SIEMENS

SIMOTION

SIMOTION SCOUT
Output Cams and Measuring Inputs

Function Manual

11/2010

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Contents

Preface 1

This **document** is part of the **System and Function Descriptions** documentation package.

Scope

This manual applies to SIMOTION SCOUT in association with the SIMOTION Cam or Cam_ext technology package for product version 4.2.

Chapters in this manual

This manual provides information about the functions, operation, command execution, and technology alarms of the technology objects.

- **Output Cam technology object** (part I)
  Functions and operation
- **Cam Track technology object** (part II)
  Functions and operation
- **TO measuring input** (part III)
  Functions and operation
- **Index**
  Keyword index for locating information

1.1 SIMOTION Documentation

An overview of the SIMOTION documentation can be found in a separate list of references.

This documentation is included as electronic documentation in the scope of delivery of SIMOTION SCOUT. It comprises 10 documentation packages.

The following documentation packages are available for SIMOTION V4.2:

- SIMOTION Engineering System
- SIMOTION System and Function Descriptions
- SIMOTION Service and Diagnostics
- SIMOTION IT
- SIMOTION Programming
- SIMOTION Programming - References
- SIMOTION C
- SIMOTION P
- SIMOTION D
- SIMOTION Supplementary Documentation

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Output Cam TO - Part I

2

2.1 Overview of Output Cam TO

2.1.1 General information about the Output Cam TO

The **Output Cam** technology object

- Generates position-dependent switching signals
- Can be assigned to positioning axes, synchronous axes, path axes or external encoders
- The axes can be real or virtual.

Different switching signals distinguish different types of output cam:

- **Software cam**
  Switching signals are used internally in the user program by evaluating the relevant **state** system variable.
- **Hardware cam**
  Switching signals are output **externally** on I/O devices by assigning a digital output to the Output Cam TO. For example, digital output modules from the ET 200 I/O system can be used for the cam output.

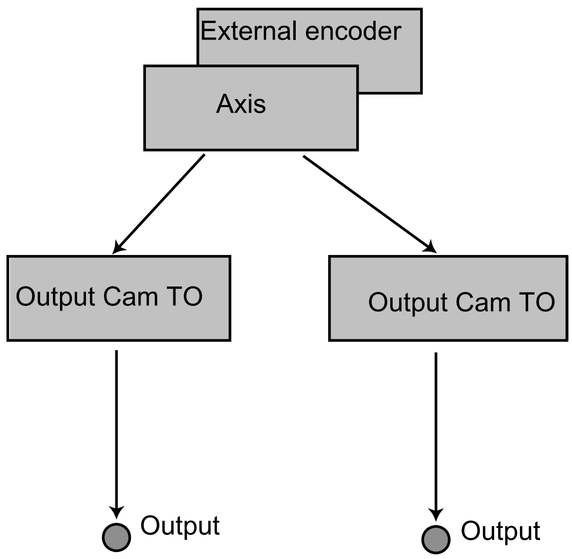

Figure 2-1 Interconnection options for the output cam TO

A range of output cam types with different switching behaviors are available.

- Position-based cam

  The switching signal is supplied between the switch-on position and the switch-off position.
- Time-based cam

  The switching signal is supplied for a specified time period after the switch-on position is reached.
- Unidirectional output cam

  The switching signal is supplied when the axis reaches the switching position and is then reset by the user.
- Counter cam

  Counter cams are not a separate output cam type, but rather position-based or time-based type cams. Counter cams can be configured so that they are output for every switching or for every nth switching. They can only be programmed and activated in the user program.
- Cam output types

  While output cams are usually output in the IPO cycle clock or the position control cycle clock, high-speed output cams provide better output accuracy than the position control cycle clock because the switching edges are positioned within the position control cycle clock.

2.1.2 Functionality

It is possible to define an effective direction for the Output Cam TO, i.e. the output cam is only active when the direction of motion of the axis is the same as the effective direction.

The output cam can be calculated in the position control cycle clock, IPO cycle clock, or IPO2 cycle clock.

The reference values of the cam depend on the axis type or the external encoder:

Table 2- 1 Reference to the actual or setpoint position

Technology object	Reference to actual position possible	Reference to position setpoint possible
Real drive axis	-	-
Real position axis	X	X
Real synchronized axis	X	X
Virtual axes	-	X
External encoder	X	-

In this case, the output cam functionality can be applied to axes or external encoders with or without modulo properties.

The output cam is also effective for axes that have not been homed.

The Output Cam technology object is assigned to exactly one output during configuration. Output can be achieved via:

- Integrated I/Os
- Drive I/O (e.g. TB30, TM31, TM1x)
- SIMOTION C centralized I/O
- Distributed I/Os; PROFIBUS DP I/Os (e.g. ET 200M)

However, the output must not be in the process image.

The switching accuracy is dependent on the following:

- Output accuracy of the I/O
- How the output cam is allocated in the task system
- How constant deceleration times are compensated

Several Output Cam TOs can be connected to the same output (see Section **Logical operation**). Alternatively, the Cam Track TO can be used for this purpose.

Example

Lines of glue are applied to a wooden board. The output cams are assigned to an external encoder. Output cams assigned to outputs Q 0 to Q 4 are switched on and off at specified positions.

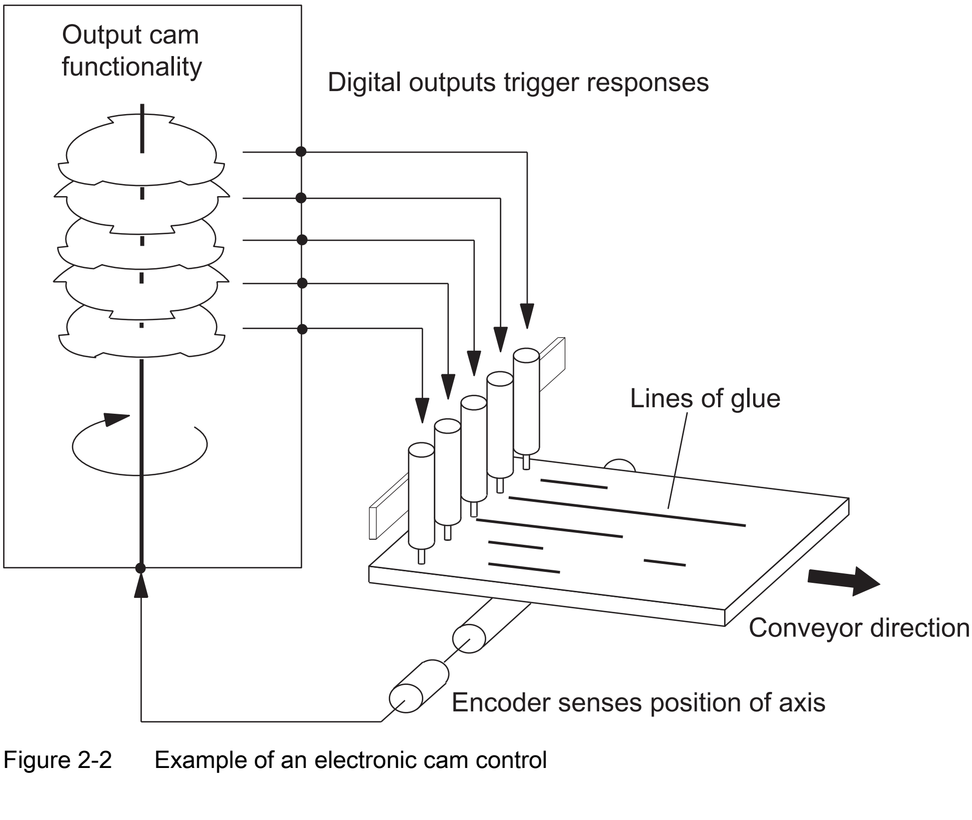

Figure 2-2 Example of an electronic cam control

See also

Logical operation (Page 30)

2.1.3 Comparison of Output Cam TO and Cam Track TO

Depending on the application, it may be practical to use either the Cam Track TO or one or more Output Cam TOs. The table below should help you to decide which TO should be used in which case.

Table 2- 2 Comparison of Output Cam TO and Cam Track TO

Features	Output Cam TO	Cam Track TO
Availability	• As of Version 1.0	• As of Version V3.2
Supported output cams	• Position-based cam • Time-based output cam • Unidirectional output cam • Counter cam • Exact time setting of an output, exact time output cams (as of V4.1)	• Position-based cam • Time-based output cam • Time-based cam with maximum ON length
Several output cams on one output	• Via logical operation (AND/OR)	• Maximum 32 output cams of the same type in one track • No cam track logical operations (AND/OR)
Different types of output cam on one output	• Via AND/OR	• Not available
Output cam definition	• Related to axis • Via system variables	• Related to cam track (cam track can be mapped as required on axis) • Via system-variables array
Hysteresis	• Available	• Available
Effective direction	• Available	• Not available
Derivative-action times	• Separate for power ON/power OFF	• Separate for power ON/power OFF
Deactivation time for time-based cam	• As of Version V3.2	• As of Version V3.2
Activation/deactivation types	• Active immediately	• Start and stop mode parameterizable
Types of output	• Cyclic	• Cyclic • Once
Output cam status	• System variable	• Status of single output cams over one array of byte
Output cam enable	• Via_enableOutputCam	• via_enableCamTrack • Validity of single output cams configurable via system variables
Performance	• Depends on number of single output cams	• When 5 or more output cams are used in one output cam track instead of 5 single output cams, the output cam track performs better. This performance advantage amounts to at least a factor of 2 for 32 single output cams.
MCC command available	• Available	• Available (V4.0 and higher)

2.2 Output cam TO basics

2.2.1 Output cam type

2.2.1.1 Software cam

Switching signals are used **internally** in the user program by evaluating the relevant **state** system variable.

2.2.1.2 Hardware cam

Switching signals are output **externally** on I/O devices by assigning a digital output to the Output Cam TO.

The following can be used as digital outputs:

- Onboard outputs (SIMOTION C, D, ...)
- Centralized I/O (SIMOTION C)
- Distributed I/Os via PROFIBUS DP (e.g. ET 200M) and PROFINET IO (e.g. ET 200S)
- Drive I/O (for example TM15 and TM17 high feature terminal modules)

Hardware for output cams

Cam output on cam output (I/O channel is configured as CAM)

- SIMOTION D4x5-2 (X142, V4.2 or higher)
- TM15, TM17 high feature

Cam output on high-speed output with direct access (I/O channel is configured as DO)

- SIMOTION D4xx / D4x5-1
- SIMOTION D4x5-2 (X142, V4.2 or higher)
- SIMOTION C240, C240 PN

Cam output on standard output (I/O channel is configured as DO)

- SIMOTION C/D/CX onboard I/O
- SINAMICS onboard I/O
- TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30
- Standard DO (SIMATIC ET200, ...)

For more information, see cam output types. (Page 18)

2.2.1.3 Position-based cam

Direction-neutral switching

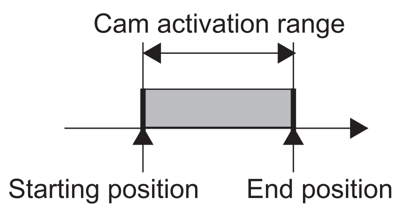

Figure 2-3 Position-controlled output cam with start position less than end position

Limits imposed by start and end positions

The output cam is activated:

- Axis position is within the switch-on area
- Axis position value is shifted into the switch-on area of the output cam

  The position value of the interconnected object can change abruptly, for example, when it is homed or when its coordinate system is shifted with the **_redefinePosition** command.

The output cam is switched off:

- When the axis position is outside the start or end position
- When the axis position value is shifted outside the switch-on area
- When commands are issued that deactivate the output cam, e.g. **_disableOutputCam**, **_setOutputCamState**, and **_resetOutputCam**

Switch-on area

The switch-on area of the output cam is defined from the start position to the end position in a positive counting direction, i.e. within a range between the start position and the end position. If the end position is greater than the start position, the switch-on area is defined by the start and end positions (see figure above).

The switch-on area is outside the area between the end and start positions if the end position is less than the start position (see figure below).

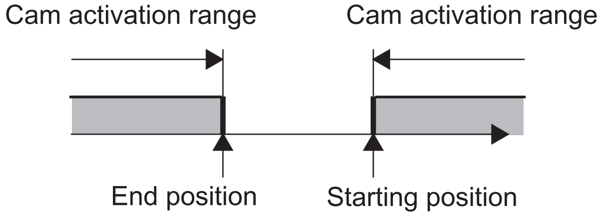

Figure 2-4 Position-controlled output cam with end position less than start position

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Note

This definition of the switch-on area is possible for all modulo and non-modulo axes.

ON duration

The ON duration of the output cam depends on the velocity at which the axis traverses the output cam length.

Direction-dependent switching

The output cam is activated:

- When the axis position is between the start and end positions, and the axis is moving in the programmed effective direction

The output cam is switched off:

- When the axis position is outside the start or end position
- When the motion direction is not the same as the assigned effective direction
- When the axis position value is shifted outside the switch-on area
- When commands are issued that deactivate the output cam, e.g. _disableOutputCam, _setOutputCamState, and _resetOutputCam

2.2.1.4 Time-based output cam

Direction-neutral switching

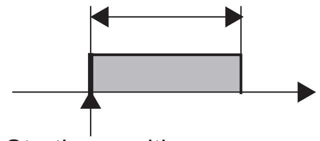

Figure 2-5 Time-controlled output cam

Limits imposed by starting position and ON duration

The output cam is switched on:

- At the starting position.

  If the starting position is overrun again during the ON duration, the time-based cam is not switched on again. It is not possible to retrigger a time-based cam.

The output cam is switched off:

- When the assigned time period expires
- When commands are issued that deactivate the output cam, e.g. _disableOutputCam, _setOutputCamState and _resetOutputCam

Output cam length

The output cam length is dependent on the velocity at which the assigned axis traverses during ON duration of the output cam.

Direction-dependent switching

The output cam is switched on:

- At the starting position if the traversing direction is the same as the effective direction

The output cam is switched off:

- When the assigned time period expires
- When commands are issued that deactivate the output cam, e.g. **_disableOutputCam**, **_setOutputCamState** and **_resetOutputCam**

A change of direction will not lead to the output cam being switched off if the time-based cam has already been activated.

2.2.1.5 Unidirectional output cam

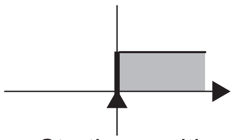

Figure 2-6 Unidirectional output cam

Limits imposed by starting position

The output cam is switched on:

- At the starting position if the axis is moving in the programmed effective direction

The output cam is switched off:

- By the **_disableOutputCam**, **_setOutputCamState** and **_reset** commands

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Note

The unidirectional output cam does not switch unless the starting position is explicitly crossed, e.g. by setting the actual value.

An end position is not defined for the unidirectional output cam. The output cam signal depends solely on the switching criteria when the output cam is crossed over. The unidirectional cam can be reset via the program (e.g. by calling up the system function **_enableOutputCam** again).

2.2.1.6 Counter cam

For a counter cam, it can be specified whether the output cam is to be output **every** time it switches or every **nth** time it switches.

Note

Counter cams can only be configured for position-based and time-based cams. A counter cam is used via the **_setOutputCamCounter** system function.

Counter cams can only be defined in the user program. In configuring the output cam, the output cam type **cannot** be defined as counter cam.

Every counter cam has a starting count value and a current count value.

The current count value for the output cam is reduced by 1 every time the output cam switches. If the current count reaches 0, the output cam is output (**state** system variable and output cam output). At the same time, the current count value is reset to the starting count value. If the current count value does not reach 0, the output cam output is suppressed. The default setting of the starting count value and current count value is 1. The starting count value and current count value are programmed by means of the **_setOutputCamCounter**. The current count values can be scanned with the **counterCamData.actualValue** and **counterCamData.startValue** system variables. No resetting of the values by the system takes place, e.g. after **_enableOutputCam** or **_disableOutputCam**.

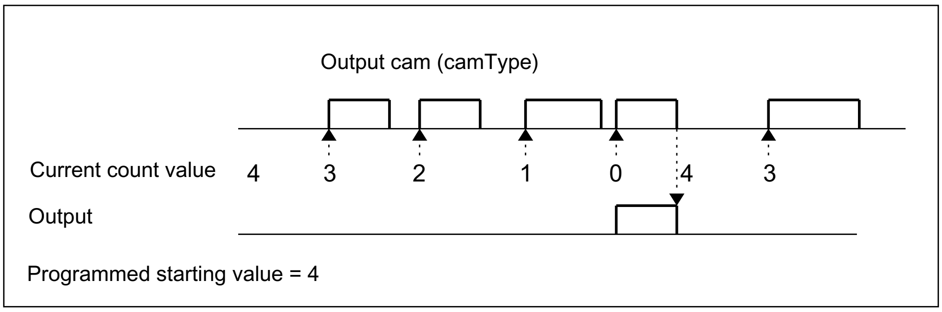


Figure 2-7 Example of a counter cam

2.2.1.7 Cam output types

The output cam calculations are performed in the execution cycle (IPO or IPO2 cycle clock or in the position control cycle clock). For the possible setting IPO_fast, see the chapter entitled Second position control cycle clock (Servo_fast) in the Motion Control Basic Functions manual.

The temporal resolution of cam output depends on the hardware used and the setting in the configuration. In standard applications, the setting is undertaken using screens. The configuration data can also be set via the expert list

The possible setting options for cam output are described below:

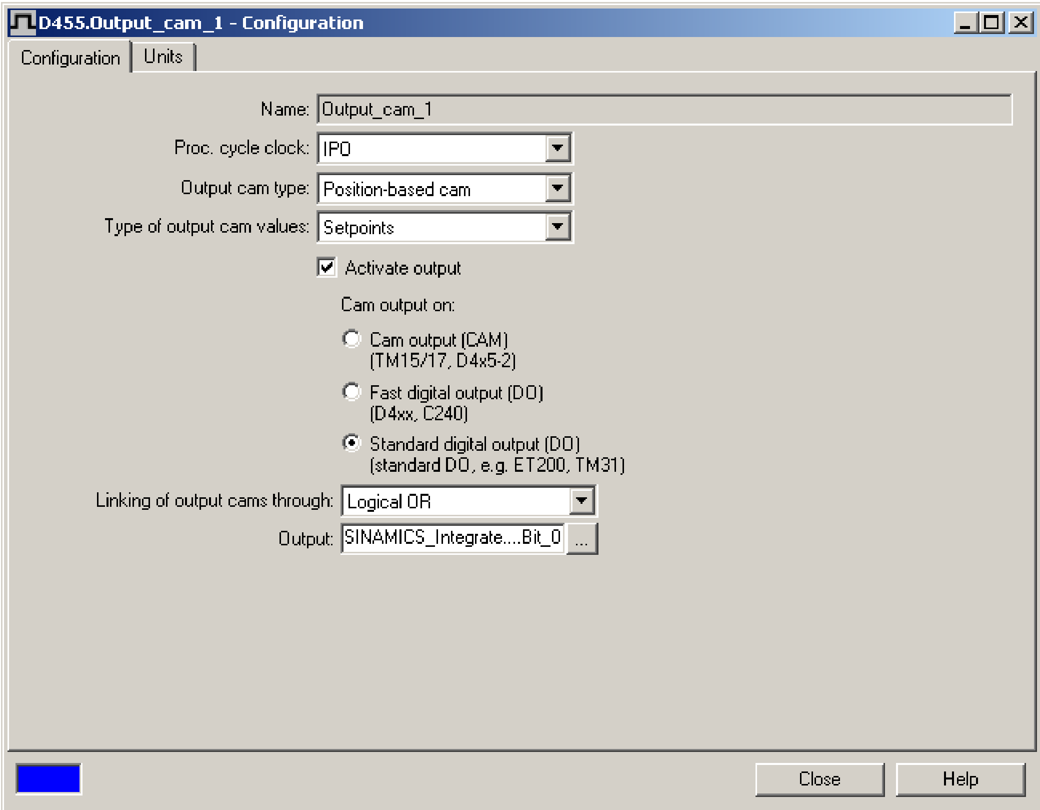


Figure 2-8 Output cam configuration using the example of a position-based cam

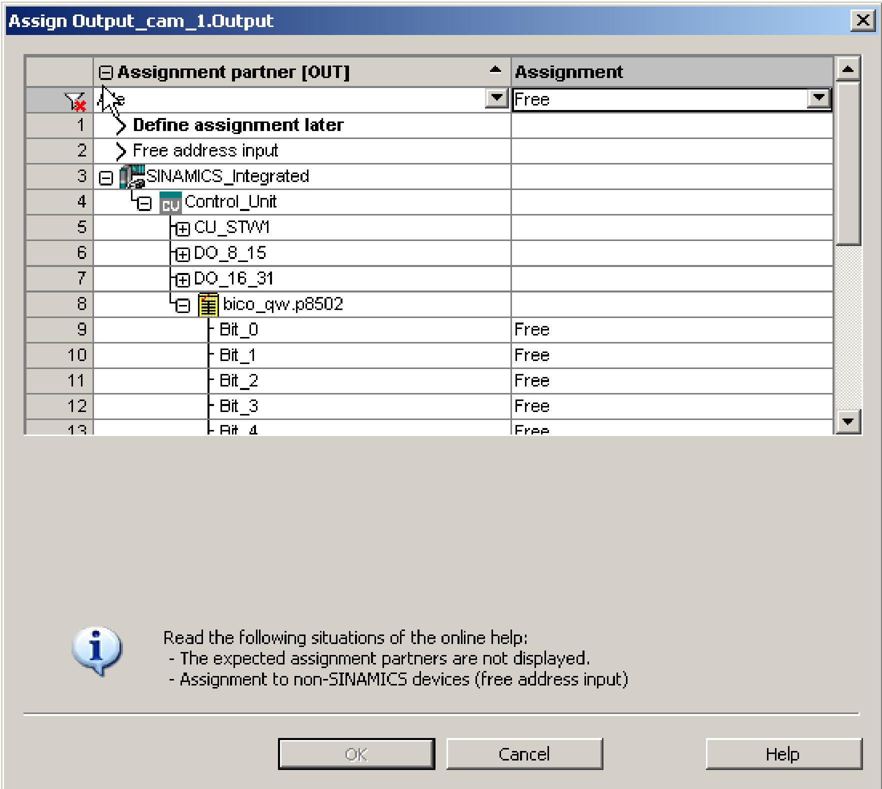


Figure 2-9 Assignment dialog

Symbolic assignment is activated by default in projects as of V4.2 (**Project > Use symbolic assignment**)

Cam output (CAM)

Cam output is based on an internal time stamp. The temporal resolution of cam output depends on the hardware used. In the case of D4x5-2 and the TM17 high feature, the resolution is 1 µs.

Hardware supported

- SIMOTION D4x5-2 (X142)
- TM15, TM17 high feature

The I/O channel must be configured as CAM.

SIMOTION D4x5-2 onboard outputs (interface X142)

The D4x5-2 onboard outputs can be used as cam output (CAM) from the user program. The D4x5-2 onboard outputs are permanently assigned to SIMOTION. The X142 I/Os are configured using HW Config.

The X142 configuration screen can be accessed directly from the project navigator in SIMOTION SCOUT.

With SIMOTION D4x5-2, output cams are output at the X142 interface with a resolution of 1 µs.

TM15 / TM17 high feature Terminal Modules

The TM15 and TM17 high feature terminal modules can be used to set up cam outputs (CAM) within the SIMOTION Motion Control system. The terminal modules are connected directly to SIMOTION D or CX32/CX32-2 via DRIVE-CLiQ for this purpose.

Alternatively, TM15 and TM17 high feature can be connected to a SINAMICS S120 Control Unit

CU320/CU320-2/CU310 with higher-level SIMOTION C, P or D.

Output cams on the TM15 operate with DRIVE-CLiQ cycle-clock resolution (typically 125 µs).

Output cams on the TM17 high feature have a resolution of 1 µs.

High-speed digital output (DO)

Output cams are output via SIMOTION CPU onboard outputs. Output is via a hardware timer, which achieves cam output with a temporal resolution < position control cycle clock.

The time that it takes for the axis to reach the output cam switching position with reference to the processing cycle clock is calculated by linear extrapolation. Calculated from the beginning of the 1st position control cycle clock, the output cam function is triggered by a hardware time when this time is reached.

Hardware supported

The onboard I/O of the following CPUs is used:

- SIMOTION D4x5-2 (interface X142), 8 high-speed cam outputs, V4.2 or higher (The I/O channel must be configured as **DO**)
- SIMOTION D4x5 (interface X122, X132), 8 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**)
- SIMOTION D410 (interface X121), 4 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**)
- SIMOTION C240, C240 PN (interface X1), 8 high-speed cam outputs

SIMOTION D410/D4x5 onboard outputs

Output cams are output via **a high-speed digital output (DO).**

- Up to and including SCOUT V4.1 SP5, all D410/D4x5 onboard I/Os configured as digital outputs are exclusively available to SIMOTION
- As of SCOUT V4.2, D410/D4x5 onboard I/Os configured as digital outputs can be switched over to SINAMICS using BICO interconnection (channel granular)

SIMOTION D4x5-2 onboard outputs (interface X142)

Output cams are output via a "high-speed digital output (DO)". The D4x5-2 onboard outputs are permanently assigned to SIMOTION.

The X142 I/Os are configured using HW Config.

The X142 configuration screen can be accessed directly from the project navigator in SIMOTION SCOUT.

Standard digital output (DO)

The output cam calculations are performed in the processing clock cycle (IPO or IPO2 cycle clock or position control cycle clock).

Actual cam output takes place in the position control cycle clock. The temporal resolution of cam output is usually reduced by the output cycle of the I/O used.

Therefore the resolution

- with a standard I/O (e.g. ET 200) depends on the cycle time of the bus system (PROFIBUS DP / PROFINET IO)
- with TM15 / TM17 depends on the cycle time of the bus system (PROFIBUS Integrated / PROFIBUS DP / PROFINET IO)
- with TM15 DI/DO, TM31, TM41, TB30 depends on the configured sampling time
  - cu.p0799 (CU inputs/outputs sampling time) for TB30 and onboard outputs
  - p4099 (TMxx inputs/outputs sampling time) for TM15 DI/DO, TM31 and TM41

Hardware supported

- Onboard outputs (SIMOTION D, Controller Extension CX, SINAMICS Control Unit CU3xx)
- Centralized I/O (SIMOTION C)
- Distributed I/O via PROFIBUS DP/PROFINET IO (e.g. ET 200, ...)
- Drive I/O TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30

Configuration data of cam output types in expert list

Table 2- 3 Setting options for cam output

Selection in configuration screen	Setting in expert list
Cam output (CAM) (TM15/17, D4x5-2)	OcaBaseCfg.outputType = [1] TIME_STAMP OcaBaseCfg.hwTimer = [91] NO
High-speed digital output (DO) (D4xx, D4x5-2, C240)	OcaBaseCfg.outputType = [0] STANDARD OcaBaseCfg.hwTimer = [173] YES
Standard digital output (DO) (Standard DO, e.g. ET200, TM31)	OcaBaseCfg.outputType = [0] STANDARD OcaBaseCfg.hwTimer = [173] NO

Output cams on **cam output (CAM)** or on **high-speed digital output (DO)** are also referred to below as high-speed, hardware-supported output cams.

Note

Further information and the output accuracy for high-speed output cams is described in the PM21 catalog and in the respective product brief or commissioning/equipment manual.

Commissioning Manual *Terminal Modules TM15/TM17 High Feature*
Operating instructions *SIMOTION C2xx*
Commissioning Manual SIMOTION D410
Commissioning and Hardware Installation Manual SIMOTION D4x5
Commissioning and Hardware Installation Manual SIMOTION D4x5-2

See also

Configuring cams on SIMOTION D4xx onboard (Page 42)

2.2.1.8 Exact time setting of an output, exact time output cams (as of V4.1)

You can switch a high-speed output cam On/Off at an exact time within an execution cycle (position control, IPO cycle) via the **timeOffset** parameter of the **_setOutputCamState** system function.

Enter an offset of the switching edge in the configured unit (e.g. s) of the Output Cam TO in the **timeOffset** parameter. The reference point of the offset is the start of the next execution cycle of the Output Cam TO. You can read out the value of the time offset (system-dependent execution time between the execution cycle and the output cycle) in the **tOutput** system variable. The time in **tOutput** is the earliest possible time to switch the output cam. The **timeOffset** is added to this time.

Features

- The offset must be less than the cycle clock time of the processing cycle clock. The offset is limited automatically and a technological alarm is output when the cycle clock time is exceeded.
- It is possible to switch on or off within a cycle clock.
- When this function is used, there is a dependency on the processing cycle clock and the set cycle clock times.
- The offset is valid for every output cam type. If only switched once, the unidirectional output cam type is recommended.
- The offset can only be stated if the output cam TO on the outputs is configured with a time stamp (cam output (CAM)).
- For output cams without time stamp (e.g. C230-2 onboard output cams), **tOutput** (time stamp) is set to 0.0.

- If multiple activation or deactivation signal edges are issued in a cycle clock, the most recently written values apply.
- The start of the output cycle clock is shifted with respect to the beginning of the processing cycle clock by the value output in the **tOutput** system variable and the specified **timeOffset**.

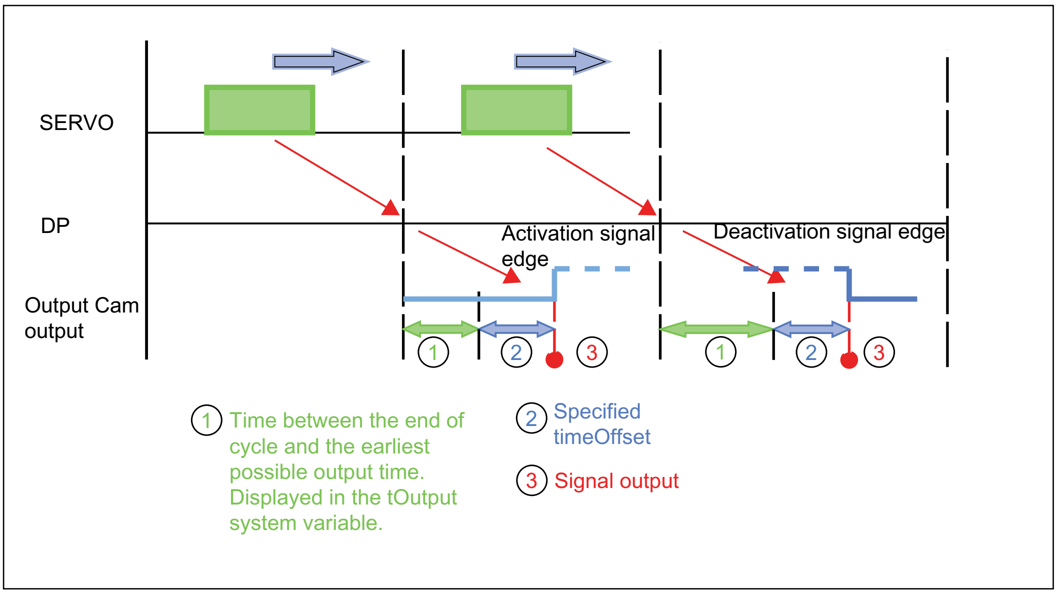


Figure 2-10 Exact-time output setting for DP:POSITION CONTROL=1:1

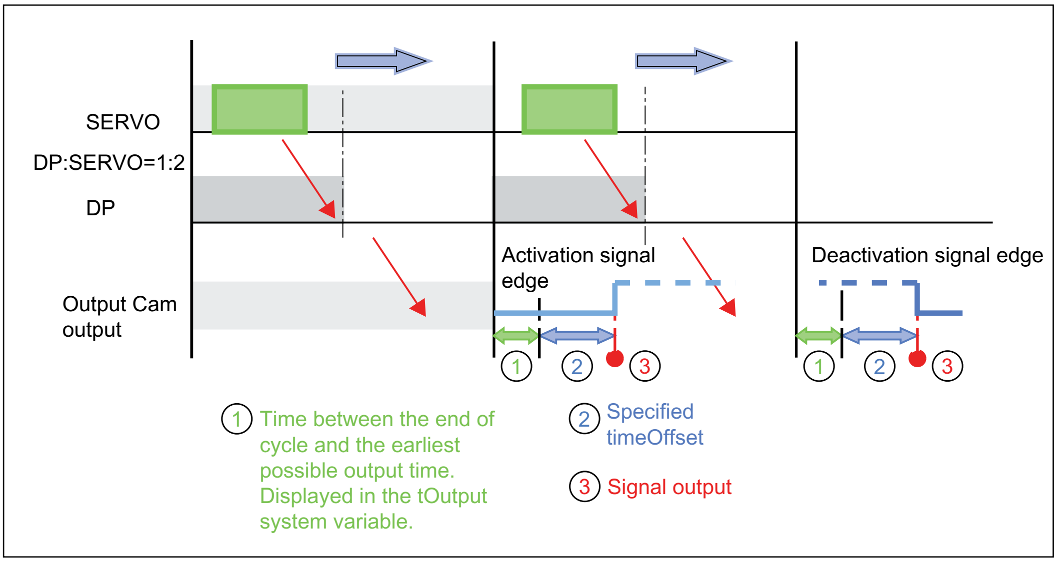


Figure 2-11 Exact-time output setting for DP:POSITION CONTROL=1:2

2.2.2 Cam parameters

2.2.2.1 Reaction, effective direction

Behavior

The following diagram shows output cam behavior when switching on and off, without hysteresis, activation, or deactivation time.

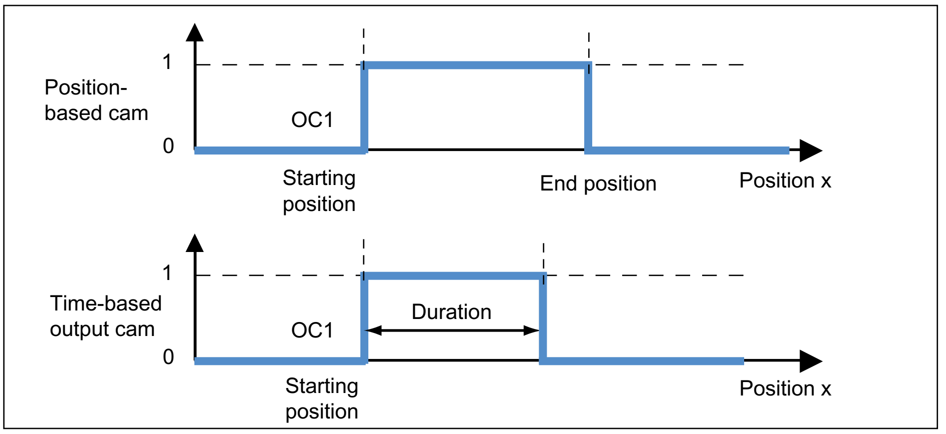


Figure 2-12 Output cam behavior when switching on/off

The switching action depends on the position only (position setpoint or actual position).

Effective direction

You can define a default effective direction when you activate output cams. The output cam only switches when the motion direction and effective direction are identical.

Options:

Table 2- 4 Effective direction and behavior

Effective direction	Behavior
Positive	The output cam is activated only in positive direction of motion.
Positive and negative	The output cam is activated independent of the direction of motion.
Negative	The output cam is activated only in negative direction of motion.
Last programmed direction of rotation	With this setting, the output cam switches for the last programmed direction of rotation. If no direction of rotation has been previously programmed, the default setting is used.

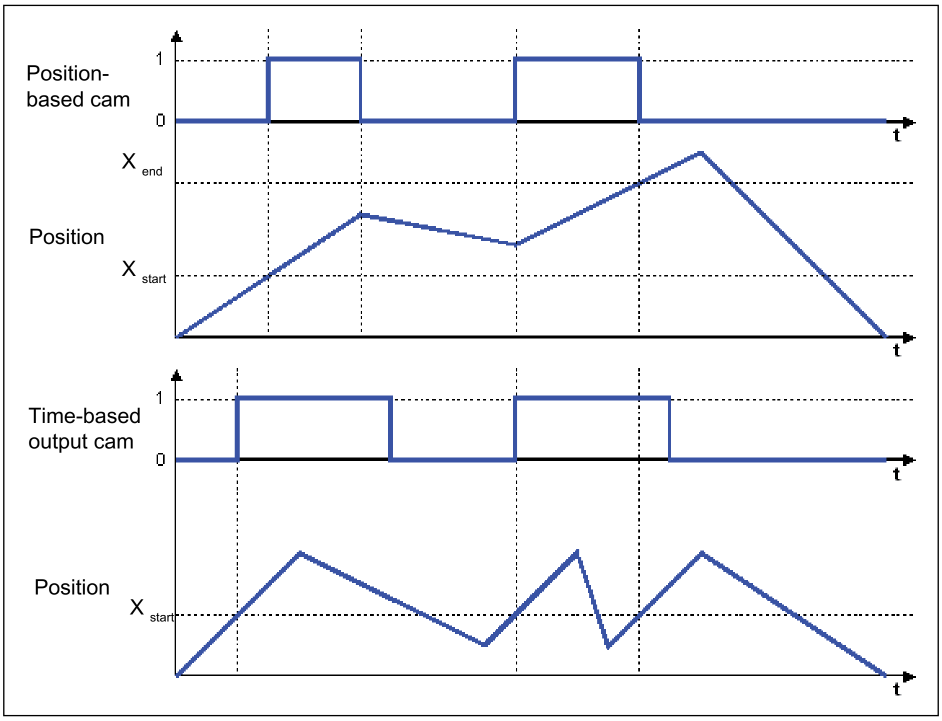


Figure 2-13 Positive effective direction and output cam switching behavior

2.2.2.2 Hysteresis

If the actual position value tends to fluctuate due to mechanical influences, specification of a **hysteresis** prevents the output cam from unintended switch status changes.

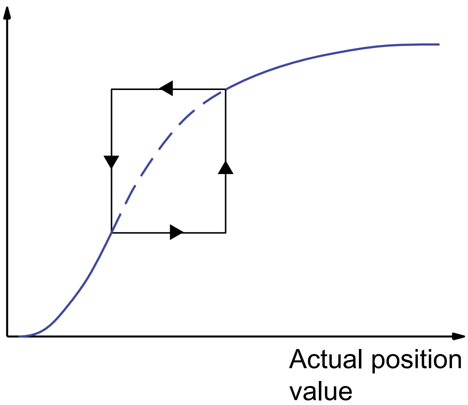


Figure 2-14 Hysteresis

Hysteresis range conditions

- Hysteresis is not activated until the direction has been reversed.
- The direction of motion is not redefined within the hysteresis.

- Within the hysteresis, the switching state of position-based cams is not changed.
- If modified switching conditions for the output cam are detected when the output cam is outside the hysteresis range, this current switching state is set.

Example: position-based cam hysteresis

Output cam configuration:
output cam type: position-based cam; switch-on position, 20 mm; switch-off position, 200 mm; hysteresis, 20 mm; effective direction: positive

Axis positions:
0 mm -> 100 mm -> 10 mm -> 50 mm -> 0 mm -> 150 mm -> 0 mm

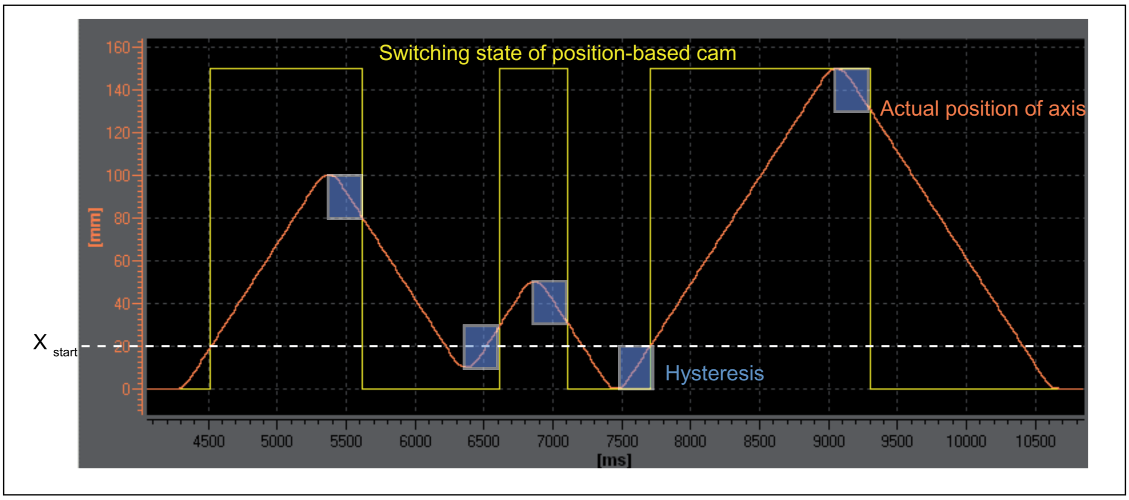


Figure 2-15 Hysteresis range (height of blue sections) and behavior of a position-based cam, positive effective direction

Output cam's second switch-on point is moved to position 30 mm, due to hysteresis (see figure above).

Example: time-based cam hysteresis

Output cam configuration:
output cam type: time-based cam; switch-on position, 40 mm; ON duration, 0.5 s; hysteresis, 20 mm; effective direction: positive

Axis positions:
0 mm -> 100 mm -> 20 mm -> 60 mm -> 30 mm -> 80 mm -> 10 mm -> 150 mm

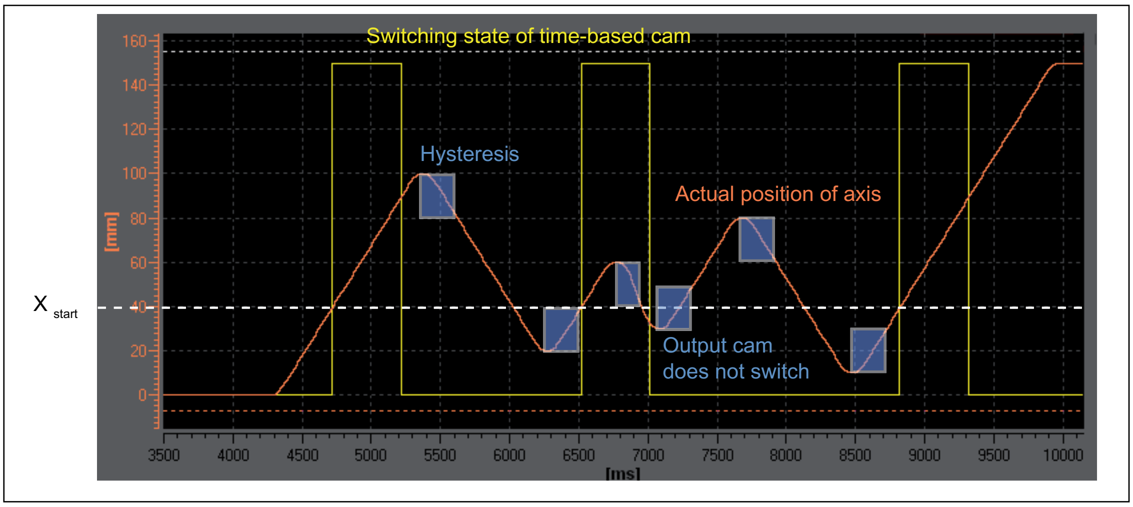


Figure 2-16 Hysteresis range (height of blue sections) and behavior of a time-based cam, positive effective direction

Time-based cam switches off only after ON duration has expired, not after change of direction.

Time-based cam with a start position within the hysteresis range is not output (see figure above).

Hysteresis range

The upper limit of the hysteresis range is set at 25% of the working range for a linear axis, and 25 % of the rotary axis range for a rotary axis. If you violate this maximum setting, an error message is issued. In practice, a lower setting is used for the hysteresis range.

- Path-controlled output cam

  The hysteresis becomes active after direction reversal is detected. If only a positive or only a negative effective direction has been parameterized for an output cam, the output cam does not switch off after a reversal of direction until it has left the hysteresis.

- Time-based cam

  The switching behavior of a time-based cam is determined by the ON duration, not by the hysteresis. This means that an entered hysteresis range has no influence on the ON duration of an output cam. It only has an influence on the switch-on time (start position).

Note

If a time-based cam's start position lies within the hysteresis, it is **not** output.

2.2.2.3 Derivative-action times (activation/deactivation time)

To compensate for the switching times of digital outputs and connected switching elements, or of propagation delays, it is possible to specify **actuation times**. Actuation times are calculated from the sum of all delay times and can be specified separately for activation and deactivation edges as an actuation time at the activation edge (activation time) or an actuation time at the deactivation edge (deactivation time).

The activation/deactivation times of the Output Cam TO are dynamically compensated by means of the derivative-action times. In this way, output cams are dynamically shifted depending on the actual velocity.

For example, a valve that should open at 200°, with an activation time of 0.5 s

- Must be controlled at 195° at a velocity of 10°.
- Must be controlled at 190° at a velocity of 20°.

This dynamic shift takes place automatically by means of the Output Cam TO.

Settings for the activation and deactivation times can contain positive or negative values.

A negative activation time must be entered if the output cam is to be switched before the programmed start of the output cam.

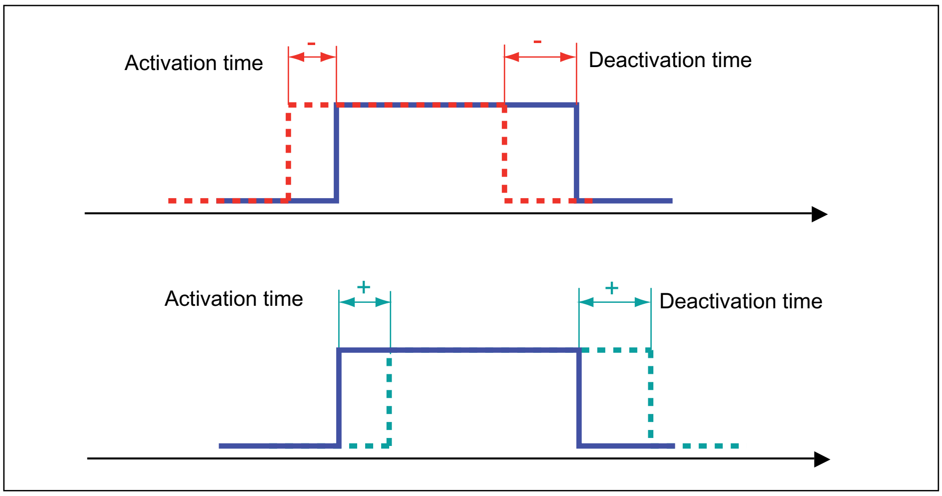


Figure 2-17 Switching behavior at varying actuation times

Note

The time of output for the output cam in the control is relevant for calculation of the dynamic adjustment. If velocity changes up to signal output, these changes are no longer taken into account.

Dead times, e.g. PROFIBUS DP communication times, output delay times on digital outputs, etc., are taken into account in the actuation time.

Long actuation times exceeding one modulo cycle may lead to heavy fluctuation of the switching position of actual value output cams (actual value curve). Here, setpoint output cams should be used or the actuation time should be considerably less than one modulo cycle.

The system takes into account the specified actuation times when the output cams are calculated and managed. If, allowing for actuation times, the output cam was switched, then the system deems this operation to have occurred, and it does not switch the output cam again even if any subsequent current velocity changes occur.

The dynamic actuation of modulo axes can be greater than one modulo length. However, the number of switching operations is not collected by the system, i.e. for actuation times longer than one modulo length, a switching operation cannot take place in each modulo cycle. One switching operation is active in the system at any given point in time. A switching operation is completed when the output cam is switched off.

Actuation times and cycle clock settings

A change of cycle clock settings does not have to be taken into account for the actuation time settings (activation/deactivation time). These are, for example:

- Change of position control/IPO/IPO2 cycle clock settings (e.g. from "1/1/1 ms" to "2/2/2 ms").
- Change of processing cycle clock of the output cam TO (setting: position control cycle clock, IPO, or IPO2).

When the position control:IPO ratio is ≠ 1:1, then the greatest possible accuracy for the calculation is reached for "output cams related to position value" when the **position control cycle clock** is set as the processing cycle clock for the output cam TO.

Deactivation time for time-based cam

Deactivation time is also taken into account in setting a time-based cam.

Deactivation time must be:

- Deactivation time ≤ activation time + ON duration

Activation and deactivation times can vary independently of the I/O and can, therefore, influence the ON duration of the time-based cam.

To achieve compatibility with older software versions (<V3.2), deactivation time for time-based cams can be activated or deactivated in the **Defaults** window, by means of the **Use deactivation time** checkbox.

See also

Determining derivative-action times for output cams (dead time compensation) (Page 39)

2.2.2.4 Logical operation

Through a setting in the LogAdress.logicOperation configuration data element you can specify whether the output cam is connected to the output using an AND or OR operation.

That is, all ORed output cams will be grouped and then logically linked at the output with the output cams linked by AND logic.

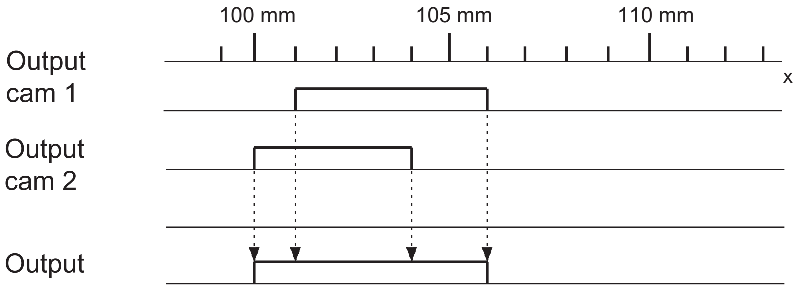


Figure 2-18 OR operation of two output cams

Note

If hardware output cams are configured, you can configure an I/O variable in the symbol browser for monitoring.

2.2.2.5 Simulation

Operation can be simulated by means of the simulation commands on the output cam. The output cam status is then not output to the hardware output. In simulation mode, a hardware cam behaves as a software cam. It is then only used for programming purposes.

If an active output cam is switched to simulation mode (_enableOutputCamSimulation), the output cam status remains the same, and only the control of the output is reset or interrupted.

2.2.2.6 Inversion

The inversion of single output cams is available and is set on the _enableOutputCam command by a parameter (invertOutput).

2.2.3 Configure Units

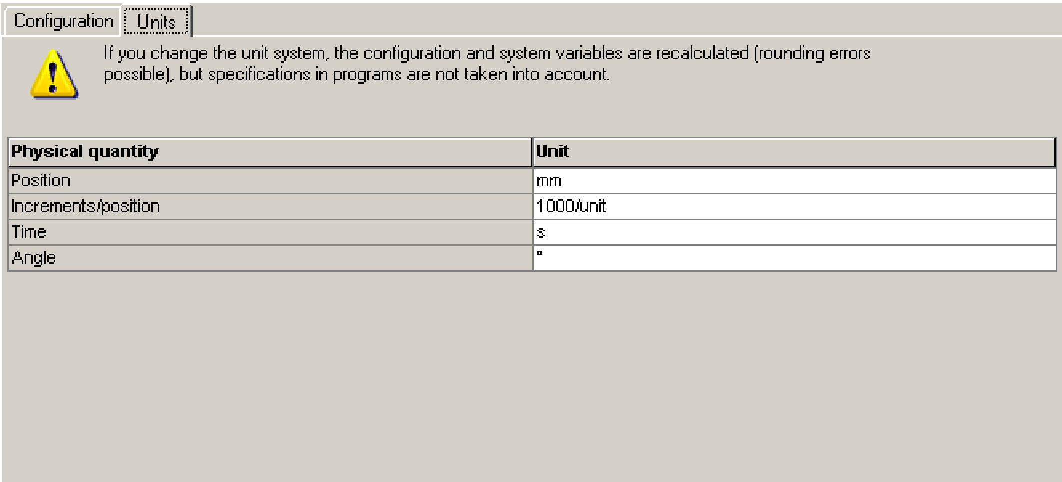
You can define the basic units for each technology object. The same physical variables can have different units in different technology objects. These are converted:

How to configure the units:

1. Open the context menu for the technology object in the project navigator.
2. In the context menu, select **Expert > Configure units**. The **Configure Units** window appears in the working area.
3. Select the **unit** for the **physical variables**. These units are used for the technology object, e.g. s for time units.

or

1. In the project navigator, open the **Configuration** under the TO.
2. Select the tab **Units**.



You can set the following parameters:

Field/Button	Explanation/Instructions
Unit system	Drop down list for preselecting the units to be displayed The "SI units system" is set by default in the drop down list when creating anew.
Table with units	
Physical parameter column	Displays the physical parameter. The physical parameters which are also used by the TO are made available.
Unit column	Display and configuration for unit. A drop down list for selecting the unit appears when you click on the cell.
Toolbar	
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display
Close	Button for closing the dialog.
Help	Button for opening the dialog's online help.

2.3 Configuring the Output Cam technology object

2.3.1 Insertion of Output Cam

Note

Before you insert an output cam, the axis (position or synchronous axis) or external encoder to which the output cam is assigned has to be created.

If the output cams are to be output on a TM15/TM17 high feature, the module must be added and configured before output cam configuration.

To insert a new output cam:

1. In the project navigator, highlight the OUTPUT CAMS folder under the relevant axis or external encoder.
2. Select Insert > Technology object > Output cam or double-click Insert output cam in the project navigator under the axis or external encoder in the OUTPUT CAMS folder. The Insert output cam window appears.
3. Enter a name for the output cam. You can also enter a comment.
   Names must be unique throughout the project and must comply with ST syntax conventions. For this reason, all the existing output cams are displayed under Available output cams.
4. Confirm with OK. In the working area, the window for the configuration is displayed and the created output cam TO is shown in the project navigator.

2.3.2 Parameterize Output Cam technology object

General information about configuration data and system variables

Two data classes are distinguished when parameterizing a TO.

Configuration data define the principal functionality of a TO. They are set within the object configuration framework with the SCOUT engineering system and are not normally changed during runtime.

System variables provide status data of the TO for the user program and a parameterization interface on the TO. System variables can be changed during runtime.

Note

For more information about technology objects, refer to the *SIMOTION Motion Control Basic Functions functional description*.

To parameterize an output cam:

1. In the project navigator under the folder **OUTPUT CAMS**, find the output cam TO that you want to parameterize. Double-click the output cam TO to display the associated objects.
2. Double-click Configuration or Default in the project navigator. The window appears in the working area.
   – **Configuration**:
   Define the **configuration data** of the output cam here. This includes, for example, output cam type.
   – **Default**:
   Define the output cam defaults of the **system variables** here. This includes, for example, the effective direction.
3. Change the configuration data and output cam defaults.
4. Click **Close** to accept the changes.
5. Repeat steps 2 to 4 for all objects in which you want to change the configuration data and output cam defaults.

See also

Output cam configuration (Page 34)

Defining output cam defaults (Page 38)

2.3.3 Using the expert list for output cams

For standard SIMOTION applications, necessary parameters (configuration data and system variables) are parameterized into the Output Cam technology object directly by means of screen forms or are defined automatically.
It can be necessary to change automatically defined parameters for special SIMOTION applications. These configuration data and system variables can only be displayed and changed in the expert list.

Note

For more information about working with the expert list, refer to the *SIMOTION Motion Control Basic Functions functional description*.

2.3.4 Output cam configuration

In the **Configuration** window, define the configuration data values for the output cam.

Double-clicking in the project navigator below the output cam on the **Configuration** element displays the window in the working area.

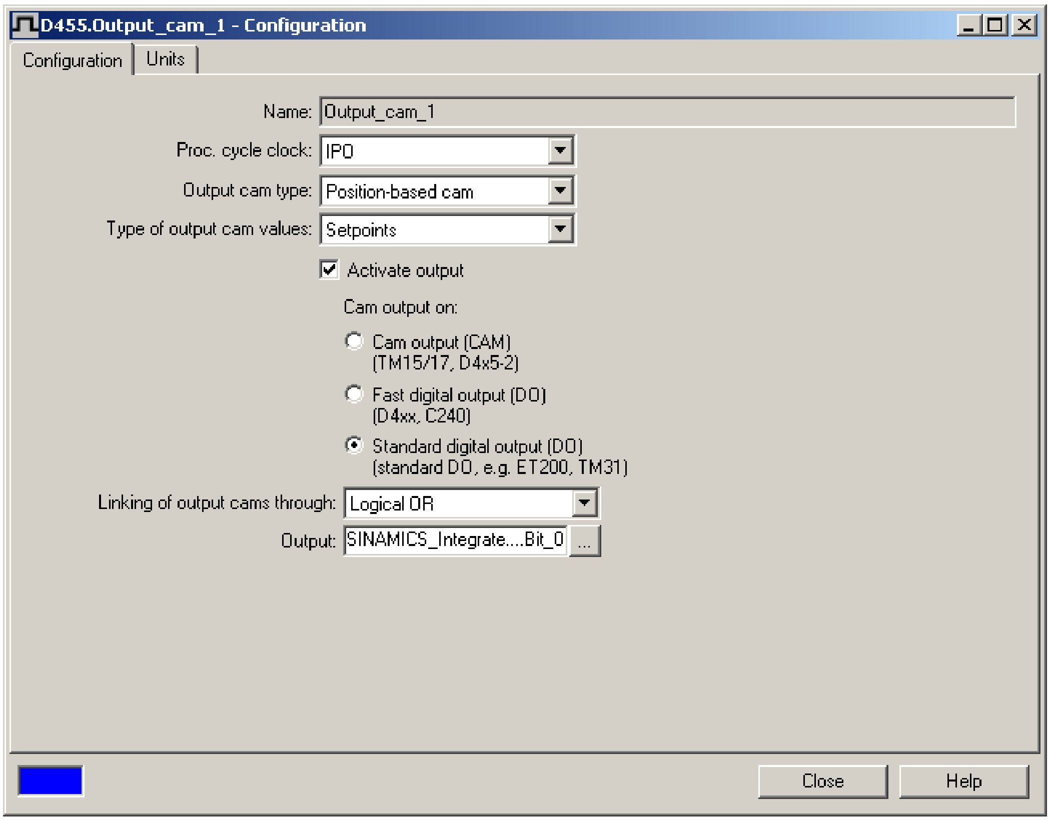


Figure 2-19 Output cam configuration using the example of a position-based cam

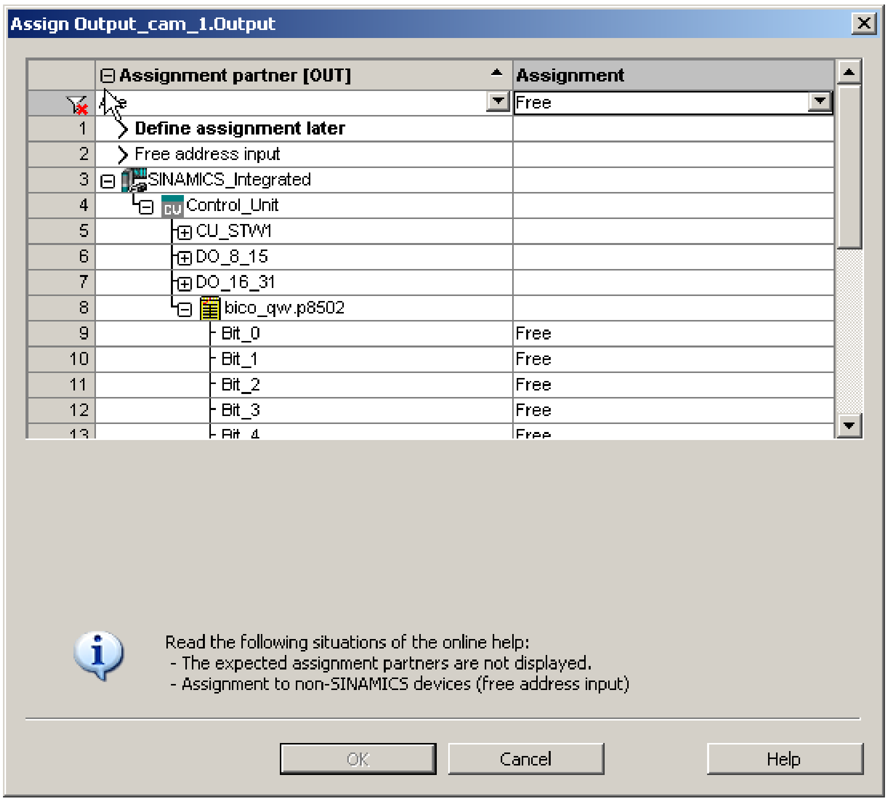


Figure 2-20 Assignment dialog

You can set the following parameters:

Table 2- 5 Output cam configuration data

Field/Button	Significance/Note
Name	The name of the created output cam is displayed here.
Output cam type	Choose **Output cam type** to select the type of output cam. **Position-based cam** (Default value) The switching signal is active when the position of the axis lies between two markers (start and end position). **Time-based cam** The switching signal is on for a specific period of time after reaching the switching position (starting position). **Unidirectional output cam** The switching signal changes when the axis reaches the switching position (starting position). The output cam remains switched on even if the starting position is crossed over several times. The output cam must be explicitly reset.

Field/Button	Significance/Note
Processing cycle clock	Choose **Processing cycle clock** to select the system cycle clock used to update the output cam signal at the output or in the system variables. The output cam calculations are performed in the IPO or IPO2 cycle clock, or the position control cycle clock. The processing cycle clock is set in the configuration by means of the **OcaBaseCfg.taskLevel** configuration data element. **IPO** (default value) The output cam signal is updated in the interpolator cycle clock. **IPO2** The output cam signal is updated in the interpolator cycle clock 2. The IPO2 cycle clock length is at least twice that of the IPO. **Position control cycle clock** The output cam signal is refreshed in the position control cycle clock. **The following configurations of the processing cycle clock are possible:** • Axis in IPO cycle clock and output cam in IPO2 cycle clock • Output cam in position control cycle clock and axis in IPO or IPO2 cycle clock For the possible setting IPO_fast, see the chapter entitled Second position control cycle clock (Servo_fast) in the Motion Control Basic Functions manual. It is not possible to configure the axis in the IPO2 cycle clock and the output cam in the IPO cycle clock. **Note:** When the position control:IPO ratio is ≠ 1:1, then the greatest possible accuracy for the calculation is reached for "output cams related to position value" when the **position control cycle clock** is set as the processing cycle clock for the output cam TO.
Type of output cam value	Select the position value that is the reference for the output cam during processing. **Setpoints** (Default value) The output cam refers to the current setpoint during processing. With regard to output cam values at the setpoint, the output cams are output delayed by one cycle because the setpoints are also only output and can therefore only take effect in the next cycle. This also relates to displaying the output cam status. **Actual values** The output cam refers to the current actual value during processing.
Activate output	Activate the checkbox if the output cam signal is to be applied to a digital output. Parameters are displayed.
Cam output on	
cam output (CAM)	If the output check box is activated and the cam output (CAM) radio button selected, the output cams are output on the basis of an internal time stamp. The temporal resolution of cam output depends on the hardware used. In the case of D4x5-2 and the TM17 high feature, the resolution is e.g. 1 µs. Hardware supported: • SIMOTION D4x5-2 (X142) • TM15, TM17 high feature The I/O channel must be configured as **CAM**. For more details, see cam output types. (Page 18) **Note** Cam output (CAM) or high-speed digital output (DO) are also known as high-speed, hardware-supported output cams.

Field/Button	Significance/Note
High-speed digital output (DO)	If the output check box is activated and the "High-speed digital output (DO)" radio button selected, the output cam is output via onboard outputs of the SIMOTION CPU. Output is via a hardware timer, which achieves cam output with a temporal resolution < position control cycle clock. The time that it takes for the axis to reach the output cam switching position with reference to the processing cycle clock is calculated by linear extrapolation. Calculated from the beginning of the 1st position control cycle clock, the output cam function is triggered by a hardware time when this time is reached. Hardware supported: The onboard I/O of the following CPUs is used: • SIMOTION D4x5-2 (interface X142), 8 high-speed cam outputs, V4.2 or higher (The I/O channel must be configured as **DO**) • SIMOTION D4x5 (interface X122, X132), 8 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**) • SIMOTION D410 (interface X121), 4 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**) • SIMOTION C240, C240 PN (interface X1), 8 high-speed cam outputs For more details, see cam output types. (Page 18) **Note** Cam output (CAM) or high-speed digital output (DO) are also known as high-speed, hardware-supported output cams.
Standard digital output (DO)	If the output check box is activated and the "Standard digital output (DO)" radio button selected, the output cam is output in the position control cycle clock. The temporal resolution of cam output is usually reduced by the output cycle of the I/O used. Hardware supported: • Onboard outputs (SIMOTION D, Controller Extension CX, SINAMICS Control Unit CU3xx) • Centralized I/O (SIMOTION C) • Distributed I/O via PROFIBUS DP/PROFINET IO (e.g. ET 200, ...) • Drive I/O TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30 For more details, see cam output types. (Page 18)
Logical operation (Page 30)	You can assign several TO output cams to an output. Select the logical link of the output cam signal with the output. During the operation, all output cam signals are first grouped together with the logical operation OR. The result of this operation is then combined with the output cam signals to which a logical AND was assigned.
Output	The output can be symbolically assigned via the assignment dialog (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) using the ... button in the Output field (symbolic assignment is activated by default in projects as of V4.2). If symbolic assignment is not active or if the CPU version < V4.2, a physical output is assigned by entering the HW address and bit number in the Output field. Enter the logical HW address of the output to which the output cam signal is to be applied. Only the output cam signal may be present at this address. If other objects are already using this output, an error occurs that is reported following downloading into the target system. The logical HW address must be located outside the process image and therefore be greater than 63. For more details, see cam output types. (Page 18)

Field/Button	Significance/Note
	Button for opening the assignment dialog (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual). Select a parameter or an address in the assignment dialog.
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display

2.3.5 Defining output cam defaults

You can define the defaults for every output cam. These values are stored in system variables and can be changed by programs.

Double-clicking in the project navigator below the output cam on the **Defaults** element displays the window in the working area.

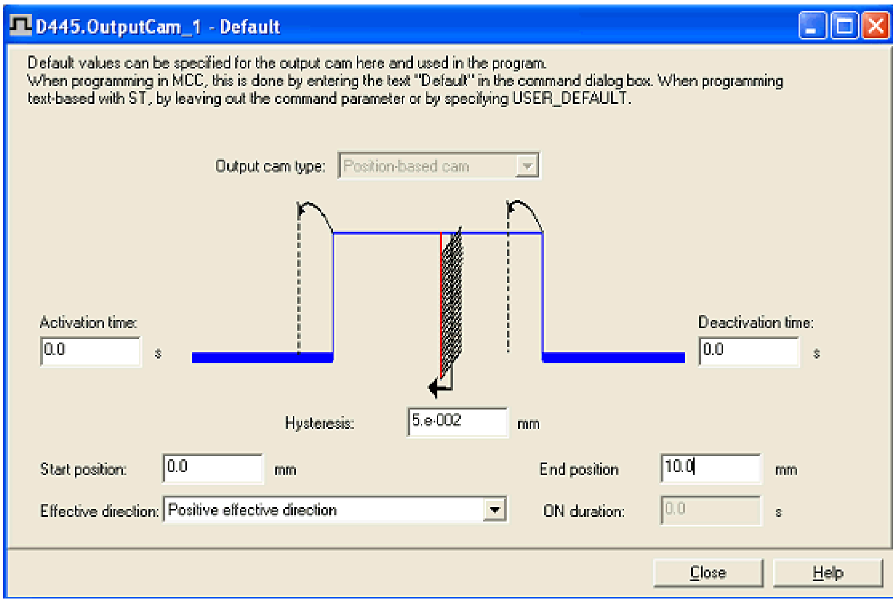


Figure 2-21 Output cam defaults, position-based cam example

You can set the following parameters:

Table 2- 6 Defining output cam defaults

Field/Button	Significance/Note
Output cam type	**Output cam type** displays the type of output cam selected in the Configuration window.
Activation time See also the **Actuation times (activation/deactivation time)** section.	Enter the **activation time** here. The output cam switching time is set to the point when the start position is reached, plus this period. The output cam position is adapted dynamically. This allows you to compensate for propagation delays. If a negative value is entered as an activation time, the switching signal is activated before the start position is reached.

Field/Button	Significance/Note
Using deactivation time	Activate the checkbox if you want to use a deactivation time when working with time-based cams. If this checkbox is deactivated, you cannot enter a time. In this respect, the time-based cam is compatible with older software versions (<V3.2).
Deactivation time	Enter the **deactivation time** here. The output cam switch-off time is set to the point when the end position is reached, plus this period. The output cam position is adapted dynamically. This allows you to compensate for propagation delays. If a negative value is entered as a deactivation time, the switching signal is activated before the end position is reached.
Hysteresis	Enter a range for the **hysteresis** here. The output cam does not change its switching state in this defined range around the switching position even under changed switching conditions. This prevents a repeated change of the switching state.
Start position See also the **Output cam types** section.	Enter the start position of the output cam. For path-controlled output cams this is the left switching position.
End position	Enter the end position of the output cam. For path-controlled output cams this is the right switching position.
Effective direction	Enter the **effective direction** for the output cam. The output cam is active only if the current direction of motion of the axis corresponds to the parameterized effective direction. **Positive and negative effective direction (both)** Output cam switches in both directions of motion **Last programmed effective direction (effective)** Output cam switches only in the last programmed effective direction **Negative effective direction (negative)** Output cam switches only for negative direction of motion **Positive effective direction (positive)** Output cam switches only for positive direction of motion
ON duration	Enter the ON duration for time-controlled output cams here. After the axis has passed the switch-on position, the time-based cam output remains on for the ON duration.

See also

Derivative-action times (activation/deactivation time) (Page 27)

Reaction, effective direction (Page 24)

Hysteresis (Page 25)

2.3.6 Determining derivative-action times for output cams (dead time compensation)

Depending on the system and the device, there is a certain time between the setting of a cam output by the program and the actual reaction of the actuator (e.g. solenoid valve). This time is called dead time and depends, for example, on the load-dependent delay times of a digital output, the switching properties of a valve, etc. Usually the exact value for the dead time is not known and can therefore be determined empirically through measurements.

In order that an output cam switches at the correct time, the dead time must be compensated by specifying a derivative-action time, which offsets the cam output by the dead time. Whereby it must be taken into account that the derivative-action times for switching an actuator on and off are usually different.

The empirical determination of the dead times using a difference measurement as an example.

Note

The procedure applies not only to output cams, but also to cam tracks. However, with cam tracks you can only specify a derivative-action time for the entire cam track.

Example

Lines of glue are to be applied to a product at a defined position and with a fixed length. The glue output is controlled by an output cam or a cam track. The glue is output from the start of output cam (switch-on point) to the end of output cam (switch-off point). The offset of the begin and end of output cam with respect to the velocity can be observed on the length and position of the glue line on the product (see figure). The figure below shows the line of glue for two velocities (v_1, v_2) with $v_2 > v_1$.

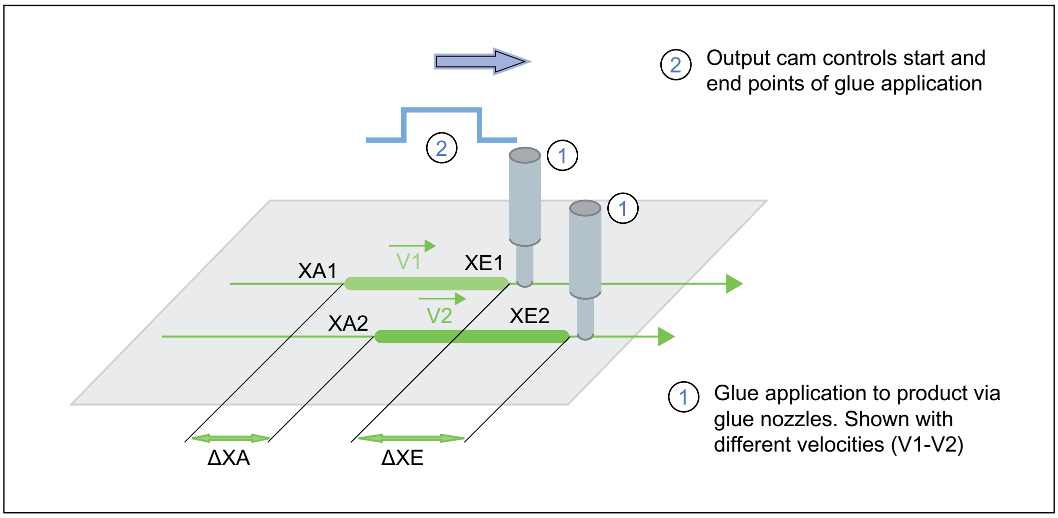


Figure 2-22 Offset of the output of output cam through dead times (dead time compensation)

Procedure:

1. Set all actuation times for start of output cam (activation time) and end of output cam (deactivation time) to 0.
2. Define the velocities for which the positions are to be determined. You should select two velocities that correspond to velocities that occur during production (e.g. minimum and maximum velocity).
3. Start the application and determine the start positions (x_{A1} and x_{A2}) and end positions (x_{E1} and x_{E2}) of the line of glue for the velocities v_1 and v_2.

Note

To increase the accuracy, you can perform several comparison measurements and use the average measured values.

---

4. You can determine the actuation times for the output of output cam using the following formula.

   $t_{Activation} = \Delta s/\Delta v = (x_{A2}-x_{A1})/(v_2-v_1)$
   $t_{Deactivation} = \Delta s/\Delta v = (x_{E2}-x_{E1})/(v_2-v_1)$

5. Enter the calculated actuation times as **activationtime** for the start of output cam and as **deactivationtime** for the end of output cam. Note that the actuation time must be entered as a negative when the output time is to be before the programmed output cam switching time.
6. After you have determined the activation time and the deactivation time for the output of output cam, you should perform a control measurement and check the result.

Note

Depending on the application, it may be, e.g. with eccentric presses, that there is no linear relationship between dead time and velocity (e.g. non-linear response of an applied brake). You have to dynamically adapt the dead time to the respective velocity for these applications. This can be implemented in the application with a user program. After the actuation time has been changed, you have to activate the output cam again with **_enableOutputCam** or the cam track with **_enableCamTrack**.

See also

Derivative-action times (activation/deactivation time) (Page 27)

2.3.7 Configuring cams on SIMOTION D4xx onboard

Output cams and cam tracks can be configured for standard outputs, or as high-speed, hardware-based output cams / cam tracks.

Cams can be configured on SIMOTION D4xx onboard as follows:

1. In the project navigator, switch to the control unit via **SINAMICS_Integrated > Control_Unit**.
2. Double-click **Inputs/outputs** below the control unit. The window appears in the working area.
3. Switch to the **Bidirectional digital inputs/outputs** tab.
4. Click the **button** to switch between the input and output for the digital inputs/outputs (**DO8 to DO15**). In each case, switch the DI/DO to the output you wish to use as the output of output cam. The designation at the terminal strip of DI or DO switches to DO. Outputs of the output cam can only be used if they have been defined as an output. DO8 is configured as output in the figure. For the output, select the **DO (SIMOTION)** setting.

Note

Mixed use of the SIMOTION D4xx DI/O as high-speed outputs (of output cams) and inputs of measuring inputs is possible.

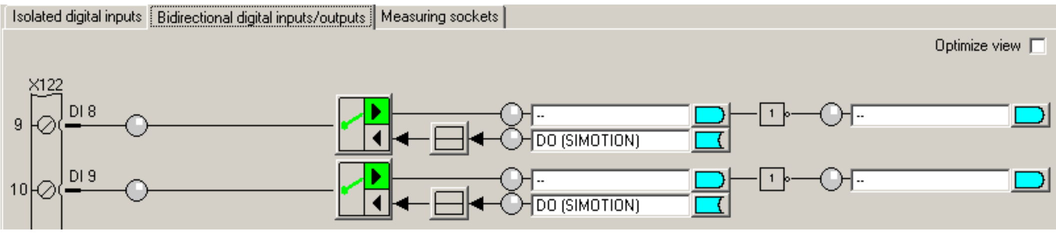


Figure 2-23 SIMOTION D4xx digital inputs/outputs

5. Click **Close**.
6. Insert a new output cam or a new cam track or use an existing one.
7. Parameterize the TO Output Cam / Cam Track
8. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
9. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used. Should you wish to configure a high-speed output cam, select the **Activate output** check box and select the **High-speed digital output (DO)** radio button.
10. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
11. Click **OK** to close the window and select **Project > Save**.

To determine the logical hardware address for outputs on SIMOTION D4xx onboard (only if symbolic assignment is not activated)

1. In the project navigator, below the SIMOTION D device, select **SINAMICS_Integrated > Communication > Message Frame Configuration.**
2. Double-click Configuration and, in the window which appears, select the tab **IF1: PROFIdrive PZD message frame.** The components are displayed there with address range (input/output data).
3. Select SIEMENS message frame 390, 391 or 392 as message frame type. A maximum of eight output cams can be configured for each message frame. The number of DI/DO is limited to eight, i.e. only two output cams can be configured for message frame 392 if you are already using six measuring inputs. Therefore consider whether you also want to use measuring inputs during the message frame selection.

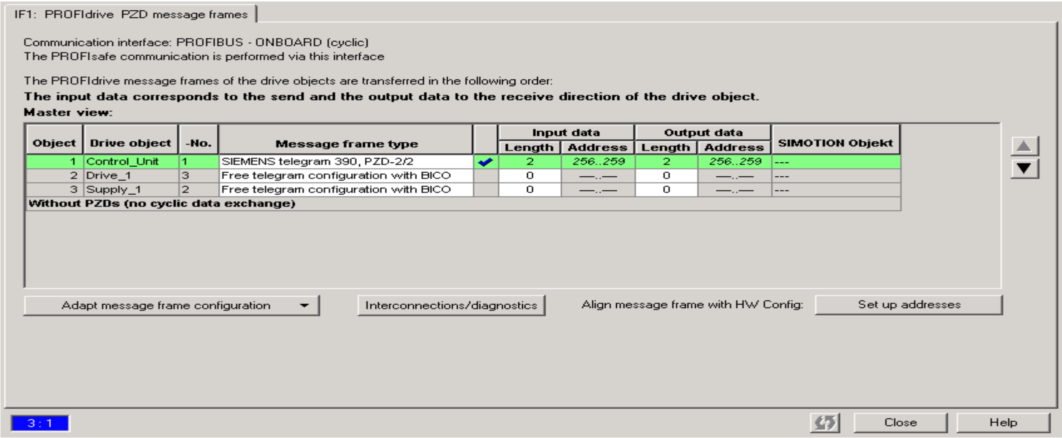


Figure 2-24 Determining the hardware address of the components

4. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses.** If there are question marks in the fields instead of I/O addresses, you must also perform an alignment.
5. Now calculate the HW address by adding the base output address (first value of the output data) of the Control Unit to the offset (for example 298 + 3 = 301). The offset always has the value **3.**
6. You will find the bit number in the following table.

Table 2- 7 Bit numbers for D410 and D4x5

Output D4x5	Output D410	Bit number
X122.7 (DI/DO 8)	X121.7 (DI/DO 8)	Bit 0
X122.8 (DI/DO 9)	X121.8 (DI/DO 9)	Bit 1
X122.10 (DI/DO 10)	X121.10 (DI/DO 10)	Bit 2
X122.11 (DI/DO 11)	X121.11 (DI/DO 11)	Bit 3
X132.7 (DI/DO 12)	-	Bit 4
X132.8 (DI/DO 13)	-	Bit 5
X132.10 (DI/DO 14)	-	Bit 6
X132.11 (DI/DO 15)	-	Bit 7

Note

In the case of versions earlier than V4.2, when using 39x message frames, the onboard D4x5 outputs are to be assigned exclusively to SIMOTION.

See also

Insertion of Output Cam (Page 32)

Parameterize Output Cam technology object (Page 32)

Cam output types (Page 18)

2.3.8 Configuring cams on SIMOTION D4x5-2 onboard

With SIMOTION D4x5-2 the outputs on the interface X142 are used for cam output

1. The **Inputs/outputs X142** entry in the project navigator can be used to open the configuration screen in HW Config.
2. For the selected I/O channel, select **Output cam** as the function.

Note

If you do not use any symbolic assignments (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual), then you must note the logical address. (see Figure I/O Properties) This address must be configured at the TO output cam

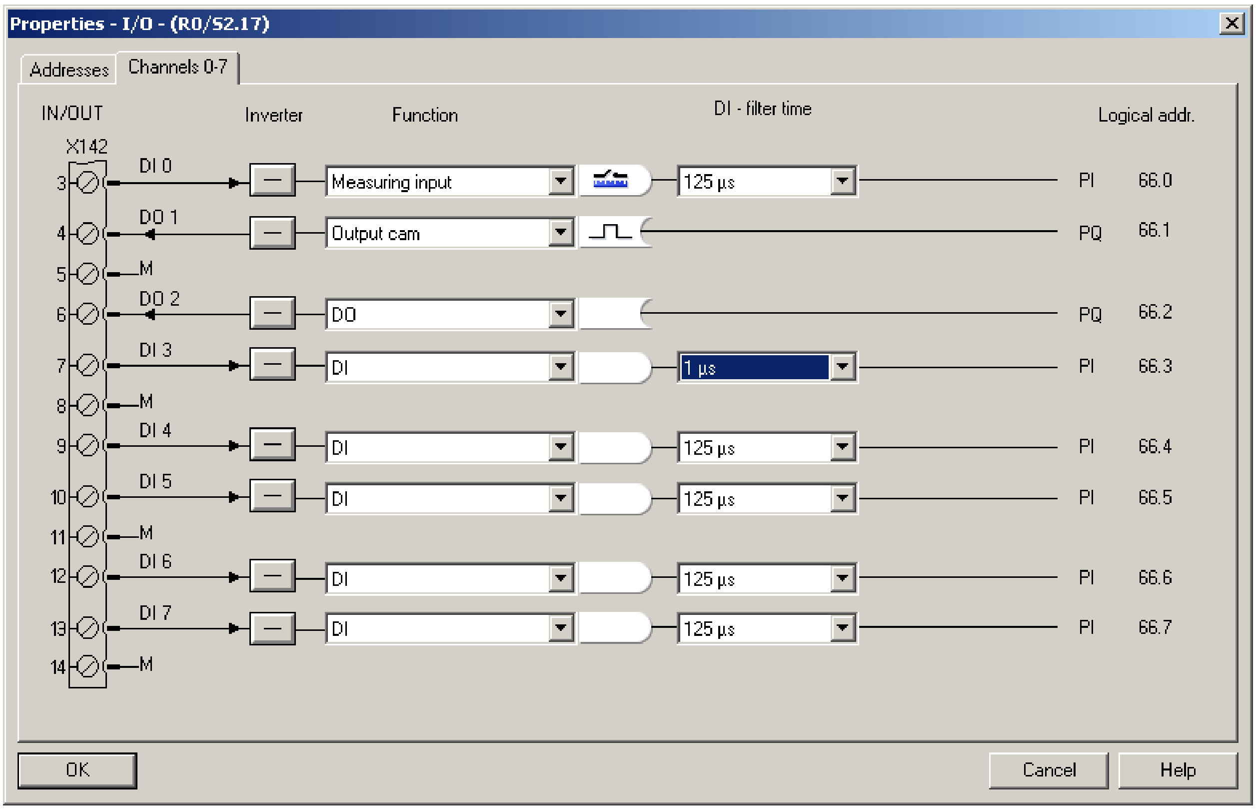


Figure 2-25 I/O Properties

3. Click OK.
4. Insert a new output cam or a new cam track or use an existing one.
5. Parameterize the TO Output Cam / Cam Track
6. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.

7. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used.
   Should you wish to configure a high-speed output cam, select the Activate output check box and select the Cam output (CAM) radio button.
8. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment or by entering the HW address.
9. Click OK to close the window and select **Project > Save**.

2.3.9 Configuring an output cam on a TM15/TM17 High Feature

1. In the project navigator, below the input/output component (TM15/TM17) that you want to use, double-click the entry **Inputs/outputs.** The **Bidirectional Digital Inputs/Outputs** window is displayed.
2. For the selected I/O channel, select **Output cam** as the function.

Note

If you do not use symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual), then you must note the offset (e.g. 3.1).

---

3. Insert a new output cam or a new cam track or use an existing one.
4. Parameterize the TO Output Cam / Cam Track
5. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
6. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used.
   Should you wish to configure a high-speed output cam, select the **Activate** output check box and select the **Cam output (CAM)** radio button.
7. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
8. Click OK to close the window and select **Project > Save**.

To determine the logical hardware address for TM15/TM17 High Feature outputs (only if symbolic assignment is not activated)

1. In the project navigator, below the SIMOTION device or the SINAMICS drive unit
   - for SIMOTION D, select: **SINAMICS_Integrated > Communication > Message Frame Configuration**
   - for SINAMICS S/G drive unit (position axis only): **Communication > Message Frame Configuration**
2. Double-click **Message frame configuration** and, in the window which appears, select tab **IF1: PROFIdrive PZD message frame.** The components are displayed there with the address ranges (e.g. TM17 output data 304 to 315).

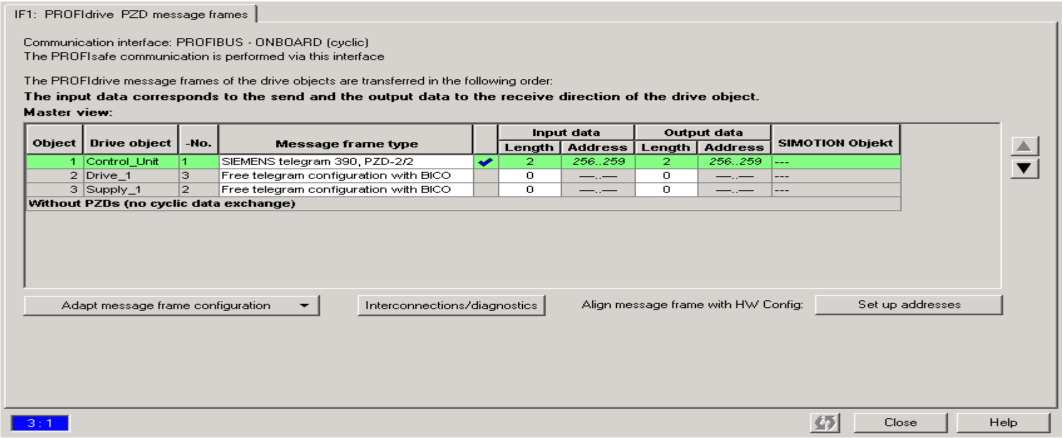


Figure 2-26 Determining the hardware address of the components

3. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses**. If question marks are entered in the fields instead of I/O addresses, either alignment has not yet taken place, or the address is not recognized by SIMOTION SCOUT. In this case, you must perform an alignment.
4. Now calculate the HW address by adding the base output address (first value of the address range) of the TM to the offset (e.g. 304 + 3 = 307).
5. The bit number is defined by means of the offset. For example, an offset of an output cam on DO1 of 3.1 results in a bit number of 1.

2.3.10 Configuring cams on SIMOTION C240

1. Insert a new output cam or a new cam track or use an existing one.
2. Parameterize the TO Output Cam / Cam Track
3. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
4. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used. Should you wish to configure a high-speed output cam, select the **Activate output** check box and select the **High-speed digital output (DO)** radio button

5. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
6. Click OK to close the window and select Project > Save.

2.3.11 HW enable for Output Cam TO

You can make the output of output cams dependent on a hardware-supported enable (only with the TM17 High Feature).

Because HW enables are used predominantly for output cam tracks, this function is described with the Cam Track TO (Page 109).

2.4 Programming/references of Output Cam TO

2.4.1 Programming

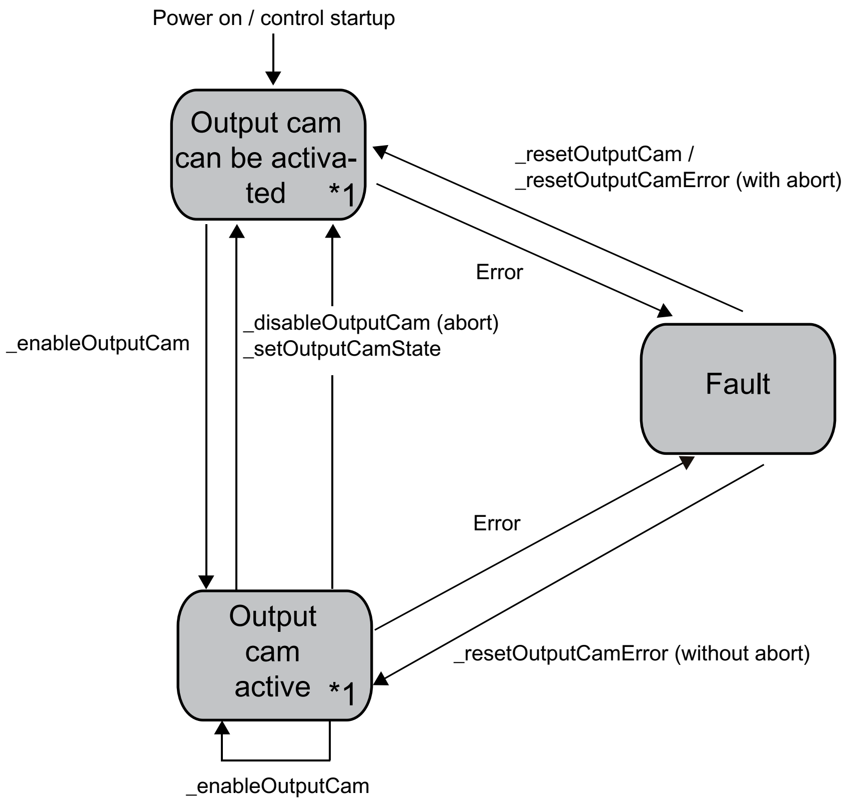


Figure 2-27 Programming and execution model for Output Cam technology object

*1 The following commands are effective in the TO states **can be activated** and **active**:

- **_disableOutputCamSimulation**
- **_enableOutputCamSimulation**

The simulation commands are modal / act in parallel and do not replace any existing _enableOutputCam commands.

2.4.2 Commands

The Output Cam technology object can be addressed in the user program using the following commands:

Table 2- 8 Output Cam TO system functions

Commands	Description	Application
_enableOutputCam	Activate output cam	Output cam analysis is activated. If the switching condition for the output cam is fulfilled, the output or state system variable is set.
_disableOutputCam	Deactivate output cam	Output cam analysis is deactivated. If the switching condition for the output cam is fulfilled, the output or state system variable is not set. Controlled output cams are reset immediately.
_enableOutputCamSimulation	Activate simulation mode. This function simulates an output cam by disconnecting the output.	Values are calculated, but not forwarded to the hardware. Hardware output cams act as software cams. The output cam remains internally active, the status is retained, the output of output cam is not switched. If an active output cam is switched to simulation mode, the output cam status remains the same, and only the control of the output is reset or interrupted.
_disableOutputCamSimulation	The output cam is reset from simulation mode.	The output of output cam is switched according to the output cam status and the signal inversion.
_setOutputCamState	Deactivate the output cam function and set the output cam status to the specified value.	This is used if the output should not be controlled by the output cam TO. **Example:** A glue nozzle is controlled by the output cam TO (applying glue dots). As a service function, it should also be possible to rinse the nozzle while constantly controlling it. This is achieved via _setOutputCamState.
_resetOutputCamError	Reset error on output cam TO.	E.g. acknowledge configuration errors after entering correct values.
_setOutputCamCounter	Change starting count for a counter cam.	Output cam is output on every nth switching operation.
_resetOutputCam	This function sets the output cam to an initial state. Pending errors are deleted. Modified configuration data is reset on request.	Create initial state of output cam TO.
_resetOutputCamConfigDataBuffer	This function deletes the configuration data collected in the buffer since the last activation without activating it.	Changing configuration data in the RUN state discards the accumulated modifications.

Commands	Description	Application
_getStateOfOutputCamCommand (V3.2 and higher)	This function returns the execution state of a command.	Check whether the output cam switching has already taken place, i.e. whether the command ID is still available or has already been deleted.
_bufferOutputCamCommandId (V3.2 and higher)	This function enables **commandId** and the associated command status to be saved beyond the execution period of the command. The **commandId** parameter is used to define the command for which the respective status is to be saved. The maximum number of saveable command status is specified in the **decodingConfig.numberOfMaxBufferedCommandId** configuration data element.	Subsequent check of how command was terminated, e.g. error-free or number of error that occurred.
_removeBufferedOutputCamCommandId (V3.2 and higher)	This function ends saving of **commandId** and the associated command status beyond the execution period of the command.	Explicit deletion of previously saved command IDs.

For further information on the system functions, please refer to the *SIMOTION TP CAM Reference Lists*.

2.4.3 Process Alarms

You can predefine local alarm responses via SIMOTION SCOUT.

Note

For more information, refer to the *Motion Control Technology Objects Basic Functions* functional description.

How to configure the alarm response:

1. Double-click **Execution system** in the project navigator below the SIMOTION device. The execution system opens.
2. In the execution level tree, select **SystemInterruptTasks > TechnologicalFaultTask.**
3. Then click the **Alarm Response** button in the displayed window. The **Alarm Response** window appears. You can configure the alarm response for every TO here.

A system variable **error** indicates that a technology alarm has been generated. The response to the alarm is displayed in the **errorReaction** variable.

Table 2- 9 Possible alarm responses

Alarm Response	Description	Application
NONE	No response	-
DECODE_STOP	Command processing is aborted, the output cam function remains active. Execution on the technology object can continue after **_resetOutputCam** or **_resetOutputCamError**.	The Output Cam TO can only be reactivated after the error has been acknowledged.
OUTPUTCAM_DISABLE	Command processing is aborted, current output cam function is aborted. Execution on the technology object can continue after **_resetOutputCam** or **_resetOutputCamError**.	The Output Cam TO can only be reactivated after the error has been acknowledged.

2.4.4 Output Cam TO menus

2.4.4.1 Output cam menu

Grayed-out menu functions cannot be selected. The menu is only active if an output cam window is active in the working area.

You can select the following functions:

Table 2- 10 Output cam TO menu

Function	Significance/Note
Close	Select **Close** to close the configuration window for the output cam that is open in the working area.
Characteristics	Select **Properties** to display the properties of the output cam highlighted in the project navigator.
Configuration	Select **Configuration** to determine the configuration data (for example output cam type) of the output cam.
Default	Select **Default** to define the default settings of the system variables (e.g. effective direction) for the output cam.
Expert	
Expert list	Select **Expert list** to open the expert list for the highlighted output cam. The configuration data and system variables can be displayed and changed in this list.
Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.

2.4.4.2 Output cam context menu

Grayed-out functions in the context menu cannot be selected.
You can select the following functions:

Table 2- 11 Output cam context menu

Function		Significance/Note
Open configuration		Select **Open configuration** to display the window for configuring the output cam in the working area. Enter the configuration data (for example output cam type) for the output cam in this window.
Cut		Select **Cut** to remove the selected object and save it to the clipboard.
Copy		Select **Copy** to copy the selected object. It is stored in the clipboard.
Paste		Select **Paste** to insert the output cam stored in the clipboard.
Delete		Select **Delete** to delete the highlighted output cam. The entire data of the output cam is deleted permanently.
Rename		Use **Rename** to rename the object selected in the project navigator. Note that with name changes, name references to this object are not adapted.
Expert		
	Expert list	Select **Expert list** to open the expert list for the highlighted output cam. The configuration data and system variables can be displayed and changed in this list.
	Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.
	Insert script folder	**Insert script folder** enables you to insert a folder below the TO. You can create scripts in this folder in order to, for example, automate the configuration.
	Import object	**Import object** imports the data of a SIMOTION object from another project which was previously created with a selective XML export. You cannot import the entire project, only the data of the SIMOTION object.
	Save project and export object	**Save project and export object** exports selected data of the selected object in XML format. This data export can then be reimported into other projects. Only the data of the selected object, not the entire project, is exported.
Print		Select **Print** to print the configuration of the output cam. All system variables and configuration data with the associated values are printed.
Print preview		Select **Print preview** to open the preview of the output cam data to be printed.
Default		Select **Default** to define the default setting of the system variables (e.g. effective direction) of the output cam.
Properties		Select **Properties** to display the properties of the output cam highlighted in the project navigator.

3 Cam Track TO - Part II

3.1 Overview of TO Cam Track

3.1.1 General information about Cam Track TO

Cam tracks allow several output cams to be output as a track on one output.

The **Cam Track** technology object

- Generates position-dependent switching signals
- Can be assigned to positioning axes, synchronous axes or external encoders
- The axes can be real or virtual.

Different switching signals distinguish different types of output cam on the cam track:

- **Software cam**

  Switching signals are used **internally** in the user program by evaluating the relevant **state** system variable.

- **Hardware output cam**

  Switching signals are output **externally** on I/O by assigning a digital output to the cam track TO. For example, digital output modules from the ET 200 I/O system can be used for cam track output.

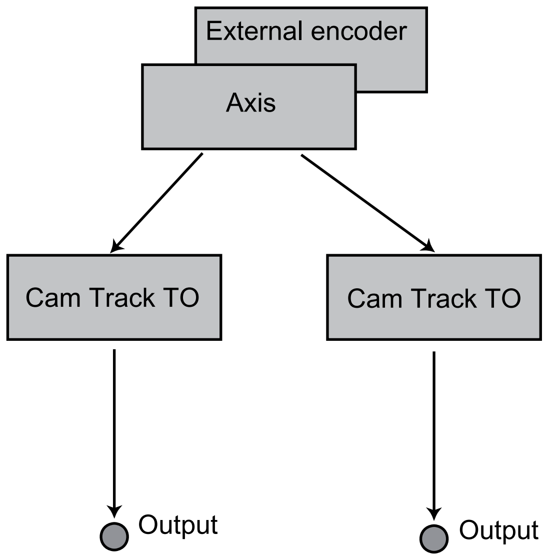


Figure 3-1 Interconnection options for the cam track TO

A range of output cam types with different switching behaviors are available on a cam track:

- **Position-based cam**

  The switching signal is supplied between the switch-on position and the switch-off position.

- **Time-based cam**

  The switching signal is supplied for a specified time period after the switch-on position is reached.

- **Time-based cam with maximum ON length**

  A maximum ON length can be defined for time-based cams. This means that the time-based cam is deactivated once it has covered the maximum length, even though the parameterized time has not yet expired.

- **High-speed/accurate output cam (hardware-based output cam)**

  While output cams are usually output in the IPO cycle clock or the position control cycle clock, high-speed output cams provide better output accuracy than the position control cycle clock because the switching edges are positioned within the position control cycle clock.

3.1.2 Functionality

Cam track functionality

- Cam tracks allow up to 32 output cams to be configured within one TO and allow, for example, the switching point for all output cams to be shifted collectively.
- The switching of several output cams is dependent on the same setpoint/actual value, and they are output on one output.
- Any number of cam tracks can be used per axis. The only restriction placed on this number is the system performance.
- The cam track can be calculated in the position control cycle clock, IPO cycle clock, or IPO2 cycle clock.
- All output cams on one track are of the same type (position or time-based cams).
- Cam tracks can be activated once or cyclically.
- Various modes are available for activating and deactivating cam tracks, e.g. **active immediately**, **next track cycle**, etc.
- Cam track output can be inverted.
- The status of each single output cam (controlled/not controlled) can be read over one array of byte.
- Single output cams on a cam track can also be defined as valid/invalid.
- In connection with the TM17 High Feature terminal module, the cam track output can be controlled via a high-speed hardware enabling signal.

Reference to axis

The reference values of the cam track depend on the axis type or the external encoder:

Table 3- 1 Reference to the actual or set position

Technology object	Reference to actual position possible	Reference to set position possible
Real drive axis	-	-
Real position axis	X	X
Real synchronized axis	X	X
Virtual axes	-	X
External encoder	X	-

- In this case, the cam track functionality can be applied to axes or external encoders with or without modulo properties.
- The cam track is also effective for axes that have not been homed.
- The cam track is defined independently of the axis. The cam track is mapped on the axis via an axis reference position, once the track is activated. This enables cam tracks to be operated in a particularly flexible way (e.g. relative output of a cam track on the basis of a measured edge on the measuring input, cam track offset, etc.).

Output on one output

The cam track TO is assigned to one output only during configuration. Output can be achieved via:

- Onboard I/O
- Drive I/O (e.g. TB30, TM31, TM1x)
- SIMOTION C centralized I/O
- Distributed I/O; PROFIBUS DP I/O (e.g. ET 200M)

However, the output must not be in the process image.

The switching accuracy is dependent on the following:

- Output accuracy of the I/O
- How the cam track is allocated in the task system
- How constant delay times are compensated

3.1.3 Comparison of Output Cam TO and Cam Track TO

Depending on the application, it is practical to use either the Cam Track TO or one or more Output Cam TOs. The table below should help you to decide which TO should be used in which case.

Table 3- 2 Comparison of Output Cam TO and Cam Track TO

Features	Output Cam TO	Cam Track TO
Availability	• As of Version 1.0	• As of Version V3.2
Supported output cams	• Position-based cam • Time-based output cam • Unidirectional output cam • Counter cam • Exact time setting of an output, exact time output cams (as of V4.1)	• Position-based cam • Time-based output cam • Time-based cam with maximum ON length
Several output cams on one output	• Via logical operation (AND/OR)	• Maximum 32 output cams of the same type in one track • No cam track logical operations (AND/OR)
Different types of output cam on one output	• Via AND/OR	• Not available
Output cam definition	• Related to axis • Via system variables	• Related to cam track (cam track can be mapped as required on axis) • Via system-variables array
Hysteresis	• Available	• Available
Effective direction	• Available	• Not available
Derivative-action times	• Separate for power ON/power OFF	• Separate for power ON/power OFF
Deactivation time for time-based cam	• As of Version V3.2	• As of Version V3.2
Activation/deactivation types	• Active immediately	• Start and stop mode parameterizable
Types of output	• Cyclic	• Cyclic • Once
Output cam status	• System variable	• Status of single output cams over one array of byte
Output cam enable	• Via_enableOutputCam	• via_enableCamTrack • Validity of single output cams configurable via system variables
Performance	• Depends on number of single output cams	• When 5 or more output cams are used in one output cam track instead of 5 single output cams, the output cam track performs better. This performance advantage amounts to at least a factor of 2 for 32 single output cams.
MCC command available	• Available	• Available (V4.0 and higher)

3.2 TO Cam Track basics

3.2.1 Cam track features

A cam track has parameters that are valid for the track as a whole, and parameters that can be configured for each single output cam on a track.

Track data

Track data is valid for all output cams on a track and is, therefore, configured for the cam track as a whole.

- Output cam type
  Position-based, time-based, etc.
- Cam track start
  Always defined from "0"
- Track length
  Cam track start to cam track end
- Hysteresis
  Even if the switching conditions change, the output cam does not change its switching state in this defined range around the switching position.
- Actuation times
  Actuation times can be specified to compensate for the switching times of digital outputs and connected switching elements.
- Axis reference position
  Cam tracks are defined independently of the axis. The axis reference position is used to define how the cam track is mapped on the axis, or from which axis position the cam track should be output.
- Cyclic or non-cyclic activation mode
  With non-cyclic output of the cam track, it must be reactivated after execution.
- Start mode and stop mode
  Start mode or stop mode can be used, for example, to define whether a cam track should be output immediately, or not until the next track cycle.

Output cam data

Output cam data can be configured separately for each single output cam on a cam track.

- Output cam parameters:
  Depending on output cam type, start position, end position, ON duration, maximum ON length.
- Validity of single output cam
  Single output cams on a defined cam track can be parameterized as "invalid". This output cam is completely suppressed and is not output. It also has no status indication.

Example of a cam track definition

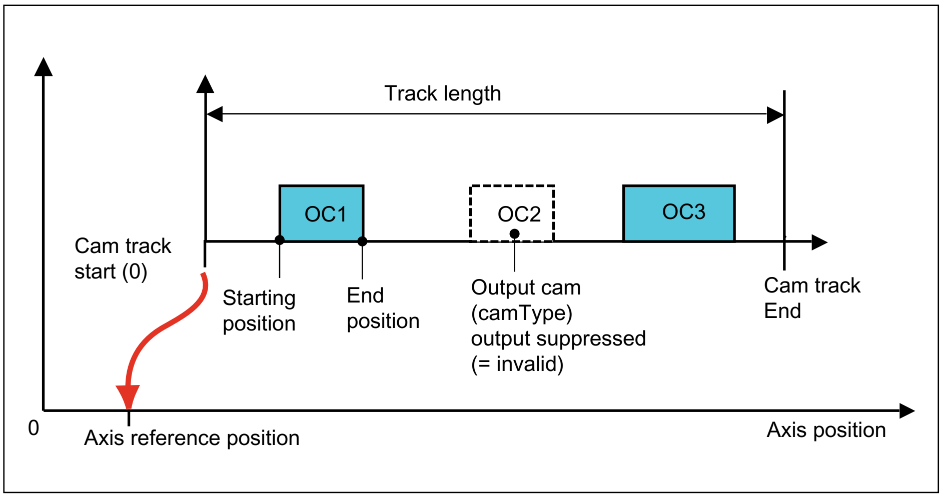


Figure 3-2 Definition of a cam track with 3 output cams

3.2.2 Output cam types of the single output cams on a track

The following chapter provides an overview of the output cam types within a cam track. All output cams on a cam track are always of the same output cam type.

Software cam (Page 60)

Hardware cam (Page 60)

Position-based cam (Page 61)

Time-based cam (Page 63)

Time-based cam with maximum ON length (Page 64)

High-speed/accurate output cam (Page 65)

3.2.2.1 Software cam

Switching signals are used **internally** in the user program by evaluating the relevant **state** system variable.

3.2.2.2 Hardware cam

Switching signals are output **externally** on I/O devices by assigning a digital output to the Cam Track TO.

The following can be used as digital outputs:

- Onboard outputs (SIMOTION C, D, ...)
- Centralized I/O (SIMOTION C)
- Distributed I/Os via PROFIBUS DP (e.g. ET 200M) and PROFINET IO (e.g. ET 200S)
- Drive I/O (for example TM15 and TM17 high feature terminal modules)

Hardware for cam track

Cam output on cam output (I/O channel is configured as CAM)

- SIMOTION D4x5-2 (X142, V4.2 or higher)
- TM15, TM17 high feature

Cam output on high-speed output with direct access (I/O channel is configured as DO)

- SIMOTION D4xx / D4x5-1
- SIMOTION D4x5-2 (X142, V4.2 or higher)
- SIMOTION C240, C240 PN

Cam output on standard output (I/O channel is configured as DO)

- SIMOTION C/D/CX onboard I/O
- SINAMICS onboard I/O
- TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30
- Standard DO (SIMATIC ET200, ...)

See also

Cam output types (Page 65)

3.2.2.3 Position-based cam

Switching behavior

Position-based cams on a cam track switch independently of the direction of motion, i.e. they always have a positive and negative effective direction.

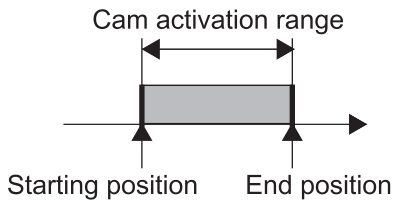


Figure 3-3 Position-controlled output cam with starting position less than end position

Limits imposed by starting and end positions

The output cam is switched on:

- Axis position is within the switch-on area
- Axis position value is shifted into the switch-on area of the output cam

  The position value of the interconnected object can change abruptly, for example, when it is homed or when its coordinate system is shifted with the _redefinePosition command.

The output cam is switched off:

- When the axis position is outside the starting or end area
- When the axis position value is shifted outside the switch-on area
- When commands are issued that deactivate the output cam, e.g. _disableOutputCam, _setOutputCamState and _resetOutputCam

Cam activation range

The switch-on area of the output cam is defined from the starting position to the end position in a positive counting direction, i.e. within a range between the starting position and the end position. If the end position is greater than the starting position, the switch-on area is defined by the starting and end positions (see figure above).

The switch-on area is outside the area between the end and starting position if the end position is less than the starting position (see figure below).

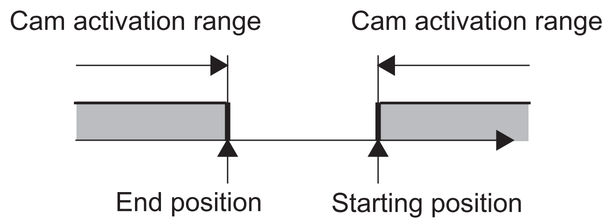


Figure 3-4 Position-controlled cam with end position less than starting position

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Note

This definition of the switch-on area is possible for all modulo and non-modulo axes.

Last programmed ON duration

The ON duration of the output cam depends on the velocity at which the axis traverses the output cam length.

3.2.2.4 Time-based output cam

Switching behavior

Time-based cams on a cam track switch independently of the direction of motion, i.e. they always have a positive and negative effective direction.

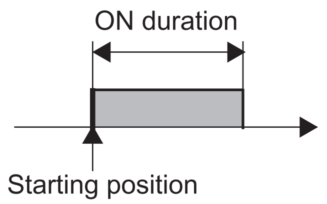


Figure 3-5 Time-controlled output cam

Limits imposed by starting position and ON duration

The output cam is switched on:

- At the starting position.
  If the starting position is overrun again during the ON duration, the time-based cam is not switched on again. It is not possible to retrigger a time-based cam.

The output cam is switched off:

- When the assigned time period expires
- When commands are issued that deactivate the output cam, e.g. _disableOutputCam, _setOutputCamState and _resetOutputCam

Output cam length

The output cam length is dependent on the velocity at which the assigned axis traverses during ON duration of the output cam.

3.2.2.5 Time-based cam with maximum ON length

Additional limits imposed by maximum ON length

A maximum ON length can also be defined for time-based cams on cam tracks. This means that the time-based cam is deactivated once it has covered the maximum length, even though the parameterized time has not yet expired.

This is the case if, for example, glue dots should be applied to a workpiece and the amount of glue should be independent (constant time -> time-based cam) of the throughput rate.

To avoid the time-based cam still being controlled after the end of the workpiece at high sweep rates, the ON duration can be limited by a maximum ON length (related to the start position of the output cam). This prevents a glue dot being placed adjacent to the workpiece.

The maximum ON length is effective in both traversing directions of the axis, and the cam track's switch-on position is the reference position.

Parameters of a time-based cam with maximum ON length

Every time-based cam on a track has three parameters

- Start of output cam (SOC)
- ON time (t)
- Maximum ON length (Lmax)
  This always relates to the dynamically adjusted start of output cam SOC, i.e. the assigned activation time **is** taken into account. The output cam is then traversed over the maximum ON length, **without** taking into account the deactivation time (see the **Actuation times (activation time/deactivation time** section).

Example of a cam track which controls glue application

In the following example, a cam track with three output cams is used to control the application of glue onto a workpiece. No glue may be applied outside of the predefined areas.

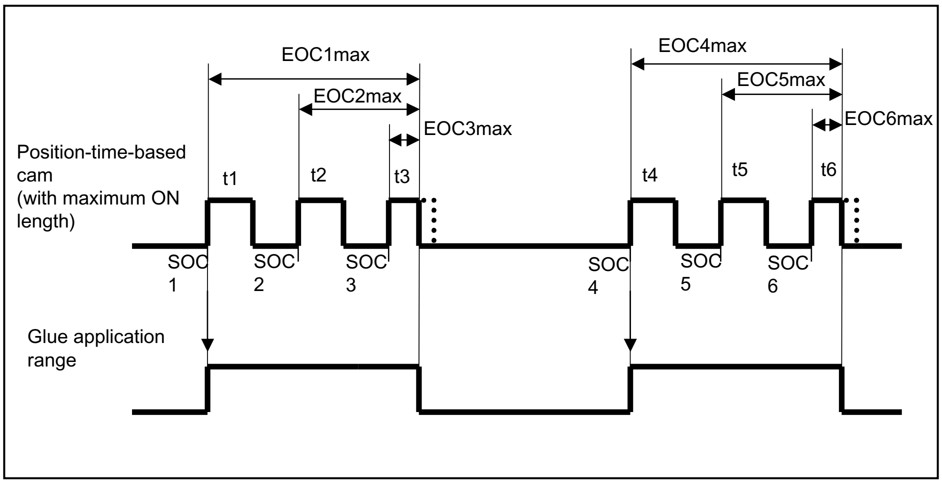


Figure 3-6 Control of glue application via a cam track, based on a time-based cam with maximum ON length

- The start of output cam (here, SOC1 and SOC4) is used to exactly define the start of glue application.
- The ON time (t) is used to ensure that the same amount of glue is applied, independent of the axis speed.
- The maximum ON length Lmax is used to ensure that no glue is applied outside of the defined area. In the example, the output cam ON durations t_3 and t_6 are limited by the maximum ON length.

3.2.2.6 Cam output types

The output cam calculations are performed in the execution cycle (IPO or IPO2 cycle clock or in the position control cycle clock). For the possible setting IPO_fast, see the chapter entitled Second position control cycle clock (Servo_fast) in the Motion Control Basic Functions manual.

The temporal resolution of cam output depends on the hardware used and the setting in the configuration. In standard applications, the setting is undertaken using screens. The configuration data can also be set via the expert list

The possible setting options for cam output are described below:

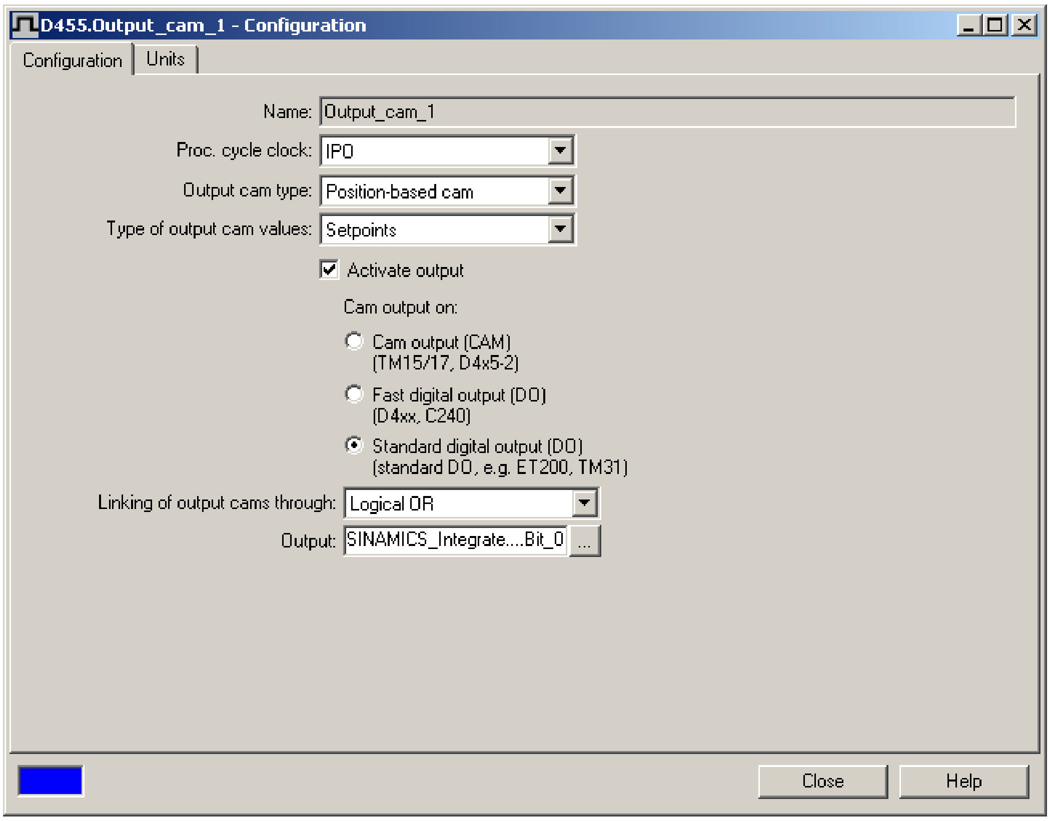


Figure 3-7 Output cam configuration using the example of a position-based cam

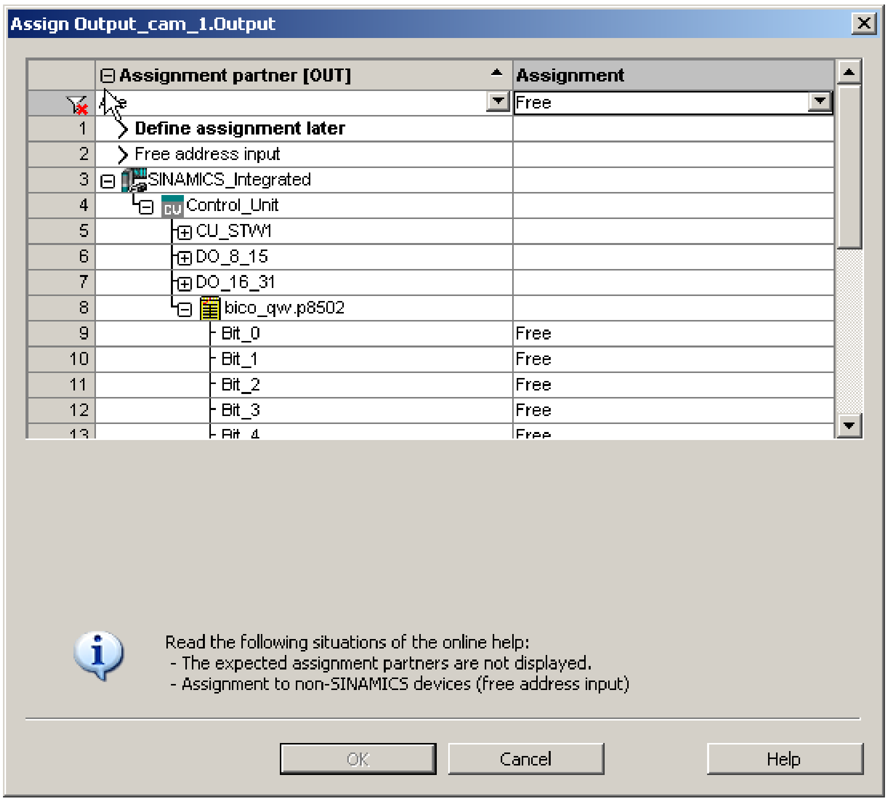


Figure 3-8 Assignment dialog

Symbolic assignment is activated by default in projects as of V4.2 (**Project > Use symbolic assignment**)

Cam output (CAM)

Cam output is based on an internal time stamp. The temporal resolution of cam output depends on the hardware used. In the case of D4x5-2 and the TM17 high feature, the resolution is 1 µs.

Hardware supported

- SIMOTION D4x5-2 (X142)
- TM15, TM17 high feature

The I/O channel must be configured as CAM.

SIMOTION D4x5-2 onboard outputs (interface X142)

The D4x5-2 onboard outputs can be used as cam output (CAM) from the user program. The D4x5-2 onboard outputs are permanently assigned to SIMOTION. The X142 I/Os are configured using HW Config.

The X142 configuration screen can be accessed directly from the project navigator in SIMOTION SCOUT.

With SIMOTION D4x5-2, output cams are output at the X142 interface with a resolution of 1 µs.

TM15 / TM17 high feature Terminal Modules

The TM15 and TM17 high feature terminal modules can be used to set up cam outputs (CAM) within the SIMOTION Motion Control system. The terminal modules are connected directly to SIMOTION D or CX32/CX32-2 via DRIVE-CLiQ for this purpose.

Alternatively, TM15 and TM17 high feature can be connected to a SINAMICS S120 Control Unit

CU320/CU320-2/CU310 with higher-level SIMOTION C, P or D.

Output cams on the TM15 operate with DRIVE-CLiQ cycle-clock resolution (typically 125 μs).

Output cams on the TM17 high feature have a resolution of 1 μs.

High-speed digital output (DO)

Output cams are output via SIMOTION CPU onboard outputs. Output is via a hardware timer, which achieves cam output with a temporal resolution < position control cycle clock.

The time that it takes for the axis to reach the output cam switching position with reference to the processing cycle clock is calculated by linear extrapolation. Calculated from the beginning of the 1st position control cycle clock, the output cam function is triggered by a hardware time when this time is reached.

Hardware supported

The onboard I/O of the following CPUs is used:

- SIMOTION D4x5-2 (interface X142), 8 high-speed cam outputs, V4.2 or higher (The I/O channel must be configured as **DO**)
- SIMOTION D4x5 (interface X122, X132), 8 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**)
- SIMOTION D410 (interface X121), 4 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as **DO**)
- SIMOTION C240, C240 PN (interface X1), 8 high-speed cam outputs

SIMOTION D410/D4x5 onboard outputs

Output cams are output via **a high-speed digital output (DO).**

- Up to and including SCOUT V4.1 SP5, all D410/D4x5 onboard I/Os configured as digital outputs are exclusively available to SIMOTION
- As of SCOUT V4.2, D410/D4x5 onboard I/Os configured as digital outputs can be switched over to SINAMICS using BICO interconnection (channel granular)

SIMOTION D4x5-2 onboard outputs (interface X142)

Output cams are output via a "high-speed digital output (DO)". The D4x5-2 onboard outputs are permanently assigned to SIMOTION.

The X142 I/Os are configured using HW Config.

The X142 configuration screen can be accessed directly from the project navigator in SIMOTION SCOUT.

Standard digital output (DO)

The output cam calculations are performed in the processing clock cycle (IPO or IPO2 cycle clock or position control cycle clock).

Actual cam output takes place in the position control cycle clock. The temporal resolution of cam output is usually reduced by the output cycle of the I/O used.

Therefore the resolution

- with a standard I/O (e.g. ET 200) depends on the cycle time of the bus system (PROFIBUS DP / PROFINET IO)
- with TM15 / TM17 depends on the cycle time of the bus system (PROFIBUS Integrated / PROFIBUS DP / PROFINET IO)
- with TM15 DI/DO, TM31, TM41, TB30 depends on the configured sampling time
  - cu.p0799 (CU inputs/outputs sampling time) for TB30 and onboard outputs
  - p4099 (TMxx inputs/outputs sampling time) for TM15 DI/DO, TM31 and TM41

Hardware supported

- Onboard outputs (SIMOTION D, Controller Extension CX, SINAMICS Control Unit CU3xx)
- Centralized I/O (SIMOTION C)
- Distributed I/O via PROFIBUS DP/PROFINET IO (e.g. ET 200, ...)
- Drive I/O TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30

Configuration data of cam output types in expert list

Table 3- 3 Setting options for cam output

Selection in configuration screen	Setting in expert list
Cam output (CAM) (TM15/17, D4x5-2)	OcaBaseCfg.outputType = [1] TIME_STAMP OcaBaseCfg.hwTimer = [91] NO
High-speed digital output (DO) (D4xx, D4x5-2, C240)	OcaBaseCfg.outputType = [0] STANDARD OcaBaseCfg.hwTimer = [173] YES
Standard digital output (DO) (Standard DO, e.g. ET200, TM31)	OcaBaseCfg.outputType = [0] STANDARD OcaBaseCfg.hwTimer = [173] NO

Output cams on **cam output (CAM)** or on **high-speed digital output (DO)** are also referred to below as high-speed, hardware-supported output cams.

Note

Further information and the output accuracy for high-speed output cams is described in the PM21 catalog and in the respective product brief or commissioning/equipment manual.

Commissioning Manual *Terminal Modules TM15/TM17 High Feature*
Operating instructions *SIMOTION C2xx*
Commissioning Manual SIMOTION D410
Commissioning and Hardware Installation Manual SIMOTION D4x5
Commissioning and Hardware Installation Manual SIMOTION D4x5-2

3.2.3 Cam track parameters

3.2.3.1 Track length

The camTrackLength system variable is used to parameterize the track length. The track length is calculated from the start of the cam track (always 0) to the end of the cam track. Usually, the output cams of the cam track are located within the track length. The track length must not be 0. When track length = 0, an error is reported when the cam track of a non-modulo axis is activated. If track length = 0 for a modulo axis during cam track activation, the cam track length is set to the axis modulo length.

3.2.3.2 Effective direction and behavior

The following diagram shows output cam behavior on switching on and off, without hysteresis, activation or deactivation time.

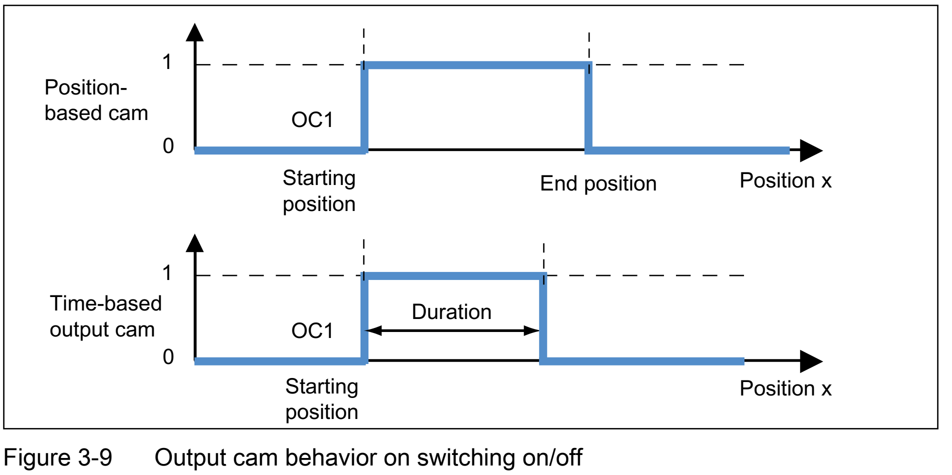


Figure 3-9 Output cam behavior on switching on/off

The switching characteristic depends only on the position (position setpoint or actual position). The cams on a cam track switch independently of the direction of motion, i.e. they always have a positive and negative effective direction. A position-based cam can be output **repeatedly** on changing the direction of movement. Time-based cams are output **once only**.

3.2.3.3 Hysteresis

If the actual position value tends to fluctuate due to mechanical influences, specification of a **hysteresis** prevents the output cam from unintended switch status changes.

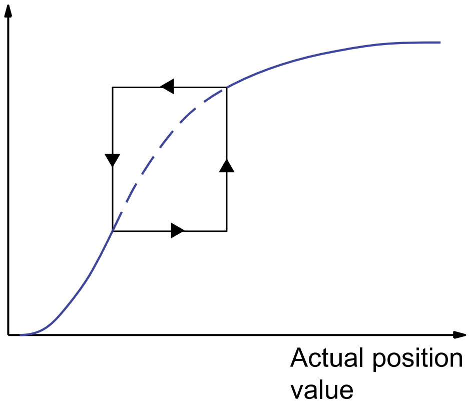


Figure 3-10 Hysteresis

Conditions for the hysteresis range

- Hysteresis is not activated until the direction has been reversed.
- The direction of motion is not redefined within the hysteresis.
- Within the hysteresis, the switching state of position-based cams is not changed.
- If modified switching conditions for the output cam are detected when the output cam is outside the hysteresis range, this current switching state is set.

Example: position-based cam hysteresis

Cam track configuration (only one output cam configured):
Output cam type: position-based cam; switch-on position, 20 mm; switch-off position, 200 mm; hysteresis, 20 mm; effective direction: both

Axis positions:
0 mm -> 100 mm -> 10 mm -> 50 mm -> 0 mm -> 150 mm -> 0 mm

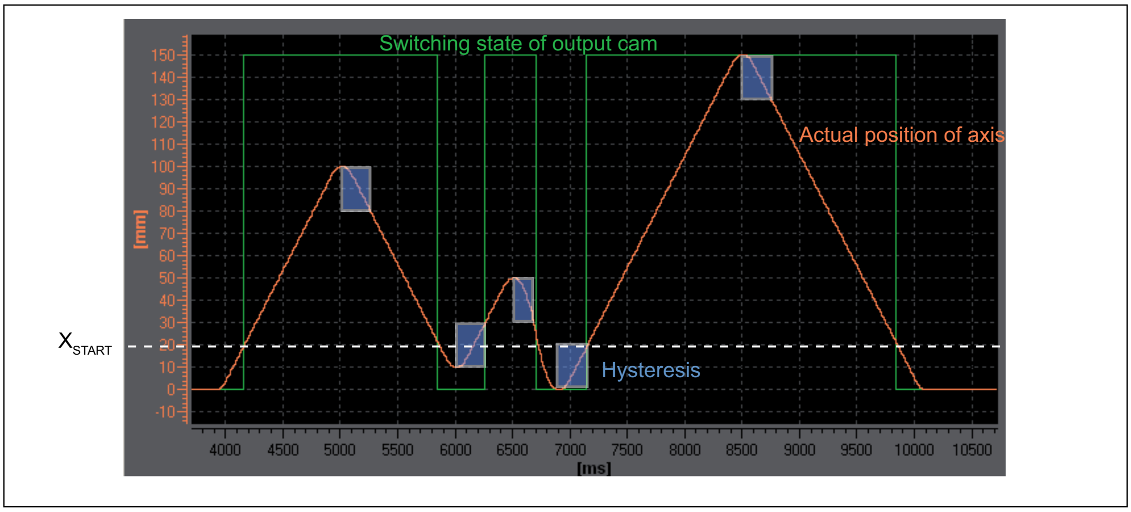


Figure 3-11 Hysteresis range (height of blue sections) and behavior of a cam track with a position-based cam, effective direction in both directions.

As the cam track switches in both directions, the output cam does not switch off after the first reversal of direction. The second switch-on point is moved to position 30, due to active hysteresis.

Example: time-based cam hysteresis

Cam track configuration (only one output cam configured):
Output cam type: time-based cam; switch-on position, 40 mm; ON duration, 0.5 s; hysteresis, 20 mm; effective direction: both

Axis positions:
0 mm -> 100 mm -> 20 mm -> 50 mm -> 30 mm -> 80 mm -> 10 mm -> 150 mm

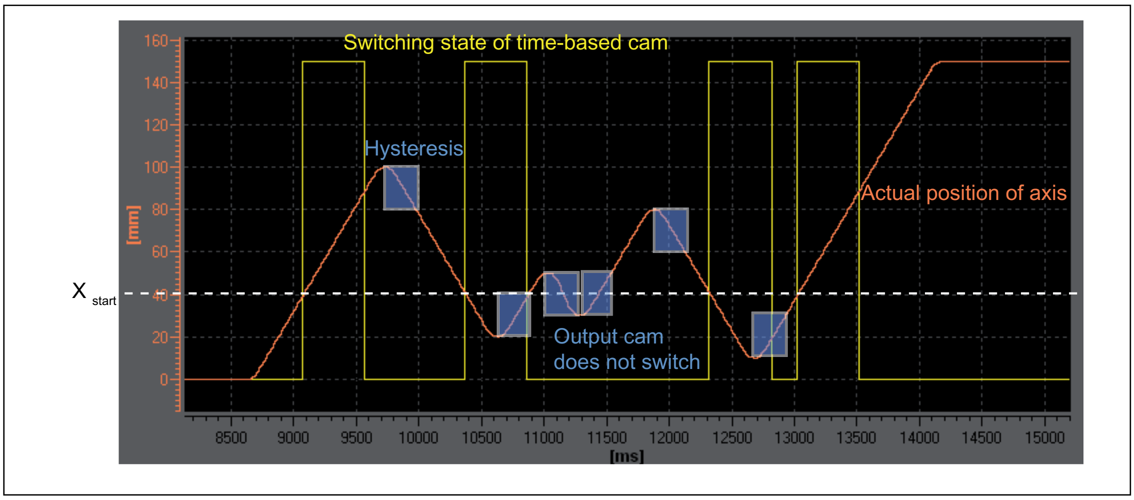


Figure 3-12 Hysteresis range (height of blue sections) and behavior of a cam track with one time-based cam, no effective direction.

Time-based cam switches off only after ON duration has expired, not after change of direction.

Time-based cams with a start position within the hysteresis range are not output (see figure above).

Hysteresis range

The upper limit of the hysteresis range is set at 25% of the working range for a linear axis, and 25 % of the rotary axis range for a rotary axis. If you violate this maximum setting, an error message is issued. In practice, a lower setting is used for the hysteresis range.

- **Path-controlled output cam**

  The hysteresis becomes active after direction reversal is detected. The output cam switches off once the hysteresis has been left and the position is located outside of a defined output cam.

- **Time-based cam**

  The switching behavior of a time-based cam is determined by the ON duration, not by the hysteresis. This means that an entered hysteresis range has no influence on the ON duration of an output cam. It only has an influence on the switch-on time (start position).

- **Time-based cam with maximum ON length**

  The maximum ON length switches off the output cam once the hysteresis has been left and the maximum ON length has been exceeded.

Note

If a time-based cam's start position lies within the hysteresis, it is **not** output.

3.2.3.4 Derivative-action times (activation time/deactivation time)

To compensate for the switching times of digital outputs and connected switching elements, or of propagation delays, it is possible to specify **actuation times**. Actuation times are calculated from the sum of all delay times and can be specified separately for activation and deactivation edges as an actuation time at the activation edge (activation time) or an actuation time at the deactivation edge (deactivation time).

The activation/deactivation times of the output cam are dynamically compensated by means of the derivative-action times. In this way, output cams are dynamically shifted depending on the actual velocity.

For example, a valve that should open at 200°, with an activation time of 0.5 s

- Must be controlled at 195° at a velocity of 10°.
- Must be controlled at 190° at a velocity of 20°.

This dynamic shift takes place automatically by means of the Cam Track TO.

Settings for the activation and deactivation times can contain positive or negative values.

A negative activation time must be entered if the output cam is to be switched before the programmed start of the output cam.

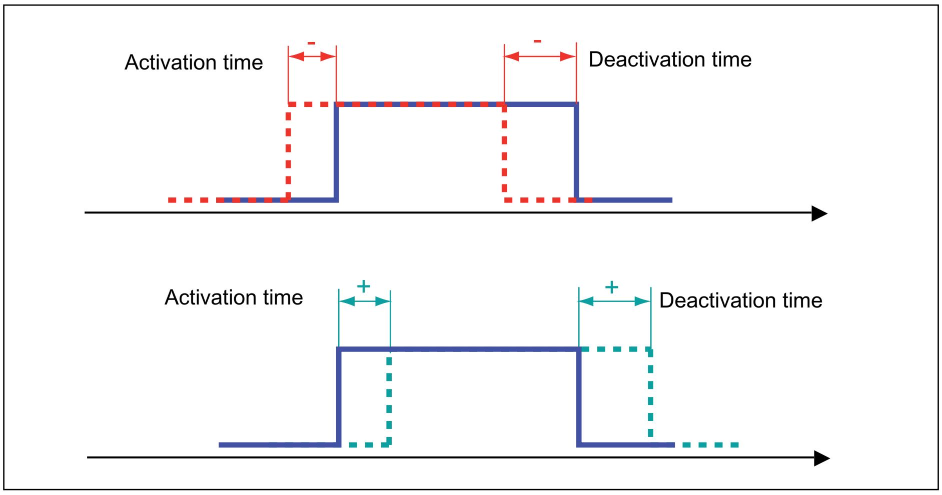


Figure 3-13 Switching behavior at varying actuation times

Note

The time of output for the output cam in the control is relevant for calculation of the dynamic adjustment. If velocity changes up to signal output, these changes are no longer taken into account.

Dead times, e.g. PROFIBUS DP communication times, output delay times on digital outputs, etc., are taken into account in the actuation time.

Long actuation times exceeding one modulo cycle may lead to heavy fluctuation of the switching position of actual value output cams (actual value curve). Here, setpoint output cams should be used or the actuation time should be considerably less than one modulo cycle.

The system takes into account the specified actuation times when the output cams are calculated and managed. If, allowing for actuation times, the output cam was switched, then the system deems this operation to have occurred, and it does not switch the output cam again even if any subsequent current velocity changes occur.

The dynamic actuation of modulo axes can be greater than one modulo length. However, the number of switching operations is not collected by the system, i.e. for actuation times longer than one modulo length, a switching operation cannot take place in each modulo cycle. One switching operation is active in the system at any given point in time. A switching operation is completed when the output cam is switched off.

Actuation times and cycle clock settings

A change of cycle clock settings does not have to be taken into account for the actuation time settings (activation/deactivation time). These are, for example:

- Change of position control/IPO/IPO2 cycle clock settings (e.g. from "1/1/1 ms" to "2/2/2 ms").
- Change of processing cycle clock of the cam track TO (setting: position control cycle clock, IPO, or IPO2).

When the position control:IPO ratio is ≠ 1:1, then the greatest possible accuracy for the calculation is reached for "output cams related to position value" when the position control cycle clock is set as the processing cycle clock for the cam track TO.

Deactivation time for time-based cam

Deactivation time is also taken into account in setting a time-based cam.

Deactivation time must be:

- Deactivation time ≤ activation time + ON duration

Activation and deactivation times can vary independently of the I/O and can, therefore, influence the ON duration of the time-based cam.

3.2.3.5 Cam track activation

The _enableCamTrack command activates the cam track. On activation, the defaults are transferred to the system variables. If you explicitly want to use other values, these must be transferred with the command.

The following parameters are transferred via the _enableCamTrack command:

- Cam track data
- Output cam data

If you do not transfer any new data when activating the command, the defaults are used.

3.2.3.6 Cam track deactivation

Cam tracks are deactivated automatically or via a command.

Automatic deactivation

Automatic cam track deactivation is only possible when the configuration data octBaseCfg.keepEnabledOutOfTrackRange has been set to NO. In this case deactivation occurs on exiting the domain of the cam track, i.e. the track start (in a negative direction) or the track end (in a positive direction). It is not possible to reverse the direction of movement repeatedly within the track length. Output cams can therefore be output repeatedly. Automatic deactivation is set as default. As of V4.1 you can set the deactivation via the configuration data.

Note

In the cam track Configuration window, you can configure the automatic deactivation via Leave non-cyclic activated cam track active in the axis range.

Deactivation via command

The _disableCamTrack command is used to deactivate the cam track.

You can parameterize the deactivation time for the _disableCamTrack command (see Section Start mode and stop mode).

3.2.3.7 Leave cam track active in the axis range (as of V4.1)

Non-cyclic activated cam tracks are deactivated per default when the cam track length is exited. So that the non-cyclic cam track remains active over the entire axis range (also outside of the cam track length), you must set the configuration data octBaseCfg.keepEnabledOutOfTrackRange to YES. When the cam track length is exited, the non-cyclic cam track remains active and is deactivated, for example, via command.

Note

In the cam track **Configuration** window, you can deselect the automatic deactivation via **Leave non-cyclic activated cam track active outside of the track range.**

Features

- Valid for modulo axes and non-modulo axes
- With modulo axes, the cam track is only switched in the appropriate modulo range of the axis, and **not** in every modulo range. This also ensures a clear assignment when cam track lengths ≥ modulo length.
- Value=NO: Non-cyclic cam track is only active within the cam track length.
  If the axis or external encoder moves out beyond the cam track length, the cam track is deactivated. Returning to this length triggers new switching operations.
- Value=YES: Non-cyclic cam track is active over the entire axis range, also after leaving the cam track length If the axis or external encoder moves out beyond the cam track length and then back into the cam track range, the configured output cams switch again.

Example

There is a linear axis (non-modulo axis) with a traversing range of -1000 mm to 1000 mm and a cam track with a track length of 200 mm (-100 mm to 100 mm). The cam track is to remain active over the entire axis range and the cam track is to be activated non-cyclically.

After the cam track is exited (2), it remains active and is switched again after the reversal of direction (3) (see figure below).

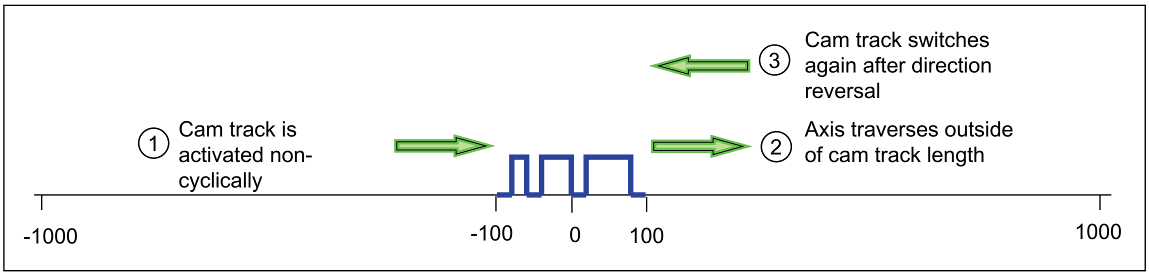


Figure 3-14 Leaving cam track active over the entire axis range

3.2.3.8 Start mode and stop mode

Start mode and stop mode are used to parameterize behavior on activation or deactivation of a track.

Start mode

The start mode (startMode) is used to define when the cam track should become effective after activation, or how tracks should be changed.

The mode is defined either as part of the cam track configuration in the Default window, or directly as a default setting using the _enableCamTrack command.

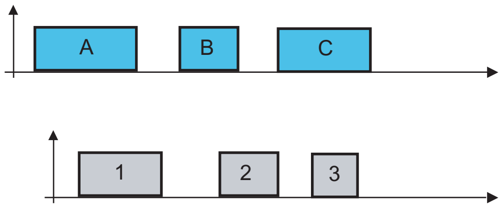
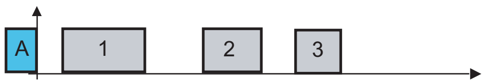
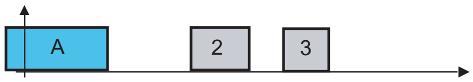
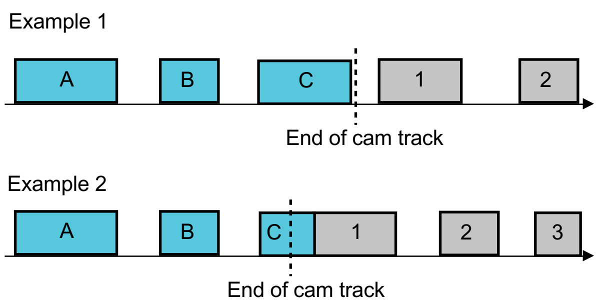
Table 3- 4 Types of start mode

Start mode	Description
Effective immediately (default) (IMMEDIATELY)	Track becomes active immediately. If an output cam (or time-based cam) is defined or active at the current position of the old track, the output is aborted. The new track is enabled without delay (as quickly as possible). This enables high-speed exchange of cam tracks. If an output cam is already controlled and new data from the exchanged cam track continues to control the track signal, the track signal is not interrupted.
Immediately when cam track output inactive (IMMEDIATELY_BY_CAM_TRACK_OUTPUT_INACTIVE)	Changeover is made to the new cam track if no single output cam is active (any longer) on the old cam track. An active (output) single output cam on the old cam track is still output completely. If a changeover to the new track has not been made at the start position of a single output cam on the new track, this output cam is not output. Only after the tracks have been exchanged are the subsequent output cams on the new track output.
With next track cycle (NEXT_CAM_TRACK_CYCLE)	Track does not become active until the next track cycle, after either the axis reference position (in the positive traversing direction) or the end position of the cam track (in the negative traversing direction). The cam track end of the old track equals the axis reference position of the new track. Immediately the first output cam on the new track switches, a changeover is made to the new track. Up to that point, a time-based cam on the old track is output. The previous cycle is processed according to the previous command, the next cycle according to the _enable command. This allows the next track to be enabled, although another track is currently being processed. It is necessary to use this mode if the enable must occur before the start of the new cam track, for example, if the first output cam lies at the very start, but an output cam at the very end of an old (inactive) track is not to be enabled by mistake.
Last programmed value	The last programmed stop mode is active. If a stop mode is not programmed, the user default setting is used.

Changing cam track output on the basis of the selected start mode

The effect of the start mode on cam track output is shown in the following table for two cam tracks. The examples refer to activation of the same cam track with new or modified data.

Table 3- 5 Start mode examples

Mode	Description	Display on cam track output
	One cam track with different data is given. • Cam track 1 (A to C) active cam track • Cam track 2 (1 to 3) is activated	
Effective immediately (IMMEDIATELY)	• New cam track becomes active immediately. • Cam track output becomes inactive. • Output cams 1, 2 and 3 are output.	
Cam track output inactive (IMMEDIATELY_BY_CAM_TRACK_OUTPUT_INACTIVE)	• New cam track becomes active at a cam track output of zero. • Output cam A on the active track is output completely. • Output cams 2 and 3 are output. • Output cam 1 is not output.	
With next track cycle (NEXT_CAM_TRACK_CYCLE)	• Cam track is exchanged at the axis reference position of the new cam track. • Example 1, position-based cam: Position-based cam of the old track is terminated. • Example 2, time-based cam: New cam track becomes active with the first output cam of the new track, at the latest. Up to that point, time-based cams remaining from the old cam track are still output.	

Stop mode

The stop mode (**stopMode**) is used to define the behavior of the cam track on deactivation.

The mode is defined either as part of the cam track configuration in the **Default** window, or directly as a default setting using the **_disableCamTrack** command.

Table 3- 6 Types of stop mode

Stop mode	Description
Effective immediately (default) (IMMEDIATELY)	Track is deactivated immediately. If an output cam (or time-based cam) is defined or active at the current position of the track, the output of output cam is aborted.
Immediately when cam track output inactive (IMMEDIATELY_BY_CAM_TRACK_OUTPUT_INACTIVE)	If no single output cam is active (any longer), the active cam track is stopped. An active (output) single output cam is still output completely.
At end of cam track (BY_CAM_TRACK_END)	Track is deactivated at its end. Immediately the final output cam on the track switches, the track is deactivated. Up to that point, a time-based cam on the track is output.
Last programmed value	The last programmed start mode is active. If a start mode is not programmed, the user default setting is used.

3.2.3.9 Output activation mode

Cam tracks can be output in a cyclic or non-cyclic mode. This setting is also transferred when activating the cam tracks (_enableCamTrack)

Cyclic output

The CYCLIC setting in the activationMode parameter is used to predefine the activation mode for cyclic output of the cam track.

The cam track's track length is mapped from the start position and continued/repeated cyclically. The cam track switches after the axis reference position and remains active until it is switched off with _disableCamTrack.

Non-cyclic output

The NO_CYCLIC setting in the activationMode parameter is used to predefine the activation mode for non-cyclic output of the cam track.

The cam track is mapped from the start position, output once only and terminated automatically after reaching the end position or remains active in the axis range. The performance depends on the value of the configuration date octBaseCfg. keepEnabledOutOfTrackRange.

Example of cyclic and non-cyclic output

A cam track is mapped onto a modulo axis. The figure shows a representation of the different activation modes.

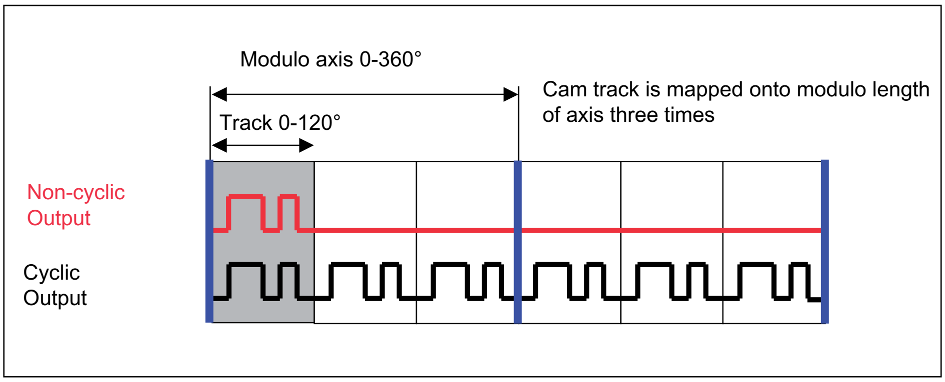


Figure 3-15 Example of cyclic and non-cyclic output on a modulo axis

3.2.3.10 Axis reference position and cam track offset

Cam tracks are defined independently of the axis. Output cams are not calculated according to the defaults until they are mapped onto the axis. The (enableCamTrack.axisReferencePosition) axis reference position is used to define from which position on the axis the cam track should be output. The axis reference position value can be negative or positive. The cam track is always output relative to this position data.

The axis reference position enables you to offset the cam track on the axis as you wish, and therefore to define when the output should take place (see figure in Section Cam track features).

A cam track is mapped to the axis range exactly once, beginning with the axis reference position specified in the enable command. This axis reference position represents the beginning of the cam track (applies for modulo and non-module axes). Upon activation, the cam track is executed once (NO_CYCLIC) or continued cyclically (CYCLIC).

3.2.3.11 Simulation

Operation can be simulated by means of the simulation commands on the cam track. The cam track status is then not output to the hardware output. In simulation mode, hardware cams behave as software cams. They are then only used for programming purposes.

If an active cam track is switched to simulation mode (_enableCamTrackSimulation), the output cam status remains the same, and only the control of the output is reset or interrupted.

3.2.4 Configure Units

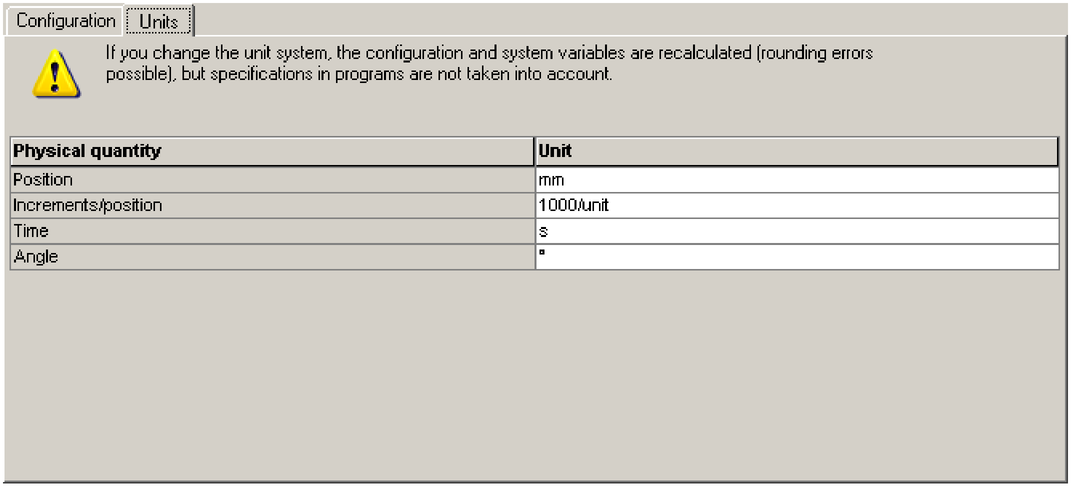
You can define the basic units for each technology object. The same physical variables can have different units in different technology objects. These are converted:

How to configure the units:

1. Open the context menu for the technology object in the project navigator.
2. In the context menu, select Expert > Configure units. The Configure Units window appears in the working area.
3. Select the unit for the physical variables. These units are used for the technology object, e.g. s for time units.

or

1. In the project navigator, open the Configuration under the TO.
2. Select the tab Units.



You can set the following parameters:

Field/Button	Explanation/Instructions
Unit system	Drop down list for preselecting the units to be displayed The "SI units system" is set by default in the drop down list when creating anew.
Table with units	
Physical parameter column	Displays the physical parameter. The physical parameters which are also used by the TO are made available.
Unit column	Display and configuration for unit. A drop down list for selecting the unit appears when you click on the cell.
Toolbar	
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display
Close	Button for closing the dialog.
Help	Button for opening the dialog's online help.

3.2.5 Mapping a cam track onto an axis

The cam track is defined independently of the axis. On activation, the cam track is mapped onto the axis. Only then are the switching states of the output cams calculated.

See also

Basics of cam track mapping (Page 81)

Mapping output cams onto the cam track (Page 82)

Mapping onto negative axis positions (e.g. linear axes) (Page 83)

Relation of track length, modulo length and activation mode in mapping (Page 84)

3.2.5.1 Basics of cam track mapping

- Conversion and mapping of the track onto the axis is identical for modulo and non-modulo axes. Certain points must be noted when mapping onto negative reference positions (see Section **Mapping onto negative axis positions (e.g. linear axes)**).
- The track length can be longer than, shorter than or equal to the modulo length of the axis. Based on this relationship, the switching states of the output cams may differ when they are mapped onto the axis.
- The positions of single output cams always relate to the cam track, not to the axis position. Only on activation of the cam track and entry of the axis reference position is a relationship to the axis position created (start of cam track output).
- If the cam track is activated and the axis rotates negatively, the track will also travel in a negative direction. There is no conversion on the basis of the direction of rotation (see figure). If a cam track should always be output in a positive direction, irrespective of the axis direction, this must be solved in the application.

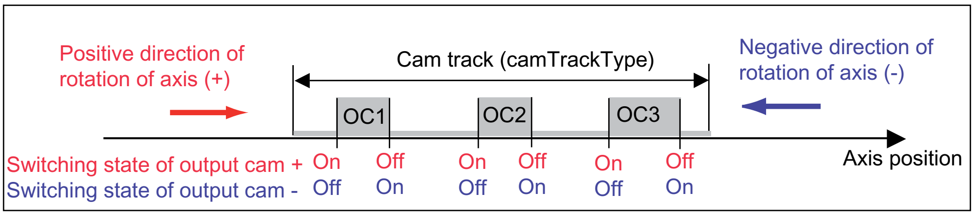


Figure 3-16 Cam track in positive and negative direction, depending on axis direction

- Cam tracks defined outside of the track length limits are mapped or converted during mapping onto the track range.

3.2.5.2 Mapping output cams onto the cam track

The _enableCamTrack command is used to map the starting and end positions of the output cam individually onto the cam track (not onto the axis). Output cams, which have been defined outside of the track range, are converted to this track. Negative starting and end-position values are also converted to the cam track.

"Unfavorable" starting and end-position default settings for output cams, e.g. output cam position outside of the track range, can lead to output cams being shifted, or new output cams being created. This must be taken into account when mapping the cam track onto the axis.

Note

After converting the cam track onto the axis, the effective output cam length is always shorter than or equivalent to the track length. No output cams are defined outside of the track length.

For standard applications, and in the interests of clear programming, automatic conversion of output cams should be avoided. This can be achieved by only defining output cams, which lie within the track length.

Mapping example

A cam track with three output cams (OC1 - OC3) is provided. The end position of output cam OC2 and the entire output cam OC3 are defined outside of the track length. After being mapped onto the axis, OC3 is converted to the track length and mapped to position OC3*. A new output cam OC4* arises from partial output cam OC2.

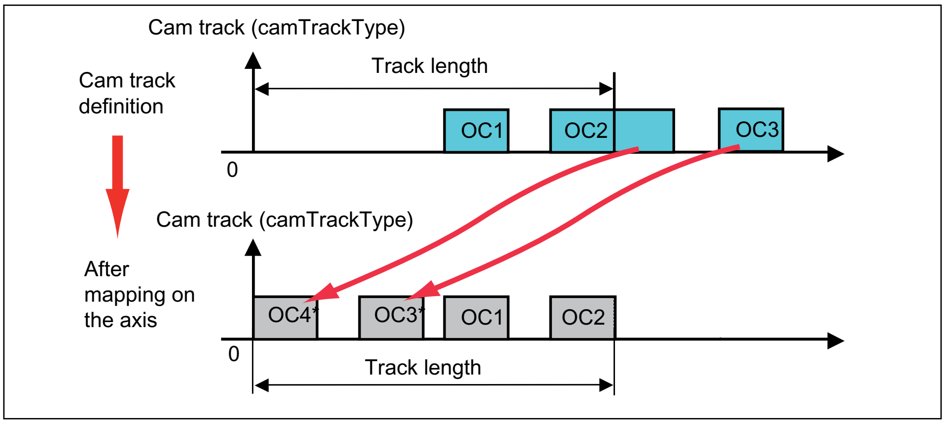


Figure 3-17 Parts of cam track lie outside of the track length

3.2.5.3 Mapping onto negative axis positions (e.g. linear axes)

Output cams on the cam track are always predefined positively. If you want to output output cams at negative axis positions, the cam track output start must be set in the negative range by means of the axis reference position.

Example of a linear axis with negative axis position

- Range of linear axis: -1000 mm to +1000 mm (non-modulo axis)
- Output of output cam at axis position: -100 mm to -200 mm
- Cam track length: 2000 mm
- Definition of the output cam on the track: SOC=800 mm; EOC=900 mm

By mapping the cam track via the axis reference position, the output cam OC1 can be output at a negative axis position.

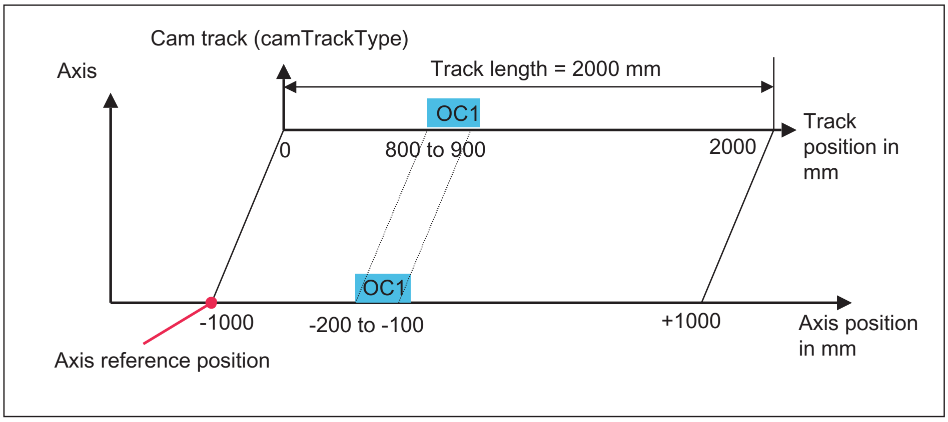


Figure 3-18 Linear axis with output of output cam at negative axis position

Please note that during cyclic output (CYCLIC), cam tracks are continued cyclically even with non-modulo axes, and thus the cam track can be output multiple times to different axis positions.

If a cam track is to remain switched on permanently and only output at one axis position, we recommend the following setting: cam track length ≥ axis traversing range.

This setting prevents the cam track from being continued cyclically in the case of cyclic output of a cam track after execution of the track range (in the figure: axis position - 1000 to +1000).

In the above figure, for example, the cam track would be continued cyclically

- in the positive range from axis position 1000 to 3000; 3000 to 5000 etc
- In the negative range from axis position -1000 to -3000; -3000 to -5000 etc.

.

The same behavior applies also for non-modulo rotary axes.

3.2.5.4 Relation of track length, modulo length and activation mode in mapping

In conventional output-cam output (comparable to mechanical cam controllers), the track length corresponds to the modulo length of the axis and cyclic output takes place.

With electronic cam controllers, the track length can be shorter or longer than the modulo length of the axis, therefore offering a greater degree of flexibility.

- Track length (tl) < modulo length (m) (integer ratio m to tl)
  Track length is output n-fold (n = m/tl) on modulo length.
- Track length (tl) > modulo length (m) (integer ratio tl to m)
  Output takes place on every nth rotation (n = tl/m). Output always takes place after the first quadrant. If the output takes place differently, a greater track length must be defined and the output cam placed accordingly.
- Non-integer division ratios lead to the cam track being dislocated on every axis rotation.

Use of cyclic output with track length = n x modulo length

If the track length is n times the modulo length, cyclic output allows a repetitive output of output cam to be easily achieved on every nth rotation (e.g. an air nozzle, which is always activated in the same angular range on every nth rotation).

Use of cyclic output with track length = 1/n x modulo length

A cycle scan rate is described using the example of a packaging machine with variable product lengths.

A cam controller controls/triggers all machine functions through a machine cycle of 0-360° (fed from left-hand area, see figure below). The product lengths may vary and are always mapped at 360°.

The machine cycle is subdivided into four identical operation steps at an operating station (right-hand area). The output cam is output cyclically for the operating station, with the track length = 1/4 modulo length of axis. The output cams on a cam track define the operating steps for one of the four identical feeds.

The advantage of this solution is that the product defaults are set in mm of the blister length and calculation/mapping at 360° only has to take place once. In this example, one machine cycle is used for four purposes. The same outputs are required for one use. Therefore, the same configuration does not have to be performed four times. Rather, the repetition factor n is calculated into the track length of the cyclically active track.

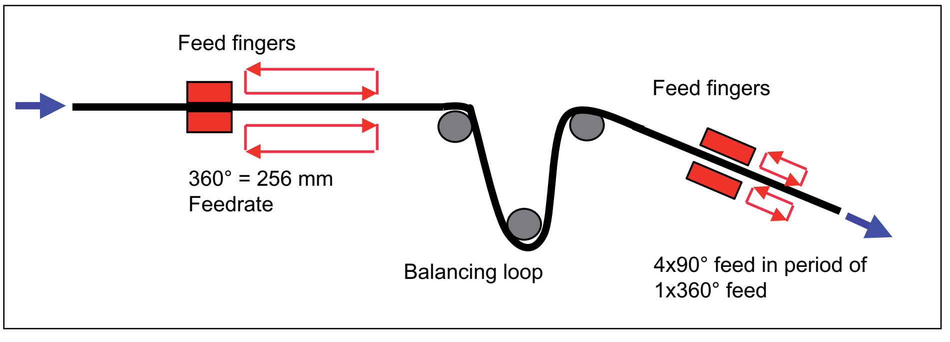
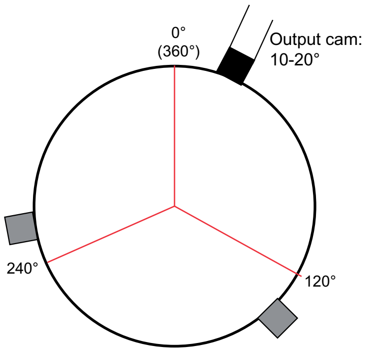


Figure 3-19 Packaging machine with reduced cycle

Example of a modulo axis with cyclic output

Table 3- 7 Example of a modulo axis with cyclic output and track length < modulo length

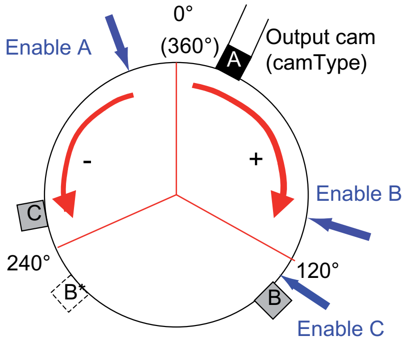
Cam track data/Explanation	Representation
• Modulo length: 360° • Track length: 0-120° • Output cam defaults: SOC=10°, EOC=20° Output cam is output cyclically every 10-20°, 130-140°, 250-260°, etc. If the direction of movement is reversed at 50°, for example, the 10-20° output cam will be output again.	

Example of a modulo axis with non-cyclic output

The example (following table) below shows a modulo axis with non-cyclic output, **next-track-cycle** start mode, and varying enable positions and axis reference positions.

- **Enable A, axis reference position 0°, positive direction of rotation:**
  output cam A is output.
  If the cam track is not exited, output cam A switches multiple times when the direction is reversed. The cam track output is terminated on exiting the cam track.
- **Enable A, axis reference position 240°, negative direction of rotation:**
  output cam C is output during the next cycle.
- **Enable B, axis reference position 120°, positive direction of rotation:**
  output cam B is output.
- **Enable C, axis reference position 240°, positive direction of rotation:**
  output cam C is output.

Table 3- 8 Example of a modulo axis with non-cyclic output and track length < modulo length

Cam track data/Explanation	Representation
• Modulo length: 360° • Track length: 0-120° • Output cam defaults: SOC=10°, EOC=20° • Start mode: with next track cycle	

3.2.6 Cam track operating behavior

Changes made to the configuration and defaults of cam tracks or their associated axes during operation affect the cam track, which is active at that time. This section briefly describes the most important changes.

An explanation of how you can determine the status of single output cams and cam tracks is also provided.

The values of system variables are stored in the **userdefault** array. This array is transferred on using **_enableCamTrack** to activate a cam track. These defaults are configured during cam track configuration or other values can be written to them dynamically in the user program.

See also

Changing output cams on a cam track during runtime (Page 87)

Changing the track length during operation (Page 88)

Changing the axis configuration when a cam track is active (Page 88)

Calling up the status of cam tracks and single output cams (Page 89)

3.2.6.1 Changing output cams on a cam track during runtime

Changing start and end positions of an output cam

The start and end positions of single output cams can only be changed by transferring the new single positions to the **userdefault** array and using **_enableCamTrack** to activate the changed array.

Validity of single output cams on a track

You can define whether single output cams on a track are valid or invalid. This enables you to define whether single output cams should be output or not. If existing output cams are to be activated on an already active cam track, the relevant **userdefault.singleCamSettings.cam.cam[0-31].validity** system variable can be set with the value **YES** or **NO**, and the **_enableCamTrack** system function must be executed.

When parameterizing the cam track in SIMOTION SCOUT, validity can be set during configuration in the **Default** window and the **Output cam data** tab (see the **Defining cam track defaults** section).

Disabling or enabling valid output cams of a cam track without reactivation via _enableCamTrack (as of V4.1)

Valid output cams of a cam track can be quickly disabled or enabled via the **enableValidCam** system variable without reactivation of the cam track via **_enableCamTrack**.

Default setting of the **enableValidCam** system variable is **0xFFFFFFFF**, i.e. all valid output cams are enabled. By setting the bit of the relevant output cam, e.g. Bit_0 for output cam 0, the valid output cam is enabled with **1** and disabled with **0** (e.g. only output cam 0 is disabled with **0x FFFFFFFE**).

Properties of enableValidCam:

- Value of **enableValidCam** is retained with reactivation by **_enableCamTrack**
- During system ramp-up or with **_resetCamtTrack**, **enableValidCam** is set to the default setting 0xFFFFFFFF.
- Invalid output cams cannot be enabled via **enableValidCam**.
- System variable takes effect immediately without activation of the cam track.

3.2.6.2 Changing the track length during operation

The userdefault.camTrackLength system variable can be used to change the track length of an active cam track during operation. Changes to a track length do not become effective until the cam track is reactivated (_enableCamTrack). The track length of the cam track that is already active remains unchanged unless it is overridden by the changed cam track.

Example of a changed track length

- 360° track length is changed to 400° and the new track is activated.
- Output cam defaults: SOC=310°, EOC=30°

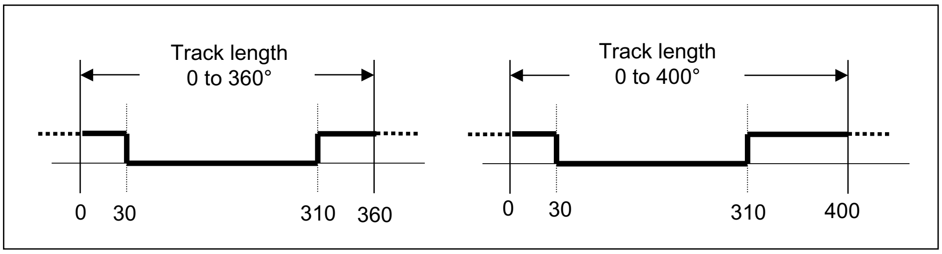


Figure 3-20 Changed track length with an effect on switching states

3.2.6.3 Changing the axis configuration when a cam track is active

Changing the axis configuration for an assigned, active cam track affects cam track behavior.

Changing modulo length

Changing the modulo length of an axis does not affect the definition or behavior of a cam track when it is enabled.

If the modulo length of an axis is changed, the conversion of the cam track on that axis is not automatically adjusted. If necessary, when changing the modulo length, you must deactivate the active cam track and activate it again, so that the axis can be mapped according to the new modulo length.

Output-cam output is aborted if the modulo length on an axis is changed and the axis is restarted.

Redefine axis

If the axis position is changed during operation, e.g. with _redefinePosition, the cam track is aborted and restarted. The change is interpreted as a skip in the modulo range. The cam track is mapped onto the new modulo range of the axis.

3.2.6.4 Calling up the status of cam tracks and single output cams

You can detect the status of single output cams and cam tracks at any time via system variables, and use the status in the user program.

Table 3- 9 Status and position of cam tracks and single output cams

System variable	Meaning	Description
control	Functional status of Cam Track TO	The variable displays the state of the cam track. For example, it can be active, inactive or waiting for the next cam track cycle.
state	Output status	The variable displays if cam track output is in an ON or OFF state.
singleCamState	Status of single output cam	The singleCamState system variable is used to read out the status of single output cams. The variable consists of a 32-bit array, in which the lowest bit (bit0) represents output cam 0.
camTrackPosition	Position of the cam track	The camTrackPosition system variable is used to read out the actual position of a cam track operation within a cam track cycle. The cam track position is required, because the actual track position of a cam track cannot be determined by means of the axis position of a modulo axis (as, for example, the track length could be longer than the modulo range of the axis). The detected value always lies between the start (always "0") and end (defined by the cam track length) of the track.

3.2.7 Inverting a cam track

If the application requires, you can invert the cam track's activation level. The Cam Track TO retains its positive logic. The cam track switches at level 1 or high.

You can set the inversion via the OctTechnologicalCfg.invertOutput configuration data element or in the Configuration window of the cam track. The TO must be restarted in order for a change to be made.

3.2.8 Effect of cam track parameters on mapping

This chapter uses examples to explain the effect of configuration changes on cam track mapping onto an axis.

See also

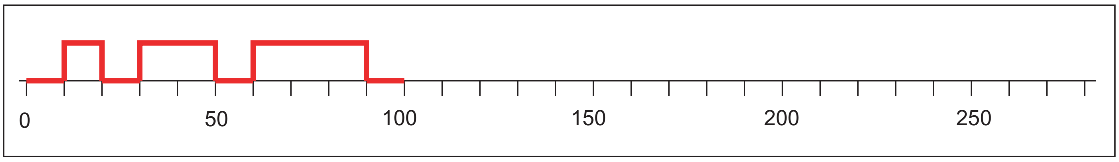
Basic mapping of a simple cam track (Page 90)

Advanced mappings with shifted output cam positions (Page 91)

3.2.8.1 Basic mapping of a simple cam track

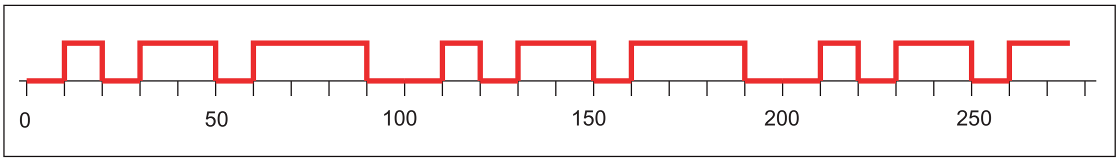
One cam track with the following data is given.

- Three position-based cams (10-20; 30-50; 60-90)
- Activation mode: Non-cyclical cam track activation
- Start mode and stop mode: Effective immediately
- Track length: 100
- All other user-default variables are the default setting unless another setting is mentioned explicitly.

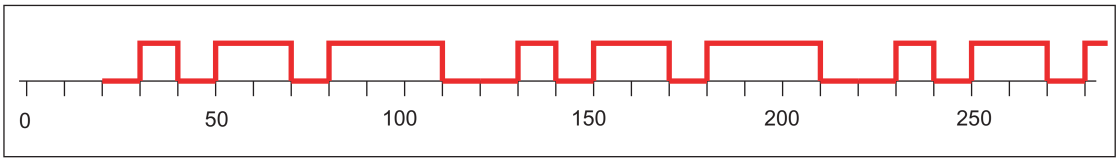


Display of given cam track with modified axis reference position, activation mode, and track length

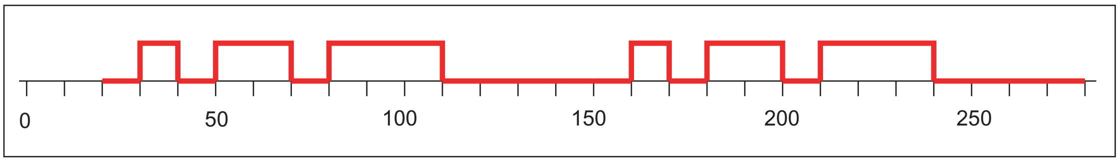
- Activation mode: Cyclic



- Activation mode: Cyclic
- Axis reference position: 20



- Activation mode: Cyclic
- Axis reference position: 20
- Track length: 130

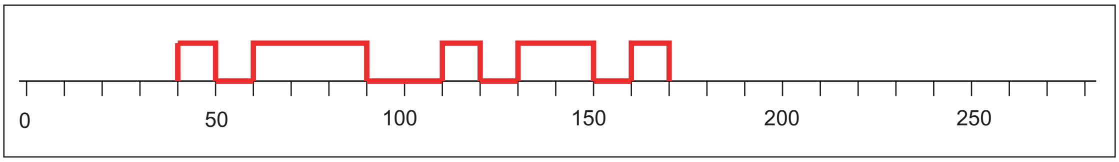


The following applies:

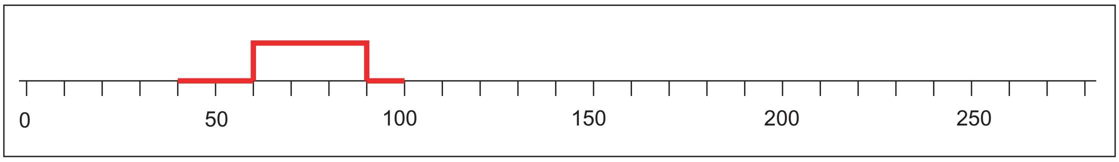
- A change of axis reference position causes a change in the cyclic and non-cyclic mode. The cam track is offset once.
- A track length change only affects the cyclic mode and causes an offset in the cam track cycle.

Display of given cam track with modified start/stop mode

- Start mode: Effective immediately
- Position of axis on which _enableCamTrack occurs: 40
- Position at which _disableCamTrack occurs: 170
- Activation mode: Cyclic



- Start mode: Immediate for inactive output cam track output
- Position of axis on which _enableCamTrack occurs: 40

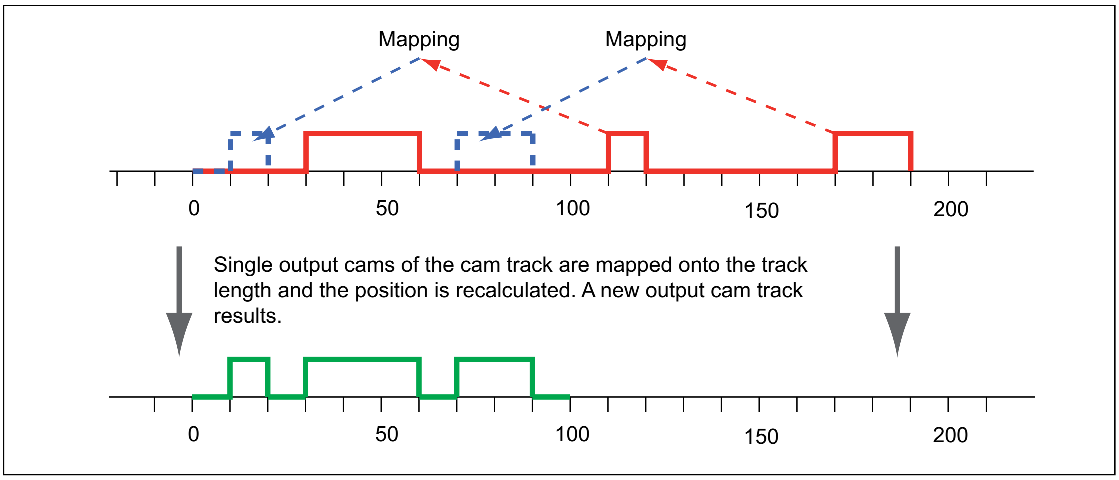


3.2.8.2 Advanced mappings with shifted output cam positions

The following chapter presents examples of a cam track with shifted single cams, i.e. when they are mapped onto the axis, single cams are shifted to another position if they are defined outside the track length.

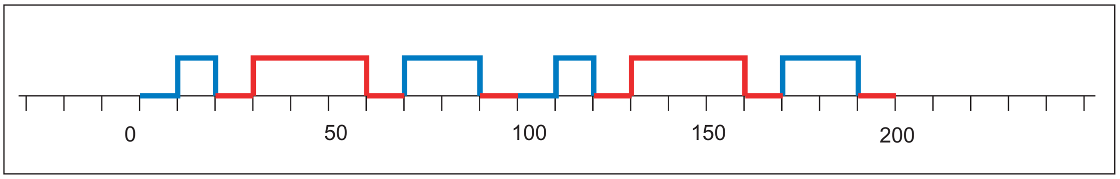
One cam track with the following data is given.

- Three position-based cams (30-60; 110-120; 170-190)
- Track length: 100
- Axis reference position: 0
- All other user-default variables are the default setting unless another setting is mentioned explicitly.

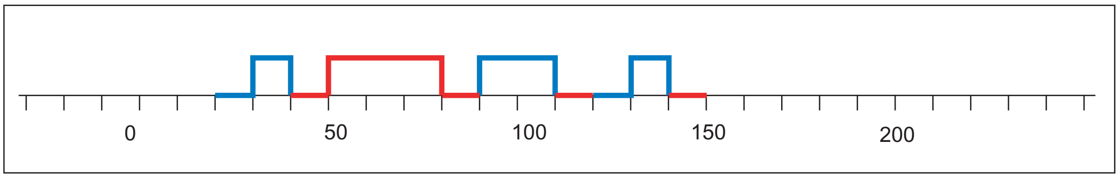


Display of given cam track with modified activation mode and axis reference position

- Activation mode: Cyclic



- Mode: Cyclic
- Axis reference position: 20
- Position at which _disableCamTrack occurs: 150



3.3 Configuring the TO Cam Track

This chapter describes typical operations used when working with the Cam Track technology object.

See also

Inserting cam tracks (Page 92)

Parameterizing the Cam Track technology object (Page 93)

Using expert list for cam tracks (Page 94)

Configuring a cam track (Page 94)

Defining cam track defaults (Page 97)

Determining derivative-action times for cam tracks (dead time compensation) (Page 107)

Using HW enable for cam tracks (Page 109)

3.3.1 Inserting cam tracks

Note

Before you insert a cam track, the axis or external encoder to which the cam track is assigned has to be created.

To insert a cam track:

1. In the project navigator, highlight the **OUTPUT CAMS** folder under the relevant axis or external encoder.
2. Select **Insert > Technology object > Cam track** or double-click **Insert cam track** in the project navigator under the axis or external encoder in the OUTPUT CAMS folder. The **Insert cam track** window appears.
3. Enter a **name** for the cam track. You can also enter a **comment**.
   Names must be unique throughout the project. For this reason, all the existing output cams are displayed under **Available cam tracks**.
4. Confirm with **OK**. In the working area, the window for the configuration is displayed and the created cam track TO is shown in the project navigator.

3.3.2 Parameterizing the Cam Track technology object

General information about configuration data and system variables

Two data classes are distinguished when parameterizing a TO.

Configuration data define the principal functionality of a TO. They are set within the object configuration framework with the SCOUT engineering system and are not normally changed during runtime.

System variables provide status data of the TO for the user program and a parameterization interface on the TO. System variables can be changed during runtime.

Note

For more information about technology objects, refer to the *SIMOTION Motion Control Basic Functions* functional description.

To parameterize a cam track

1. In the project navigator under the **OUTPUT CAMS** folder, find the cam track technology object (TO) that you want to parameterize. Double-click the cam track TO to display the associated objects.
2. Double-click **Configuration** or **Default** in the project navigator. The window appears in the working area.
   – **Configuration** (see the **Configuring a cam track** section):
     Define the values for the **configuration data** of the cam track here. This includes, for example, output cam type.
   – **Default** (see the **Defining cam track defaults** section):
     Define the cam track defaults of the **system variables** here. This can include, for example, cam track and output cam data.
3. Changing configuration data and defaults
4. Click **Close** to accept the changes.
5. Repeat steps 2 to 4 for all objects in which you want to change the configuration data and defaults.

3.3.3 Using expert list for cam tracks

Parameters required for standard SIMOTION applications (configuration data and system variables) are parameterized in the Cam Track TO directly by means of screen forms or are defined automatically.
It may be necessary to change automatically-defined parameters for special SIMOTION applications. These configuration data and system variables can only be displayed and changed in the expert list.

Note

For more information about working with the expert list, refer to the *SIMOTION Motion Control Basic Functions* functional description.

3.3.4 Configuring a cam track

In the **Configuration** window, define the configuration data values for the cam track.

Double-clicking in the project navigator below the cam track on the **Configuration** element displays the window in the working area.

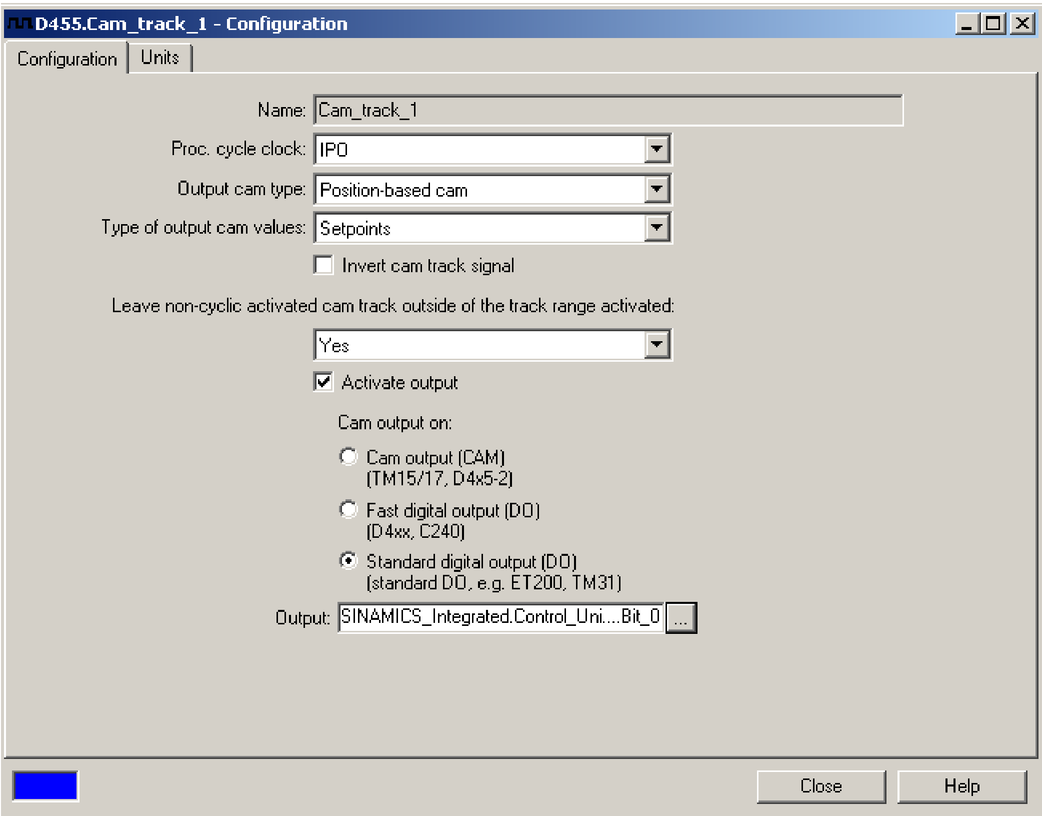


Figure 3-21 Output cam configuration using the example of a position-based cam

You can set the following parameters:

Table 3- 10 Cam track configuration data

Field/Button	Significance/Note
Name	The name of the created cam track is displayed here.
Output cam type (see the **Output cam types of the single output cams on a track** section)	Choose the type of output cam used on the track in **Output cam type**. **Position-based cam** (default value) The switching signal is active when the position of the axis lies between two markers (start and end position). **Time-based cam** The switching signal is on for a specific period of time after reaching the switching position (start position). **Time-based cam with maximum ON length** A maximum ON length can also be defined for time-based cams. This means that the time-based cam is deactivated once it has covered the maximum length, even though the parameterized time has not yet expired.
Processing cycle clock	Choose **Processing cycle clock** to select the system cycle clock used to update the output cam signal at the output or in the system variables. The output cam calculations are performed in the IPO or IPO2 cycle clock, or the position control cycle clock. The processing cycle clock is set in the configuration by means of the **OctBaseCfg.taskLevel** configuration data element. **IPO** (default value) The output cam signal is updated in the interpolator cycle clock. **IPO2** The output cam signal is updated in the interpolator cycle clock 2. The IPO2 cycle clock length is at least twice that of the IPO. **Position control cycle clock** The output cam signal is refreshed in the position control cycle clock. **The following configurations of the processing cycle clock are possible:** • Axis in IPO cycle clock and output cam in IPO2 cycle clock • Output cam in position control cycle clock and axis in IPO or IPO2 cycle clock It is not possible to configure the axis in the IPO2 cycle clock and the output cam in the IPO cycle clock. **Note:** When the position control:IPO ratio is ≠ 1:1, then the greatest possible accuracy for the calculation is reached for "output cams related to position value" when the **position control cycle clock** is set as the processing cycle clock for the cam track TO.
Type of output cam value	Select the position value that is the reference for the output cam during processing. **Setpoints** (default value) The output cam refers to the current setpoint during processing. With regard to output cam values at the setpoint, the output cams are output delayed by one cycle because the setpoints are also only output and can therefore only take effect in the next cycle. This also relates to displaying the output cam status. **Actual values** The output cam refers to the current actual value during processing.
Activate output	Activate the checkbox if the output cam signal is to be applied to a digital output. Parameters are displayed.

Field/Button		Significance/Note
Cam output on		
	cam output (CAM)	If the output check box is activated and the cam output (CAM) radio button selected, the output cams are output on the basis of an internal time stamp. The temporal resolution of cam output depends on the hardware used. In the case of D4x5-2 and the TM17 high feature, the resolution is e.g. 1 µs. Hardware supported: • SIMOTION D4x5-2 (X142) • TM15, TM17 high feature The I/O channel must be configured as **CAM**. For more details, see cam output types. (Page 18) **Note** Cam output (CAM) or high-speed digital output (DO) are also known as high-speed, hardware-supported output cams.
	High-speed digital output (DO)	If the output check box is activated and the "High-speed digital output (DO)" radio button selected, the output cam is output via onboard outputs of the SIMOTION CPU. Output is via a hardware timer, which achieves cam output with a temporal resolution < position control cycle clock. The time that it takes for the axis to reach the output cam switching position with reference to the processing cycle clock is calculated by linear extrapolation. Calculated from the beginning of the 1st position control cycle clock, the output cam function is triggered by a hardware time when this time is reached. Hardware supported: The onboard I/O of the following CPUs is used: • SIMOTION D4x5-2 (interface X142), 8 high-speed cam outputs, V4.2 or higher (The I/O channel must be configured as DO) • SIMOTION D4x5 (interface X122, X132), 8 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as DO) • SIMOTION D410 (interface X121), 4 high-speed cam outputs, V4.1 or higher (The I/O channel must be configured as DO) • SIMOTION C240, C240 PN (interface X1), 8 high-speed cam outputs For more details, see cam output types. (Page 60) **Note** Cam output (CAM) or high-speed digital output (DO) are also known as high-speed, hardware-supported output cams.
	Standard digital output (DO)	If the output check box is activated and the "Standard digital output (DO)" radio button selected, the output cam is output in the position control cycle clock. The temporal resolution of cam output is usually reduced by the output cycle of the I/O used. Hardware supported: • Onboard outputs (SIMOTION D, Controller Extension CX, SINAMICS Control Unit CU3xx) • Centralized I/O (SIMOTION C) • Distributed I/O via PROFIBUS DP/PROFINET IO (e.g. ET 200, ...) • Drive I/O TM15, TM15 DI/DO, TM17 high feature, TM31, TM41, TB30 For more details, see cam output types. (Page 60)

Field/Button	Significance/Note
Output	The output can be symbolically assigned via the assignment dialog (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) using the ... button in the Output field (symbolic assignment is activated by default in projects as of V4.2). If symbolic assignment is not active or if the CPU version < V4.2, a physical output is assigned by entering the HW address and bit number in the Output field. Enter the logical HW address of the output to which the output cam signal is to be applied. Only the output cam signal may be present at this address. If other objects are already using this output, an error occurs that is reported following downloading into the target system. The logical HW address must be located outside the process image and therefore be greater than 63. For details see Cam output types (Page 18)
	Button for opening the assignment dialog (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual). Select a parameter or an address in the assignment dialog.
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display

3.3.5 Defining cam track defaults

You can define defaults for every cam track. These values are stored in system variables and can be changed by programs.

Double-clicking in the project navigator below the cam track on the **Defaults** element displays the window in the working area.

See also

Track data (Page 98)

Output cam data (Page 100)

3.3.5.1 Track data

The defaults for the track system variables, e.g. track length, are displayed in the **Track Data** tab.

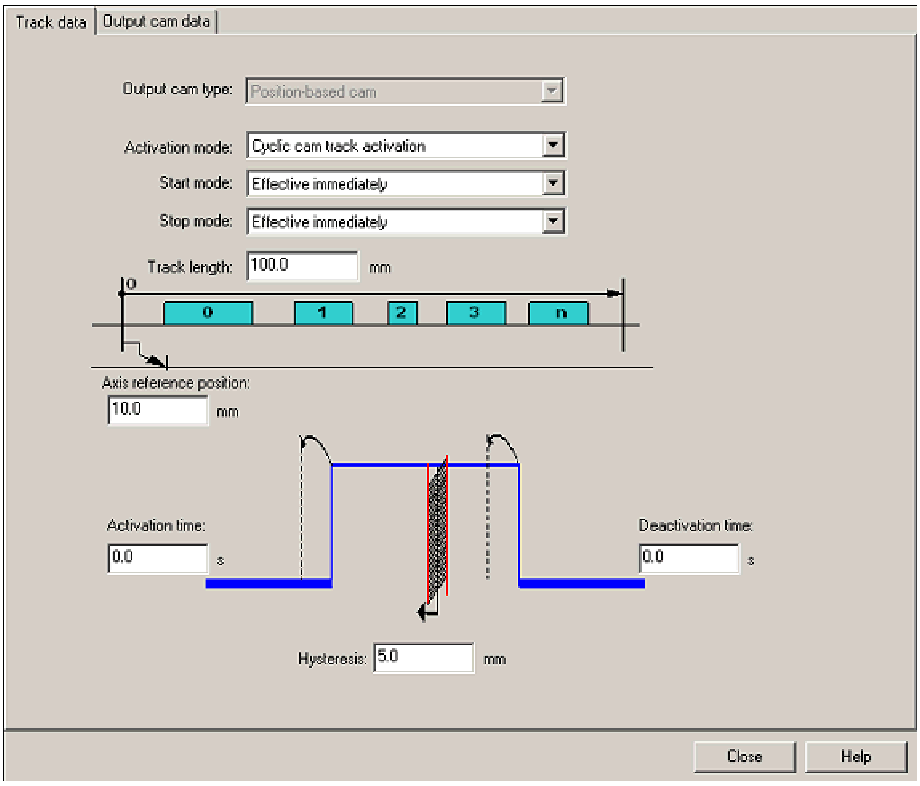


Figure 3-22 Cam track data using the example of a position-based cam

You can set the following parameters:

Table 3- 11 Defaults for cam track data

Field/Button	Significance/Note
Output cam type	**Output cam type** displays the type of output cam selected for the cam track in the **Configuration** window.
Activation mode (See the **Output activation mode** section)	Cam tracks can be output in a cyclic or non-cyclic mode. **Cyclic cam track activation** The cam track's track length is mapped from the axis reference position and continued/repeated cyclically. **Non-cyclic cam track activation** Cam track is mapped from the axis reference position, output once, and terminated automatically after exiting the cam track or remains active in the axis range. This setting depends on the value of the **octBaseCfg.disableOutOfTrackRange** configuration data element.

Field/Button	Significance/Note
Start mode (See the **Start mode and stop mode** section)	The start mode (**startMode**) is used to define when the cam track should become effective after activation, or how tracks should be changed. **Last programmed value** The last programmed start mode is active. If a start mode is not programmed, the user default setting is used. **Effective immediately** Track becomes active immediately. If an output cam (or time-based cam) is defined or active at the current position of the old track, the output is aborted. The new track is enabled without delay (as quickly as possible). This enables high-speed exchange of cam tracks. **Immediately with inactive cam track output** Changeover is made to the new cam track if no single output cam is active (any longer) on the old cam track. An active (output) single output cam on the old cam track is still output completely. **With next track cycle** The track becomes active at the next track cycle. Immediately the first output cam on the new track switches, a changeover is made to the new track. Up to that point, a time-based cam on the old track is output.
Stop mode (See the **Start mode and stop mode** section)	The stop mode (**stopMode**) is used to define the behavior of the cam track on deactivation. **Last programmed value** The last programmed stop mode is active. If a stop mode is not programmed, the user default setting is used. **Effective immediately** Track is deactivated immediately. If an output cam (or time-based cam) is defined or active at the current position of the track, the output of output cam is aborted. **Immediately with inactive cam track output** If no single output cam is active (any longer), the active cam track is stopped. An active (output) single output cam is still output completely. **At cam track end** Track is deactivated at its end. Immediately the final output cam on the track switches, the track is deactivated. Up to that point, a time-based cam on the track is output.
Track length	Enter the track length. The track length is calculated from the start of the cam track to the end of the cam track.
Axis reference position (See the **Cam track features** section)	The axis reference position is used to define how the cam track is mapped on the axis, or from which axis position the cam track should be output.
Axis modulo length (See the **Relation of track length, modulo length, and activation mode** section)	The modulo length of the axis, which the cam track is linked to, is displayed here. The modulo length does not have to be identical to the track length. To change the modulo length of the axis, you must work through the axis wizard. It is only displayed when the axis is configured as a modulo axis.
Activation time (See the **Actuation times (activation time/deactivation time)** section)	Enter the **activation time** here. The output cam switching time is set to the point when the start position is reached, plus this period. The output cam position is adapted dynamically. This allows you to compensate for propagation delays. If a negative value is entered as an activation time, the switching signal is activated before the start position is reached.

Field/Button	Significance/Note
Deactivation time	Enter the **deactivation time** here. The output cam switch-off time is set to the point when the end position is reached, plus this period. The output cam position is adapted dynamically. This allows you to compensate for propagation delays. If a negative value is entered as a deactivation time, the switching signal is activated before the end position is reached.
Hysteresis (See the **Hysteresis** section)	Enter a range for the **hysteresis** here. The output cam does not change its switching state in this defined range around the switching position even under changed switching conditions. This prevents a repeated change of the switching state.

3.3.5.2 Output cam data

The defaults for system variables of single output cams on a track, e.g. starting and end position, are displayed in the **Output Cam Data** tab.

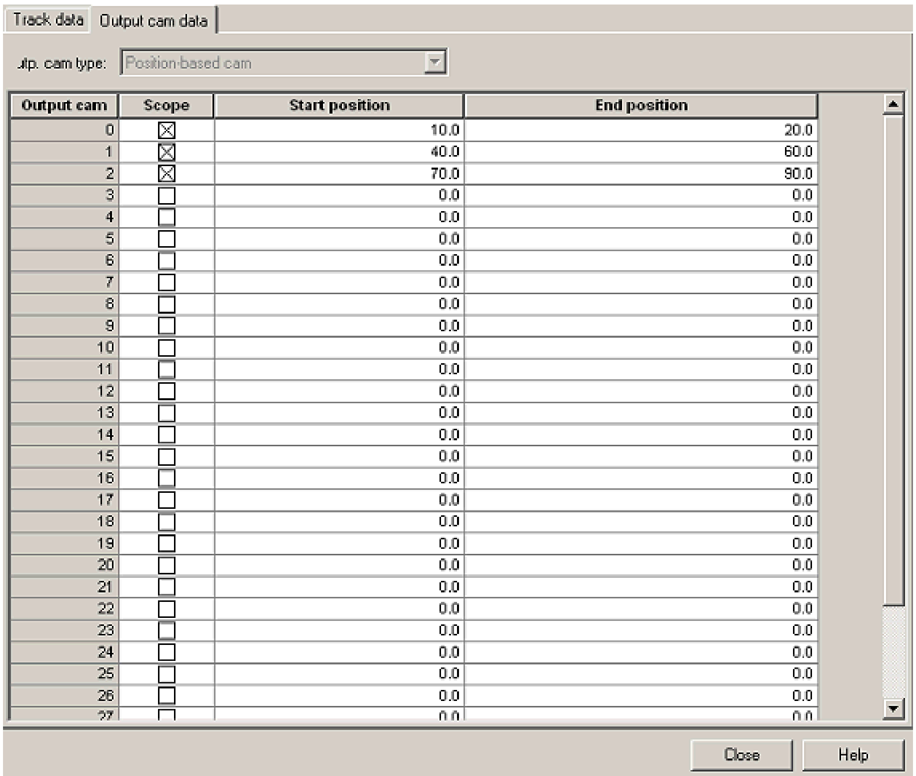


Figure 3-23 Cam track output cam data, position-based cam example

You can set the following parameters:

Table 3- 12 Cam track output cam data defaults

Field/Button	Meaning/Note
Output cam (camType)	The output cam number (0 - 31) is displayed here. Each track can have up to 32 output cams.
Validity	Select this checkbox, if you want to set the output validity of single output cams on a track. If the box is activated, the output cam will be output, along with the track. If it is not activated, the output cam is not output.
Starting position	Enter the starting position of the output cam.
End position	Enter the end position of the position-based cam here.
Last programmed ON duration (See Section Time-based cam)	Enter the ON duration for time-based cams here. The output cam switches off once the parameterized time has expired.
Max. ON length (See Section Time-based cam with maximum ON length)	Enter the maximum ON length for time-based cams with maximum ON length here.

3.3.6 Configuring cam tracks on SIMOTION D4xx onboard

Output cams and cam tracks can be configured for standard outputs, or as high-speed, hardware-based output cams / cam tracks.

Cams can be configured on SIMOTION D4xx onboard as follows:

1. In the project navigator, switch to the control unit via SINAMICS_Integrated > Control_Unit.
2. Double-click Inputs/outputs below the control unit. The window appears in the working area.
3. Switch to the Bidirectional digital inputs/outputs tab.

4. Click the **button** to switch between the input and output for the digital inputs/outputs (**DO8 to DO15**). In each case, switch the DI/DO to the output you wish to use as the output of output cam. The designation at the terminal strip of DI or DO switches to DO. Outputs of the output cam can only be used if they have been defined as an output. DO8 is configured as output in the figure. For the output, select the **DO (SIMOTION)** setting.

Note

Mixed use of the SIMOTION D4xx DI/O as high-speed outputs (of output cams) and inputs of measuring inputs is possible.

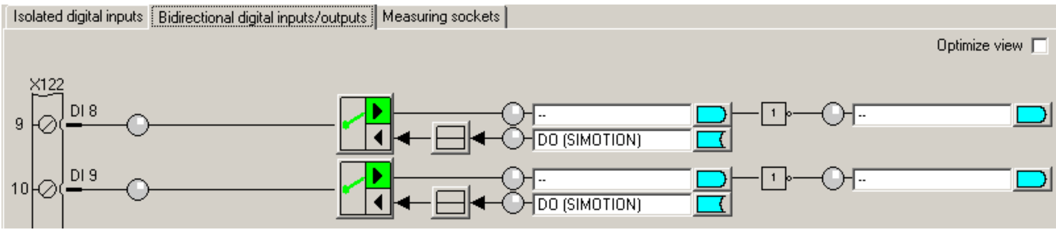


Figure 3-24 SIMOTION D4xx digital inputs/outputs

5. Click **Close**.
6. Insert a new output cam or a new cam track or use an existing one.
7. Parameterize the TO Output Cam / Cam Track
8. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
9. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used. Should you wish to configure a high-speed output cam, select the **Activate output** check box and select the **High-speed digital output (DO)** radio button.
10. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
11. Click **OK** to close the window and select **Project > Save**.

To determine the logical hardware address for outputs on SIMOTION D4xx onboard (only if symbolic assignment is not activated)

1. In the project navigator, below the SIMOTION D device, select **SINAMICS_Integrated > Communication > Message Frame Configuration**.
2. Double-click Configuration and, in the window which appears, select the tab **IF1: PROFIdrive PZD message frame**. The components are displayed there with address range (input/output data).

3. Select SIEMENS message frame 390, 391 or 392 as message frame type. A maximum of eight output cams can be configured for each message frame. The number of DI/DO is limited to eight, i.e. only two output cams can be configured for message frame 392 if you are already using six measuring inputs. Therefore consider whether you also want to use measuring inputs during the message frame selection.

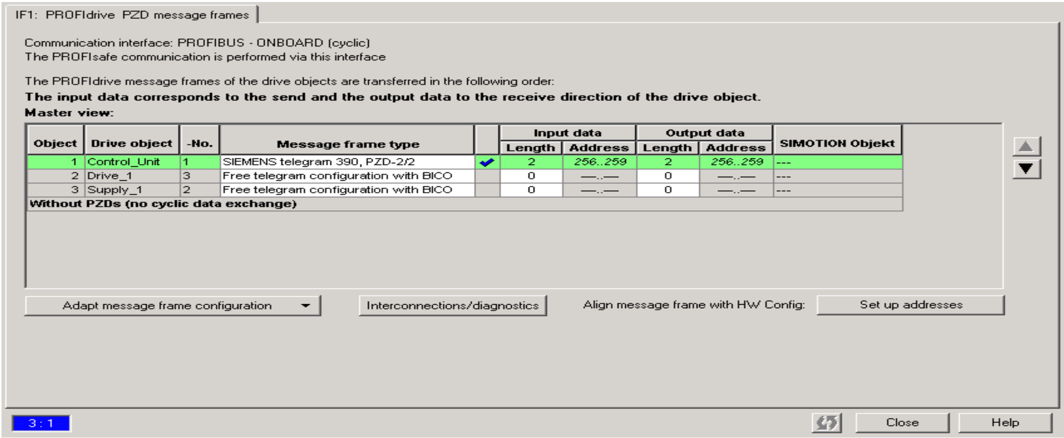


Figure 3-25 Determining the hardware address of the components

4. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses**. If there are question marks in the fields instead of I/O addresses, you must also perform an alignment.
5. Now calculate the HW address by adding the base output address (first value of the output data) of the Control Unit to the offset (for example 298 + 3 = 301). The offset always has the value **3**.
6. You will find the bit number in the following table.

Table 3- 13 Bit numbers for D410 and D4x5

Output D4x5	Output D410	Bit number
X122.7 (DI/DO 8)	X121.7 (DI/DO 8)	Bit 0
X122.8 (DI/DO 9)	X121.8 (DI/DO 9)	Bit 1
X122.10 (DI/DO 10)	X121.10 (DI/DO 10)	Bit 2
X122.11 (DI/DO 11)	X121.11 (DI/DO 11)	Bit 3
X132.7 (DI/DO 12)	-	Bit 4
X132.8 (DI/DO 13)	-	Bit 5
X132.10 (DI/DO 14)	-	Bit 6
X132.11 (DI/DO 15)	-	Bit 7

Note

In the case of versions earlier than V4.2, when using 39x message frames, the onboard D4x5 outputs are to be assigned exclusively to SIMOTION.

3.3.7 Configuring cam tracks on SIMOTION D4x5-2 onboard

With SIMOTION D4x5-2 the outputs on the interface X142 are used for cam output

1. The **Inputs/outputs X142** entry in the project navigator can be used to open the configuration screen in HW Config.
2. For the selected I/O channel, select **Output cam** as the function.

> **Note**
>
> If you do not use any symbolic assignments (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual), then you must note the logical address. (see Figure I/O Properties) This address must be configured at the TO output cam

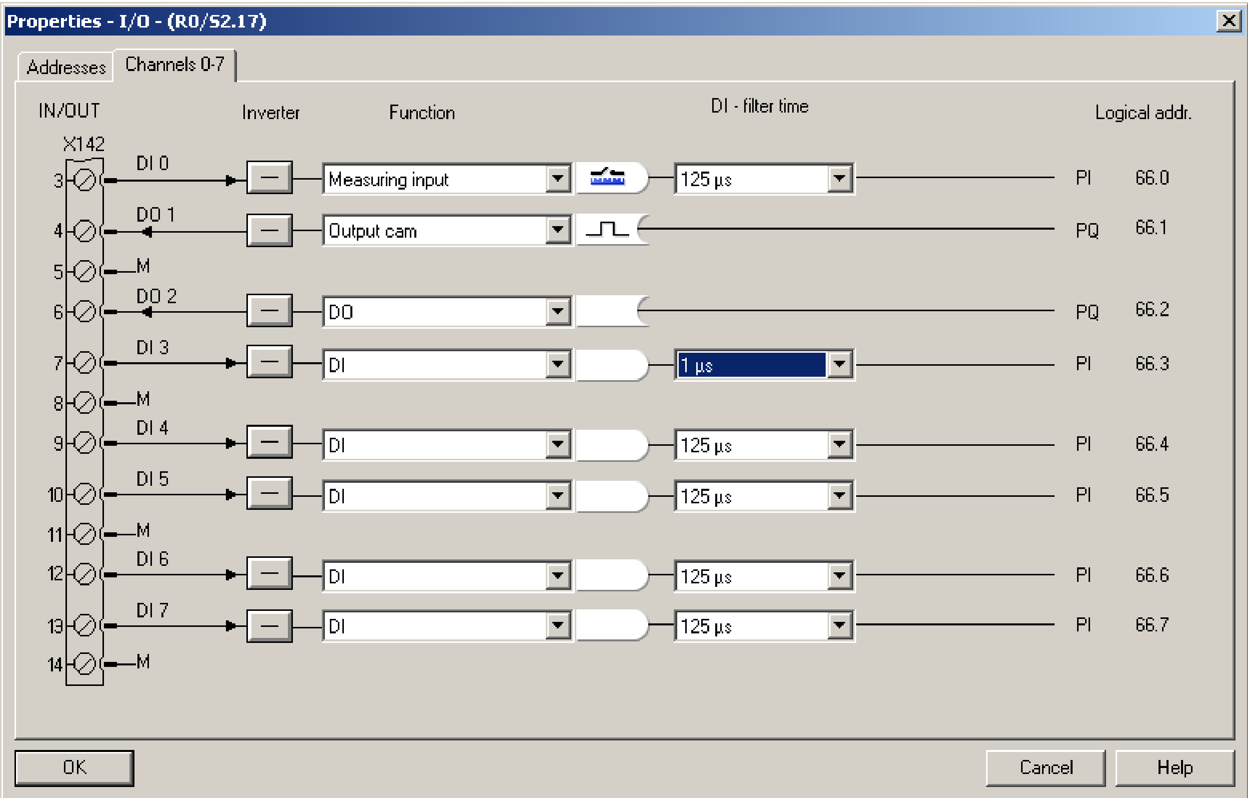


Figure 3-26 I/O Properties

3. Click OK.
4. Insert a new output cam or a new cam track or use an existing one.
5. Parameterize the TO Output Cam / Cam Track
6. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.

7. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used.
   Should you wish to configure a high-speed output cam, select the Activate output check box and select the Cam output (CAM) radio button.
8. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment or by entering the HW address.
9. Click OK to close the window and select **Project > Save**.

3.3.8 Configuring cam tracks on a TM15/TM17 High Feature

1. In the project navigator, below the input/output component (TM15/TM17) that you want to use, double-click the entry **Inputs/outputs.** The **Bidirectional Digital Inputs/Outputs** window is displayed.
2. For the selected I/O channel, select **Output cam** as the function.

> **Note**
>
> If you do not use symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual), then you must note the offset (e.g. 3.1).

3. Insert a new output cam or a new cam track or use an existing one.
4. Parameterize the TO Output Cam / Cam Track
5. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
6. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used.
   Should you wish to configure a high-speed output cam, select the **Activate** output check box and select the **Cam output (CAM)** radio button.
7. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
8. Click OK to close the window and select **Project > Save**.

To determine the logical hardware address for TM15/TM17 High Feature outputs (only if symbolic assignment is not activated)

1. In the project navigator, below the SIMOTION device or the SINAMICS drive unit
   - for SIMOTION D, select: **SINAMICS_Integrated > Communication > Message Frame Configuration**
   - for SINAMICS S/G drive unit (position axis only): **Communication > Message Frame Configuration**
2. Double-click **Message frame configuration** and, in the window which appears, select tab **IF1: PROFIdrive PZD message frame**. The components are displayed there with the address ranges (e.g. TM17 output data 304 to 315).

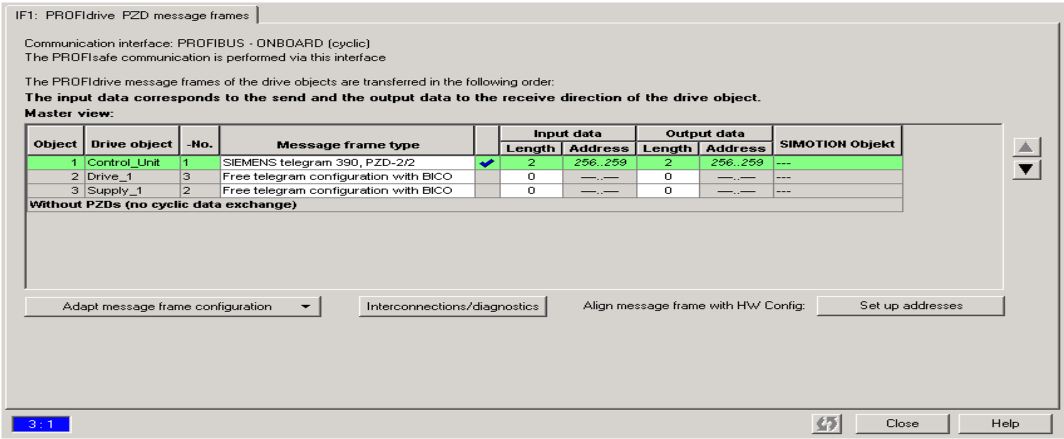


Figure 3-27 Determining the hardware address of the components

3. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses**. If question marks are entered in the fields instead of I/O addresses, either alignment has not yet taken place, or the address is not recognized by SIMOTION SCOUT. In this case, you must perform an alignment.
4. Now calculate the HW address by adding the base output address (first value of the address range) of the TM to the offset (e.g. 304 + 3 = 307).
5. The bit number is defined by means of the offset. For example, an offset of an output cam on DO1 of 3.1 results in a bit number of 1.

3.3.9 Configuring cam tracks on SIMOTION C240

1. Insert a new output cam or a new cam track or use an existing one.
2. Parameterize the TO Output Cam / Cam Track
3. Double-click **Configuration** below the output cam or the cam track in the project navigator. The **Configuration** window appears in the working area.
4. For high-speed, hardware-supported output cams, you can achieve an output accuracy exceeding the position control cycle clock based on the hardware used. Should you wish to configure a high-speed output cam, select the **Activate output** check box and select the **High-speed digital output (DO)** radio button
5. Assignment of an output to an output cam/cam track is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address.
6. Click OK to close the window and select **Project > Save**.

3.3.10 Determining derivative-action times for cam tracks (dead time compensation)

Depending on the system and the device, there is a certain time between the setting of a cam output by the program and the actual reaction of the actuator (e.g. solenoid valve). This time is called dead time and depends, for example, on the load-dependent delay times of a digital output, the switching properties of a valve, etc. Usually the exact value for the dead time is not known and can therefore be determined empirically through measurements.

In order that an output cam switches at the correct time, the dead time must be compensated by specifying a derivative-action time, which offsets the cam output by the dead time. Whereby it must be taken into account that the derivative-action times for switching an actuator on and off are usually different.

The empirical determination of the dead times using a difference measurement as an example.

Note

The procedure applies not only to output cams, but also to cam tracks. However, with cam tracks you can only specify a derivative-action time for the entire cam track.

Example

Lines of glue are to be applied to a product at a defined position and with a fixed length. The glue output is controlled by an output cam or a cam track. The glue is output from the start of output cam (switch-on point) to the end of output cam (switch-off point). The offset of the begin and end of output cam with respect to the velocity can be observed on the length and position of the glue line on the product (see figure). The figure below shows the line of glue for two velocities (v_1, v_2) with $v_2 > v_1$.

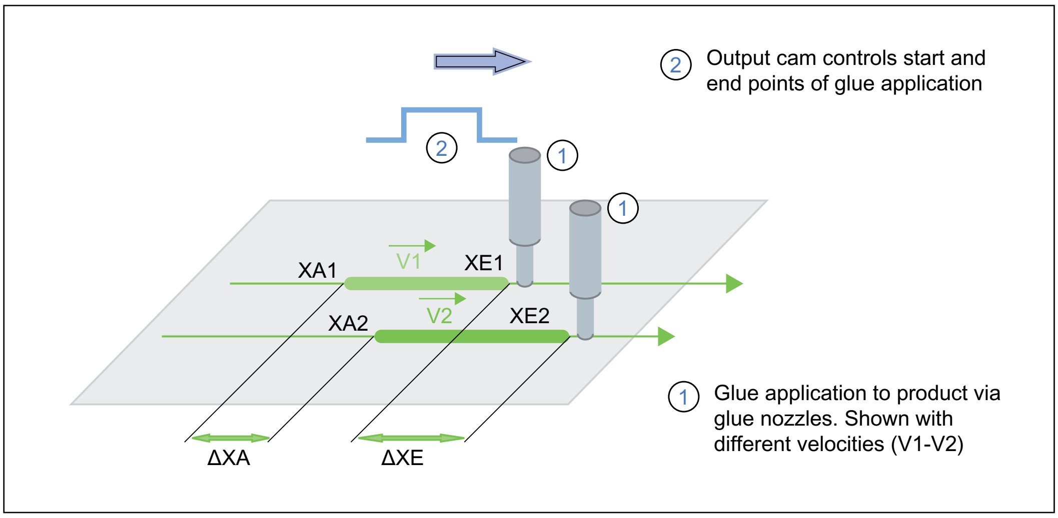


Figure 3-28 Offset of the output of output cam through dead times (dead time compensation)

Procedure:

1. Set all actuation times for start of output cam (activation time) and end of output cam (deactivation time) to 0.
2. Define the velocities for which the positions are to be determined. You should select two velocities that correspond to velocities that occur during production (e.g. minimum and maximum velocity).
3. Start the application and determine the start positions (x_{A1} and x_{A2}) and end positions (x_{E1} and x_{E2}) of the line of glue for the velocities v_1 and v_2.

Note

To increase the accuracy, you can perform several comparison measurements and use the average measured values.

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4. You can determine the actuation times for the output of output cam using the following formula.

   $t_{Activation} = \Delta s/\Delta v = (x_{A2}-x_{A1})/(v_2-v_1)$
   $t_{Deactivation} = \Delta s/\Delta v = (x_{E2}-x_{E1})/(v_2-v_1)$

5. Enter the calculated actuation times as **activationtime** for the start of output cam and as **deactivationtime** for the end of output cam. Note that the actuation time must be entered as a negative when the output time is to be before the programmed output cam switching time.
6. After you have determined the activation time and the deactivation time for the output of output cam, you should perform a control measurement and check the result.

Note

Depending on the application, it may be, e.g. with eccentric presses, that there is no linear relationship between dead time and velocity (e.g. non-linear response of an applied brake). You have to dynamically adapt the dead time to the respective velocity for these applications. This can be implemented in the application with a user program. After the actuation time has been changed, you have to activate the output cam again with **_enableOutputCam** or the cam track with **_enableCamTrack**.

3.3.11 Using HW enable for cam tracks

You can make cam track output dependent on a hardware-based enable (only with the TM17 High Feature). The cam track is, for example, output cyclically on the TM17 High Feature. The enable signal (level or edge-controlled) triggers output of the cam track on the TM17 High Feature.

A Measuring Input TO can be configured to implement an edge-controlled enable on the enable input of the TM17 High Feature. Once the configured measuring signal drops in, the cam track is enabled at the output of the TM17 High Feature.

A HW enable can be configured for Cam Track TOs, as well as Output Cam TOs. The procedure to be used is described below using the example of a Cam Track TO. Subject to any stated restrictions, this procedure is also used for Output Cam TOs.

Note

A HW enable can only be used if the "High-speed output cam on TM15/17" option is activated for the Cam Track TO or the Output Cam TO (see Section **Configuring cam tracks for HW output cams**).

Note

For more information about HW enable input, see the *Terminal Modules TM15 / TM17 High Feature* Commissioning Manual.

See also

Absolute level-controlled (TM17 High Feature) (Page 110)

Absolute edge-controlled (TM17 High Feature) (Page 111)

Setting (overriding) the enable via a program (Page 112)

Relative edge-controlled (Page 113)

3.3.11.1 Absolute level-controlled (TM17 High Feature)

Required configuration for level-controlled HW enable

- Cam track TO or output cam TO configured
- Digital output on TM17 High Feature parameterized for cam track output, and level-triggered enable set at this output. The appropriate enable input for the enabling signal is parameterized automatically.
- Digital output configured for cam track output (HW address)
- Cam track TO or output cam TO must be active.

Level-controlled enable procedure

For cam tracks with a level-controlled enable, output cams are output for as long as the cam track is active in the TO (set with the **_enableCamTrack** command) and as long as a HW-enable enabling signal, which has been parameterized on the TM17 High Feature, is present. This means that a cam track can also be output multiple times with a continuous enabling signal. An output cam, which is already active, is still output even if the enable is deactivated.

An output cam cannot be activated until a HW enabling signal is present at the TM17. If the enable takes place within an output cam, it is not output. Subsequent output cams are, however, output. This can be parameterized in the track enable of the TO (see the **Start mode and stop mode** section).

It is also possible to execute the output with inverted logic, i.e. the enable input on the TM17 can be operated inversely and then works in LOW-active mode.

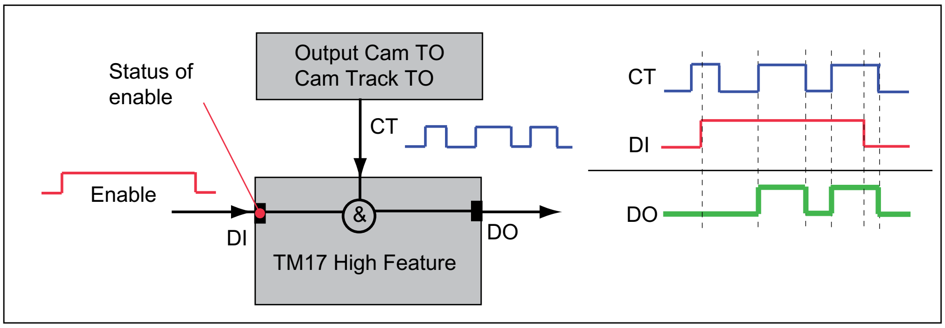

Figure 3-29 Schematic representation of a level-controlled HW enable

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Note

With level-controlled HW enables, the **state** system variable does not indicate the status of the output (DO), but rather the status of the cam track signal (C-TS).

Determining the status of the enable

The I/O area of the digital input for the enabling signal is used to determine the status of the enable. For more information, see the *Terminal Modules TM15/TM17 High Feature* Commissioning Manual.

3.3.11.2 Absolute edge-controlled (TM17 High Feature)

Required configuration for edge-controlled HW enable

- Cam track TO or output cam TO configured
- Digital output on TM17 High Feature parameterized for cam track output, and edge-triggered enable set at this output. The appropriate enable input for the enabling signal is parameterized automatically.
- Measuring input configured (measuring range, edge, operating mode of measurement once)
- Digital output on the TO configured for cam track output (HW address)
- Cam track TO or output cam TO must be active.

Evaluating edges for the measurement

For the measuring input, only the measurement once mode is permitted with the following edge detection:

- Rising edge
- Falling edge
- Both edges

A measuring of both edges, first rising and both edges, first falling and the cyclic measuring mode is not supported.

Edge-controlled enable procedure

In the case of edge-controlled HW enable inputs, the cam track is output when the track is active (_enableCamTrack command set) and the configured edge has been detected by the configured measuring input at the TM17 High Feature input. This edge enables the hardware gate for outputting the active cam track. The edge is detected in the configured measuring range (if configured) or with _enableMeasuringInput (without measuring range) on the measuring input.

The measuring range operates with IPO/IPO2 or position control cycle clock resolution, and the enable input (measuring input) with 1 µs. The enable signal position can be evaluated in the usual way using the measuring input.

An output cam cannot be controlled until a HW enabling signal is present at the TM17 High Feature (edge). If the enable takes place within an output cam, it is not output. Subsequent output cams are, however, output.

As soon as a new measurement job is transmitted (measuring input activated) or a new measuring range begins, the enable for the active output is reset.

To achieve quick response times, the cam track is continually output by the TO (cyclic cam track output), i.e. all output cams are transferred to the TM17 High Feature.

In principle, non-cyclic cam track output is possible (e.g. if a HW enable is coupled to a SW enable). The cam track is then only output once after the HW enable.

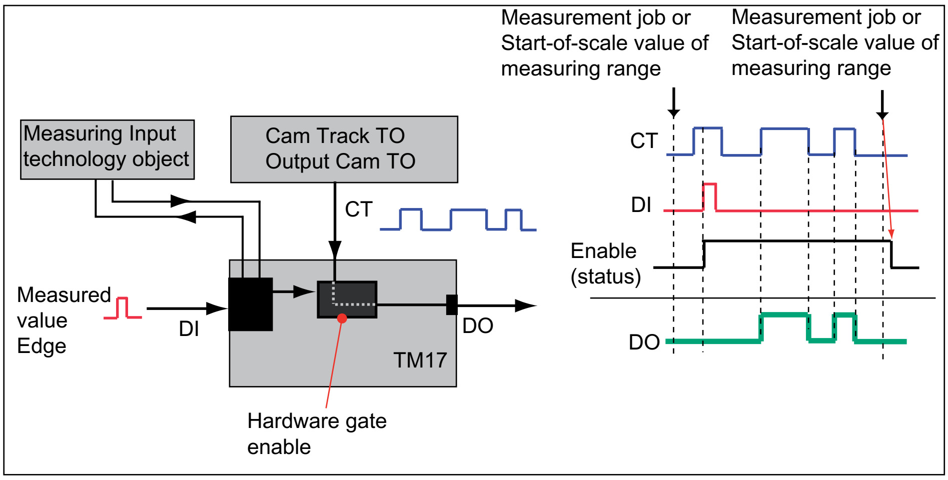

Figure 3-30 Schematic representation of an edge-controlled HW enable

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Note

With an edge-controlled HW enable, the **state** system variable does not indicate the status of the output (DO), but rather the status of the cam track signal (C-TS).

Determining the status of the enable

The I/O area of the digital input for the enabling signal is used to determine the status of the enable. For more information, see the *Terminal Modules TM15/TM17 High Feature* Commissioning Manual.

3.3.11.3 Setting (overriding) the enable via a program

It is possible to set the HW input of the enable for the cam track via a SW enable signal. For this, you have to access the HW input directly via its address in the user program and set the bit.

- **Level-controlled:**
  Enable, as long as the bit is set (functions as enable input). This can be achieved by logically ORing the SW enable and enable input (i.e. the enable can also be active "outside of" the SW enable, if the enable input is active).
- **Edge-controlled:**
  Enable is set as long as the bit is set, irrespective of the measurement jobs on the Measuring Input TO.
  If the measured-value edge appears at the enable input during SW enable, the enable remains active even after the SW enable has been cancelled, until a new measurement job/new measuring range occurs.

3.3.11.4 Relative edge-controlled

You can use the user program to implement a relative, edge-controlled enable input for a cam track.
Follow the steps outlined below:

1. Configure the cam track.
2. Configure a measuring input that detects the measured result for exchanging the cam track (e.g. position of a workpiece edge).
   The measuring input can be connected, for example, to a drive via PROFIBUS DP, a SIMOTION CPU, or a TM15/TM17 High Feature. Unintended edges apparent during measuring can be hidden using the measuring range.
3. Depending on the measured position, the configured cam track can be activated with _enableCamTrack in the user program and the detected position can be calculated via the axis reference position. Cam track output then occurs relative to the measured position.

Note that output cams cannot be output immediately after the measurement has taken place, due to data transfer times (for example bus runtimes).

This must be taken into account as follows in your application:

- A certain time interval should be left between the measurement and output of the first output cam.
- The edge-detecting sensor should be positioned in the machine accordingly.

3.4 Programming/References of TO Cam Track

3.4.1 Programming

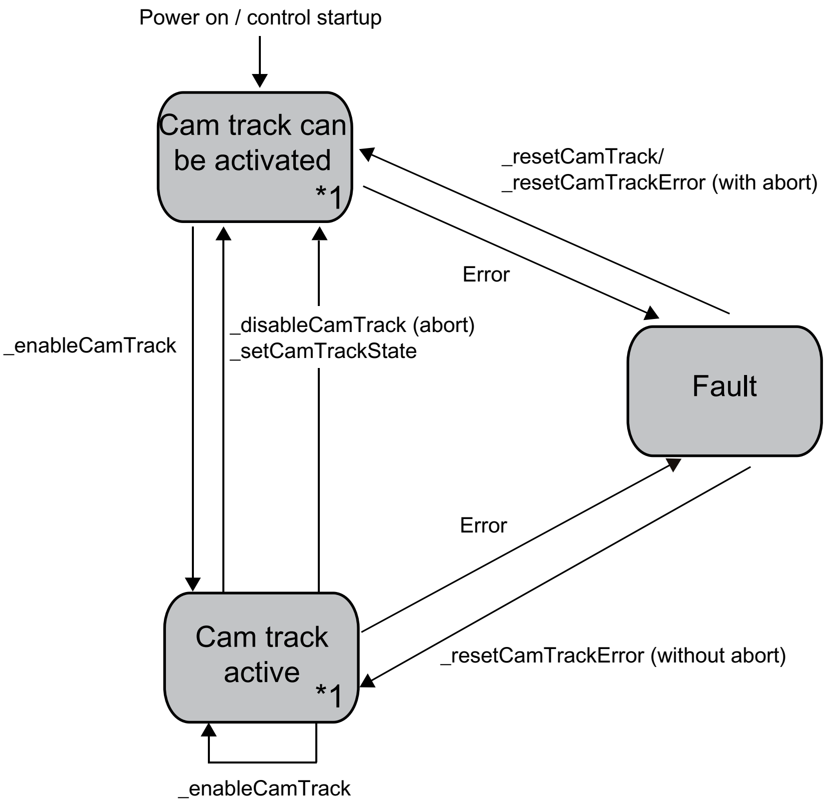


Figure 3-31 Programming and execution model for the Cam Track TO

*1 The following commands are available in the technology object states **can be activated** and **active**:

- **_disableCamTrackSimulation**
- **_enableCamTrackSimulation**

The simulation commands are modal/act in parallel and do not replace any existing _enableCamTrack commands.

3.4.2 Commands

The Cam Track technology object can be addressed in the user program using the following commands:

Table 3- 14 Cam Track TO system functions

Commands	Description	Application
_enableCamTrack	Activates cam track execution	Cam track evaluation is activated. If the switching condition for the output of output cam is fulfilled, the output or **state** system variable is set. It is also effective for axes that have not been homed.
_disableCamTrack	Deactivates cam track execution	Cam track evaluation is deactivated. If the switching condition for the output of output cam is fulfilled, the output or **state** system variable is not set.
_enableCamTrackSimulation	This function simulates a cam track by disconnecting the output. The cam track remains internally active, the status is retained, the cam track output is not switched.	Values are calculated, but not forwarded to the hardware. Hardware output cams act as software cams. The cam track remains internally active, the status is retained, the cam track output is not switched. If an active cam track is switched to simulation mode, the output cam status remains the same, and only the control of the output is reset or interrupted.
_disableCamTrackSimulation	The cam track is reset from simulation mode. The cam track output is switched according to the cam track status and the signal inversion.	The output of output cam is switched according to cam track status and signal inversion.
_setCamTrackState	This function deactivates the cam track function and sets the cam track status to the specified value.	This is used if the output should not be controlled by the cam track TO. **Example:** A glue nozzle is controlled by the cam track TO (applying glue dots). As a service function, it should also be possible to rinse the nozzle while constantly controlling it. This is achieved via **_setCamTrackState**.
_resetCamTrack	This function switches the cam track to an initial state. Pending errors are deleted. Modified configuration data is reset on request.	Creating initial state of cam track TO
_resetCamTrackError	Resets cam track errors. It is terminated with a negative acknowledgment for any errors that cannot be acknowledged at this point.	E.g. acknowledging configuration errors after entering correct values.
_getCamTrackErrorNumberState	Readout of error number status.	Check for occurrence of an error with the specified error number
_getStateOfCamTrackCommand	This function returns the execution state of a command.	Check whether or not cam track switching has already taken place (i.e. the command ID is still available or has already been deleted)

Commands	Description	Application
_resetCamTrackConfigDataBuffer	Changed configuration data is collected and stored in a buffer, and is activated with this command in the RUN configuration. This function deletes the configuration data collected in the buffer since the last activation without activating it.	Changing configuration data in the RUN state discards the accumulated modifications.
_bufferCamTrackCommandId	This function enables **commandId** and the associated command status to be saved beyond the execution period of the command. The **commandId** parameter is used to define the command for which the respective status is to be saved. The maximum number of savable command states is specified in the **decodingConfig.numberOfMaxBufferedCommandId** configuration data element.	Subsequent check of how command was terminated, e.g. error-free or number of error that occurred.
_removeBufferedCamTrackCommandId	This function ends the saving of **commandId** and the associated command status beyond the execution period of the command.	Explicit deletion of previously saved command IDs.

For further information on the system functions, please refer to the *SIMOTION TP CAM Reference Lists*.

3.4.3 Process Alarms

You can predefine local alarm responses via SIMOTION SCOUT.

Note

For more information, refer to the *Motion Control Technology Objects Basic Functions* functional description.

How to configure the alarm response:

1. Double-click **Execution system** in the project navigator below the SIMOTION device. The execution system opens.
2. In the execution level tree, select **SystemInterruptTasks > TechnologicalFaultTask**.
3. Then click the **Alarm Response** button in the displayed window. The **Alarm Response** window appears. You can configure the alarm response for every TO here.

A system variable **error** indicates that a technology alarm has been generated. The response to the alarm is displayed in the **errorReaction** variable.

Table 3- 15 Possible alarm responses

Alarm Response	Description	Application
NONE	No response	-
DECODE_STOP	Command processing is aborted, the cam track function remains active. Execution on the technology object can continue after **_resetOutputCam** or **_resetOutputCamError**.	The Cam Track TO can only be reactivated after the error has been acknowledged.
CAMTRACK_DISAB LE	Command processing is aborted, current cam track function is aborted. Execution on the technology object can continue after **_resetCamTrack** or **_resetCamTrackError**.	The Cam Track TO can only be reactivated after the error has been acknowledged.

3.4.4 TO Cam Track menus

3.4.4.1 Cam track menu

Grayed-out menu functions cannot be selected. The menu is only active if a Cam Track TO window is active in the working area.

You can select the following functions:

Table 3- 16 Cam track TO menu

Function		Significance/Note
Close		Select **Close** to close the configuration window for the cam track that is open in the working area.
Properties		Select **Properties** to display the properties of the cam track highlighted in the project navigator.
Configuration		Select **Configuration** to determine the configuration data (e.g. output cam type) of the cam track.
Default		Select **Default** to define the defaults of the system variables (e.g. track data and output cam data) of the cam track.
Expert		
	Expert list	Select **Expert list** to open the expert list for the highlighted cam track. The configuration data and system variables can be displayed and changed in this list.
	Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.

3.4.4.2 Cam track context menu

Grayed-out functions in the context menu cannot be selected.
You can select the following functions:

Table 3- 17 Cam track TO context menu

Function		Significance/Note
Open configuration		Select **Open configuration** to display the window for configuring the cam track in the working area. Enter the configuration data for the cam track in this window.
Cut		Select **Cut** to remove the selected object and save it to the clipboard.
Copy		Select **Copy** to copy the selected object. It is stored in the clipboard.
Paste		Select **Paste** to insert the cam track stored in the clipboard.
Delete		Select **Delete** to delete the selected cam track. The entire data of the cam track is deleted permanently.
Rename		Use **Rename** to rename the object selected in the project navigator. Note that with name changes, name references to this object are not adapted.
Expert		
	Expert list	Select **Expert list** to open the expert list for the highlighted cam track. The configuration data and system variables can be displayed and changed in this list.
	Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.
	Insert script folder	**Insert script folder** enables you to insert a folder below the TO. You can create scripts in this folder in order to, for example, automate the configuration.
	Import object	**Import object** imports the data of a SIMOTION object from another project which was previously created with a selective XML export. You cannot import the entire project, only the data of the SIMOTION object.
	Save project and export object	**Save project and export object** exports selected data of the selected object in XML format. This data export can then be reimported into other projects. Only the data of the selected object, not the entire project, is exported.
Print		Select **Print** to print the configuration of the cam track. All system variables and configuration data with the associated values are printed.
Print preview		Select **Print preview** to open the preview of the output cam data to be printed.
Default		Select **Default** to define the system variables (e.g. track data and output cam data) of the cam track.
Properties		Select **Properties** to display the properties of the cam track highlighted in the project navigator.

Measuring Input TO - Part III

4

4.1 Overview of Measuring Input TO

4.1.1 General information about the Measuring Input TO

The **Measuring Input** technology object is used for fast, accurate measurement of actual positions. This is achieved with hardware support (e.g. measuring input on the associated drive unit).

Measurement jobs are activated and configured using the functions of the Measuring Input TO.

Local and global measuring inputs

Depending on the hardware platform, local and global measuring inputs are available for the measuring tasks. Local measuring inputs are axis-related and are mainly implemented in the drive. The actual position value is measured.
Global measuring inputs can be freely assigned to the axes and add an internal time stamp to the measurement result for more precise determination of the axis positions.

Assignment to axes and encoders

The measuring input TO can be assigned to the following axes/encoders:

- Position, synchronized, or path axes
- External encoders
- Virtual axes (only global measuring inputs)

Note

It is not possible to assign a measuring input to speed-controlled axes.

Measurement once

A measurement job is started by a program command. When a signal edge is detected at the measuring input, the current position (for virtual axes, either setpoint or actual value, as required) is stored temporarily. When the current system cycle clock finishes (either position control cycle clock or interpolator cycle clock), this value is available in a system variable for further processing in low-priority tasks.

Cyclic measurement (global measuring inputs only)

A measurement job is started by a program command. Up to two edges can be detected for each processing cycle clock of the measuring input TO (with measuring inputs of SIMOTION D, CX32, CX32-2, CU310, CU320, CU320-2 onboard, max. of two edges for every three position control cycle clocks). These are stored in system variables and remain available until they are overwritten by more recent measurements. The measured values are detected continuously/cyclically until the program command is deactivated. Cyclic measuring is only possible with global measuring inputs.

Measuring range

By specifying a measuring range, the validity of the measurement can be restricted to this range; the measurement will only be activated when the position lies within the measuring range.

One measuring input for more than one axis (as of V4.0)

By creating a measuring input with the "monitoring measuring input" property, measurements can be made with one measuring input simultaneously on more than one axis/external encoder.

4.2 Fundamentals of Measuring Input technology object

4.2.1 Measuring input types - local and global measuring inputs

Depending on the hardware platform (measuring input type), local and global measuring inputs are available for the measuring tasks. Compared to local measuring inputs, global measuring inputs have a greater range of functions and enable measurements to be made faster. During the configuration of a Measuring Input TO, you must consider which functions (measurement, interconnection options) are to the used. Depending on the requirements, you have to configure a local or a global measuring input.

Local measuring inputs

With a signal edge at the relevant input, the current actual values of an encoder connected to SIMOTION C230-2, C240, D4xx, D4x5-2 (X122/X132), CX32, CX32-2 or to the drive (e.g. SIMODRIVE 611U, MASTERDRIVES MC, SINAMICS) are measured with positioning accuracy to determine lengths or distances. The device on which the measuring system is available, is used for the measuring.

The assignment of inputs is not fixed depending on the hardware and is performed in the SCOUT engineering system during configuration of the Measuring Input TO symbolically or via the HW address.

Local measuring inputs refer to the respective drive. Configuration usually takes place via drive parameters.

Global measuring inputs

With a signal edge at the relevant input, the current actual values of one or more encoders are measured using time stamp functionality with positioning accuracy in order to provide information for determining lengths or distances (possible with any encoders included in the project).

Each measurement result is assigned a very precise "internal" time stamp which is then used to determine the corresponding actual position in SIMOTION.

The assignment of inputs is not fixed depending on the hardware and is performed in the SCOUT engineering system during configuration of the Measuring Input TO symbolically or via the HW address.

Global measuring inputs support extended functionalities

- More than one measuring input on one axis/encoder, whereby these can be active simultaneously.
- More than one measuring input is assigned to one measuring input (monitoring measuring input).
  With this functionality, one measuring input can have a functional effect on more than one measuring input and therefore on more than one axis/external encoder.
- Cyclic measuring
- Measuring on virtual axes
- should be configured on the respective device. (I/O channel is configured as measuring input (MI)).
- can be assigned on the SIMOTION-CPU to an axis TO or external encoder TO.
- Configuration by way of symbolic assignment is possible.

Time stamp functionality

With global measuring inputs, a time value (time stamp) is stored with each measurement. In this way, the exact axis position can still be determined even with different propagation delays between the time of the measurement to the evaluation.

4.2.2 Hardware for measuring inputs

Global measuring inputs are only supported by certain hardware (measuring inputs) (see table below).

Hardware for local and global measuring inputs

The following table provides an overview of which hardware supports local and which hardware supports global measuring inputs.

Table 4- 1 Hardware for local and global measuring inputs

Hardware (measuring inputs)	Local measuring inputs	Global measuring inputs
TM15, TM17 high feature	-	X
SIMOTION C240/C240 PN (B1-B4)	-	X
SIMOTION C230/C240 (M1, M2)	X	-
SIMOTION D4xx	X	X (V4.1 and higher)
SIMOTION D4x5-2	X (X122/X132 only)	X (X122/X132/X142)
SIMOTION CX32/CX32-2	X	X (V4.1 SP2 and higher)
SINAMICS S120 drive CU310, CU320, CU320-2	X	X (V4.1 SP2 and higher)
MASTERDRIVES MC	X	-
SIMODRIVE 611U	X	-
ADI4, IM174	X	-
PROFIdrive units	X	-
IM174/ADI4	X	-

Quantity structures for hardware measuring inputs

Table 4- 2 Measuring inputs - Overview of quantity structures and functionality

	Maximum available quantity structure									
	CU310, D410, CX32	D4x5, CU320	D4x5-2	CU320-2	CX32-2	C230-2	C240	C240 PN	TM15	TM17 High Feature
Maximum number of inputs of measuring inputs	3	6	16	8	4	2	6	4	24	16
Can be configured as a local measuring input	X	X	Max. 8	X	X	2 (M1, M2)	2 (M1, M2	-	-	-
Can be configured as a global measuring input	X	X	Max.16	X	X	-	4 (B1-B4)	4 (B1-B4)	X	X

4.2.3 Interconnections

The Measuring Input TO can be linked to all technology objects, such as Axis TO (positioning axis, following axis, path axis) and External Encoder TO.

A TO, such as an Axis TO, can be interconnected simultaneously with several Measuring Input TOs. The assignment can be configured.

With local measuring inputs, the measuring input TO is assigned symbolically or if <V4.2 as part of its configuration. The configuration specifies the number of the measuring input to be used and the number of the encoder on the assigned axis.

(See also Local measuring (Page 147))

With global measuring inputs, the HW address is used for assignment to the measuring input.

(See also Global measuring (Page 148))

With V4.2 and higher, global measuring inputs can also be configured with symbolic assignments. Address handling is thereby no longer required.

4.2.3.1 Measuring input connection options

Measuring input on C2xx controller, analog drive connected

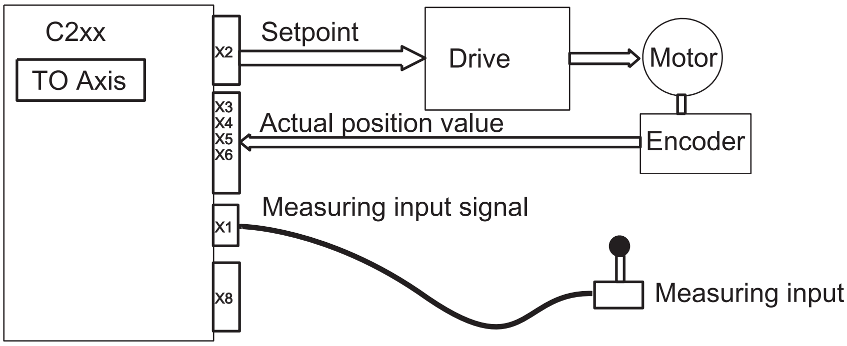


Figure 4-1 Connection of measuring input to the C2xx and an analog axis

Measuring input directly on drive, connected to SIMOTION via PROFIBUS DP

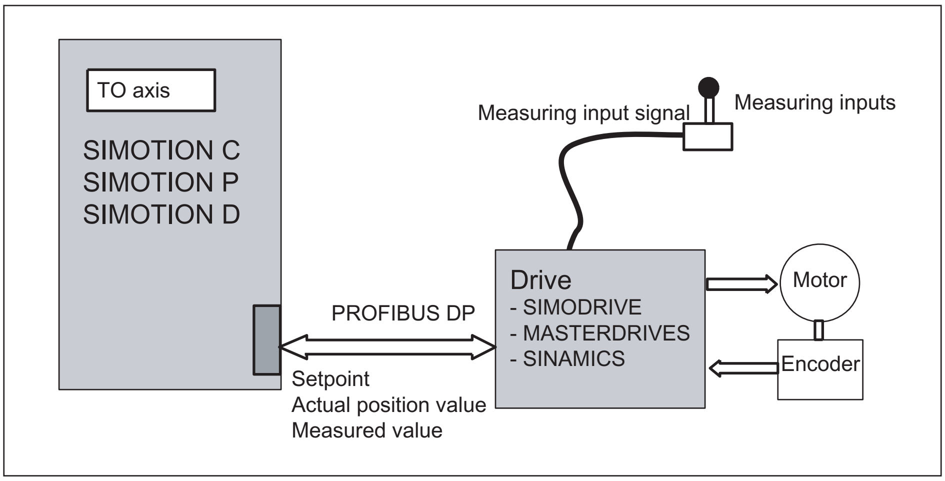


Figure 4-2 Connection of the measuring input on the drive, connected to SIMOTION via PROFIBUS

Measuring inputs on the digital onboard measuring inputs of SIMOTION D or on TM15/TM17 High Feature

Measuring inputs on the digital onboard measuring inputs of SIMOTION D or on TM15/TM17 High Feature, linked to SIMOTION D via DRIVE-CLiQ.

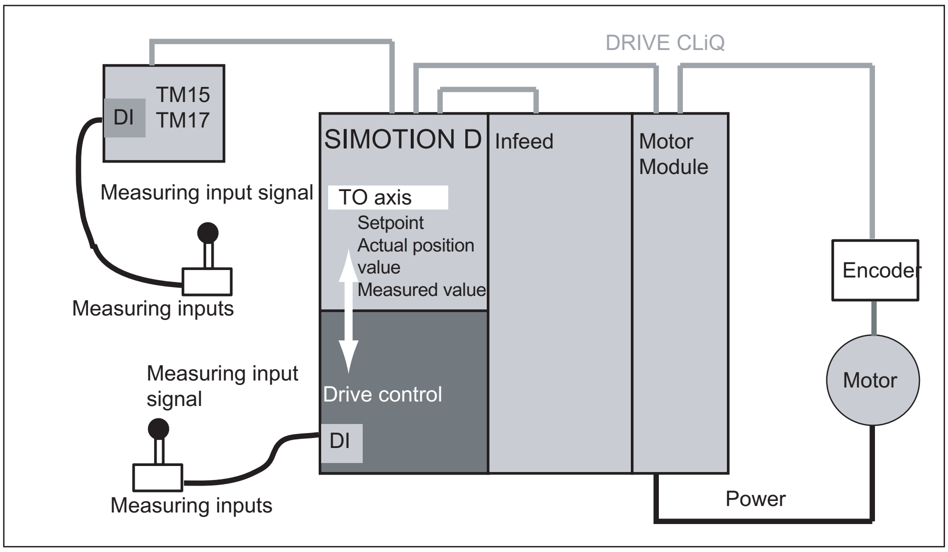


Figure 4-3 Connection of measuring input to SIMOTION D4x5 and TM15/TM17 High Feature

The TO Measuring Input cannot be interconnected with DP I/O or integrated I/O (with the exception of inputs of measuring inputs).

4.2.3.2 Several Measuring Input TOs on one axis/encoder (as of V3.2)

Several Measuring Input TOs can be assigned to an Axis TO or an External Encoder TO. The number of measuring inputs is determined according to the functionality (local or global).

Local measuring inputs

For local measuring input (see Hardware for measuring inputs (Page 124)) the following applies:

- Only **two** measuring inputs can be configured per axis TO or external encoder.
- Only **one** measuring input can be active on an axis TO or external encoder.

Global measuring inputs

For global measuring inputs (see Hardware for measuring inputs (Page 124)) the following applies:

- **More than one** measuring input can be configured per axis TO or external encoder.
- **More than one** measuring input can be active simultaneously on an axis TO or external encoder.

As far as interconnections of measuring inputs TO are concerned, therefore, **one** local measuring input can be configured on an onboard measuring input and **one** or **more** global measuring inputs can be configured and active simultaneously on measuring inputs of C240/C240 PN (B1-B4), D4xx, D4x5-2 (X122/X132/X142), CX32, CX32-2, CU310/320/320-2, and TM15/TM17 high feature.

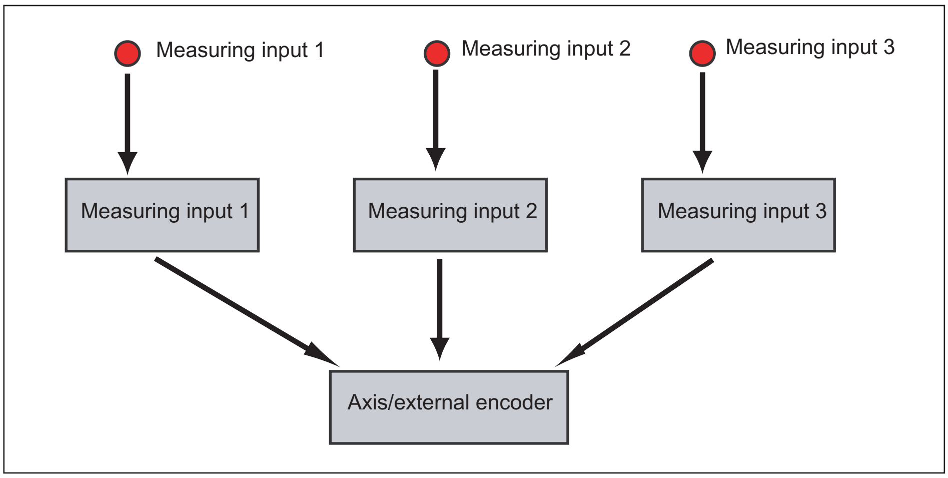


Figure 4-4 Example of interconnection of more than one measuring input with one axis or one external encoder

See also

Measuring input types - local and global measuring inputs (Page 122)

4.2.3.3 More than one measuring input TO on a single measuring input (C230-2/C240 only)

It is possible to assign more than one measuring input to a single measuring input (onboard inputs C230-2/C240 (M1-M2)). In this case, however, it must be ensured that only one measuring input is active at any one time.

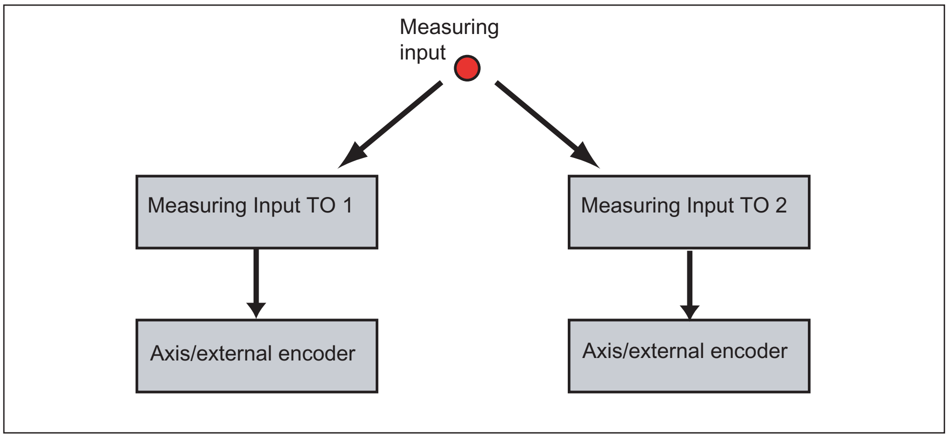


Figure 4-5 Interconnection of more than one measuring input with a single C230-2/C240 (M1-M2) onboard input

4.2.3.4 Measuring one measurement event on several axes - Listening measuring input (V4.0 and later)

With the "Monitoring measuring input" function, the measurement event of a measuring input can also be measured simultaneously by several Measuring Input TOs. To do so, an original measuring input (hereinafter referred to only as measuring input) is configured on a HW input. Additional Measuring Input TOs can be configured as monitoring measuring inputs and interconnected with the Measuring Input TO. The monitoring Measuring Input TOs "listen in" on the measurement event of the Measuring Input TO.

The monitoring Measuring Input TOs can also be assigned to other axes / external encoders. With this functionality, one measuring input can have a functional effect on several axes / external encoders.

The "listening in" property on the Measuring Input TO is set with the configuration data element **inputAccess**:=TO_INTERFACE.

Note

One single event can only be measured on several axes/external encoders at the same time if the measuring input TO is configured as a global measuring input (see Hardware for measuring inputs (Page 124)). Only these inputs have the necessary time stamp functionality.

Procedure

One measuring input is interconnected with one measuring input, as usual. This measuring input is the **original** measuring input. The measuring process is activated and the measurement events are measured on this measuring input. The monitoring measuring inputs are connected internally to the measuring input via an interconnection interface, and the measurement events are communicated simultaneously.

The activation and deactivation of the measurement, as well as the configuration of a measuring range can only take place on the measuring input. Activation and deactivation commands issued on the monitoring measuring input are not executed and are returned with errors. Technology alarm 40011 is issued.

Functionality

- Activation and deactivation of the measuring process on the measuring input only. These commands are not active on the monitoring measuring input.
- Measuring range and edge selection are only available on the measuring input.
- The monitoring measuring input must be configured correctly at the time of the measurement (measuring input cycle clock, system number).
- A monitoring measuring input does not have its own measuring input and cannot perform any measurements of its own.
- The processing cycle clocks of the measuring input and the monitoring measuring input do not have to have the same setting. However, accuracy is lost if the measuring input is assigned to the IPO cycle clock and the monitoring measuring input is assigned to the IPO2 cycle clock, and IPO and IPO2 are configured differently.

The following must be considered when interconnecting more than one measuring input:

- The measuring input and the monitoring measuring input are interconnected with one axis TO or external encoder.
- A measuring input can be interconnected with **more than one** monitoring measuring input **on the output side.**
- A measuring input has **no interconnection on the input side.**
- A monitoring measuring input can only be interconnected with **one** measuring input **on the input side.**
- A monitoring measuring input has **no interconnection on the output side.**
- An axis TO or an external encoder can be interconnected with more than one measuring input, including a mixture of measuring inputs and monitoring measuring inputs. Depending on the hardware (see the **More than one measuring input on one axis/encoder (as of V3.2)** section), more than one measuring input may be active simultaneously.
- Local measuring inputs (onboard I/O from SINAMICS and C2xx) cannot be used for the measuring input. Only global measuring inputs can be used (see Hardware for measuring inputs (Page 124)).
- Only single-stage interconnections are possible.

Note

For more information about interconnections, refer to the *Motion Control Basic Functions* Function Manual.

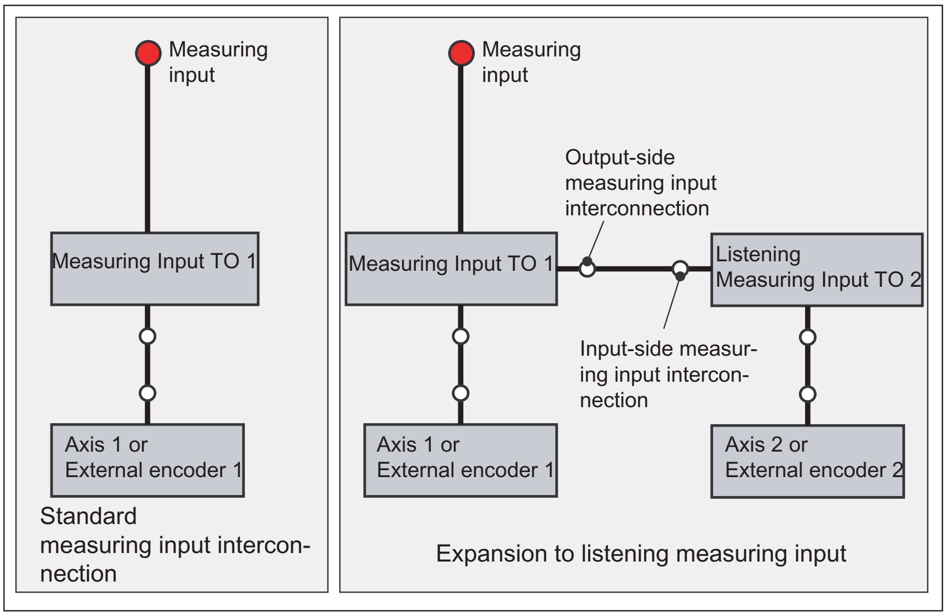


Figure 4-6 Interconnecting monitoring measuring inputs

See also

Several Measuring Input TOs on one axis/encoder (as of V3.2) (Page 127)

Measuring input types - local and global measuring inputs (Page 122)

4.2.4 Measurement

The measuring process is divided into one-time and cyclic measurement modes. The operating mode is distinguished using two separate program commands.

Table 4- 3 Overview of one-time and cyclic measurement functions

Measurement once	Cyclic measurement (global measuring inputs only)
As of version V1.0	As of Version V3.2
Call up with **_enableMeasuringInput** command.	Call up with **_enableMeasuringInputCyclic** command.
Measurement jobs must be issued individually for each measurement.	Measuring is activated just once and runs cyclically until deactivated with **_disableMeasuringInput**.
Several interpolation cycle clocks between two measurements	Up to two edges can be measured in each execution cycle of the Measuring Input TO (IPO interpolation cycle clock, IPO2 interpolation cycle clock or position control cycle clock). With SIMOTION D4x5, D4x5-2 (X122/X132) onboard, CX32, CX32-2 and CU310/320/320-2, the minimum distance between two measurements is 3 position control cycle clocks. The measured values must be read from the user program before they can be overwritten by a new measurement.
Supported by: For hardware for local and global measuring inputs, see Hardware for measuring inputs (Page 124)	Supported by: For hardware for global measuring inputs, see Hardware for measuring inputs (Page 124) (excluding TM15)
Optional measuring range is possible.	One measuring range can be defined as of V4.0. Prior to V4.0, measuring range for TO cannot be configured (must be solved in the application).

4.2.4.1 One-time measurement

In one-time measurement mode, the measured result must be waited for. On its occurrence, the measuring process is terminated.

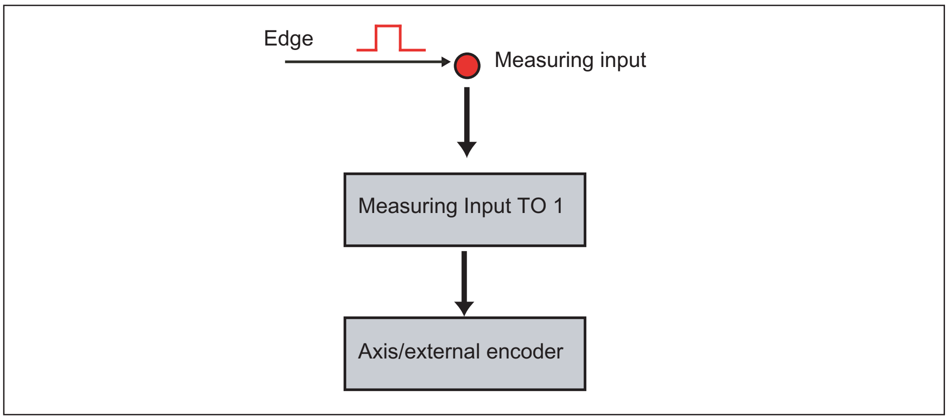


Figure 4-7 Measuring input, measurement once

Measurement process

A measurement is activated by the **_enableMeasuringInput** program command. The **enableCommand** variable indicates the execution status of this command.

The **control** system variable indicates whether the measuring function is active. If, for example, a positive measured edge has been selected and the measuring input is deflected, i.e. a measuring event occurred, the system variable cannot assume the value ACTIVE until the measuring input is no longer deflected.

The **state** variable is set to the value WAITING_FOR_TRIGGER. A rising edge (from 0 to 1) or a falling edge (from 1 to 0) triggers the measuring function. The **measuredEdgeMode** parameter can be used to select which type of edge should be acquired. Acquisition of both measured edges can also be activated by means of a measurement job, in which case you can specify in the command which edge is to be acquired first, for example, first the rising edge and then the falling edge.

The drive must be capable of evaluating the signal edge (rising, falling, or both edges) selected by SIMOTION at the measuring input.

When the measurement result is received, the measurement position is stored. Once the measurement has been made, the **state** variable is set to TRIGGER_OCCURRED, and the measured values can be evaluated using the **measuredValue1** and **measuredValue2** variables for two measured edges.

Activation/deactivation of measurement job

The measurement job remains active until the measurement result has been obtained or until the job is terminated by a command (e.g. **_disableMeasuringInput**).

The measuring process must be reactivated for each new measurement.

The measuring accuracy depends on the accuracy of the hardware used. It lies in the range of microseconds.

4.2.4.2 Cyclic measurement (as of V3.2)

In cyclic measurement mode, up to two edges can be measured in each processing cycle clock of the measuring input TO for TM17 high feature, D4x5-2 (X142) and C240 (B1-B4) (IPO interpolation cycle clock, IPO2 interpolation cycle clock or position control cycle clock).

With onboard measuring inputs of D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310/320/320-2, the minimum duration between two measurements is 3 position control cycle clocks. Measuring signals in between are not detected. Measurements are taken cyclically, until they are terminated with a command.

The measured values must be read from the user program before they can be overwritten by a new measurement.

Note

Cyclic measuring is only possible with global measuring inputs (see Hardware for measuring inputs (Page 124)(excluding TM15)).

During configuration, you are not prevented from also using local measuring inputs for cyclic measuring. However, this is a purely software-side solution, and only unique measuring processes are cyclically collected. The minimum time between two measurements is therefore much longer than with cyclic measuring with global measuring inputs.

When cyclic measurement is activated with local measuring inputs (command **_enableMeasuringInputCyclic**), with V4.2 and higher, **Note 40014** is output stating that during cyclic measuring with local measuring inputs, results may be lost if they are not spaced sufficiently.

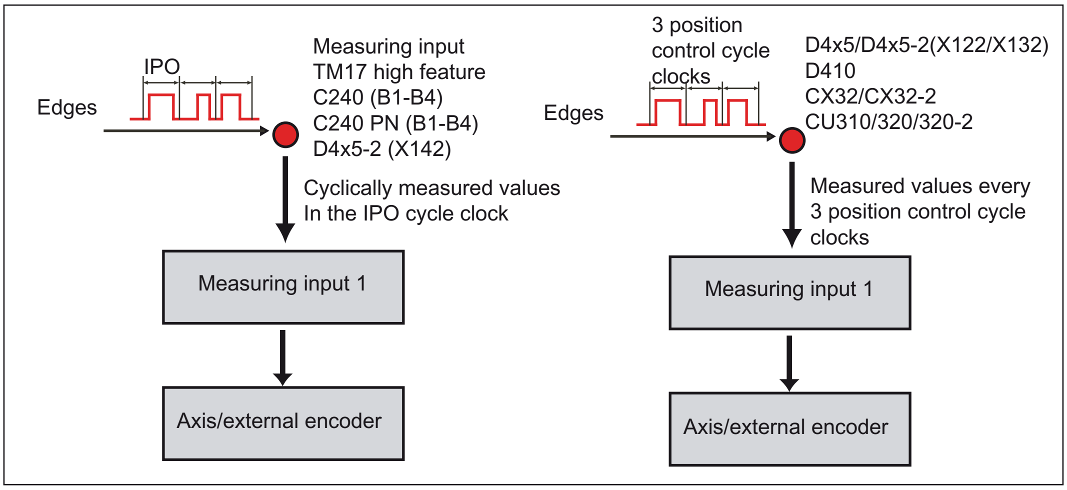


Figure 4-8 TO measuring inputs, cyclic measuring (IPO processing cycle clock)

Measurement process

A measurement is activated by the **_enableMeasuringInputCyclic** program command. The **cyclicMeasuringEnableCommand** variable indicates the execution status of this command.

The **control** system variable indicates whether the measuring function is active. Measuring begins on activation of the program command.

The **userdefault.measurededgecyclicMode** system variable is used to select which type of edge should be acquired. Up to two edges can be measured in each processing cycle clock of the TO measuring input (IPO interpolation cycle, IPO2 interpolation cycle, or position control cycle).

With cyclic measuring, the **state** variable remains in the WAITING_FOR_TRIGGER state even after the arrival of events, as waiting is continued for further events. Increases on the **countermeasuredvalue1/2** event counter indicate that a measurement event has occurred.

When the measurement event occurs, the measurement position is stored. After successful measurement, the measured values are stored in the **measuredValue1** and **measuredValue2** system variables and can be evaluated. The measured values must be read from the user program before they can be overwritten by a new measurement. For example, if polling is being carried out in the IPO-synchronous task, up to two edges can be evaluated per IPO cycle clock.

Table 4- 4 Archiving measurement results in the system variables within an IPO cycle clock

Edges per IPO	measuredValue1	measuredValue2	Description
Rising and falling	First rising edge	First falling edge	-
Rising only or falling only	First edge	Second edge	-
One edge only	First edge	-	-
More than two edges	First edge	Second edge	Error status is synchronously reported with the **error** system variable, and the 40009 TO alarm is output.

counterMeasuredValue system variable

The **counterMeasuredValue1** and **counterMeasuredValue2** counter variables are defined for the **measuredValue1** and **measuredValue2** system variables and are automatically incremented by a value of one for each measuring input. New results can be traced immediately and can also be read from non-IPO-synchronous tasks.

The counter variables are incremented for each measurement input, even if the measured value is rejected (e.g. more than two measured values per IPO cycle clock).

Counter variables are reset on power-up, reset, restart, and on first activation of cyclic measuring. Counter variables are not reset if cyclic measuring was already active and, for example, only a parameter was changed with the **_enableMeasuringInputCyclic** command.

Activation/deactivation of measurement job

The measurement job remains active until deactivated with the **_disableMeasuringInput** command.

See also

Measuring input types - local and global measuring inputs (Page 122)

4.2.4.3 Measurement activation times

Various response times (e.g. effects of propagation delays) must be taken into account in the application for the measuring function, depending on the axis/external encoder connection (onboard C2xx, PROFIBUS axis), the drive used (611U, MASTERDRIVES MC, SINAMICS), and the execution level (IPO, IPO2, or position control cycle clock).

The measuring process is started with **_enableMeasuringInput** or **_enableMeasuringInputCyclic** in the user program.

The runtime up to the evaluation of the measured edge at the HW input is dependent on the configuration. In order to detect the measured edge correctly, you must ensure in the user program that **_enableMeasuringInput** or **_enableMeasuringInputCyclic** have been executed prior to this runtime.

Utilities & applications

The SIMOTION Utilities & Applications contains examples of and help for SIMOTION. It serves to support SIMOTION users and clarify SIMOTION applications.

SIMOTION Utilities & Applications includes, for example, a tool to estimate:

- The time elapsed from activating the **_enableMeasuringInput** and **_enableMeasuringInputCyclic** command to the measuring input job becoming effective in the drive
- The minimum time between two measurement jobs
- Derivative action time when applying a measuring range (fine range)

The SIMOTION Utilities & Applications is shipped with the SIMOTION SCOUT software package.

4.2.5 Measuring range

A measuring range (system variable **userdefault.measuringRangeMode**) can be predefined for a measurement job. This can either be valid for the whole range, or restricted by entering a measuring range start and end.

Note

The measuring range can be used for single measurement and, as of V4.0, for cyclic measurement. If a measuring range is required for cyclic measurement (prior to V4.0), this can be implemented in the application.

A user program in the IPO-synchronous task can detect up to two edges in each IPO cycle clock. If an "unintended edge" is detected, it simply has to be rejected.

Measuring process with measuring range

When measuring with a measuring range, initially, **_enableMeasuringInput** or **_enableMeasuringInputCyclic** simply records the measurement job in the system. The measurement will then be triggered only when the axis position lies within the measuring range. Measuring is only valid within this range.

Figure 4-9 Measuring in the measuring range

The time that elapses after reaching the start of the measuring range on the axis (mechanics) until the measured edge is evaluated at the HW input is dependent on the configuration. In order to activate the measuring function on reaching the desired start of the measuring range on the axis (mechanics), you must preset the start of the measuring range with the **_enableMeasuringInput** or **_enableMeasuringInputCylic** command, depending on the axis velocity and response time.

This procedure is the same for the end of the measuring range. Here, it is important that the measuring function is deactivated as soon as the end of the measuring range on the axis (mechanics) is crossed.

If no measured edge is detected in the measuring range during a single measurement, the measuring job is aborted and a TO alarm is triggered. During cyclic measuring, each measurement result in the measuring range is reported. However, a TO alarm is not output if no measured edge is detected in the measuring range.

During cyclic measuring, the measurement remains active for modulo and non-modulo axes even after the measuring range is exited, and even over several modulo cycles. The measurement is only terminated with **_disableMeasuringInput**.

For non-modulo axes, the sequence in which the start and end of the measuring range are specified is irrelevant. If the start of the measuring range is greater than the end of the measuring range value, the two values are exchanged.

If the start of the measuring range is greater than the end of the measuring range in a modulo axis, the measuring range is extended from the start of the measuring range over the modulo transition of the axis to the end of the measuring range.

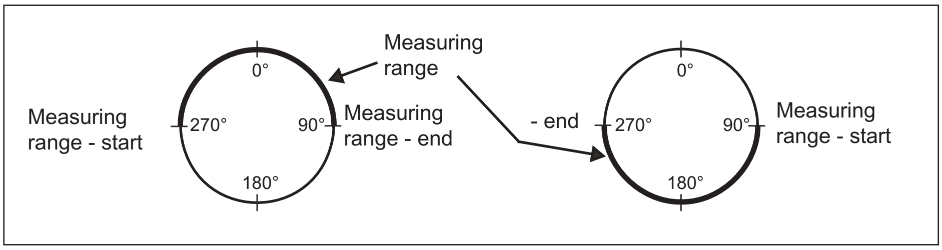


Figure 4-10 Measuring range for modulo axes for the measuring input

Dynamic measuring range

The measuring range can also be switched on or off dynamically. An activation time is allowed for this purpose when switching on or off.

The activation time can be specified by means of the **measuringRange.activationTime** configuration data element.

This time can be used, for example, to compensate for the runtimes during activation via PROFIBUS and the drive.

The following applies here:

- Activation of the measuring range and consideration of the activation time are performed on a position control granular basis.
- This means that the accuracy depends on the position control cycle clock.
- The runtime should be taken into consideration: Position control DP cycle clock activation in the drive (i.e. the position of the position control cycle clock in relation to the DP cycle clock as well).
- The actual position of the encoder is not evaluated directly, instead the filtered actual position is evaluated (see Actual value system).

4.2.6 Configure Units

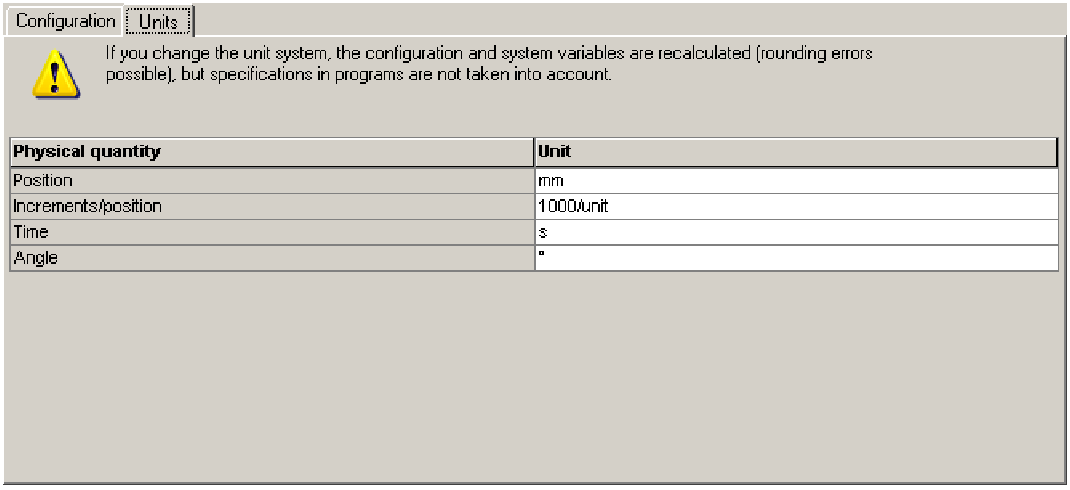
You can define the basic units for each technology object. The same physical variables can have different units in different technology objects. These are converted:

How to configure the units:

1. Open the context menu for the technology object in the project navigator.
2. In the context menu, select **Expert > Configure units**. The **Configure Units** window appears in the working area.
3. Select the **unit** for the **physical variables**. These units are used for the technology object, e.g. s for time units.

or

1. In the project navigator, open the **Configuration** under the TO.
2. Select the tab **Units**.



You can set the following parameters:

Field/Button	Explanation/Instructions
Unit system	Drop down list for preselecting the units to be displayed The "SI units system" is set by default in the drop down list when creating anew.
Table with units	
Physical parameter column	Displays the physical parameter. The physical parameters which are also used by the TO are made available.
Unit column	Display and configuration for unit. A drop down list for selecting the unit appears when you click on the cell.
Toolbar	
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display
Close	Button for closing the dialog.
Help	Button for opening the dialog's online help.

4.2.7 Simulation

This function activates the measuring input simulation (**simulation**=active). **Measured result arrived** is set and allocated to the programmed measured value as a measured result.

If the simulation mode is active on the measuring input, the simulated measured value is entered in **Measuredvalue1** using the function **_enableMeasuringInput** (trigger), and **state**=trigger_occurred is set.

4.3 Configuring the Measuring Input technology object

4.3.1 Inserting Measuring Inputs

Note

Before you insert a measuring input, the hardware must be configured and the axis or external encoder to which the measuring input cam is assigned has to be created.

To insert a new measuring input

1. In the project navigator, highlight the **MEASURING INPUTS** folder under the relevant axis or external encoder.
2. Select **Insert > Technology Objects > Measuring Input** , or double-click **Insert Measuring Input** in the project navigator at the axis or external encoder entry in the MEASURING INPUTS folder. The **Insert Measuring Input** window appears.
3. Enter a **name** for the measuring input. You can also enter a **comment**.
   Names must be unique throughout the project. For this reason, all the inserted measuring inputs are displayed under **Available measuring inputs**.
4. Confirm with **OK**. In the working area, the window for the configuration is displayed and the measuring input created is shown in the project navigator.

4.3.2 Parameterization of the Measuring Input technology object

General information about configuration data and system variables

Two data classes are distinguished when parameterizing a TO.

Configuration data defines the principal functionality of a TO. They are set within the object configuration framework with the SCOUT engineering system and are not normally changed during runtime.

System variables provide status data of the TO for the user program and a parameterization interface on the TO. System variables can be changed during runtime.

Note

For more information about technology objects, refer to the *SIMOTION Motion Control Basic Functions* functional description.

To parameterize a measuring input:

1. In the project navigator under the **MEASURING INPUTS** folder, find the measuring input technology object (TO) that you want to parameterize. Double-click the measuring input to display the associated objects.
2. Double-click **Configuration** or **Default** in the project navigator. The window appears in the working area.
   - **Configuration** (see the **Configuring a measuring input** section):
     Define the **configuration data** of the measuring input here. This includes, for example, the processing cycle clock.
   - **Default** (see the **Measuring input defaults** section):
     Define the measuring input defaults of the **system variables** here. These include the edge, start of measuring range, and end of measuring range.
3. Change configuration data and measuring input defaults.
4. Click **Close** to accept the changes.
5. Repeat steps 2 to 4 for all objects in which you want to change the configuration data and defaults.

See also

Measuring Input Configuration (Page 140)

Measuring input defaults (Page 145)

4.3.3 Use Expert List for Measuring Inputs

Parameters required for standard SIMOTION applications (configuration data and system variables) are parameterized into the output cam technology object directly by means of screen forms or are defined automatically.
It may be necessary to change automatically-defined parameters for special SIMOTION applications. These configuration data and system variables can only be displayed and changed in the expert list.

Note

For more information about working with the expert list, refer to the *SIMOTION Motion Control Basic Functions* functional description.

4.3.4 Measuring Input Configuration

4.3.4.1 Measuring Input Configuration

In the **Configuration** window, define the configuration data values for the measuring input.

Double-clicking in the project navigator below the measuring input on the **Configuration** element displays the window in the working area.

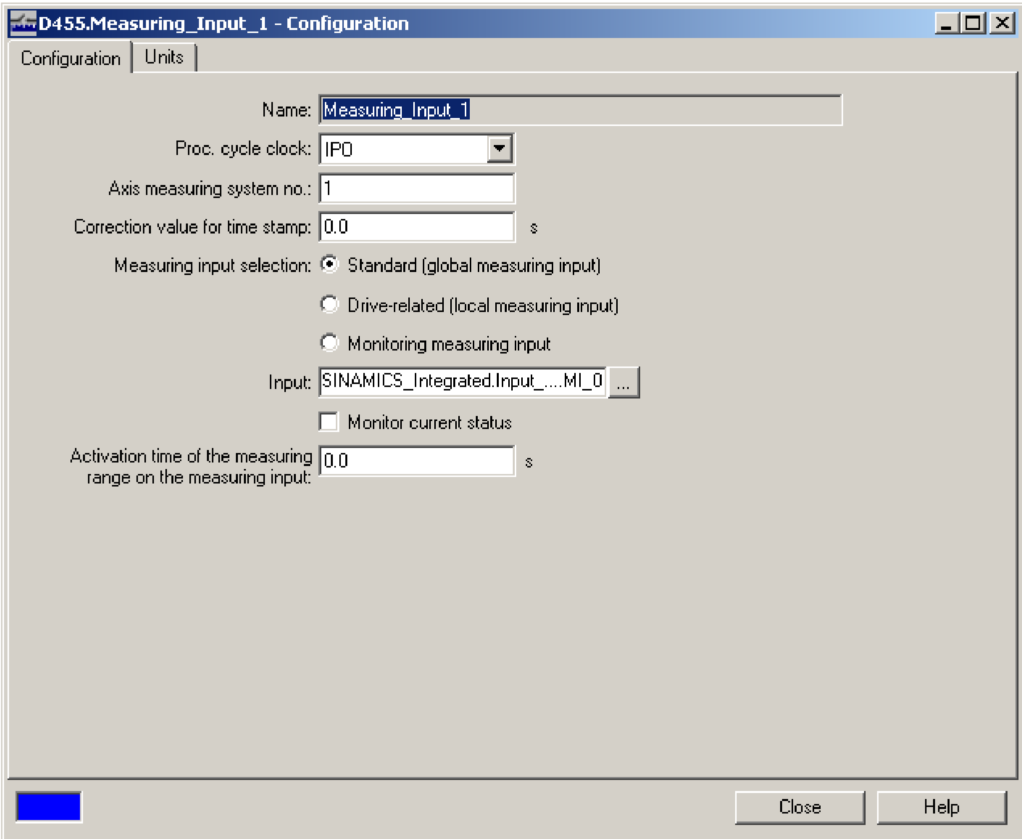


Figure 4-11 Global measuring input

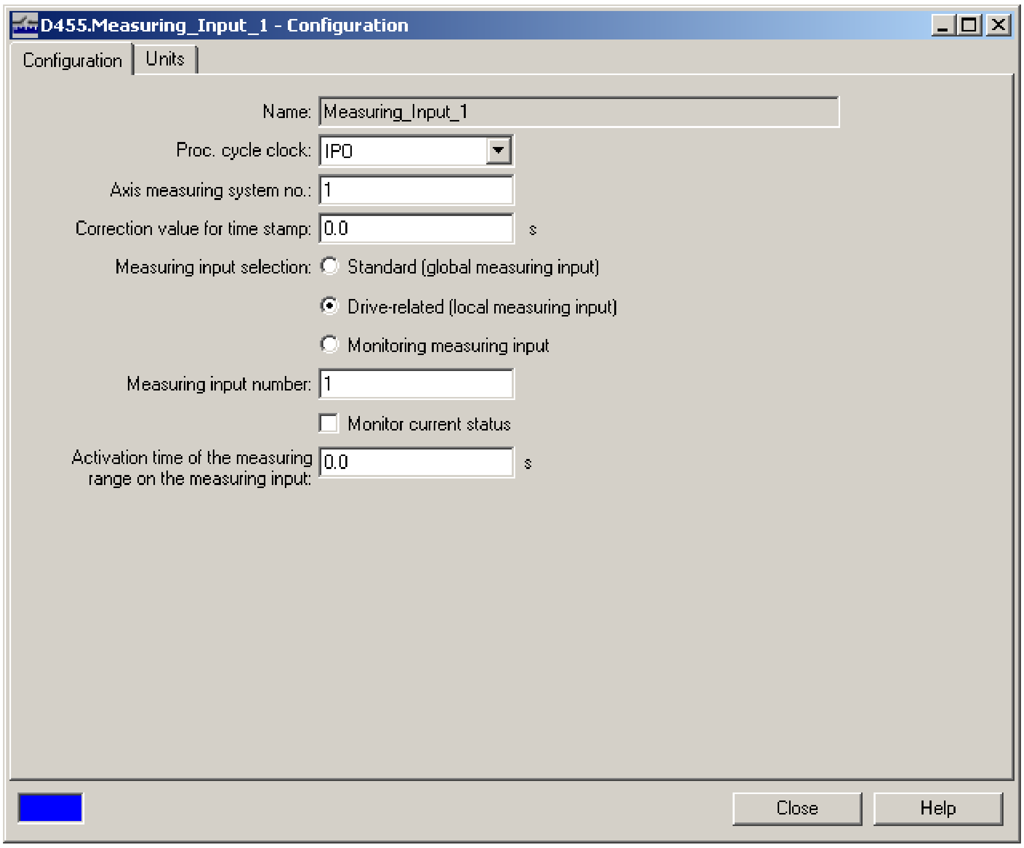


Figure 4-12 Local measuring input

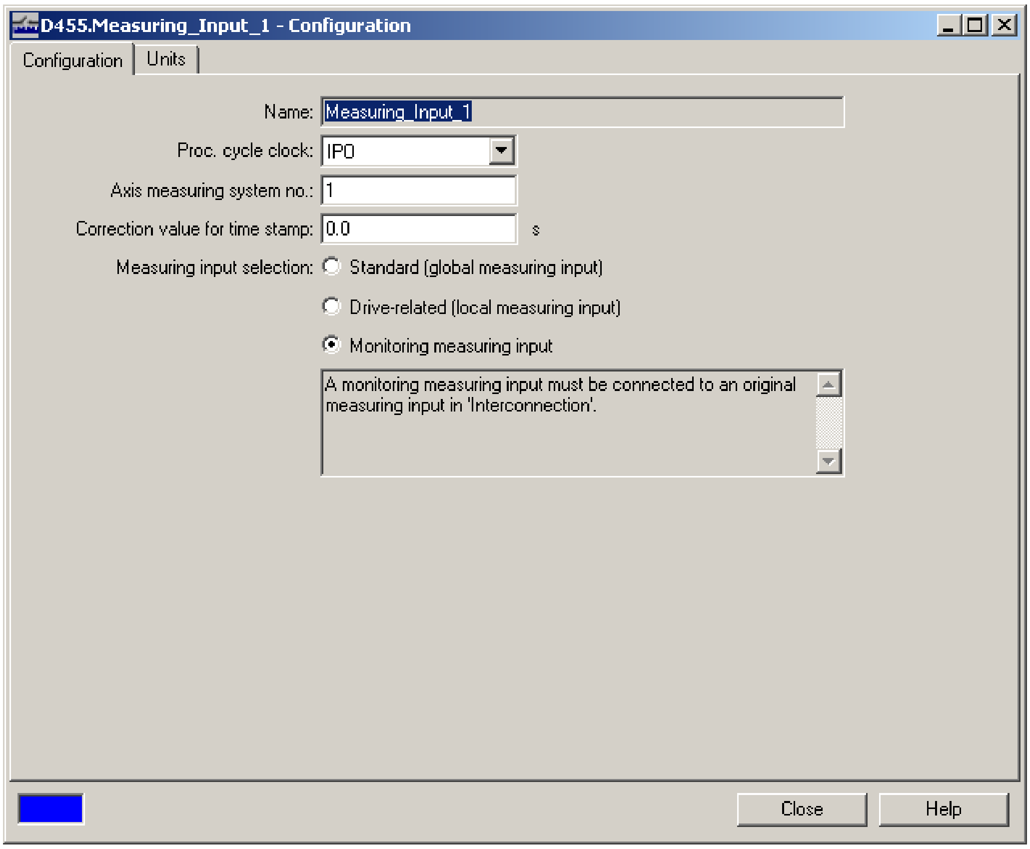


Figure 4-13 Monitoring measuring input

You can set the following parameters:

Table 4- 5 Measuring input configuration data

Field/Button	Significance/Note
Name	The name of the created measuring input is displayed here.
Processing cycle clock	Use this to select the system cycle during which the measurement result is interpolated and stored in the system variables. **IPO** (Default value) Measurement result is refreshed in the interpolator cycle clock. **IPO2** Measurement result is updated in the interpolator cycle clock 2. The IPO2 cycle clock length is at least twice that of the IPO. **Position control cycle clock** Measurement result is refreshed in the position control cycle clock. For the possible setting IPO_fast, see the chapter entitled Second position control cycle clock (Servo_fast) in the Motion Control Basic Functions manual.

Field/Button		Significance/Note
Axis measuring system no.		Under **Axis measuring system no.**, enter the number of the encoder system used on the measuring input (if the axis has more than one encoder). Encoder system 1 is the default setting. An encoder system can be assigned to several measuring inputs. **Note:** With global measuring inputs, please note that measurement is not based on the encoder which is active for the control/Ipo, but on the axis measuring system set on the measuring input. **Note:** With virtual axes the axis measuring system no. is irrelevant because only setpoints are measured.
Monitor current status (measurement once)		If the checkbox is activated, short pulses (short servo cycle clock) will be suppressed at the measuring input. If the measuring input is activated, provided that rising edge is selected under **Edge**, the measuring input will only be activated when the measuring input was at signal status 0 for at least one servo cycle.
Activation time of the measuring range on measuring input		Enter an activation time, in seconds, for the activation and deactivation of the measuring range here. With this time, you can compensate, for example, the runtimes during activation via PROFIBUS and drive. The accuracy of the activation depends on the servo cycle clock.
Compensation value for time stamp (Page 144)		Here, you enter the time-based compensation value for the time stamp evaluation. The compensation value is stored in the configuration data **TimeStampConfig.correctionTime**. Every measurement result has a time stamp. When measuring actual values on a real axis, the time that elapses after the measurement event is measured until it is communicated to the SIMOTION system, is corrected by interpolation (runtimes based on bus and cycle clock system). For measurement on virtual axes, setpoints are measured, rather than actual values. With setpoints, there are no runtimes. For example, if you set a measurement in the actual value system in relation to a virtual axis in the setpoint system (e.g. master axis), a compensation value for the offset time must be taken into account in order for the position to be calculated correctly.
Measuring input number		Enter the measuring input at the drive of the axis here. One input can be assigned to several measuring inputs. Input 1 is the default setting.
Measuring input selection		
	Standard (global measuring input), e.g. on the TM15/TM17 module/ C240 (B1-B4) or SIMOTION D onboard (Refer to chapter Global measuring (Page 148))	Select the radio button if you want to configure a measuring input for global measuring. This functionality is available for hardware (see Hardware for measuring inputs (Page 124)). With global measuring, the current actual values of one or more encoders are measured with positioning accuracy with a signal edge on the relevant input in order to determine lengths or distances from these (possible with any encoders present in the project). The output can be symbolically assigned via the assignment dialog using the ... button in the Output field (symbolic assignment is activated by default in the project with V4.2 or higher). For more details, see cam output types. (Page 18) If symbolic assignment is not active or if the CPU version < V4.2, a physical output is assigned by entering the HW address and bit number in the Output field.
	Drive-related (local measuring input)	Activate the radio button if the measuring input is connected directly to the C230-2/C240, D4xx, D4x5-2 (X122/X132), or the drive. Measurements can be taken only on the device that has a measuring system. You still have to enter the name of the measuring input number.
	Monitoring measuring input	Select the radio button if you want to configure a monitoring measuring input. If the check box is selected, the measurement result of a measuring input TO that is interconnected on another HW input (see Hardware for measuring inputs (Page 124)) is also measured by the measuring input configured as a monitoring measuring input (listening in on the measurement event). With this functionality, one measuring input can have a functional effect on several axes / external encoders. If you have configured a monitoring measuring input, you can now only select the processing cycle clock and axis measuring system number.

Field/Button	Significance/Note
	Button for opening the assignment dialog. Select a parameter or an address in the assignment dialog.
	Displays whether offline data or online data is shown • Blue field = offline display • Yellow field = online display

4.3.4.2 Time stamp correction value

When measuring with measuring inputs, the following should be taken into account when calculating the measurement positions from the measurement result and actual position of axis / external encoder:

- the filter time constant setting on the measuring input (e.g. TM17 smoothing filter),
- the delay times in the transmission section and sensors and
- with global measuring inputs also the Ti setting on axis / external encoder

The hardware delay times on the measuring inputs can be found in the Manuals and can usually be ignored for values of much less than 125 µs (e.g. with SIMOTION D, SINAMICS Control Units, SIMOTION C240))

If the filter time can be parameterized for the hardware used (e.g. TM17 high feature: 1 µs or 125 µs), set the smallest possible value for the measuring inputs.

The delay times up to the measuring input, due to the transmission line and sensor technology, depend on the components used and are usually unknown. If these values are small, they can also be ignored.

You must also take the Ti setting into account for "global" measuring inputs. The value can be found in the properties of the SINAMICS drive unit in the HW Config.

Example of how to proceed:

- For SIMOTION D: in HW Config, double-click on **SINAMICS Integrated**
- Under **DP slave properties**, in the tab **Cycle synchronization** read off the value **Ti**

During the measuring input configuration of "global" measuring inputs, also enter the negated value of **Ti** as offset value of the time stamp (**TimeStampConfig.correctionTime**).

If measurements have to be performed with "very high" accuracy or the dead times caused by the filter time constant and delay times from the transmission line, BERO, converter, contacts, etc. cannot be ignored, we recommend the machine-specific determination of the dead times that really occur, through measurements or series of measurements.

Measurements with velocity-dependent displaced measuring results are an indication that the dead times have not been compensated or incorrectly compensated.

The procedure for **empirical/measuring technique determination** of dead times is similar to the process for determining dead times during cam output.

See also

Determining derivative-action times for output cams (dead time compensation) (Page 39)

4.3.5 Measuring input defaults

You can define the defaults for every measuring input. These values are stored in system variables and can be changed by programs.

Double-clicking in the project navigator below the measuring input on the **Defaults** element displays the window in the working area.

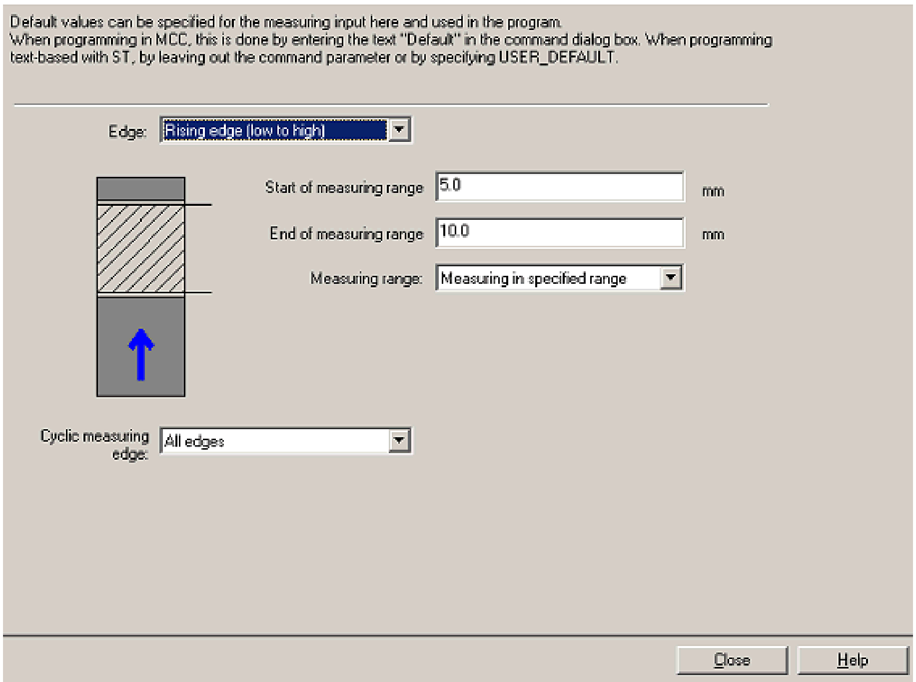


Figure 4-14 Measuring input defaults

You can set the following parameters:

Table 4- 6 Measuring input defaults

Field/Button	Significance/Note
Edge (measurement once)	Under **Edge** you select the signal edge that starts the measurement when present at the measuring input and measures the actual position of the axis. The drive must be capable of evaluating the signal edge (rising, falling, or both edges) selected by SIMOTION at the measuring input. **Rising edge (low to high)** The actual position is recorded with the rising edge of the measuring input. **Falling edge (high to low)** The actual position is recorded with the falling edge of the measuring input. **Measure at both edges** The actual position is recorded using both the rising and falling edge of the measuring input. **Measure at both edges, starting with a rising edge (low to high)** The actual position is recorded using both the rising and falling edge of the measuring input, and measurement is begun at the first rising edge. **Measure at both edges, starting with a falling edge (high to low)** The actual position is recorded using both the rising and falling edge of the measuring input, and measurement is begun at the first falling edge.
Start of measuring range/ End of measuring range (measurement once) (See the **Measuring range** section also)	Enter the start and end of the measuring range here. If the start of the measuring range is greater than the end of the measuring range for modulo axes, the measuring range extends from the initial value through the modulo transition to the end value. For non-modulo axes the initial and end values are swapped in this case.
Measuring range (measurement once) (See the **Measuring range** section also)	Under **Measuring range** you can choose whether or not to apply the defined measuring range. **Measuring without specified range** The measuring input records the measured values in the entire traversing range. **Measuring in specified range** The measuring input only records the measured values within the measuring range defined by the start and end points.
Cyclic measuring edge (Page 132)	The edges to be detected in cyclic measuring are selected here. Up to two edges can be measured in each processing cycle clock of the measuring input (IPO interpolation cycle clock, IPO2 interpolation cycle clock, or position control cycle clock). Cyclic measuring is only possible with certain hardware (see Hardware for measuring inputs (Page 124)). **All edges** Both rising and falling edges are measured. **Rising edges only** Only rising edges are measured. **Falling edges only** Only falling edges are measured.

See also

Measuring range (Page 135)

4.3.6 Local measuring

Introduction

With local measuring inputs, the measuring input is assigned as part of its configuration. The configuration specifies the number of the measuring input to be used and the number of the encoder on the assigned axis (PROFIdrive).

4.3.6.1 Local measuring on C230-2, C240 (not C240 PN)

With a signal edge at the relevant M1 or M2 input, the current actual values of one or more encoders connected to the onboard encoder interfaces (X3 to X6) are measured with positioning accuracy to determine lengths or distances.

The assignment of inputs is not fixed; the special use is activated in the SCOUT engineering system during configuration of the measuring input via the measuring input number.

Note

As the C240 PN has no onboard encoder interfaces, it has no local inputs of measuring inputs.

4.3.6.2 Local measuring on D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310, CU320 and CU320-2

If you connect a local measuring input TO to the measuring inputs of D4xx, D4x5-2 (X122/X132), CX32, CX32-2 and CU320 and CU320-2, you will have to set the following parameters (PROFIdrive):

- Parameter p488 on the associated drive for one local measuring input
- Parameters p488 and p489 on the associated drive for two local measuring inputs
- Parameters p728.8 - p728.15 on the control unit as inputs for all DI/DO used as measuring inputs (these settings can also be made using a parameterization mask)

4.3.6.3 Local measuring on other drives (MASTERDRIVES MC, SIMODRIVE 611U, etc.)

With SIMOTION, the measuring input is assigned as part of its configuration. The configuration specifies the number of the measuring input to be used and the number of the encoder on the assigned axis.

Please refer to the documentation for the respective drive system for details of any additional settings which may be required.

4.3.7 Global measuring

With global measuring, the current actual values of one or more encoders are measured with positioning accuracy with a signal edge on the relevant input in order to determine lengths or distances from these (possible with any encoders present in the project). Up to two edges can be measured for each position control cycle clock of the Measuring Input TO.

The assignment of the inputs is not fixed, and the special use is activated via the HW address when the Measuring Input TO is configured.

Note

Global measuring is only possible for measuring inputs with time stamp. Hardware for measuring inputs (Page 124)

See also

Global measuring on D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310, CU320 and CU320-2 (Page 151)

Configuring and interconnecting a listening Measuring Input TO (Page 157)

4.3.7.1 Global measuring on TM15/TM17 High Feature

Digital inputs are available for connection of measuring inputs on the TM15 and TM17 High Feature terminal modules. These can be used for one-off or cyclic measuring. Cyclic measuring is only supported by the TM17 High Feature.

Note

For more information about the Measuring Input TO on terminal modules, see the *Terminal Modules TM15 / TM17 High Feature* Commissioning Manual.

To configure a measuring input on a TM15/TM17 High Feature

1. In the project navigator, below the input/output component (TM15/TM17) that you want to use, double-click the entry **Inputs/outputs.** The **Bidirectional Digital Inputs/Outputs** window is displayed.
2. For the selected I/O channel, select measuring input as the function.

   Note

   If you do not use symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual), then you must note the offset (e.g. 3.1).

   ---

3. Insert a new measuring input or use an existing one.
4. Assign parameters to the measuring input TO.

5. Double-click **Configuration** below the measuring input in the project navigator. The **Configuration** window appears in the working area.
6. Activate the option **Standard (global measuring input)**. Assignment of an output to a measuring input is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address. In order to assign a physical output, the HW address and bit number must be entered in the **Output** field.
7. Click **OK** to close the window and select **Project > Save**.

To determine the logical hardware address for a TM15/TM17 high feature (only if symbolic assignment is not activated)

1. For TM15/TM17 modules, the hardware addresses result from the configured address range, and the bit numbers from the offset.
2. In the project navigator, below the input/output component (TM15/TM17) that you want to use, double-click the entry **Inputs/outputs.** The **Bidirectional Digital Inputs/Outputs** window is displayed.
3. Find the input that you want to use (**Measuring input** must be selected under **Function**) and note the offset (e.g. 3.0).
4. In the project navigator, below the SIMOTION device or the SINAMICS drive unit, select
   – For SIMOTION D:
     SINAMICS_Integrated > Communication > Message frame configuration
   – For the SINAMICS S120 drive unit:
     Communication > Message frame configuration
5. Double-click **Message frame configuration** and, in the window which appears, select the tab **PROFIdrive PZD message frames.** The components are displayed there with the address ranges (e.g. TM17 input data 328 to 343).

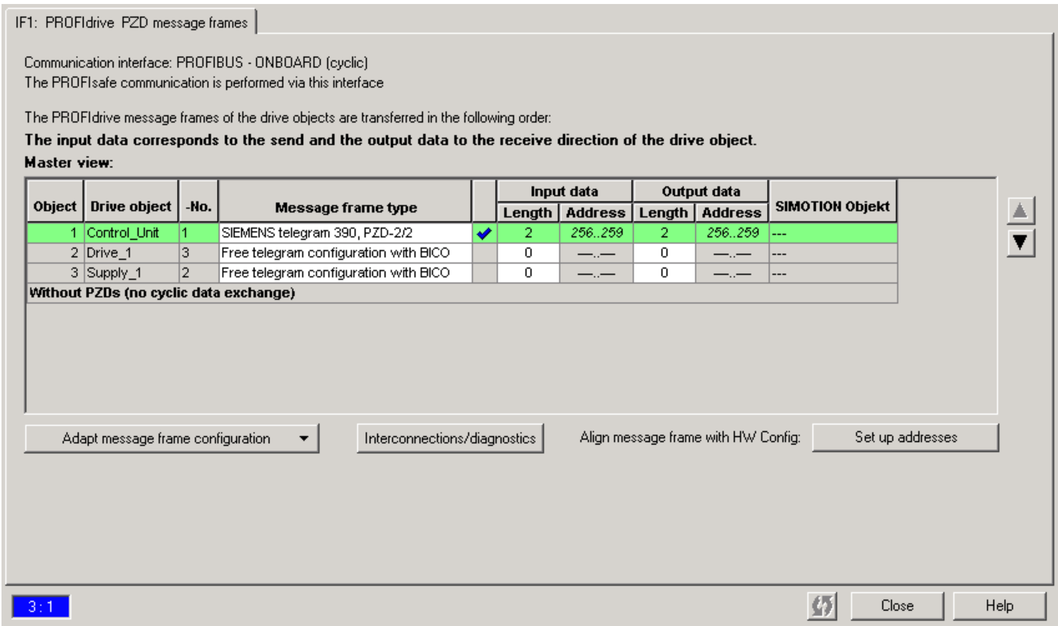


Figure 4-15 Determining the hardware address of the components

6. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses**. If there are question marks in the fields instead of I/O addresses, you must also perform an alignment.
7. Now calculate the HW address by adding the base input address (first value of the address range) of the TM to the offset (e.g. 328 + 3 = 331).
8. The bit number is defined by means of the offset. For example, an offset of **3.0** results in a bit number of **0**.

See also

Inserting Measuring Inputs (Page 138)

Parameterization of the Measuring Input technology object (Page 138)

4.3.7.2 Global measuring on C240/C240 PN (B1-B4)

The inputs B1-B4 are available for global measuring on the C240. These can be used for one-off or cyclic measuring.

Note

For more information about the measuring input on C240/C240 PN, refer to the *C2xx* Operating Instructions.

To configure a measuring input on a C240/C240 PN (B1-B4) (global measuring)

1. Insert a new measuring input (see **Inserting measuring inputs** section) or use an existing one.
2. Parameterize the measuring input (see the **Parameterization of the measuring input technology object** section)
3. Double-click **Configuration** below the measuring input in the project navigator. The **Configuration** window appears in the working area.
4. Activate the option **Standard (global measuring input)**. If symbolic assignment is not active or if the CPU version < V4.2, a physical output is assigned by entering the HW address and bit number in the Output field.
5. Enter the **HW address** and the **bit number**. The hardware address and the bit number can be ascertained in **HW Config** (e.g. 64.2 for the measuring input Pin 3 of connector X1).
6. Click **OK** to close the window and select **Project > Save**.

See also

Inserting Measuring Inputs (Page 138)

Parameterization of the Measuring Input technology object (Page 138)

4.3.7.3 Global measuring on D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310, CU320 and CU320-2

D4xx, D4x5-2, CX32, CX32-2, CU310, and CU320 have digital inputs for connecting to a global measuring input. These can be used for one-off or cyclic measuring.

If symbolic assignment is not active or if the CPU version < V4.2, the following applies:

Measurement results are transferred via standard message frames 391 and 392 rather than via the axis message frame.

If a message frame 39x is set, the SINAMICS I/Os are interconnected automatically to this message frame 39x using BICO interconnections and are so available for SIMOTION.

Note

In the case of versions earlier than V4.2, when using 39x message frames, the onboard D4x5 outputs are to be assigned exclusively to SIMOTION.

Inverting global measuring inputs

When selecting telegram 39x, inverting of the global measuring inputs is activated on Sinamics_Integrated, CX32, CX32-2 and S120 via parameters p490 and p2088[2].

The default assignment of p2088[2] is as follows:

- p2088[2].0 -> Inverting of DI/DO8
- p2088[2].1 -> Inverting of DI/DO9
- p2088[2].2 -> Inverting of DI/DO10
- p2088[2].3 -> Inverting of DI/DO11
- p2088[2].4 -> Inverting of DI/DO12
- p2088[2].5 -> Inverting of DI/DO13
- p2088[2].6 -> Inverting of DI/DO14
- p2088[2].7 -> Inverting of DI/DO15

If the default assignment of the digital inputs to PZD2 is changed in message frame 39x, this must be taken account of in p2088[2] correspondingly.

To configure a measuring input on a D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310, CU320, CU320-2 measuring input

1. In the project navigator, switch to the **Control_Unit** entry under the control unit for the respective device.
2. Double-click **Inputs/outputs** below the control unit. The window appears in the working area.
3. Select **Bidirectional digital inputs/outputs**.
4. Select the measuring input function (SIMOTION).
5. Insert a new measuring input (see **Inserting measuring inputs** section) or use an existing one.

6. Assign parameters to the measuring input TO.
7. Double-click **Configuration** below the measuring input in the project navigator. The **Configuration** window appears in the working area.
8. Activate the option **Standard (global measuring input)**. Assignment of an output to a measuring input is supported as of V4.2 using symbolic assignment (see the Chapter entitled Symbolic Assignment (from V4.2 onward) in the Motion Control Basic Functions manual) or by means of entering the HW address. In order to assign a physical output, the HW address and bit number must be entered in the **Output** field.
9. Click **OK** to close the window and select **Project > Save**.

To determine the logical hardware address for the onboard inputs of D4xx, D4x5-2 (X122/X132), CX32, CX32-2, CU310, CU320, CU320-2 (only if symbolic assignment is not activated)

1. In the project navigator, select **Communication > Message frame configuration** under the SIMOTION or SINAMICS device.
2. Double-click **Message frame configuration** and, in the window which appears, select the tab **PROFIdrive PZD message frames**. The components are displayed there with address range (input/output data).

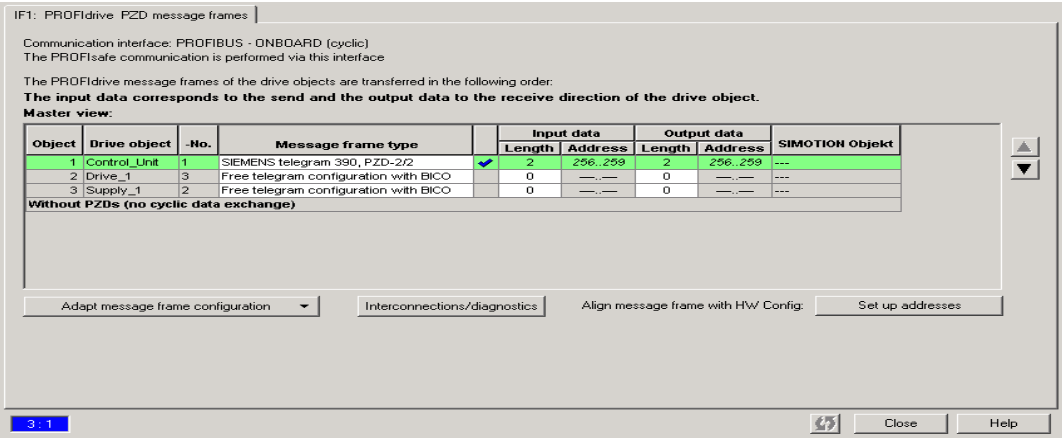


Figure 4-16 Control unit I/O addresses

3. Select the message frame type **SIEMENS message frame 391** (two measuring inputs max.) or **392** (six measuring inputs max.). The telegram depends on the number of measuring inputs configured.
4. Before you determine the hardware address, an alignment between HW Config and SIMOTION SCOUT, with respect to the address, must be performed. If this has not been performed or you have changed the addresses, click on **Set up addresses**. If there are question marks in the fields instead of I/O addresses, you must also perform an alignment.
5. Now calculate the HW address by adding the base input address (first value of the input data) of the control unit to the offset (e.g. 298 + 3 = 301). The offset always has the value 3.
6. You will find the bit number in the following table. The inputs are set in parameters 680.0 to 680.7 of the control unit, e.g. bit 1 in parameter 680.0.

Table 4- 7 Bit numbers for D410, D4x5, D4x5-2 (X122/X132), CX32, CX32-2 CU310, CU320, CU320-2

Input D4x5, D4x5-2, CU320	Input D4x5-2, CU320-2	Input D410, CU310, CX32	Input CX32-2	Bit number
-	X122.9 (DI/DO8)	-	X122.9 (DI/DO8)	Bit 0
X122.8 (DI/DO9)	X122.10 (DI/DO9)	X121.8 (DI/DO9)	X122.10 (DI/DO9)	Bit 1
X122.10 (DI/DO10)	X122.12 (DI/DO10)	X121.10 (DI/DO10)	X122.12 (DI/DO10)	Bit 2
X122.11 (DI/DO11)	X122.13 (DI/DO11)	X121.11 DI/DO11)	X122.13 (DI/DO11)	Bit 3
-	X132.9 (DI/DO12)	-		Bit 4
X132.8 (DI/DO13)	X132.10 (DI/DO13)	-		Bit 5
X132.10 (DI/DO14)	X132.12 (DI/DO14)	-		Bit 6
X132.11 (DI/DO15)	X132.13 (DI/DO15)	-		Bit 7

4.3.7.4 Global measuring on D4x5-2 (X142)

Unlike (X122/X132), measuring inputs on measuring input D4x5-2 (X142) are configured in HW configuration

Configuration of terminals and function as well as the fixed telegram's start address are configured in HW Config.

To configure a measuring input on an input of D4x5-2 (X142)

The dialog to configure the X142 can be opened via the input/output X142 in the project navigator. Alternatively, you can access the dialog to be configured via the HW configuration by going to **Open HW Configuration ...** in the device's context menu.

Slot X142 is shown in the detail view and in the station window of the respective D4x5-2 device. You can access the **Properties** dialog via the **Object properties...** context menu or by double-clicking on the X142 line.

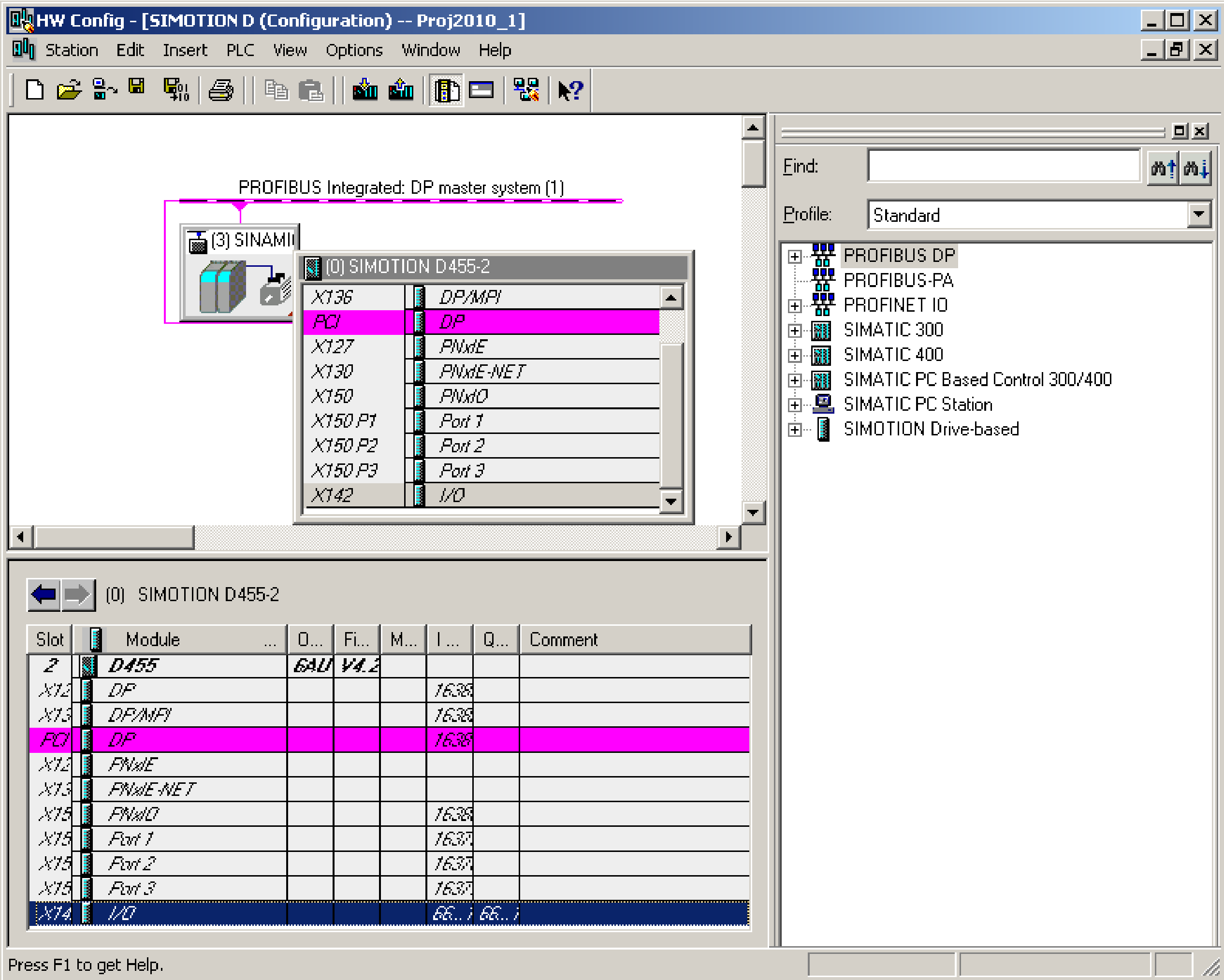


Figure 4-17 Display of D4x5-2 in HW configuration

In the **Properties** dialog, you can manage **Addresses** and interconnect **Bidirectional digital inputs/outputs 0-7**.

Addresses

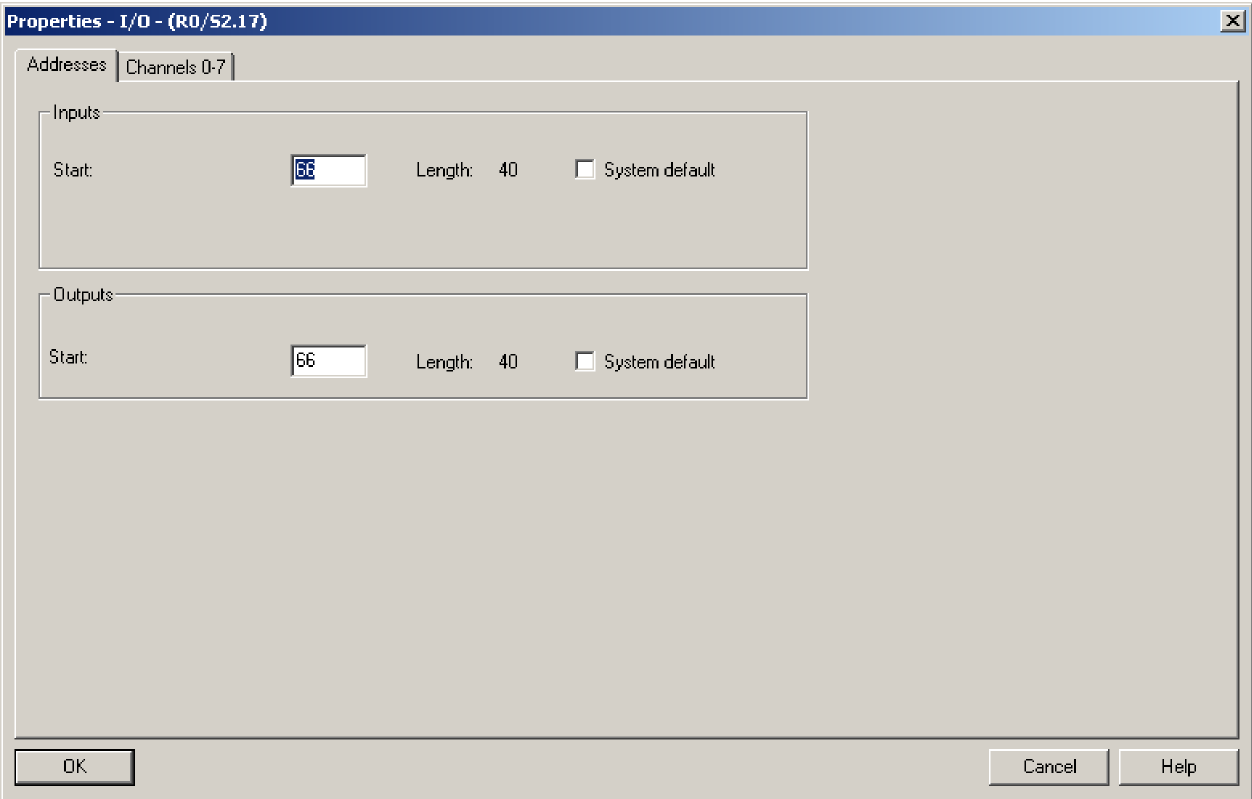


Figure 4-18 Manage addresses

Table 4- 8 Addresses

Function		Description
Inputs		
	Start	Under **Start**, enter the start address of the digital inputs.
	Length	The **length** of the digital input address cannot be modified.
	System specification	With **System specification**, you can activate or deactivate the automatic setting of digital input addresses.
Outputs		
	Start	Under **Start**, you can enter the start address of the digital outputs.
	Length	The **length** of the digital output address cannot be modified.
	System specification	With **System specification**, you can activate or deactivate the automatic setting of digital output addresses.

Channels 0-7

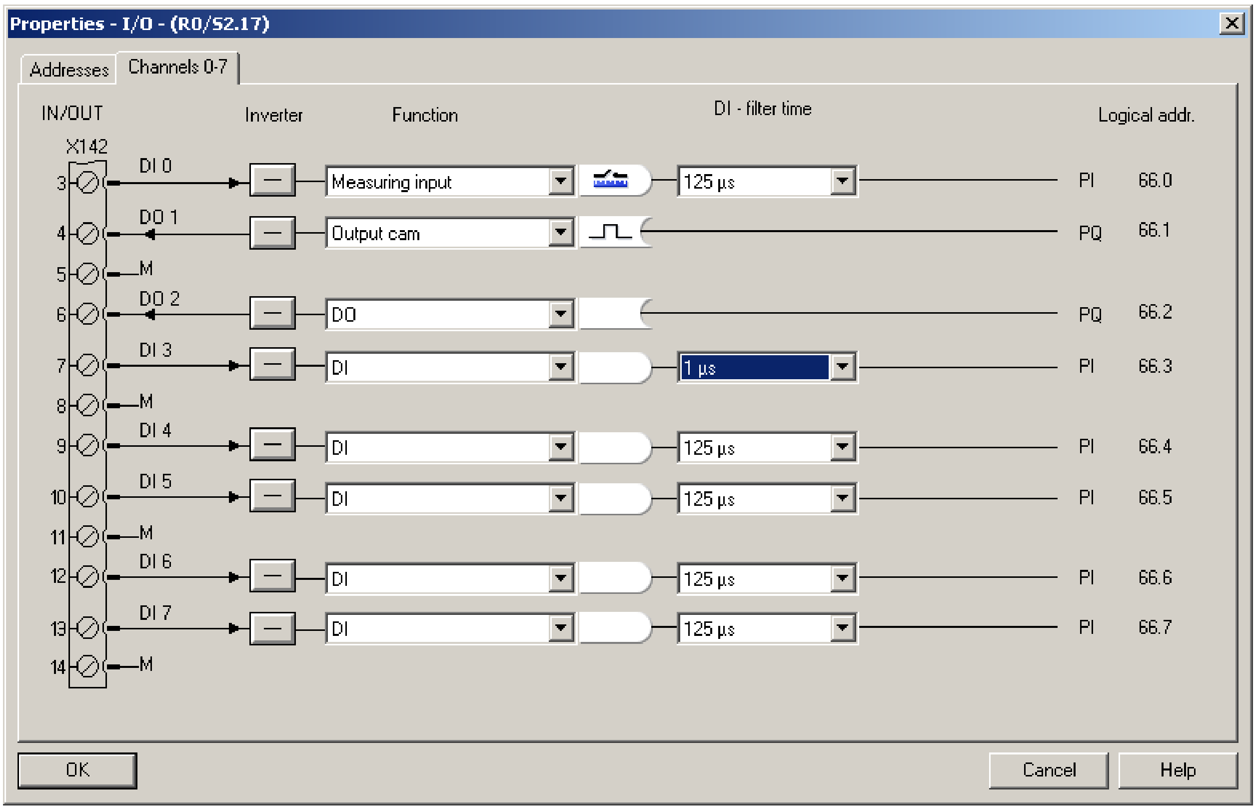


Figure 4-19 Channels 0-7

Table 4- 9 Channels 0-7

Function		Description
IN/OUT X142		Inputs/outputs (IN/OUT 0-7) of X142.
Inverter		Button for inverting.
Function		
	DI	Digital input.
	DO	Digital output.
	Output cam	Output for cam.
	Measuring inputs	Probe input.
IN filter time/OUT replacement value strategy		
	Filter time	The drop down list contains 1µs and 125µs values. Only available for **DI** and **measuring input** function.
	Set substitute value/keep last value	The selection options are available for the **DO** and **output cam** function.
Logical adr.		PI, PQ for output cam and measuring input. Note: Logical address is only required if you work without symbolic assignment.

4.3.8 Configuring and interconnecting a listening Measuring Input TO

With the "Monitoring measuring input" function, the measurement event of a measuring input can also be measured simultaneously by several Measuring Input TOs.

To configure and interconnect a monitoring measuring input:

1. Before you configure a monitoring measuring input, a measuring input must be configured on a measuring input with a HW address. This can be a measuring input (see Hardware for measuring input (Page 124)). (see chapter Global measuring (Page 148)).
2. Insert a new measuring input (see Inserting Measuring Inputs (Page 138) section).
3. Double-clicking in the project navigator below the measuring input on the **Configuration** element displays the window in the working area.
4. Select **Monitoring measuring input**, and enter the **processing cycle clock** and the **system number** (see the **Measuring input configuration** section).
5. Double-clicking in the project navigator below the monitoring measuring input on the **Interconnections** element displays the window in the working area.
6. In the **EventIn** table row under the **Interconnected to output connectors** column, select the **EventOut** of the measuring input with which you want to interconnect the monitoring measuring input. The axis to which the monitoring measuring input is assigned is automatically displayed under **Reference**.

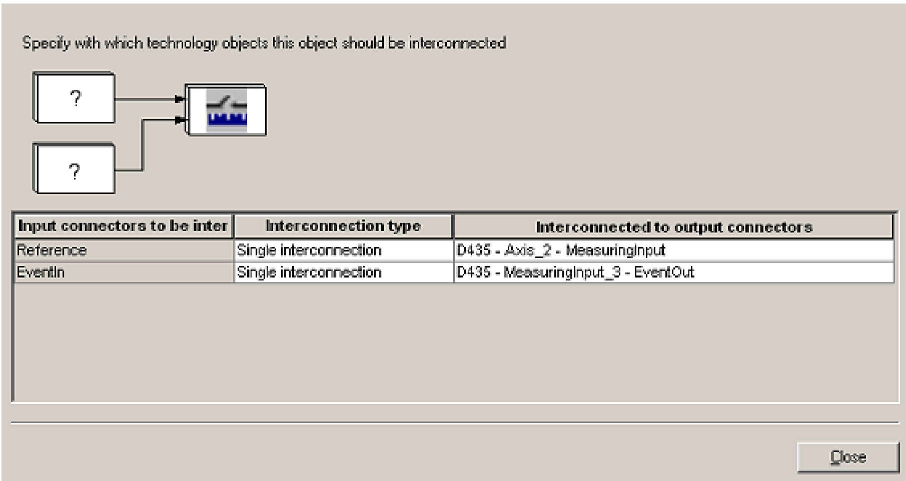


Figure 4-20 Interconnecting a monitoring measuring input

7. Click **Close.** The monitoring measuring input is configured and interconnected.

See also

Measuring Input Configuration (Page 140)

Measuring one measurement event on several axes - Listening measuring input (V4.0 and later) (Page 129)

4.3.9 Measuring input with HW enable input (TM17 High Feature)

On the TM17 High Feature, hardware-based enable inputs can be configured for up to six measuring-input inputs. Measuring signals can only be detected at the assigned measuring input if an enable is present (this is a gate function).

Note

In order to be able to use an enable input it must be configured on the TM17 High Feature (see Section **Global measuring on the TM15/TM17 and C240 (B1-B4)**).

For more information about HW enable input, see the *Terminal Modules TM15 / TM17 High Feature* Commissioning Manual.

Required configuration for level-controlled HW enable

- Measuring input is configured
- Digital input on TM17 High Feature parameterized for measuring input, and level-triggered enable set at this input. The appropriate enable input for the enabling signal is parameterized automatically.
- Digital input configured for detecting measured values (HW address)
- Measuring input must be active

Level-controlled enable procedure

The measuring input is activated with **_enableMeasuringInput** or **_enableMeasuringInputCyclic**. No measured values are forwarded to the TO in this state, as no enabling signal is present yet (gate closed). Edges are forwarded to the TO by setting the enable (gate open).

Depending on the configured measuring range, measured edges are filtered by the TO in the measuring input processing cycle clock and by the TM17 High Feature at a resolution of several µs.

Edges are not detected if:

- The measuring process is terminated with **_disableMeasuringInput**.
- The edges fall outside the measuring range.
- No enabling signal is present (gate closed).

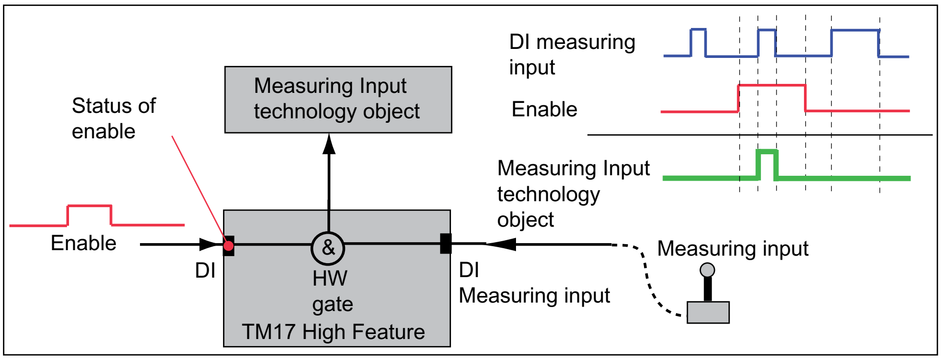


Figure 4-21 Schematic representation of HW enable on the measuring input

It is also possible to execute the enable with inverted logic, i.e. the enable input on the TM17 High Feature can be operated inversely and then works in LOW-active mode.

Determining the status of the enable

The I/O area of the digital input for the enabling signal is used to determine the status of the enable.

Overriding the enable

It is possible to override the measuring enable input with a SW enable signal. For this, you have to access the input directly via its address and set the bit. The enable is achieved, as long as the bit is set (functions as enable input)

See also

Global measuring (Page 148)

4.4 Measuring Input technology object programming/references

4.4.1 Programming

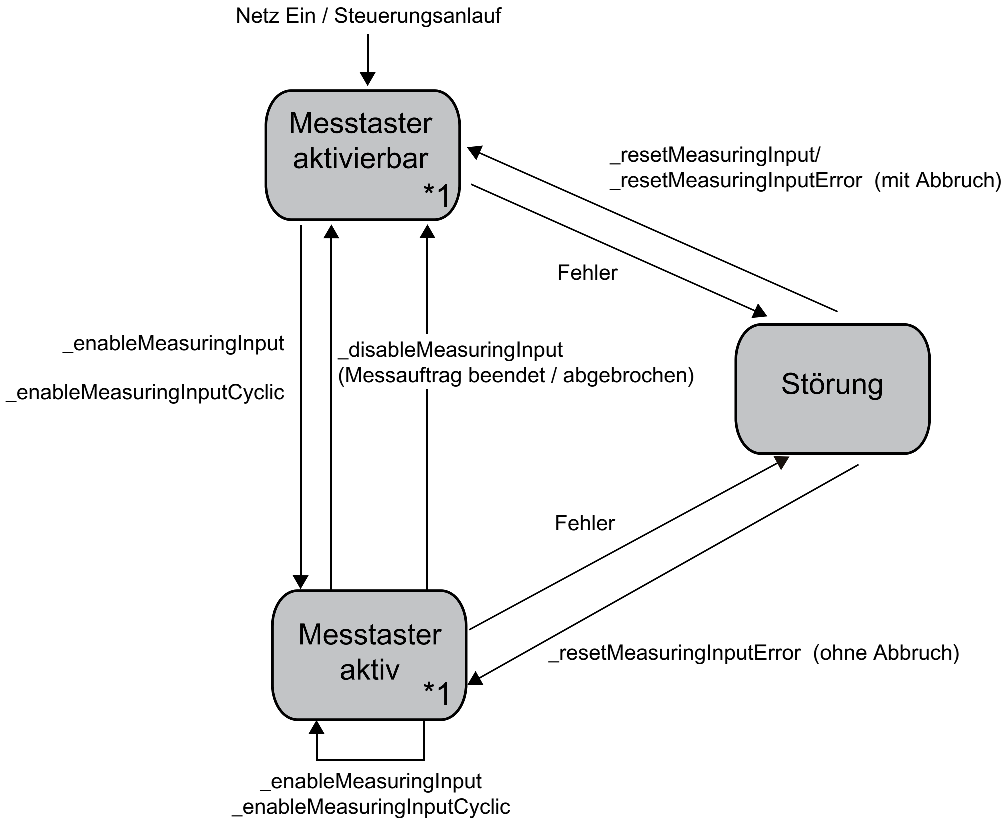


Figure 4-22 Programming and execution model for the Measuring Input TO

***1** The following commands are effective in the TO states **can be activated** and **active**:

- **_disableMeasuringInputSimulation**
- **_enableMeasuringInputSimulation**

4.4.2 Commands

The Measuring Input technology object can be addressed in the user program using the following commands:

Table 4- 10 Measuring Input TO system functions

Commands	Description	Application
_enableMeasuringInput	Activate measurement job.	Measurement is activated. Measuring is terminated after the measuring process has been executed.
_enableMeasuringInputCyclic (V3.2 and higher)	This function activates a cyclical measurement job. The results of the last measurement are displayed in the system variables.	Cyclic measuring of axis/encoder positions by activating a measurement job once only
_disableMeasuringInput	Deactivate measurement job.	Measurement is terminated.
_enableMeasuringInputSimulation	Activates measuring input simulation. **Measured result arrived** is set and allocated to the programmed measured value as a measured result.	Simulation of a program run using default settings of programmed measured values
_disableMeasuringInputSimulation	Deactivate simulation mode.	-
_resetMeasuringInput	Reset measuring input.	Create initial state of measuring input.
_resetMeasuringInputError	Reset error on measuring input.	E.g. acknowledge configuration errors after entering correct values.
_resetMeasuringInputConfigDataBuffer	This function clears the configuration data collected in the buffer since the last activation without activating them.	Changing configuration data in the RUN state discards the accumulated modifications.
_getMeasuringInputErrorNumberState (V3.1 and higher)	Readout of error number status.	Check for occurrence of an error with the specified error number
_getStateOfMeasuringInputCommand (V3.2 and higher)	This function returns the execution state of a command.	Check whether or not measurement has already taken place (i.e. the command ID is still available or has already been deleted)
_bufferMeasuringInputCommandId (V3.2 and higher)	This function enables **commandId** and the associated command status to be saved beyond the execution period of the command. The **commandId** parameter is used to define the command for which the respective status is to be saved. The maximum number of saveable command statuses is specified in the **decodingConfig.numberOfMaxBufferedCommandId** configuration data element.	Subsequent check of how command was terminated (e.g. error-free or number of error that occurred)
_removeBufferedMeasuringInputCommandId (V3.2 and higher)	This function ends the saving of **commandId** and the associated command status beyond the execution period of the command.	Explicit deletion of previously saved command IDs

For further information on the system functions, please refer to the *SIMOTION TP CAM Reference Lists*.

4.4.3 Process Alarms

You can predefine local alarm responses via SIMOTION SCOUT.

Note

For more information, refer to the *Motion Control Technology Objects Basic Functions* functional description.

How to configure the alarm response:

1. Double-click **Execution system** in the project navigator below the SIMOTION device. The execution system opens.
2. In the execution level tree, select **SystemInterruptTasks > TechnologicalFaultTask**.
3. Then click the **Alarm Response** button in the displayed window. The **Alarm Response** window appears. You can configure the alarm response for every TO here.

A system variable **error** indicates that a technology alarm has been generated. The response to the alarm is displayed in the **errorReaction** variable.

Table 4- 11 Possible alarm responses

Alarm Response	Description	Application
NONE	No response	-
DECODE_STOP	Command processing is aborted, the current measuring function remains active. Further processing on the technology object can continue after **_resetMeasuringInput** or **_resetMeasuringInputError**.	The TO measuring input can only be reactivated after the error has been acknowledged.
MEASURING_INPUT_DISABLE	Stop and abort of all commands. Further processing on the technology object can continue after **_resetMeasuringInput** or **_resetMeasuringInputError**.	The TO measuring input can only be reactivated after the error has been acknowledged.

4.4.4 Measuring input menus

4.4.4.1 Measuring Input technology object menu

Grayed-out menu functions cannot be selected. The menu is only active if a Measuring Input TO window is active in the working area.
You can select the following functions:

Table 4- 12 Measuring input menu

Function		Significance/Note
Close		Select **Close** to close the configuration window for the measuring input that is open in the working area.
Properties		Select **Properties** to display the properties of the measuring input selected in the project navigator.
Configuration		Select **Configuration** to define the configuration data for the measuring input.
Default		Select **Default** to define the values for the system variables of the measuring input.
Expert		
	Expert list	Select **Expert list** to open the expert list for the selected measuring input. The configuration data and system variables can be displayed and changed in this list.
	Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.

4.4.4.2 Measuring input TO context menu

Grayed-out functions in the context menu cannot be selected.

You can select the following functions:

Table 4- 13 Measuring input context menu

Function		Significance/Note
Open configuration		Select **Open configuration** to display the window for configuring the measuring input in the working area. Enter the configuration data of the measuring input in this window.
Cut		Select **Cut** to remove the selected object and save it to the clipboard.
Copy		Select **Copy** to copy the selected object. It is stored in the clipboard.
Paste		Select **Paste** to insert the measuring input stored in the clipboard.
Delete		Select **Delete** to delete the selected measuring input. The entire data of the measuring input is deleted permanently.
Rename		Use **Rename** to rename the object selected in the project navigator. Note that with name changes, name references to this object are not adapted.
Expert		
	Expert list	Select **Expert list** to open the expert list for the selected measuring input. The configuration data and system variables can be displayed and changed in this list.
	Configure units	Select **Configure units** to open the **Configure units of the object** window in the working area. You can configure the units used for the selected object here.
	Insert script folder	**Insert script folder** enables you to insert a folder below the TO. You can create scripts in this folder in order to, for example, automate the configuration.
	Import object	**Import object** imports the data of a SIMOTION object from another project which was previously created with a selective XML export. You cannot import the entire project, only the data of the SIMOTION object.
	Save project and export object	**Save project and export object** exports selected data of the selected object in XML format. This data export can then be reimported into other projects. Only the data of the selected object, not the entire project, is exported.
Print		Select **Print** to print the configuration of the measuring input. All system variables and configuration data with the associated values are printed.
Print preview		Select **Print preview** to open the preview of the measuring input data to be printed.
Default		Select **Default** to define the values for the system variables of the measuring input.
Properties		Select **Properties** to display the properties of the measuring input selected in the project navigator.

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