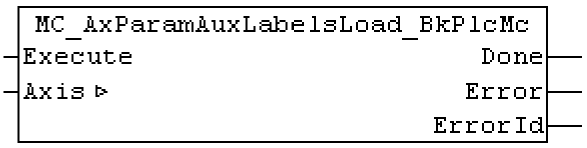
bClear: Indicates that an ADS access indicated with bValid should be acknowledged.

bPending: Indicates that an ADS access indicated with bValid is being processed.

Behaviour of the function block

If, when the bValid signal is present, the function block indicates neither bClear nor bPending it has not decoded the combination of nIdxGroup and nIdxOffs, and has not generated a response. In such a case, the ADS server (if there is one) must call another decoder, or must generate a response with the appropriate error code.

4.5.5 MC_AxParamAuxLabelsLoad_BkPlcMc (from V3.0)



The function block loads the label texts for the customer-specific axis parameters from a file. These texts can be generated with a simple text editor such as Microsoft Notepad.

Note	The file must be structured according to the rules specified below. Otherwise, significant problems may occur, including system crash.

This function block is generally not called directly by the application. If possible, a function block of type MC_AxUtiStandardInit_BkPlcMc [▸ 182] should be used, which uses a function block of type **MC_AxParamAuxLabelsLoad_BkPlcMc**.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The loading process is initiated by a rising edge at this input.

Done: Successful loading of the parameters is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

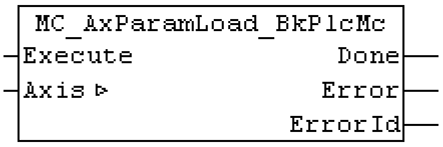
- If one of the pointers has not been initialised the function block reacts with **Error** and with **ErrorID**:=dwTcHydErrCdPtrPlcMc or dwTcHydErrCdPtrMcPlc.

The loading process begins if these checks are carried out without problems.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals provided at the end of the operation (**Error**, **ErrorID, Done**) are made available for one cycle.

NOTE! The number of rows in the file must match the number specified in the global constants of the library as iTcHydfCustDataMaxIdx (currently: 20). The maximum number of characters in each row is 20 (included spaces, without line breaks).

4.5.6 MC_AxParamLoad_BkPlcMc (from V3.0)



The function block loads the parameters for an axis from a file. A function block of type MC_AxParamSave_BkPlcMc [▶ 204] must be used to generate a compatible parameter file.

This function block is generally not called directly by the application. If possible, a function block of type MC_AxUtiStandardInit_BkPlcMc [▶ 182] should be used, which uses a function block of type **MC_AxParamLoad_BkPlcMc**.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The loading process is initiated by a rising edge at this input.

Done: Successful loading of the parameters is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

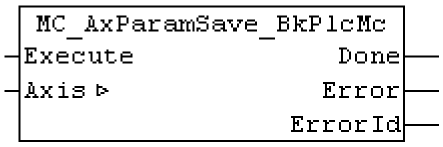
The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the file cannot be opened for reading, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc or dwTcHydErrCdPtrMcPlc.

The loading process begins if these checks are carried out without problems. The file version is determined, and any parameters that are not specified by the file are replaced with neutral default values. If the file contains parameters that are not used or no longer used, these are ignored.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals provided at the end of the operation (**Error**, **ErrorID, Done**) are made available for one cycle.

4.5.7 MC_AxParamSave_BkPlcMc (from V3.0)



The function block writes the parameters for an axis into a file. A function block of type MC_AxParamLoad_BkPlcMc [▶ 203] must be used to read the file.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Done:           BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

Done: Successful writing of the parameters is indicated here.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

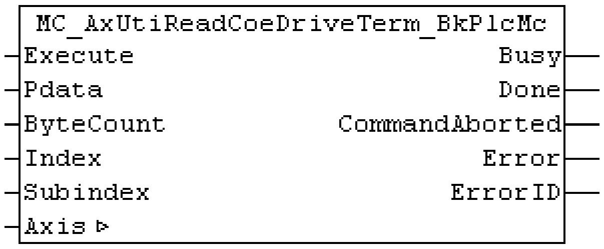
The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the file cannot be opened for writing, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc or dwTcHydErrCdPtrMcPlc.

The writing process begins if these checks are carried out without problems. The versions of the saved parameters are logged.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals provided at the end of the operation (**Error**, **ErrorID, Done**) are made available for one cycle.

4.5.8 MC_AxUtiReadCoeDriveTerm_BkPlcMc (from V3.0)



The function block reads the contents of a register from the EL terminal, which is used as drive interface for the axis.

```
VAR_INPUT
    Execute:         BOOL;
    Pdata:           POINTER TO BYTE:=0;
    ByteCount:       BYTE:=0;
    Index:           WORD:=0;
    Subindex:        BYTE:=0;
END_VAR
VAR_OUTPUT
    Busy:            BOOL;
    Done:            BOOL;
    CommandAborted:  BOOL;
    Error:           BOOL;
    ErrorID:         UDINT;
END_VAR
VAR_INOUT
    Axis:            Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the read process.

Pdata: Here, the address of the variable is specified, in which the read value is to be output.

ByteCount: Here, the size of the variable is specified in bytes.

Index, **Subindex**: Here, the addressing of parameter in the terminal is specified.

Busy: Indicates that a command is being processed.

Done: Successful loading of the parameter is indicated here.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

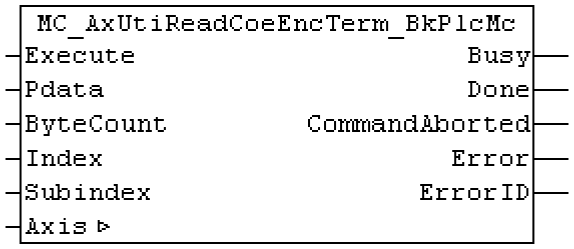
Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Index** or **Subindex** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If **ByteCount** or **Pdata** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- If problems occur during the ADS communication with the terminal, the corresponding ADS error code is returned as **ErrorID**, and **Error** is indicated. The following codes [▶ 236] may occur:
    - 16#0006 = 6 = The port number of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0007 = 7 = The AmsNetID of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0702 = 1794 = dwTcHydAdsErrInvalidIdxGroup = The terminal does not support the CoE protocol.
    - 16#0703 = 1795 = dwTcHydAdsErrInvalidIdxOffset = The address in index and subindex is not supported in the terminal.
    - 16#0745 = 1861 = dwTcHydAdsErrTimeout = Timeout.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.9 MC_AxUtiReadCoeEncTerm_BkPlcMc (from V3.0)



The function block reads the contents of a register from the EL terminal, which is used as encoder interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Pdata:          POINTER TO BYTE:=0;
    ByteCount:      BYTE:=0;
    Index:          WORD:=0;
    Subindex:       BYTE:=0;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the read process.

Pdata: Here, the address of the variable is specified, in which the read value is to be output.

ByteCount: Here, the size of the variable is specified in bytes.

Index, **Subindex**: Here, the addressing of parameter in the terminal is specified.

Busy: Indicates that a command is being processed.

Done: Successful loading of the parameter is indicated here.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

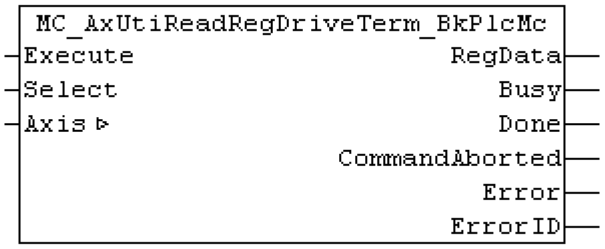
The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Index** or **Subindex** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.

- If **ByteCount** or **Pdata** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nEncoder_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- If problems occur during the ADS communication with the terminal, the corresponding ADS error code is returned as **ErrorID**, and **Error** is indicated. The following codes [▶ 236] may occur:
    - 16#0006 = 6 = The port number of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0007 = 7 = The AmsNetID of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0702 = 1794 = dwTcHydAdsErrInvalidIdxGroup = The terminal does not support the CoE protocol.
    - 16#0703 = 1795 = dwTcHydAdsErrInvalidIdxOffset = The address in index and subindex is not supported in the terminal.
    - 16#0745 = 1861 = dwTcHydAdsErrTimeout = Timeout.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.10 MC_AxUtiReadRegDriveTerm_BkPlcMc (from V3.0)



The function block reads the contents of a register from the KL terminal, which is used as drive interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Select:         INT;
END_VAR
VAR_OUTPUT
    RegData:        WORD;
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the read process.

Select: The register number should be transferred here.

RegData: The read value is output here.

Busy: Indicates that a command is being processed.

Done: Successful loading of the parameter is indicated here.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

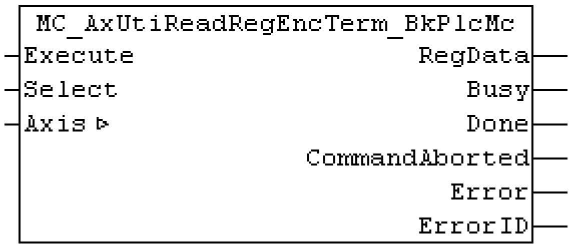
- If one of the pointers ST_TcPlcDeviceInput [▸ 104] and ST_TcPlcDeviceOutput [▸ 106] is not initialised, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.

If these checks could be performed without problem, the read operation is initiated.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals at the end of the operation (**RegData, Done, CommandAborted, Error**, **ErrorID, Done**) are issued for one cycle.

NOTE! The drive types iTcMc_DriveKL2521, iTcMc_DriveKL4032, iTcMc_DriveKL2531 and iTcMc_DriveKL2541 support the parameter communication.

4.5.11 MC_AxUtiReadRegEncTerm_BkPlcMc (from V3.0)



The function block reads the contents of a register from the KL terminal, which is used as encoder interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Select:         INT;
END_VAR
VAR_OUTPUT
    RegData:        WORD;
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: A rising edge at this input starts the read process.

Select: The register number should be transferred here.

RegData: The read value is output here.

Busy: Indicates that a command is being processed.

Done: Successful loading of the parameter is indicated here.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

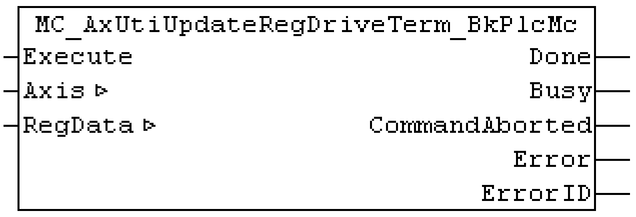
- If one of the pointers ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] is not initialised, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nEncoder_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.

If these checks could be performed without problem, the read operation is initiated.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the loading process is still active, the process that had started continues unaffected. The signals at the end of the operation (**RegData, Done, CommandAborted, Error**, **ErrorID, Done**) are issued for one cycle.

NOTE! The drive types iTcMc_EncoderKL3002, iTcMc_EncoderKL3042, iTcMc_EncoderKL3062, iTcMc_EncoderKL3162, iTcMc_EncoderKL5101, iTcMc_EncoderKL5111, iTcMc_EncoderKL2521, iTcMc_EncoderKL2531 und iTcMc_EncoderKL2541 support parameter communication.

4.5.12 MC_AxUtiUpdateRegDriveTerm_BkPlcMc (from V3.0.7)



The function block writes a parameter set into the registers of a KL terminal. It uses MC_AxUtiReadRegDriveTerm_BkPlcMc [▶ 207] and MC_AxUtiWriteRegDriveTerm_BkPlcMc [▶ 215] function blocks for this purpose.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Done:           BOOL;
    Busy:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
    RegData:        ST_TcPlcRegDataTable;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

RegData: Here, the address of parameter set should be specified, whose content is to be written into the terminal.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Done: Indicates successful writing of the parameter.

Busy: Indicates that a command is being processed.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

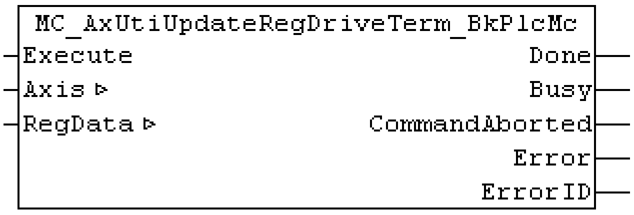
Behavior of the function block:

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If one of the pointers ST_TcPlcDeviceInput [▸ 104] and ST_TcPlcDeviceOutput [▸ 106] is not initialized, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- The value in ST_TcPlcRegDataTable [▸ 109].RegDataItem[...].**Access** determines how the element is treated.
    - 0: Element is ignored.
    - 1: The register addressed through **Select** is read. Its contents are compared with **RegData**. **If the contents differ, the write operation is aborted with Error** and **ErrorID**:=16#FFFFFFFF.
    - 2: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not larger, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
    - 3: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not smaller, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
    - 4: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not larger or equal, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
    - 5: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not smaller or equal, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
    - 10: The register addressed through **Select** is written with **RegData**.
    - Other values are currently ignored. Future versions of the library may support additional functions. An empty element should therefore always be identified with 0.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.13 MC_AxUtiUpdateRegEncTerm_BkPlcMc (from V3.0.7)



The function block writes a parameter set into the registers of a KL terminal. It uses MC_AxUtiReadRegDriveTerm_BkPlcMc [▶ 208] and MC_AxUtiWriteRegDriveTerm_BkPlcMc [▶ 216] function blocks for this purpose.

```
VAR_INPUT
    Execute:        BOOL;
END_VAR
VAR_OUTPUT
    Done:           BOOL;
    Busy:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
    RegData:        ST_TcPlcRegDataTable;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

RegData: Here, the address of parameter set should be specified, whose content is to be written into the terminal.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Done: Indicates successful writing of the parameter.

Busy: Indicates that a command is being processed.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Behaviour of the function block

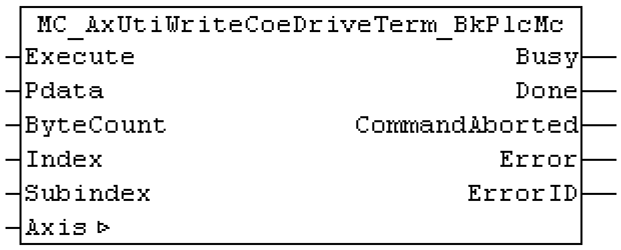
The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If one of the pointers ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] is not initialised, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- The value in ST_TcPlcRegDataTable [▶ 109].RegDataItem[...].**Access** determines how the element is treated.
    - 0: Element is ignored.
    - 1: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents differ, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.

- 2: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not larger, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
- 3: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not smaller, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
- 4: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not larger or equal, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
- 5: The register addressed through **Select** is read. Its contents are compared with **RegData**. If the contents are not smaller or equal, the write operation is aborted with **Error** and **ErrorID**:=16#FFFFFFFF.
- 10: The register addressed through **Select** is written with **RegData**.
- Other values are currently ignored. Future versions of the library may support additional functions. An empty element should therefore always be identified with 0.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.14 MC_AxUtiWriteCoeDriveTerm_BkPlcMc (from V3.0)



The function block writes the contents of a register of the EL terminal, which is used as drive interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Pdata:          POINTER TO BYTE:=0;
    ByteCount:      BYTE:=0;
    Index:          WORD:=0;
    Subindex:       BYTE:=0;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

Pdata: Here, the address of the variable should be specified, whose content is to be written into the terminal.

ByteCount: Here, the size of the variable is specified in bytes.

Index, **Subindex**: Here, the addressing of parameter in the terminal is specified.

Busy: Indicates that a command is being processed.

Done: Indicates successful writing of the parameter.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

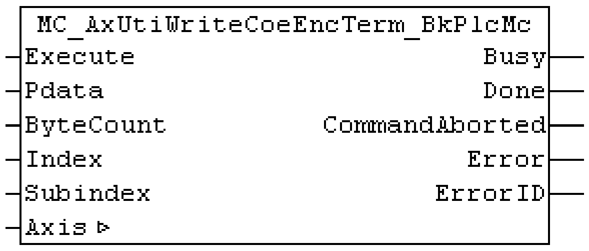
Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Index** or **Subindex** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If **ByteCount** or **Pdata** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- If problems occur during the ADS communication with the terminal, the corresponding ADS error code is returned as **ErrorID**, and **Error** is indicated. The following codes [▸ 236] may occur:
    - 16#0006 = 6 = The port number of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0007 = 7 = The AmsNetID of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0702 = 1794 = dwTcHydAdsErrInvalidIdxGroup = The terminal does not support the CoE protocol.
    - 16#0703 = 1795 = dwTcHydAdsErrInvalidIdxOffset = The address in index and subindex is not supported in the terminal.
    - 16#0745 = 1861 = dwTcHydAdsErrTimeout = Timeout.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.15 MC_AxUtiWriteCoeEncTerm_BkPlcMc (from V3.0)



The function block writes the contents of a register of the EL terminal, which is used as encoder interface for the axis.

```
VAR_INPUT
    Execute:         BOOL;
    Pdata:           POINTER TO BYTE:=0;
    ByteCount:       BYTE:=0;
    Index:           WORD:=0;
    Subindex:        BYTE:=0;
END_VAR
VAR_OUTPUT
    Busy:            BOOL;
    Done:            BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

Pdata: Here, the address of the variable is specified, whose content is to be written into the terminal.

ByteCount: Here, the size of the variable is specified in bytes.

Index, **Subindex**: Here, the addressing of parameter in the terminal is specified.

Busy: Indicates that a command is being processed.

Done: Indicates successful writing of the parameter.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

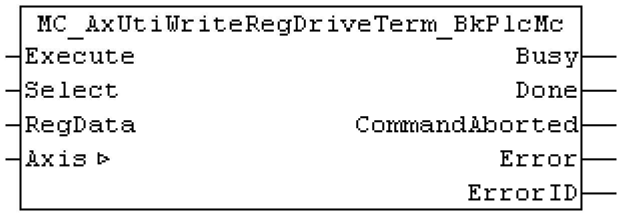
Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Index** or **Subindex** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If **ByteCount** or **Pdata** are outside the permitted range, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nEncoder_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.
- If problems occur during the ADS communication with the terminal, the corresponding ADS error code is returned as **ErrorID**, and **Error** is indicated. The following codes [▶ 236] may occur:
    - 16#0006 = 6 = The port number of the ADS address used is invalid: Check the mapping of the InfoData element of the terminal!
    - 16#0007 = 7 = The AmsNetID of the ADS address used is invalid: 16#0006 = 6 = The port number of the ADS address used is invalid:
    - 16#0702 = 1794 = dwTcHydAdsErrInvalidIdxGroup = The terminal does not support the CoE protocol.
    - 16#0703 = 1795 = dwTcHydAdsErrInvalidIdxOffset = The address in index and subindex is not supported in the terminal.
    - 16#0745 = 1861 = dwTcHydAdsErrTimeout = Timeout.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**Done, CommandAborted, Error**, **ErrorID**) are issued for one cycle.

4.5.16 MC_AxUtiWriteRegDriveTerm_BkPlcMc (from V3.0)



The function block writes the contents of a register of the KL terminal, which is used as drive interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Select:         INT;
    RegData:        WORD;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

Select: The register number should be transferred here.

RegData: The value to be written should be transferred here.

Busy: Indicates that a command is being processed.

Done: Indicates successful writing of the parameter.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▶ 67] should be transferred.

Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

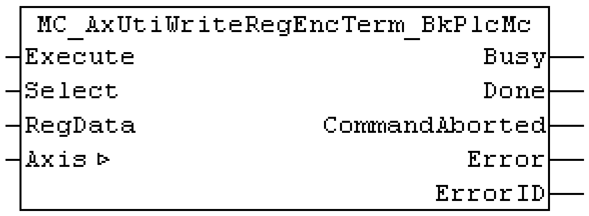
- If one of the pointers ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] is not initialised, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nDrive_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.

The writing process begins if these checks are carried out without problems.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**RegData, Done, CommandAborted, Error**, **ErrorID, Done**) are issued for one cycle.

NOTE! The drive types iTcMc_DriveKL2521, iTcMc_DriveKL4032, iTcMc_DriveKL2531 and iTcMc_DriveKL2541 support the parameter communication.

4.5.17 MC_AxUtiWriteRegEncTerm_BkPlcMc (from V3.0)



The function block writes the contents of a register of the KL terminal, which is used as encoder interface for the axis.

```
VAR_INPUT
    Execute:        BOOL;
    Select:         INT;
    RegData:        WORD;
END_VAR
VAR_OUTPUT
    Busy:           BOOL;
    Done:           BOOL;
    CommandAborted: BOOL;
    Error:          BOOL;
    ErrorID:        UDINT;
END_VAR
VAR_INOUT
    Axis:           Axis_Ref_BkPlcMc;
END_VAR
```

Execute: The writing process is initiated by a rising edge at this input.

Select: The register number should be transferred here.

RegData: The value to be written should be transferred here.

Busy: Indicates that a command is being processed.

Done: Indicates successful writing of the parameter.

CommandAborted: Indicates abortion of the read operation.

Error: The occurrence of an error is indicated here.

ErrorID: An encoded indication of the cause of the error is provided here.

Axis: Here, the address of a variable of type Axis_Ref_BkPlcMc [▸ 67] should be transferred.

Behaviour of the function block

The function block is activated by a rising edge at **Execute**, and investigates the axis interface that has been passed to it. A number of problems can be detected and reported during this process:

- If one of the pointers ST_TcPlcDeviceInput [▸ 104] and ST_TcPlcDeviceOutput [▸ 106] is not initialised, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdPtrPlcMc.
- If the axis is enabled for operation, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotReady.
- If **Select** is outside the permitted range of 0 to 63, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdTblIllegalIndex.
- If an I/O module, which does not support parameter communication, is set as nEncoder_Type in the axis parameters, the system responds with **Error** and **ErrorID**:=dwTcHydErrCdNotCompatible.

The writing process begins if these checks are carried out without problems.

A falling edge at **Execute** clears all the pending output signals. If **Execute** is set to FALSE while the writing process is still active, the process that had started continues unaffected. The signals at the end of the operation (**RegData, Done, CommandAborted, Error**, **ErrorID, Done**) are issued for one cycle.

NOTE! The drive types iTcMc_EncoderKL3002, iTcMc_EncoderKL3042, iTcMc_EncoderKL3062, iTcMc_EncoderKL3162, iTcMc_EncoderKL5101, iTcMc_EncoderKL5111, iTcMc_EncoderKL2521, iTcMc_EncoderKL2531 und iTcMc_EncoderKL2541 support parameter communication.

5 Knowledge Base

Knowledge Base of the TcPlcHydraulics PLC library (from V3.0)

Here you will find a number of answers to recurring questions.

Topics

Name	Description
Global Constants [▶ 235]	Pre-defined error codes, masks for bit queries, ADS codes etc.
Setup	Commissioning information
SampleList [▶ 255]	Program examples
Ideas Bank [▶ 219]	Tips and tricks
HMI tool [▶ 252]	The PlcMcManager

Problems during library updates

Compilation problems may occur when the library is updated. The reason may be a change of name of one or several function blocks or data types. Such changes are not always avoidable and generally implemented for one of the following reasons:

- Adaptation to the rules of the PLC Open Motion Control definitions.
- Further development of the PLC Open Motion Control definitions.
- Further development the technology provided.
- Adaptation to the technology used, particularly support of further I/O devices.
- Avoidance of name collisions and other compatibility problems with other libraries.

From V3.0 build 22, the library uses TcEtherCAT.LIB for communication via the EtherCAT fieldbus. In older TwinCAT environments this library is not yet available. If the TcPlcHydraulics library is to be used in such an environment, the TcEtherCatDummy.LIB provided should be copied into the project directory and renamed to TcEtherCAT.LIB. This library should then be added to the project **BEFORE** TcPlcHydraulics.LIB.

Note	This procedure must not be used in TwinCAT environments that support EtherCAT. The file provided must **NOT** be used to replace an existing operational TcEtherCAT.LIB.

NOTE! There are no functions that require EtherCAT technologies.

NOTE! The library version used in a project should be copied into the project directory and backed up together with the project. This avoids inadvertent version changes, which could otherwise occur if TwinCAT is updated in the meantime. To update the library, copy the new version directly into the project directory.

NOTE! We strongly recommend carrying out a trial compilation of the whole project after a library update. In addition, the mapping should be updated with the System Manager. If the table shown below indicates a change in size in one of the structures, it is essential to check the address assignment.

Note	If the library is updated to a version that differs not only in the third (build) number, but also in the major and minor version number, it can be assumed that the mappings created by the System Manager are no longer correct. In this case it is imperative to refresh the links.

Old name	New name	Reason of for the change
ST_TcMcAxInterface	Axis_Ref_BkPlcMc	Adaptation to PLC Open Motion Control definitions.
ST_TcPlcMcCamId	MC_CAM_ID_BkPlcMc	Adaptation to PLC Open Motion Control definitions.
ST_TcPlcMcCamRef	MC_CAM_REF_BkPlcMc	Adaptation to PLC Open Motion Control definitions.
E_TcMCDirection	MC_Direction_BkPlcMc	Adaptation to PLC Open Motion Control definitions.
E_TcMCStartMode	MC_StartMode_BkPlcMc	Adaptation to PLC Open Motion Control definitions.
ST_TcPlcMcEncoderIn	---	Omitted; task is handled by ST_TcPlcDeviceInput
ST_TcPlcMcEncoderOut	---	Omitted; task is handled by ST_TcPlcDeviceOutput
ST_TcPlcMcDriveIn	---	Omitted; task is handled by ST_TcPlcDeviceInput
ST_TcPlcMcDriveOut	---	Omitted; task is handled by ST_TcPlcDeviceOutput
ST_TcPlcMcAx2000In	---	Omitted; task is handled by ST_TcPlcDeviceInput
ST_TcPlcMcAx2000Out	---	Omitted; task is handled by ST_TcPlcDeviceOutput
MC_AxUtiCancelMonitoring_BkPlcMc	---	Omitted; redundant due to PLC Open definitions

Size of the I/O structures in bytes

Name	V 2.1.X	from V3.0.0	from V3.1.0 (proposed)
ST_TcPlcMcEncoderIn	16	-	-
ST_TcPlcMcEncoderOut	1	-	-
ST_TcPlcMcDriveIn	23	-	-
ST_TcPlcMcDriveOut	40	-	-
ST_TcPlcMcAx2000In	37	-	-
ST_TcPlcMcAx2000Out	26	-	-
ST_TcPlcDeviceInput [▸ 104]	-	143	?
ST_TcPlcDeviceOutput [▸ 106]	-	103	?

5.1 FAQs (from V3.0)

Here you will find answers to frequently asked questions.

Name	Description
FAQ #1 [▸ 220]	How do I integrate one or more axes into a PLC application?
FAQ #2 [▸ 221]	What data has to be created in the PLC application for the axes?
FAQ #3 [▸ 221]	How do I initialize the data and load the parameters for an axis when the PLC starts?
FAQ #4 [▸ 222]	How is the actual position of the axes determined?
FAQ #5 [▸ 225]	How is the control value for an axis created?
FAQ #6 [▸ 225]	How is the control value for an axis prepared for output?
FAQ #7 [▸ 225]	How is the control value output to an axis?
FAQ #8 [▸ 227]	In what order should the function blocks of an axis be called?
FAQ #9 [▸ 227]	How do I control a valve output stage (on-board or externally)?
FAQ #10 [▸ 227]	How do I create a message buffer?
FAQ #11 [▸ 228]	How do I abort monitoring of a function?
FAQ #12 [▸ 229]	How do I monitor the communication with an I/O device?
FAQ #13 [▸ 229]	How do I assign my own labels to customer-specific axis parameters?
FAQ #14 [▸ 229]	How do I control a current valve?
FAQ #15 [▸ 229]	Which axis variables should be logged with the Scope?
FAQ #16 [▸ 230]	What is the purpose of the variable nDebugTag in Axis_Ref_BkPlcMc?
FAQ #17 [▸ 230]	What has to be taken into account when Sercos drives are used?
FAQ #18 [▸ 231]	How is a pressure or a force determined?
FAQ #19 [▸ 231]	What has to be taken into account when AX5000 drives are used?
FAQ #20 [▸ 231]	How do I prepare an axis for blending based on PLC Open?
FAQ #21 [▸ 233]	How can I access registers of a terminal, to which an encoder or a valve of an axis is connected?
FAQ #22 [▸ 233]	What is the structure of an ASCII file for a linearization table?
FAQ #23 [▸ 234]	How can PlcMcManager commands be blocked?
Setup	How is operation of the axis begun, and how is it optimized?

FAQ #1 How do I integrate one or more axes into a PLC application?

The procedure here differs fundamentally from an axis guided by the NC task, because in this case everything done by the NC task is performed by the PLC. Ready-made function blocks are, however, available in most areas, so that the additional programming effort is held within reasonable limits. The following particular points must be considered:

- Axis data in the PLC application (FAQ #2 [▸ 221])
- Initializing and loading the axis parameters when starting the PLC application (FAQ #3 [▸ 221])
- Acquisition of actual values (FAQ #4 [▸ 222])
- Generating control values (FAQ #5 [▸ 225])
- Processing control values in preparation for output (FAQ #6 [▸ 225])
- Setting up the axes (Setup)
- Commissioning of actual pressure determination with function blocks of type MC_AxRtReadPressureSingle_BkPlcMc [▸ 158] or MC_AxRtReadPressureDiff_BkPlcMc [▸ 156].
- Organization of the procedure for movement (FAQ #7 [▸ 225])

NOTE! If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc should be used for simplicity.

FAQ #2 What data has to be created in the PLC application for the axes?

For each axis, one variables of each type Axis_Ref_BkPlcMc [▸ 67], ST_TcPlcDeviceInput [▸ 104] and ST_TcPlcDeviceOutput [▸ 106] has to be created. The use of variable fields is highly recommended for multiple axes. Examples for one and five axes can be found in the sample programs https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007200854594443.zip and https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007200854596619.zip.

The procedure using MC_AxUtiStandardInit_BkPlcMc [▸ 182] function blocks shown in these examples ensures correct initialization on start-up of the PLC and initiates loading of the axis parameters from files.

NOTE! Further data are required for realizing message logging. See also FAQ #10 [▸ 227].

NOTE! Further data are required for assigning one's own IDs to customer-specific axis parameters in the PlcMcManager. See also FAQ #13 [▸ 229]

NOTE! Further data are required in order to utilize blending according to PLC Open. See also FAQ #20 [▸ 231].

FAQ #3 How do I initialize the data for an axis?

A number of initializations must be carried out when the PLC applications starts. This is best done in three stages, which are provided by an MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block and should only be realized directly by the application in special cases. They are described here only for the sake of completeness.

1. A number of pointers must be correctly set up to link the components of the axes together. This task should be solved with a function block of type MC_AxUtiStandardInit_BkPlcMc [▸ 182], which detects a shift or change in size in the memory or the change of a type code during a subsequent online change and then ensures that the pointers are reinitialised and the parameters are reloaded.
2. The parameters for the axis must be appropriately set. Although it would be technically possible for the application to do have these assignments hard-coded, this is not usually helpful. It is preferable to save the settings in files, which are loaded on system startup under control of the application through the MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block. Notes on setting up an axis can be found under Setup.
3. The task cycle time should be applied in the axis parameters. This should be done at the end of the parameter loading procedure, in order to set this value correctly, in view of the fact that it is important for the function of many function blocks. An MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block deals with this task automatically.

NOTE! If a function block of type MC_AxAdsCommServer_BkPlcMc is used in the application, the function block must be called in the same task that carries out the pointer assignments. If this is not possible, or for some reason difficult, then calling the function block must be prevented while the assignments are being carried out. The result, otherwise, can be that the PLC application crashes as a result of serious runtime errors (Page Fault Exception).

NOTE! All activities listed here should through be realized and coordinated by an MC_AxUtiStandardInit_BkPlcMc function block. If the nInitState variable in Axis_Ref_BkPlcMc of the axis adopts either the value 2 or -2, then the initialization has been successful or has ended with an error. If the initialization is successful, MC_AxUtiStandardInit_BkPlcMc.Ready and bParamsEnable in Axis_Ref_BkPlcMc are TRUE, otherwise this variable remains FALSE.

NOTE! The sample programs provided specify the name of the axis and the name (included the path) of the corresponding parameter file. It is essential that these specifications are modified to match the particular application.

FAQ #4: How is the actual position of the axes determined?

A range of signal transducers may be considered for use as position sensors, operating according to a variety of physical principles to generate a position-dependent electrical magnitude. This magnitude determines the type of I/O components that must be used. The variables of types ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] must be created for each axis, and contain elements that are to be linked to the actual value, counter, latch, control and status variables associated with the I/O hardware.

Here are a few examples:

I/O component	Signal	Encoder Type
AX2000 B110 with absolute encoder	EtherCAT	iTcMc_EncoderAx2000_B110A [▶ 136]
AX2000 B110 with resolver	EtherCAT	iTcMc_EncoderAx2000_B110R [▶ 126]
AX2000 B200 with resolver	EtherCAT	iTcMc_EncoderAx2000_B200R [▶ 126]
AX2000 B750 with absolute encoder	EtherCAT	iTcMc_EncoderAx2000_B750A [▶ 139]
AX2000 B900 with resolver	EtherCAT	iTcMc_EncoderAx2000_B900R [▶ 126]
AX5000 B110 with multi-turn absolute encoder	EtherCAT	iTcMc_EncoderAX5000_B110A [▶ 139]
EtherCAT servo controllers with CoE DS402 support and multi-turn encoder	EtherCAT	iTcMc_EncoderCoE_DS402A [▶ 141]
EtherCAT servo controllers with CoE DS402 support and resolver or single-turn encoder	EtherCAT	iTcMc_EncoderCoE_DS402SR [▶ 141]
EL3102	-10V .. 10V	iTcMc_EncoderEL3102 [▶ 144]
EL3142	0mA .. 20mA	iTcMc_EncoderEL3142 [▶ 144]
EL3162	0 .. 10V	iTcMc_EncoderEL3162 [▶ 144]
EL3255	Potentiometric displacement transducer	iTcMc_EncoderEL3162 [▶ 144]
EL5001	SSI	iTcMc_EncoderEL5001 [▶ 145]
EL5101	A/B increments, RS422="TTL"	iTcMc_EncoderEL5101 [▶ 146]
EL7041	A/B increments, RS422="TTL"	iTcMc_EncoderEL7041 [▶ 147]
EtherCAT encoder with CoE_DS406 profile	EtherCAT	iTcMc_EncoderCoE_DS406 [▶ 142]
IE5009	SSI	iTcMc_EncoderIx5009 [▶ 147]
IP5009	SSI	iTcMc_EncoderIx5009 [▶ 147]
KL10xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL11xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL12xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL13xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL14xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL17xx	2 bit, A/B increments	iTcMc_EncoderDigIncrement [▶ 144]
KL10xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]
KL11xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]
KL12xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]
KL13xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]
KL14xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]
KL17xx	4 bit, position cams	iTcMc_EncoderDigCam [▶ 144]

I/O component	Signal	Encoder Type
KL2521	Pulse Train	iTcMc_EncoderKL2521 [▸ 147]
KL2531	Stepper motor, direct (encoder emulated through pulse counter)	iTcMc_EncoderKL2531 [▸ 148]
KL2541	Stepper motor, direct (with encoder or encoder emulates through pulse counter)	iTcMc_EncoderKL2541 [▸ 148]
KL2542	DC motor, direct with encoder	iTcMc_EncoderKL2542 [▸ 149]
KL3001	-10V .. 10V	iTcMc_EncoderKL3002 [▸ 149]
KL3002	-10V .. 10V	iTcMc_EncoderKL3002 [▸ 149]
KL3011	0mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3012	0mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3021	4mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3022	4mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3041	0mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3042	0mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3044	0mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3051	4mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3052	4mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3054	4mA .. 20mA	iTcMc_EncoderKL3042 [▸ 149]
KL3061	0V .. 10V	iTcMc_EncoderKL3062 [▸ 150]
KL3062	0V .. 10V	iTcMc_EncoderKL3062 [▸ 150]
KL3064	0V .. 10V	iTcMc_EncoderKL3062 [▸ 150]
KL3162	0V .. 10V	iTcMc_EncoderKL3162 [▸ 150]
KL5001	SSI	iTcMc_EncoderKL5001 [▸ 150]
KL5101	A/B increments, RS422="TTL"	iTcMc_EncoderKL5101 [▸ 150]
KL5111	A/B increments, RS422="HTL"	iTcMc_EncoderKL5111 [▸ 151]
M2510	-10V .. 10V	iTcMc_EncoderM2510 [▸ 151]
M3100	A/B increments, RS422="TTL"	iTcMc_EncoderM3120 [▸ 151]
M3120	A/B increments, RS422="TTL"	iTcMc_EncoderM3120 [▸ 151]

If one of the components mentioned here is used, then one of the encoder function blocks provided will usually be applied. The interfaces of these function blocks are not guaranteed and should therefore not be called directly by the application. It is better to set the encoder type according to the constants in E_TcMcEncoderType [▸ 75] under nEnc_Type in ST_TcHydAxParam [▸ 93], and to use a function block of type MC_AxRtEncoder_BkPlcMc [▸ 135]. This then automatically calls the correct type of sub-function-block for the type concerned.

All encoder function blocks use the parameters fEnc_IncWeighting and fEnc_IncInterpolation as increment assessment. fEnc_ZeroShift is also used as a zero shift for absolute displacement sensors. Incremental sensors usually require a reference travel using a MC_Home_BkPlcMc [▸ 57] function block, during which fEnc_RefShift in ST_TcHydAxRtData [▸ 99] is determined. This value then does the job of the zero shift. It goes without saying that in special cases the zero shift can also be defined with an MC_SetPosition_BkPlcMc [▸ 39] function block. The referenced status of the axis should be defined with MC_SetReferenceFlag_BkPlcMc [▸ 40]().

If it is not possible to determine the actual position with function blocks from the library for technical reasons, this task can be handled by application function blocks, and the result can be entered in fActPos, and fActVelo can be entered in ST_TcHydAxRtData [▸ 99], if required. For the sake of uniformity use should again be made here of the fEnc_IncWeighting, fEnc_IncInterpolation and fEnc_ZeroShift or fEnc_RefShift parameters.

NOTE! If only the usual function blocks (encoder, generator, finish, drive) for the axis are to be called, a function block of type MC_AxStandardBody_BkPlcMc should be used for simplicity.

NOTE! Commissioning of an actual pressure determination with function blocks of type MC_AxRtReadPressureSingle_BkPlcMc or MC_AxRtReadPressureDiff_BkPlcMc is described in the documentation for the function block.

FAQ #5: How is the control value for an axis created?

In each cycle, the PLC application must call a function block of type MC_AxRuntime_BkPlcMc [▶ 167], or alternatively a suitable controller function block (e.g. a pressure regulator) for each axis. The parameter nProfileType in ST_TcHydAxParam [▶ 93] specifies the procedure that is to be used to generate the control value. Velocity control values are calculated here according to the type, and depending on other parameters associated with the axis and on the movement data. These control values are, however, normalized to the abstract numerical range ±1.0, and have not yet been prepared for immediate output to I/O hardware.

NOTE! If only the usual function blocks (encoder, generator, finish, drive) for the axis are to be called, a function block of type MC_AxStandardBody_BkPlcMc [▶ 181]should be used for simplicity.

FAQ #6: How is the control value for an axis prepared for output?

After calling the MC_AxRuntime_BkPlcMc [▶ 167] function block, a function block of type MC_AxRtFinish_BkPlcMc [▶ 175] must be called for each axis. This function block assembles a number of velocity components (control value, controller output, offset compensation, overlap compensation), and also takes into account in the bends in the feed forward characteristic curve.

Numerical adjustment is usually necessary prior to output to an I/O module. An MC_AxRtDrive_BkPlcMc [▶ 125] function block is to be called for each axis for this purpose. The value of nDrive_Type in ST_TcHydAxParam [▶ 93] selects the hardware-specific sub-function-block to be used.

The variables of types ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] must be created for each axis, and contain elements that are to be linked to the set value and control variables of the I/O hardware.

NOTE! If only the usual blocks (encoder, generator, finish, drive) for the axis are to be called, a block of type MC_AxStandardBody_BkPlcMc [▶ 181] should be used for simplicity.

FAQ #7: How is the control value output to an axis?

A range of devices and equipment might be functioning as actuators, applying a variety of physical principles to create a variable velocity that depends on an electrical magnitude. This magnitude determines the type of I/O components that must be used. The variables of types ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] must be created for each axis, and contain elements that are to be linked to the variables of the I/O hardware.

Here are a few examples:

I/O component	Signal	Drive Type
AX2000 B110 with absolute encoder	EtherCAT	iTcMc_DriveAX2000_B110A [▶ 126]
AX2000 B110 with resolver	EtherCAT	iTcMc_DriveAX2000_B110R [▶ 126]
AX2000 B200 with resolver	EtherCAT	iTcMc_DriveAX2000_B200R [▶ 126]
AX2000 B750 with absolute encoder	EtherCAT	iTcMc_DriveAx2000_B750A [▶ 126]
AX2000 B900 with resolver	EtherCAT	iTcMc_DriveAX2000_B900R [▶ 126]
AX5000 B110 with absolute encoder	EtherCAT	iTcMc_DriveAX5000_B110A [▶ 126]
EtherCAT servo controllers with CoE DS402 support and resolver, single-turn or multi-turn encoder	EtherCAT	iTcMc_DriveCoE_DS402 [▶ 127]
EtherCAT valve with CoE_DS408 profile	EtherCAT	iTcMc_Drive_CoE_DS408 [▶ 127]
EL2535	PWM	iTcMc_DriveEL2535
EL4031, EL4032, EL4034, EL4038 EL4131, EL4132, EL4134	-10V .. 10V	iTcMc_DriveEL4132 [▶ 128]
EL4011, EL4012, EL4014, EL4018, EL4112 EL4021, EL4022, EL4024, EL4028, EL4122, EL4124	0..20mA 4..20mA	iTcMc_DriveEL4x22
EL7031	Stepper motor, direct	iTcMc_DriveEL7031 [▶ 130]
EL7041	Stepper motor, direct	iTcMc_DriveEL7041 [▶ 130]
IE2512	PWM	iTcMc_DriveIx2512_1Coil [▶ 128] iTcMc_DriveIx2512_2Coil [▶ 128]
IP2512	PWM	iTcMc_DriveIx2512_1Coil [▶ 128] iTcMc_DriveIx2512_2Coil [▶ 128]
KL20xx, KL21xx, KL22xx, KL24xx	5 bit for operating a frequency converter with fixed frequencies	iTcMc_DriveLowCostInverter [▶ 134]
KL20xx, KL21xx, KL22xx, KL24xx	4 bit for operating a voltage-controlled stepper motor	iTcMc_DriveLowCostStepper [▶ 134]
KL2521	Pulse Train	iTcMc_DriveKL2521 [▶ 131]
KL2531	Stepper motor, direct	iTcMc_DriveKL2531 [▶ 131]
KL2532	DC motor, direct with encoder	iTcMc_DriveKL2532 [▶ 132]
KL2535	PWM	iTcMc_DriveKL2535_1Coil [▶ 132] iTcMc_DriveKL2535_2Coil [▶ 132]
KL2541	Stepper motor, direct	iTcMc_DriveKL2541 [▶ 132]
KL2542	DC motor, direct with encoder	iTcMc_DriveKL2542 [▶ 133]
KL4031	-10V .. 10V	iTcMc_DriveKL4032 [▶ 133]
KL4032	-10V .. 10V	iTcMc_DriveKL4032 [▶ 133]
KL4034	-10V .. 10V	iTcMc_DriveKL4032 [▶ 133]
M2400	-10V .. 10V	iTcMc_DriveM2400_D1 [▶ 135], iTcMc_DriveM2400_D2, iTcMc_DriveM2400_D3, iTcMc_DriveM2400_D4

If one of the components mentioned here is used, then one of the drive function blocks provided will usually be used. These interfaces of these function blocks are not guaranteed and should therefore not be called directly by the application. It is better to set the drive type according to the constants in E_TcMcDriveType [▸ 72] under nDrive_Type in ST_TcHydAxParam [▸ 93], and to use a function block of type MC_AxRtDrive_BkPlcMc [▸ 125].

NOTE! If only the usual function blocks (encoder, generator, finish, drive) for the axis are to be called, a function block of type MC_AxStandardBody_BkPlcMc [▸ 181]should be used for simplicity.

FAQ #8: In what order should the function blocks of an axis be called?

1. Obligatory: all function blocks, which detect the actual status of the axis. These include function blocks of types MC_AxRtEncoder_BkPlcMc [▸ 135], MC_AxRtReadPressureDiff_BkPlcMc [▸ 156] or MC_AxRtReadPressureSingle_BkPlcMc [▸ 158].
2. Usual: function blocks or commands, which update the enable signals of the axis. This is usually a function block of type MC_Power_BkPlcMc [▸ 26]. For axes with an incremental encoder, which is referenced using a cam, a function call MC_AxRtSetReferencingCamSignal_BkPlcMc is used in addition.
3. Optional: Function blocks, which derive a decision or trigger a command based on an actual axis status, an I/O signal or an application signal. For example, an axis start can be triggered in response to the signal of a proximity limit switch, or an axis movement can be stopped before the target position is reached, depending on the pressure increase.
4. Obligatory: Control value generators such as function blocks of type MC_AxRuntime_BkPlcMc [▸ 167].
5. Optional: Various controllers can be called at this point, as required. This can be a function block of type MC_AxCtrlSlowDownOnPressure_BkPlcMc [▸ 119] or similar.
6. Obligatory: An adaptation function block of type MC_AxRtFinish_BkPlcMc [▸ 175].
7. Optional: If required, a function block for the automatic commissioning can be called at this point.
8. Obligatory: An output function block of type MC_AxRtDrive_BkPlcMc [▸ 125].

Instead of the library function blocks, application function blocks can be used. However, one should check carefully whether this is necessary, in which case compatibility with the library must be ensured. In some applications this may become necessary, in order to adapt a non-standard sensor or actuator, or to solve a special control task.

FAQ #9: How do I control a valve output stage (on-board or externally)?

The ST_TcPlcDeviceOutput [▸ 106] structure is intended for the **bPowerOn** and **bEnable** signals and for controlling the output stage supply and activation. Both signals are set by function blocks of type MC_Power_BkPlcMc [▸ 26], if the input **Enable is set.** At the same time this function block sets the software controller enable in ST_TcHydAxRtData [▸ 99].nDeCtrlDWord [▸ 236].

The ST_TcPlcDeviceInput [▸ 104] structure is intended for the signals **bPowerOk, bEnAck** and **bReady** for the output stage supply control, feedback from the output stage activation and the status signal. The differences in the signals provided by different manufacturer can be very significant. **Currently, only the bPowerOk** signal is used for specifying the **Status** output of the MC_Power_BkPlcMc [▸ 26] function block. If no suitable signal is available, or if no monitoring is to be realised, ST_TcHydAxParam [▸ 93].bDrive_DefaultPowerOk should be set.

FAQ #10: How do I create a message buffer?

Direct output of messages from the function blocks would result in runtime variations that would be difficult to calculate. For this reason, the messages are stored in a buffer and output in the Windows Event Viewer one after another, if required.

In order to be able to use a message buffer, a variable of type ST_TcPlcMcLogBuffer [▸ 107] must be created. This buffer is used to hold the messages from **all** axes. It is important that only one such variable is created in the project, irrespective of the number of axes. The address of this buffer should be transferred to the MC_AxUtiStandardInit_BkPlcMc [▸ 182] function blocks of all axes, together with the addresses of the other individual axis components. This function blocks are usually called in the initialization part of the project. This address is stored in the element pStAxLogBuffer in the structure Axis_Ref_BkPlcMc [▶ 67] and by the function block.

nLogLevel in Axis_Ref_BkPlcMc [▶ 67] is used to specify the significance level threshold for storing messages in the buffer. The values [▶ 244] to be used are defined in the global variables of the library. Note that this setting is required for each axis.

The library function blocks detect the preparations mentioned above and will commence issuing messages. However, if the message output is enabled, the buffer would fill up quickly and not accept further messages. There are two ways to avoid this.

FAQ #10.1: Passing on messages to the Windows Event Viewer

In order to transfer messages from the LogBuffer of the library to the Windows Event Viewer, a function block of type MC_AxRtLoggerSpool_BkPlcMc [▶ 187] should be called cyclically. Witch each call a message is removed from the LogBuffer.

NOTE! Computers running Windows CE are also capable of amending an Event Viewer for the messages created by TwinCAT. To this end this service is emulated by the TwinCAT system service. However, usually only a flash disk will be available. In order to avoid overloading the relatively small message capacity of the Event Viewer, only errors should be logged.

FAQ #10.2: Deleting the oldest messages

In order to ensure a minimum number of messages that can be handled, a function block of type MC_AxRtLoggerDespool_BkPlcMc [▶ 186] should be called cyclically. With each call, this function block removes the oldest message from the LogBuffer, until a transferred number of free messages is available. The deleted messages are lost.

FAQ #10.3: Generating logger entries through the application

An application can output a message either axis-related or non-axis-related. The function blocks MC_AxRtLogAxisEntry_BkPlcMc [▶ 184] and MC_AxRtLogEntry_BkPlcMc [▶ 185] are available for this purpose.

FAQ #11: How do I abort monitoring of a function?

Some library function blocks start an activity, for which cyclic calling is no longer essential. However, these function blocks are also structured according to the rules of the PLCopen Motion Control guidelines in such a way that they fully monitor the activity and present it at their outputs. This is indicated by the output Busy, which most function blocks provide.

Omitting the cyclic call of a function block that is in this monitoring state would usually result in significant problems. The next function start with the respective function block would have problems with evaluating the edges at its inputs, or it would detect that meanwhile the axis has executed another function and indicated a problem that doesn't exist (CommandAborted).

In older versions of the library a function block of type MC_AxUtiCancelMonitoring_BkPlcMc() was provided, which for a few motion functions aborted the monitoring by the function block initiating the function. This function block is no longer required, in view of the fact that in the meantime the PLC Open rules have been implemented more fully.

To instruct a function block to terminate monitoring its function, in most cases it is sufficient to call it once or several times with **Execute**:=FALSE. This applies in particular to MC_MoveAbsolute_BkPlcMc [▶ 60](), MC_MoveRelative_BkPlcMc [▶ 63]() and MC_MoveVelocity_BkPlcMc [▶ 64]().

Subsequently, a new functionality can be started in same or a later cycle with the same function block or an instance of the same or another type. This procedure can be repeated as required.

NOTE! Complex functions consisting of several sub-actions such as MC_Home_BkPlcMc() require the function block to be called continuously, since the function block organizes the required processes itself. MC_Home_BkPlcMc()) [▶ 57]

FAQ #12: How do I monitor the communication with an I/O device?

ST_TcPlcDeviceInput [▶ 104] and ST_TcPlcDeviceOutput [▶ 106] variables provide an element with the name **uiBoxState**. If the Bus Couplers or the interface cards of the power units used offer a corresponding variable and the variable assumes the value 0 with undisturbed communication in the fieldbus used, a link should be created. This is possible, for example, with **Beckhoff Lightbus** and **Real-time Ethernet**. If an MC_Power_BkPlcMc [▶ 26] function block is used for the axis, the function block monitors the **uiBoxState** and reports problems with the communication. In such a case the axis is put in an error state.

EtherCAT offers enhanced options.

FAQ #13: How do I assign my own labels to customer-specific axis parameters?

The Axis_Ref_BkPlcMc [▶ 67] structure uses the pAuxLabels pointer to support the application of an array of texts, which are displayed by the PlcMcManager. These texts can be loaded by the MC_AxUtiStandardInit_BkPlcMc [▶ 182] function block when the application is started from a file. To this end this function block must be provided with the address of an ST_TcMcAuxDataLabels [▶ 103] variable and a suitable file.

It goes without saying that it is also possible to define the elements of the ST_TcMcAuxDataLabels [▶ 103] variable through direct assignment from the application. In this case, the file is not required.

NOTE! A number of controller function blocks of the library define the arrays texts automatically.

FAQ #14: How do I control a current valve?

In contrast to a 4/2 or 3/2 directional proportional valve or a servo valve, a current valve is controlled with a 0..10 V signal (if a valve output stage is present) or actuated with a load-independent current of 0...$I_{Nominal}$. In this control, only the magnitude of the velocity is transferred. The direction is transferred not with the sign, but by other means. This usually requires digital signals, which are used for controlling switching valves. The ST_TcPlcDeviceOutput [▶ 106] structure provides elements such as **bBrakeOff**, **bMovePos** and **bMoveNeg** for this purpose. For generating an absolute control value, bDrive_AbsoluteOutput should be set in the axis parameters.

NOTE! This also enables the use of conventional frequency converters with asynchronous motor, encoder and brake, if the converter provides an analog input.

FAQ #15: Which axis variables should be logged with the Scope?

The following signal composition is recommended:

- Always: **actual axis position**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData [▶ 99].fActPos: in actual value units, as specified by the encoder scaling.
- Only for gear or synchronization coupling, cam plate: **set axis position**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fSetPos: in actual value units, as specified by the encoder scaling.
- Particularly during commissioning: **actual velocity value**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fActVelo: velocity in physical representation.
- Particularly during commissioning: **residual distance** or **target position**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fDistanceToTarget or Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fTargetPos: in actual value units, as specified by the encoder scaling.
- Only if pressure/force logging is active: **various actual pressure and force values**: in Axis_Ref_BkPlcMc.ST_TcHydAxRtData: as required fActPressure fActPressureA fActPressureB fActForce fValvePressure fSupplyPressure: pressures and forces, unit is defined through parameterization of the logging function blocks.
- Particularly during commissioning: **velocity control value**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fActVelo: velocity in physical representation.
- Particularly during commissioning: **controller output**: Axis_Ref_BkPlcMc.ST_TcHydAxRtData.fLagCtrlOutput: velocity in physical representation.

NOTE! The signal selection in ScopeView is simplified if the Axis_Ref_BkPlcMc variables contain a name that begins with aaa_. This approach is used in the sample programs and ensures that the variables can be found quickly in the symbol list.

NOTE! In the signal composition of ScopeView, channels can be temporarily disabled. In this way it is possible to maintain a comprehensive configuration but limit logging to data that are currently of interest.

FAQ #16: What is the purpose of the variable nDebugTag in Axis_Ref_BkPlcMc?

This variable is used by nearly all library function blocks to store a unique ID for the duration of their execution. To this end the content that was found is stored in a local variable of the function block and restored immediately before the function block is exited.

Should the program crash, or if there is a suspicion that there was a problem in a library function block, the **nDebugTag** variables of all axes should be checked. If a value <> 0 is present, the function block was affected by the crash, and the reason should be investigated. The numeric values used are listed in the library under "Global constants". In addition, the contents of ST_TcHydAxRtData [▸ 99].**sTopBlockName** should be determined. Usually, the name of the function block called directly by the application can be found here.

FAQ #17: What has to be taken into account when Sercos drives are used?

If Sercos drives (from V3.0.26) are used, the following rules must be followed:

- The Sercos master interface (e.g. FC7501 etc.) must be allocated the name "SercosMaster" in the System Manager. Otherwise neither control of the Sercos phase nor parameter and diagnostics communication is possible.
- Only a Sercos segment with the library can be used.
- In the System Manager, the drive devices at the Sercos Segment should be allocated the name under which they are known to the library by calling the MC_AxUtiStandardInit_BkPlcMc() function block. Otherwise neither control of the Sercos phase nor parameter and diagnostics communication is possible.
- The input variable SystemState [▸ 126] of the Sercos master interface should be linked for each drive device of the Sercos segment.
- If one or several drives at the Sercos segment are reset, the segment can interrupt the fieldbus. In this case, the Sercos master interface will undergo a corresponding phase change. Usually, the startup up to phase 4 will be automatic. Then:
    - the axis addressed by the reset will be error-free, as long as there are no ongoing problems.
    - all other axes at the Sercos segment will be in error state (fieldbus failure, axis not ready for operation). Once the triggering reset of the first axis has been processed, the other axes can usually be brought into an error-free state through a reset without a phase change.

  This behavior is determined by characteristics of the Sercos fieldbus and cannot be influenced by the library. It must be taken into account in the application in a suitable manner.
- Depending on certain parameter settings of the drive actuator, axis parameters are determined automatically or have to be specified manually:
    - S-0-0076, bits 0 to 2 specify the weighting type of the position data. Supported features:
    - a) 0 0 1 translatory weighting:
      S-0-0123 defines the rotation resolution (encoder-interpolation). The revolutional feed rate is calculated from this number and the weighting (S-0-0077, S-0-0078).
    - b) 0 1 0 rotary weighting:
      S-0-0079 defines the rotation resolution (encoder-interpolation). The revolutional feed rate has to be set manually.
    - S-0-0044, bits 0 to 2 specify the weighting type of the velocity data. Supported features:
    - a) 0 0 1 translatory weighting:
      The velocity control value is converted to a velocity in encoder increments per time, based on the revolutional feed rate and the rotation resolution. This information is offset against the velocity resolution (S-0-0045, S-0-0046) and output.

- b) 0 1 0 rotational weighting
  The velocity control value is converted to a speed based on the revolutional feed rate and output.
- S-0-0091 is converted with the method described above for velocity control values and used as reference velocity. If the maximum speed exceeds the value determined in this way, it is limited accordingly.

FAQ #18: How is a pressure or a force determined?

To determine an actual pressure or an actual force, one or several function blocks of types MC_AxRtReadPressureDiff_BkPlcMc [▸ 156], MC_AxRtReadForceDiff_BkPlcMc [▸ 152], MC_AxRtReadForceSingle_BkPlcMc [▸ 154] or MC_AxRtReadPressureSingle_BkPlcMc [▸ 158] have to be called for each axis. Details for the call sequence can be found under FAQ #8 [▸ 227].

The AD converter values to be transferred to the function blocks have to be linked with allocated variables of the application. Details regarding selection and parameterization can be found in the function blocks descriptions.

FAQ #19: What has to be taken into account when AX5000 drives are used?

For AX5000 devices, a number of IDNs are read from the device, and a number of different parameters are calculated automatically.

IDN	Used for parameter
44	Reference velocity, internally: scaling of the velocity output
45	Internal: scaling of the velocity output
46	Internal: scaling of the velocity output
76	Encoder interpolation
79	Encoder interpolation
91	Reference velocity

The following parameters are thus set automatically and cannot be influenced via the PlcMcManager:

Parameter		influences which other parameters
Global: reference velocity	Calculated from the maximum speed of the device and the revolutional feed rate	Manuel velocities, max. appl. velocity
Encoder: inc. interpolation	Read from IDN79 of the device	**Attention:** the revolutional feed rate has to be entered as inc. evaluation

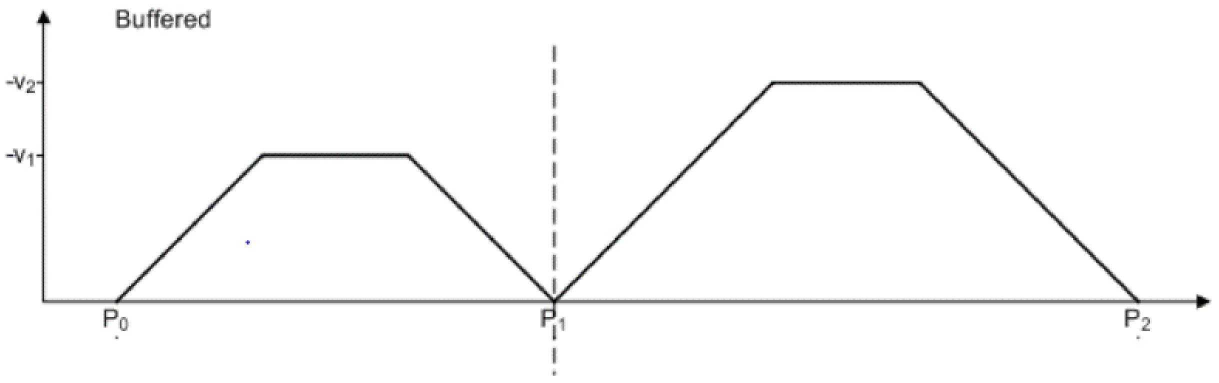
FAQ #20: How do I prepare an axis for blending based on PLC Open?

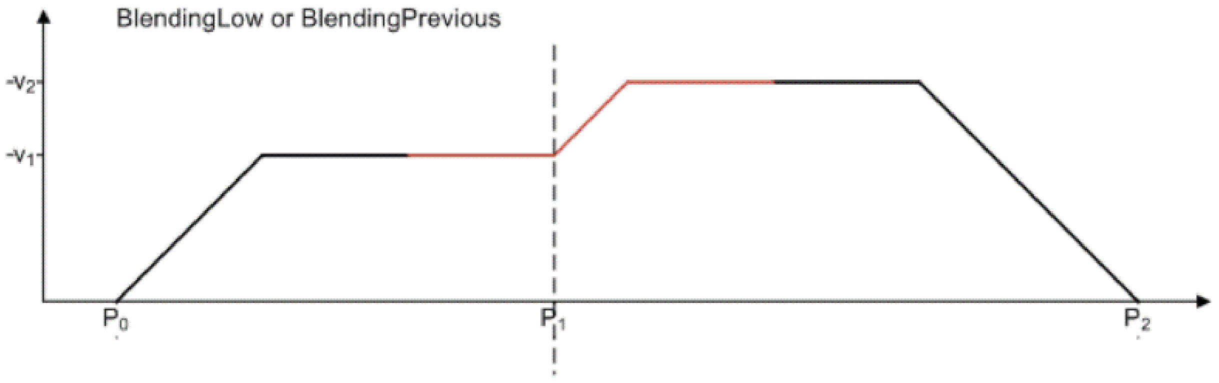
In Hydraulik.lib it is possible to command up to 12 buffered movements. For this purpose, a command buffer of type ST_TcPlcCmdCmdBuffer_BkPlcMc must be passed to the MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block for updating the axis reference and a function block MC_AxRtCmdBufferExecute_BkPlcMc must be called cyclically.

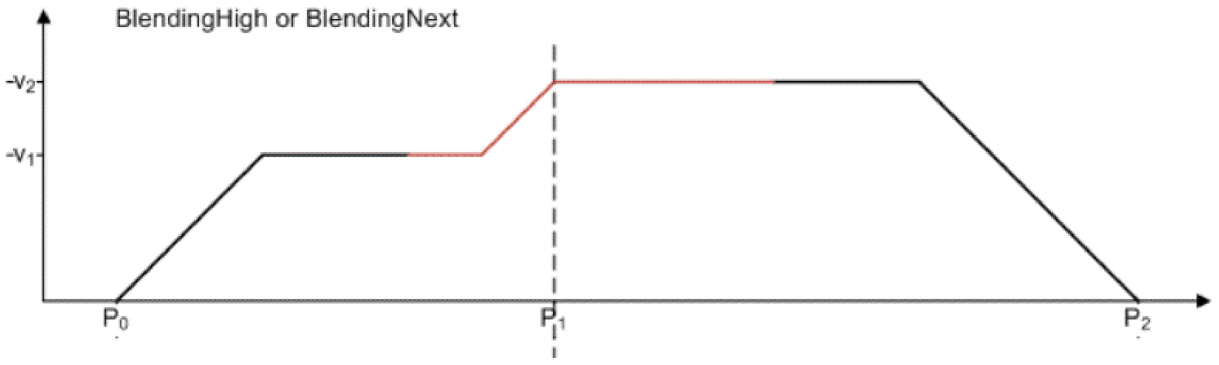
If Move function blocks such as MC_MoveAbsolute_BkPlcMc [▸ 60], MC_MoveRelative_BkPlcMc [▸ 63] or MC_MoveVelocity_BkPlcMc [▸ 64] are now activated, they enter their data in the command buffer.

In buffered mode make sure that the Move function blocks and the MC_AxRuntime_BkPlcMc [▸ 167] function block of the axis run in a PLC task.

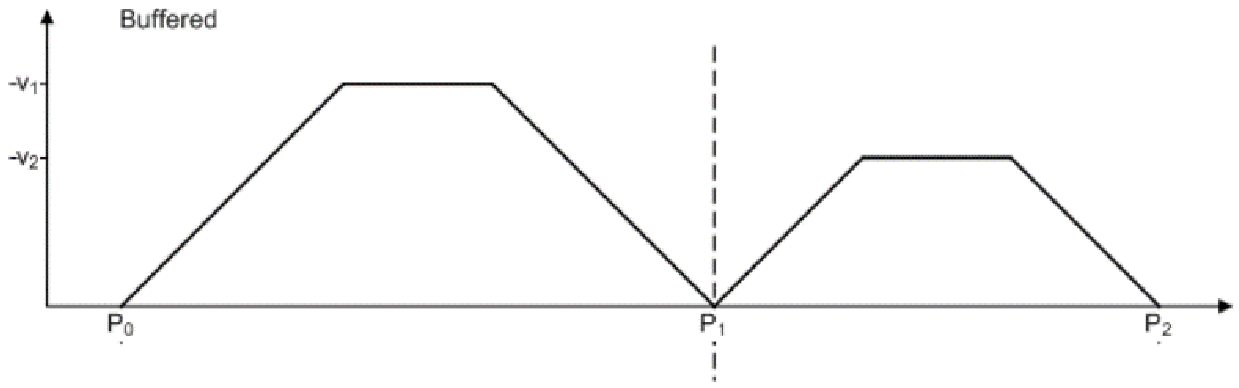
Transition between a slow and a fast section.

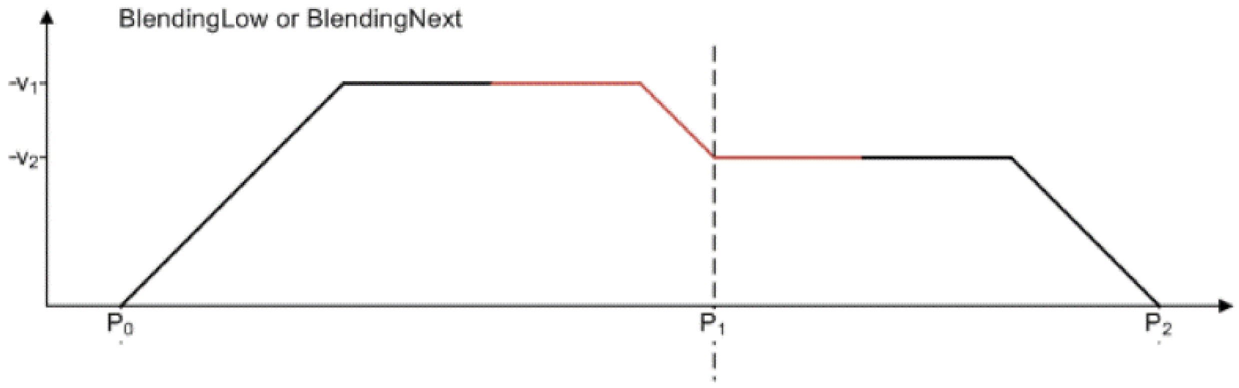


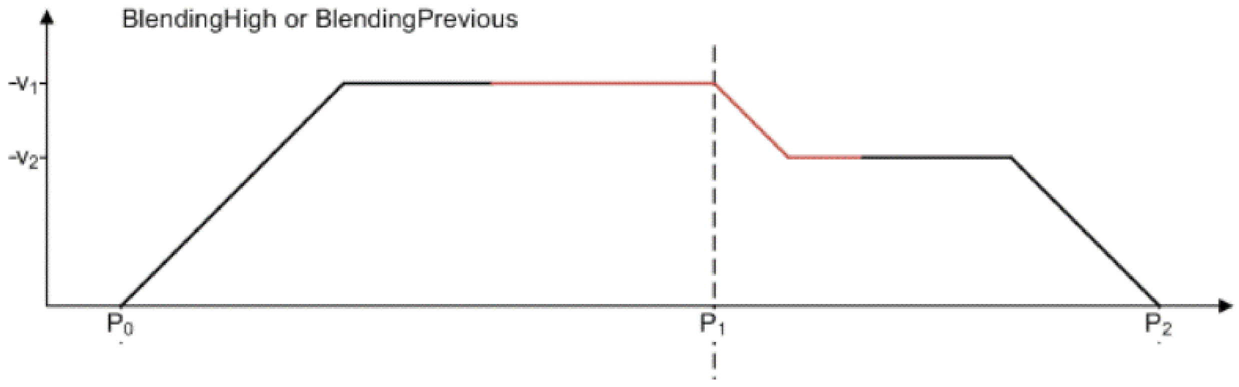




Transition between a fast and a slow section.







FAQ #21: How can I access registers of a terminal, to which an encoder or a valve of an axis is connected?

For register communication with terminals to which the encoder or the valve of an axis is connected, it is recommended to use function blocks of types MC_AxUtiReadRegDriveTerm_BkPlcMc [▸ 207](), MC_AxUtiReadRegEncTerm_BkPlcMc [▸ 208](), MC_AxUtiWriteRegDriveTerm_BkPlcMc [▸ 215]() and MC_AxUtiWriteRegEncTerm_BkPlcMc [▸ 216]().

FAQ #22: What is the structure of an ASCII file for a linearization table?

The format of an ASCII file from a linearization table is specified as follows:

- One linearization point per row.
- For each row first a velocity value, then an output value.
- The velocity values are normalized to the reference velocity. They are therefore in the range -1,000 to 1,000 inclusive.
- The output values are normalized to the full scale value. They therefore cover the range -1,000 to 1,000.

- The first value in a row may be preceded by white space characters (space, tab).
- Between the two values in row there must be at least one white space character (space, tab).
- Between the two values of a row there may be further white space characters (space, tab).
- Point and comma are permitted as decimal separator.
- No non-digits are permitted between a negative sign and the first digit.
- The first point specifies the negative end of the table.
- The velocity value of all further points must be higher (i.e. less negative or more positive) than its predecessor.
- It makes sense if the output value of a point is higher (i.e. less negative or more positive) than its predecessor, since otherwise there would be a negative slope in this section. This would result in a change of sign of the gain and therefore instability in an active control.
- The zero point (i.e. both coordinates of the point are 0.000) has to be specified.

Example: The following (idealized) table describes a cylinder, which in negative direction only reaches half the velocity of the positive direction due to asymmetric effective areas (due to single-sided piston rod). It is assumed that the cylinder is operated with a zero overlap valve with a bend in the characteristic curve at 40%

Normalized velocity	Normalized output
-0.500	-1.000
-0.430	-0.900
-0.360	-0.800
-0.290	-0.700
-0.220	-0.600
-0.150	-0.500
-0.080	-0.400
-0.060	-0.300
-0.040	-0.200
-0.020	-0.100
0.000	0.000
0.040	0.100
0.080	0.200
0.120	0.300
0.160	0.400
0.300	0.500
0.440	0.600
0.580	0.700
0.720	0.800
0.860	0.900
1.000	1.000

FAQ #23: How can PlcMcManager commands be blocked?

In some situations the triggering of commands by the PlcMcManager can be problematic. This would be the case if a certain sequence of actions has to be processed completely, for example. In order to prevent inadvertent issuing of commands by the PlcMcManager in such cases, the MC_AxRtCommandsLocked_BkPlcMc [▶ 187] function can be used to enter a lock in the status double word of the axis. If this lock is active, any command sent by PlcMcManager sent is rejected with a write protection error.

NOTE! It is essential to remove the lock, once the action to be protected has been processed. This also and in particular applies in the event of errors.

An example is available.

Also see about this

- MC_AxStandardBody_BkPlcMc (V3.0) [▸ 181]

Documents about this

- tcplcmcex_18.pro (https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/pro/1599851275.pro)

5.2 Global constants (from V3.0)

Bit-masks for position cams

These masks are to be used by the application to provide digital movement cams for bActPosCams in ST_TcHydAxRtData.

Constant	Description
bTcHydActPosCamPos	Summary of bTcHydActPosCamHigh and bTcHydActPosCamUp.
bTcHydActPosCamHigh	The axis has reached the upper target position.
bTcHydActPosCamUp	The axis is located close to the upper target position.
bTcHydActPosCamDown	The axis is located close to the lower target position.
bTcHydActPosCamLow	The axis has reached the lower target position.
bTcHydActPosCamNeg	Summary of bTcHydActPosCamLow and bTcHydActPosCamDown.

Bit-masks for axis status information

These masks are to be used by the application to interrogate status signals in nStateDWord in ST_TcHydAxRtData.

Constant	Description
dwTcHydNsDwFunctional	Axis is ready for operation.
dwTcHydNsDwReferenced	Axis has been referenced.
dwTcHydNsDwSteady	Axis is not active.
dwTcHydNsDwInTargRng	The axis is located within a distance from the target position specified by fMonPositionRange in ST_TcHydAxParam.
dwTcHydNsDwInTarget	The axis has been located without interruption since a time specified by fMonTargetFilter within a distance from the target position specified by fMonTargetRange in ST_TcHydAxParam.
dwTcHydNsDwDontTouchProtected	Reserved. Not supported.
dwTcHydNsDwStopped	The last movement of the axis was stopped without reaching the specified target position.
dwTcHydNsDwBusy	The axis is active.
dwTcHydNsDwMoveUp	The axis is moving in the direction of increasing positions.
dwTcHydNsDwMoveDown	The axis is moving in the direction of decreasing positions.
dwTcHydNsDwReferencing	Axis is homing.
dwTcHydNsDwConstVelo	The axis is moving with constant velocity.
dwTcHydNsDwExtSetpointActive	The axis is controlled by an MC_AxRtSetExtGenValues_BkPlcMc [▸ 180] function block.
dwTcHydNsDwStartedOver	The axis was started, i.e. the last accepted command took effect while the axis was still in motion.
dwTcHydNsDwControlActive	Reserved. Not supported.
dwTcHydNsDwErrState	The axis is in an error state.

Bit-masks for axis enable information

These masks are to be used by the application to provide enable signals in nDeCtrlDWord in ST_TcHydAxRtData.

Constant	Description
dwTcHydDcDwCtrlEnable	Controller enable. This enable is a precondition for the output of control value and controller outputs.
dwTcHydDcDwFdPosEna	Advance movement enable in positive direction. This enable is a precondition for the output of control value and controller outputs in the direction of increasing values of position.
dwTcHydDcDwCtrlPosEna	Combination of dwTcHydDcDwCtrlEnable and dwTcHydDcDwFdPosEna.
dwTcHydDcDwFdNegEna	Advance movement enable in negative direction. This enable is a precondition for the output of control value and controller outputs in the direction of decreasing values of position.
dwTcHydDcDwCtrlNegEna	Combination of dwTcHydDcDwCtrlEnable and dwTcHydDcDwFdNegEna.
dwTcHydDcDwRefIndex	Referencing cam.
dwTcHydDcDwAcceptBlockedDrive	Reserved. Not supported.
dwTcHydDcDwBlockedDriveDetected	Reserved. Not fully supported. Note: This signal suppresses any active velocity controller.

Error Codes

These constants are to be used for the outputs of ErrorID from function blocks and for nErrorCode in ST_TcHydAxRtData.

Constant	Hexadecimal	Decimal	Description
dwTcHydAdsErrNoError	0	0	No error.
dwTcHydAdsErrUnknownPort	16#0006	6	ADS port unknown. Possible causes: • AMS NetID / ADS port address the wrong runtime system or the wrong computer • another project is running in the addressed PLC • the application does not call a MC_AxAdsCommServer_BkPlcMc [▶ 198]() function block
dwTcHydAdsErrUnknownTarget	16#0007	7	Target machine unknown. Possible causes: • AMS NetID / ADS port address the wrong runtime system or the wrong computer • the target system has not been started • TwinCAT has not been started • the connection is electrically / mechanically interrupted • for communication via Ethernet: the TCP/IP connection is not working
dwTcHydAdsErrInvalidIdxGroup	16#0702	1794	Invalid IndexGroup. Possible causes: • AMS NetID / ADS port address the wrong runtime system or the wrong computer • another project is running in the addressed PLC • application software error (incorrect combination of ADS port / IdxGroup / IdxOffset)
dwTcHydAdsErrInvalidIdxOffset	16#0703	1795	Invalid IndexOffset. Possible causes: • AMS NetID / ADS port address the wrong runtime system or the wrong computer • another project is running in the addressed PLC • application software error (incorrect combination of ADS port / IdxGroup / IdxOffset) • attempted access to an array element with invalid index (out of bounds)
dwTcHydAdsErrRdWrNotPermitted	16#0704	1796	Access (write, read) not permitted. Possible causes: • a write access to a variable without write permission was requested
dwTcHydAdsErrInvalidSize	16#0705	1797	Size (number of bytes) not permitted. Possible causes: • application software error (incorrect combination of ADS port / IdxGroup / IdxOffset)
dwTcHydAdsErrIllegalValue	16#0706	1798	Value not permitted. Possible causes: • the transferred value is outside absolute parameter limits • the transferred value is outside parameter limits, which have been specified by other already applicable parameters
dwTcHydAdsErrNotReady	16#0707	1799	Not ready for operation. Possible causes: • an MC_Power_BkPlcMc function block was prompted by its Enable input to activate an axis that is not ready for operation

Constant	Hexadeci-mal	Decimal	Description
dwTcHydAdsErrBusy	16#0708	1800	Already active. Possible causes: • the axis could not accept an instruction because it is already dealing with another task
dwTcHydAdsErrNoFile	16#070C	1804	reserved: File is missing / not accessible.
dwTcHydAdsErrSyntax	16#070D	1805	Syntax in command or file invalid. Possible causes: • invalid characters or character combinations were detected while reading a characteristic curve file stored in ASCII format • incomplete information was detected while reading a characteristic curve file stored in ASCII format
dwTcHydAdsErrTimeout	16#0745	1861	Timeout. Possible causes: • during a communication the response did not arrive within a designed time ◦ the chosen time is too short ◦ the connection is interrupted • the process has prevented processing of the command or delayed it beyond the designated time • the specified commands parameters have increased the time requirement beyond the designated value
dwTcHydAdsErrNoAmsAddr	16#0749	1865	AMS/ADS address missing: • The ADS address of the device was not mapped to the corresponding variable of the input structure.
dwTcHydErrCdNotCompatible	16#4040	16448	The axis is incompatible with the required function. Possible causes: • application software error
dwTcHydErrCdIllegalOutputNumber	16#4104	16644	The output number is outside the permitted range. Possible causes: • an MC_ReadDigitalOutput_BkPlcMc or MC_WriteDigitalOutput_BkPlcMc function block was called with an invalid parameter.
dwTcHydErrCdNotSupport	16#4107	16647	Function or command not supported. Possible causes: • application software error
dwTcHydErrCdCycleTime	16#4205	16901	Cycle time (fCycletime in ST_TcHydAxParam) not permitted. Possible causes: • Parameterization error
dwTcHydErrCdMissingEnc	16#4210	16912	There is no connection to an encoder interface (pStDeviceInput and/or pStDeviceOutput in Axis_Ref_BkPlcMc [▶ 67]). Possible causes: • Application software error (the MC_AxUtiStandardInit_BkPlcMc function block was not called or not provided with the address of an ST_TcPlcDeviceInput and an ST_TcPlcDeviceOutput structure)

Constant	Hexadeci-mal	Decimal	Description
dwTcHydErrCdMissingDrive	16#4212	16914	There is no connection to a drive interface (pStDeviceInput and/or pStDeviceOutput in Axis_Ref_BkPlcMc [▸ 67]). Possible causes: • Application software error (the MC_AxUtiStandardInit_BkPlcMc function block was not called or not provided with the address of an ST_TcPlcDeviceInput and an ST_TcPlcDeviceOutput structure)
dwTcHydErrCdCannotSynchronize	16#421A	16922	Start distance inadequate when an MC_GearInPos_BkPlcMc() function block is called. Possible causes: • the axis is too close to the sync point when the function block is activated • the dynamic axis parameters are inadequate
dwTcHydErrCdIllegalGearFactor	16#421B	16923	The parameters of a gear coupling are not permitted. Possible causes: • the parameter of the function block is not permitted
dwTcHydErrCdSoftEnd	16#4222	16930	The target position is located on the far side of an active software limit switch, and is therefore not permitted.
dwTcHydErrCdLowDist	16#4228	16936	The travel distance is unacceptably small.
dwTcHydErrCdIllegalStartType	16#4239	16953	Invalid start type.
dwTcHydErrCdCommandBufferOverflow	16#423F	16959	Command buffer is full.
dwTcHydErrCdEncLostCamm	16#4253	16979	Reserved. Not supported.
dwTcHydErrCdCtrlEnaLost	16#4260	16992	Controller enable was withdrawn during the motion. Possible causes: • the axis enable was withdrawn at an unexpected time due to a machine logic signal • application software error
dwTcHydErrCdEncNoCammFound	16#429C	17052	Reserved. Not supported.
dwTcHydErrCdEncNoCammEnd	16#429D	17053	Reserved. Not supported.
dwTcHydErrCdEncNoSyncPulse	16#429E	17054	Reserved. Not supported.
dwTcHydErrCdAcc	16#4309	17161	The acceleration is not acceptable.
dwTcHydErrCdDec	16#430A	17162	The deceleration is not acceptable.
dwTcHydErrCdJerk	16#430B	17163	The jerk limitation is invalid.
dwTcHydErrCdPtrPlcMc	16#4345	17221	No connection to one of the required axis interfaces (pStDeviceInput or pStDeviceOutput in Axis_Ref_BkPlcMc [▸ 67]).
dwTcHydErrCdPtrMcPlc	16#4346	17222	No connection to one of the required axis interfaces (pStDeviceInput or pStDeviceOutput in Axis_Ref_BkPlcMc [▸ 67]).
dwTcHydErrCdCtrlEna	16#4356	17238	Movement without controller enable is not permitted.
dwTcHydErrCdNegFdEna	16#4357	17239	Movement in the direction of reducing positions without the negative direction advance enable is not permitted.

Constant	Hexadeci-mal	Decimal	Description
dwTcHydErrCdPosFdEna	16#4358	17240	Movement in the direction of increasing positions without positive direction advance enable is not permitted.
dwTcHydErrCdSetVelo	16#4359	17241	The required velocity is not acceptable.
dwTcHydErrCdPehTimeout	16#435C	17244	The axis does not reach the target window within the specified time.
dwTcHydErrCdNotMoving	16#435D	17245	The axis is not moving, or not in the correct direction.
dwTcHydErrCdConsequenti al	16#43A0	17312	Consequential error: The axis was put in an error state due to a problem with another axis.
dwTcHydErrCdEncType	16#4401	17409	The parameter type is invalid.
dwTcHydErrCdEncScaling	16#4406	17414	The increment scaling is not permitted.
dwTcHydErrCdEncSyncDist	16#4414	17428	The distance between Latch_Enable and the sync pulse is too small.
dwTcHydErrCdEncSetActP os	16#4422	17442	A problem occurred during actual value setting.
dwTcHydErrCdPtrPlcEncIn	16#4442	17474	The axis does not have a pointer to an encoder input interface
dwTcHydErrCdPtrPlcEncOu t	16#4443	17475	The axis does not have a pointer to an encoder output interface.
dwTcHydErrCdEncUnderru n	16#4450	17488	Reported by some encoder types: The actual position has passed the lower count limit of the encoder.
dwTcHydErrCdEncOverrun	16#4451	17489	Reported by some encoder types: The actual position has passed the upper count limit of the encoder.
dwTcHydErrCdEncHdwFail ed	16#4464	17508	Drive actuator or encoder report a hardware fault.
dwTcHydErrCdSsi	16#4470	17520	An error was detected when operating an SSI encoder.
dwTcHydErrCdPosLag	16#4550	17744	The lag error exceeds an active limit.
dwTcHydErrCdDriveType	16#4601	17921	The value set in nDrive_Type is not permitted.
dwTcHydErrCdRefVelo	16#4605	17925	Reference velocity (fRefVelo in ST_TcHydAxParam) is invalid.
dwTcHydErrCdStepperStall ed	16#4636	17974	A stall situation was detected.
dwTcHydErrCdPtrPlcDriveIn	16#4642	17986	The axis does not have a pointer to a drive input interface.
dwTcHydErrCdPtrPlcDriveO ut	16#4643	17987	The axis does not have a pointer to a drive output interface.
dwTcHydErrCdDriveNotRea dy	16#4650	18000	Power section not ready for operation.
dwTcHydErrCdTblEntryCou nt	16#4A02	18946	The number of table entries (rows) is not permitted.
dwTcHydErrCdTblInvalidMa sterStep	16#4A04	18948	The table contains entries with invalid master step size.
dwTcHydErrCdTblNoInit	16#4A10	18960	The table is not initialized.
dwTcHydErrCdTblIllegalInd ex	16#4A13	18963	Table index not permitted.
dwTcHydErrCdTblLineCoun t	16#4A15	18965	The number of table entries is too large.
dwTcHydErrCdNotStartable	16#4B01	19201	Axis in a state that does not allow it to start.
dwTcHydErrCdFuncTimeout	16#4B07	19207	The function was not reported as complete within the specified time.
dwTcHydErrCdNotReady	16#4B09	19209	The axis is not in an operable state.

Constant	Hexadeci-mal	Decimal	Description
dwTcHydErrCdHomingType	16#4F00	20224	Referencing method (nEnc_HomingType in ST_TcHydAxParam) is not permitted.
dwTcHydErrCdEncCutOff	16#4F01	20225	The limit frequency for the actual value acquisition has been exceeded.
dwTcHydErrCdIllegalDistance	16#4F02	20226	Distance is invalid: zero or negative.
dwTcHydErrEncDisconected	16#4FF0	20464	Encoder hardware is uncoupled. Possible causes: • the fieldbus connection is interrupted • the power supply for the device is not available • the device is faulty • another device, which is located in the fieldbus connection between the controller and the device, has no power supply or is faulty
dwTcHydErrDriveDisconected	16#4FF1	20465	Drive hardware is uncoupled. Possible causes: • the fieldbus connection is interrupted • the power supply for the device is not available • the device is faulty • another device, which is located in the fieldbus connection between the controller and the device, has no power supply or is faulty
dwTcHydErrDistanceInsufficient	16#4FF2	20466	The travel path is inadequate.

Device-specific error codes of function block MC_Power_BkPlcMc

These values appear at the **ErrorID** output of an MC_Power_BkPlcMc function block, if an error is reported by the external device.

Constant	Hexadeci-mal	Decimal	Description
dwTcHydErrCdAX2000MainPwrTmOut	16#0001	1	Only for AX2000: no feedback by the mains contactor (timeout during waiting for ST_TcPlcMcAx2000In.bPowerOk).
dwTcHydErrCdAX2000MainPwrFault	16#0002	2	Only for AX2000: negative edge on feedback from mains contactor (ST_TcPlcMcAx2000In.bPowerOk).
dwTcHydErrCdAX2000PwrStageTmOut	16#0003	3	Only for AX2000: no feedback from AX output stage (timeout during waiting for ST_TcPlcMcAx2000In.DriveState[3].6, no Ready).
dwTcHydErrCdAX2000PwrStageFault	16#0004	4	Only for AX2000: Negative edge of AX output stage (ST_TcPlcMcAx2000In.DriveState[3].6, no Ready).
dwTcHydErrCdAX2000ReportsError	16#0005	5	Only for AX2000: error message from AX device (ST_TcPlcMcAx2000In.DriveState[3].7 or ST_TcPlcMcAx2000In.DriveError<>0).
dwTcHydErrCdAX2000ErrorI2T	16#0006	6	Only for AX2000: I^2T error message from AX output stage (ST_TcPlcMcAx2000In.DriveState[0].0).
dwTcHydErrCdAX2000ErrorChopper	16#0007	7	Only for AX2000: brake resistor of the AX output stage faulty (ST_TcPlcMcAx2000In.DriveState[0].1).
dwTcHydErrCdAX2000ErrorWatchDog	16#0008	8	Only for AX2000: watchdog (timeout during communication) of the AX output stage was triggered (ST_TcPlcMcAx2000In.DriveState[0].3).
dwTcHydErrCdAX2000ErrorPwrLine	16#0009	9	Only for AX2000: supply error reported by AX output stage (ST_TcPlcMcAx2000In.DriveState[0].4).
dwTcHydErrCdAX2000ConnectionLost	16#000A	10	Only for AX2000: The connection to the AX device is broken or substantially disrupted (ST_TcPlcMcAx2000In.BoxState<>0).
dwTcHydErrCdAX2000ConnectionTmOut	16#000B	11	Only for AX2000: The communication with the AX device could not be established (timeout).
dwTcHydErrCdKL2531OverTemp	16#0001	1	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports overtemperature alarm.
dwTcHydErrCdKL2531UnderVoltage	16#0002	2	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports inadequate supply voltage on the power rail.
	16#0003	3	Only for KL2531/KL2541: Reserved.
dwTcHydErrCdKL2531OpenLoadA	16#0004	4	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports broken wire on the A-side.
dwTcHydErrCdKL2531OpenLoadB	16#0005	5	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports broken wire on the B-side.
dwTcHydErrCdKL2531OverCurrentA	16#0006	6	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports overcurrent at output stage A.
dwTcHydErrCdKL2531OverCurrentB	16#0007	7	Only for KL2531/KL2541: The KL2531/KL2541 terminal reports overcurrent at output stage B.
dwTcHydErrCdKL2531NotReady	16#0008	8	Only for KL2531/KL2541: The terminal reports a output stage problem (enabled, not ready).
dwTcHydErrCdKL2531ConnectionLost	16#000A	10	Only for KL2531/KL2541: The connection to the terminal is broken or substantially disrupted (ST_TcPlcMcDriveIn.uiBoxState<>0).
dwTcHydErrCdKL2531ConnectionTmOut	16#000B	11	Only for KL2531/KL2541: The communication with the terminal could not be established (timeout).

ADS Codes

These constants are accepted by the MC_AxAdsReadDecoder and MC_AxAdsWriteDecoder function blocks.

IndexGroup	IndexOffset	Type	R/W	Description
16#4000 + axis index	2	STRING()	R	Axis name in text form.
	4	UDINT	R	Cycle time in microseconds.
	16#10003	UDINT	R	Encoder type: nEnc_Type from ST_TcHydAxParam.
	16#10006	LREAL	R	Incremental evaluation: fEnc_IncWeighting from ST_TcHydAxParam.
	16#30003	UDINT	R	Drive type: nDrive_Type from ST_TcHydAxParam.
16#4100 + axis index	1	UDINT	R	Error code: nErrorCode from ST_TcHydAxRtData.
	16#10002	LREAL	R	Actual position: fActPos from ST_TcHydAxRtData.
	16#10005	LREAL	R	Actual velocity: fActVelo from ST_TcHydAxRtData.
16#4200 + axis index	1	-	W	Execute axis reset.
	16#10	-	W	Start homing.
	16#21	Structure	W	Start axis movement.
	16#FFFF0001	-	W	Save parameters.
	16#FFFF0002	-	W	Load parameters.
16#4300 + axis index	16#81	UDINT	R	Status double word: nStateDWord from ST_TcHydAxRtData.
	16#B1	UDINT	R	Error code: nErrorCode from ST_TcHydAxRtData.
16#F000 + axis index	1	Structure	R	The ST_TcHydAxRtData variable for the axis.
	2	Structure	R/W	The ST_TcHydAxParam variable for the axis.
16#800F0000 + axis index	E_TcMCParameter [▶ 79]		R/W	Parameters and actual values of the axis.
16#FFFFFFFF	0	String()	R	Identification of the server.
	1	UINT	R	Major version of the library.
	2	UINT	R	Minor version of the library.
	3	UINT	R	Release of the library.
	4	UINT	R	Number of axes supported

Array Dimensions

The following constants used for dimensioning of fields and can be used by the application.

Constant	Description
ciBkPlcMc_CamSwitchRef_MinIdx	Lower boundary index on an array[] of CAMSWITCH_REF_BkPlcMc [▶ 69], supplied to blocks of type MC_DigitalCamSwitch_BkPlcMc [▶ 48]
ciBkPlcMc_CamSwitchRef_MaxIdx	Upper boundary index on an array[] of CAMSWITCH_REF_BkPlcMc [▶ 69], supplied to blocks of type MC_DigitalCamSwitch_BkPlcMc [▶ 48]
ciBkPlcMc_TrackRef_MinIdx	Lower boundary index on an array[] of TRACK_REF_BkPlcMc [▶ 109], supplied to blocks of type MC_DigitalCamSwitch_BkPlcMc [▶ 48]
ciBkPlcMc_TrackRef_MaxIdx	Upper boundary index on an array[] of TRACK_REF_BkPlcMc [▶ 109], supplied to blocks of type MC_DigitalCamSwitch_BkPlcMc [▶ 48]

Logger Levels

The following constants are used for the specification of the level, from which messages are included in the logger function of the library.

Constant	Description
dwTcHydLogLevel_None	No logging
dwTcHydLogLevel_Errors	Only error messages
dwTcHydLogLevel_Warnings	Error messages and warnings
dwTcHydLogLevel_Actions	Error messages, warnings and activities

Logger Sources

The following constants are used to specify the source of messages in the logger function of the library.

Constant	Description
dwTcHydLogSource_Library	A function block of the hydraulics library
dwTcHydLogSource_LibExt_2R2V	A function block of the 2R2V library
dwTcHydLogSource_Application	A function block of the application
dwTcHydLogSource_ApplicationFramework	A function block of an application platform

Logger Argument Types

The following constants are used to specify the type of an optional parameter for a message in the logger function of the library.

Constant	Description
dwTcHydLogArgType_DInt	The message contains a parameter of type DINT. The message text must include a placeholder in the form %d.
dwTcHydLogArgType_LReal	The message contains a parameter of type LREAL. The message text must include a placeholder in the form %f.
dwTcHydLogArgType_String	The message contains a parameter of type STRING. The message text must include a placeholder in the form %s.

5.3 Valve

The valve is generally the actuator, which controls the axis. For continuous valves, a distinction is made between:

- Servo valve
- Proportional valve
- Control valve

Servo valve

These valves control large oil flows via small electrical signals

- A small torque motor controls the connected control oil, thereby adjusting the slider of the main stage.
- Often multi-stage design
- High responsiveness and controllability

Proportional valve

A coil current generates a proportional force, which moves the valve slider against the force of a spring.

Compared to servo valve:

- Longer step response time
- Higher current consumption
- Larger hysteresis
- More robust against contamination
- Attractive price

Control valve:

A proportional valve, for which the slider position is measured and automatically adjusted:

- Shorter step response time
- Smaller hysteresis
- Smaller load reaction
- More complex and more expensive than proportional valves
- Electronics on the valve or in the control cabinet

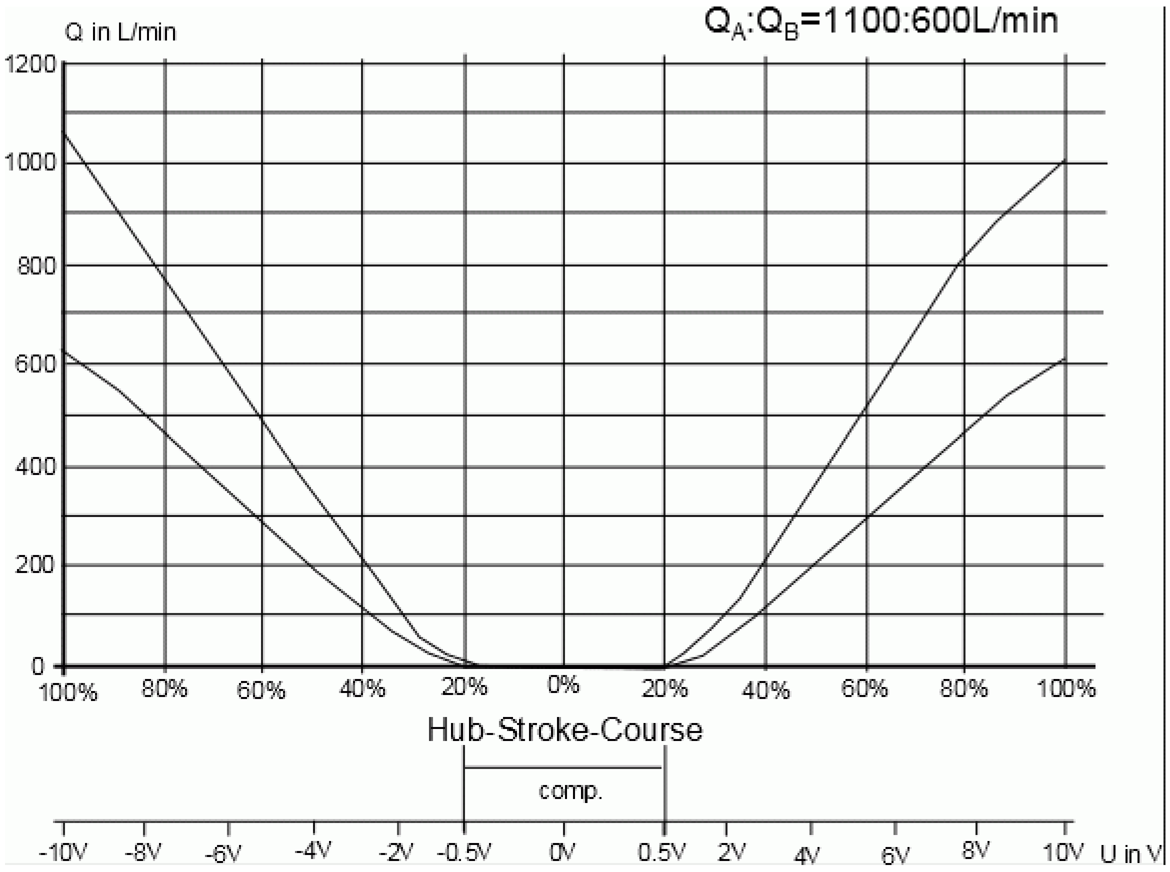
Basic principles of reading valve data sheets

A continuous valve is usually used as actuator for a controller. The designs of valves from different manufacturers or different types may differ quite significantly. In order to adapt the output scaling to the particular situation, the valve data sheet for the continuous valve must be available during commissioning. A valve has a number of hydraulic ports. A and B are the valve outputs; A is connected to the cylinder side with the larger piston area, B is connected to the cylinder side with the smaller piston area. P and T represent the supply connections. P is the pressure line, and T is the return line to the tank.

NOTE! In the hydraulics library, the A-side is always the side under positive pressure, the B-side is the side under negative pressure.

In many cases the valve slide has to move slightly before an oil flow can be detected. This stroke is listed in the valve data sheet under overlap.

NOTE! The data sheet may indicate an overlapped valve, although this overlap is compensated in the valve electronics.



The characteristic volume flow curve shows the key information for the valve. The diagram above shows that the piston itself has an overlap of 20%, which was reduced to 5% in the valve electronics. As a result, no overlap compensation via the hydraulics library is required.

NOTE! The fact that overlap compensation was carried out in the valve does not make it a zero overlap valve, and the axis is therefore only capable of position control to a limited degree.

The diagram shows that the oil flow in the A-chamber of the piston is greater than the oil flow in the B-chamber. This asymmetry indicates an area compensation in valve, in this case with a ratio of 11:6.

5.4 Configuration of an axis

In contrast to the Beckhoff NC, the axis in the hydraulic library is configured by the application itself. This means that the function blocks for operating an axis (read actual value, generate set values, generate position rules, linearization and output) must be called up individually.

All function blocks work on a common axis reference, which must be created globally. If there is more than one axis, the axis references must be created as an array.

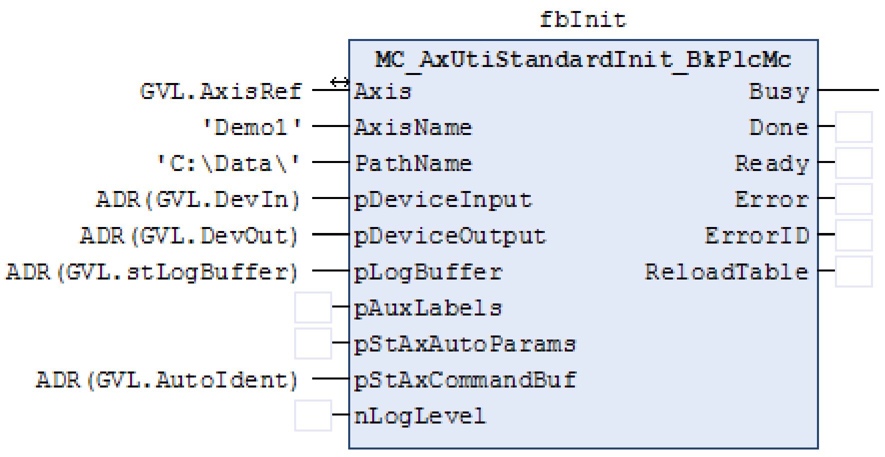
In addition to the axis reference (AXIS_REF_BkPlcMc [▸ 67]), the I/O structures ST_TcPlcDeviceInput [▸ 104] and ST_TcPlcDeviceOutput [▸ 106] must be declared for each axis. If other sensors such as pressure or load cells are used in the application in addition to position detection, the I/O value must be set in the application. The parameterization of the scaling can be managed in the fCustomerData[] section of the axis. For each axis 20 customer-specific data are provided in this section. This data is saved via the axis, loaded and displayed in the PLcMcManager. For the display in the PlcMcManager the label can be changed by declaring the structure ST_TcMcAuxDataLabels [▸ 103].

To view messages a ST_TcPlcMcLogBuffer [▸ 107] is declared. This buffer is shared by all axes.

```
VAR_GLOBAL
    AxisRef:          AXIS_REF_BkPlcMc;
    DevIn:            ST_TcPlcDeviceInput;
    DevOut:           ST_TcPlcDeviceOutput;

    AuxAxLabel:       ST_TcMcAuxDataLabels;

    stLogBuffer:      ST_TcPlcMcLogBuffer;

    AutoIdent:        ST_TcMcAutoIdent;

    ForceInput:       INT;
END_VAR
```

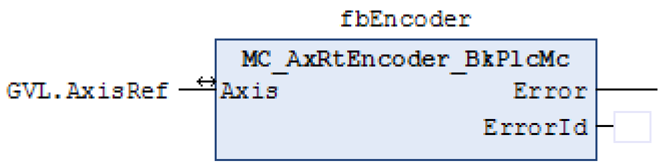
The individual function blocks required for a complete axis are listed and described below.

5.4.1 FB_Init



The function block loads the parameters from the given file path and transfers them to the axis reference.
The function block also links the input and output structures to the axis reference.
All parameters are stored in binary form in an *Axis name.dat* file.
Once the parameters have been loaded successfully, the bParamsEnable flag in the axis reference becomes TRUE. Only now may all other axis-related function blocks be called up, otherwise calculations would be carried out with incorrect parameters.
The Init function block should be called cyclically to check the pointer addresses. Variables that are passed as addresses are marked with the prefix "p".

5.4.2 FB_Encoder



The actual value is read from the input structure via the selected encoder type and converted into a position [mm] and velocity [mm/s].

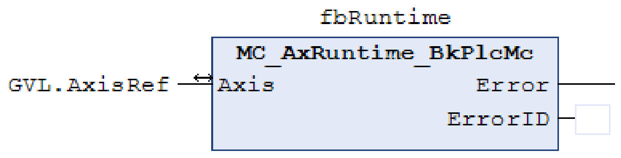
If the actual values are very noisy, it is possible to filter them via a moving average (MC_AxUtiSlidingAverage_BkPlcMc [▶ 191]) or a Pt1 element (MC_AxUtiPT1_BkPlcMc [▶ 189]). In addition, it is possible to build custom filters.

The filter function blocks must be called after the encoder. The variable to be filtered must be passed to the filter function block at the input, and the corresponding variable of this axis reference can be written at the output of the filter function block. This causes the old noisy value to be overwritten by a new, stabilized value.

NOTE! If a heavily filtered actual value is used for control purposes, the dynamics can be affected due to the filter jump response.

Additional function blocks are available for reading in pressure and force values. The function block to be used depends on the variable to be measured. In contrast to position determination, for force and pressure determination the mapping interface and terminal monitoring must be provided by the application.

5.4.3 FB_Runtime



The setpoint generator is integrated in function block FB_Runtime [▶ 167]. It calculates the corresponding set position, set velocity and, if applicable, also the set pressure for each cycle. In addition to generating set values, the runtime function block also deals with position control.
The following setpoint generators are provided:

- iTcMc_ProfileCtrlBased:
  The profile generation takes place via an acceleration phase, a constant velocity phase and a brake phase.
- iTcMc_ProfilJerkBasiert
  The profile generation takes place via a jerk phase, an acceleration phase, a jerk phase, a constant velocity phase, a jerk phase, a brake phase and a jerk phase.
- ProfilBufferedJerk
  The profile generation takes place in buffered form via up to 12 velocity profiles, which must be known when the axis is started. The individual velocity profiles are structured as in "iTcMc_ProfileJerkBased".

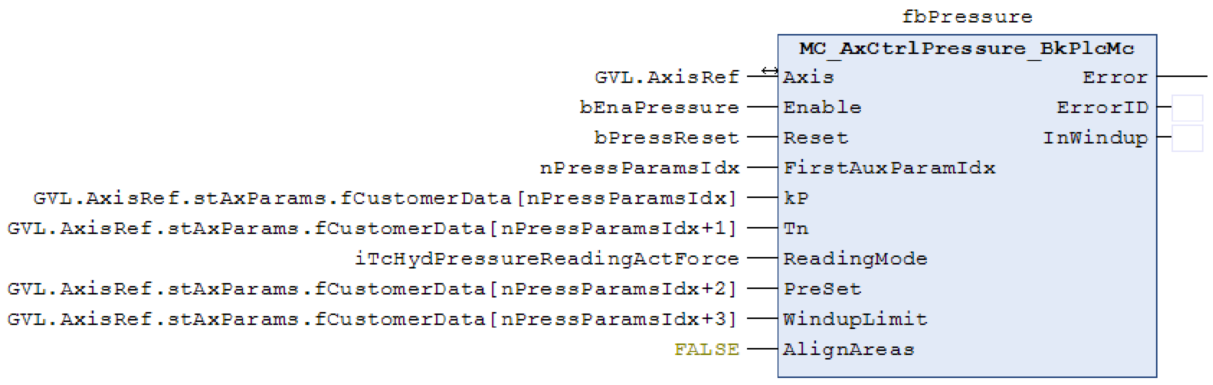
In addition to the various set value profiles, it is possible to operate the axis as a time-based axis or a displacement-based axis via the parameter timebased.

If the setpoint generator is to follow a curve not determined by itself, the function block MC_AxRtSetExtGenValues_BkPlcMc [▶ 180] must be called and the set position must be passed here. The set value can then come from the NCI's setpoint generator, for example.

The position controller is integrated in the setpoint generator.

5.4.4 FB_Regler

If a force or pressure regulator is required in the application, it must be called up after the setpoint generator and before the linearization function block.

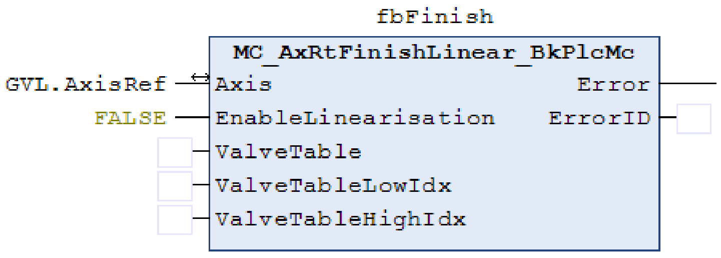

fbPressure
MC_AxCtrlPressure_BkPlcMc
GVL.AxisRef
bEnaPressure
bPressReset
nPressParamsIdx
GVL.AxisRef.stAxParams.fCustomerData[nPressParamsIdx]
GVL.AxisRef.stAxParams.fCustomerData[nPressParamsIdx+1]
iTcHydPressureReadingActForce
GVL.AxisRef.stAxParams.fCustomerData[nPressParamsIdx+2]
GVL.AxisRef.stAxParams.fCustomerData[nPressParamsIdx+3]
FALSE
Axis
Enable
Reset
FirstAuxParamIdx
kP
Tn
ReadingMode
PreSet
WindupLimit
AlignAreas
Error
ErrorID
InWindup

When the controller is active, it overwrites the output of the setpoint generator. Care must be taken that the input variable to be controlled is selected at the ReadingMode input.

Controller parameters such as Tn, Kp etc. are not automatically supplied via the parameter structure, but must be transferred from the application to the function block. In order to save these parameters together with all other axis parameters, it is possible to store them in stAxParams.fCustomerData. Up to 20 application-specific data can be stored here. If the input FirstAuxParamIdx >0 is entered, the next four fCustomerData values are labeled as appropriate for the controller. The function block uses GVL.AxisRef.pStAxAuxLabels for labeling. Of course, the labels can also be adapted via the application.

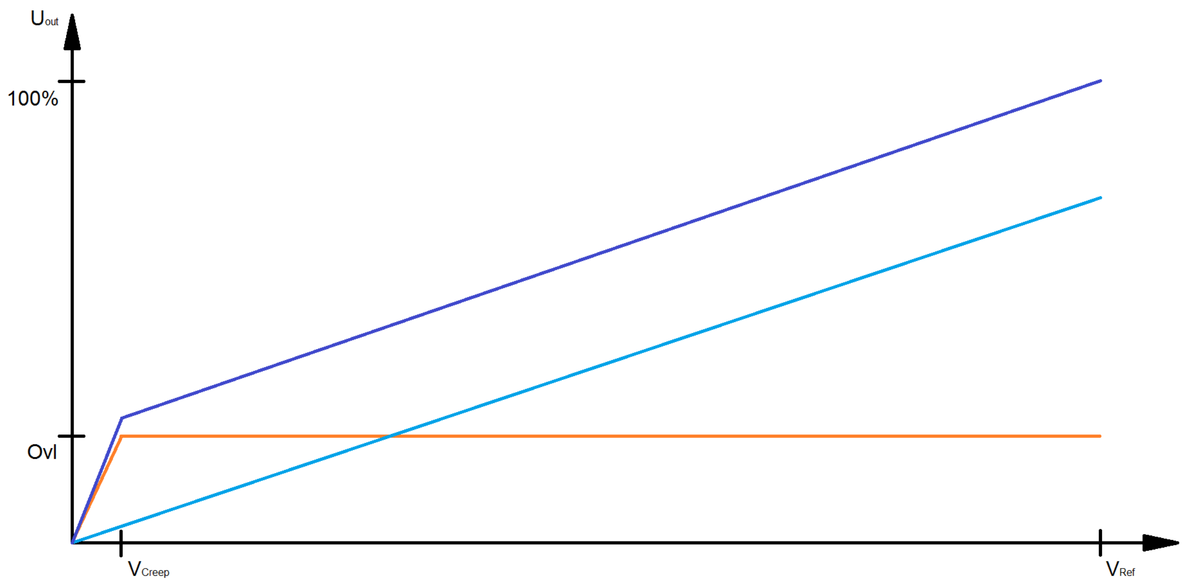
NOTE! Careful consideration must be given to how the controller should behave so that no jumps occur during activation and deactivation. As a rule, the pressure regulator is activated as soon as a small but significant pressure/force increase is detected.

5.4.5 FB_Finish



The function block deals with the output linearization. For this purpose, it summarizes and standardizes the set velocity and the position controller output. The result can be found in stRtData.fOutput. There are various options available for linearization:

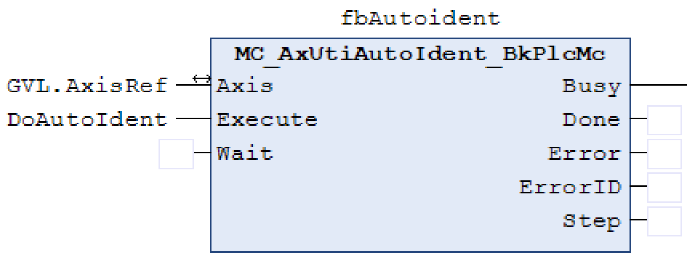
- Section by section:



  The overlap, velocity ratio and reference velocity are used here. The output from zero to creep velocity V_{Creep} is ramped linearly from zero to the overlap compensation Ovl. From creep velocity to reference velocity V_{Ref}, the overlap compensation interpolates linearly up to 100% valve opening.
- Bend compensation:
  This should only be used for zero overlap valves, which have two sections with different slopes.
- Characteristic curve:
  Table-based characteristic curve with up to 99 points.

The library contains two linearization function blocks, MC_AxRtFinish_BkPlcMc [▶ 175] and MC_AxRtFinishLinear_BkPlcMc [▶ 176]. The function block MC_AxRtFinishLinear_BkPlcMc represents a further development of MC_AxRtFinish_BkPlcMc and additionally contains the complete linearization of characteristic curves.

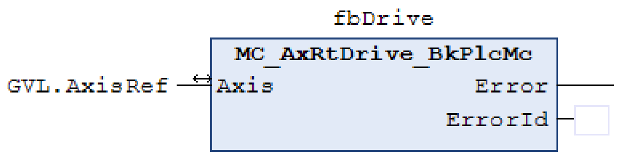
5.4.6 FB_Autoident



The function block MC_AxUtiAutoIdent_BkPlcMc [▶ 192] is responsible for measuring the characteristic curve. The parameters to be set for this are stored in the structure ST_TcMcAutoIdent. The determined characteristic curve is activated via MC_AxRtFinish_BkPlcPlcMc.EnableLinearization.

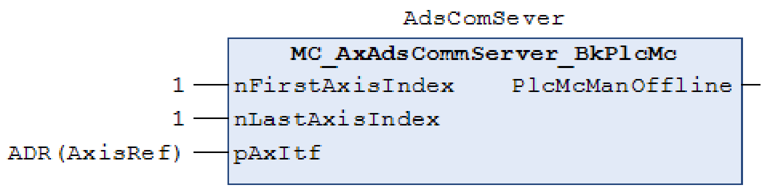
NOTE! An MC_AxUtiAutoIdent_BkPlcMc function block must be called after the MC_AxRtFinishLinear_BkPlcMc function block and before the MC_AxRtDrive_BkPlcMc function block of the axis.

5.4.7 FB_Drive



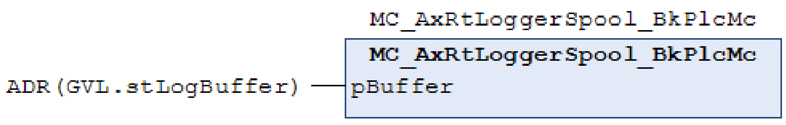
The function block prepares the standardized output variable fOutput for output to the hardware.

5.4.8 FB_AdsComServer



The function block may only be instantiated once per project. This function block provides the connection to the PlcMcManager. For this reason, the function block must be called cyclically. The axis references and the number of axes are transferred at the input of the function block.

5.4.9 FB_Logger



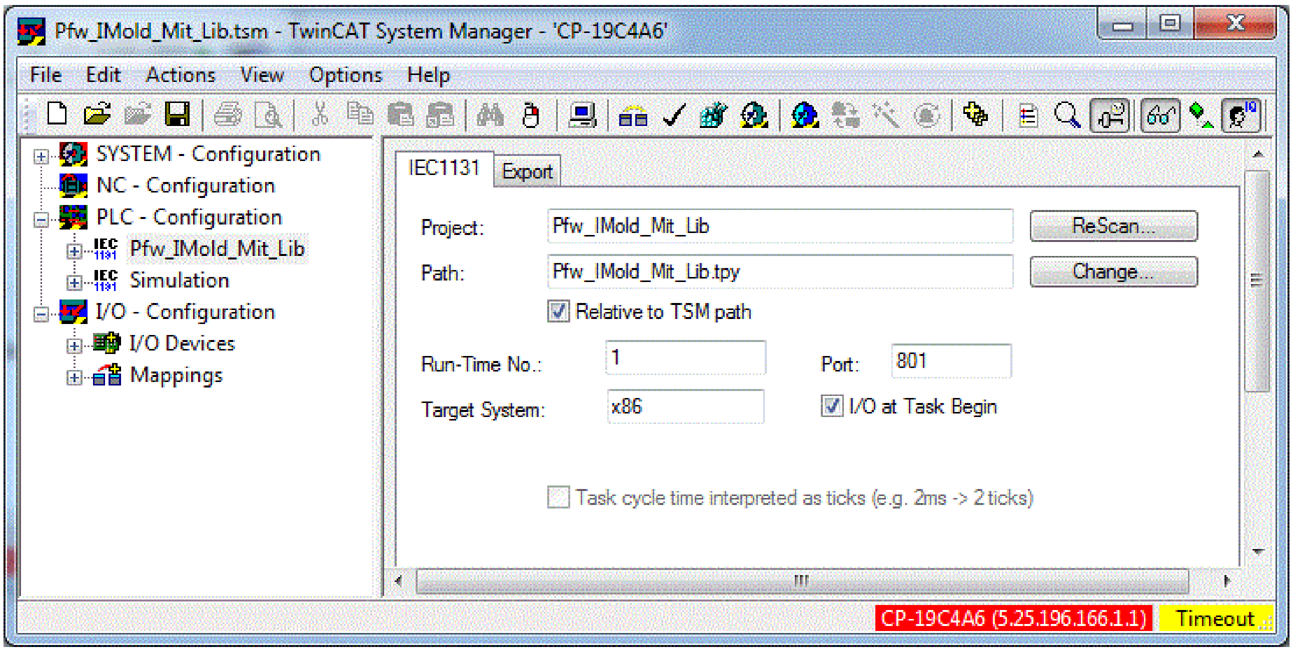
The function block may only be called once in the application. It manages all messages of the different axes and passes them on to the PlcMcManager as well as the message buffer of the System Manager.

5.4.10 General settings

To ensure that the I/O is always read at the same interval, the following attribute must be set in TwinCAT 3 in the program: {attribute' TcCallAfterOutputUpdate'}.

```
{attribute 'TcCallAfterOutputUpdate'}
PROGRAM MAIN
VAR
    fbAxis:     FB_Axis;
END_VAR

```

In TwinCAT 2, the **I/O flag at the start of the task** must be set in the System Manager under **PLC configuration**.



Pfw_IMold_Mit_Lib.tsm - TwinCAT System Manager - 'CP-19C4A6'

File Edit Actions View Options Help

SYSTEM - Configuration
NC - Configuration
PLC - Configuration
Pfw_IMold_Mit_Lib
Simulation
I/O - Configuration
I/O Devices
Mappings

IEC1131 | Export

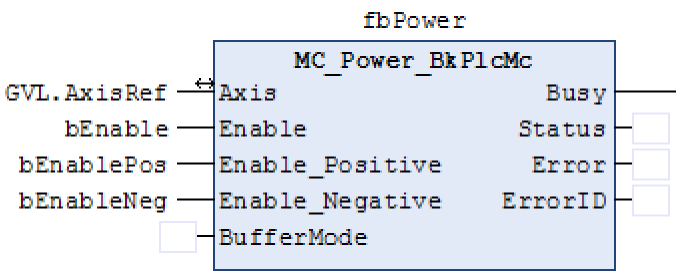
Project: Pfw_IMold_Mit_Lib [ReScan...]
Path: Pfw_IMold_Mit_Lib.tpy [Change...]
☑ Relative to TSM path
Run-Time No.: 1 Port: 801
Target System: x86 ☑ I/O at Task Begin
☐ Task cycle time interpreted as ticks (e.g. 2ms -> 2 ticks)

CP-19C4A6 (5.25.196.166.1.1) Timeout

In contrast to NC, the hydraulic axis itself (setpoint generator, controller, etc.) is calculated directly in the PLC. It is therefore recommended to set the cycle time of the task to less than 10 ms.

The resulting axis can be loaded onto the target system and started. Since the axis is calculated in the application, function blocks can be replaced on a project-related basis and manipulations between the function blocks can be carried out.

5.4.11 FB_Power



The function block manages the axis enables. A distinction is made between controller enable and direction-dependent feed enable in positive and negative direction. Feed enable is an internal enable for the setpoint generator, whereas controller enable is used for the position controller and also for the output stage of drives.

5.5 The PlcMcManager

The PlcMcManager supports commissioning and testing of axes, which are automated using the hydraulics library. It visualizes the actual state and enables access to parameters and triggering of commands.

NOTE! The PlcMcManager is not intended for operating machines and systems. It is not a substitute for a user interface.

Safety instructions

Attention	**Unexpected machine behavior** The commands triggered by the PlcMcManager can obstruct automatic actions and re-sponses of the control software obstruct or influence them in an unexpected or undesirable direction. This may result in unexpected and dangerous movements.

Installation

For TC2: A license-free copy of the PlcMcManager is provided with the library or the documentation. Select a suitable path, then create a shortcut on the desktop of the PC. Without such a shortcut, the PlcMcManager can only be started from Explorer.

For TC3: When downloading the library, a license-free copy of the PlcMcManager is created in the directory *C:\TwinCAT\Functions\TF5810-TC3_Hydraulics-Positioning*. If your TwinCAT not installed under to *C:* or in another directory, the path must be adjusted accordingly.

Running the PlcMcManager

If the tool is stored on the PC, it can be started by double-clicking.

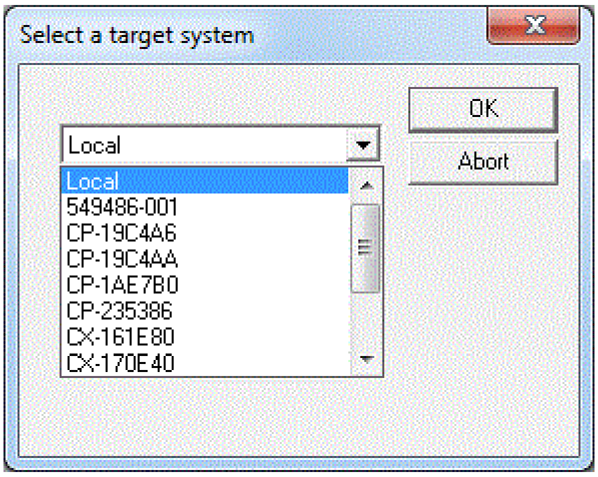
Offline display of a parameter file

In the menu bar under **Online** you will find the **Offline file mode**, where a dialog for selecting an axis parameter file of type DAT is offered. When a file is opened, the axis parameters are show like in online mode, as far as possible.

NOTE! No actual axis states are shown, and no axis commands can be triggered. This also applies if the displayed parameters belong to an axis, to which access would be possible.

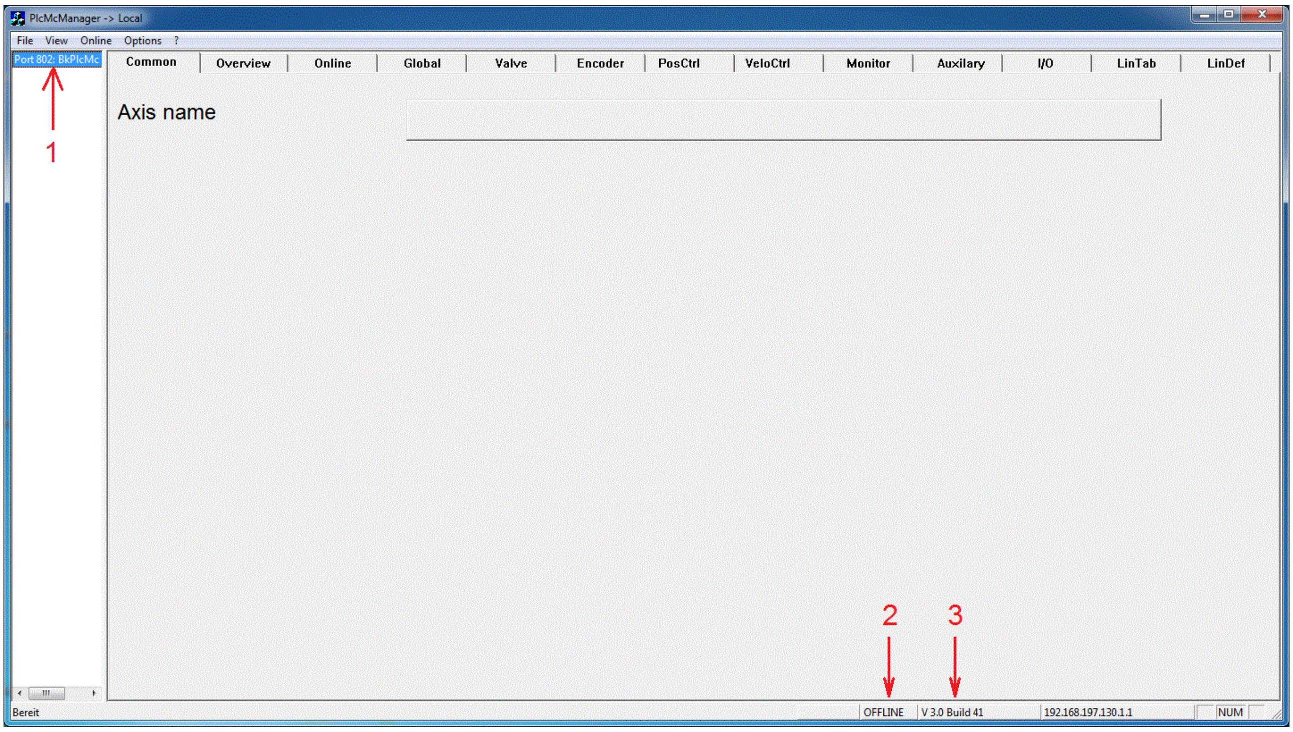
Online operation

If the runtime system with the library function blocks is not present on the PC on which the PlcMcManager is running, the target system has to be selected first. In the menu bar under **Online** you will find the **Target** dialog, where the computers are listed that are entered as **Remote Computers** in **TwinCAT System Service** on the **AMS Router** tab.



By selecting a **Remote Computer**, the communication with the runtime system is activated automatically. If the runtime system with the library function blocks is present on the PC on which the PlcMcManager is running, the communication with the runtime system can be activated with **Login** via the menu bar under **Online**.

In the current versions the PlcMcManager is prepared for use under TC3. To establish the connection at runtime, it checks the expected ADS addresses for both TC2 and TC3. This may take several seconds, particularly if a network connection is used. The details shown below should then appear.



1. Shows the port and the server used for the communication with the runtime system.
2. The mode is displayed. Since no axis has been selected up to this point, the PlcMcManager is still in OFFLINE mode.
3. Shows the version information of the library used by the PLC application.

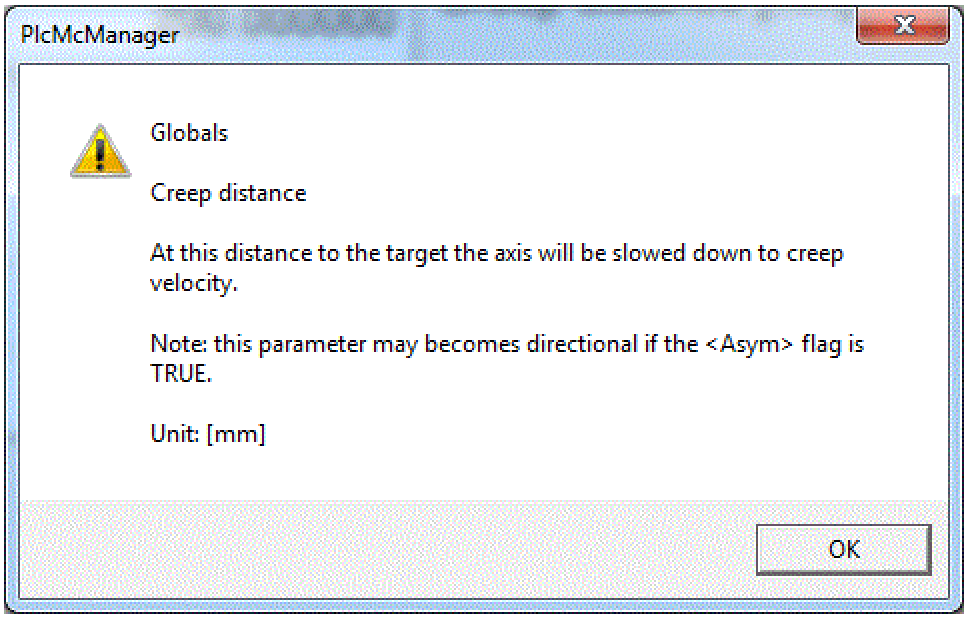
If these details do not appear after a few seconds, the connection has failed. This can have a number of reasons:

- No target system was selected, despite the fact that the application is not running on the same computer as the PlcMcManager.
- The PLC application does not contain a MC_AxAxAdsCommServer_BkPlcMc [▶ 198] function block or does not call it.
- The application is not running on the selected target system.
- No connection to the selected target system.
- The PC on which the PlcMcManager is running has no access rights to the selected target system.
- The PLC is not running.

If a dialog with an error message appears at this point, the connection to the target system is disturbed (timeout), or the PlcMcManager and the library used in the application are not compatible. Incompatibility is usually due to a new library version being used, without updating the PlcMcManager.

Many parameter input fields have a "?" field on the left-hand side. This can be used to call up a brief explanation of the parameter.

Example: Explanation of the parameter <Global.creep velocity:



PlcMcManager

Globals

Creep distance

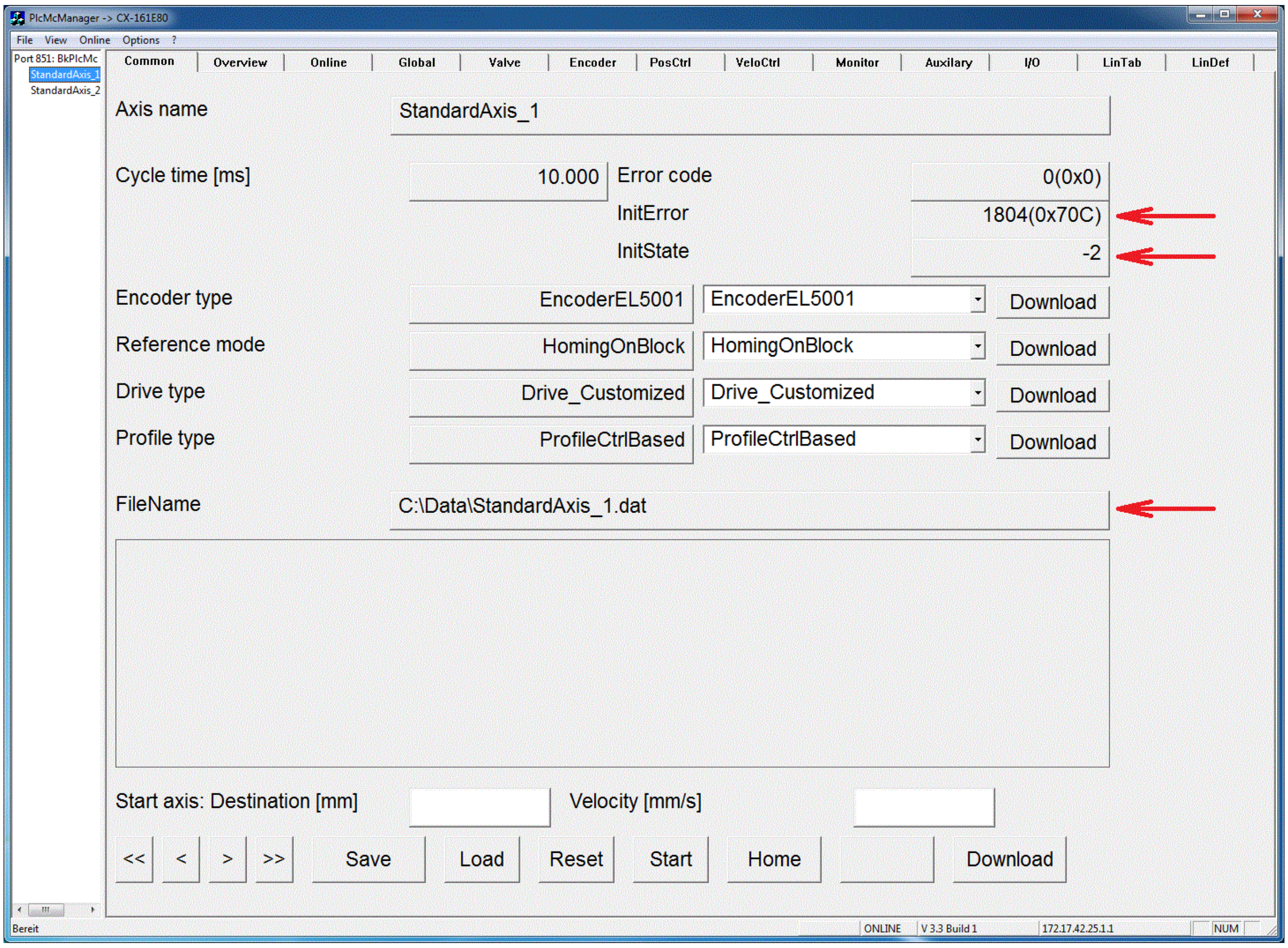
At this distance to the target the axis will be slowed down to creep velocity.

Note: this parameter may becomes directional if the <Asym> flag is TRUE.

Unit: [mm]

First steps

Double-clicking on the server shown on the left displays the axes used in the application as a list. Click on an axis to select it. Its status is then cyclically updated, and its parameter are accessible. If the communication fails for some reason, it can be restarted by clicking on an axis.



PlcMcManager -> CX-161E80

Port 851: BkPlcMc
StandardAxis_1
StandardAxis_2

Axis name	StandardAxis_1		
Cycle time [ms]	10.000	Error code	0(0x0)
		InitError	1804(0x70C)
		InitState	-2
Encoder type	EncoderEL5001	EncoderEL5001	Download
Reference mode	HomingOnBlock	HomingOnBlock	Download
Drive type	Drive_Customized	Drive_Customized	Download
Profile type	ProfileCtrlBased	ProfileCtrlBased	Download
FileName	C:\Data\StandardAxis_1.dat		

Start axis: Destination [mm]   Velocity [mm/s]

Bereit   ONLINE   V 3.3 Build 1   172.17.42.25.1.1   NUM

This example shows the file path and name used for this axis. However, an **InitError 1804 (0x70C)** and an **InitState** of **-2** are reported. The error code indicates a file error and the InitState is "negative terminated". There are several possible causes for this:

- The path does not exist on the computer where the PLC application is running. Problems can easily arise if the application goes online for the first time on another system.

- The path is not accessible from the location of the PLC runtime. This is possible, for example, if the path points to a network.
- Reading and/or writing is not allowed on this path.
- The path or file name is not spelled correctly. The backslash may be missing at the end of the path name.
- There is no corresponding file under the specified path name.

The last cause listed always occurs when commissioning of a PLC application is started without an existing file. To create a file with default parameters, press the **[Save]** key to initiate a write operation with the initial parameter values. The **[Reset]** key deletes the error state, and in this case the loading of the parameters from the file is repeated. If the problem cannot be solved by this procedure, it is caused by another of the listed causes.

Data and commands

The PlcMcManager only graphically displays variables from the PLC. Runtime values can be found in the AxisRef in stRtData. Parameters that are changed via the PlcMcManager must actively be written to the variables of the PLC via the **Activate** button. All values that have to be saved permanently are stored in the AxisRef under stAxParams. These parameters are saved by the PLC, not by the PlcMcManager.

If the axis is controller and feed enabled by the PLC with an MC_Power_BkPlcMc function block, it can be moved using the jog keys (<, <<, >>, >). At this time it is still a simulated axis. The axis can also be commanded via the **Position** and **Velocity** fields. The movement command is executed via the **Start** button.

5.6 Sample programs (from V3.0)

Structure of the application

The application is largely made up of PLCopen function blocks. A selection of function blocks is available, which are equipped with an interface defined by the PLCopen. A number of examples are described below, which provide a good basis for project configuration.

Each example contains the project file, the required axis parameter files and a scope configuration. The axis parameter files must be stored in a folder on the target system. The file path must be adjusted in the global constant "cnst_ParamFilePath" of the project file.

Example 1: Single axis

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007200854594443.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192204171.zip

The MC_AxUtiStandardInit_BkPlcMc [▸ 182] function block loads the parameters and monitors the pointer addresses. After the data has been loaded successfully, "bParamsEnable" becomes TRUE and the actual axis blocks are called.

MC_AxStandardBody_BkPlcMc [▸ 181] internally calls the required function blocks such as MC_AxRtEncoder_BkPlcMc [▸ 135], MC_AxRuntime_BkPlcMc [▸ 167], MC_AxRtFinish_BkPlcMc [▸ 175] and MC_AxRtDrive_BkPlcMc [▸ 125]. However, if a filter, a pressure regulator, a characteristic curve measurement or similar is required, the individual components must be called instead of MC_AxStandardBody_BkPlcMc [▸ 181].
By using a MC_AxAdsCommServer_BkPlcMc [▸ 198] function block the axis can be commanded via the PlcMcManager. The MC_AxParamDelayedSave_BkPlcMc function block saves changes made by the PlcMcManager after a given time (here 10 s).
Via the PlcMcManager you can log onto the target system and actively move the axis.

Example 2: Multi-axis application

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007200854596619.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192206731.zip

The example illustrates a configuration with arrays of function blocks and structures. The range of functions corresponds to example 1.

Example 3: Pressure-controlled braking

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599857803.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192209291.zip

The example shows how the pressure regulator MC_AxCtrlSlowDownOnPressure_BkPlcMc [▸ 119] throttles the feed rate of an axis depending on the pressure. In this example, the controller becomes active when the actual pressure exceeds the set pressure. Since the result is transferred via an application code to "fLagCtrlOutput", the controller must be called after the setpoint generator. Otherwise, fLagCtrlOutput would be overwritten by the position controller in MC_AxRuntime_BkPlcMc [▸ 167].
If a command is started in the PlcMcManager with a velocity of 100 mm/s and a position of 500 mm, for example, the scope shows that the pressure increases continuously with increasing position. At a position of 400 mm, the system has reached the set pressure of 50 bar and stops.

Example 5: Move function blocks

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599859979.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192288651.zip

In this example, various function blocks are used for motion control. If the variable bStart becomes TRUE, the state machine starts the axis with MC_MoveAbsolute_BkPlcMc [▸ 60] to the position 500 mm. When the axis has reached the target and the target window conditions are met (in PosRang, in TargetRange for TargetFilterTime and in BrakeDistance), a MC_MoveVelocity_BkPlcMc [▸ 64] automatically starts with a velocity of 400 mm/s. This velocity remains active for 5 seconds and is then terminated with MC_Stop_BkPlcMc [▸ 66], so that the axis comes to a standstill. This is followed by a relative movement of 100 mm with MC_MoveRelative_BkPlcMc [▸ 63] and a move to position 0.0 mm. Different acceleration and deceleration ramps are used in the different motion profiles.

Example 6: Time ramp generator

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599862155.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192291211.zip

An axis without encoder cannot be controlled via the standard setpoint generator. For this type of axis, iTcMc_ProfileTimeRamp [▸ 172] provides an alternative setpoint generator. If the variable "bUp" or "bDown" is TRUE in the global variables, the axis moves at the specified velocity (here 500 mm/s) to the first limit switch (DigCamP – for positive/ DigCamM – for negative) and then slows down to the corresponding creep velocity. After reaching DigCamPP – for positive/ DigCamMM – for negative the output is deleted.

Example 7: Override and function generator

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599864331.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192293771.zip

Demonstration of the function block MC_SetOverride_BkPlcMc [▸ 37]. Global variables (bOverrideSinusoidal, fOverrideCycleTime, fOverrideMinValue, fOverrideMaxValue) can be used to specify the sequence, the period and the limitations of a signal generator, which modifies the override. Function blocks of type MC_FunctionGeneratorFD_BkPlcMc [▸ 159], MC_FunctionGeneratorTB_BkPlcMc [▸ 161] and MC_FunctionGeneratorSetFrq_BkPlcMc [▸ 160] are used for generating the override.

Example 8: Digital cam controller

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599866507.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192296331.zip

The example shows how to control digital cams through an axis and MC_DigitalCamSwitch_BkPlcMc [▸ 48].
In the example two cams are activated in TRACK_REF_BkPlcMc [▸ 109] (maximum 32). The first cam is activated under three different conditions:
1. from position -1000 mm to 1000 mm and positive direction
2. from position 2000 mm to 3000 mm and positive direction
3. from position 3000 mm to 2500 mm and negative direction
The second cam has only one condition:
1. to be active in positive and negative direction for a time of 1.35 s from position 3000 mm.
In addition to the switching conditions, a cam can also have a switch-on and switch-off delay. For cam 1, the switch-on delay is set to 0.125 s and the switch-off delay is set to 0.250 s. The conditions for switching a cam are specified in CAMSWITCH_REF_BkPlcMc [▸ 69]. The output of a cam is specified in OUTPUT_REF_BkPlcMc [▸ 92].
The axis must be commanded via the PlcMcManger (position greater than 3000 mm).

Example 9: Joystick

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599868683.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192298891.zip

The example demonstrates the use of the function block MC_MoveJoySticked_BkPlcMc [▸ 62]. With this function block, the axis is moved in an endless motion at a velocity specified by JoyStick. Joystick is a normalized value between +/-1.0, which, multiplied by the commanded velocity, results in the set velocity.

Example 10: Identification and linearization

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599870859.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192352651.zip

The example describes the automatic characteristic curve measurement with MC_AxUtiAutoIdent_BkPlcMc [▸ 192] and the use of the characteristic curve with MC_AxRtFinishLinear_BkPlcMc [▸ 176]. The settings for the automatic characteristic curve measurement are accessible in the PlcMcManger under the **LinDef** tab and can be found in the structure ST_TcMcAutoIdent [▸ 93].
In the example, you can choose between three different valve simulations using the global variable nTest. A suitable *.dat* file is loaded according to the selected simulation. The parameters for the characteristic curve measurement are preset in the *.dat* file as required. Caution: If nTest is switched while the PLC is running, the PlcMcManager must be reconnected. The following scenarios can be selected via nTest:

1. Only the overlap and velocity ratio is missing
2. A zero overlap characteristic curve with bend is missing
3. A characteristic curve with overlap is missing

The variable "bStartAuto" can be used to start MC_AxUtiAutoIdent_BkPlcMc [▸ 192]. During the measurement the function block returns Busy, and the already measured characteristic curve is displayed on the **LinTab** tab.
If the measurement was successful, the characteristic curve can be used by the function block MC_AxRtFinishLinear_BkPlcMc [▸ 176]. The characteristic curve is automatically saved and loaded in the *.dat* file of the axis. The function block MC_AxTableToAsciFile_BkPlcMc [▸ 162] is available for exporting the characteristic curve in an ASCII-readable format.

Example 11: Stop function blocks

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599873035.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192355211.zip

The different ways of stopping an axis are compared here. The example can be started by setting the variable bStart to TRUE.

MC_Stop_BkPlcMc [▶ 66]: Executes a stop with preset deceleration parameters. The axis reports ready when the calculated target including target tolerances (in PosRange, in TargetRange for target filter time and in BrakeDistance) has been reached.

MC_EmergencyStop_BkPlcMc [▶ 50]: Brakes with preset ramp to standstill.

MC_ImediateStop_BkPlcMc [▶ 59]: Sets the set value to zero without ramp.

Example 12: Buffering and blending

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599875211.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192357771.zip

The basic procedure for buffered movements is explained in FAQ 20 [▶ 231]. To start the example, the variable bStart must become TRUE. The Scope View shows that there are six movements, which are processed in coupled mode.

Example 13: Filter

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599877387.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192360331.zip

The example shows the behavior of several filter types and what to consider when using filters.
If all signals with the name "Noisy" are switched off in Scope View, the original signal and the filtered signals can be seen with corresponding offsets. The shape of the signal is retained. The more a signal is filtered, the stronger the phase shift between the original and filtered signal. This phase shift has a direct influence on the controllability of axes and other sections.
If the noisy signals are made visible in the Scope, it can be seen that the noise portion in the signal is considerably lower both through a MC_AxUtiSlidingAverage_BkPlcMc [▶ 191] and after a MC_AxUtiPT1_BkPlcMc [▶ 189].

Example 14: Function generator

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599879563.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192362891.zip

In some applications, a setpoint generator is required to generate sinusoidal, trapezoidal or sawtooth signals. For example, the signals generated with MC_FunctionGeneratorTB_BkPlcMc [▶ 161] and MC_FunctionGeneratorFD_BkPlcMc [▶ 159] can be transferred to an axis via MC_AxRtSetExtGenValues_BkPlcMc [▶ 180].

Example 15: Pressure regulator

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599881739.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192365451.zip

The example shows the reading and scaling of an actual pressure value in the application. A pressure control for an axis with MC_AxCtrlPressure_BkPlcMc [▶ 115] is demonstrated.
The application first moves to a position at which a pressure increase is expected via a fast movement. The movement continues at a slower velocity and the controller is activated when the set pressure has been reached.

Example 16: Distributed axis references

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599883915.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192368011.zip

The example shows the use of a list of POINTER TO Axis_Ref_BkPlcMc. The use of MC_AxAdsPtrArrCommServer_BkPlcMc [▸ 199] instead of MC_AxAdsCommServer_BkPlcMc [▸ 198] makes it possible to distribute the axis references.

The list must be updated in each cycle. This update must be carried out before calling MC_AxAdsPtrArrCommServer_BkPlcMc [▸ 199].

Example 18: Locking PlcMcManager

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599886091.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192370571.zip

It may be necessary to disable PlcMcManager commands such as Jog, MoveAbs or Stop. This can be done in the PLC with MC_AxRtCommandsLocked_BkPlcMc [▸ 187].

Example 100: Electronic gearing

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599888267.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192404619.zip

The example shows how two slave axes can be coupled by an electronic gearing via a master axis (axis 3). The coupling is created and released by MC_GearIn_BkPlcMc [▸ 51] and MC_GearOut_BkPlcMc [▸ 55].
It must be ensured that the dynamic parameters of the master and slave are compatible with each other, otherwise the slave cannot follow the master.
To establish the coupling, the master and slave must be in idle state. The coupling can be released during the motion. The master axis moves to the target and the slave axis is stopped when the coupling is released.

Example 101: Electronic cam plate

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599890443.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192407179.zip

Axes 1 and 2 are coupled to virtual axis 3 via a cam plate. In this example, the coupling parameters for axis 1 are stored in the text file *TcPlcMcEx_101_2.txt*. For axis 2, the coupling parameters are calculated in function block "FB_CalculateCamTable2". MC_CamTableSelect_BkPlcMc [▸ 46] is used to specify the master and slave axis and the cam table. In function block MC_CamIn_BkPlcMc [▸ 44] the coupling is generated and the set values for the slave are calculated. If the master axis is moved via the PlcMcManager, the slave axis follows the corresponding cam plate. The coupling is canceled with MC_CamOut_BkPlcMc [▸ 45].

Example 103: Flying gear coupling

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599892619.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192409739.zip

Demonstration of an activated flying gear coupling with function blocks MC_GearInPos_BkPlcMc [▸ 53] and MC_GearOut_BkPlcMc [▸ 55].

Example 104: Synchronization control

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599894795.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192412299.zip

Demonstration of a synchronization control for a two-axis gantry using a virtual master. Synchronization control is always used where two or more axes have to be controlled in a balanced manner. A virtual master axis is used for generating the set values. The set values are distributed to the slave axes, which add their local position controller. For example, the current position of the virtual master axis is calculated as an average value over the slave axes.
In order to ensure smooth commissioning, it is essential that certain parameters are kept the same. This applies in some cases within the group of slave axes, partly also for the master axis. In "FB_Parameter" this is forced by cyclic copying.

Example 105: Linearization for synchronization control

For TC2: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/1599896971.zip

For TC3: https://infosys.beckhoff.com/content/1033/tcplcLibhydraulics30/Resources/zip/9007204192414859.zip

This example demonstrates the characteristic curve determination for a two-axis gantry (see also example 104) with the function blocks MC_AxUtiAutoIdent_BkPlcMc [▶ 192] and MC_AxUtiAutoIdentSlave_BkPlcMc.

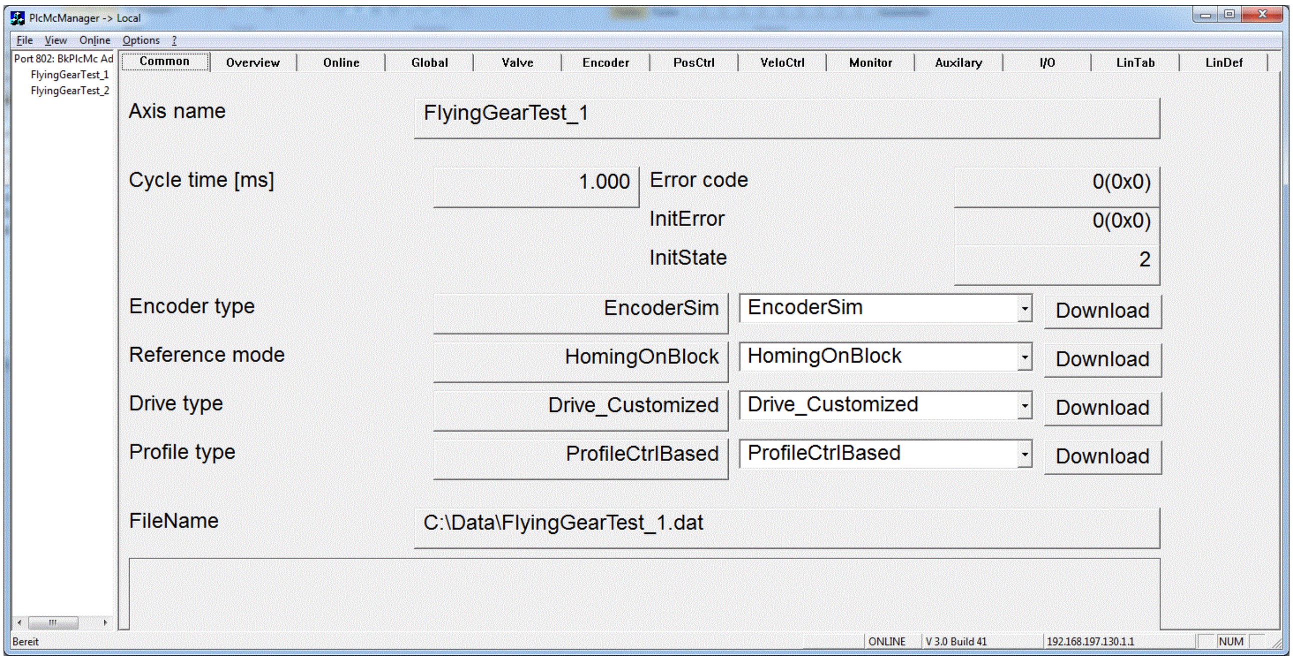
5.7 Commissioning

The procedure described here refers to basic commissioning of an axis of which nothing is known. With identical axes, certain points can be skipped.

5.7.1 Basic settings

In order to start up the real axis, various default settings must be applied.

The corresponding encoder type must be entered in the **General** tab. To do this, the corresponding encoder must be selected via the selection menu and written to the runtime variables via **Activate**. The currently active type is displayed to the left of the selection window.



Axis name	FlyingGearTest_1		
Cycle time [ms]	1.000	Error code	0(0x0)
		InitError	0(0x0)
		InitState	2
Encoder type	EncoderSim	EncoderSim	Download
Reference mode	HomingOnBlock	HomingOnBlock	Download
Drive type	Drive_Customized	Drive_Customized	Download
Profile type	ProfileCtrlBased	ProfileCtrlBased	Download
FileName	C:\Data\FlyingGearTest_1.dat		

The Knowledge Base contains a table [▶ 222], which helps to select the correct encoder type and explains the mapping interface to I/O.

If, for technical reasons, it is not possible to determine the actual position with the standard encoder function block of the library, this task can also be executed by application function blocks. Then enter the result in fActPos and fActVelo in ST_TcHydAxRtData and update the position change in the current cycle in fActPosDelta. bEncoderResponse should be used to indicate whether the actual values could be updated. For the sake of uniformity use should again be made here of the fEnc_IncWeighting, fEnc_IncInterpolation and fEnc_ZeroShift or fEnc_RefShift parameters.

A range of devices and equipment might be functioning as actuators (Drivetyp), applying a variety of physical principles to create a variable velocity that depends on an electrical magnitude. Depending on the corresponding I/O component, the Drivetype must be set in the selection window and the variables must be linked to the field device. The Knowledge Base contains a table [▸ 225] which supports the selection of the type to be set.

If the position measuring system is an incremental system, the corresponding referencing method [▸ 79] must also be defined.

On the **Global** tab you should initially enter 100 for the reference velocity. The value is corrected later, but in this way, overlap etc. can be entered directly in %.

The acceleration and deceleration should be set to 100 mm/s². With this setting, this axis will accelerate to reference velocity in 1 s. The jog parameters should be set to 5 mm/s and 10 mm/s. The creep velocity should be set to 5 mm/sec, the creep distance should be 10 mm and the braking distance 2 mm.

If the valve is covered and the valve data sheet is available, you can enter the overlap from the data sheet on the **Valve** tab.

On the **Encoder** tab, enter the resolution per increment in **Inc. evaluation**. Alternatively, an increment number can also be specified in **Inc. interpolation** and the corresponding path in **Inc. evaluation**.

In the **Controller** tab, the lag and velocity controller must be set to zero.

For further commissioning, a Scope with the following variables should be recorded:

- SetVelo
- ActVelo
- SetPos
- ActPos
- fOutput
- fLagCtrlOutput

If available, record pressures, forces and valve slide position.

If the controller enable and feed enable of the axis are set, the axis must not move. If this is the case, a temporary zero balance must be carried out.

5.7.2 Temporary zero compensation

The **Offset compensation** parameter is set in the **Controller** tab. Depending on the direction in which the axis is drifting, a value between -10 V and +10 V must be entered. As a rule, values of +/- 0.5 V are to be expected.

5.7.3 Movement directions

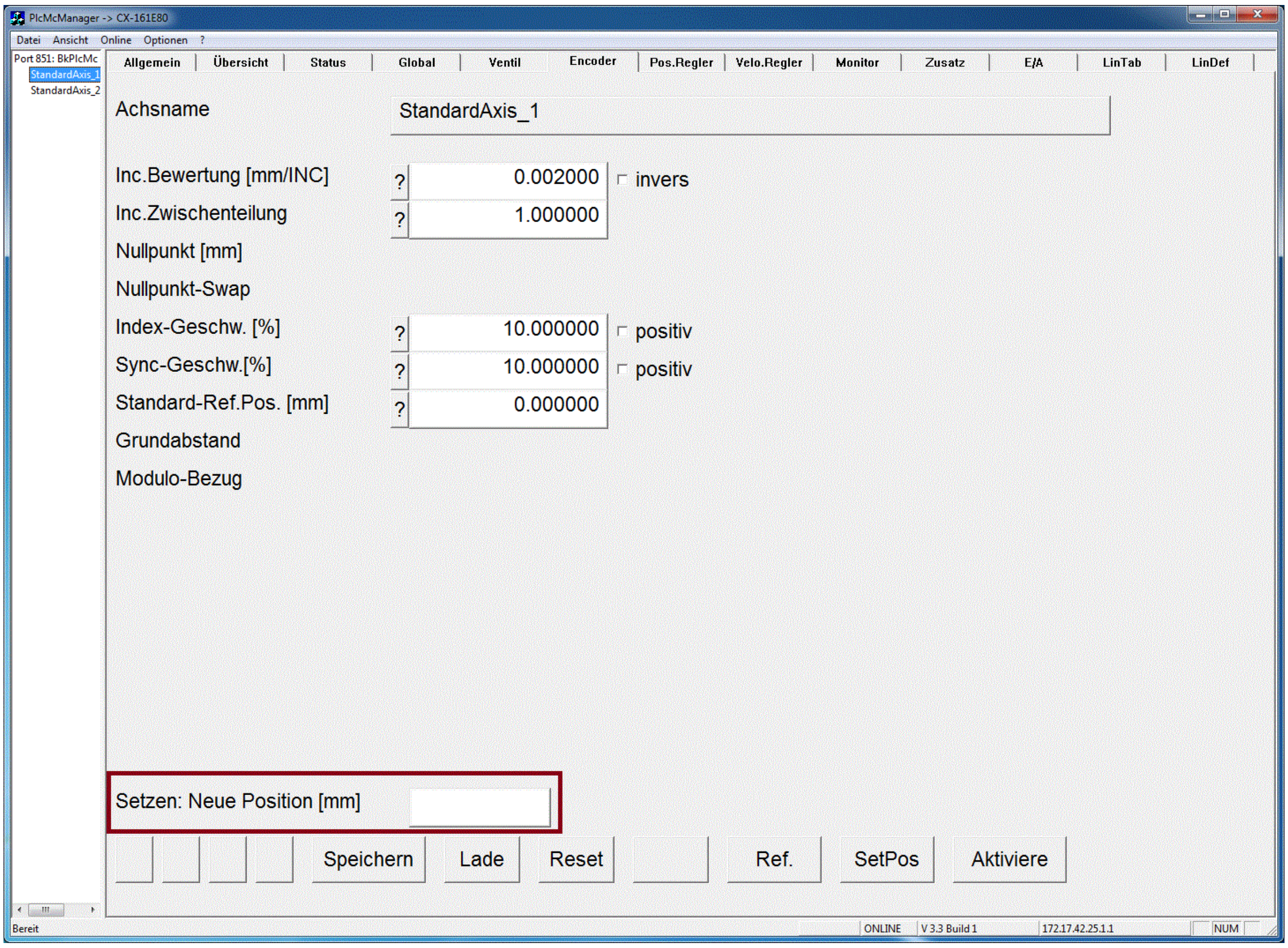
The jog button should be used to move the axis slowly. If this is not the case, the pressure supply must be checked. Furthermore, switching valves may also have to be operated or the compensation of the valve overlap is set too small.

It is recommended to specify a positive direction of movement for the axis that corresponds to the way the machine works. If the axis moves in this direction, the actual position should count upwards. If this is not the case, the counting direction can be inverted on the **Encoder** tab. If the direction of change of the indicated position corresponds to the mechanical movement, but the direction of action of the given commands is not as desired, the output can be inverted on the **Valve** tab.

NOTE! When the valve output is inverted, the offset compensation must be adjusted, as it is not inverted and its effect is reversed.

5.7.4 Position measuring system

The axis should show a plausible actual position for both an absolute and an incremental position measuring system. The zero point of the encoder and the defined zero point of the axis usually do not coincide. On the **Encoder** tab, you can enter the desired current position and transfer it to the axis via the **Set-Pos** button. At this point in time, this set position does not have to match the actual position exactly. Especially with incremental measuring systems, homing is carried out later on.


PlcMcManager -> CX-161E80
Datei Ansicht Online Optionen ?
Port 851: BkPlcMc
StandardAxis_1
StandardAxis_2
Allgemein Übersicht Status Global Ventil Encoder Pos.Regler Velo.Regler Monitor Zusatz E/A LinTab LinDef
Speichern Lade Reset Ref. SetPos Aktiviere
Bereit ONLINE V 3.3 Build 1 172.17.42.25.1.1 NUM

Achsname	StandardAxis_1	
Inc.Bewertung [mm/INC]	0.002000	☐ invers
Inc.Zwischenteilung	1.000000	
Nullpunkt [mm]		
Nullpunkt-Swap		
Index-Geschw. [%]	10.000000	☐ positiv
Sync-Geschw.[%]	10.000000	☐ positiv
Standard-Ref.Pos. [mm]	0.000000	
Grundabstand		
Modulo-Bezug		
Setzen: Neue Position [mm]		

The PlcMcManager adapts the display of the parameters as far as possible to the set encoder type. As a result, different parameters can be visible for different axes.

For incremental encoder types, the diagram shown above appears. The visibility of the parameters for homing depends on the set homing method.

To avoid collisions during commissioning, the software limit switches should be activated and set appropriately in the **Monitor** tab. Since the actual position can differ slightly from the actual position, it is recommended to set the software limit switches a little closer.

5.7.5 Characteristic curve measurement

The characteristic curve measurement (MC_AxUtiAutoIdent_BkPlcMc) not only determines the characteristic curve itself, but also the reference velocity, the velocity ratio and the optional travel distance limits. For more information on the setting options, see the function block itself.

The reference velocity should be preset to an approximate plausible value. One possibility is to calculate the smaller cylinder area (A [mm²]) with the nominal volume flow (Qn [l/min)] of the valve:

Vref:= Qn*1.000.000/60/ A

The **LinDef** tab can be used to implement various settings. Further information can be found here.

If this is activated, the AutoIdent function block starts by first determining the travel limits. The axis is then positioned at a distance of at least 10 % from the travel limits, in order to determine the overlap. Once this has been carried out successfully, the axis moves to the lower end and starts measuring. Depending on the available travel distance, several measurements are carried out in each direction.

Once the characteristic curve has been successfully measured, it can be viewed in the **LinTab** tab. A successfully measured characteristic curve can be recognized by the fact that stParams.bLinTabAvaiable is TRUE.

The chapter Coverage and reference velocity should be skipped if the characteristic curve was measured successfully.

5.7.6 Overlap

In order to determine the overlap, the set velocity must be increased slowly until a response by the actual velocity can be recognized. It is possible that the set velocity must be increased to a value of up to 30 mm/s before a response of the actual velocity can be seen. When measuring the overlap, the overlap itself should always be set to zero.

If different velocity set values are required in order to move the axis in positive or negative direction from standstill, this indicates an asymmetric valve. In this case the check mark **Asym** in the **Global** tab must be set and activated. The valve can now be parameterized separately in positive and negative direction.

The set velocity at which the axis moves must be entered under Overlap in the "Valve" tab. If the overlap has already been assigned a value, this value must be taken into account. For asymmetric valves ensure that the entry is made in the correct field; the overlap for the positive direction is expected in the upper field, the overlap for the negative direction in the lower field.

After this optimization the axis should also respond at different small velocities. Whether the axis responds with the right velocity is not important.

If an overlap has been entered from the data sheet and the axis always moves too fast, the overlap should be reduced.

5.7.7 Reference velocity/velocity ratio

NOTE! This chapter describes manual commissioning. A characteristic curve measurement also determines the parameters discussed here. If it is used, this chapter should be skipped.

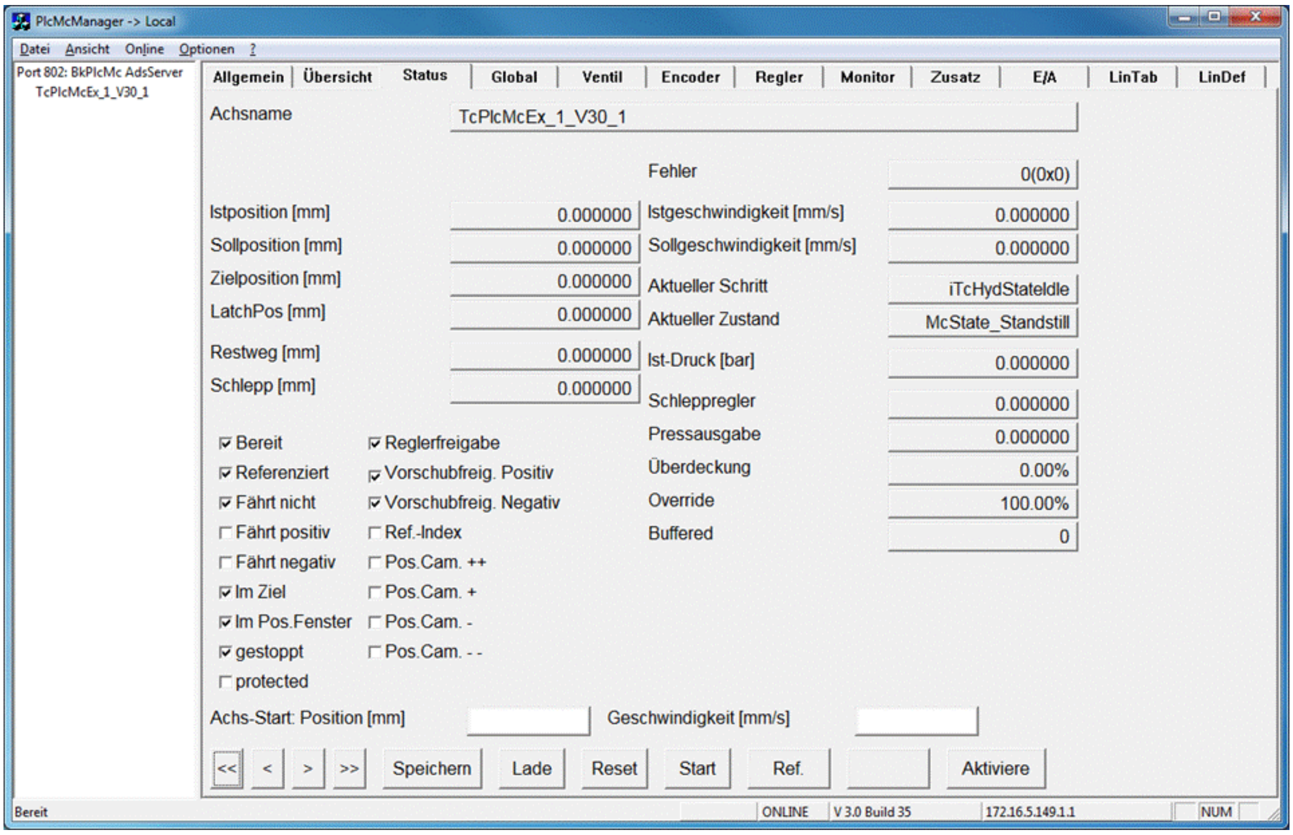
Once the axis can be moved at low velocity, the reference velocity must be set.

In order to determine the reference velocity, the set velocity is increased step-by-step, and a check is carried out to determine whether the axis follows with approximately the set velocity.

NOTE! In this step, only movements in the faster direction are to be evaluated. The oil is transported into the small piston surface! The next step deals with directional dependency.

To trigger the required movements, the position and velocity can be specified in the **Status** tab. The movement is executed with the Start button. The previously created Scope View should be used to analyze the velocities.

NOTE! The software limit switches should be activated and set so that the axis does not hit the mechanical limit stops.



Achsname	TcPlcMcEx_1_V30_1		
		Fehler	0(0x0)
Istposition [mm]	0.000000	Istgeschwindigkeit [mm/s]	0.000000
Sollposition [mm]	0.000000	Sollgeschwindigkeit [mm/s]	0.000000
Zielposition [mm]	0.000000	Aktueller Schritt	iTcHydStateIdle
LatchPos [mm]	0.000000	Aktueller Zustand	McState_Standstill
Restweg [mm]	0.000000	Ist-Druck [bar]	0.000000
Schlepp [mm]	0.000000	Schleppregler	0.000000
		Pressausgabe	0.000000
		Überdeckung	0.00%
		Override	100.00%
		Buffered	0

✓ Bereit	✓ Reglerfreigabe
✓ Referenziert	✓ Vorschubfreig. Positiv
✓ Fährt nicht	✓ Vorschubfreig. Negativ
☐ Fährt positiv	☐ Ref.-Index
☐ Fährt negativ	☐ Pos.Cam. ++
✓ Im Ziel	☐ Pos.Cam. +
✓ Im Pos.Fenster	☐ Pos.Cam. -
✓ gestoppt	☐ Pos.Cam. - -
☐ protected	

Achs-Start: Position [mm] Geschwindigkeit [mm/s]

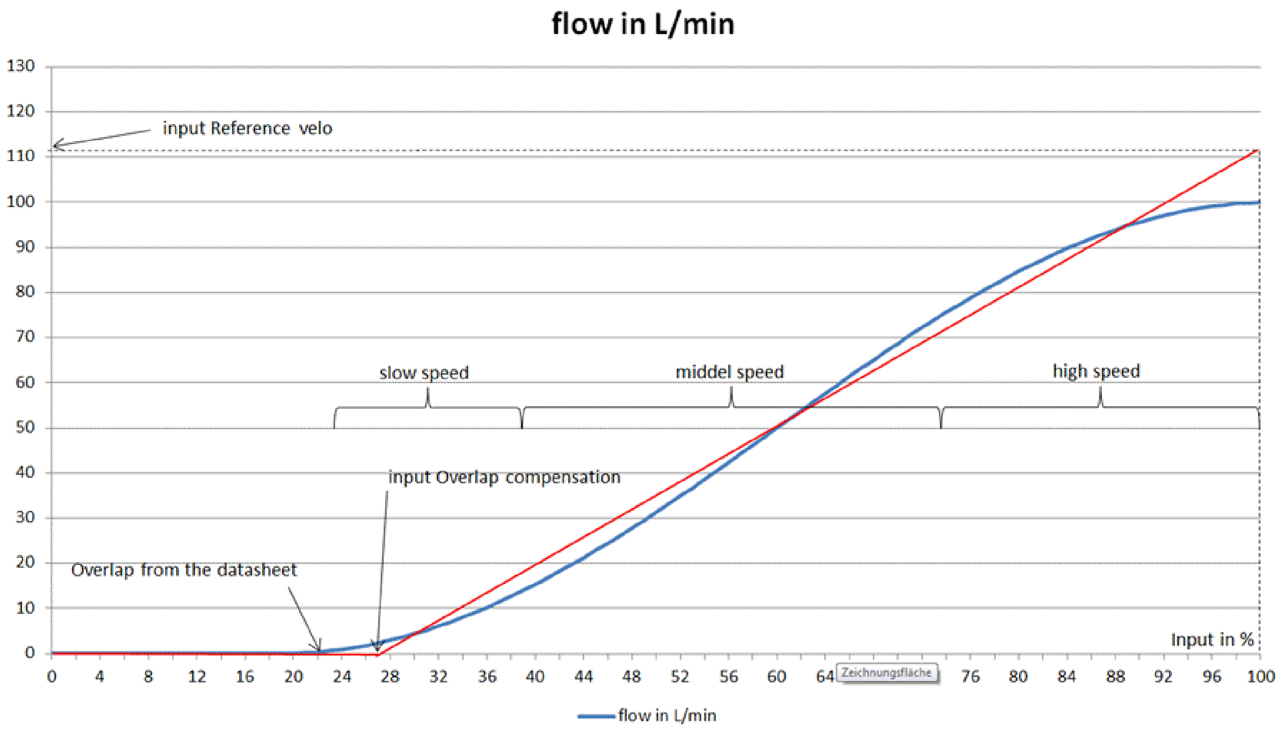
If the actual velocity is much lower than the set velocity, the reference velocity should be reduced.

If the actual velocity is much higher than the set velocity, the reference velocity should be increased.

The appropriate reference velocity has been found when the medium to high set and actual velocities almost match.

NOTE! The reference velocity does not have to correspond to the actual or calculated maximum velocity of the axis.

The following diagram shows the linearization section-by-section through overlapping and reference velocity with a non-linear characteristic curve. It is left to the user to decide where the maximum deviation between the linearization and the actual characteristic curve can occur.



The usual asymmetry of the cylinders causes the axis to move too slowly in the slower direction at any commanded velocity when the reference velocity is set. This behavior can be compensated for on the Valve tab by using the velocity ratio parameter.

When the behavior is symmetrical, this parameter should be set to 1,000. If the positive direction of travel is the slower direction, use a value greater than 1,000. If the negative direction of travel is the slower direction, a value less than 1,000 should be used. This increases the output in the slower direction and compensates for the asymmetry.

NOTE! With this compensation, the output can only be increased up to its maximum value. The parameterization must be carried out at velocities that the axis can reach in both directions.

NOTE! If the parameter is changed in the wrong direction, the velocity decreases in the faster direction. In this case the reference velocity must not be corrected.

5.7.8 Referencing

For incremental position measuring systems: Now at the latest, the axis should be referenced correctly and fully. Enter the index velocity, index direction, sync velocity, sync direction and the reference position under the **Encoder** tab. For more information see MC_Home_BkPlcMc [▶ 57].

NOTE! It may be necessary to reset the travel limits.

5.7.9 Dynamics/target approach

At this point in time, the axis is able to position with different velocities and moderate dynamics.

On the **Monitor** tab you can set when the axis should report ready. An axis is in the target if the remaining distance is smaller than PosRange and BrakeDistance; for the TargetFilterTime the remaining distance must be smaller than Targetrange. These three parameters must be set appropriately according to the application requirements.

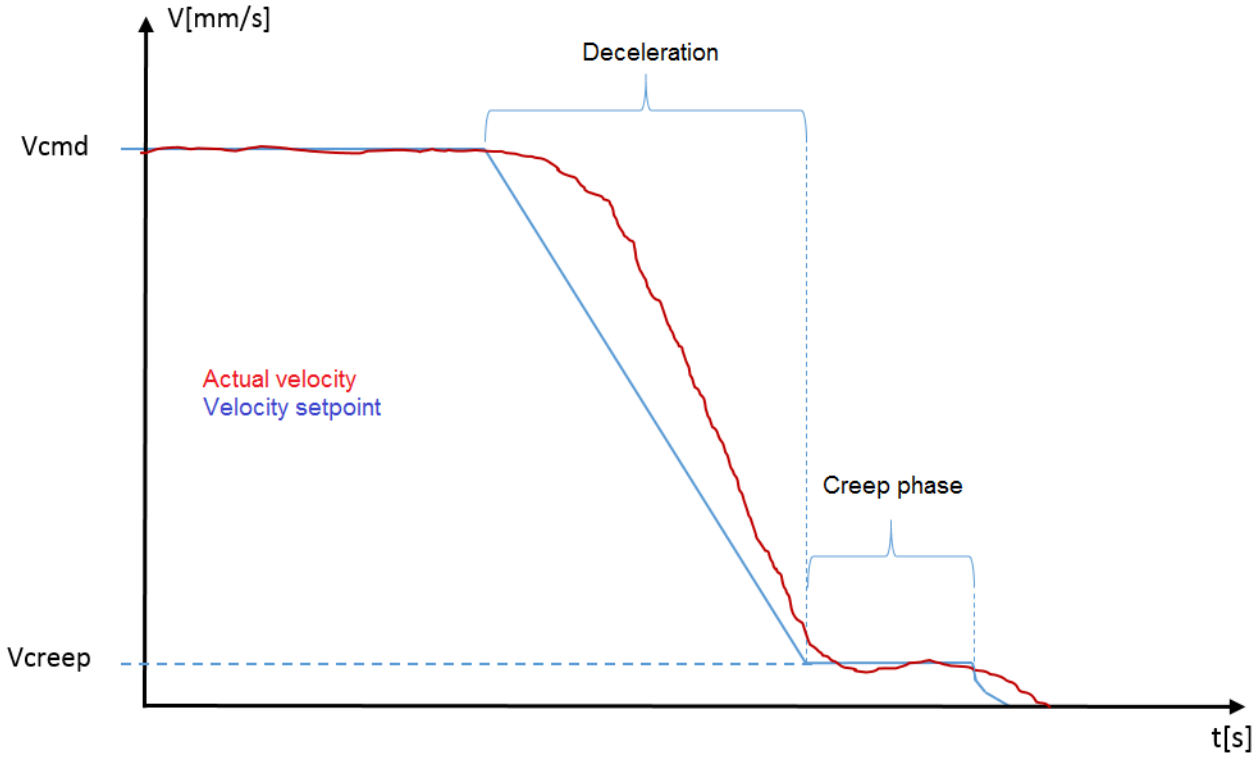
The user subsequently has to decide whether the axis should be positioned time-based or displacement-based.

Most hydraulic applications can be operated path-controlled. If, however, time-based profile generation is necessary, the **TimeBased** check mark should be set.

5.7.9.1 Displacement-based axis

The position controller is only active for the target approach.
The acceleration can be set so steeply that the axis gently accelerates without significant jerks when it starts moving.
For braking on the target approach, not only the deceleration but also the creep distance, creep velocity and braking distance must be set. All three parameters depend on each other and influence the target approach. If the axis is within the braking distance, it is only controlled by the position controller. The creep velocity and creep distance are used to stabilize the axis after deceleration, in order to take it to its target via the position controller.

The target approach should look like this:



It is often observed that an axis that is extremely slowed down requires a longer creep phase in order to position as accurately as an axis with a gentler deceleration.

5.7.9.2 Time-based axis control

If the axis control is to be time-based, the position controller is active during the entire motion. This option should only be used for axes with a high natural frequency and ideally with a zero overlap valve.

The acceleration must be limited to values that the axis can follow without strong vibration. Special attention should be paid to starting up.

When braking, the deceleration must be adjusted so that the axis can follow the set value ramp.

The creep velocity, creep distance and braking distance can be set to zero. The actual position must follow the set position to avoid overshooting. If this is not the case, the pre-control must be reduced.

At this point, the axis is fully commissioned for positioning. If a pressure regulator, cam plate or gear coupling is used in the application, these elements must also be put into operation.

6 Appendix

6.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages:
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You will also find further documentation for Beckhoff components there.

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