Working with Integrated Motion Control

TM410

Perfection in Automation
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Requirements

Training modules:	TM210 – The Basics of Automation Studio TM400 – The Basics of Drive Technology
Software	Automation Studio 3.0.90
Hardware	B&R drive system

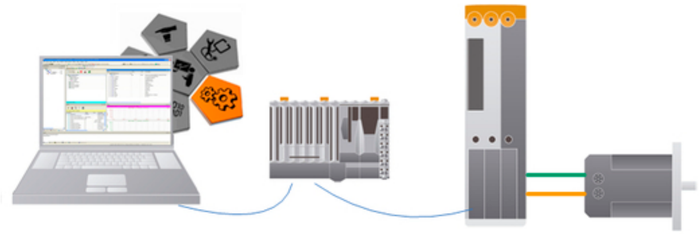
TABLE OF CONTENTS

1 INTRODUCTION

The B&R drive solution is **fully integrated in Automation Studio**. The result is a simple and uniform tool for creating projects as well as commissioning control and positioning tasks.

This training module explains step-by-step how to create a drive configuration in Automation Studio.

It then provides detailed descriptions of components that can be used to manage and edit your configuration, including their respective tools and interfaces.



Project creation with the B&R drive solution

Integrated diagnostic tools provide an efficient environment for testing and commissioning.

1.1 Training module objectives

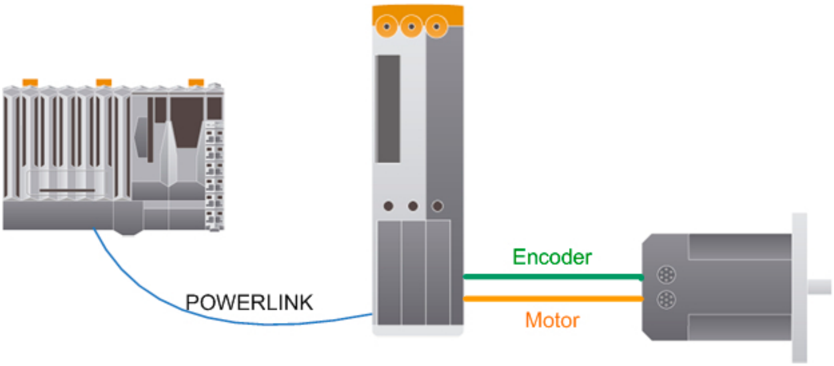
You will learn how to set up a drive configuration in Automation Studio with the help of example tasks.

You will learn how to…

- ... Insert a drive axis
- ... Configure and set parameters for servo drives
- ... use motion diagnostic tools
- ... Simulating a servo drive and motor

2 DRIVE CONCEPT

The following section deals with the system architecture of the **B&R drive solution**. Our goal is to establish a basic understanding of the procedures and relationships in this system.



Drive concept structure: plc - drive - motor

The components required for a drive configuration are shown in the image. In order to understand how this works, we will first take a closer look at the individual components and then the shared interfaces.

Project creation

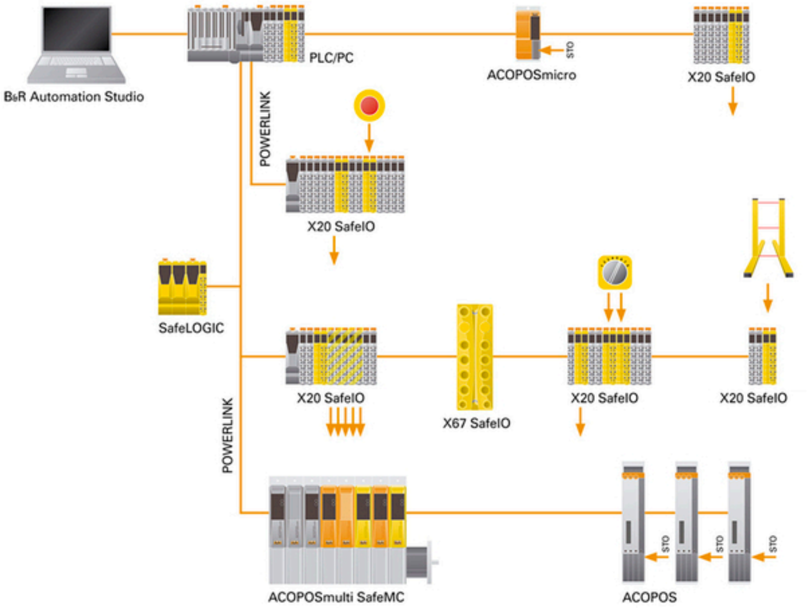
A project is creating using B&R Automation Studio. The following possibilities are available for creating the project:

Project creation via ...	Description
Configuration	Components in the various configurations must be adapted correctly to themselves. These settings are made using Automation Studio. (4 "Drive configuration sections")
Software creation	To control and implement the positioning sequences using an application program. For the B&R drive solution, the software is generated using the PLCopen motion control library. (TM440, TM441)
Diagnostic and testing tools	The user is offered various diagnostic possibilities by the Automation Studio and the Diagnostics System Manager. Movements can be simulated and recorded for analysis. (5 "Commissioning and diagnostics environment")
Simulation	Simulation of motors and servo drives is supported by Automation Studio. (6 "Simulation options")

Table: Overview of project creation possibilities in Automation Studio

2.1 Drive hardware

Different areas of application require different types of drive technology These different types are fully integrated in the B&R system. Communication between the controller and the drives is handled using the decentralized backplane or POWERLINK.



Hardware configuration

The ACOPOS series

System	Description
ACOPOS	Integrated in the ACOPOS module: Line filter, braking resistor and electronic restart inhibit.
ACOPOSmulti	Modular concept with different cooling methods, supply voltage modules, auxiliary voltage modules and inverter modules
ACOPOSmulti SafeMC	Also offers expanded safety functions in addition to the system features of the ACOPOSmulti series (Safely Limited Speed, etc.)
ACOPOSmulti65	Distributed system based on ACOPOSmulti for flexible machine architecture
ACOPOSmulti65m	Motor integrated amplifier based on ACOPOSmulti for highest machine modularity, integrated safety technology
ACOPOSmicro	Ideal application in the two lowest power ranges for servo and stepper motor applications.
ACOPOSinverter	Broad performance range for cost-effective applications without positioning tasks.

Table: The ACOPOS series

The X20 / X67 System

System	Description
SM – modules	Up to two stepper motors can be operated using a single module from the X20 or X67 series.

Table: The X20 / X67 System

System	Description
MM – modules	Up to four DC motors can be operated using a single module from the X20 or X67 series.

Table: The X20 / X67 System

Detailed information regarding functionality and wiring can be found in the respective user's manuals, datasheets or the Automation Studio Online Help system.

Hardware \ Motion Control

Hardware \ X20 System

Hardware \ X67 System

Drives use two types of internal parameters:

- Parameters for the hardware configuration
- Parameters for positioning sequences

Parameters for the hardware configuration

The servo drive must be configured according to the connected hardware.

The following parameters must be defined:

- Characteristics of the motor and holding brake (if present)
- Plug-in cards (encoder and network cards)

Parameters for positioning sequences

The servo drive processes parameters that are used to control and check positioning sequences.

The following parameters are relevant:

- Movement parameters, commands and status values
- Monitor functions

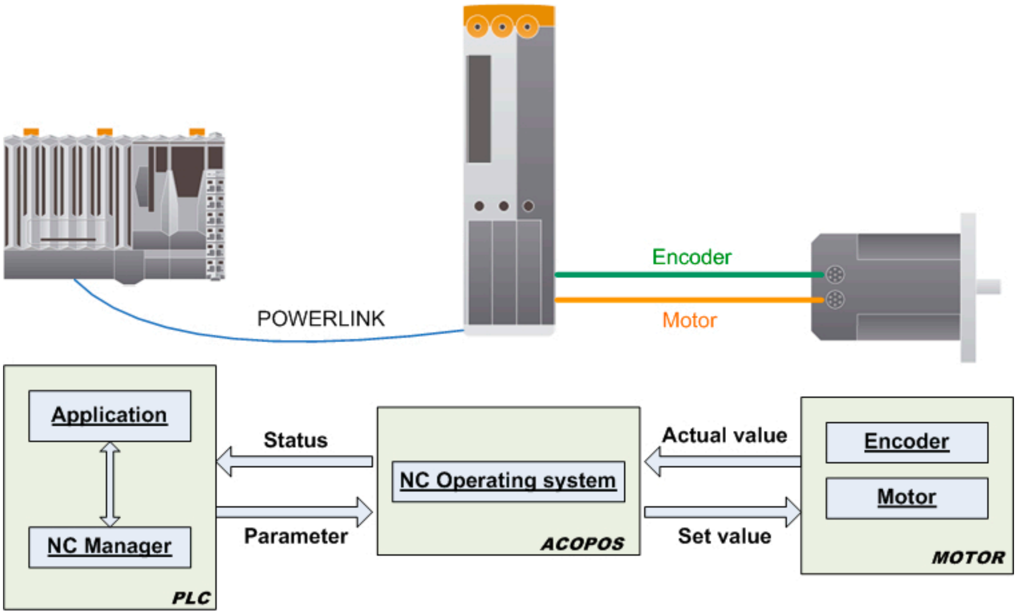
We will take a closer look at the processes in the servo drive in the section 2.2 "Software concept".

Control and communication

The drive is operated with the help of parameters.

Data is exchanged between the controller and the drive on the bus system and is controlled by **NC Manager**.

This acts as the link between the user application and the **NC operating system** on the servo drive.



Drive control and communication

There are two types of data to be exchanged:

- **Parameter data and commands** are sent from the controller to the servo drive.
- **Status data** is sent from the servo drive to the controller.

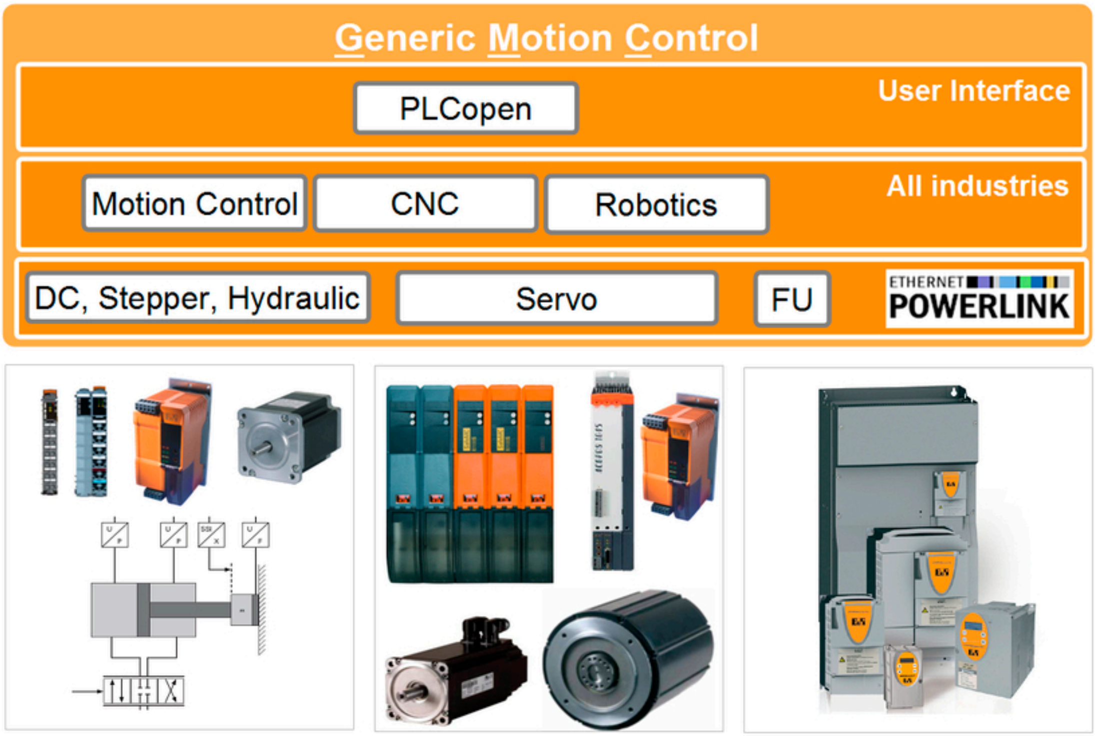
Commands are sent to the **NC-Manager** using simple functions. NC Manager then communicates with the **NC-Betriebssystem** to execute the respective actions.

2.2 Software concept

The software concept is extremely simple because it works the same way for all types of drives.

The application specifies set values, which are then forwarded to the configured hardware via selected function types.

NC objects are created for motion control, CNC and robotics:



Software concept

Behind the NC object hides a global **operating structure**:

These NC objects are managed via NC Manager. It transfers the **control commands** and theire **econfigured parameters** from the NC object to the corresponding drive.

The NC manager also ensures that the corresponding status values are returned to the structure of the respective NC object.

The flexibility of this software concept makes it possible to use the same application for different drive types.

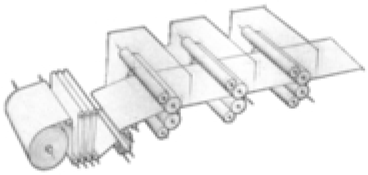
The following NC objects are available:

- Real axis
- Virtual axis
- CNC system
- Robotics

Drive concept

Real axis

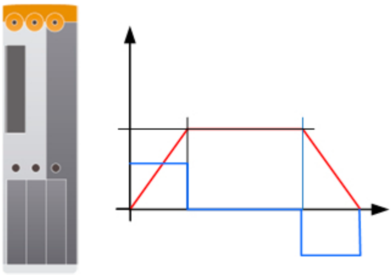
This NC object is used to operate a real drive with a motor and a position encoder.



Motor driving a winder drive

Virtual axis

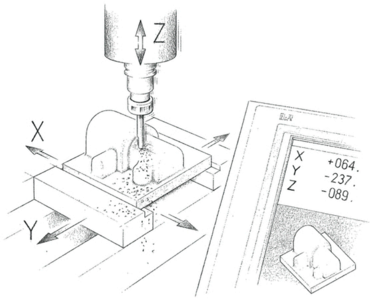
In addition to the real axes, ACOPOS also offers the option of operating a virtual drive. This drive works solely as a type of "set value generator" (i.e. generates values for position and speed) and is operated the same as a real axis. It can be used for various applications such as linking a real axis to the position of a virtual axis.



Virtual axis

CNC system

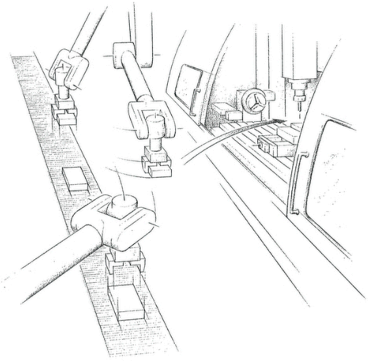
A CNC system is used in applications where multiple axes are linked with each other and perform defined movements. The CNC system handles the management and coordination of the individual CNC axes.



CNC milling machine application

Robotics

A robotics system is used in applications where multiple axes are linked with each other and perform defined movements. Unlike a CNC system, however, a robotics system is based on kinematics.



Pick-and-place application

The operating structure for NC objects differs according to the type of application in which they are used. For example, a virtual axis requires fewer operating parameters than a real axis because it does not have encoder or control parameters.

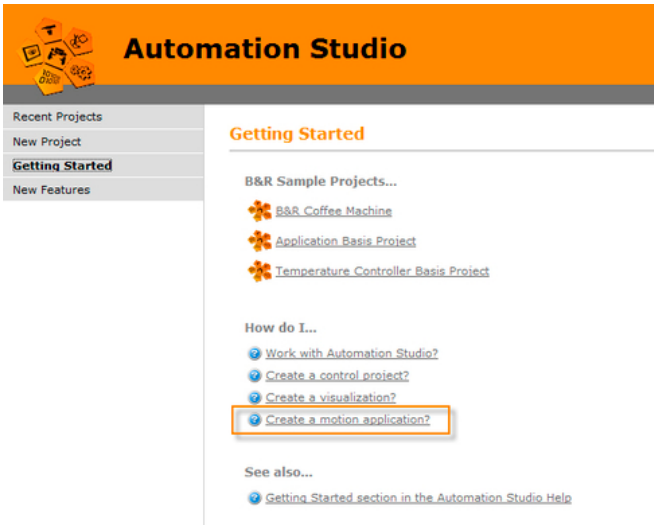
? Motion \ Reference manual \ ACP10 \ NC objects

3 THE FIRST PROJECT

IIn this section, we will use the Automation Studio help system to create a motion project, transfer the project to a CompactFlash card and test the axis using NC Test.

Exercise: Create your first project using the help system

You can open the proper section of the Automation Studio help system directly from the start page.



Getting Started

B&R Sample Projects...

- B&R Coffee Machine
- Application Basis Project
- Temperature Controller Basis Project

How do I...

- Work with Automation Studio?
- Create a control project?
- Create a visualization?
- Create a motion application?

See also...

- Getting Started section in the Automation Studio Help

Automation Studio start page - Getting Started

1) From the start page, open the chapter "How do I create a motion application?"

2) Select the Getting Started example "First motion application"

3) Work through each of the steps.

After following the instructions of the help system the axis will move supported by the test window.

The "Getting Started" examples can also be accessed directly via the Automation Studio help system.

Automation Software \ Getting started \ Create a motion application in Automation Studio

Motion \ Project creation \ Motion control \ Creating an axis

4 DRIVE CONFIGURATION SECTIONS

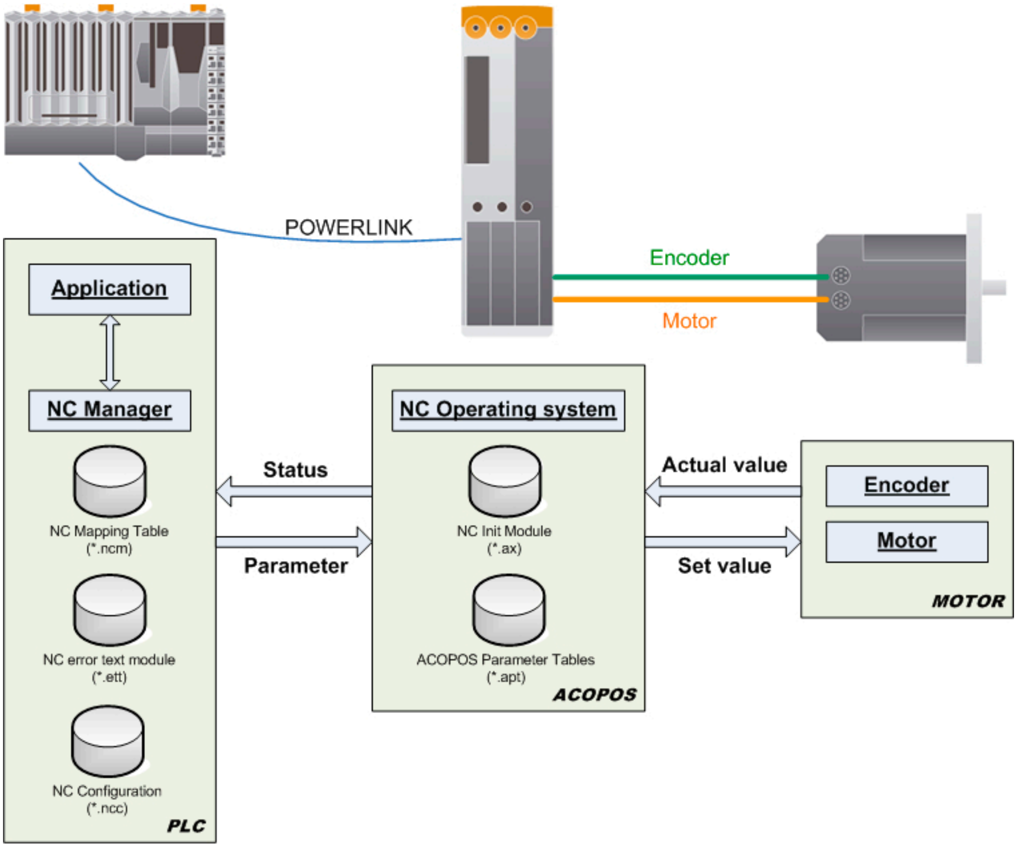
A variety of settings and parameters are required to implement a drive configuration.

These are managed and accessed the same regardless of the hardware being used. This prevents any limitations from occurring due to the drive technology being used.

For example, this means that replacing a servo drive with a stepper motor will not cause any problems.

The drive configuration consists of the following components:

- 4.1 "Configuration modules"
- 4.2 "System settings"



Drive configuration components

Motion \ Project creation \ Motion Control \ Configuration modules

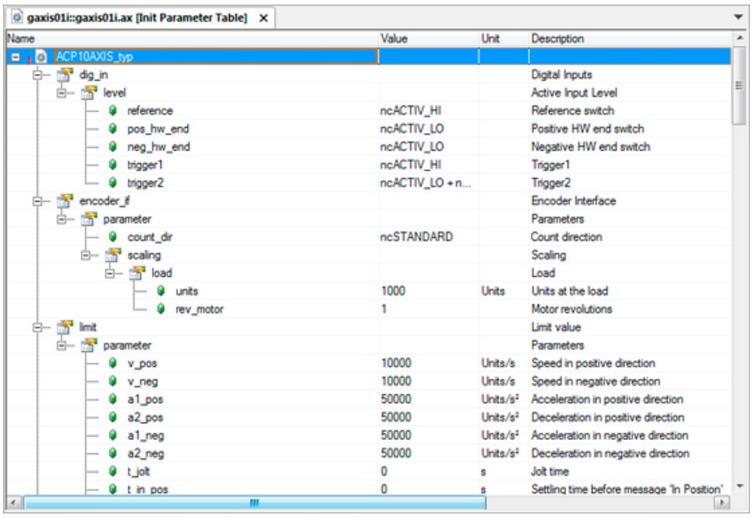
4.1 Configuration modules

The modules created when adding the drive (3 "The first project") will be described in the following sections.

4.1.1 NC Init module

The NC Init module contains basic axis parameters that are used by NC Manager to initialize axis referencing when starting up the controller.

The NC Init module is accessed via the Logical View. Double-clicking on the corresponding file with the extension „**.ax**" opens a window where the initialization parameters can be changed.



gaxis01i::gaxis01i.ax [Init Parameter Table]

Name	Value	Unit	Description
ACP10AXIS_typ			
dig_in			Digital Inputs
level			Active Input Level
reference	ncACTIV_HI		Reference switch
pos_hw_end	ncACTIV_LO		Positive HW end switch
neg_hw_end	ncACTIV_LO		Negative HW end switch
trigger1	ncACTIV_HI		Trigger1
trigger2	ncACTIV_LO + n...		Trigger2
encoder_if			Encoder Interface
parameter			Parameters
count_dir	ncSTANDARD		Count direction
scaling			Scaling
load			Load
units	1000	Units	Units at the load
rev_motor	1		Motor revolutions
limit			Limit value
parameter			Parameters
v_pos	10000	Units/s	Speed in positive direction
v_neg	10000	Units/s	Speed in negative direction
a1_pos	50000	Units/s²	Acceleration in positive direction
a2_pos	50000	Units/s²	Deceleration in positive direction
a1_neg	50000	Units/s²	Acceleration in negative direction
a2_neg	50000	Units/s²	Deceleration in negative direction
t_jolt	0	s	Jolt time
t_in_pos	0	s	Settling time before message 'In Position'

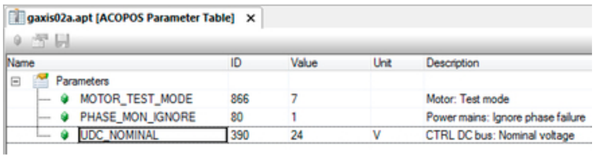
NC Init module

? Motion \ Project creation \ Motion control \ Configuration modules \ NC Init module

4.1.2 ACOPOS parameter table

IUnlike the NC Init module, specific axis parameters are defined in the ACOPOS parameter table. (CTRL DC bus: Nominal voltage, ...). These parameters are also named as a parameter IDs (short ParIDs)

This can be opened by double-clicking on the ACOPOS parameter table in the Logical View („**.apt**" file extension).



gaxis02a.apt [ACOPOS Parameter Table]

Name	ID	Value	Unit	Description
Parameters				
MOTOR_TEST_MODE	866	7		Motor: Test mode
PHASE_MON_IGNORE	80	1		Power mains: Ignore phase failure
UDC_NOMINAL	390	24	V	CTRL DC bus: Nominal voltage

ACOPOS parameter table

? Motion \ Project creation \ Motion control \ Configuration modules \ ACOPOS parameter table

Exercise: Search ParIDs

The Automation Studio help system can be used to search ParIDs.

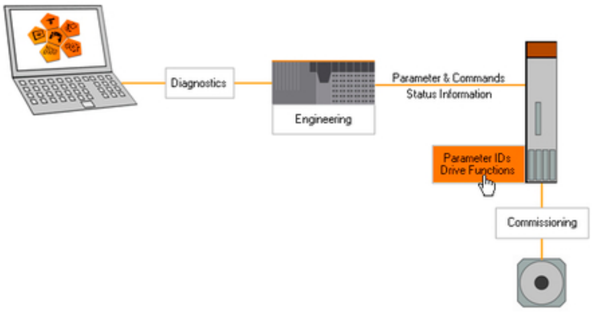
Search for the ParIDs of the following parameters:

- Temperature of the temperature sensor, current motor temperature
- Motor torque, current torque
- DC bus voltage
- Temperature of the cooler - temperature sensor on the power element

1) Start the Automation Studio Help system

2) Select the **Motion** folder from the Help system

3) Select the hotspot "Parameter IDs Drive Functions"



Selection aids in the Automation Studio help system

4) Search for the required parameters

Motion

Motion \ Reference manual \ ACP10 \ ACOPOS Parameter-IDs

4.1.3 NC error text table

The NC Error Text module contains the text groups for the drive, which makes it possible to generate clear text error messages.

This can be opened from the Logical View by double-clicking on the NC error text module. It can be identified by the „*.ett*“ file extension.

Motion \ Project creation \ Motion control \ Configuration modules \ NC error text table

4.1.4 NC Manager configuration

NC Manager is configured using the NC Manager configuration. These settings are separate from the-actual hardware.

For more information about this, please see the section 4.2 "System settings".

? Motion \ Project creation \ Motion control \ Configuration modules \ NC Manager configuration

4.1.5 NC mapping table

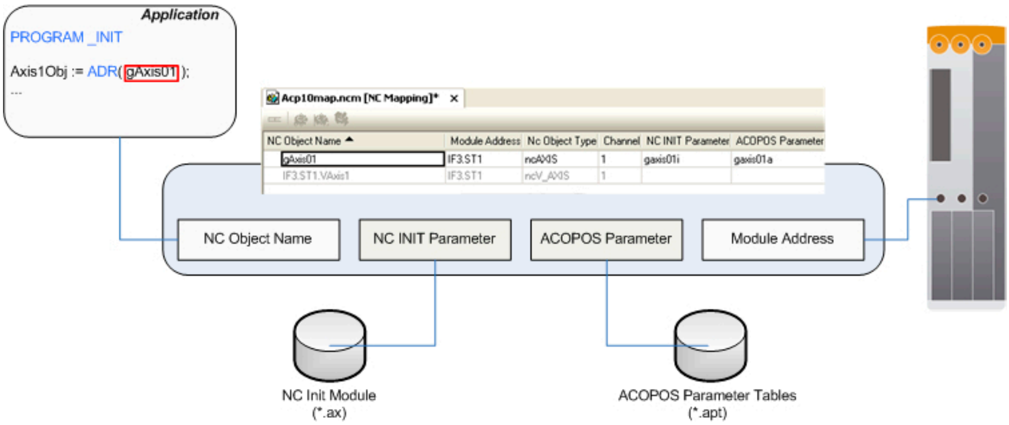
When configuring a drive, the wizard creates a global variable.

The name of this variable is also identified as axis reference and is defined by the user It is used to form the link between the application and the physical drive.

Each drive can be assigned an NC Init module and an ACOPOS parameter table via the NC mapping table.

The NC mapping table assigns the following configuration modules to an axis:

- NC Init module
- ACOPOS parameter table
- Axis reference (gAxis01)



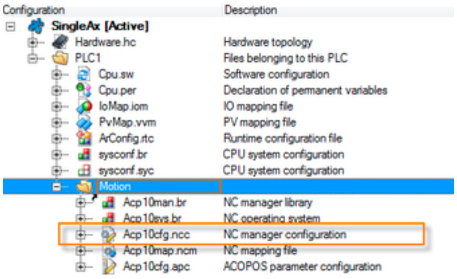
```
PROGRAM _INIT
Axis1Obj := ADR(gAxis01);
...
```

Acp10map.ncm [NC Mapping]*

NC Object Name	Module Address	Nc Object Type	Channel	NC INIT Parameter	ACOPOS Parameter
gAxis01	IF3.ST1	ncAXIS	1	gaxis01i	gaxis01a
IF3.ST1.VAxis1	IF3.ST1	ncV_AXIS	1		

Linking the drive with an axis variable

The NC mapping table can be opened by double-clicking in the Configuration View. t can be identified by the „.**ncm**“ file extension.



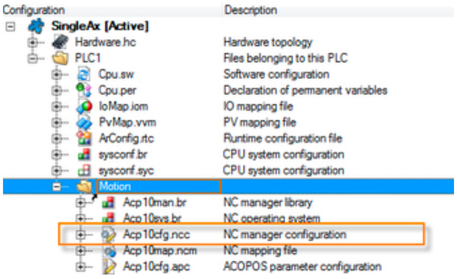
Configuration	Description
SingleAx [Active]	
Hardware.hc	Hardware topology
PLC1	Files belonging to this PLC
Cpu.sw	Software configuration
Cpu.per	Declaration of permanent variables
IoMap.iom	IO mapping file
PvMap.vvm	PV mapping file
ArConfig.rtc	Runtime configuration file
sysconf.br	CPU system configuration
sysconf.syc	CPU system configuration
Motion	
Acp10man.br	NC manager library
Acp10sys.br	NC operating system
Acp10cfg.ncc	NC manager configuration
Acp10map.ncm	NC mapping file
Acp10cfg.apc	ACOPOS parameter configuration

Opening the NC mapping table

? Motion \ Project creation \ Motion control \ Configuration modules \ NC mapping table

4.2 System settings

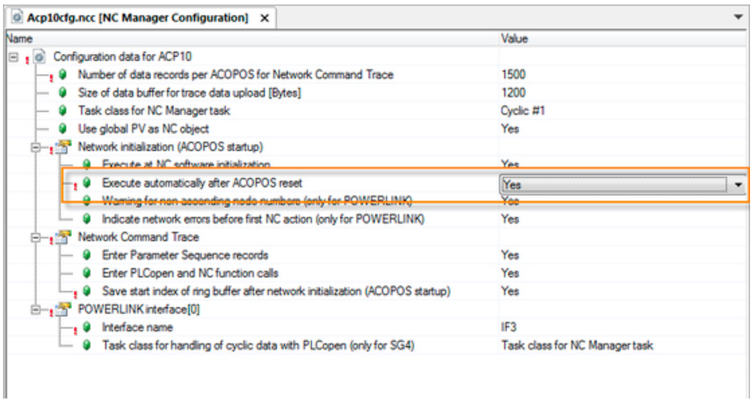
This can be opened by double-clicking on the NC Manager configuration in the Configuration View (***".ncc"*** file extension).



Configuration	Description
SingleAx [Active]	
Hardware.hc	Hardware topology
PLC1	Files belonging to this PLC
Cpu.sw	Software configuration
Cpu.per	Declaration of permanent variables
IoMap.iom	IO mapping file
PvMap.vvm	PV mapping file
ArConfig.rtc	Runtime configuration file
sysconf.br	CPU system configuration
sysconf.syc	CPU system configuration
Motion	
Acp10man.br	NC manager library
Acp10sys.br	NC operating system
Acp10cfg.ncc	NC manager configuration
Acp10map.ncm	NC mapping file
Acp10cfg.apc	ACOPOS parameter configuration

NC Manager configuration

The system settings are used to configure NC Manager. For example, the user can define the buffer size for the network command trace (5.4.2 "Network command trace") or the restart behavior of the drive.



Acp10cfg.ncc [NC Manager Configuration]

Name	Value
Configuration data for ACP10	
Number of data records per ACOPOS for Network Command Trace	1500
Size of data buffer for trace data upload [Bytes]	1200
Task class for NC Manager task	Cyclic #1
Use global PV as NC object	Yes
Network initialization (ACOPOS startup)	
Execute at NC software initialization	Yes
Execute automatically after ACOPOS reset	Yes
Warning for non ascending node numbers (only for POWERLINK)	Yes
Indicate network errors before first NC action (only for POWERLINK)	Yes
Network Command Trace	
Enter Parameter Sequence records	Yes
Enter PLCopen and NC function calls	Yes
Save start index of ring buffer after network initialization (ACOPOS startup)	Yes
POWERLINK interface[0]	
Interface name	IF3
Task class for handling of cyclic data with PLCopen (only for SG4)	Task class for NC Manager task

System settings

Communication between NC Manager and the operating system on the servo drive is lost when the control voltage is shut off. Change the setting "*Execute automatically after ACOPOS reset*" to "Yes" if communication should be reestablished automatically.

?

Motion \ Project creation \ Motion Control \ Configuration modules \ NC Manager configuration

5 COMMISSIONING AND DIAGNOSTICS ENVIRONMENT

Two environments are available for quickly and easily commissioning and diagnosing the drive configuration. These environments are controlled separately from the resulting application.

The following tools are used:

- SDM – System Diagnostics Manager

  Possibilities:

  - Read only access
  - Show axis state
  - Show axis errors
  - Downloading error list and files

- NC Test

  Possibilities:

  - Sending commands
  - Accessing the drive's parameters
  - Displaying status parameters
  - Recording real-time data on the drive

Commissioning and diagnostics

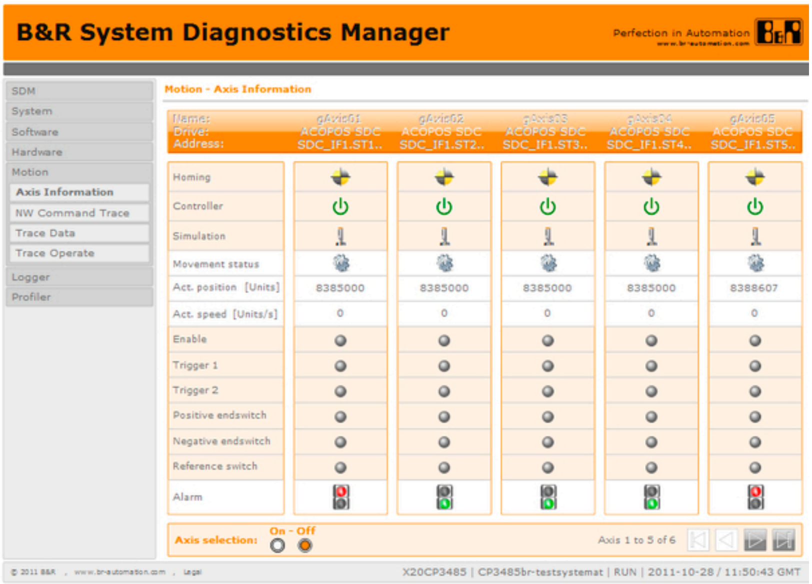
Additionally, a "commissioning checklist" (5.5 "Commissioning checklist") is also provided.

SDM – System Diagnostics Manager

The SDM can be used to quickly and easily evaluate drive status data, such as current speed or limit switch positions.

This can be accessed using a standard Web browser.

Other functions are also provided, such as starting a trace recording and then uploading the resulting data or the network command trace.



Motion - Axis Information

Name: Drive: Address:	gAxis01 ACOPOS SDC SDC_IF1.ST1..	gAxis02 ACOPOS SDC SDC_IF1.ST2..	gAxis03 ACOPOS SDC SDC_IF1.ST3..	gAxis04 ACOPOS SDC SDC_IF1.ST4..	gAxis05 ACOPOS SDC SDC_IF1.ST5..
Homing	⊕	⊕	⊕	⊕	⊕
Controller	⏻	⏻	⏻	⏻	⏻
Simulation					
Movement status	⚙	⚙	⚙	⚙	⚙
Act. position [Units]	8385000	8385000	8385000	8385000	8388607
Act. speed [Units/s]	0	0	0	0	0
Enable	●	●	●	●	●
Trigger 1	●	●	●	●	●
Trigger 2	●	●	●	●	●
Positive endswitch	●	●	●	●	●
Negative endswitch	●	●	●	●	●
Reference switch	●	●	●	●	●
Alarm	🔴	🟢	🟢	🟢	🔴

Axis selection: On - Off ○ ●   Axis 1 to 5 of 6

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Diagnostics with the SDM

Diagnostics and service \ Diagnostics tools \ System Diagnostics Manager

NC Test

Unlike the SDM, Automation Studio is required for the NC Test environment. A number of functions and parameters are included that are used for commissioning and/or diagnostics.

These include:

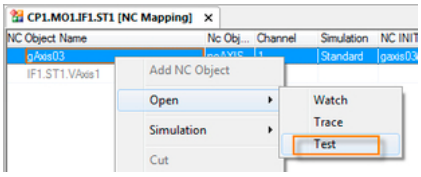
- Command interface
- Parameter management
- Displaying axis information
- Trace functions

A connection between Automation Studio, the controller and the drive is required in order to use NC Test.

Opening NC Test

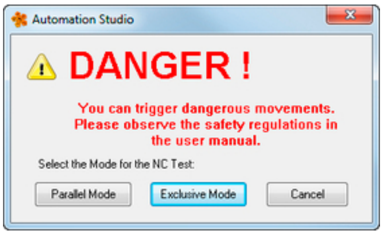
The mapping table is opened by **double-clicking** on the ACOPOS instance in the hardware tree.

NC Test can be opened by **right-clicking** on the corresponding axis object in the mapping table and selecting **Test**.



Opening NC Test

The following dialog box appears when the test window is opened:



DANGER !

You can trigger dangerous movements. Please observe the safety regulations in the user manual.

Select the Mode for the NC Test:

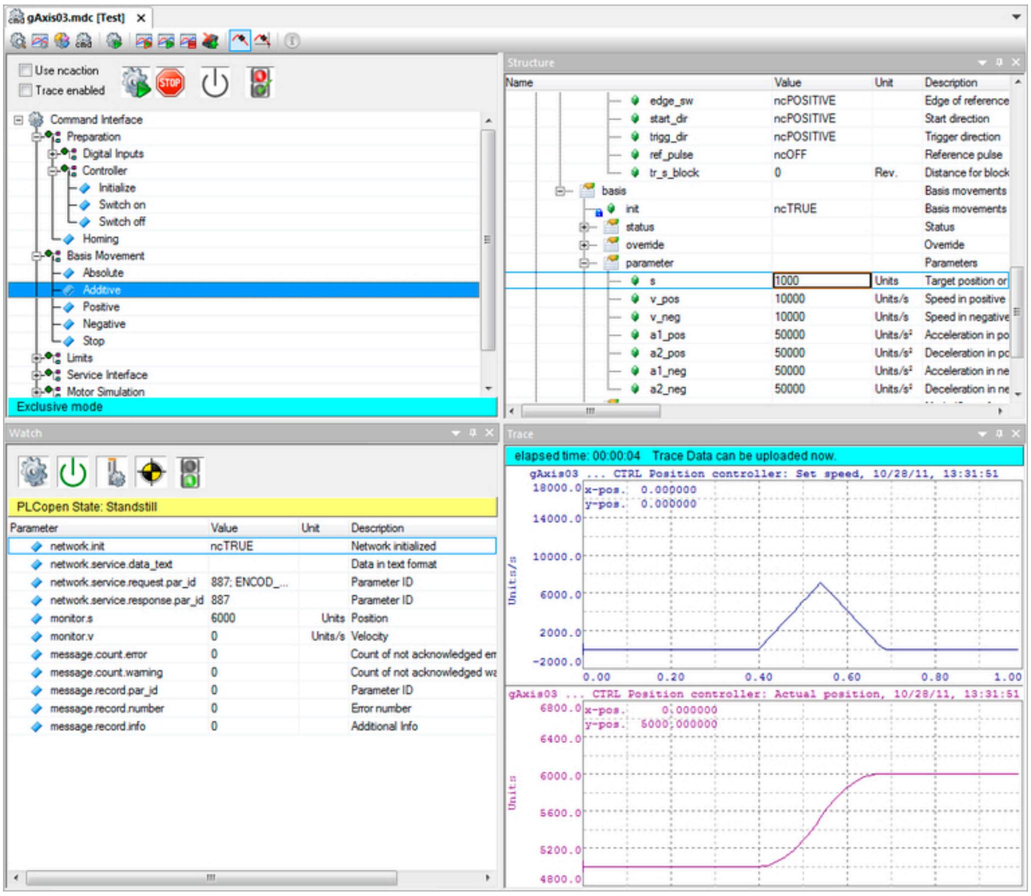
NC Test mode

The user must decide whether NC Test should access the axis **in parallel** or **exclusive** mode. In exclusive mode, the application commands are not forwarded to the axis. Instead, operation takes place exclusively from NC Test.

NC Test window appearance

The NC Test window consists of the following four sections:

- Command interface (5.1 "Command interface")
- Parameter management (5.2 "Parameter management")
- NC-Watch (5.3 "Displaying axis information")
- NC-Trace (5.4 "Trace function")



Name	Value	Unit	Description
edge_sw	ncPOSITIVE		Edge of reference
start_dir	ncPOSITIVE		Start direction
trigg_dir	ncPOSITIVE		Trigger direction
ref_pulse	ncOFF		Reference pulse
tr_s_block	0	Rev.	Distance for block
basis			Basis movements
init	ncTRUE		Basis movements
status			Status
override			Override
parameter			Parameters
s	1000	Units	Target position or
v_pos	10000	Units/s	Speed in positive
v_neg	10000	Units/s	Speed in negative
a1_pos	50000	Units/s²	Acceleration in po
a2_pos	50000	Units/s²	Deceleration in po
a1_neg	50000	Units/s²	Acceleration in ne
a2_neg	50000	Units/s²	Deceleration in ne

PLCopen State: Standstill

Parameter	Value	Unit	Description
network.init	ncTRUE		Network initialized
network.service.data_text			Data in text format
network.service.request.par_id	887: ENCOD_...		Parameter ID
network.service.response.par_id	887		Parameter ID
monitor.s	6000	Units	Position
monitor.v	0	Units/s	Velocity
message.count.error	0		Count of not acknowledged err
message.count.warning	0		Count of not acknowledged wa
message.record.par_id	0		Parameter ID
message.record.number	0		Error number
message.record.info	0		Additional Info

elapsed time: 00:00:04 Trace Data can be uploaded now.

NC Test window structure

If the NC Test window is closed during an active movement, then the user must choose whether the movement should be stopped or not.

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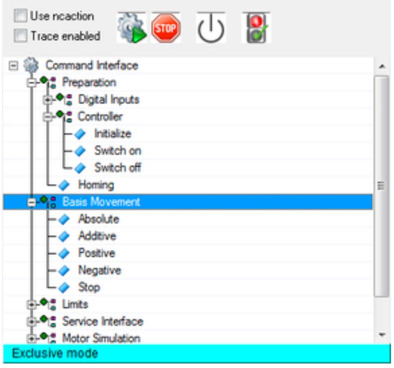
Motion \ Diagnostics \ NC Test

5.1 Command interface

The command interface is used for controlling an axis.



Command interface

Motion \ Diagnostics \ NC Test \ Command interface

The command interface is divided into the following sections:

- Preparation
- Basis movement
- Limit values
- Service interface
- Motor simulation
- Setting

Preparation

Before an axis can be put into motion, the drive's closed loop controller must be turned on using the command **"Switch On"**. The axis is referenced using the **"Homing"** command. Basis movements can then be executed.

The **"Initialize"** command can be used if parameters need to be initialized.

The digital inputs (limit switch, E-stop) can only be initialized when the closed loop controller is turned on. The controller parameters can also be initialized during the controller is switched on. The section 5.2 "Parameter management" describes where the parameters are located and how to change them..

Basis movement

Once prepared, the drive is ready to perform basis movements. These are the movement procedures that can be implemented in an application using PLCopen function blocks. They are performed by selecting the corresponding movement.

A detailed description of movement procedures can be found in the respective PLCopen function blocks.

Programming \ Libraries \ Motion libraries \ ACP10_MC \ Function blocks \ Basis movements

Service interface

The service interface can be used to read or write to individual parameters from the drive.

Limit values

The command ***"Initialize"*** can be used for any limits that have been changed and must be initialized. This requires that the closed loop controller be switched off.

The section 5.2 "Parameter management" provides more information regarding where parameters can be managed and changed.

Motor simulation

Motor simulation can be enabled using **"Switch on"** in the event that a motor must be simulated because it is not physically available or should not be moved (for testing).

Simulation can be disabled using **"Switch off"** if the function is no longer needed.

Setup

The setup section is used to determined controller parameters using the integrated auto-tuning procedure.

Exercise: Reading ParIDs

Determine the following drive parameters:

- Motor ambient temperature
- Actual position

1) Search ParIDs in the Automation Studio Help system.

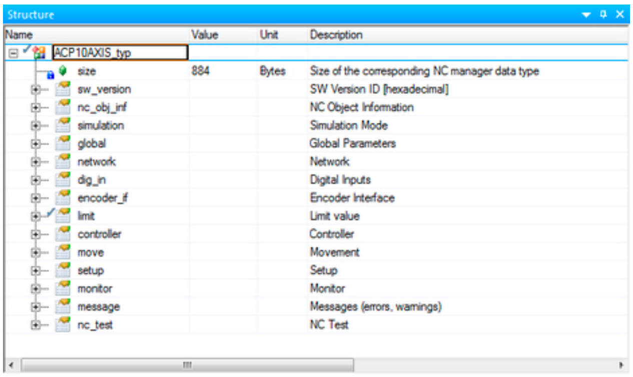
2) Reading ParID by using the command interface

3) Read out the values using the Watch window.

The values of the specified ParIDs were determined right on the drive.

5.2 Parameter management

Drive parameters are managed in the parameter window.

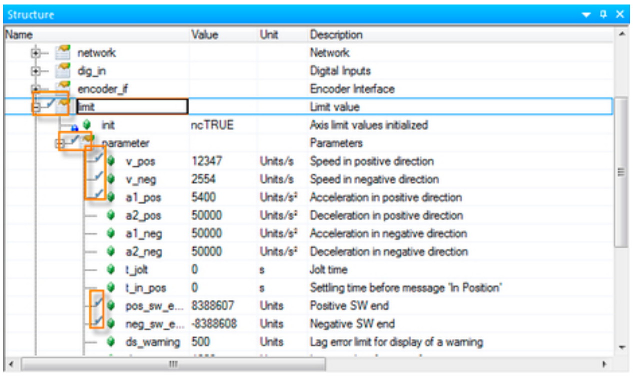


Name	Value	Unit	Description
ACP10AXIS_typ			
size	884	Bytes	Size of the corresponding NC manager data type
sw_version			SW Version ID [hexadecimal]
nc_obj_inf			NC Object Information
simulation			Simulation Mode
global			Global Parameters
network			Network
dig_in			Digital Inputs
encoder_if			Encoder Interface
limit			Limit value
controller			Controller
move			Movement
setup			Setup
monitor			Monitor
message			Messages (errors, warnings)
nc_test			NC Test

Parameter window

The parameter structure contains parameters for the INIT parameter module.

Values that are changed manually are compared with the saved parameters and identified with a black check mark.

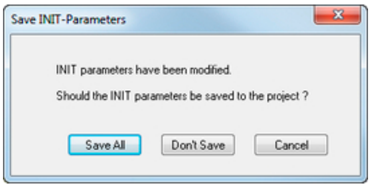


Name	Value	Unit	Description
network			Network
dig_in			Digital Inputs
encoder_if			Encoder Interface
limit			Limit value
init	ncTRUE		Axis limit values initialized
parameter			Parameters
v_pos	12347	Units/s	Speed in positive direction
v_neg	2554	Units/s	Speed in negative direction
a1_pos	5400	Units/s^2	Acceleration in positive direction
a2_pos	50000	Units/s^2	Deceleration in positive direction
a1_neg	50000	Units/s^2	Acceleration in negative direction
a2_neg	50000	Units/s^2	Deceleration in negative direction
t_jolt	0	s	Jolt time
t_in_pos	0	s	Settling time before message 'In Position'
pos_sw_e...	8388607	Units	Positive SW end
neg_sw_e...	-8388608	Units	Negative SW end
ds_warning	500	Units	Lag error limit for display of a warning

Changed parameters

Any initial parameters that were changed can be applied to the INIT parameter module.

A dialog box appears when exiting NC Test if saving does not take place explicitly. This allows the user to choose whether or not the changed INIT values will be saved to the INIT parameter module.



INIT parameters have been modified.

Should the INIT parameters be saved to the project ?

Exiting NC Test

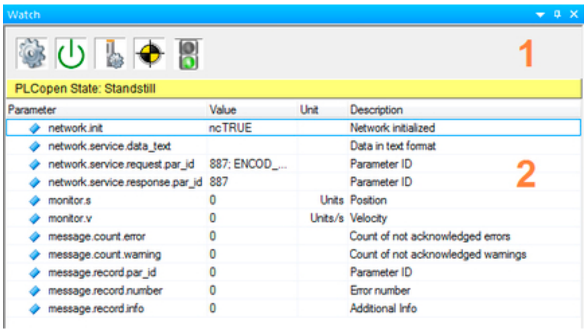
Motion \ Diagnostics \ NC Test \ Parameter window

5.3 Displaying axis information

NC Watch shows the user the current status of an NC object.

The NC Watch window can be divided into three sections:

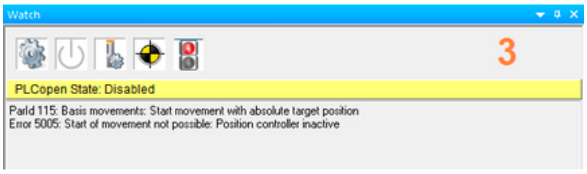
1 Object states
2 Object data
3 Error text



PLCopen State: Standstill

Parameter	Value	Unit	Description
network.init	ncTRUE		Network initialized
network.service.data_text			Data in text format
network.service.request.par_id	887; ENCOD_...		Parameter ID
network.service.response.par_id	887		Parameter ID
monitor.s	0	Units	Position
monitor.v	0	Units/s	Velocity
message.count.error	0		Count of not acknowledged errors
message.count.warning	0		Count of not acknowledged warnings
message.record.par_id	0		Parameter ID
message.record.number	0		Error number
message.record.info	0		Additional Info

NC Watch window



PLCopen State: Disabled

ParId 115: Basis movements: Start movement with absolute target position
Error 5005: Start of movement not possible: Position controller inactive

NC Watch window

This tool can also be opened outside of NC Test (same procedure as opening NC Test, **Selection: Watch**).

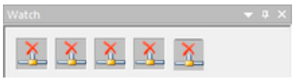
Diagnostics and service \ Diagnostics tool \ NC Diagnosis

Motion \ Diagnostics \ NC Watch

5.3.1 Object states

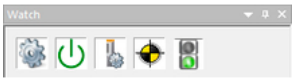
Icons in the bar at the top display the most important drive states.

Any connection errors that occur between the NC object and the controller appear as follows:



Watch: Problem with communication

After the connection has been established successfully and the drive has been prepared, the object states appear as follows:



Watch: Status icons

The traffic light icon (far right) is used for switching to and from the NC Watch window. This is needed to display the error text for any errors that are pending.

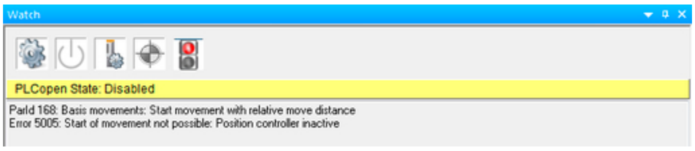
No error pending on the axis:

Green traffic light

Error pending on the axis:

Red traffic light

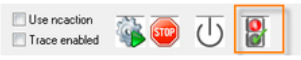
If there is an error, a detailed error description appears below the icons.



PLCopen State: Disabled

ParId 168: Basis movements: Start movement with relative move distance
Error 5005: Start of movement not possible: Position controller inactive

Error text



Acknowledge in the command area

The button in the command area can be used to acknowledge one or more errors.

If an action causes multiple errors simultaneously, they will be acknowledged in order.

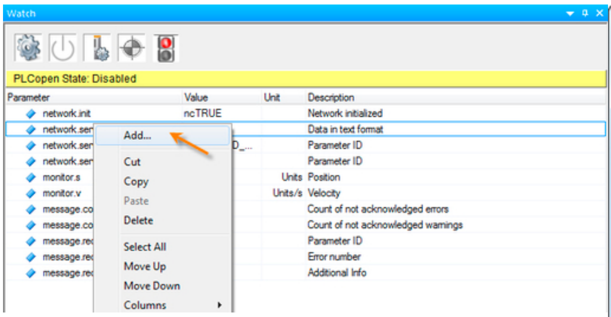
Diagnostics and service \ Diagnostic Tools \ NC Diagnosis \ NC Test

Motion \ Diagnostics \ NC Watch

5.3.2 Object data

The first time NC Watch is opened, this section displays elements from the operating structure that are used frequently. The user can modify the list to include other parameters.

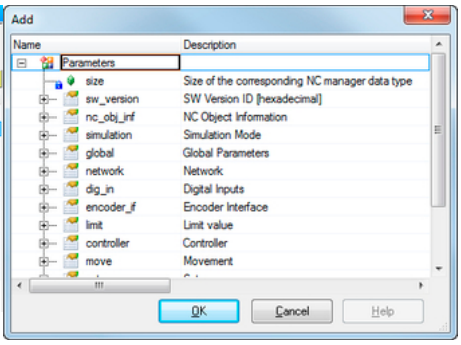
This is done by **right-clicking**:**Add**



PLCopen State: Disabled

Parameter	Value	Unit	Description
network.init	ncTRUE		Network initialized
network.ser			Data in text format
network.ser	D_...		Parameter ID
network.ser			Parameter ID
monitor.s		Units	Position
monitor.v		Units/s	Velocity
message.co			Count of not acknowledged errors
message.co			Count of not acknowledged warnings
message.re			Parameter ID
message.re			Error number
message.re			Additional Info

Adding a command



Name	Description
Parameters	
size	Size of the corresponding NC manager data type
sw_version	SW Version ID [hexadecimal]
nc_obj_inf	NC Object Information
simulation	Simulation Mode
global	Global Parameters
network	Network
dig_in	Digital Inputs
encoder_if	Encoder Interface
limit	Limit value
controller	Controller
move	Movement

Selecting the command

The desired elements are selected from the NC object operating structure subgroups in the corresponding dialog box.

The selected entries are then added to NC Watch.

The list of the parameters displayed in the parameter window is saved (without the parameter values) when the NC Watch window is closed. This list is restored the next time NC Watch is opened.

5.4 Trace function

The target system provides two different trace functions.

One is NC Trace, which makes it possible to record real-time data right on the drive. The other is the network command trace, which can be used to log commands at the network level.

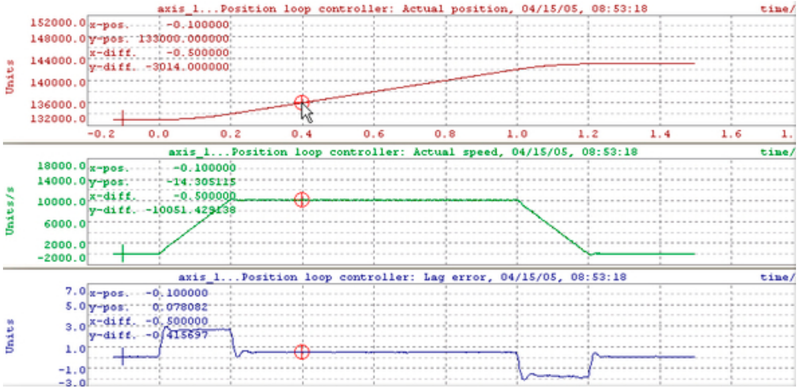
5.4.1 NC Trace

Real-time data is recorded directly on the drive. The recorded data is loaded to Automation Studio from the ACOPOS device via the PLC and displayed graphically.

Among other things, this trace provides the following features:

- Setting the control parameters
- Checking the motor load
- Checking the load on the ACOPOS
- Checking the positioning sequence
- Multi-axis trace (synchronous recording of multiple axes)

The following image shows how the results are displayed in NC Trace:



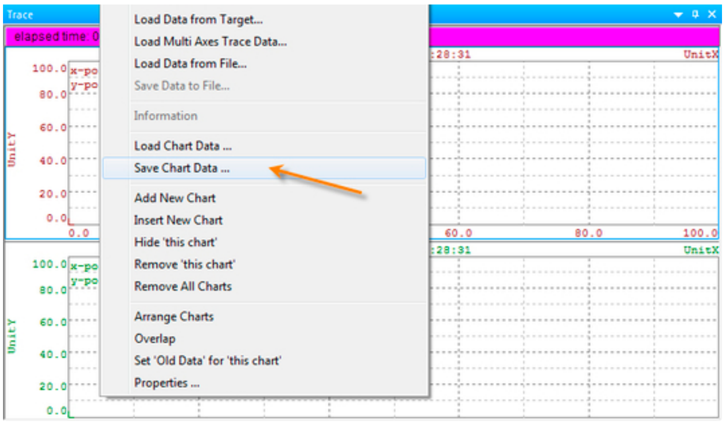
Example of a parameter trace

A number of different tools can be used for detailed data analysis.

Like NC Watch, the Trace function can be operated independently of NC Test by opening it directly for the NC object.

Saving trace data

Collected trace data can be saved to a file and used again later by **ight-clicking** in the NC Trace window and selecting "Save Chart Data".

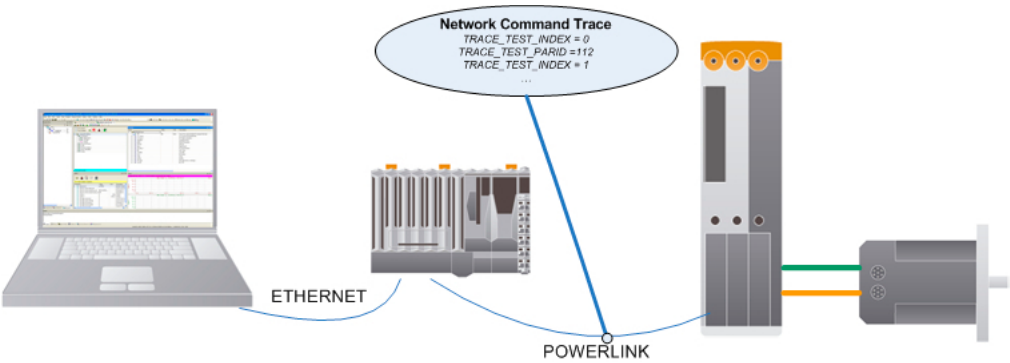


Saving trace data

Motion \ Diagnostics \ NC Trace

5.4.2 Network command trace

The network command trace can be used to record communication between the PLC and the drive. This means an accurate analysis of the network communication between the controller and the drive is possible.

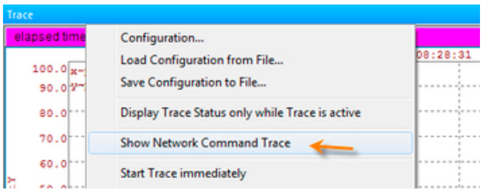


Network command trace

Among other things, this function can help check the order in which commands will be sent by the tasks to the PLC. The procedure is traceable and any errors that might occur can be found quickly and easily.

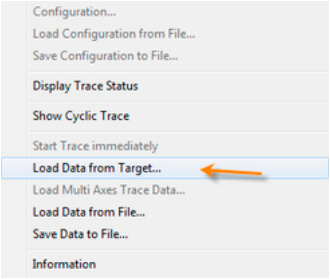
The network command trace is an expansion of NC Trace and is therefore also opened in the trace environment.

The network command trace is opened by **right-clicking** on the NC Trace interface and selecting **Show Network Command Trace**. This method can also be used to switch back to the cyclic trace.


Trace
elapsed time
Configuration...
Load Configuration from File...
Save Configuration to File...
Display Trace Status only while Trace is active
Show Network Command Trace
Start Trace immediately
100.0
90.0
80.0
70.0
60.0
08:28:31

Opening the network command trace

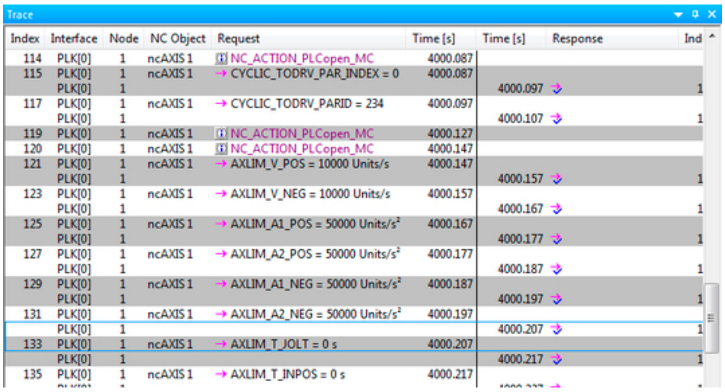
The network command trace is constantly active. The size defined for the recording buffer determines how many entries can be viewed. The recordings are loaded to the trace by **right-clicking** and selecting **Load Data from Target...**.



Configuration...
Load Configuration from File...
Save Configuration to File...
Display Trace Status
Show Cyclic Trace
Start Trace immediately
Load Data from Target...
Load Multi Axes Trace Data...
Load Data from File...
Save Data to File...
Information

Loading the data

The network command trace shows a list of entries. These entries provide information about the parameters that have been sent to the drive by the NC Manager. Information about the drive's corresponding response is also provided.



Trace

Index	Interface	Node	NC Object	Request	Time [s]	Time [s]	Response	Ind
114	PLK[0]	1	ncAXIS 1	NC_ACTION_PLCopen_MC	4000.087			
115	PLK[0]	1	ncAXIS 1	→ CYCLIC_TODRV_PAR_INDEX = 0	4000.087			
	PLK[0]	1				4000.097	→	1
117	PLK[0]	1	ncAXIS 1	→ CYCLIC_TODRV_PARID = 234	4000.097			
	PLK[0]	1				4000.107	→	1
119	PLK[0]	1	ncAXIS 1	NC_ACTION_PLCopen_MC	4000.127			
120	PLK[0]	1	ncAXIS 1	NC_ACTION_PLCopen_MC	4000.147			
121	PLK[0]	1	ncAXIS 1	→ AXLIM_V_POS = 10000 Units/s	4000.147			
	PLK[0]	1				4000.157	→	1
123	PLK[0]	1	ncAXIS 1	→ AXLIM_V_NEG = 10000 Units/s	4000.157			
	PLK[0]	1				4000.167	→	1
125	PLK[0]	1	ncAXIS 1	→ AXLIM_A1_POS = 50000 Units/s^2	4000.167			
	PLK[0]	1				4000.177	→	1
127	PLK[0]	1	ncAXIS 1	→ AXLIM_A2_POS = 50000 Units/s^2	4000.177			
	PLK[0]	1				4000.187	→	1
129	PLK[0]	1	ncAXIS 1	→ AXLIM_A1_NEG = 50000 Units/s^2	4000.187			
	PLK[0]	1				4000.197	→	1
131	PLK[0]	1	ncAXIS 1	→ AXLIM_A2_NEG = 50000 Units/s^2	4000.197			
	PLK[0]	1				4000.207	→	1
133	PLK[0]	1	ncAXIS 1	→ AXLIM_T_JOLT = 0 s	4000.207			
	PLK[0]	1				4000.217	→	1
135	PLK[0]	1	ncAXIS 1	→ AXLIM_T_INPOS = 0 s	4000.217			

Example of a network command trace

More detailed information can be found in the Automation Studio documentation.

?

Motion \ Diagnostics \ Network Command Trace

Exercise: Record lag errors using the trace function

Set up a trace for an additive movement using NC Trace.

At too high acceleration or speed, an lag error can happen. The movement stops. Determined by the data, the maximum speed can be determined.

Check the following settings in the parameter window:

- s = 10000
- v = 10000

1) Prepare the drive (initialize and turn on the controller)

2) Configure the trace.

Adding the parameters:

- Actual speed / set speed
- Lag error

3) Start tracing.

4) Execute the additive movement.

5) After finishing the trace, set the measurement cursors for the current speed at the beginning and end.

6) Adjust the chart properties for the current speed curve to display the average speed.

7) Achnowledge axis error

8) Set the average speed as the maximum speed.

> The trace indicates that the lag error increases up to the configured value and pushes the drive into an error state.
>
> The average value for an axis can be displayed in the area between the measurement cursors by making a simple change to the chart properties.
>
> With the changed (reduced) maximum speed of the leg error remains within its borders, the movement stop no longer occurs.

Exercise: Trace the deceleration ramp

Use a trigger to start recording the deceleration ramp.

Use a trigger to start recording the deceleration ramp. The following parameters must be recorded:

- Actual speed / set speed
- Lag error

The trigger should have the following conditions:

- Set speed is within the range v_max and v_max – 10%
- "Stop" command has been issued

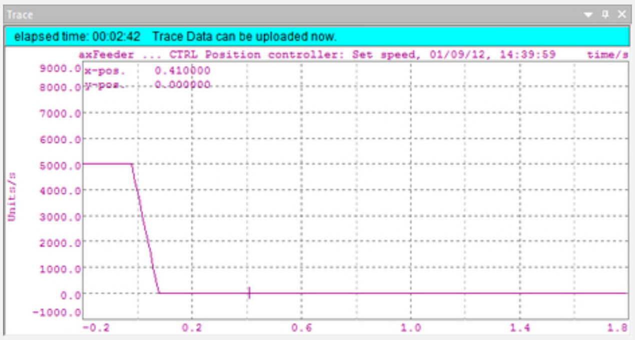
1) Set the trigger conditions.

2) Perform a movement in the positive direction.

3) Stop the movement.

4) Evaluate the trace recording.

The drive's deceleration can be seen in the trace recordings.



elapsed time: 00:02:42 Trace Data can be uploaded now.

Deceleration of the set speed in the trace

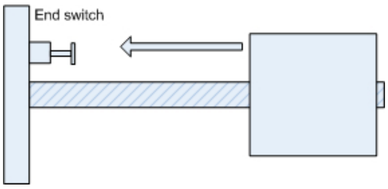
5.5 Commissioning checklist

This section provides step-by-step instructions for commissioning a hardware configuration with drives.

The following points needs to be taken into account:

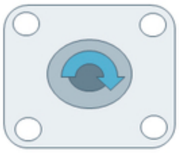
- Safety
  It is particularly important to test the safety features. includes the emergency stop and the limit switches installed on the machine.

E_stop



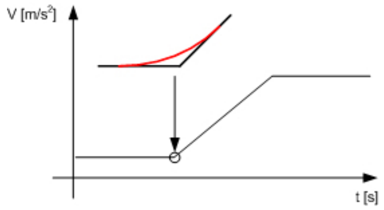
Limit switches

- Units / Parameters
  The configured units must be checked as well as the settings that have been made (those below, for example):
  - Resolution of a motor rotation
  - Lag error
  - Software limits
  - Acceleration values / speed values
  - Stop functions - direction of motor rotation
  - Etc.



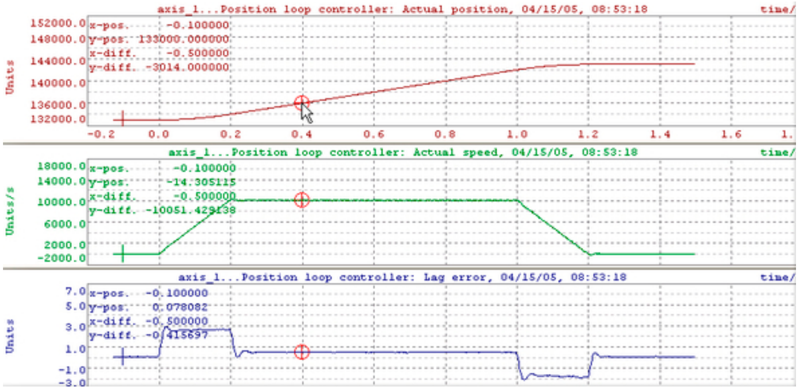
Checking the direction of rotation

- Jolt time
  Using jolt time is recommended to prevent placing unnecessary load on the mechanical components. This is set up using the parameter t_jolt.



Jolt time

- Tuning & Autotuning
  Tuning is necessary in order to adjust the controller settings to the exact mechanical requirements.. Automation Studio provides an integrated auto-tuning procedure to determine the controller parameters.



Performing a tuning operation

Motion \ Reference manual \ APC10 \ NC-Objects \ NC-Object "ncAXIS" \ Setup (from V1.24 on) \ Setup for Controller (Autotuning)

- Homing methods
  To ensure that positioning is accurate, a homing procedure must fist be executed on the drive. There are a few different ways to do this.

Programming \ Libraries \ Motion Libraries \ ACP10_MC \ Function Blocks \ Drive Preparation \ MC_Home

Motion \ Reference manual \ ACP10 \ NC-Objects \ NC-Object "ncAXIS" \ Homing Procedure

- Digitale inputs
  Check whether the servo drive's digital inputs have been wired according to the defined parameters.

ACOPOS input

Exercise: Impact of the commissioning parameters

Change the following parameters and check their functionality.

Parameters:

- Jolt time (t_jolt)
- Lag error
- Direction of motor rotation (count_dir)
- Homing procedure

1) Find and change the parameters in the parameter window
2) Save and transfer the changed values
3) Initialize the servo drive
4) Start the movement and tracing
5) Evaluate the trace data
6) Perform auto-tuning
7) Start movement and trace
8) Evaluate trace data
9) Working with the different homing procedures

   Use the Automation Studio Help to explore the different homing procedures. Then, a homing to a limit switch (if any) should be performed.

The motor rotates in the opposite direction. The jolt time as well as the lag error were changed.

6 SIMULATION OPTIONS

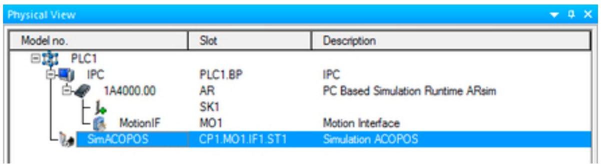
Automation Studio supports several possibilities for simulating drives and motors.

6.1 Simulation environment - ArSim

If *"PC Based Simulation Runtime - ArSim"* is used as the controller, then axes can be added and configured for this configuration.

This is done by right-clicking on **Slot MO1** in the Physical View and selecting "Insert". A dialog box appears with **MotionIF** selected.

To insert an axis, open MotionIF and select **SimACOPOS** by right-clicking and selecting "Insert". The same wizard as before guides the user through the dialog boxes to create configuration modules just like for a real drive.



Model no.	Slot	Description
PLC1		
IPC	PLC1.BP	IPC
1A4000.00	AR	PC Based Simulation Runtime ARsim
	SK1	
MotionIF	MO1	Motion Interface
SimACOPOS	CP1.MO1.IF1.ST1	Simulation ACOPOS

Simulating an axis

There is no limitation to the use of diagnostics tools in the simulation. Full functionality is available to the user.

Motion \ Project creation \ Motion Control \ Creating an axis \ Insert drive

6.2 Motor and drive simulation

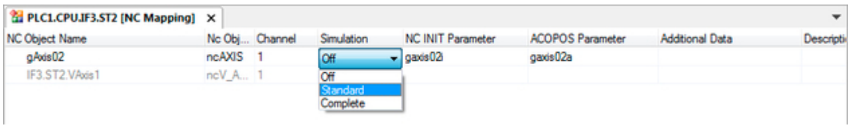
A motor which is not connected to the drive or cannot currently be moved is able to be simulated. It is even possible to fully simulate the complete drive.

Motor simulation

Simulation mode is enabled in the NC Test window using the command interface under "Motor Simulation". Simulation is started with the **"switch on"** command and stopped with **"switch off"**. The motor simulation can also be activated using the ACOPOS parameter table.

Drive simulation

The simulation mode for the drive can be selected in the NC mapping table. Depending on the mode, a complete simulation is performed rather than only set value generation without controller cascade.



PLC1.CPU.IF3.ST2 [NC Mapping]

NC Object Name	Nc Obj...	Channel	Simulation	NC INIT Parameter	ACOPOS Parameter	Additional Data	Descripti
gAxis02	ncAXIS	1	Off	gaxis02i	gaxis02a		
IF3.ST2.VAxis1	ncV_A...	1					

Activating drive simulation in the NC mapping table

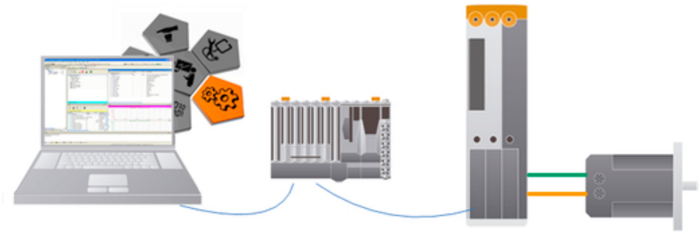
Motion \ Reference manual \ ACOPOS drive functions \ ACOPOS simulation

7 SUMMARY

Drives are managed and configured centrally in Automation Studio.

NC Manager uses the controller to communicate with the NC operating system on the servo drive over an entire network.

NC Manager is the central component for controlling the drives. It sends parameters and commands to the drive, as well as providing the user with status information.



The integrated drive concept in Automation Studio

Diagnostic tools provide an efficient environment for testing and commissioning.

This considerably reduces both costs as well as the time needed for programming software, commissioning and maintenance.

TRAINING MODULES

TM210 – Working with Automation Studio
TM213 – Automation Runtime
TM220 – The Service Technician on the Job
TM223 – Automation Studio Diagnostics
TM230 – Structured Software Development
TM240 – Ladder Diagram (LD)
TM241 – Function Block Diagram (FBD)
TM242 – Sequential Function Chart (SFC)
TM246 – Structured Text (ST)
TM250 – Memory Management and Data Storage
TM261 – Closed Loop Control with LOOPCONR
TM400 – Introduction to Motion Control
TM410 – Working with Integrated Motion Control
TM440 – Motion Control: Basic Functions
TM441 – Motion Control: Multi-axis Functions
TM450 – ACOPOS Control Concept and Adjustment
TM460 – Initial Commissioning of Motors
TM480 – The Basics of Hydraulics
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TM510 – Working with SafeDESIGNER
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TM610 – Working with Integrated Visualization
TM630 – Visualization Programming Guide
TM640 – Alarms, Trends and Diagnostics
TM670 – Advanced Visual Components
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