BECKHOFF New Automation Technology

Manual | EN

TS5065

TwinCAT 2 | Motion Control XFC/XFC NC I

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1 Foreword

1.1 Notes on the documentation

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

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

Disclaimer

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

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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:
EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702
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1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of symbols

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

⚠ DANGER

Serious risk of injury!

Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.

NOTE

Damage to the environment or devices

Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.

Tip or pointer

This symbol indicates information that contributes to better understanding.

2 Overview

A prerequisite is high-precision dead time compensation of the axes, which is available from TwinCAT 2.11 for EtherCAT and Sercos drives.

A precise correlation between time and position can thus be established at any time.

The library TcMC2 XFC facilitates precisely timed acquisition of axis positions and output of digital signals at precise positions in conjunction with EtherCAT XFC terminals (time stamp terminals and oversampling terminals).

Important applications include the acquisition of latch positions (touch probe or measuring probe function) and the realization of digital cam controllers. The library provides various function blocks for this.

The TcNci_XFC library facilitates the precisely timed recording of relative path distances and the path-precise output of digital signals in connection with the EtherCAT XFC terminals. The required output function blocks are included in the TcMC2_XFC library.

The library provides various function blocks for the calculation of the timestamps or positions.

To use the library in a project, the following additional libraries have to be included:

TcNci.lib (enthält die Struktur des zyklischen Kanal-Interface)

TcMc2_XFC.lib [▶ 13] (enthält die benötigten Ausgabebausteine für die Ansteuerung der XFC-Ausgangsklemmen, sowie weitere wiederverwendete Strukturen)

TcMC2.lib (Wiederverwendete Strukturen)

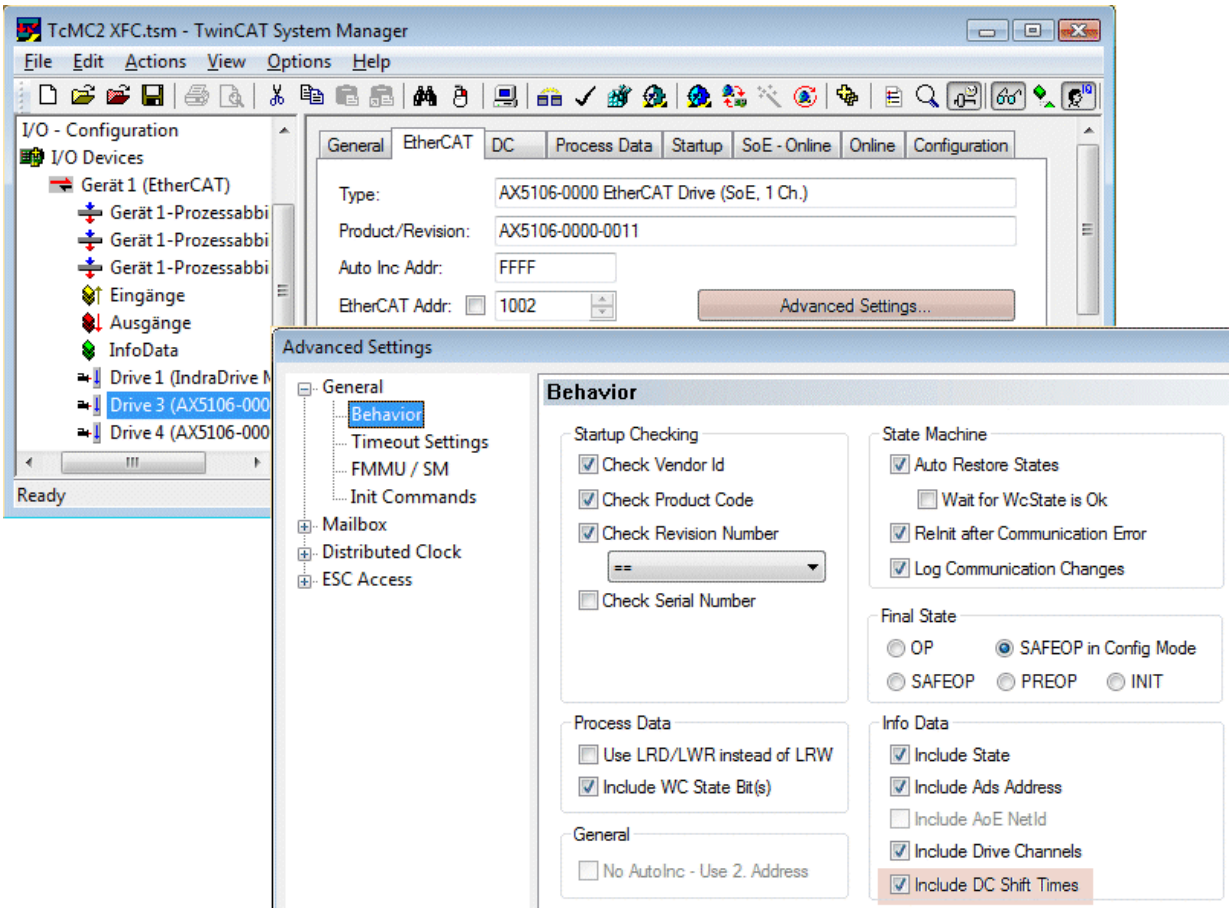
3 Dead time compensation

A prerequisite for high-precision conversion of positions into times and vice versa is precise dead time compensation of the axes. From TwinCAT 2.11 such a dead time compensation function is available for EtherCAT and Sercos axes. It operates largely automatically. Nevertheless, a manual configuration can be necessary, for example to compensate the drive's internal dead times.

Support of distributed clocks

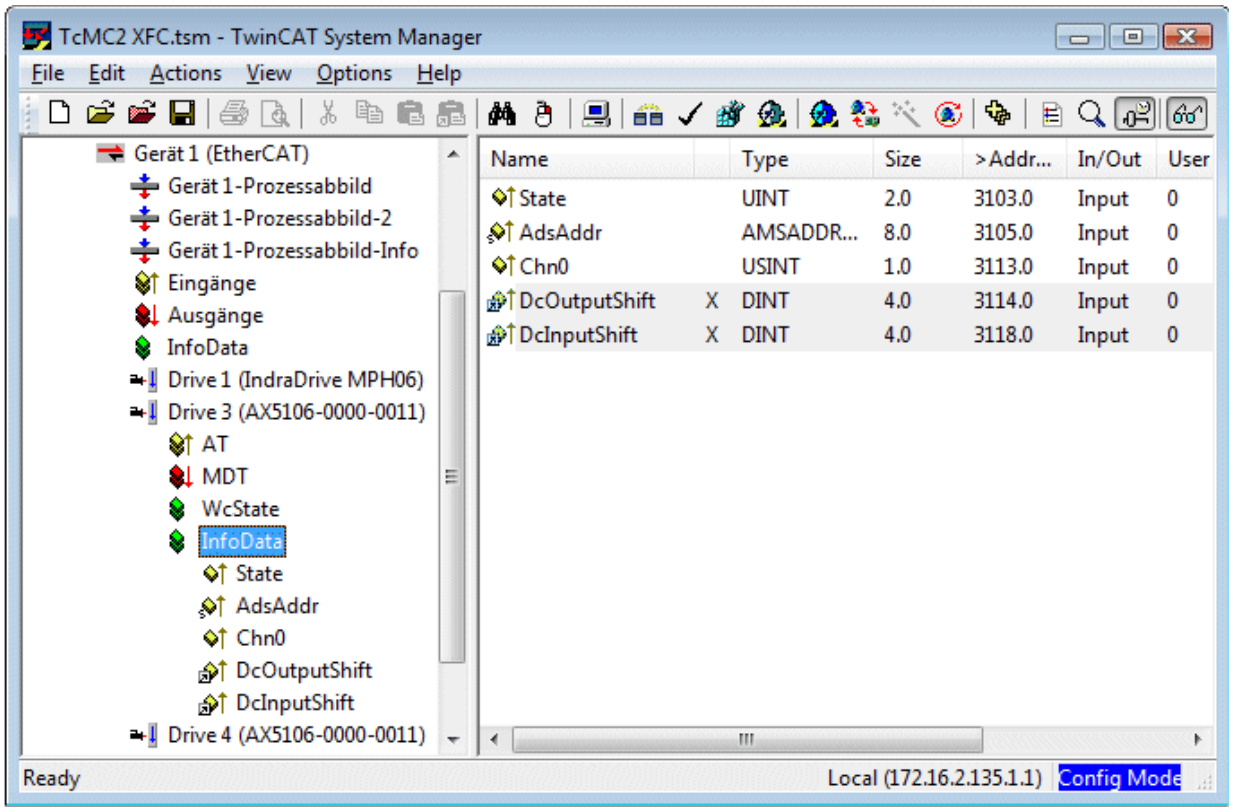
Support for distributed clocks must initially be activated in EtherCAT drives as follows:

1. Call the drive's Ether CAT "Advanced Settings" dialog.



2. Activate the switch "Include DC Shift Times"

⇨ The time information is made available in the info data ("InfoData") of the drive and later linked with the NC axis.

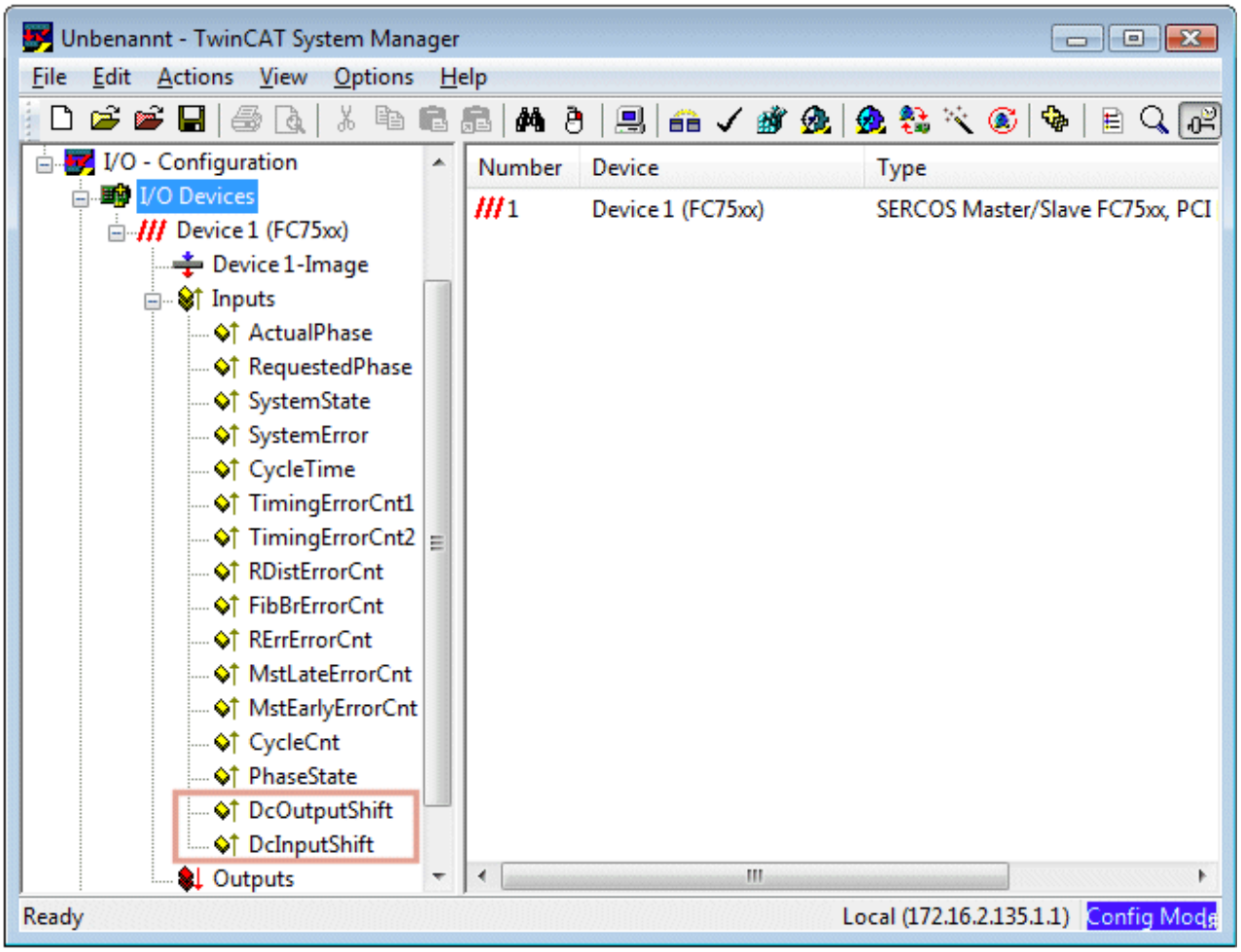


"DcInputShift" is the time required to transmit status information, such as the actual position of a drive, to the controller. In other words, it is the time between the acquisition and the evaluation of these data.

"DcOutputShift" is the time for the output of the process data to the drive, i.e. for the time delay between the calculation and the effect of these data.

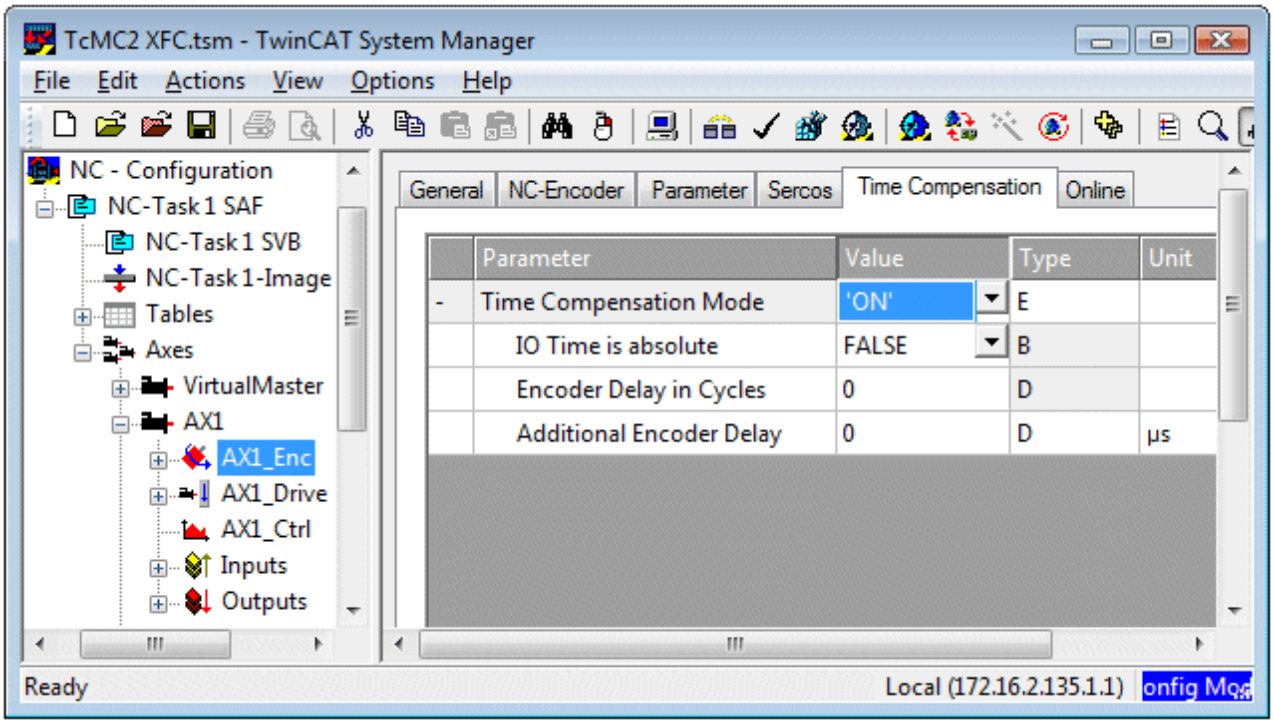
The time information is provided dynamically by the system and is used by the NC for dead time compensation of an axis.

For Sercos axes the times DcInputShift and DcOutputShift are provided by the Sercos card and do not have to be configured. If a drive is linked to an NC axis these times are also linked.



Compensation of the encoder dead time

The dead time compensation for the data acquisition side is activated on the "Time Compensation" tab of the axis encoder. The dead time from DcInputShift provided by the system is used for calculating the compensation.



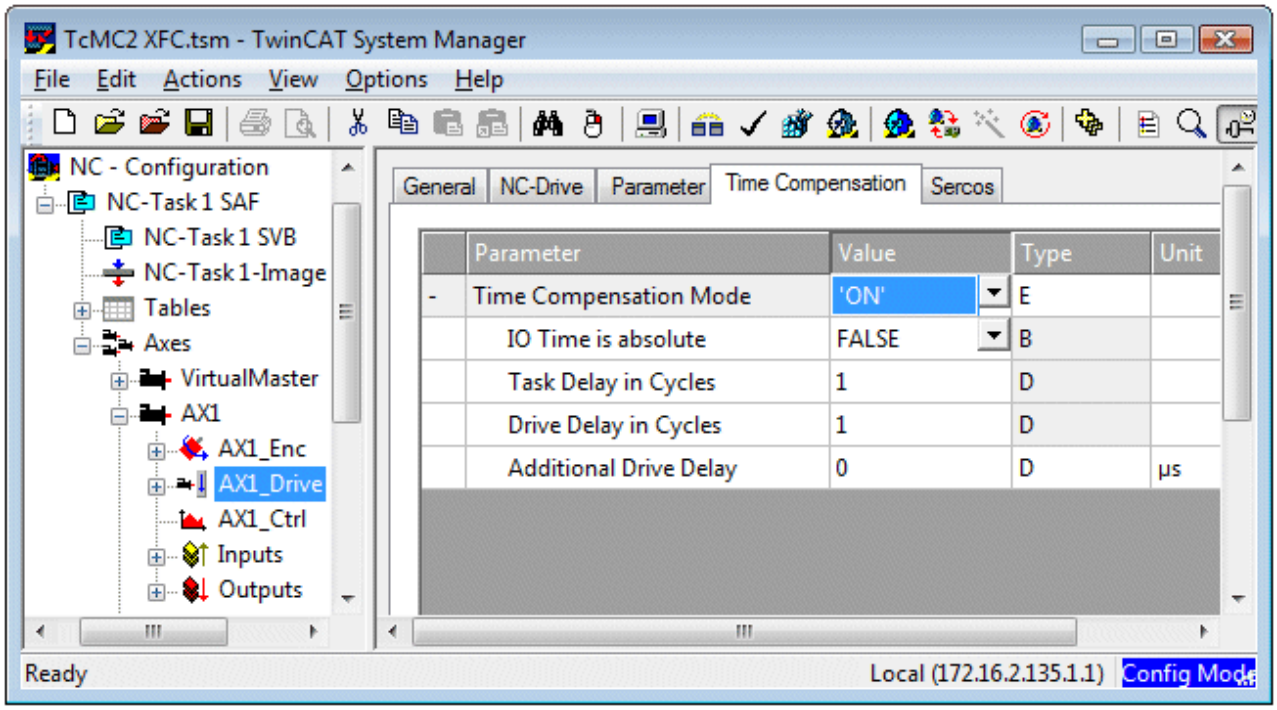
In special cases, for example in the event of additional dead times due to the hardware used, it may be necessary to configure further times.

The value Encoder Delay in Cycles indicates additional delays (whole I/O cycles). This time is therefore not a fixed value, but changes with the cycle time.

The value "Additional Drive Delay" is a fixed time value in µs caused by the hardware used.

Compensation of the drive dead time

The dead time compensation in the output direction is activated on the "Time Compensation" tab of the NC axis drive. As a result the time from DcOutputShift provided by the system is used for calculating the compensation.



In special cases further times can be configured.

The value Task Delay in Cycles is based on the setting in the task configuration. Depending on the set task timing the dead time may be extended by one cycle.

The value "Drive Delay in Cycles" indicates additional delays by whole I/O cycles caused by the drive.

The value "Additional Drive Delay" is a fixed time value in µs caused by the hardware used.

Effect of dead time compensation

Dead time compensation is used for conversion of all NC data that are cyclically exchanged with the PLC (NcToPlc) to the current time. The actual position, set position and following error of the axis in particular refer to the current time and reflect the physical axis position at this time. The PLC can use these values for further high-precision time and position calculations. (See basic functions XFC_GetCurDcTaskTime [▶ 31] , XFC_TimeOfPosition [▶ 36] and XFC_PositionAtTime [▶ 31].)

4 PLC API

4.1 TcMC2_XFC

4.1.1 CAMSWITCH_REF

The data type *CAMSWITCH_REF* refers to a data structure with cam parameters for a digital cam controller *MC_DigitalCamSwitch*.

```
TYPE CAMSWITCH_REF :
STRUCT
    NumberOfSwitches : UDINT;
    pSwitches        : POINTER TO MC_CamSwitch;
    SizeOfSwitches   : UDINT;
END_STRUCT
END_TYPE
```

The actual data structure for parameterization of a digital cam controller is usually an ARRAY OF MC_CamSwitch [▶ 13]. *CAMSWITCH_REF* refers to this structure via a pointer and clearly defines the size of the structure and the number of actual cams.

A variable of type *CAMSWITCH_REF* is initialized as illustrated in the following example:

```
VAR
    CamSwitchArray : ARRAY[1..3] OF MC_CamSwitch;
    CamSwitchRef   : CAMSWITCH_REF;
END_VAR
```

MC_CamSwitch [▶ 13]

```
(* real number of defined digital cams *)
CamSwitchRef.NumberOfSwitches := 1; (* 1..3 *)
(* pointer to the digital cam data array *)
CamSwitchRef.pSwitches        := ADR(CamSwitchArray);
(* maximum size of the digital cam data array *)
CamSwitchRef.SizeOfSwitches   := SIZEOF(CamSwitchArray);
```

Example with two cam tracks

CamSwitchRefTrack1 : CAMSWITCH_REF	
	Value
NumberOfSwitches	3
pSwitches	ADR(CamSwitchArrayTrack1)
SizeOfSwitches	SIZEOF(CamSwitchArrayTrack1)

CamSwitchArrayTrack1 : Array [1..n] OF MC_CamSwitch

	Switch 1	**Switch 2**	**Switch 3**	**...**	**Switch n**
FirstOnPosition	2000	2500	4000		
LastOnPosition	3000	3000	1000		
AxisDirection	POSITIVE	NEGATIVE	BOTH		
CamSwitchMode	POSITION	POSITION	POSITION		
Duration [s]	—	—	—		

CamSwitchRefTrack2 : CAMSWITCH_REF	
	Value
NumberOfSwitches	1
pSwitches	ADR(CamSwitchArrayTrack2)
SizeOfSwitches	SIZEOF(CamSwitchArrayTrack2)

CamSwitchArrayTrack2 : Array [1..m] OF MC_CamSwitch

	Switch 1	**...**	**Switch m**
FirstOnPosition	3000		
LastOnPosition	—		
AxisDirection	BOTH		
CamSwitchMode	TIME		
Duration [s]	1,350		

4.1.2 MC_CamSwitch

The data type *MC_CamSwitch* contains all parameters of a digital cam for a digital cam controller *MC_DigitalCamSwitch*.

```
TYPE MC_CamSwitch :
STRUCT
    FirstOnPosition : LREAL;
    LastOnPosition  : LREAL;
    AxisDirection   : E_CamSwitchDirection;
    CamSwitchMode   : E_CamSwitchMode;
    Duration        : LREAL;
END_STRUCT
END_TYPE
```

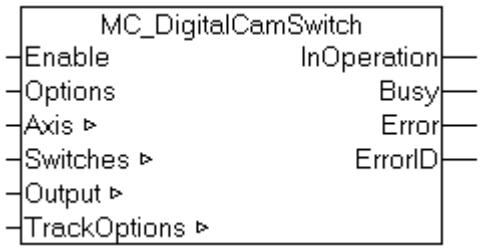
The data structure for parameterization of a digital cam controller is usually an ARRAY OF *MC_CamSwitch*. A further structure CAMSWITCH_REF [▶ 13] refers to this structure.

FirstOnPosition	First position from which the cam is switched on.
LastOnPosition	Last position up to which the cam is switched on. The cam function is inverted, if *LastOnPosition* < *FirstOnPosition*. *LastOnPosition* is not used for time cams.
AxisDirection	AxisDirection defines in which axis travel direction the digital cam is active (positive, negative or both directions).
CamSwitchMode	Digital cam type (position cam, time cam or brake cam).
Duration	Duration defines the switch-on time of the cam in [s] and is only used for time cams.

```
TYPE E_CamSwitchDirection :
(
    CAMSWITCHDIRECTION_BOTH,     (* digital cam will work in both directions *)
    CAMSWITCHDIRECTION_POSITIVE, (* digital cam is just working in positive direction *)
    CAMSWITCHDIRECTION_NEGATIVE  (* digital cam is just working in negative direction *)
);
END_TYPE
```

```
TYPE E_CamSwitchMode :
(
    CAMSWITCHMODE_POSITION, (* position cam *)
    CAMSWITCHMODE_TIME,     (* time cam *)
    CAMSWITCHMODE_BREAK     (* break cam *)
);
END_TYPE
```

4.1.3 MC_DigitalCamSwitch



MC_DigitalCamSwitch is a digital cam controller with one or several cams on a digital output track.

Position, time and brake cams can be realized through suitable parameterization. Further output tracks can be realized with independent instances of the function block.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations. This information is used for the actual output at an XFC output terminal with a downstream function block (XFC_EL2252 or XFC_EL2262 [▶ 28]).

Inputs

```
VAR_INPUT
    Enable  : BOOL;
    Options : ST_CamSwitchOptions;
END_VAR
```

Enable	The cam controller is activated via the *Enable* input. The initial state remains unchanged, as long as *Enable=FALSE*.

Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
Options.	**UseAcceleration**	*UseAcceleration* can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

Outputs

```
VAR_OUTPUT
    InOperation : BOOL;
    Busy        : BOOL;
    Error       : BOOL;
    ErrorID     : UDINT;
END_VAR
```

InOperation	*InOperation* is TRUE, as long as the cam controller is active and the cam track is calculated according to the cam parameterization.
Busy	*Busy* is TRUE as long as the block function is not completed.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

Inputs/outputs

```
VAR_IN_OUT
    Axis         : AXIS_REF;
    Switches     : CAMSWITCH_REF [▶ 13];
    Output       : OUTPUT_REF [▶ 18];
    TrackOptions : TRACK_REF [▶ 20];
END_VAR
```

Axis	Axis data structure
Switches	The data structure *Switches* contains a reference to the parameterization of all cams on the cam track.
Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

Example for two digital cam tracks

CamSwitchRefTrack1 : CAMSWITCH_REF	
	Value
NumberOfSwitches	3
pSwitches	ADR(CamSwitchArrayTrack1)
SizeOfSwitches	SIZEOF(CamSwitchArrayTrack1)

CamSwitchArrayTrack1 : Array [1..n] OF MC_CamSwitch

	Switch 1	**Switch 2**	**Switch 3**	**...**	**Switch n**
FirstOnPosition	2000	2500	4000		
LastOnPosition	3000	3000	1000		
AxisDirection	POSITIVE	NEGATIVE	BOTH		
CamSwitchMode	POSITION	POSITION	POSITION		
Duration [s]	—	—	—		

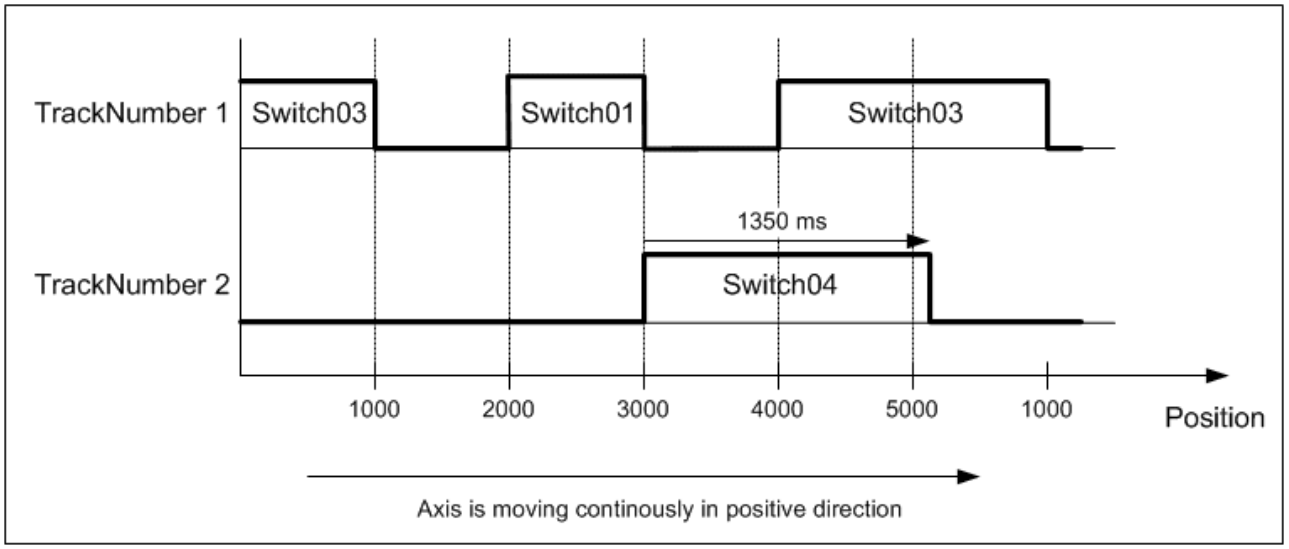
CamSwitchRefTrack2 : CAMSWITCH_REF	
	Value
NumberOfSwitches	1
pSwitches	ADR(CamSwitchArrayTrack2)
SizeOfSwitches	SIZEOF(CamSwitchArrayTrack2)

CamSwitchArrayTrack2 : Array [1..m] OF MC_CamSwitch

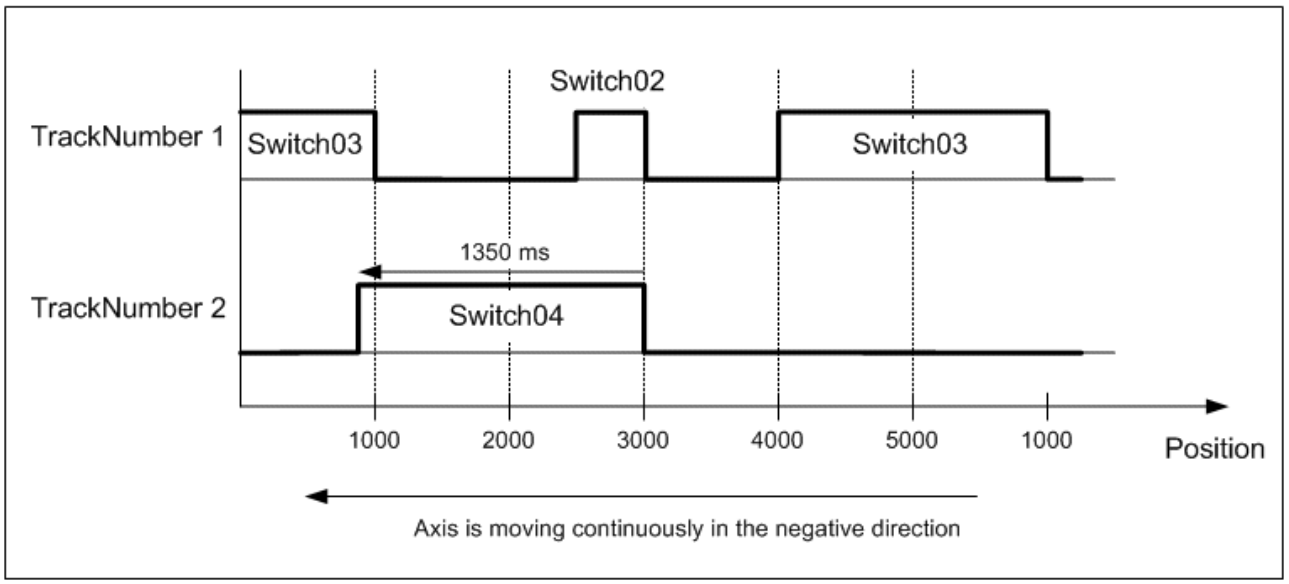
	Switch 1	**...**	**Switch m**
FirstOnPosition	3000		
LastOnPosition	—		
AxisDirection	BOTH		
CamSwitchMode	TIME		
Duration [s]	1,350		

The following switching diagrams result from the cam data. The switching sequence is represented without any time compensation and hysteresis and varies for both directions of travel due to the cam data.

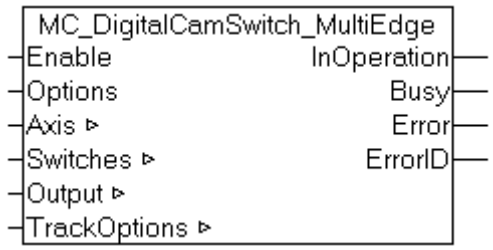
Switching sequence for positive direction of travel



Switching sequence for negative direction of travel



4.1.4 MC_DigitalCamSwitch_MultiEdge



MC_DigitalCamSwitch_MultiEdge is a digital cam controller with one or several cams on a digital output track. The function block supplements the function block *MC_DigitalCamSwitch* by the capability of being able to perform multiple switching operations during a PLC cycle. The switching operations are defined by position cams. Further output tracks can be realized with independent instances of the function block.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations. With this information the actual output can take place on an XFC multi-timestamp output terminal with a downstream function block (XFC_EL1259_MultiEdge, XFC_EL2212_MultiEdge, XFC_EL2258_MultiEdge or XFC_EL2262_MultiEdge).

Note Time cams and brake cams cannot be used with the function block MC_DigitalCamSwitch_MultiEdge. Terminals without multi-timestamp functionality are not suitable for use with this function block.

Inputs

```
VAR_INPUT
    Enable  : BOOL;
    Options : ST_CamSwitchOptions;
END_VAR
```

Enable	The cam controller is activated via the *Enable* input. The initial state remains unchanged, as long as *Enable*=FALSE.	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
Options.	**UseAcceleration**	UseAcceleration can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

Outputs

```
VAR_OUTPUT
    InOperation : BOOL;
    Busy        : BOOL;
    Error       : BOOL;
    ErrorID     : UDINT;
END_VAR
```

InOperation	*InOperation* is TRUE, as long as the cam controller is active and the cam track is calculated according to the cam parameterization.
Busy	*Busy* is TRUE as long as the block function is not completed.

Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

Inputs/outputs

```
VAR_IN_OUT
    Axis         : AXIS_REF;
    Switches     : CAMSWITCH_REF [▶ 13];
    Output       : OUTPUT_REF_MULTIEDGE [▶ 18];
    TrackOptions : TRACK_REF [▶ 20];
END_VAR
```

Axis	Axis data structure
Switches	The data structure *Switches* contains a reference to the parameterization of all cams on the cam track.
Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.5 OUTPUT_REF

The data type *OUTPUT_REF* contains data describing the state of a digital output. In addition to the switching state it contains time stamps for state changes.

```
TYPE OUTPUT_REF :
STRUCT
    Level                : BOOL;       (* current level of the digital output *)

    NextStateChangeValid : BOOL;       (* time value NextStateChange is valid *)
    NextStateChange      : T_DCTIME32; (* time of next state change -
 current level will be inverted *)

    NextOnTimeValid      : BOOL;       (* time value NextOnTime is valid *)
    NextOnTime           : T_DCTIME32; (* time when the digital output is turned ON next time *)

    NextOffTimeValid     : BOOL;       (* time value NextOffTime is valid *)
    NextOffTime          : T_DCTIME32; (* time when the digital output is turned OFF next time *)
END_STRUCT
END_TYPE
```

Level	Current switching state of the digital output
NextStateChangeValid	*NextStateChangeValid* is TRUE, if the time stamp *NextStateChange* is valid.
NextStateChange	Time of the next change of state (distributed clock TimeStamp)
NextOnTimeValid	*NextOnTimeValid* is TRUE, if the time stamp *NextOnTime* is valid.
NextOnTime	Time of the next positive switching edge (distributed clock TimeStamp)
NextOffTimeValid	*NextOffTimeValid* is TRUE, if the time stamp *NextOffTime* is valid.
NextOffTime	Time of the next negative switching edge (distributed clock TimeStamp)

4.1.6 OUTPUT_REF_MULTIEDGE

The data type *OUTPUT_REF_MULTIEDGE* contains data describing the state of a digital output. In addition to the switching state it contains time stamps for state changes. The data type is used in conjunction with terminals that allow multiple switching operations per PLC cycle by means of multi-timestamp.

```
TYPE OUTPUT_REF_MULTIEDGE :
STRUCT
    SwitchEvent : ARRAY [0..TCMC2_XFC_MAXINDEXOFMULTIEDGEOUTPUTEVENTS] OF ST_SwitchEvent;
END_STRUCT
END_TYPE
```

```
TYPE ST_SwitchEvent :
STRUCT
    ID       : UDINT;
    Valid    : BOOL;       (* time value is valid *)
    Level    : BOOL;       (* next level of the digital signal *)
    Position : LREAL;
    DcTime   : T_DCTIME32; (* time when the digital output changes *)
    Duration : DINT;
END_STRUCT
END_TYPE
```

ID	Internal ID of the switching edge
Valid	Valid is TRUE if the *DcTime* timestamp is valid.
Level	Current switching state of the digital output
Position	Switching position of the switching operation
DcTime	Time of the next change of state (distributed clock TimeStamp)
Duration	Not used

4.1.7 ST_EL2258_Diagnostics

The data type *ST_EL2258_Diagnostics* contains diagnostic data that can be used for error analysis.

```
TYPE ST_EL2258_Diagnostics :
STRUCT
    ErrorOnOutputMissed     : BOOL;
    ErrorOffOutputMissed    : BOOL;
    ErrorNoOfEventsExceeded : BOOL;
    ErrorBufferOverflow     : BOOL;
    ErrorEventDistance      : BOOL;
    OnPrecisionReduced      : BOOL;
    OffPrecisionReduced     : BOOL;
    LastOutputLevel         : BOOL;
    ActivatedOnValues       : INT;
    ActivatedOffValues      : INT;
END_STRUCT
END_TYPE
```

ErrorOnOutputMissed	Indicates that a rising switching edge could not be determined to an exact cycle and therefore could not be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
ErrorOffOutputMissed	Indicates that a falling switching edge could not be determined to an exact cycle and therefore could not be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
ErrorNoOfEventsExceeded	Indicates that too many edges were delivered for a cycle and that therefore not all of them can be output.
ErrorBufferOverflow	Indicates that the output buffer of the EL2258 is full.
ErrorEventDistance	Indicates that the distance between two consecutive edges is too small.
OnPrecisionReduced	Indicates that a rising switching edge could not be determined to an exact cycle. However, the switching edge was output as well as possible.
OffPrecisionReduced	Indicates that a falling switching edge could not be determined to an exact cycle. However, the switching edge was output as well as possible.
LastOutputLevel	indicates which signal state the channel of the EL2262 will have after the following update.
ActivatedOnValues	Number of rising edges activated in this cycle
ActivatedOffValues	Number of falling edges activated in this cycle

4.1.8 ST_EL2262_Diagnostics

The data type *ST_EL2262_Diagnostics* contains diagnostic data that can be used for error analysis.

```
TYPE ST_EL2262_Diagnostics :
STRUCT
    ErrorOnOutputMissed     : BOOL;
    ErrorOffOutputMissed    : BOOL;
    OnPrecisionReduced      : BOOL;
    OffPrecisionReduced     : BOOL;
    LastOutputLevel         : BOOL;
    ActivatedOnValues       : INT;
    ActivatedOffValues      : INT;
END_STRUCT
END_TYPE
```

ErrorOnOutputMissed	Indicates that a rising switching edge could not be determined to an exact cycle and therefore could not be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
ErrorOffOutputMissed	Indicates that a falling switching edge could not be determined to an exact cycle and therefore could not be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
OnPrecisionReduced	Indicates that a rising switching edge could not be determined to an exact cycle. However, the switching edge was output as well as possible.
OffPrecisionReduced	Indicates that a falling switching edge could not be determined to an exact cycle. However, the switching edge was output as well as possible.
LastOutputLevel	Indicates which signal state the channel of the EL2262 will have after the following update.
ActivatedOnValues	Number of rising edges activated in this cycle
ActivatedOffValues	Number of falling edges activated in this cycle

4.1.9 TRACK_REF

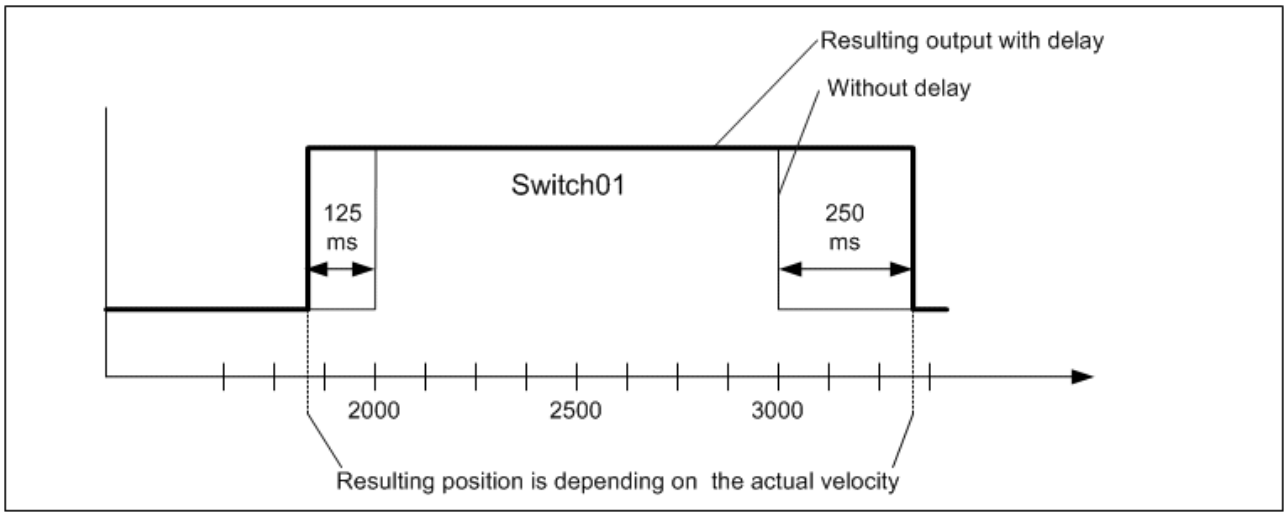
The data type *TRACK_REF* contains the parameters of a digital cam track for a digital cam controller *MC_DigitalCamSwitch*.

```
TYPE TRACK_REF :
STRUCT
    ModuloPositions : BOOL := TRUE; (* all cam positions are interpreted as modulo positions when TR
UE *)
    ModuloFactor    : LREAL := 360; (* e. g. 360 degrees *)
    OnCompensation  : LREAL;        (* compensation time [s] *)
    OffCompensation : LREAL;        (* compensation time [s] *)
    Hysteresis      : LREAL;        (* distance from last switch position (+ or -) *)
    BreakRelease    : BOOL;         (* allow break to be released when TRUE, break cams will be acti
vated when FALSE *)
    Force           : BOOL;         (* override all digital cams and set track ON *)
    Disable         : BOOL;         (* override all digital cams and set track OFF -
 overrides Force as well *)
END_STRUCT
END_TYPE
```

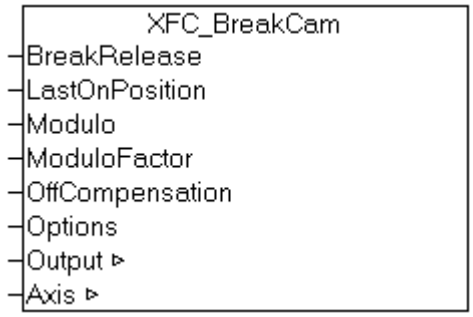
ModuloPositions	If *Modulo* TRUE, all positions are interpreted as modulo. The cam function is repeated cyclically. The parameter *ModuloFactor* is used for calculating the modulo cycle.
ModuloFactor	*ModuloFactor* indicates the length of a modulo cycle in the positioning unit of the axis and is only used if *Modulo* TRUE.
OnCompensation	Compensation time for the rising edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed.
OffCompensation	Compensation time for the falling edge of the cam in [s]. For negative values of *OffCompensation* the switching time is brought forward, otherwise it is delayed.

Hysteresis	not implemented. Hysteresis of the switching operations for reversing the rotation direction. The hysteresis is specified in the position unit of the axis.
BreakRelease	Brake enable for brake cams on this cam track
Force	The digital output is activated independent of the cams on this track. *Disable* has priority over *Force*.
Disable	The digital output is deactivated independent of the cams on this track. *Disable* has priority over *Force*.

Method of function of the time compensation



4.1.10 XFC_BreakCam



XFC_BreakCam realizes a brake cam, which deactivates a digital output depending on the position as soon as *BreakRelease* is withdrawn.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations. This information is used for the actual output at an XFC output terminal with a downstream function block (XFC_EL2252 or XFC_EL2262 [▶ 28]).

Inputs

```
VAR_INPUT
    BreakRelease    : LREAL;
    LastOnPosition  : LREAL;
    Modulo          : BOOL;
    ModuloFactor    : LREAL := 360;
    OffCompensation : LREAL;
    Options         : ST_CamSwitchOptions;
END_VAR
```

BreakRelease	Brake enable. The cam remains active as long as *BreakRelease* is TRUE. When *BreakRelease* becomes FALSE, the cam is switched off at position *LastOnPosition*.

LastOnPosition	Last position up to which the cam is switched on.	
Modulo	If *Modulo* TRUE, all positions are interpreted as modulo. The cam function is repeated cyclically. The parameter *ModuloFactor* is used for calculating the modulo cycle.	
ModuloFactor	ModuloFactor indicates the length of a modulo cycle in the positioning unit of the axis and is only used if *Modulo*=TRUE.	
OffCompensation	Compensation time for the falling edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed. The value OffCompensation parameterized here has priority over TRACK_REF [▶ 20].	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index can be defined here.
Options.	**UseAcceleration**	*UseAcceleration* can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

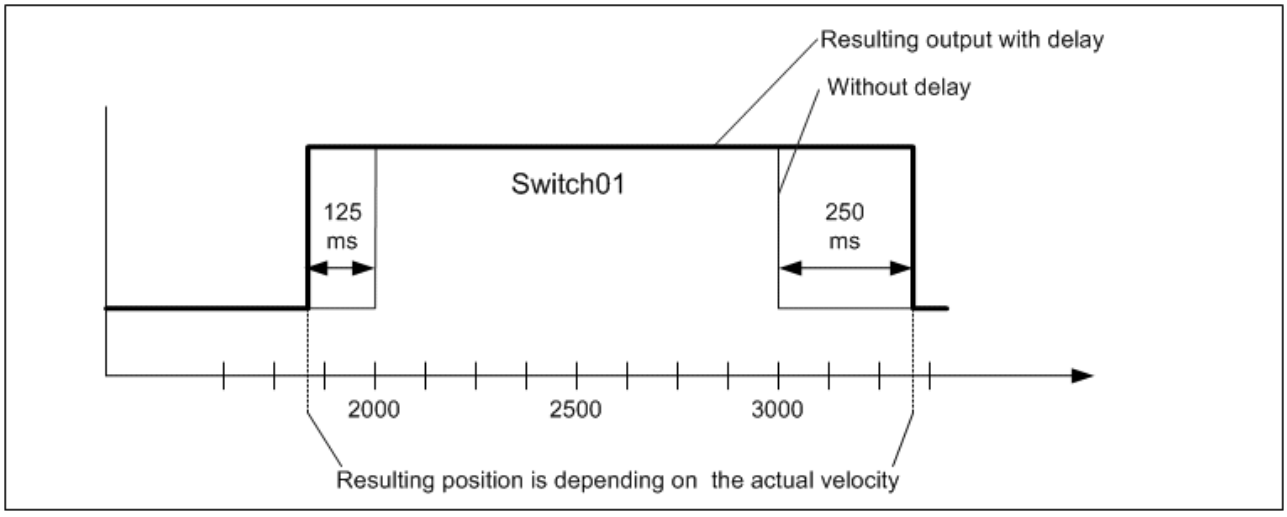
Inputs/outputs

```
VAR_IN_OUT
    Output : OUTPUT_REF [▶ 18];
    Axis   : AXIS_REF;
END_VAR
```

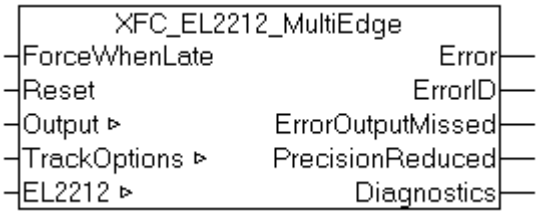
Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal.
Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

Method of function of the time compensation



4.1.11 XFC_EL1259_MultiEdge



XFC_EL1259_Multiedge handles the output of a multi-edge cam controller MC_DigitalCamSwitch_MultiEdge EL1259 XFC timestamp terminal.

Inputs

```
VAR_INPUT
    ForceWhenLate : BOOL;
    Reset         : BOOL;
END_VAR
```

ForceWhenLate	If *ForceWhenLate* is TRUE, the output is activated even if the time stamp is already exceeded. It is recommended to set *ForceWhenLate* to prevent the loss of a switching edge in case of fluctuations of the time signal.
Reset	*Reset initiates a reset of the terminal*

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
    Diagnostics       : ST_EL2258_Diagnostics;
END_VAR
```

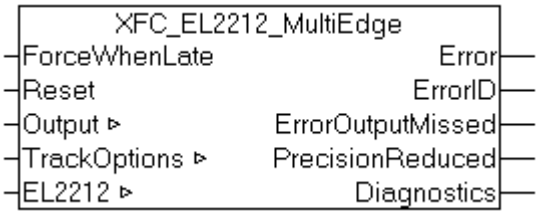
Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	The exact switching point defined by *TimeStamp* could not be adhered to and the initial state remains unchanged. If *ForceWhenLate* is TRUE, the initial state is always output and *ErrorOutputMissed* does not become TRUE.
PrecisionReduced	The exact switching point defined by *TimeStamp* could not be adhered to; the initial state was output with a delay. *PrecisionReduced* should be regarded as a warning. It can only become TRUE if *ForceWhenLate* is TRUE.

Inputs/outputs

```
VAR_IN_OUT
    Output       : OUTPUT_REF_MULTIEDGE;
    TrackOptions : TRACK_REF [▶ 20];
    EL1259       : EL1259_IoInterface;
END_VAR
```

Output	Output state for a channel of the Terminal. The data structure *Output* contains the next calculated states of the digital output and the associated timestamp for output on a digital XFC output terminal.
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.
EL1259	Process image of the terminal

4.1.12 XFC_EL2212_MultiEdge



XFC_EL2212_MultiEdge handles the output of a multi-edge cam controller MC_DigitalCamSwitch_MultiEdge EL2212 XFC timestamp terminal.

Inputs

```
VAR_INPUT
    ForceWhenLate : BOOL;
    Reset         : BOOL;
END_VAR
```

ForceWhenLate	If *ForceWhenLate* is TRUE, the output is activated even if the time stamp is already exceeded. It is recommended to set *ForceWhenLate* to prevent the loss of a switching edge in case of fluctuations of the time signal.
Reset	*Reset* initiates a reset of the terminal

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
    Diagnostics       : ST_EL2258_Diagnostics;
END_VAR
```

Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	The exact switching point defined by *TimeStamp* could not be adhered to and the initial state remains unchanged. If *ForceWhenLate* is TRUE, the initial state is always output and *ErrorOutputMissed* does not become TRUE.
PrecisionReduced	The exact switching point defined by *TimeStamp* could not be adhered to; the initial state was output with a delay. *PrecisionReduced* should be regarded as a warning. It can only become TRUE if *ForceWhenLate* is TRUE.

Inputs/outputs

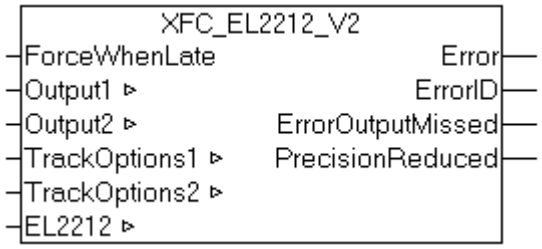
```
VAR_IN_OUT
    Output       : OUTPUT_REF_MULTIEDGE;
    TrackOptions : TRACK_REF [▶ 20];
    EL2212       : EL2212_IoInterface;
END_VAR
```

Output	Output state for a channel of the Terminal. The data structure *Output* contains the next calculated states of the digital output and the associated timestamp for output on a digital XFC output terminal.
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.
EL2212	Process image of the terminal

Process image

The terminal is inserted in the process image with up to 10 timestamps for operation with this function block in the multi-timestamp mode and the DC mode must be activated.

4.1.13 XFC_EL2212_V2



XFC_EL2212_V2 handles the output of a digital cam with the XFC time stamp terminal EL2212.

Note The function block XFC_EL2212_V2 replaces the function block XFC_EL2212, which is still included in the library for compatibility reasons.

The output of the data to the terminal takes place only shortly before reaching the timestamp of one of the outputs. Four PLC cycles are required for activation and acknowledgement of the outputs. Only then can a further edge change take place. The minimum time between two edge changes of the output signal is therefore four PLC cycles, in order to prevent errors or loss of precision. If the output signal is generated by a cam controller, a minimum cam width can be calculated from the maximum velocity and the PLC cycle time.

The outputs Output1 and Output2 cannot be used completely independently of each other since the activation takes place with only one timestamp. As a prerequisite, the switching edges of both channels must be sufficiently far apart. In this case, the respectively nearest timestamp is applied to the block.

Inputs

```
VAR_INPUT
    ForceWhenLate : BOOL;
END_VAR
```

ForceWhenLate	If *ForceWhenLate* is TRUE, the output is activated even if the time stamp is already exceeded. It is recommended to set *ForceWhenLate* to prevent the loss of a switching edge in case of fluctuations of the time signal.

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
END_VAR
```

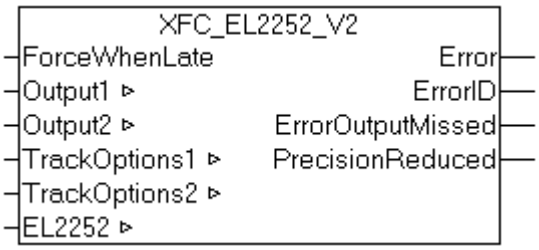
Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	The exact switching point defined by *TimeStamp* could not be adhered to and the initial state remains unchanged. If *ForceWhenLate* is TRUE, the initial state is always output and *ErrorOutputMissed* does not become TRUE.
PrecisionReduced	The exact switching point defined by *TimeStamp* could not be adhered to; the initial state was output with a delay. *PrecisionReduced* should be regarded as a warning. It can only become TRUE if *ForceWhenLate* is TRUE.

Inputs/outputs

```
VAR_IN_OUT
    Output1        : OUTPUT_REF [▶ 18];
    Output2        : OUTPUT_REF;
    TrackOptions1  : TRACK_REF [▶ 20];
    TrackOptions2  : TRACK_REF;
    EL2212         : EL2212_IoInterface;
END_VAR
```

Output1	Output state for channel 1 of the Terminal. The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
Output2	Output state for channel 2 of the Terminal. The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal.
TrackOptions1	The *TrackOptions1* data structure contains the parameterization of Cam Track 1 for Output1.
TrackOptions2	The *TrackOptions2* data structure contains the parameterization of Cam Track 2 for Output2.
EL2212	Process image of the terminal

4.1.14 XFC_EL2252_V2



XFC_EL2252 handles the output of a digital cam with the XFC time stamp terminal EL2252.

Note The function block XFC_EL2252_V2 replaces the function block XFC_EL2252, which is still included in the library for compatibility reasons.

The output of the data to the terminal takes place only shortly before reaching the timestamp of one of the outputs. Four PLC cycles are required for activation and acknowledgement of the outputs. Only then can a further edge change take place. The minimum time between two edge changes of the output signal is therefore four PLC cycles, in order to prevent errors or loss of precision. If the output signal is generated by a cam controller, a minimum cam width can be calculated from the maximum velocity and the PLC cycle time.

The outputs Output1 and Output2 cannot be used completely independently of each other since the activation takes place with only one timestamp. As a prerequisite, the switching edges of both channels must be sufficiently far apart. In this case, the respectively nearest timestamp is applied to the block.

Inputs

```
VAR_INPUT
    ForceWhenLate : BOOL;
END_VAR
```

ForceWhenLate	If *ForceWhenLate* is TRUE, the output is activated even if the time stamp is already exceeded. It is recommended to set *ForceWhenLate* to prevent the loss of a switching edge in case of fluctuations of the time signal.

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
```

```
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
END_VAR
```

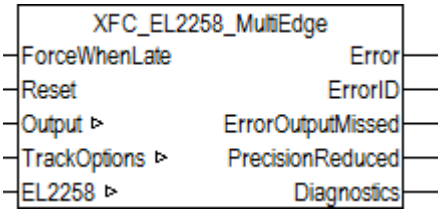
Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	The exact switching point defined by *TimeStamp* could not be adhered to and the initial state remains unchanged. If *ForceWhenLate* is TRUE, the initial state is always output and *ErrorOutputMissed* does not become TRUE.
PrecisionReduced	The exact switching point defined by *TimeStamp* could not be adhered to; the initial state was output with a delay. *PrecisionReduced* should be regarded as a warning. It can only become TRUE if *ForceWhenLate* is TRUE.

Inputs/outputs

```
VAR_IN_OUT
    Output1       : OUTPUT_REF [▶ 18];
    Output2       : OUTPUT_REF;
    TrackOptions1 : TRACK_REF [▶ 20];
    TrackOptions2 : TRACK_REF;
    EL2252        : EL2252_IoInterface;
END_VAR
```

Output1	Output state for channel 1 of the Terminal. The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal.
Output2	Output state for channel 2 of the Terminal. The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal.
TrackOptions1	The *TrackOptions1* data structure contains the parameterization of Cam Track 1 for Output1.
TrackOptions2	The *TrackOptions2* data structure contains the parameterization of Cam Track 2 for Output2.
EL2252	Process image of the terminal

4.1.15 XFC_EL2258_Multiedge



XFC_EL2258_Multiedge handles the output of a multi-edge cam controller MC_DigitalCamSwitch_MultiEdge EL2258 XFC timestamp terminal.

Inputs

```
VAR_INPUT
    ForceWhenLate : BOOL;
    Reset         : BOOL;
END_VAR
```

ForceWhenLate	If *ForceWhenLate* is TRUE, the output is activated even if the time stamp is already exceeded. It is recommended to set *ForceWhenLate* to prevent the loss of a switching edge in case of fluctuations of the time signal.
Reset	*Reset* initiates a reset of the terminal

Outputs

```
VAR_OUTPUT
    Error            : BOOL;
    ErrorID          : UDINT;
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
    Diagnostics      : ST_EL2258_Diagnostics;
END_VAR
```

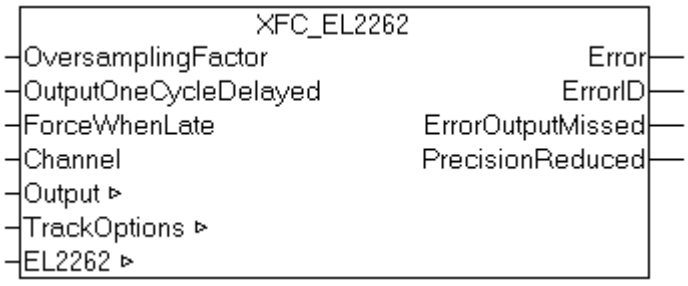
Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	The exact switching point defined by *TimeStamp* could not be adhered to and the initial state remains unchanged. If *ForceWhenLate* is TRUE, the initial state is always output and *ErrorOutputMissed* does not become TRUE.
PrecisionReduced	The exact switching point defined by *TimeStamp* could not be adhered to; the initial state was output with a delay. *PrecisionReduced* should be regarded as a warning. It can only become TRUE if *ForceWhenLate* is TRUE.
Diagnostics	Data structure [▶ 19] containing diagnostic data that can be used for error analysis.

Inputs/outputs

```
VAR_IN_OUT
    Output       : OUTPUT_REF_MULTIEDGE;
    TrackOptions : TRACK_REF [▶ 20];
    EL2258       : EL2258_IoInterface;
END_VAR
```

Output	Output state for a channel of the Terminal. The data structure *Output* contains the next calculated states of the digital output and the associated timestamp for output on a digital XFC output terminal.
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.
EL2258	Process image of the terminal

4.1.16 XFC_EL2262



XFC_EL2262 handles the output of a digital cam with the EL2262 XFC oversampling terminal.

The maximum frequency depends on the cycle time. The minimum distance between two rising signal edges is two PLC cycles. The minimum distance between rising and falling edges can be smaller than a PLC cycle. The switching accuracy is determined by the set oversampling factor of the terminal.

The two channels of the terminal are independent of each other and are served by two instances of the *XFC_EL2262* function block.

Inputs

```
VAR_INPUT
    OversamplingFactor    : UINT;
    OutputOneCycleDelayed : BOOL; (* TRUE if EL2262 is updated with the NC SAF task at the beginning
 of the next cycle *)
```

```
    ForceWhenLate          : BOOL;
    Channel                : INT;
END_VAR
```

OversamplingFactor	Oversampling factor for the EL2262 terminal
OutputOneCycleDelayed	*OutputOneCycleDelayed* is TRUE, if the output of the process image is delayed by a cycle due to the set timing. *OutputOneCycleDelayed* depends on the timing of the output task to which the EL2262 is linked.
ForceWhenLate	If the time information changes slightly from cycle to cycle, it might not be possible for a switching edge to be output. In such a situation *ForceWhenLate* forces the best possible switching. In this case the *PrecisionReduced* output goes TRUE and can be used for diagnosis. (Can be used in the case of increased jitter in an axis position where the output of a switching edge cannot be determined to an exact output cycle).
Channel	Channel number 0 or 1 of the EL2262 Terminal

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
    ErrorOutputMissed : BOOL;
END_VAR
```

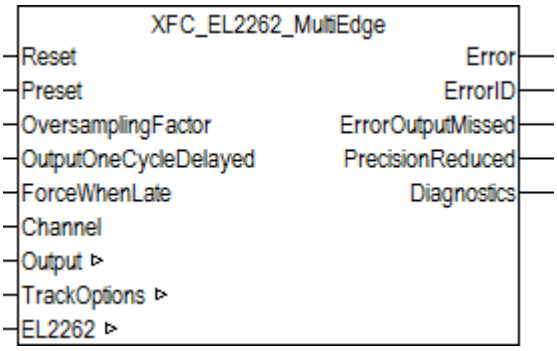
Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	indicates that a switching edge cannot be determined to an exact cycle and therefore cannot be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
PrecisionReduced	indicates that a switching edge cannot be determined to an exact cycle. However, the switching edge was output as well as possible.

Inputs/outputs

```
VAR_IN_OUT
    Output       : OUTPUT_REF [▶ 18];
    TrackOptions : TRACK_REF [▶ 20];
    EL2262       : EL2262_IoInterface;
END_VAR
```

Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.
EL2262	Process image of the terminal

4.1.17 XFC_EL2262_MultiEdge



_XFC_EL2262_MultiEdge handles the output of digital cams with the EL2262 XFC oversampling terminal.

The maximum frequency depends on the cycle time. The minimum distance between two rising signal edges = (2*PLC cycle time) / oversampling factor. The minimum distance between rising and falling edges = PLC cycle time / oversampling factor. The switching accuracy is determined by the set oversampling factor of the terminal.

Inputs

```
VAR_INPUT
    Reset                    : BOOL;
    Preset                   : BOOL;
    OversamplingFactor       : UINT;
    OutputOneCycleDelayed    : BOOL; (* TRUE if EL2262 is updated with the NC SAF task at the begi
nning of the next cycle *)
    ForceWhenLate            : BOOL; (* forces the output even when the timestamp is missed *)
    Channel                  : INT;  (* select 0 or 1 for Output0 or Output1 *)
END_VAR
```

Reset	The terminal output is deactivated.
Preset	The terminal output is activated.
OversamplingFactor	Oversampling factor for the EL2262 terminal
OutputOneCycleDelayed	*OutputOneCycleDelayed* is TRUE, if the output of the process image is delayed by a cycle due to the set timing. *OutputOneCycleDelayed* depends on the timing of the output task to which the EL2262 is linked.
ForceWhenLate	If the time information changes slightly from cycle to cycle, it might not be possible for a switching edge to be output. In such a situation *ForceWhenLate* forces the best possible switching. In this case the *PrecisionReduced* output goes TRUE and can be used for diagnosis. (Can be used in the case of increased jitter in an axis position where the output of a switching edge cannot be determined to an exact output cycle).
Channel	Defines the output channel of the EL2262, where 0 = Output0 and 1 = Output1.

Outputs

```
VAR_OUTPUT
    Error             : BOOL;
    ErrorID           : UDINT;
    ErrorOutputMissed : BOOL;
    PrecisionReduced  : BOOL;
    Diagnostics       : ST_EL2262_Diagnostics;
END_VAR
```

Error	Becomes TRUE if an error occurs.
ErrorID	If an error output is set, this parameter supplies an error number.
ErrorOutputMissed	indicates that a switching edge could be determined to an exact cycle and therefore cannot be output. The *ForceWhenLate* input can be set in order to output the switching edge as well as possible.
PrecisionReduced	indicates that a switching edge could be determined to an exact cycle. However, the switching edge was output as well as possible.
Diagnostics	Data structure [▶ 20] containing diagnostic data that can be used for error analysis

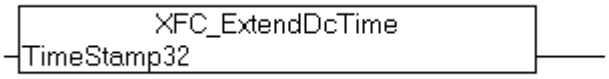
Inputs/outputs

```
VAR_IN_OUT
    Output       : OUTPUT_REF_MULTIEDGE;
    TrackOptions : TRACK_REF [▶ 20];
    EL2262       : EL2262_IoInterface;
END_VAR
```

Output	The data structure [▶ 18] *Output* contains an array of calculated states of the digital output and the associated timestamp for output on a digital XFC output terminal

TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.
EL2262	Process image of the terminal

4.1.18 XFC_ExtendDcTime



The function *XFC_ExtendDcTime* extends a 32-bit time stamp to 64 bit.

A prerequisite for the extension to a complete time stamp is that the 32-bit time stamp is valid for the current time range. It is not possible to guarantee error-free extension of a time stamp that applies more than approx. +/- 2 seconds before or after the current time.

Inputs

```
VAR_INPUT
    TimeStamp32 : T_DCTIME32;
END_VAR
```

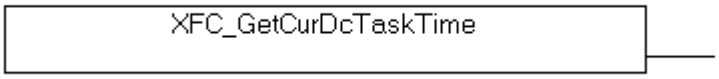
TimeStamp32	Distributed clock system time. *TimeStamp32* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.

Return value

```
FUNCTION XFCF_ExtendDcTime : T_DCTIME
```

Return value of the function	Complete 64-bit *distributed clock system time*.

4.1.19 XFC_GetCurDcTaskTime



The function *XFC_GetCurDcTaskTime* determines the start time of the current PLC cycle.

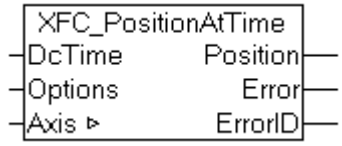
The function optimizes the calls of the system function F_GetCurDcTaskTime by answering several queries within a PLC task cycle with the same time, without calling the system function repeatedly.

Return value

```
FUNCTION XFCF_GetCurDcTaskTime : T_DCTIME
```

Return value of the function	Complete 64-bit *distributed clock system time*. Start time of the current PLC cycle (cycle of the task that calls this function.)

4.1.20 XFC_PositionAtTime



XFC_PositionAtTime calculates an axis position, which will be or was valid at a given time.

The function extrapolates the position in relation to the current position and dynamics. Precise extrapolation is only possible over a short interval, since the axis dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the position it may also return an error. This error must be analyzed in order to ensure that the calculated position is valid.

Inputs

```
VAR_INPUT
    DcTime  : T_DCTIME32;
    Options : ST_NcTimeConversionOptions;
END_VAR
```

DcTime	Distributed clock system time. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time. In order to optimise the calculation of the position value, the time should be close to the current time, i.e. only a few PLC or NC cycles in the future or the past.	
Options	Data structure with options for position extrapolation.	
Options.	SubIndex	For axes with more than one encoder the index (0..9) of the encoder to which the position refers can be specified in *SubIndex*.
Options.	InterpolationOptions	0: The position extrapolation is carried out with the current velocity, without taking into account the current acceleration. 1: The axis acceleration is included in the position extrapolation.
Options.	CompensationTime	additional compensation time.

Outputs

```
VAR_OUTPUT
    Position : LREAL;
    Error    : BOOL;
    ErrorID  : UDINT;
END_VAR
```

Position	Extrapolated position that will be or was reached at the specified time *DcTime*.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

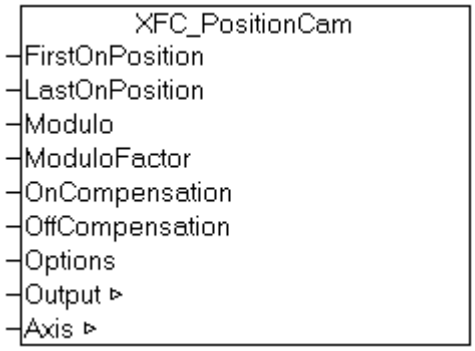
Inputs/outputs

```
VAR_IN_OUT
    Axis     : AXIS_REF;
END_VAR
```

Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.21 XFC_PositionCam



XFC_PositionCam realizes a position cam that switches a digital output on or off, depending on the position.

In contrast to the digital cam controller MC_DigitalCamSwitch [▶ 14], the function block switches precisely one cam on a digital output track. This facilitates parameterization of the block, although it cannot be used if several cams are required on an output track.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations. This information is used for the actual output at an XFC output terminal with a downstream function block (XFC_EL2252 or XFC_EL2262 [▶ 28]).

Inputs

```
VAR_INPUT
    FirstOnPosition : LREAL;
    LastOnPosition  : LREAL;
    Modulo          : BOOL;
    ModuloFactor    : LREAL := 360;
    OnCompensation  : LREAL;
    OffCompensation : LREAL;
    Options         : ST_CamSwitchOptions;
END_VAR
```

FirstOnPosition	First position from which the cam is switched on.	
LastOnPosition	Last position up to which the cam is switched on. The cam function is inverted, if *LastOnPosition* < *FirstOnPosition*	
Modulo	If *Modulo* TRUE, all positions are interpreted as modulo. The cam function is repeated cyclically. The parameter *ModuloFactor* is used for calculating the modulo cycle.	
ModuloFactor	ModuloFactor indicates the length of a modulo cycle in the positioning unit of the axis and is only used if *Modulo* TRUE.	
OnCompensation	Compensation time for the rising edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed. The value OnCompensation parameterized here has priority over TRACK_REF [▶ 20]	
OffCompensation	Compensation time for the falling edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed. The value OffCompensation parameterized here has priority over TRACK_REF [▶ 20].	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
Options.	**UseAcceleration**	*UseAcceleration* can be set to TRUE in order to incorporate the acceleration of the axis into the

		position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

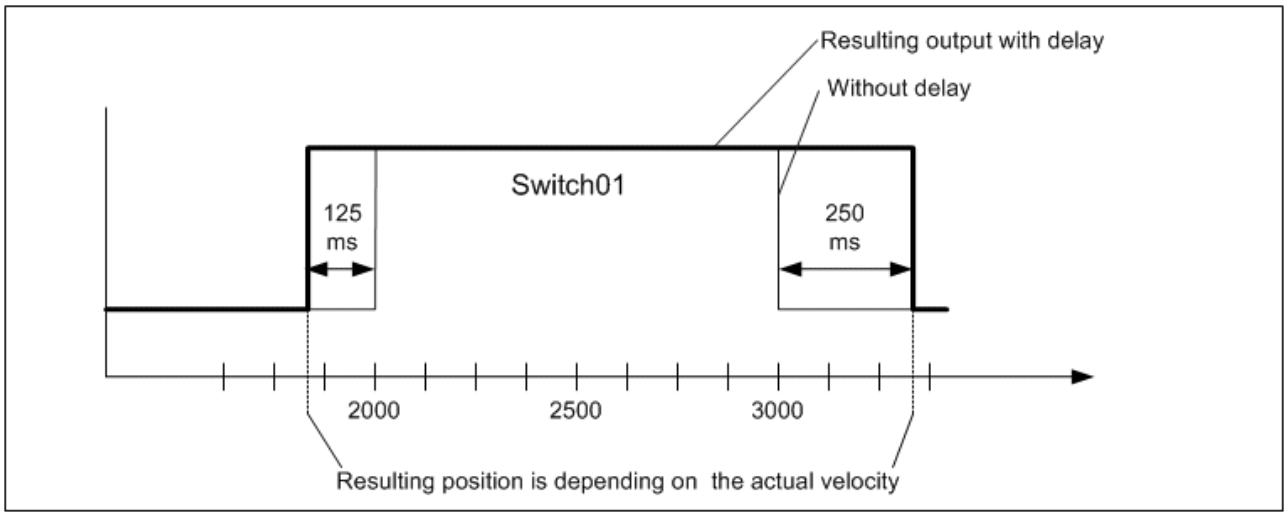
Inputs/outputs

```
VAR_IN_OUT
    Output : OUTPUT_REF [▶ 18];
    Axis   : AXIS_REF;
END_VAR
```

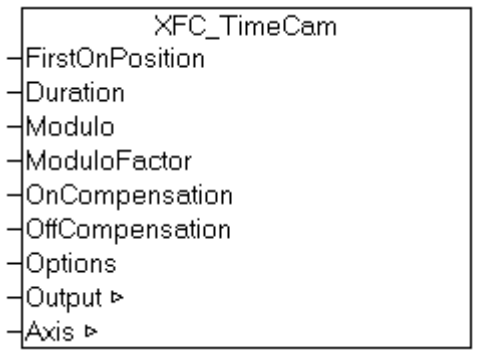
Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

Method of function of the time compensation



4.1.22 XFC_TimeCam



XFC_TimeCam realizes a time cam that activates a digital output depending on the position and switches it off after a certain time.

In contrast to the digital cam controller MC_DigitalCamSwitch [▶ 14], the function block switches precisely one cam on a digital output track. This facilitates parameterization of the block, although it cannot be used if several cams are required on an output track.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations. This information is used for the actual output at an XFC output terminal with a downstream function block (XFC_EL2252 or XFC_EL2262 [▶ 28]).

Inputs

```
VAR_INPUT
    FirstOnPosition : LREAL;
    Duration        : LREAL;
    Modulo          : BOOL;
    ModuloFactor    : LREAL := 360;
    OnCompensation  : LREAL;
    OffCompensation : LREAL;
    Options         : ST_CamSwitchOptions;
END_VAR
```

FirstOnPosition	First position from which the cam is switched on.	
Duration	Switch-on duration of the cam in [s].	
Modulo	If *Modulo* TRUE, all positions are interpreted as modulo. The cam function is repeated cyclically. The parameter *ModuloFactor* is used for calculating the modulo cycle.	
ModuloFactor	*ModuloFactor* indicates the length of a modulo cycle in the positioning unit of the axis and is only used if *Modulo* TRUE.	
OnCompensation	Compensation time for the rising edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed. The value OnCompensation parameterized here has priority over TRACK_REF [▶ 20]	
OffCompensation	Compensation time for the falling edge of the cam in [s]. For negative values of *OffCompensation* the switching time is brought forward, otherwise it is delayed. The value OffCompensation parameterized here has priority over TRACK_REF [▶ 20].	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
Options.	**UseAcceleration**	*UseAcceleration* can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

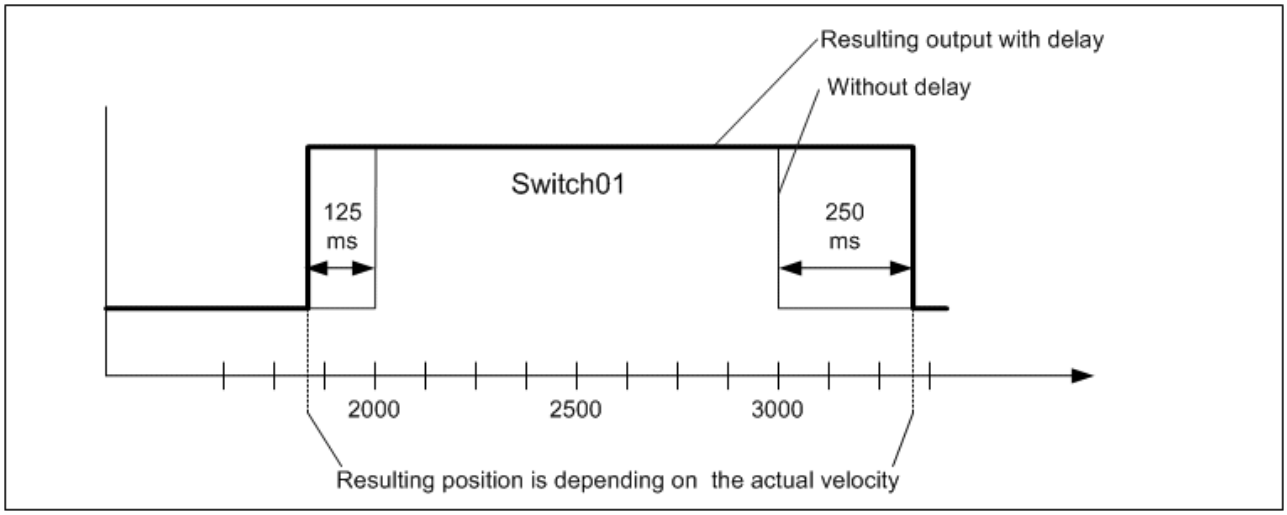
Inputs/outputs

```
VAR_IN_OUT
    Output : OUTPUT_REF [▶ 18];
    Axis   : AXIS_REF;
END_VAR
```

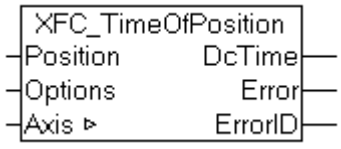
Output	The data structure *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal
Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

Method of function of the time compensation



4.1.23 XFC_TimeOfPosition



XFC_TimeOfPosition calculates the time at which the axis will be or was at a specified position.

The function extrapolates the time in relation to the current position and dynamics. Precise extrapolation is only possible over a short interval, since the axis dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the time it may also return an error. This error must be analyzed in order to ensure that the calculated time *DcTime* is valid.

Inputs

```
VAR_INPUT
    Position : LREAL;
    Options  : ST_NcTimeConversionOptions;
END_VAR
```

Position	Absolute axis position	
Options	Data structure with options for position extrapolation.	
Options.	SubIndex	For axes with more than one encoder the index (0..9) of the encoder to which the position refers can be specified in *SubIndex*.
Options.	InterpolationOptions	0: The position extrapolation is carried out with the current velocity, without taking into account the

		current acceleration. 1: The axis acceleration is included in the position extrapolation.
Options.	CompensationTime	additional compensation time

Outputs

```
VAR_OUTPUT
    DcTime  : T_DCTIME32;
    Error   : BOOL;
    ErrorID : UDINT;
END_VAR
```

DcTime	Distributed clock system time at which the *position* will be reached or was reached. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

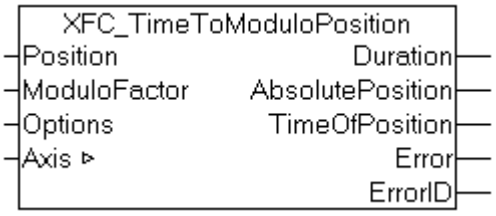
Inputs/outputs

```
VAR_IN_OUT
    Axis     : AXIS_REF;
END_VAR
```

Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.24 XFC_TimeToModuloPosition



XFC_TimeToModuloPosition calculates the time period within which an axis will reach a position, or the time that has elapsed since the axis passed this position. In this case the position is the nearest modulo position in the direction of travel.

The function extrapolates the time in relation to the current position and dynamics. Precise extrapolation is only possible over a short interval, since the axis dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the time it may also return an error. This error must be analyzed in order to ensure that the calculated time duration is valid.

Inputs

```
VAR_INPUT
    Position     : LREAL;
    ModuloFactor : LREAL;
    Options      : ST_NcTimeConversionOptions;
END_VAR
```

Position	Absolute axis position
ModuloFactor	Modulo divider to be used for the calculation. *ModuloFactor* can be identical to the modulo factor of the axis, e.g. 360. However, a factor deviating from that can also be used.

Options	Data structure with options for position extrapolation.	
Options.	SubIndex	For axes with more than one encoder the index (0..9) of the encoder to which the position refers can be specified in *SubIndex*.
Options.	InterpolationOptions	0: The position extrapolation is carried out with the current velocity, without taking into account the current acceleration. 1: The axis acceleration is included in the position extrapolation.
Options.	CompensationTime	additional compensation time

Outputs

```
VAR_OUTPUT
    Duration         : DINT;
    AbsolutePosition : LREAL;
    TimeOfPosition   : T_DCTIME32;
    Error            : BOOL;
    ErrorID          : UDINT;
END_VAR
```

Duration	Time duration in nanoseconds after which the position will be reached. Duration is a differential value from two variables of the type T_DCTIME32 Distributed Clock System Time.
AbsolutePosition	Absolute position (not modulo) corresponding to the modulo position and the determined time.
TimeOfPosition	Distributed clock system time at which the *Position* will be reached or was reached. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

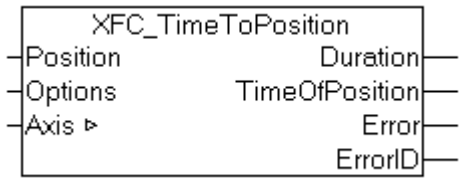
Inputs/outputs

```
VAR_IN_OUT
    Axis     : AXIS_REF;
END_VAR
```

Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.25 XFC_TimeToPosition



XFC_TimeToPosition calculates the time period within which an axis will reach a position, or the time that has elapsed since the axis passed this position.

The function extrapolates the time in relation to the current position and dynamics. Precise extrapolation is only possible over a short interval, since the axis dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the time it may also return an error. This error must be analyzed in order to ensure that the calculated time duration is valid.

Inputs

```
VAR_INPUT
    Position    : LREAL;
    Options     : ST_NcTimeConversionOptions;
END_VAR
```

Position	Absolute axis position	
Options	Data structure with options for position extrapolation.	
Options.	SubIndex	For axes with more than one encoder the index (0..9) of the encoder to which the position refers can be specified in *SubIndex*.
Options.	InterpolationOptions	0: The position extrapolation is carried out with the current velocity, without taking into account the current acceleration. 1: The axis acceleration is included in the position extrapolation.
Options.	CompensationTime	additional compensation time

Outputs

```
VAR_OUTPUT
    Duration       : DINT;
    TimeOfPosition : T_DCTIME32;
    Error          : BOOL;
    ErrorID        : UDINT;
END_VAR
```

Duration	Time duration in nanoseconds after which the position will be reached (> 0) or since the position was passed (< 0). Duration is a differential value from two variables of the type T_DCTIME32 Distributed Clock System Time.
TimeOfPosition	Distributed clock system time at which the *position* will be reached or was reached. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

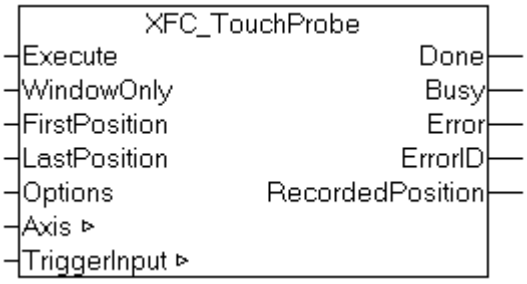
Inputs/outputs

```
VAR_IN_OUT
    Axis     : AXIS_REF;
END_VAR
```

Axis	Axis data structure

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.26 XFC_TouchProbe



The *XFC_TouchProbe* function block records an axis position at the time of the edge of a digital input signal (measuring probe function).

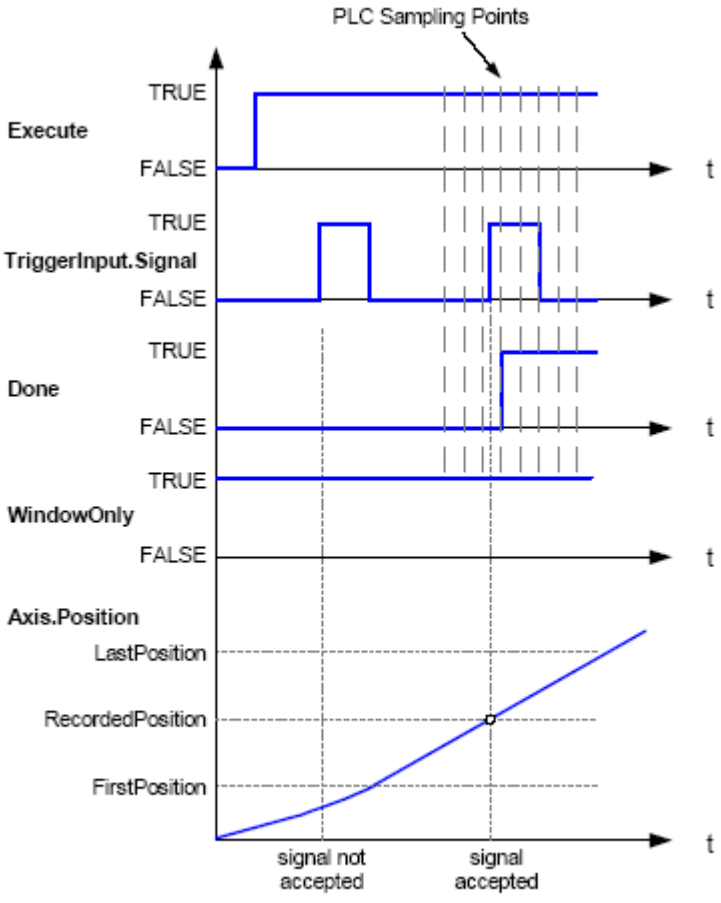
The digital input signal is recorded with an XFC input terminal (e.g. EL1252) with time stamps for the falling and rising signal edge. The function block determines the axis position at which the edge change occurred and issues it as *RecordedPosition*.

In contrast to the conventional TouchProbe function MC_TouchProbe the digital input is not directly linked to the drive hardware. The position of each EtherCAT or Sercos axis in the system can be recorded via the time stamp of the input. This axis is exactly synchronized via Dead time compensation [▶ 8].

The function block can be used in free-running or single-shot mode. In free-running mode each edge of the input signal is recorded (maximum one edge per PLC cycle). In single-shot mode the next edge is only recorded once until the function block is triggered again.

The optional window function can be used to ignore signal edges outside the defined position filter.

Signal curve



Timing example TouchProbe

Inputs

```
VAR_INPUT
    Execute       : BOOL;
    WindowOnly    : BOOL;
    FirstPosition : LREAL;
    LastPosition  : LREAL;
    Options       : ST_XfcTouchProbeOptions;
END_VAR
```

Execute	If *Execute* is active, the axis position is recorded at the defined signal edge of the input signal. A falling edge at *Execute* terminates the process immediately. Depending on the configuration in *TriggerInput.FreeRun* the next signal edge is recorded and evaluated once. If FreeRun is TRUE, a new position value is recorded continuously with each defined edge of the input signal, while *Execute* remains TRUE.	
WindowOnly	If this option is active, only one position inside the window between *FirstPosition* and LastPosition is recorded. Positions outside the window are discarded. Only if the recorded position lies inside the window does *Done* become TRUE. The recording window can be interpreted in terms of absolute or modulo values. In this connection the flag ModuloPositions [▶ 42] in the structure TriggerInput [▶ 42] is to be set accordingly. In the case of absolute value positions there is exactly one window. In the case of modulo value positions the window repeats itself within the modulo cycle defined in the axis parameters (e.g. 0 to 360 degrees).	
FirstPosition	Initial position of the recording window, if WindowOnly is TRUE. This position can be interpreted as an absolute or modulo value. In this connection the flag ModuloPositions [▶ 42] is to be set appropriately in the structure *TriggerInput* (see below).	
LastPosition	Final position of the recording window, if *WindowOnly* is TRUE. This position can be interpreted as an absolute or modulo value. In this connection the flag ModuloPositions [▶ 42] is to be set appropriately in the structure *TriggerInput* (see below).	
Options	Optional parameters	
Options.	**UseAcceleration**	*UseAcceleration* can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

Outputs

```
VAR_OUTPUT
    Done             : BOOL;
    Busy             : BOOL;
    Error            : BOOL;
    ErrorID          : UDINT;
    RecordedPosition : LREAL;
END_VAR
```

Done	The value *RecordedPosition* is valid. If *TriggerInput.FreeRun* is TRUE, *Done* only remains TRUE only for one PLC cycle and is then reset automatically, since *TouchProbe* is automatically reactivated.

Busy	Becomes TRUE as soon as the function block is active, and becomes FALSE when it has returned to its initial state. If *TriggerInput.FreeRun* is TRUE, *Busy* remains TRUE continuously, even if *Done* or *Error* become TRUE, since *TouchProbe* is automatically reactivated.
Error	Becomes TRUE, as soon as an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number
RecordedPosition	Axis position recorded at the point in time of the trigger signal. If *TriggerInput.FreeRun* is TRUE, the function block operates in free-running mode, so that each valid change in the input signal leads to a new *RecordedPosition*. The position can be analyzed, if *Done* becomes TRUE.

Inputs/outputs

```
VAR_IN_OUT
    Axis         : AXIS_REF;
    TriggerInput : XFC_TRIGGER_REF [▶ 42];
END_VAR
```

Axis	Axis data structure
TriggerInput	TriggerInput [▶ 42] is a data structure for describing the trigger source and for feeding the state and time stamp of a digital input signal. This data structure is filled by the user.

The axis data structure of type AXIS_REF addresses an axis uniquely within the system. Among other parameters it contains the current axis status, including position, velocity or error status.

4.1.27 XFC_TRIGGER_REF

The data type *XFC_TRIGGER_REF* contains the state and parameters of a digital input that is used for the function XFC_TouchProbe [▶ 40].

```
TYPE XFC_TRIGGER_REF :
STRUCT
    Signal               : BOOL;
    TimestampRisingEdge  : T_DCTIME32;
    TimestampFallingEdge : T_DCTIME32;
    Edge                 : E_SignalEdge;
    FreeRun              : BOOL;
    EncoderIndex         : UINT;
    ModuloPositions      : BOOL;
    ModuloFactor         : LREAL := 360.0;
END_STRUCT
END_TYPE
```

Signal	Current state of the digital input signal. The current state must be supplied here.
TimestampRisingEdge	Time stamp of the last rising edge of the digital input signal. Only the time stamp of the edge defined via *Edge* has to be supplied. If the input signal supplies a 64-bit time stamp *T_DCTIME*, only the lower 32 bits are supplied. It is therefore important to ensure that the value at the time of the evaluation is not older than 2 seconds.
TimestampFallingEdge	Time stamp of the last falling edge of the digital input signal. Only the time stamp of the edge defined via *Edge* has to be supplied. If the input signal supplies a 64-bit time stamp *T_DCTIME*, only the lower 32 bits are supplied. It is therefore important to ensure that the value at the time of the evaluation is not older than 2 seconds.
Edge	*Edge* defines the signal edge to be used for the evaluation of the axis position. TYPE E_SignalEdge : (RisingEdge, FallingEdge); END_TYPE

FreeRun	If *FreeRun* is TRUE, the input is latched continuously. In this case the input *Execute* must remain TRUE in function block XFC_TouchProbe [▶ 40]. No edge at Execute is required in order to record the next new position value.
EncoderIndex	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
ModuloPositions	If *Modulo* TRUE, all positions are interpreted as modulo. The parameter *ModuloFactor* is used for calculating the modulo cycle.
ModuloFactor	*ModuloFactor* indicates the length of a modulo cycle in the positioning unit of the axis and is only used if *Modulo* TRUE.

4.2 TcNci_XFC

4.2.1 MC_PathCamSwitch

The data type *MC_PathCamSwitch* contains all parameters of a digital cam for a digital cam controller *MC_PathDigitalCamSwitch_MultiEdge*.

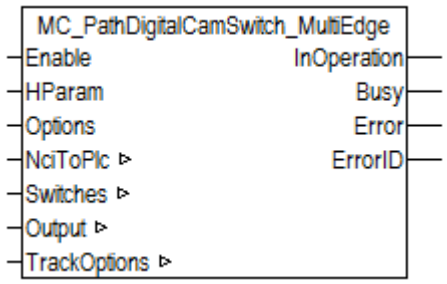
```
TYPE MC_PathCamSwitch :
STRUCT
    FirstOnPosition : LREAL;
    LastOnPosition  : LREAL;
    FirstPathId     : UDINT;
    LastPathId      : UDINT;
    CamSwitchMode   : E_CamSwitchMode;
    Duration        : LREAL;
END_STRUCT
END_TYPE
```

The data structure for parameterization of a digital cam controller is usually an ARRAY OF MC_PathCamSwitch. A further structure PATH_CAMSWITCH_REF [▶ 45] refers to this structure.

FirstOnPosition	First position from which the cam is switched on.
LastOnPosition	Last position up to which the cam is switched on. The cam function is inverted, if *LastOnPosition* < *FirstOnPosition. LastOnPosition* is not used for time cams.
FirstPathId	Unique ID that continually increases over the path and belongs to the relative path until the cam switches on.
LastPathId	Unique ID that continually increases over the path and belongs to the relative path until the cam switches off.
CamSwitchMode	Digital cam type (position cam, time cam or brake cam).
Duration	*Duration* defines the switch-on time of the cam in [s] and is only used for time cams.

```
TYPE E_CamSwitchMode :
(
    CAMSWITCHMODE_POSITION, (* position cam *)
    CAMSWITCHMODE_TIME,     (* time cam *)
    CAMSWITCHMODE_BREAK     (* break cam *)
);
END_TYPE
```

4.2.2 MC_PathDigitalCamSwitch_MultiEdge



MC_PathDigitalCamSwitch_MultiEdge is a digital cam controller with one or several cams on a digital output track. The function block is capable of performing several switching operations during a PLC cycle. The switching operations are defined by position cams. Further output tracks can be realized with independent instances of the function block.

In addition to the switching states of the digital output the output data structure contains precise time information for the next switching operations. With this information the actual output can take place on an XFC multi-timestamp output terminal with a downstream function block (XFC_EL1259_MultiEdge, XFC_EL2212_MultiEdge, XFC_EL2262_MultiEdge or XFC_EL2258_MultiEdge).

Note Time cams and brake cams cannot be used with the function block MC_PathDigitalCamSwitch_MultiEdge. Terminals without multi-timestamp functionality are not suitable for use with this function block.

Inputs

```
VAR_INPUT
    Enable  : BOOL;
    HParam  : DINT;
    Options : ST_CamSwitchOptions;
END_VAR
```

Enable	The cam controller is activated via the *Enable* input. The initial state remains unchanged, as long as *Enable=FALSE*.	
HParam	H-parameter value that corresponds to the switching state TRUE.	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here. The first encoder has the index 0.
Options.	**UseAcceleration**	UseAcceleration can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

Outputs

```
VAR_OUTPUT
    InOperation : BOOL;
    Busy        : BOOL;
    Error       : BOOL;
    ErrorID     : UDINT;
END_VAR
```

InOperation	InOperation is TRUE, as long as the cam controller is active and the cam track is calculated according to the cam parameterization.
Busy	Busy is TRUE as long as the block function is not completed.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

Inputs/outputs

```
VAR_IN_OUT
    NciToPlc      : NciChannelToPlc
    Switches      : PATH_CAMSWITCH_REF;
    Output        : OUTPUT_REF_MULTIEDGE [▶ 18];
    TrackOptions  : TRACK_REF [▶ 20];
END_VAR
```

NciToPlc	The structure of the cyclic channel interface from the NCI to the PLC. This structure is only accessed for reading.
Switches	The data structure *Switches* contains a reference to the parameterization of all cams on the cam track.
Output	The data structure *Output* contains the calculated states of the digital output and the associated time stamps for the output at a digital XFC output terminal.
TrackOptions	The data structure *TrackOptions* contains the parameterization for the cam track.

4.2.3 PATH_CAMSWITCH_REF

The data type *PATH_CAMSWITCH_REF* refers to a data structure with cam parameters for a digital cam controller *MC_PathDigitalCamSwitch_MultiEdge*.

```
TYPE PATH_CAMSWITCH_REF :
STRUCT
    NumberOfSwitches : UDINT;
    pSwitches        : POINTER TO MC_PathCamSwitch;
    SizeOfSwitches   : UDINT;
END_STRUCT
END_TYPE
```

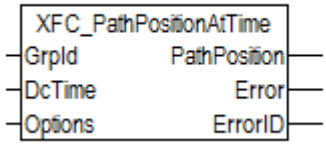
The actual data structure for parameterization of a digital cam controller is usually an ARRAY OF MC_PathCamSwitch [▶ 43]. PATH_CAMSWITCH_REF refers to this structure via a POINTER and clearly defines the size of the structure and the number of cams that were actually used.

A variable of type PATH_CAMSWITCH_REF is initialized as illustrated in the following example:

```
VAR
    CamSwitchArray   : ARRAY[1..3] OF MC_PathCamSwitch;
    CamSwitchRef     : PATH_CAMSWITCH_REF;
END_VAR

(* real number of defined digital cams *)
CamSwitchRef.NumberOfSwitches := 1; (* 1..3 *)
(* pointer to the digital cam data array *)
CamSwitchRef.pSwitches        := ADR(CamSwitchArray);
(* maximum size of the digital cam data array *)
CamSwitchRef.SizeOfSwitches   := SIZEOF(CamSwitchArray);
```

4.2.4 XFC_PathPositionAtTime



XFC_PathPositionAtTime calculates a relative path distance at a given time in relation to the current path position.

The function extrapolates the path distance in relation to the current dynamics. Precise extrapolation is only possible over a short interval, since the group dynamics may change.

The function block requires precisely one call in order to provide the result. Therefore it can be used in a similar way to a function, but may return an error in addition to the relative path distance. This error must be evaluated to ensure that the calculated path distance is valid.

Inputs

```
VAR_INPUT
    GrpId   : UDINT;
    DcTime  : T_DCTIME32;
    Options : ST_NcTimeConversionOptions;
END_VAR
```

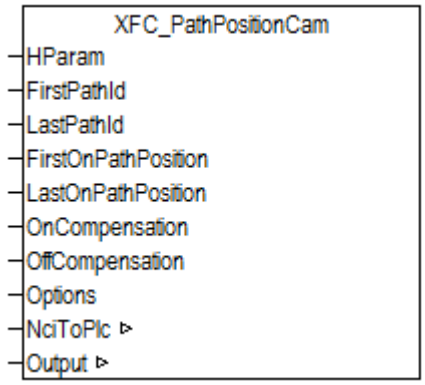
GrpId	Group ID of the Nci group. This clearly identifies the requested Nci group in the system.	
DcTime	Distributed clock system time. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time. In order to optimize the calculation of the path value, the time should be close to the current time, i.e. only a few PLC or NC cycles in the future or the past.	
Options	Data structure with options for the extrapolation of the relative path.	
Options.	SubIndex	not implemented
Options.	InterpolationOptions	0: The extrapolation of the relative path is carried out at the current path velocity without taking into account the current path acceleration. 1: The path acceleration of the axis is incorporated into the extrapolation of the relative path.
Options.	CompensationTime	additional compensation time.

Outputs

```
VAR_OUTPUT
    PathPosition : LREAL;
    Error        : BOOL;
    ErrorID      : UDINT;
END_VAR
```

PathPosition	Extrapolated relative path up to the preset time *DcTime*.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

4.2.5 XFC_PathPositionCam



XFC_PathPositionCam realizes a path cam that switches a digital output on and off depending on the path.

In contrast to the digital cam controller MC_PathDigitalCamSwitch_MultiEdge [▶ 44], the function block switches precisely one cam on a digital output track. This facilitates parameterization of the block, although it cannot be used if several cams are required on an output track.

In addition to the switching state of the digital output the output data structure contains precise time information for the next switching operations.

This information is used for the actual output at an XFC output terminal with a downstream function block (XFC_EL2252 or XFC_EL2262 [▶ 28]).

Inputs

```
VAR_INPUT
    HParam              : UDINT;
    FirstPathId         : UDINT;
    LastPathId          : UDINT;
    FirstOnPathPosition : LREAL;
    LastOnPathPosition  : LREAL;
    OnCompensation      : LREAL;
    OffCompensation     : LREAL;
    Options             : ST_CamSwitchOptions;
END_VAR
```

HParam	H_parameter value that corresponds to the switching state.	
FirstPathId	Unique ID that continually increases over the path and belongs to the relative path until the cam switches on.	
LastPathId	Unique ID that continually increases over the path and belongs to the relative path until the cam switches off.	
FirstOnPathPosition	Relative path until the cam switches on.	
LastOnPathPosition	Relative path until the cam switches off.	
OnCompensation	Compensation time for the rising edge of the cam in [s]. For negative values of *OnCompensation* the switching time is brought forward, otherwise it is delayed. The value OnCompensation parameterized here has priority over TRACK_REF	
OffCompensation	Compensation time for the falling edge of the cam in [s]. For negative values of *OffCompensation* the switching time is brought forward, otherwise it is delayed. The value OffCompensation parameterized here has priority over TRACK_REF	
Options	Optional parameters	
Options.	**EncoderIndex**	If more than one encoder is connected to the axis, the encoder index [0 – 9] can be defined here.

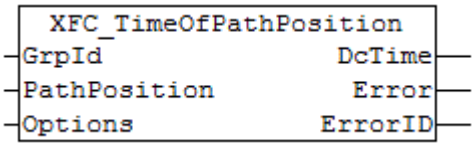
		The first encoder has the index 0.
Options.	**UseAcceleration**	UseAcceleration can be set to TRUE in order to incorporate the acceleration of the axis into the position calculation. *UseAcceleration* can be advantageous if the setpoint values of the acceleration can be used. *UseAcceleration* may be disadvantageous with encoder axes that supply a noisy position signal, because the acceleration is also erroneous.

Inputs/outputs

```
VAR_IN_OUT
    NciToPlc : NciChannelToPlc;
    Output   : OUTPUT_REF;
END_VAR
```

NciToPlc	The structure of the cyclic channel interface from the NCI to the PLC. This structure is only accessed for reading
Output	The data structure [▶ 18] *Output* contains the calculated state of the digital output and the associated time stamp for the output at a digital XFC output terminal

4.2.6 XFC_TimeOfPathPosition



XFC_TimeOfPathPosition calculates the time at which an Nci group has travelled or will have travelled a preset relative path.

The function extrapolates the time in relation to the current path position and dynamics. Precise extrapolation is only possible over a short interval, since the Nci group dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the time it may also return an error. This error must be analyzed in order to ensure that the calculated time *DcTime* is valid.

Inputs

```
VAR_INPUT
    GrpId        : UDINT;
    PathPosition : LREAL;
    Options      : ST_NcTimeConversionOptions;
END_VAR
```

GrpId	Group ID of the Nci group. This clearly identifies the requested Nci group in the system.	
PathPosition	Relative path	
Options	Data structure with options for the extrapolation of the relative path.	
Options.	SubIndex	not implemented
Options.	InterpolationOptions	0: The extrapolation of the relative path is carried out at the current path velocity without taking into account the current path acceleration.

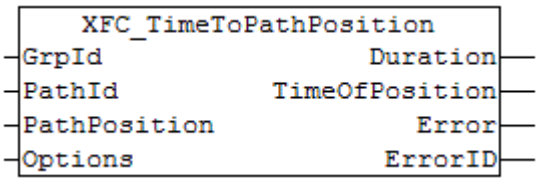
		1: The path acceleration of the axis is incorporated into the extrapolation of the relative path.
Options.	CompensationTime	additional compensation time

Outputs

```
VAR_OUTPUT
    DcTime  : T_DCTIME32;
    Error   : BOOL;
    ErrorID : UDINT;
END_VAR
```

DcTime	Distributed clock system time at which the relative path *PathPosition* will have been travelled or at which this was passed. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

4.2.7 XFC_TimeToPathPosition



XFC_TimeToPathPosition calculates the time period within which an Nci group has travelled a relative path or which has elapsed since then.

The function extrapolates the time in relation to the current path position and dynamics. Precise extrapolation is only possible over a short interval, since the group dynamics may change.

The function block requires precisely one call in order to provide the result. It can therefore be used similar to a function, although as well as the time it may also return an error. This error must be analyzed in order to ensure that the calculated time duration is valid.

Inputs

```
VAR_INPUT
    GrpId        : UDINT;
    PathId       : UDINT;
    PathPosition : LREAL;
    Options      : ST_NcTimeConversionOptions;
END_VAR
```

GrpId	Group ID of the Nci group. This clearly identifies the requested Nci group in the system.	
PathId	Unique ID that continually increases over the path course and belongs to the relative path.	
PathPosition	Relative path	
Options	Data structure with options for the extrapolation of the relative path.	
Options.	SubIndex	not implemented
Options.	InterpolationOptions	0: The extrapolation of the relative path is carried out at the current path velocity without taking into account the current path acceleration. 1: The path acceleration of the axis is incorporated into the extrapolation of the relative path.

Options.	CompensationTime	additional compensation time.

Outputs

```
VAR_OUTPUT
    Duration       : DINT;
    TimeOfPosition : T_DCTIME32;
    Error          : BOOL;
    ErrorID        : UDINT;
END_VAR
```

Duration	Time period in nanoseconds after which the relative path will have been travelled (>0) or which has elapsed since then (<0). Duration is a differential value from two variables of the type T_DCTIME32
TimeOfPosition	Distributed clock system time at which the relative path distance was or will have been be travelled. *DcTime* contains the lower 32 bits of the complete *DcTime* and covers a time range of +/- 2 seconds around the current time.
Error	Becomes TRUE if an error occurs.
ErrorID	If the error output is set, this parameter supplies the error number

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