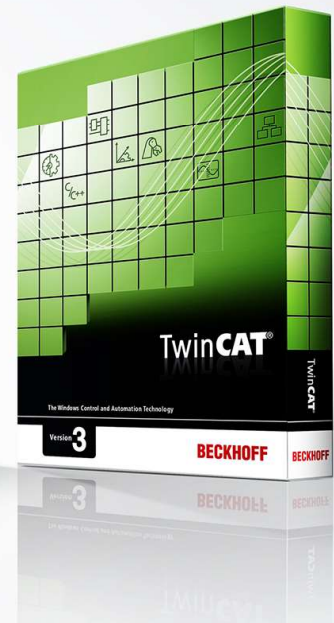
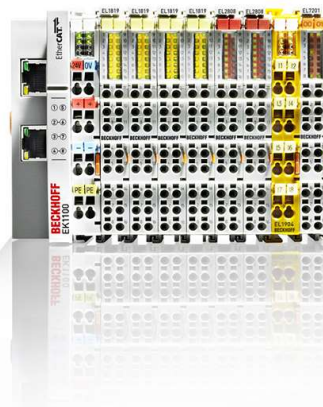


TwinCAT NC Fundamentals

BECKHOFF

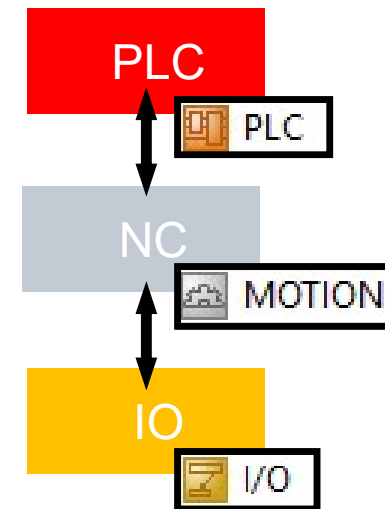
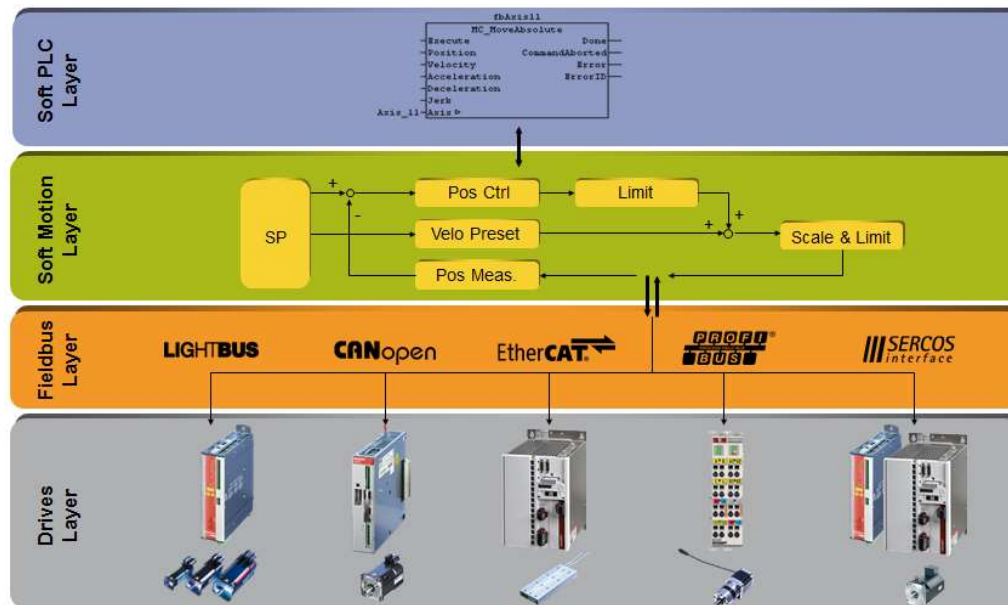


- **Overview**
- Components
- Axis Details

TwinCAT NC is the Software Motion Controller

BECKHOFF

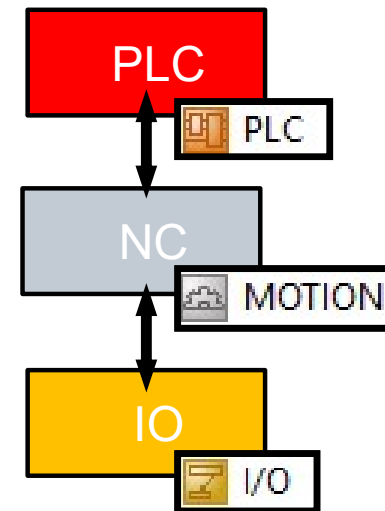
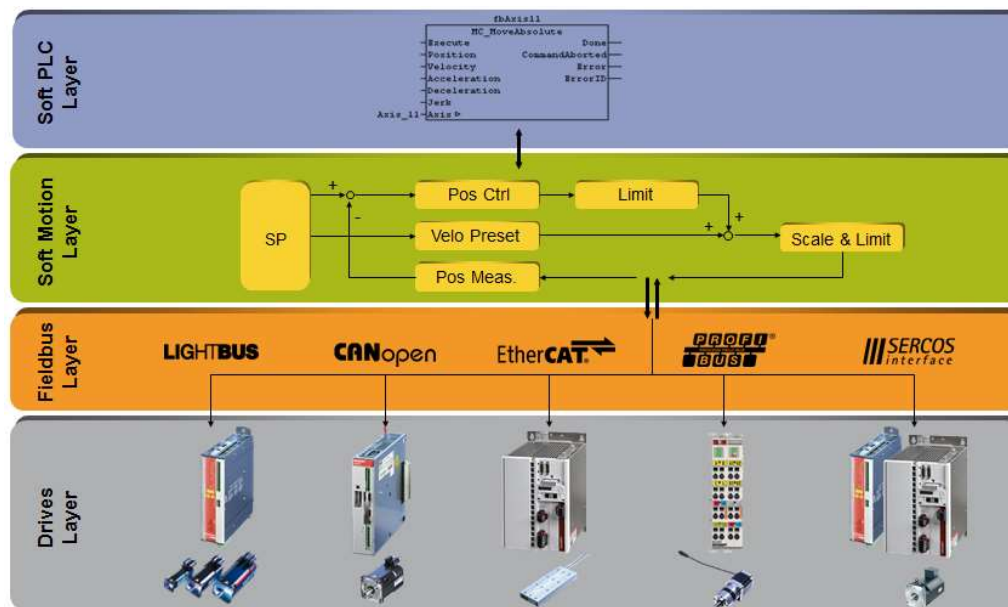
- Typical NC(Numerical Control) Configuration:
 - Receives commands from PLC Functions Blocks
 - Exchanges Data with fieldbus
 - Generates setpoint values for drive
 - Reads feedback from drive



TwinCAT NC is Modular, Flexible

BECKHOFF

- Component independence(PLC, NC, IO) means:
 - Fieldbus, drive changes easy
 - PLC code changes easy
- TwinCAT easy to reconfigure, future proof



NC has Wide Ranging Capability

BECKHOFF

- TwinCAT NC can:
 - Control up to 255 axis
 - Support many drive, motor types:
 - Servo(rotary, linear)
 - Stepper
 - Analog
 - Hydraulic
 - DC motor
 - Simulation
 - Update at 50 μ s
(1ms cycle time typical)



NC Capable of Expanded Functionality

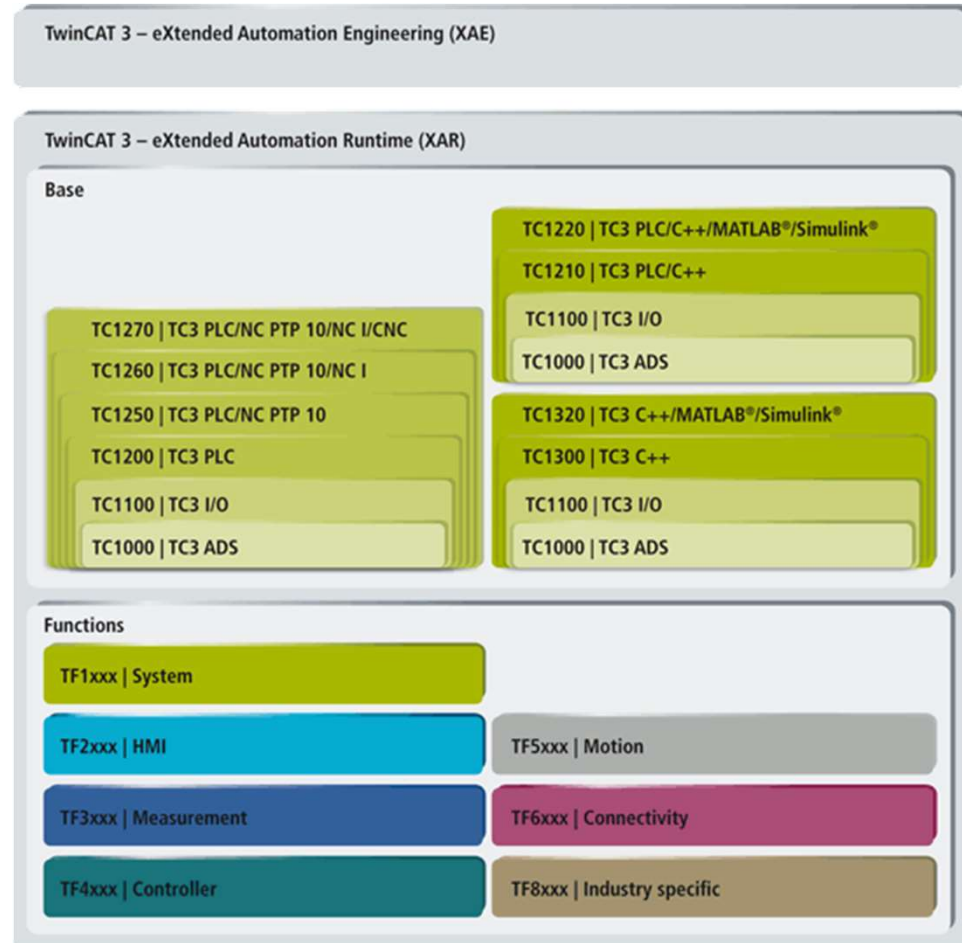
BECKHOFF

- Base Includes:

- Point to Point(PTP)
- Interpolation(NCI)
- Advanced Interpolation(CNC)

- Functions Include:

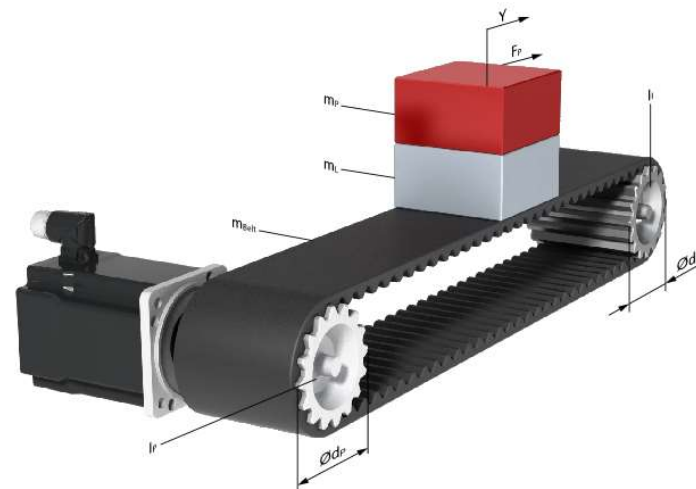
- Coupling in Motion
- Camming
- Kinematics
- XFC Motion



- Base Includes:
 - **Point to Point(PTP)**
 - Interpolation(NCI)
 - Advanced Interpolation(CNC)
- Functions Include:
 - Coupling in Motion
 - Camming
 - Kinematics
 - XFC Motion

PTP Allows for:

- Easy programming of 1D movements (relative, absolute, homing, stop)
- Coupling a slave axis to a master with a set gear ratio.



- Base Includes:
 - Point to Point(PTP)
 - **Interpolation(NCI)**
 - Advanced Interpolation(CNC)
- Functions Include:
 - Coupling in Motion
 - Camming
 - Kinematics
 - XFC Motion

NCI Allows for:

- Individual axis in a group to start and end motion at the same time
- 2D or 3D linear or non-linear moves specified with G-Code or PLC function blocks(3 Path Axes)



NC CNC Moves Groups of Axis with Added Capability

BECKHOFF

- Base Includes:

- Point to Point(PTP)
- Interpolation(NCI)
- **Advanced Interpolation(CNC)**

- Functions Include:

- Coupling in Motion
- Camming
- Kinematics
- XFC Motion

CNC Allows for:

- Advanced interpolation behavior (High Speed Cutting, Taping, Spline Interpolation, and Spindle Synchronization)
- 8 path axis(or more) to specify complex move geometries



- Base Includes:
 - Point to Point(PTP)
 - Interpolation(NCI)
 - Advanced Interpolation(CNC)
- Functions Include:
 - **Coupling in Motion**
 - Camming
 - Kinematics
 - XFC Motion

Flying Saw Allows for:

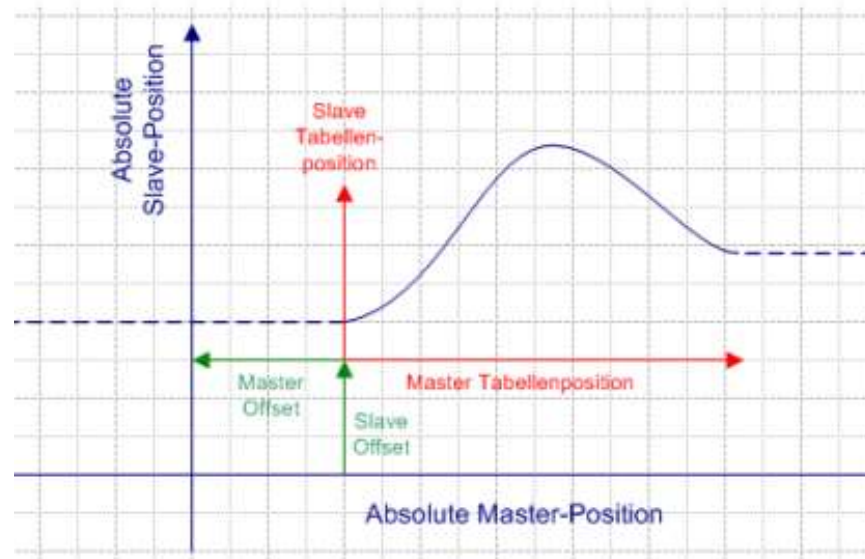
- One axis to couple to another moving axis based on velocity OR position and velocity



- Base Includes:
 - Point to Point(PTP)
 - Interpolation(NCI)
 - Advanced Interpolation(CNC)
- Functions Include:
 - Coupling in Motion
 - **Camming**
 - Kinematics
 - XFC Motion

Camming Allows for:

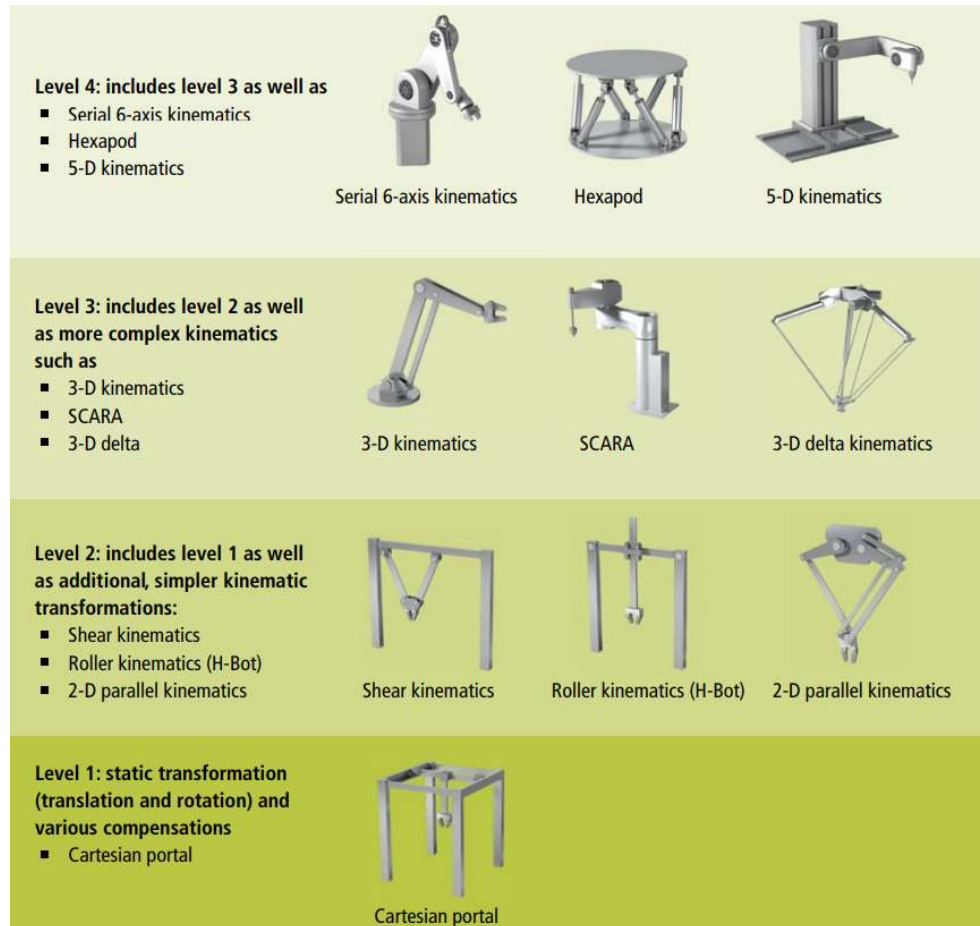
- Complex non-linear master slave relationships based on:
 - Position Tables
 - Motion Functions Tables



NC Capable of Expanded Functionality

BECKHOFF

- Base Includes:
 - Point to Point(PTP)
 - Interpolation(NCI)
 - Advanced Interpolation(CNC)
- Functions Include:
 - Coupling in Motion
 - Camming
 - **Kinematics**
 - XFC Motion



Click figure for hyperlink

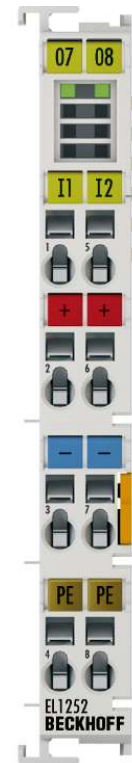
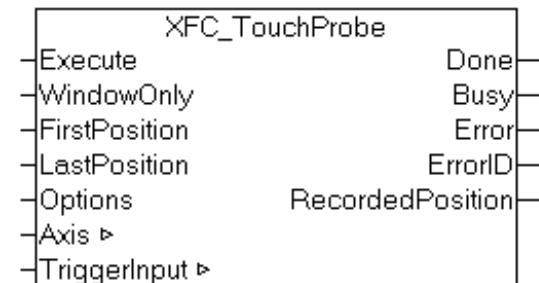
NC Capable of Expanded Functionality

BECKHOFF

- Base Includes:
 - Point to Point(PTP)
 - Interpolation(NCI)
 - Advanced Interpolation(CNC)
- Functions Include:
 - Coupling in Motion
 - Camming
 - Kinematics
 - **XFC Motion**

XFC Motion Allows for:

- Precise motor position recording using XFC terminal
- Precise output switching based on motor position

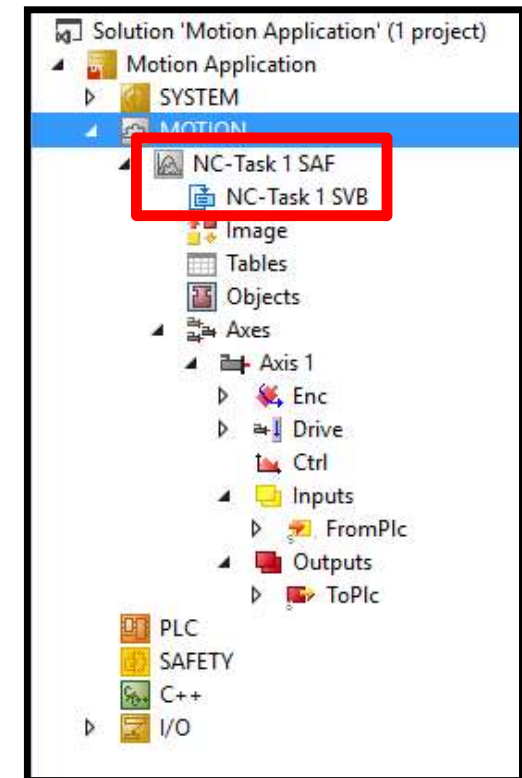


- Overview
- **Components**
- Axis Details

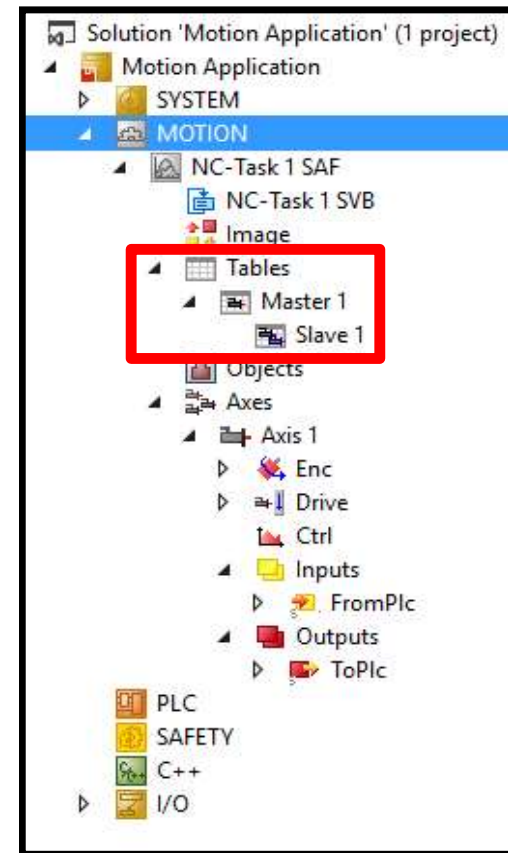
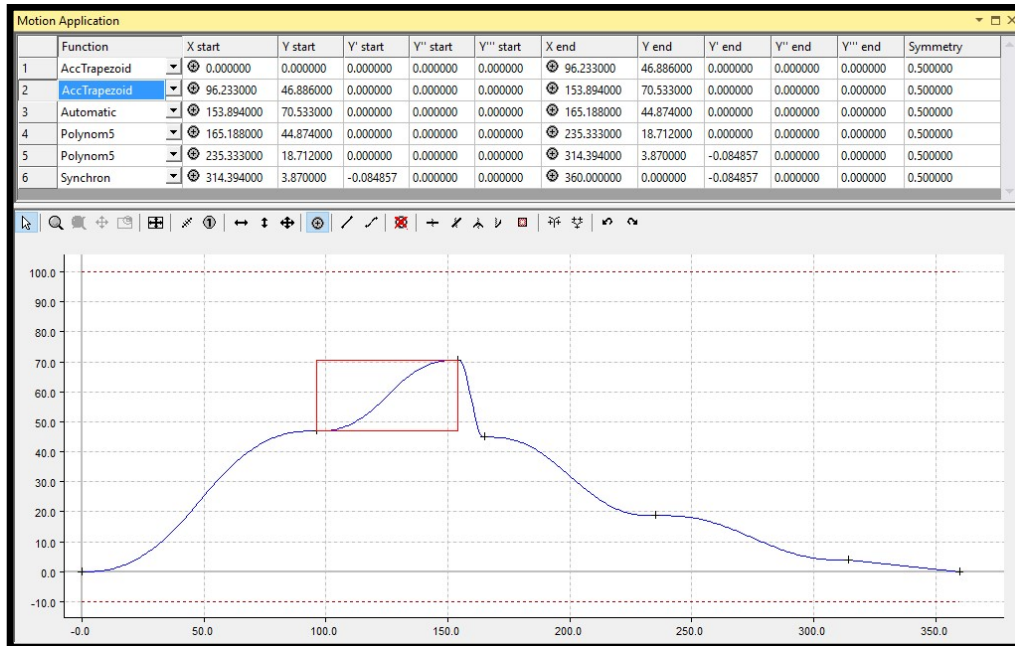
Motion Section has Many Components

BECKHOFF

- **SAF** is the '**Block Execution**' Task
 - Task Updates Drive Data
 - Feedback Data Obtained
 - Command Values Sent
 - Rate based on:
 - Motion requirements
 - Capability of Drive/Mechanics
- **SVB** is the '**Block Preparation**' Task
 - It generates SAF setpoints for higher level NC capability
 - PTP: No functionality
 - NCI: Interprets G-Code



- **Tables** are **cam tables** used for non-linear master slave coupling
 - Tables can be created, tested free
 - Saving changes requires TE1510



Axis Information Found Under Axes

BECKHOFF

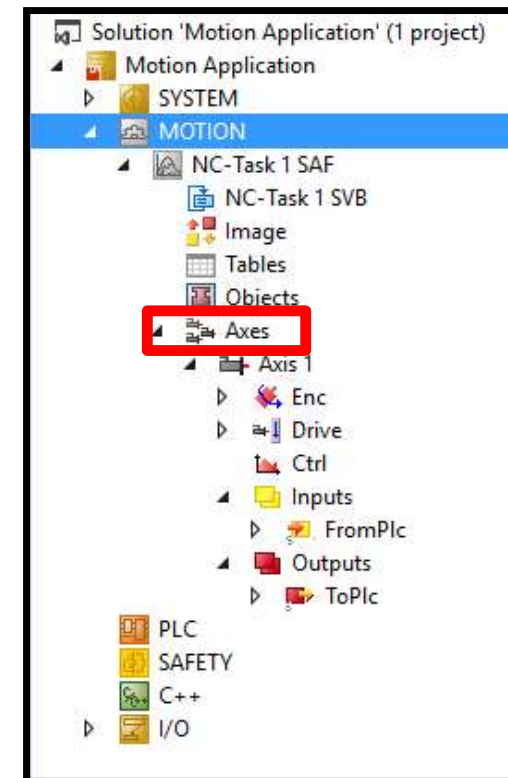
- **Axes** groups each **axis** below for:
 - NC errors and reset capability
 - Manual move options
 - Position and velocity values

Online

Name	Actual Pos.	Setp. Pos.	Lag Dist.	Setp. Velo	Error
X	0.0000	0.0000	0.0000	0.0000	0x0
Y	0.0000	0.0000	0.0000	0.0000	0x0
Z	0.0000	0.0000	0.0000	0.0000	0x0
Gripper	0.0000	0.0000	0.0000	0.0000	0x0
Theta	0.0000	0.0000	0.0000	0.0000	0x0

--- F1 - F2 + F3 ++ F4 Ⓜ F8 Select Columns

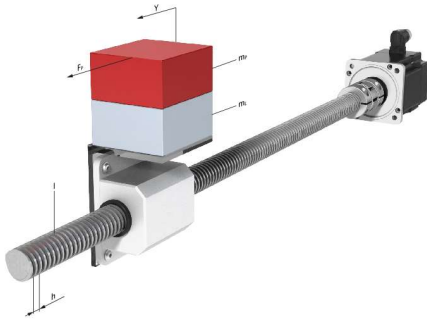
Number	Axes	Link to I/O	Link to PLC	Type
1 (Id 1)	X			Stand
2 (Id 2)	Y			Stand
3 (Id 3)	Z			Stand
4 (Id 4)	Gripper			Stand
5 (Id 5)	Theta			Stand



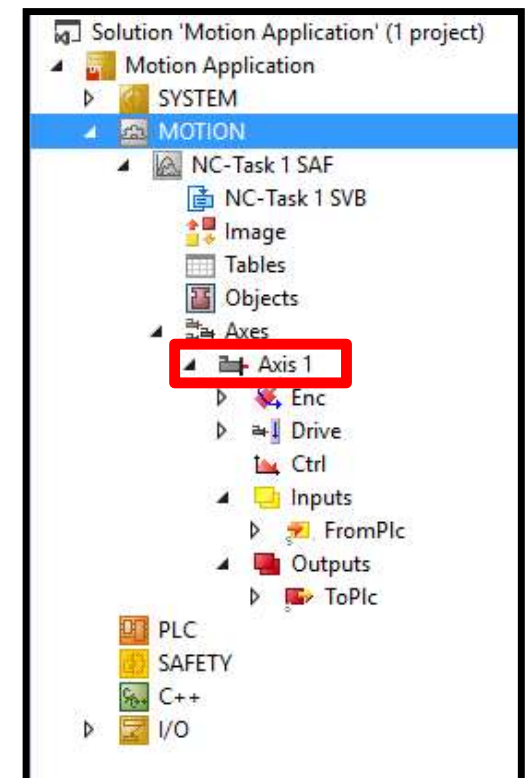
Axis Information Found Under Axes

BECKHOFF

- An **Axis** represents a mechanical system from mover to load
 - Example: Motor, coupling, ball screw, carriage, and load



- Up to 255 axes may be controlled:
 - iPC resource dependent
 - License required

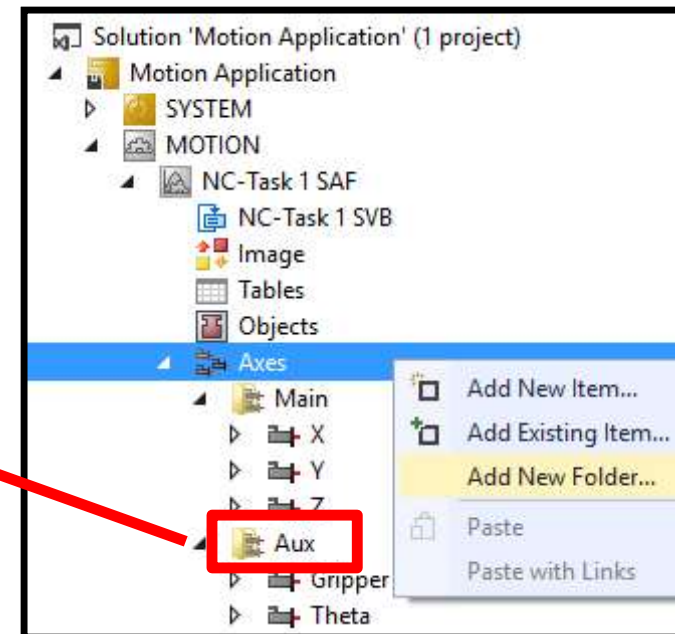


Folders Can Be Created to Group Axes

BECKHOFF

- For larger machines, **folders** can organize axes together
- Select folders to see axis information

Motion Application				
Number	Axes	Link to I/O	Link to PLC	Type
1 (Id 4)	Gripper			Standard
2 (Id 5)	Theta			Standard

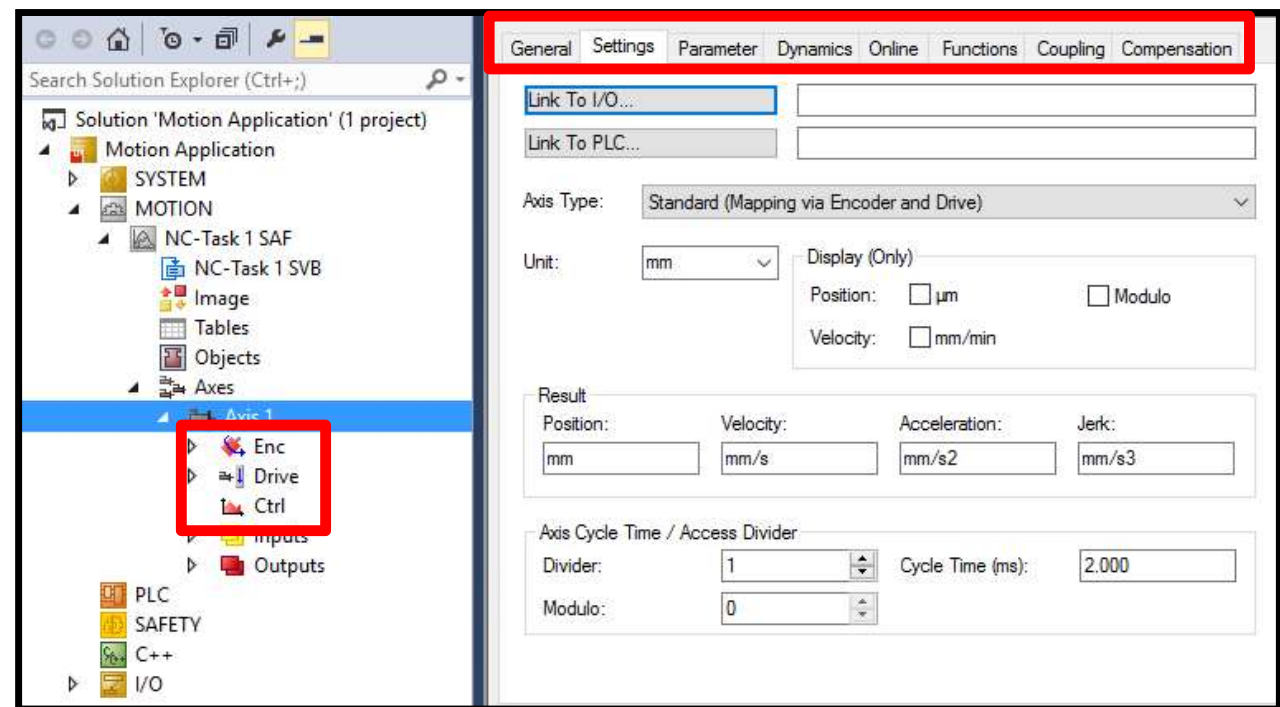


- Overview
- Components
- **Axis Details:**
 - **Main Tabs**
 - Subcomponents

Axis Interfaced through Tabs, Components

BECKHOFF

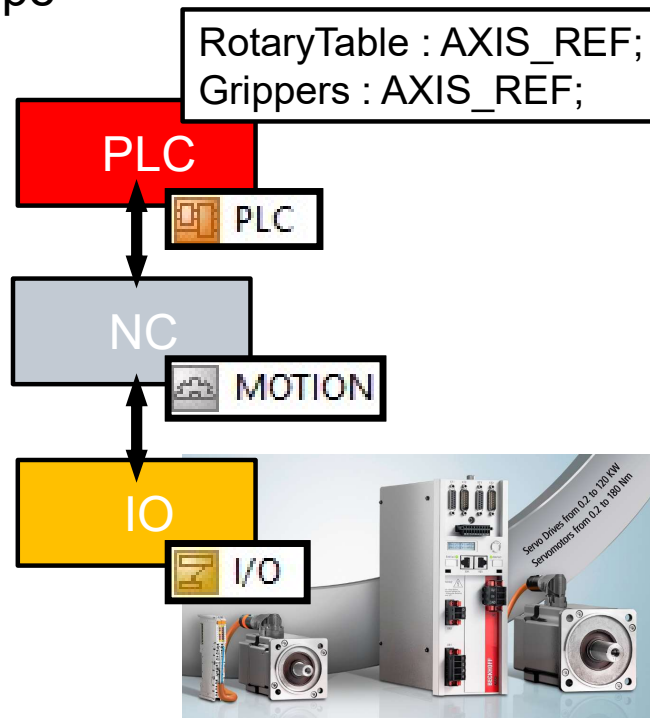
- Axis is Configured and Controlled with:
 - Tabs
 - Subcomponents



Settings Tab Links Axis

BECKHOFF

- Axis Connections Made with Link Buttons to:
 - Drive
 - PLC Data Type



General Settings Parameter Dynamics Online Functions Coupling Compensation

Link To I/O...

Link To PLC...

Axis Type: Standard (Mapping via Encoder and Drive) ▼

Unit: mm ▼ Display (Only)

Position: ☐ μm ☐ Modulo

Velocity: ☐ mm/min

Result

Position: mm Velocity: mm/s Acceleration: mm/s² Jerk: mm/s³

Axis Cycle Time / Access Divider

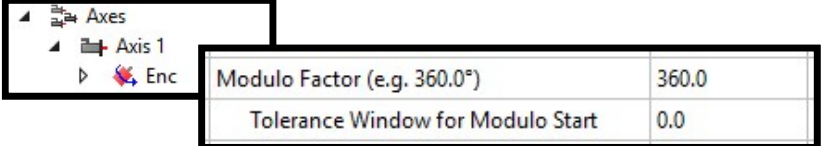
Divider: 1 Cycle Time (ms): 2.000

Modulo: 0

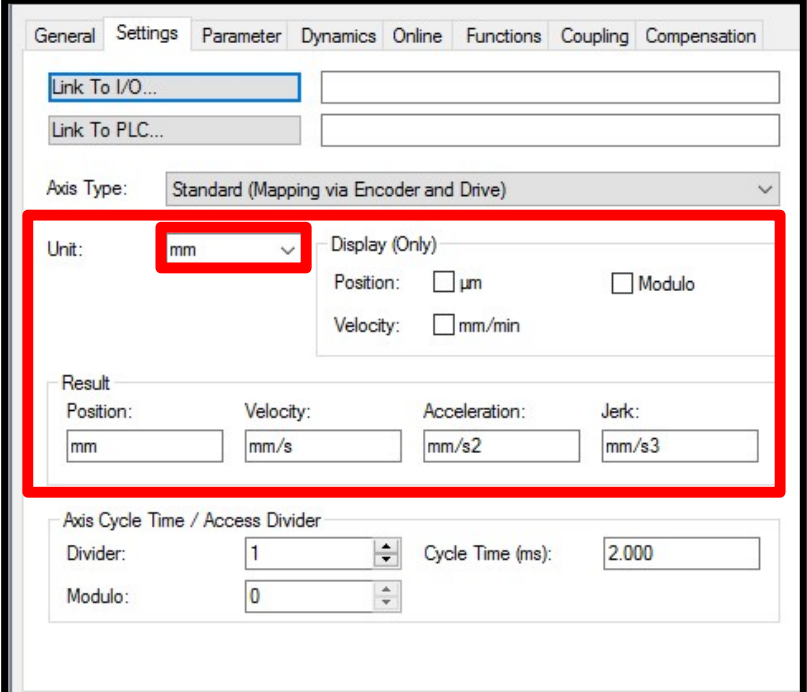
Settings Tab Shows Units

BECKHOFF

- **Units** are for display only
 - No effect on NC control
 - Select from list OR type in custom unit
- Check **Modulo** to rollover display of axis position
 - **Modulo Factor** set in encoder parameters
 - Rollover occurs when actual position exceeds integer multiple of Modulo Factor
 - NC retains absolute position



Modulo Factor (e.g. 360.0°)	360.0
Tolerance Window for Modulo Start	0.0



General Settings Parameter Dynamics Online Functions Coupling Compensation

Link To I/O...
Link To PLC...

Axis Type: Standard (Mapping via Encoder and Drive)

Unit: mm Display (Only)
Position: ☐ μ m ☒ Modulo
Velocity: ☐ mm/min

Result
Position: mm Velocity: mm/s Acceleration: mm/s² Jerk: mm/s³

Axis Cycle Time / Access Divider
Divider: 1 Cycle Time (ms): 2.000
Modulo: 0

Parameter Tab Specifies Axis Control

BECKHOFF

- **Reference velocity** is max rated speed of motor
- **Maximum** values limit command values
- **Default** values specify regular moves
- **Position Limits** are software limits for axis movement
- **Position Lag Monitoring** faults axis when position error is too large for too much time

General Settings Parameter Dynamics Online Functions Coupling Compensation					
	Parameter	Offline Value	Online Value	Type	Unit
-	Maximum Dynamics:				
	Reference Velocity	2200.0		F	mm/s
	Maximum Velocity	2000.0		F	mm/s
	Maximum Acceleration	15000.0		F	mm/s ²
	Maximum Deceleration	15000.0		F	mm/s ²
-	Default Dynamics:				
	Default Acceleration	1500.0		F	mm/s ²
	Default Deceleration	1500.0		F	mm/s ²
	Default Jerk	2250.0		F	mm/s ³
+	Manual Motion and Homing:				
+	Fast Axis Stop:				
-	Limit Switches:				
	Soft Position Limit Minimum Monitoring	FALSE		B	
	Minimum Position	0.0		F	mm
	Soft Position Limit Maximum Monitoring	FALSE		B	
	Maximum Position	0.0		F	mm
-	Monitoring:				
	Position Lag Monitoring	TRUE		B	
	Maximum Position Lag Value	5.0		F	mm
	Maximum Position Lag Filter Time	0.02		F	s

Dynamics Tab Dictates Setpoint Generation

BECKHOFF

- Move profile can be set **directly** or **indirectly**
- **Acceleration** can be the same or different than **deceleration**
- Values update Parameter Tab:
 - Default dynamics
 - Maximum velocity

	Parameter	Offline Value
-	Maximum Dynamics:	
	Reference Velocity	2200.0
	Maximum Velocity	2000.0
	Maximum Acceleration	15000.0
	Maximum Deceleration	15000.0
-	Default Dynamics:	
	Default Acceleration	1500.0
	Default Deceleration	1500.0
	Default Jerk	2250.0

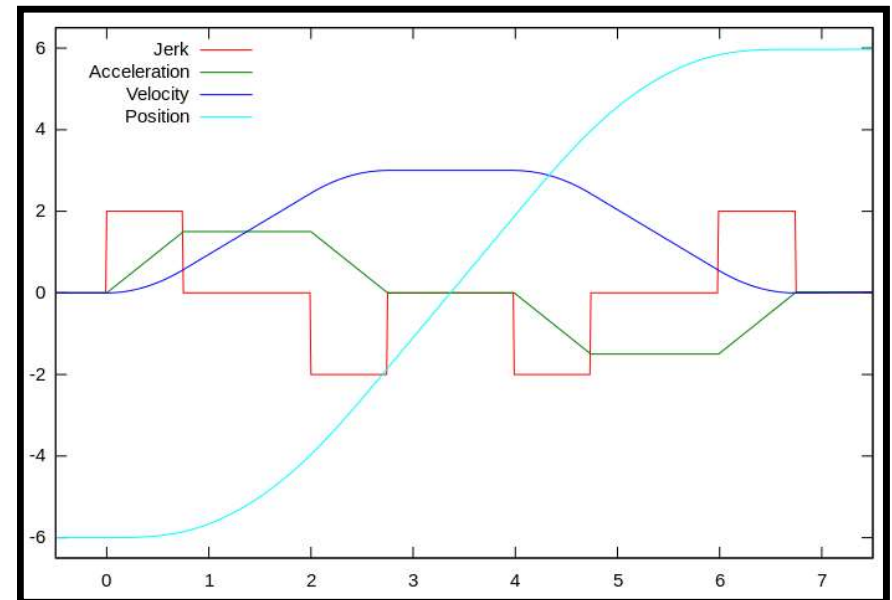
The screenshot shows the 'Dynamics' tab in a software interface. It has two main sections: 'Indirect by Acceleration Time' and 'Direct'. The 'Direct' section is selected with a radio button. In this section, 'Acceleration' is set to 1500 mm/s², 'Deceleration' is set to 1500 mm/s² (with a checked 'as above' box), and 'Jerk' is set to 2250 mm/s³. Above these, there are sliders for 'Acceleration Characteristic' and 'Deceleration Characteristic', and two waveform icons labeled 'a(t)' and 'v(t)'. The 'Indirect' section shows 'Maximum Velocity (V max)' at 2000 mm/s and 'Acceleration Time' and 'Deceleration Time' both at 2 s (with a checked 'as above' box). At the bottom are 'Download' and 'Upload' buttons.

Dynamics Tab Dictates Setpoint Generation

BECKHOFF

- Acceleration change is limited by jerk
- Velocity change is limited by acceleration
- Position change is limited by velocity
- Default Dynamics are targets, not limits

	Parameter	Offline Value
-	Maximum Dynamics:	
	Reference Velocity	2200.0
	Maximum Velocity	2000.0
	Maximum Acceleration	15000.0
	Maximum Deceleration	15000.0
-	Default Dynamics:	
	Default Acceleration	1500.0
	Default Deceleration	1500.0
	Default Jerk	2250.0



Online Tab Shows Axis Behavior

BECKHOFF

- **Setpoint** values are the incremental desired values driving axis movement
- **Actual** values are observed values obtained from motor feedback
- **Lag Distance:**
 - Defined as Setpoint – Actual Position
 - **Min/Max** values are retained until axis **Reset**

The screenshot displays the 'Online' tab of the Beckhoff TIA Portal software. A red rectangle highlights the top section containing the following data:

Parameter	Value	Unit
Setpoint Position	0.0000	[mm]
Setpoint Velocity	0.0000	[mm/s]
Lag Distance (min/max)	0.0000 (0.000, 0.000)	[mm]
Actual Velocity	0.0000	[mm/s]

Below this, the 'Status (log.)' section shows checkboxes for 'Ready' (checked), 'Calibrated', 'Has Job', 'NOT Moving' (checked), 'Moving Fw', and 'Moving Bw'. The 'Status (phys.)' section includes checkboxes for 'Coupled Mode', 'In Target Pos.', and 'In Pos. Range'. The 'Enabling' section has checkboxes for 'Controller', 'Feed Fw', and 'Feed Bw', with a 'Set' button next to 'Controller'.

Further down, the 'Controller Kv-Factor' is set to 1 [mm/s/mm], and the 'Reference Velocity' is set to 2200 [mm/s]. The 'Target Position' is 0 [mm] and the 'Target Velocity' is 0 [mm/s].

At the bottom, there is a row of function buttons: F1 (left arrow), F2 (right arrow), F3 (plus), F4 (minus), F5 (diamond), F6 (stop), F8 (reset), and F9 (home). The F8 button is highlighted with a red rectangle.

Online Tab Shows Axis Behavior

BECKHOFF

- **Override** is set by the user to scale commanded velocity
- **Total/Control Output** shows percentage of reference velocity at which axis is traveling
- **Error** displays last NC fault
 - [Infosys](#) explains errors
 - Reset with F8 or PLC

The screenshot displays the 'Online' tab of a Beckhoff control interface. A red rectangle highlights the 'Override', 'Total / Control Output', and 'Error' fields. Below this, there are status checkboxes for 'Ready', 'NOT Moving', 'Coupled Mode', 'In Target Pos.', 'In Pos. Range', 'Controller', 'Feed Fw', and 'Feed Bw'. At the bottom, a row of function keys (F1-F9) is shown, with F8 highlighted by a red rectangle.

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
0.0000				Setpoint Position: [mm]	0.0000		
Lag Distance (min/max): [mm]				Actual Velocity: [mm/s]	Setpoint Velocity: [mm/s]		
0.0000 (0.000 0.000)				0.0000	0.0000		
Override: [%]				Total / Control Output: [%]	Error:		
0.0000 %				0.00 / 0.00 %	0 (0x0)		
Status (log.)				Status (phys.)	Enabling		
☒ Ready				☒ NOT Moving	☐ Coupled Mode		
☐ Calibrated				☐ Moving Fw	☐ In Target Pos.		
☐ Has Job				☐ Moving Bw	☐ In Pos. Range		
Controller Kv-Factor: [mm/s/mm]				Reference Velocity: [mm/s]	Set		
1				2200			
Target Position: [mm]				Target Velocity: [mm/s]			
0				0			
F1 F2 F3 F4 F5 F6 F8 F9							

Online Tab Shows Read-Only Boxes

BECKHOFF

- **Ready** means Axis is functioning and controllable
 - Unchecked box may indicate drive problem
- **Calibrated** latches after NC homing completed
- **Has Job** means the active in controlling the axis
- **Moving** indicates motion state during issued command

The screenshot displays the Beckhoff online control interface with the 'Online' tab selected. The 'Status (log.)' section is highlighted with a red box, showing the following status indicators:

Status (log.)	
☒ Ready	☒ NOT Moving
☐ Calibrated	☐ Moving Fw
☐ Has Job	☐ Moving Bw

Other visible fields and controls include:

- Setpoint Position: [mm] 0.0000
- Actual Velocity: [mm/s] 0.0000
- Lag Distance (min/max): [mm] 0.0000 (0.000, 0.000)
- Override: [%] 0.0000 %
- Total / Control Output: [%] 0.00 / 0.00 %
- Error: 0 (0x0)
- Controller Kv-Factor: [mm/s/mm] 1
- Reference Velocity: [mm/s] 2200
- Target Position: [mm] 0
- Target Velocity: [mm/s] 0
- Enabling: ☐ Controller, ☐ Feed Fw, ☐ Feed Bw (with a 'Set' button)
- Status (phys.): ☐ Coupled Mode, ☐ In Target Pos., ☐ In Pos. Range
- Function keys: F1, F2, F3, F4, F5, F6, F8, F9

Online Tab Shows Read-Only Boxes

BECKHOFF

- **Coupled Mode** checked on slave axis when coupled to master
 - Online tab of Slave greyed out

Slave

General Settings Parameter Dynamics **Online** Functions Coupling Compensation

0.0000 Setpoint Position: [mm]
0.0000 Actual Velocity: [mm/s]
0.0000 Setpoint Velocity: [mm/s]
0.0000 % Override: [%] Total / Control Output: [%] Error: 0 (0x0)

Status (log.) Status (phys.) Enabling

☒ Ready ☒ NOT Moving ☒ Coupled Mode ☐ Controller ☐ Feed Fw ☐ Feed Bw

☐ Calibrated ☐ Moving Fw ☐ In Target Pos. ☐ In Pos. Range

Controller Kv-Factor: [mm/s/mm] Reference Velocity: [mm/s]
1 2200

Target Position: [mm] Target Velocity: [mm/s]
0 0

F1 F2 F3 F4 F5 F6 F8 F9

Master

General Settings Parameter Dynamics **Online** Functions Coupling Compensation

0.0000 Setpoint Position: [mm]
0.0000 Actual Velocity: [mm/s]
0.0000 Setpoint Velocity: [mm/s]
0.0000 % Override: [%] Total / Control Output: [%] Error: 0 (0x0)

Status (log.) Status (phys.) Enabling

☒ Ready ☒ NOT Moving ☐ Coupled Mode ☐ Controller ☐ Feed Fw ☐ Feed Bw

☐ Calibrated ☐ Moving Fw ☐ In Target Pos. ☐ In Pos. Range

Controller Kv-Factor: [mm/s/mm] Reference Velocity: [mm/s]
1 2200

Target Position: [mm] Target Velocity: [mm/s]
0 0

F1 F2 F3 F4 F5 F6 F8 F9

Online Tab Shows Read-Only Boxes

BECKHOFF

- **Target Position** is the final position specified for a move
 - **In Target Pos** true when axis 'near' target position for given time
 - 'Near' means $\pm$ **Target Position Window**

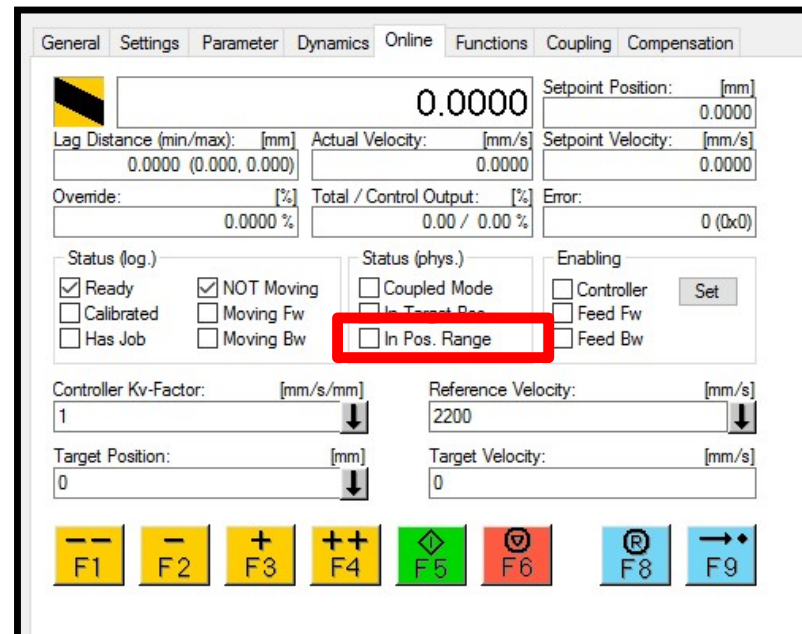
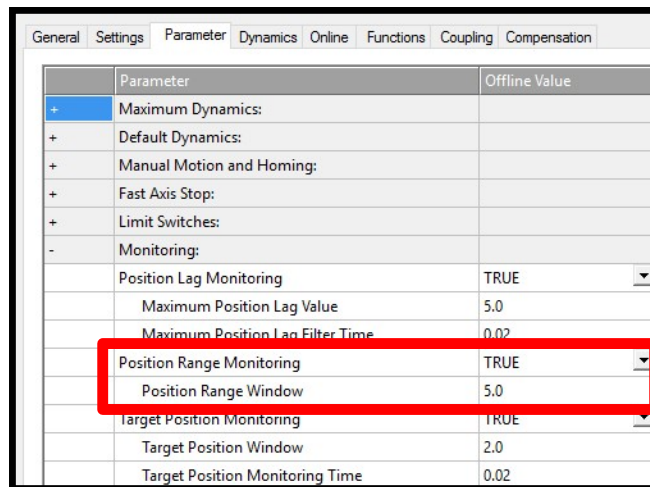
General Settings Parameter Dynamics Online Functions Coupling Compensation		
	Parameter	Offline Value
+	Maximum Dynamics:	
+	Default Dynamics:	
+	Manual Motion and Homing:	
+	Fast Axis Stop:	
+	Limit Switches:	
-	Monitoring:	
	Position Lag Monitoring	TRUE
	Maximum Position Lag Value	5.0
	Maximum Position Lag Filter Time	0.02
	Position Range Monitoring	TRUE
	Position Range Window	5.0
	Target Position Monitoring	TRUE
	Target Position Window	2.0
	Target Position Monitoring Time	0.02

General Settings Parameter Dynamics Online Functions Coupling Compensation					
	0.0000	Setpoint Position: [mm] 0.0000			
Lag Distance (min/max): [mm] 0.0000 (0.000, 0.000)	Actual Velocity: [mm/s] 0.0000	Setpoint Velocity: [mm/s] 0.0000			
Override: [%] 0.0000 %	Total / Control Output: [%] 0.00 / 0.00 %	Error: 0 (0x0)			
Status (log.) ☒ Ready ☐ Calibrated ☐ Has Job			Status (phys.) ☒ NOT Moving ☐ Moving Fw ☐ Moving Bw	☐ In Target Pos. ☐ In Pos. Range	Enabling ☐ Controller ☐ Feed Fw ☐ Feed Bw
Controller Kv-Factor: [mm/s/mm] 1			Reference Velocity: [mm/s] 2200		
Target Position: [mm] 0			Target Velocity: [mm/s] 0		
F1 F2 F3 F4 F5 F6 F8 F9					

Online Tab Shows Read-Only Boxes

BECKHOFF

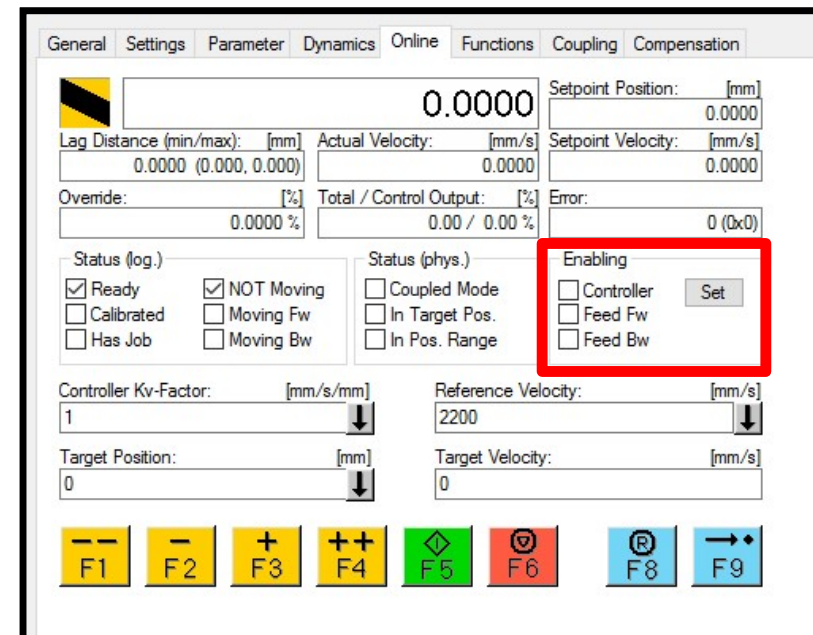
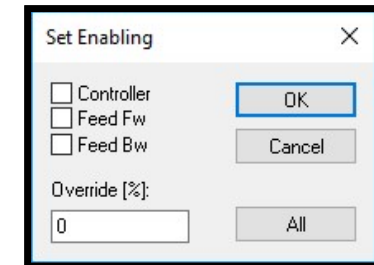
- ***In Pos. Range*** true when axis 'close' to target position
 - Time independent
 - 'Close' means $\pm$ ***Position Range Window***



Online Tab Shows Read-Only Boxes

BECKHOFF

- **Enabling** shows allowable NC control of Axis
 - **Controller** means axis OK to be controlled by NC
 - **Feed Fw** means forward move commands OK
 - **Feed Bw** means reverse move commands OK
- **Set** button allows user to change **Enabling** information
 - **All** enables everything with Override of 100%



Online Tab Allows for Axis Control

BECKHOFF

- **F5** moves axis based on **Target Position** and **Target Velocity**
 - Down arrows update position during move
- **F1-F4 Moves** axis for duration of button press
- **F6 Stops** Axis
- **F8 Resets** Axis
 - Stops axis
 - Clears NC error
 - Clears lag position

The screenshot displays the 'Online' tab of a Beckhoff control interface. It features a top navigation bar with tabs: General, Settings, Parameter, Dynamics, Online (selected), Functions, Coupling, and Compensation. The main area contains several data fields and status sections. A red rectangle highlights the 'Target Position' and 'Target Velocity' input fields, both set to 0, and the function buttons F1 through F9 below them. The 'F5' button is green with a diamond icon, while others are yellow or red. The interface also shows 'Setpoint Position' at 0.0000, 'Actual Velocity' at 0.0000, and various status checkboxes like 'Ready', 'NOT Moving', and 'In Target Pos.'.

General	Settings	Parameter	Dynamics	Online	Functions	Coupling	Compensation
				0.0000	Setpoint Position: [mm] 0.0000		
Lag Distance (min/max): [mm] 0.0000 (0.000, 0.000)				Actual Velocity: [mm/s] 0.0000	Setpoint Velocity: [mm/s] 0.0000		
Override: [%] 0.0000 %				Total / Control Output: [%] 0.00 / 0.00 %	Error: 0 (0x0)		
Status (log.) ☒ Ready ☐ Calibrated ☐ Has Job				Status (phys.) ☒ NOT Moving ☐ Moving Fw ☐ Moving Bw	Enabling ☐ Coupled Mode ☐ In Target Pos. ☐ In Pos. Range ☐ Controller ☐ Feed Fw ☐ Feed Bw Set		
Controller Kv-Factor: [mm/s/mm] 1				Reference Velocity: [mm/s] 2200			
Target Position: [mm] 0				Target Velocity: [mm/s] 0			
-- F1 - F2 + F3 ++ F4				◇ F5 ⊘ F6 Ⓡ F8 → F9			

Functions Tab Provides Move Options

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- **Extended Start** provides multiple move types

Absolute
Relative
Endless +
Endless -
Modulo
Modulo shortest way
Modulo plus direct.
Modulo minus direct.
Jog +
Jog -
+ 1
+ 0.1
+ 0.01
+ 0.001

- 1
- 0.1
- 0.01
- 0.001
Reversing Sequence
Start/Stop Sequence
Velo Step Sequence
Sinus Sequence (Bode)
Sinus Oscillation

- **Raw Drive Output** allows for constant velocity move as percent of **Reference Velocity**
- **Set Actual Position** changes current NC position

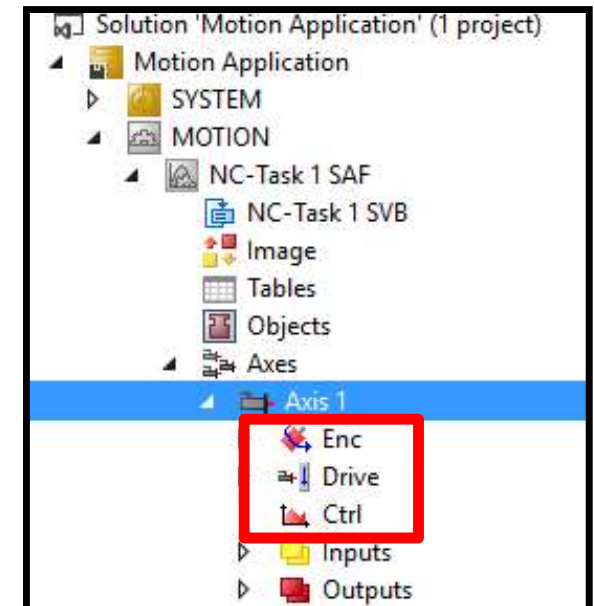
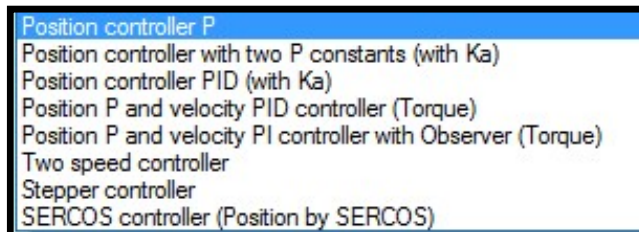
The screenshot displays the 'Functions' tab in a Beckhoff control software interface. At the top, there are tabs for 'General', 'Settings', 'Parameter', 'Dynamics', 'Online', 'Functions', 'Coupling', and 'Compensation'. The 'Functions' tab is active, showing a large display area with a black and yellow diagonal stripe icon and a numerical value '0.0000'. To the right of this display is a 'Setpoint Position:' field with a unit '[mm]' and a value of '0.0000'. Below these are three sections: 'Extended Start', 'Raw Drive Output', and 'Set Actual/Target Position'. The 'Extended Start' section includes a 'Start Mode' dropdown set to 'Absolute', and input fields for 'Target Position' (0 [mm]), 'Target Velocity' (0 [mm/s]), 'Acceleration' (0 [mm/s²]), 'Deceleration' (0 [mm/s²]), and 'Jerk' (0 [mm/s³]). There are 'Start' and 'Stop' buttons for this section, and a 'Last Time:' field showing '1.08200 [s]'. The 'Raw Drive Output' section has an 'Output Mode' dropdown set to 'Percent' and an 'Output Value' field set to '100 [%]', with 'Start' and 'Stop' buttons. The 'Set Actual Position' and 'Set Target Position' sections each have a dropdown set to 'Absolute' and a value field set to '0', with a 'Set' button for each.

- Overview
- Components
- **Axis Details:**
 - Main Tabs
 - **Subcomponents**

Axes have up to Three Main Subcomponents

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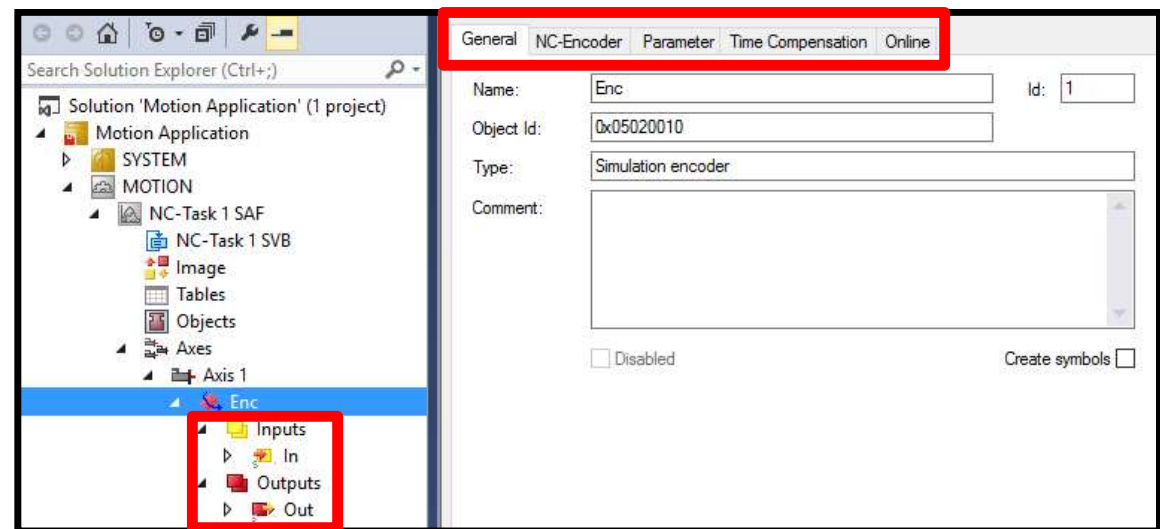
- **Enc** is the feedback for the axis:
 - Data received from resolver or encoder (motor integrated or external source)
- **Drive** is the non-feedback interface to the physical hardware amplifier
 - Data received for drive status
 - Data sent to provide desired setpoint, dictate drive mode
- **Ctrl** determines how drive setpoint values are calculated



Enc Holds Feedback Information

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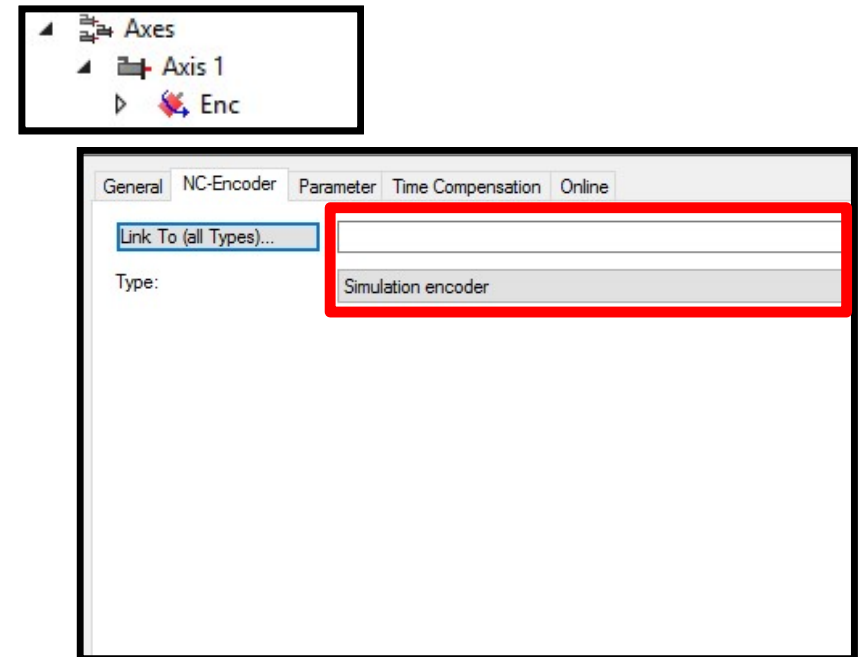
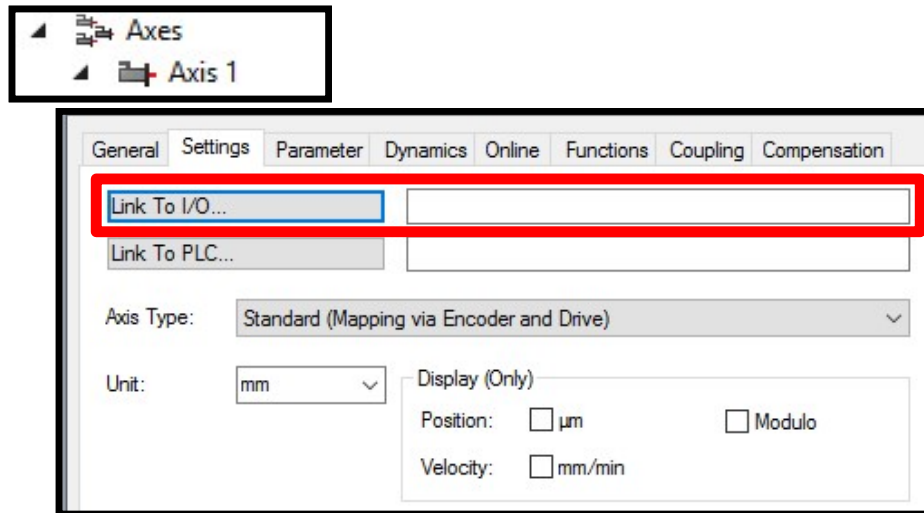
- **Feedback** parameters and information contained in:
 - **Tabs**
 - Configure feedback
 - Observe feedback
 - **Process Data**
 - Automatically linked by NC



NC-Encoder Tab Links Process Data

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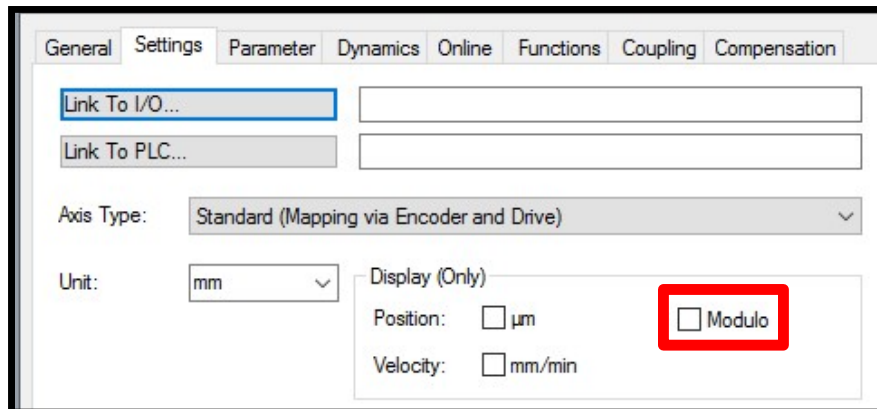
- **Link to** and **type** completed by previously linking the Axis to I/O
- **Type** updates encoder component tabs



Parameter Tab Configures Feedback

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- ***Invert Encoder Counting Direction*** changes relation between physical count direction and NC position value
- ***Modulo Factor*** is used to specify rollover of position value for NC

A screenshot of the 'Parameter' tab for Axis 1. The 'Link To I/O...' field is highlighted. The 'Axis Type' is set to 'Standard (Mapping via Encoder and Drive)'. The 'Unit' is set to 'mm'. The 'Display (Only)' section has 'Position' checked and 'Modulo' checked (highlighted with a red box).

General Settings Parameter Dynamics Online Functions Coupling Compensation

Link To I/O...

Link To PLC...

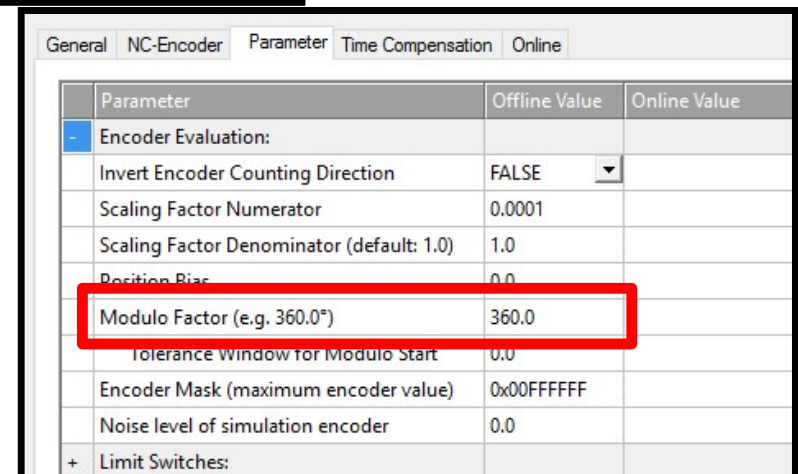
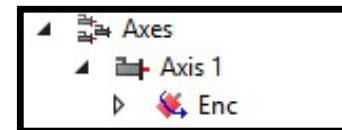
Axis Type: Standard (Mapping via Encoder and Drive) v

Unit: mm v

Display (Only)

Position: ☐ μ m ☒ Modulo

Velocity: ☐ mm/min

A screenshot of the 'Parameter' tab for Axis 1. The 'Modulo Factor (e.g. 360.0°)' is highlighted with a red box. The 'Invert Encoder Counting Direction' is set to 'FALSE'.

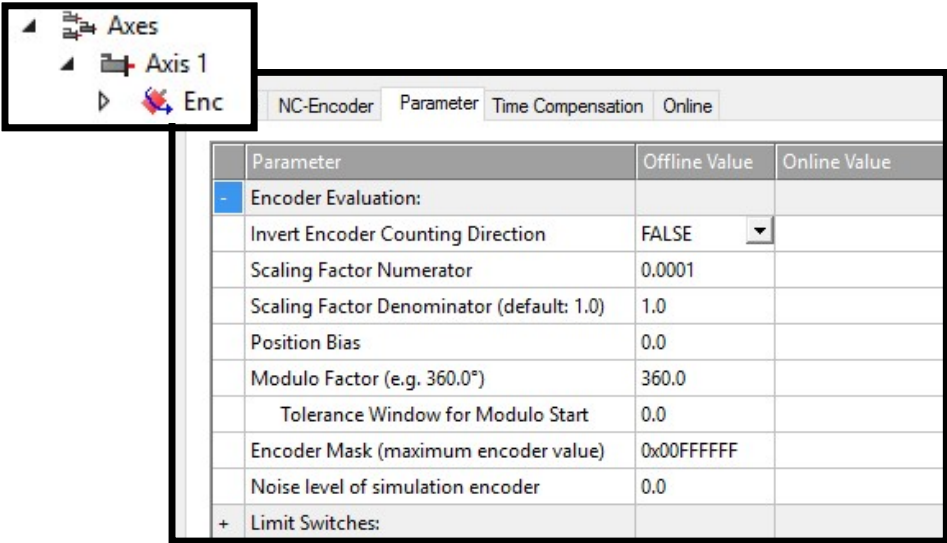
General NC-Encoder Parameter Time Compensation Online

Parameter	Offline Value	Online Value
Encoder Evaluation:		
Invert Encoder Counting Direction	FALSE v	
Scaling Factor Numerator	0.0001	
Scaling Factor Denominator (default: 1.0)	1.0	
Position Bias	0.0	
Modulo Factor (e.g. 360.0°)	360.0	
Tolerance Window for Modulo Start	0.0	
Encoder Mask (maximum encoder value)	0x00FFFFFF	
Noise level of simulation encoder	0.0	
Limit Switches:		

Parameter Tab Configures Feedback

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- **Scaling Factor** converts feedback increments to desired system unit
- **Position Bias** offsets multiturn incremental encoders
- **Encoder Mask** is used to specify how many bits are transferred from the I/O to NC



Parameter	Offline Value	Online Value
Encoder Evaluation:		
Invert Encoder Counting Direction	FALSE	
Scaling Factor Numerator	0.0001	
Scaling Factor Denominator (default: 1.0)	1.0	
Position Bias	0.0	
Modulo Factor (e.g. 360.0°)	360.0	
Tolerance Window for Modulo Start	0.0	
Encoder Mask (maximum encoder value)	0x00FFFFFF	
Noise level of simulation encoder	0.0	
+ Limit Switches:		

Feed Constant

$$Position(Y) = Feedback\ INC(X) * \frac{1\ Rev}{INC} * \frac{Distance}{1\ Rev} + Position\ Bias$$

Scaling Factor

Online Tab Shows Feedback Information

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- **Raw, scaled, and modulo** feedback representations of position are presented
- Ability to set NC ***actual position***

The screenshot displays the 'Online' tab of a Beckhoff control interface. A tree view on the left shows the hierarchy: 'Axes' (expanded), 'Axis 1' (selected), and 'Enc' (expanded). The main panel shows the following data:

Field	Value
Position:	0.0000
Id:	1
Uncorrected Position:	0.0000
Correction:	0.0000
Hard Increments:	0
Soft Increments:	higher 32-Bit: 0, lower 32-Bit: 0
Modulo Actual Pos.:	0.0000
Modulo Turns:	0
Latch Pos. Diff.:	0.0000

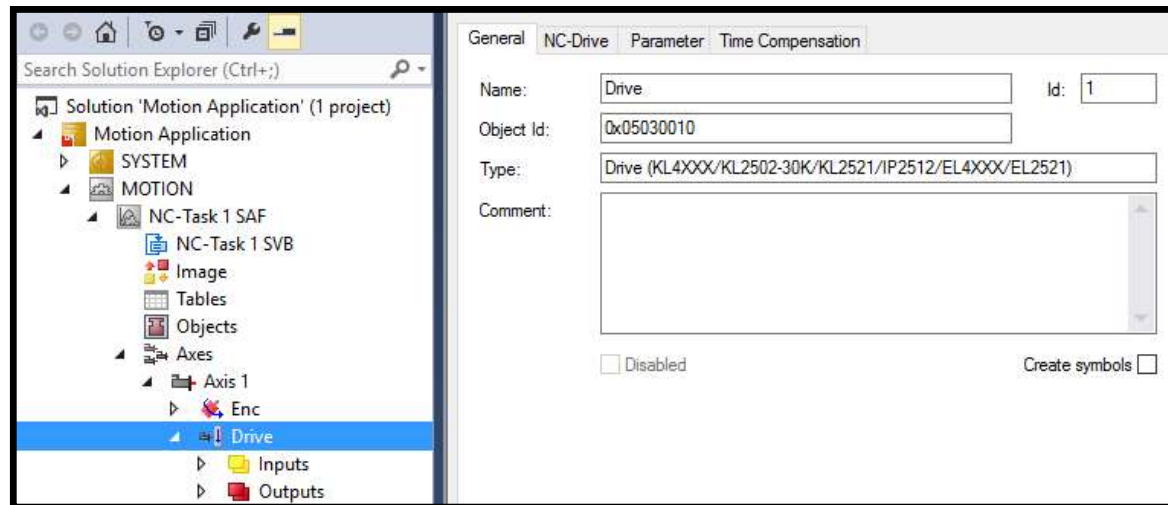
Below the data fields, there are two sections:

- Calibration Flag:** A dropdown menu set to 'Set' and a 'Reset' button.
- Set Actual Position:** A dropdown menu set to 'Absolute', a text input field containing '0', and a 'Set' button.

Drive Scales Output, Exchanges Data

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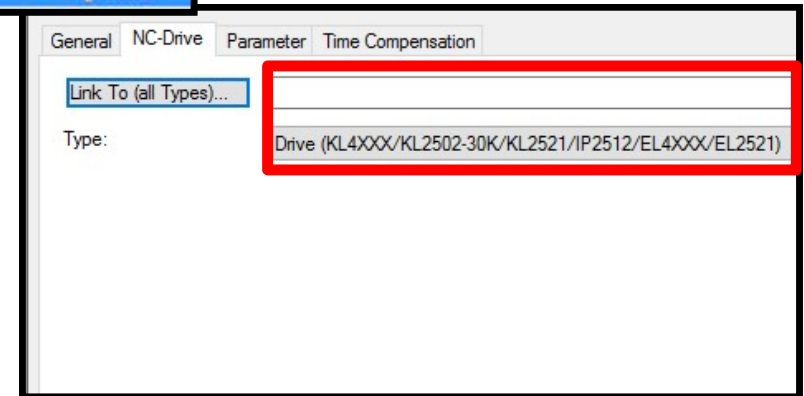
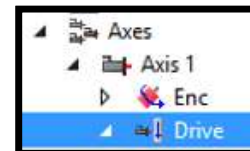
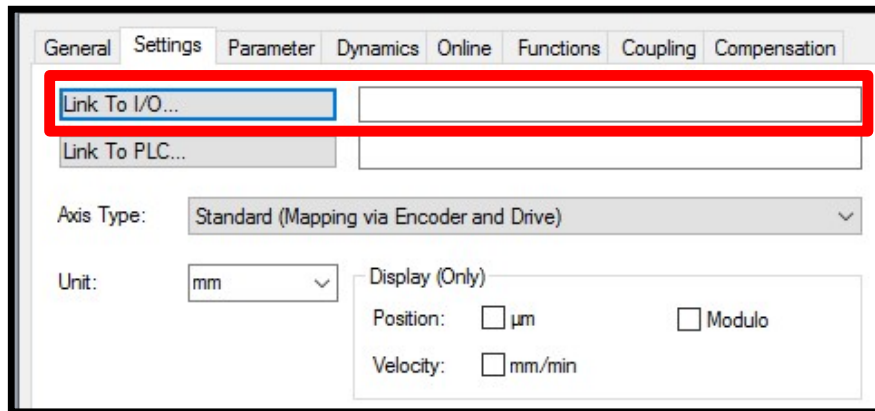
- **Drive** parameters and information contained in:
 - **Tabs**
 - Configure drive output data
 - **Process Data**
 - Automatically linked by NC



NC-Drive Connects to I/O

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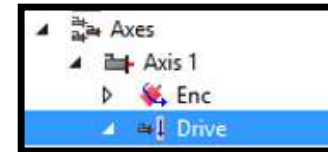
- **Link to** and **type** completed by previously linking the Axis to I/O
- **Type** updates drive component tabs



Parameter Tab Configures Drives Outputs

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- **Invert Motor Polarity** to switch the sign of the Setpoint Values sent to the drive
- **Reference velocity** is also found in axis parameters
 - For analog drives:
 - Scales the output value
 - ***Drift compensation*** corrects velocity bias



General NC-Drive Parameter Time Compensation		
	Parameter	Offline Value
-	Output Settings:	
	Invert Motor Polarity	FALSE
	Reference Velocity	2200.0
	at Output Ratio [0.0 ... 1.0]	1.0
+	Position and Velocity Scaling:	
+	Torque and Acceleration Scaling:	
+	Valve Diagram:	
-	Other Settings:	
	Drive Mode	'STANDARD'
	Drift Compensation (DAC-Offset)	0.0

Contact

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