SIEMENS

SINUMERIK

SINUMERIK 840D sl / 840Di sl / 802D sl
ADI4 - Analog drive interface for 4 axes

Manual

Valid for

Control
SINUMERIK 840D sl/840DE sl
SINUMERIK 840Di pl/840DiE pl
SINUMERIK 840Di sl/840DiE sl
SINUMERIK 802D sl

Software Version
ADI4 system software 1.4.8

03/2010
6FC5297-0BA01-0BP5

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of the Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Order number: 6FC5297-0BA01-0BP5
℗ 04/2010

Preface

Structure of the manual

SINUMERIK® Documentation

The SINUMERIK documentation is organized in 3 parts:

- General documentation
- User documentation
- Manufacturer/Service Documentation

Information on the following topics is available at
http://www.siemens.com/motioncontrol/docu:

- Ordering documentation
  Here you can find an up-to-date overview of publications.
- Downloading documentation
  Links to more information for downloading files from Service & Support.
- Researching documentation online
  Information on DOConCD and direct access to the publications in DOConWEB.
- Compiling individual documentation on the basis of Siemens contents with the My Documentation Manager (MDM), refer to http://www.siemens.com/mdm.

  My Documentation Manager provides you with a range of features for generating your own machine documentation
- Training and FAQs
  Information on the range of training courses and FAQs (frequently asked questions) are available via the page navigation

Target group

This documentation is intended for manufacturers of machine tools, particularly:

- Project engineers, electricians and installers
- Maintenance and service personnel

Benefits

The information in this manual facilitates installation and connection of the SINUMERIK 840D numerical control in the control cabinet.

Standard scope

This documentation only describes the functionality of the standard version. Extensions or changes made by the machine manufacturer are documented by the machine manufacturer.

Other functions not described in this documentation might be executable in the control. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of servicing.

For the sake of simplicity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation, or maintenance.

Technical Support

If you have any technical questions, please contact our hotline:

	Europe/Africa
Phone	+49 180 5050 222
Fax	+49 180 5050 223
0.14 €/min. from German landlines, max. 0.42 €/min for calls from a mobile phone	
Internet	http://www.siemens.com/automation/support-request

	America
Phone	+1 423 262 2522
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Fax	+86 1064 747474
E-mail	mailto:support.asia.automation@siemens.com

Note

For technical support telephone numbers for different countries, go to:

http://www.automation.siemens.com/partner

Questions about the documentation

If you have any questions (suggestions, corrections) regarding this documentation, please fax or e-mail us at:

Fax: +49 9131 98 2176

E-mail: mailto:docu.motioncontrol@siemens.com

A fax form is available in the appendix of this document.

SINUMERIK Internet address

http://www.siemens.com/sinumerik

EC Declaration of Conformity

The EC Declaration of Conformity for the EMC Directive can be found/obtained:

- On the Internet: http://support.automation.siemens.com
  under product/order number 15257461
- From the relevant regional office of the I DT MC division of Siemens AG

Convention

Throughout this document, the term "Control Unit" is also used for product designations NCU 7x0, provided that the technical conditions described are applicable to all variants.

Table of contents

Safety information

1

1.1 Danger notices

The following notices are intended firstly for your personal safety and secondly to prevent damage occurring to the product described or any connected devices and machines. Non-observance of the warnings can result in severe personal injury or property damage.

⚠DANGER

Only appropriately qualified personnel may commission/start-up SINUMERIK equipment.

The personnel must take into account the information provided in the technical customer documentation for the product, and be familiar with and observe the specified danger and warning notices.

When electrical equipment and motors are operated, the electrical circuits automatically conduct a dangerous voltage.

When the system is operating, dangerous axis movements may occur throughout the entire work area.

A potential fire hazard exists due to the energy being transferred in the equipment and the work materials used.

All work on the electrical system must be performed after the system has been switched off and disconnected from the power supply.

⚠DANGER

Proper transportation, expert storage, installation and mounting, as well as careful operation and maintenance are essential for this SINUMERIK device to operate correctly and reliably.

The details in the catalogs and proposals also apply to the design of special equipment versions.

In addition to the danger and warning information provided in the technical customer documentation, the applicable national, local, and system-specific regulations and requirements must be taken into account.

Only protective extra-low voltages (PELVs) that comply with EN 61800-5-1 can be connected to all connections and terminals between 0 and 48 V.

Should it be necessary to test or take measurements on live equipment, then the specifications and procedural instructions defined in Accident Prevention Regulation VBG A2 must be adhered to, in particular § 8 "Permissible deviations when working on live components". Suitable electric tools should be used.

⚠WARNING

Operating the equipment in the immediate vicinity (< 1.5 m) of mobile telephones with a transmitting power of > 1 W may lead to incorrect functioning of the devices.

Connecting cables and signal lines should be installed so that inductive and capacitive interference does not in any way impair the automation and safety functions.

⚠DANGER

Repairs to devices that have been supplied by our company may only be carried out by SIEMENS customer service or by repair centers authorized by SIEMENS.

When replacing parts or components, only use those parts that are included in the spare parts list.

EMERGENCY STOP devices EN 60204-1 (VDE 0113 Part 1) must remain active in all modes of the automation equipment. Resetting the EMERGENCY STOP device must not cause an uncontrolled or undefined restart.

Anywhere in the automation equipment where faults might cause physical injury or major material damage, in other words, where faults could be dangerous, additional external precautions must be taken, or facilities must be provided, that guarantee or enforce a safe operational state, even when there is a fault (e.g. using an independent limit value switch, mechanical locking mechanisms, EMERGENCY STOP devices)

1.2 ESD information

CAUTION

The modules contain electrostatically sensitive devices. Discharge yourself of electrostatic energy before touching the components. The easiest way to do this is to touch a conductive, grounded object immediately beforehand (for example, bare metal parts of control cabinet or the protective ground contact of a socket outlet).

NOTICE

Handling ESD-modules:

- When handling electrostatically sensitive devices, make sure that operator, workplace and packing material are properly grounded.
- Generally, electronic modules must not be touched unless work has to be carried out on them. When handling PCBs make absolutely sure that you do not touch component pins or printed conductors.
- Touch components only if:
  - You are permanently grounded via an ESD armband
  - You are wearing ESD shoes or ESD shoe-grounding-strips, if ESD flooring is available
- Modules may only be placed on electrically conductive surfaces (table with ESD top, conductive ESD foam plastic, ESD packaging bags, ESD transport containers).
- Keep modules away from visual display units, monitors or TV sets (minimum distance from screen 10 cm).
- Do not bring ESD-sensitive modules into contact with chargeable and highly-insulating materials, such as plastic, insulating table tops or clothing made of synthetic materials.
- Measurements on modules are allowed only if:
  - The measuring instrument is properly earthed (e.g., protective conductor) or
  - Before measuring with a floating measuring instrument, the probe is briefly discharged (e.g., touch the bare metal parts of the control housing).

1.3 Safe isolation to EN 61800-5-1

Prerequisite

The complete system includes user interfaces (UIs) and interfaces for servicing, startup and maintenance.

User interfaces (UIs)

UIs are all the interfaces that are freely accessible to the machine operator without the need for tools or aids. These user interfaces provide safe isolation up to 230 V AC according to EN 61800-5-1.

Interfaces for servicing, startup and maintenance

⚠DANGER

The interfaces for servicing/installation and start-up/maintenance purposes are provided **without** protective separation.

If necessary, these interfaces can be isolated safely using a supplementary adapter (insulation voltage 230 V AC). Although these adapters are not included in the Siemens scope of delivery, you can buy these parts from your local dealer, who will be happy to advise you.

⚠DANGER

Safe isolation can only be ensured if the system configuration specified below is strictly adhered to. When installing additional components with EUIs, please make sure that the EUIs have safe isolation for at least 230 V AC.

Note

The components of the drive control comply with EN 61800-5-1 and contain only circuits and customer terminals with class DVC A voltages and safety isolation from circuits with dangerous voltages (PELV circuits).

1.4 RI suppression measures

In addition to the protective grounding of system components, special precautions must be taken to ensure safe, fault-free operation of the system. These measures include shielded signal lines, special equipotential bonding connections, and isolation and shielding measures.

Shielded signal lines

- For the safe and smooth operation of the system, the specified cables must be used. Please refer to the chapter titled Connection.
- For digital signal transmission, the shield must have a conductive connection at both sides of the housing.

  Exception:
  Standard shielded cables grounded on one side can be used for devices from other manufacturers (printers, programming devices, etc.). However, these devices must not be connected to the controller during normal operation. However, if the system cannot operate without them, then the cable shields must be connected at both ends. Furthermore, the non-Siemens device must be connected to the controller via an equipotential bonding cable.

Cable definitions

- Signal cables (example)
  - Data cables (Ethernet, PROFINET, DRIVE-CLiQ, sensor cables, etc.)
  - Ribbon cables for digital inputs/outputs
  - EMERGENCY OFF lines
- Power cables (example)
  - Low-voltage supply cables (230 V AC, 24 V DC, etc.)
  - Supply cables to contactors (primary and secondary circuit)

Rules for routing cables

In order to maximize noise immunity for the complete system (controller, power section, machine) the following EMC measures must be observed:

- Signal cables and power cables must be routed at the greatest possible distance from one another.
- If necessary, signal and power cables may cross one another (if possible at an angle of 90°), but must never be laid close or parallel to one another.
- Signal cables may not be routed close to strong external magnetic fields (e.g., motors and transformers).
- Pulse-loaded HC/HV lines must always be laid completely separately from all other lines.
- If signal lines cannot be routed a sufficient distance away from other cables, they must be installed in grounded cable ducts (metal).
- The clearance (interference injection area) between the following lines must be kept to a minimum:
  - Signal line and electrical circuit signal line (twisted)
  - Signal line and associated equipotential bonding conductor
  - Equipotential bonding conductor and protective conductor (routed together)

Note

For more information about interference suppression measures and connection of shielded cables, see

References

/EMC/ EMC Installation Guide

System overview

2

SINUMERIK 840D sl combines CNC, HMI, PLC, closed-loop control, and communication tasks within a single NCU (Numerical Control Unit).

Components

For operation, programming, and visualization purposes, the corresponding operating software is already integrated into the CNC software for the NCU and therefore runs on the high-performance NCU multi-processor module. For increased operating performance, the SINUMERIK PCU 50.3 industrial PC can be used.

Up to four distributed OPs can be operated on one NCU/PCU. The operator panel can be installed as a Thin Client at a distance of up to 100 m.

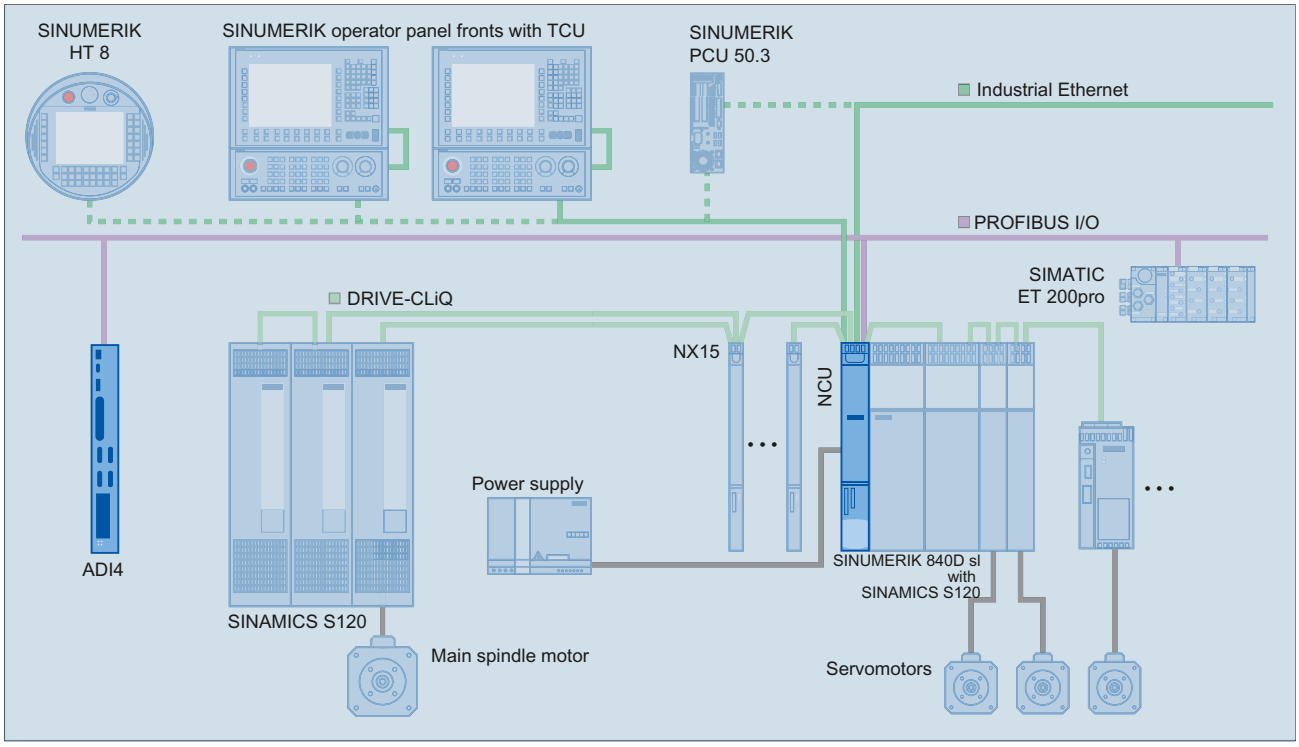


Figure 2-1 Typical topology of the SINUMERIK 840D sl complete system

The following components can be attached to the Control Unit:

- SINUMERIK operator panel front with TCU/PCU 50.3 and Machine Control Panel/Machine Push Button Panel
- SIMATIC CE panel
- SINUMERIK handheld units
- Distributed PLC I/O via PROFIBUS DP or PROFINET I/O (only applies to NCU 720.2 PN and NCU 730.2 PN)

- SINUMERIK PP 72/48 peripheral module
- SINUMERIK ADI4 (Analog Drive Interface for 4 Axes)
- SINAMICS 120 drive system
- Feed and main spindle motors
  - 1FT/1FK/1FN/1FW6/1FE1/2SP1 synchronous motors
  - 1PH/1PM asynchronous motors

With the NCU 720.2 PN and NCU 730.2 PN, the SINUMERIK 840D sl is offering integrated PROFINET functionality for the first time.

Supported:

- PROFINET CBA functionality

  The CBA functionality integrated in the NCU allows users to modularize machinery and systems: Rapid real-time communication (up to 10 ms) between the controllers means that systems lend themselves better to standardization and can be reused or expanded more easily. Response to customer demands is faster and more flexible and startup is simplified and speeded up by pretesting at component level.

- PROFINET IO

  As part of PROFINET, PROFINET IO is a communication concept that is used to implement modular, distributed applications. PROFINET IO is based on Industrial Ethernet and allows distributed field and I/O equipment to be connected to the central processing unit.

  256 PROFINET IO devices can be operated on the NCU as an IO controller.

Description 3

3.1 Properties

Properties of ADI4 module

An ADI4 module (Analog Drive Interface for 4 axes) is an interface module suitable for operating up to four drives with an analog setpoint interface and TTL/SSI encoders on an equidistant PROFIBUS-DP.

Communication between the controller and the ADI4 is performed via an ADI4-specific message frame type which, in addition to digital input/output data, also contains a message frame type for each drive specified according to a PROFIDrive profile (standard message frame 3, see Chapter "Message frame type (Page 46)"). As part of cyclic DP communication, the actual drive values (encoder values) are transferred from the ADI4 module to the controller via PROFIBUS DP, and the speed setpoints calculated by the controller are transferred to the ADI4 module.

The transferred speed setpoints are then output from the ADI4 module to the drives as analog values.

3.2 Essential features

Features of the ADI4 module

The module has the following essential features:

- PROFIBUS DP connection (maximum of 12 Mbits/s)
- 4 servo interfaces
  - Inputs: TTL/SSI encoder for incremental and absolute measuring systems
  - Bidirectional analog outputs: ±10 V
- General and drive-specific digital input/output signals
- On-board status display via four diagnostic LEDs

To supply the module and digital outputs with power, an external voltage source (+24 VDC) is needed.

3.3 Order number and firmware version

Order number

Order no.: 6FC5211-0BA01-0AA4

Firmware version

Firmware version: 1.4.8

To display the firmware version of the module, see the note on PROFIBUS address 127 in Chapter "PROFIBUS address (Page 45)".

3.4 Boundary conditions

The following supplementary conditions must be taken into account for the operation of an ADI4 on the PROFIBUS DP:

- An ADI4 can only be operated on an **equidistant** PROFIBUS DP.
- An ADI4 is **not** a certified DP standard slave as defined by the PROFIDrive profile. For example, an ADI4 does not permit acyclic communication.

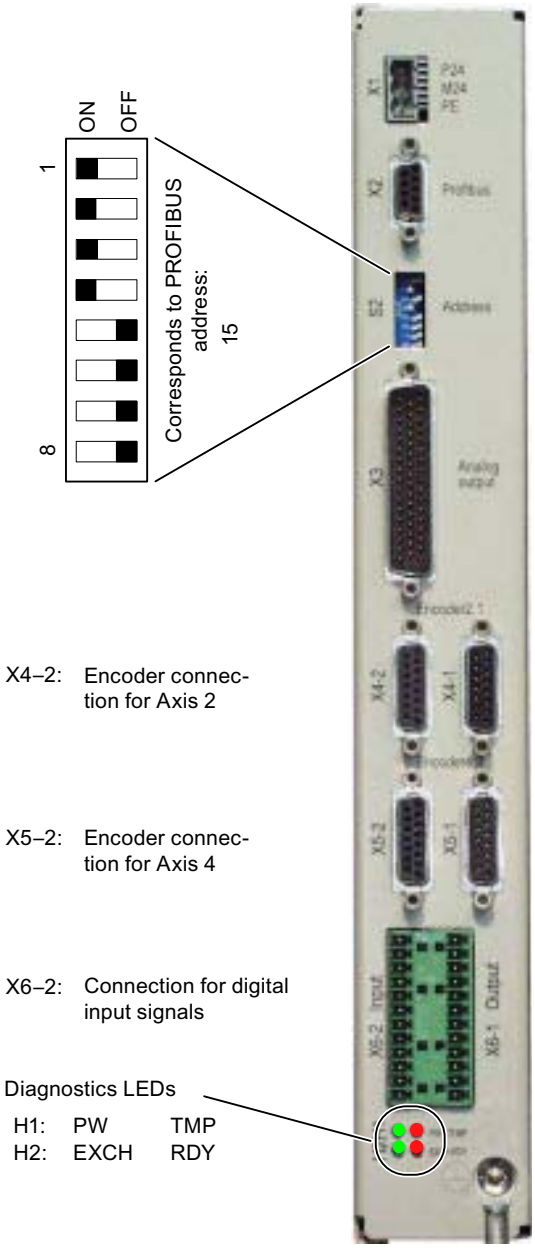
See also

Overview of connections (Page 19)

Hardware

4

4.1 Overview of connections



X1: External power supply 24 VDC

X2: PROFIBUS connection

S2: DIP switch for setting the PROFIBUS address

X3: Analog setpoint outputs ±10 VDC, Axis 1 to 4

X4–2: Encoder connection for Axis 2

X4–1: Encoder connection for Axis 1

X5–2: Encoder connection for Axis 4

X5–1: Encoder connection for Axis 3

X6–2: Connection for digital input signals

X6–1: Connection for digital output signals

Diagnostics LEDs

H1: PW TMP
H2: EXCH RDY

Connection for protective ground Screw M6

Figure 4-1 Overview of connections

4.2 Interface description

4.2.1 Interface overview

The module has the following interfaces:

Table 4- 1 Interface overview of ADI4

Interface	Designation	Type
External +24 V power supply	X1	Plug
PROFIBUS DP	X2	Socket
PROFIBUS DP address	S2	DIP switch
Analog setpoint interface	X3	Plug
Encoder connection for Axis 1	X4-1	Socket
Encoder connection for Axis 2	X4-2	Socket
Encoder connection for Axis 3	X5-1	Socket
Encoder connection for Axis 4	X5-2	Socket
Digital outputs	X6-1	Plug
Digital inputs	X6-2	Plug
Module status	H1/H2	LEDs

4.2.2 Interface (X1): External power supply

Connection

3-pin connector MSTB 2.5/3-ST-5.08 by Phoenix

Pin assignment

Table 4- 2 Pin assignment: External power supply (X1)

Pin	Designation	Type[1)]	Function
1	P24EXT1	VI	External supply for module (+24 V)
2	M24EXT1	VI	Reference for external supply
3	PE	VI	Protective conductor of the external supply
[1)] VI: Voltage input			

Connection cables

The required connecting cables must be provided by the user:

Wire, conductor cross section: 1.0 - 1.5 mm^2 (AWG17 - AWG16)

Supply voltage

The specifications of the supply voltage can be found in Section "Power supply (Page 35)".

4.2.3 Interface (X2): PROFIBUS DP

Connection

9-pin sub D socket

Pin assignment

Table 4- 3 Pin assignment: PROFIBUS DP (X2)

Pin	Designation	Type[1)]	Function
1	-	-	-
2	-	-	-
3	RxD/TxD-P	B	Receive/transmit data P (B line)
4	RTS	O	Request to Send
5	DGND	VO	Data reference potential (M5V)
6	VP	VO	Supply voltage plus (P5V)
7	-	-	-
8	RxD/TxD-N	B	Receive/transmit data N (A line)
9	-	-	-

[1)] VO: Voltage output
O: Output
B: Bidirectional

Connectors

- 6ES7 972-0BA41-0XA0; cable outlet 35°, without PG connection socket
- 6ES7 972-0BB41-0XA0; cable outlet 35°, with PG connection socket

Cables

- 6XV1 830-0EH10; by the meter; without trailing capability
- 6XV1 830-3EH10; by the meter; with trailing capability

Other technical data

Maximum possible data rate: 12 Mbits/s

4.2.4 Interface (S2): PROFIBUS address

Setting

The PROFIBUS address of the ADI4 DP slave can only be 15 or 16 for the 802D sl and is set via the S2 switch.

- PROFIBUS address 15: S2 switch, 1 to 4 set to ON
- PROFIBUS address 16: S2, only switch 5 set to ON

Table 4- 4 Meaning of switch S2

Switches	Meaning
1	PROFIBUS address: $2^0 = 1$
2	PROFIBUS address: $2^1 = 2$
3	PROFIBUS address: $2^2 = 4$
4	PROFIBUS address: $2^3 = 8$
5	PROFIBUS address: $2^4 = 16$
6	PROFIBUS address: $2^5 = 32$
7	PROFIBUS address: $2^6 = 64$
8	Not used

NOTICE
A newly set PROFIBUS address will only come into effect after power OFF/ON.

4.2.5 Interface (X3): Analog setpoint interface

Connection

50-pin sub D connector

Pin assignment

Table 4- 5 Pin assignment: Analog setpoint interface (X3)

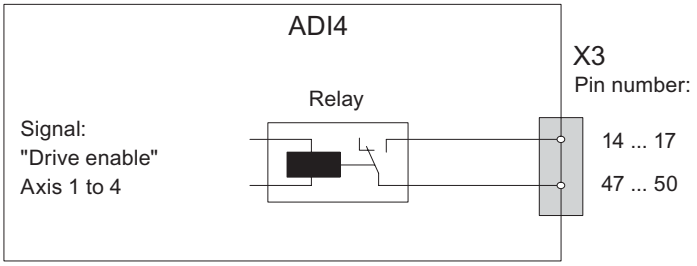
Pin	Designation	Type[1)]	Function
1	SW1	VO [3)]	Setpoint of Axis 1 (±10 V)
2	BS2	VO	Reference for setpoint of Axis 2
3	SW3	VO [3)]	Setpoint of Axis 3 (±10 V)
4	BS4	VO	Reference for setpoint of Axis 4
5-13	-	-	-

Pin	Designation	Type[1)]	Function
14	RF1_1	K [2)]	"Drive enable" of Axis 1, Relay Contact 1
15	RF2_1	K [2)]	"Drive enable" of Axis 2, Relay Contact 1
16	RF3_1	K [2)]	"Drive enable" of Axis 3, Relay Contact 1
17	RF4_1	K [2)]	"Drive enable" of Axis 4, Relay Contact 1
18-33	-	-	-
34	BS1	VO	Reference for setpoint of Axis 1
35	SW2	VO [3)]	Setpoint of Axis 2 (±10 V)
36	BS3	VO	Reference for setpoint of Axis 3
37	SW4	VO [3)]	Setpoint of Axis 4 (±10 V)
38-46	-	-	-
47	RF1_2	K [2)]	"Drive enable" of Axis 1, Relay Contact 2
48	RF2_2	K [2)]	"Drive enable" of Axis 2, Relay Contact 2
49	RF3_2	K [2)]	"Drive enable" of Axis 3, Relay Contact 2
50	RF4_2	K [2)]	"Drive enable" of Axis 4, Relay Contact 2

1) VO Voltage output
K Relay contact

2) Max. current carrying capacity: 2 A for 150 VDC or 125 VAC
Max. number of switching cycles:
- 24 VDC, 1 A: 10^7
- 24 VDC, 2 A: 10^5

3) Max. current carrying capacity: 10 mA (RL: 1 kW - 2 kW)



Prefabricated cables

Order no.: 6FX2 002-3AD01-□□□□

Cable length: ≤ 35 m

Information regarding the length codes is provided in:
References: /Z/ Catalog NC Z

Resolution of setpoint outputs

The analog setpoint outputs on the interface (X3) have the following resolution: 16-bit, including sign.

4.2.6 Interfaces (X4-1/X4-2/X5-1/X5-2): Encoder interfaces

Connection

15-pin SUB-D socket

Pin assignment

Pin assignment: Encoder interface of axes 1 to 4 (X4-1/X4-2/X5-1/X5-2) for incremental encoder (TTL) and absolute encoder (SSI)

Table 4- 6 Pin assignment: Encoder interface of axes 1 to 4 (X4-1/X4-2/X5-1/X5-2) for incremental encoder (TTL) and absolute encoder (SSI)

Pin	Designation[1]		Type [2]	Function
	Incremental	Absolute (SSI)		
1	Unassigned		-	-
2	-	CLSx	O	SSI shift clock
3	-	CLSx_N	O	SSI shift clock inverted
4	P5MS		VO	5 V DC supply voltage
5	P24SSI		VO	24 V DC supply voltage
6	P5MS		VO	5 V DC supply voltage
7	MEXT		VO	Reference for supply voltage
8	Unassigned		-	-
9	MEXT		VO	Reference for supply voltage
10	Rx_S	-	I	Zero mark signal (U_{a0})
11	XRx_S	-	I	Zero mark signal inverted ($/U_{a0}$)
12	XBx_S	-	I	Encoder signal track B inverted ($/U_{a2}$)
13	Bx_S	-	I	Encoder signal track B (U_{a2})
14	XAx_S	-	I	Encoder signal track A inverted (U_{a1})
	-	DATAx_N	I	SSI data inverse
15	Ax_S	-	I	Encoder signal track A (U_{a1})
	-	DATAx	I	SSI data

[1] x_ : Number of the encoder interface with X4-1=1, X4-2=2, X5-1=3, X5-2=4
[2] VO: Voltage output
I: Signal input
O: Signal output

Prefabricated cables

The following preassembled cables can be used, depending on the encoder type:

- **Incremental encoder (TTL) with RS 422 and operating voltage 5 V or 24 V**

  Order number (MLFB): 6FX8 002-2CD01-1□□0 (5 V)

  Order number (MLFB): 6FX5 002-2CD24-1□□0 (24 V)
  Information on the cable lengths can be found in the "Maximum cable lengths" section.

- **Absolute encoder with SSI**

  Order number (MLFB): 6FX8 002-2CC11-□□□0

  Information on the cable lengths can be found in the "Maximum cable lengths" section.

- **1FT5 motor with integrated ROD320 encoder**

  Order number (MLFB): 6FX8 002-2CE02-1□□0

  Cable length: Can be found in the "Maximum cable lengths" section.

  Information regarding the length codes is provided in:

  References: /Z/ Catalog NC Z

Maximum cable lengths

The maximum cable length depends on the following two parameters:

- **Encoder supply voltage**

Table 4- 7 Encoder supply voltage

Supply voltage: 5 V DC		
Tolerance	**Current consumption**	**Max. cable length**
4.75 V - 5.25 V	≦ 300 mA	25 m
4.75 V - 5.25 V	≦ 220 mA	35 m

Supply voltage: 24 V DC		
Tolerance	**Current consumption**	**Max. cable length**
20.4 V - 28.8 V	≦ 300 mA	100 m
11 V - 30 V	≦ 300 mA	300 m

- **Transmission frequency**

Table 4- 8 Transmission frequency

Encoder type	Supply voltage	Frequency	Max. cable length
Incremental (TTL)	5 V	1 MHz	10 m
		500 kHz	35 m
	24 V	500 kHz	150 m
Absolute (SSI)	24 V	1.5 Mbit/s	10 m
		187.5 kbit/s	250 m

Note

If cable lengths longer than 25 m or 35 m are needed for incremental encoders, encoder types with a 24 V DC supply voltage can be used instead.

CAUTION
To ensure error-free transmission of encoder data, do not exceed the maximum cable lengths shown in these tables.

Encoder supply voltages

The encoder supply voltages must comply with the following specification:

Table 4- 9 Specification of encoder supply voltages

	Supply voltage[1)]	
	P5MS	P24SSI
Voltage		
Minimum	4.75 V	20.4 V
nominal	5 V	24 V
Maximum	5.25 V	28.8 V
Ripple		
Maximum	50 mVpp	3.6 Vpp
Current load		
Per encoder connection	0.3 A	
Maximum	1.35 A	1 A
[1)] P5MS: Supply voltage for encoder (+5 V DC) P24SSI: Supply voltage for encoder (+24 V DC)		

Connectable measuring systems

Incremental encoder (TTL)

- Differential transmission with RS 422 and operating voltage 5 V or 24 V
  - Track A as true and inverted signal (U_{a1}, $/U_{a1}$)
  - Track B as true and inverted signal (U_{a2}, $/U_{a2}$)
  - Zero signal N as true and inverted signal (U_{a0}, $/U_{a0}$)
- Maximum output frequency: 1.5 MHz
- Phase shift of track A to track B: 90°±30°
- Current consumption: max. 300 mA
- Encoders with distance-coded zero marks/reference marks are not generally enabled.

Absolute value encoder (SSI)

- Transmission method: Synchronous serial interface (SSI) according to RS 485 with 5 V differential signal transmission (RS 422 standard):
  - Output signal: Data as true and inverted signal
  - Input signal: Shift clock as true and inverted signal
- "Christmas tree" output format for rotary encoders
- Resolution: max. 25 bits
- Maximum transmission frequency: 1 Mbit/s
- Current consumption: max. 300 mA

(SINUMERIK 802D sl)

- **Absolute value encoder (SSI)**

  The use of absolute encoders (SSI) has **not** been released.

(SINUMERIK 840Di sl)

- **Linear encoder with distance-coded zero marks / reference marks**

The following linear encoders with distance-coded zero marks / reference marks have been released for ADI4:

- Heidenhain: LS 476 C
- Heidenhain: LS 186 C,
  in conjunction with external pulse-shaping electronics (EXE), e.g. IBV 610

Note

Encoders with SINE/COSINE signals (1 Vpp) can be connected using external pulse shaping electronics (EXE), which convert the signals to the 5 V TTL level.

4.2.7 Interface (X6-1): Digital outputs

Connection

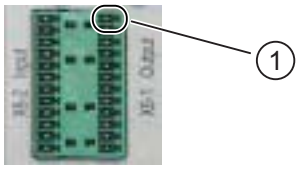
Two 12-pin connectors FK-MCP 1.5/15-ST-3.81 by Phoenix

Pin assignment

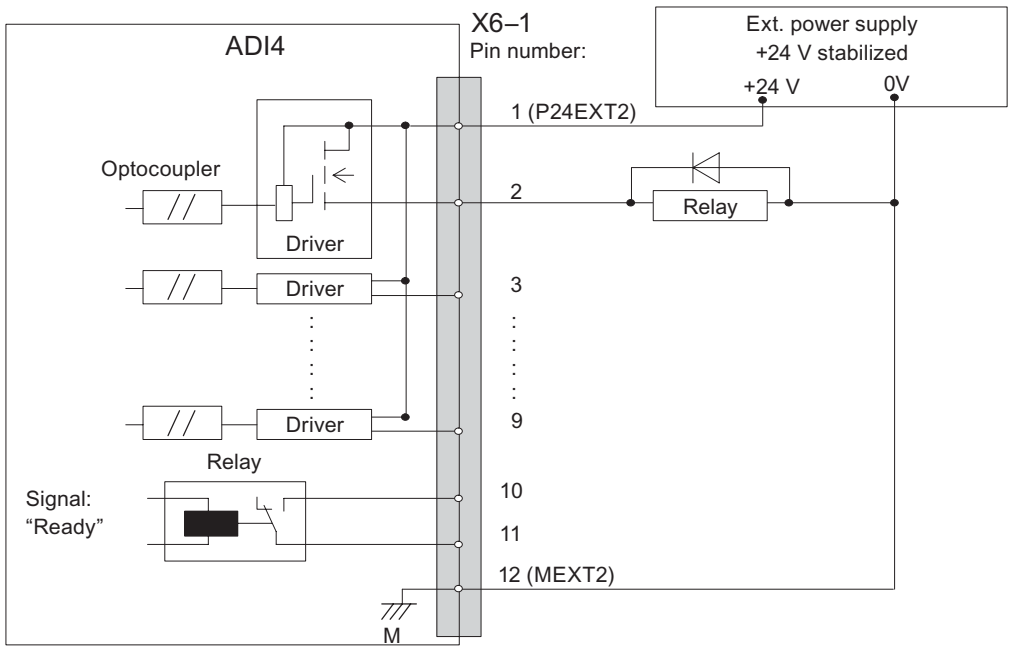
Table 4- 10 Pin assignment: Digital output interface (X6-1)

Pin	Designation	Type [1)]	Function
1	P24EXT2	VI	ext. 24 V DC supply voltage
2	Q0	DO	Digital output signal 1
3	Q1	DO	Digital output signal 2
4	Q2	DO	Digital output signal 3
5	Q3	DO	Digital output signal 4
6	DIR1	DO	Digital output signal 5 or directional signal of axis 1[3)]
7	DIR2	DO	Digital output signal 6 or directional signal of axis 2[3)]
8	DIR3	DO	Digital output signal 7 or directional signal of axis 3[3)]
9	DIR4	DO	Digital output signal 8 or directional signal of axis 4[3)]
10	RDY1	K [2)]	"Ready" signal of relay contact 1
11	RDY2	K [2)]	"Ready" signal of relay contact 2
12	MEXT2	VI	Reference of the external supply voltage

Pin	Designation	Type 1)	Function
1)	VI: Voltage input DO: Digital output (24 V) K: Relay contact		
2)	Max. current carrying capacity: 2 A for 150 V DC or 125 V AC; Max. number of operating cycles: - 24 V DC, 1 A: 10^7 - 24 V DC, 2 A: 10^5		
3)	For "unipolar spindle" function (or unipolar motor)		



① PIN 1



(SINUMERIK 802D sl)

The signals from pins 2...9 are **not** available on an ADI4 module connected to SINUMERIK 802D sl.

Supply voltage

To supply the digital outputs with power, an external 24 V DC voltage source must be connected to X6-1, pin 1 (P24EXT2).

The reference ground of the external voltage source must be connected with X6-1, pin 15 (MEXT2).

Further data can be found in the "Technical data" section.

Electrical specification

Table 4- 11 Electrical specification of the digital outputs

Digital outputs	min.	Typical	max.	nominal
Voltage for high-level (V_H)	V_{CC} - 3 V	1)	V_{CC}	24 V
Output current I_{OUT}	-	-	500 mA	-
Voltage for low level (V_L)	-	-	-	0 V
Leakage current at low level	-	50 µA	400 µA	-
Signal delay T_{PHL}, T_{PLH} 2)	-	0.5 ms	-	-
Supply voltage of the dig. outputs 1) Typical output voltage: V_{CC} - I_{OUT} *R_{ON} - 0.65 V V_{CC}: Actual operating voltage P24EXT2 Max. output current I_{OUT}: 500 mA Max. short-circuit current: 4 A (max. 100 µs, V_{CC} = 24 V) Internal resistance R_{ON}: 0.4 Ω 2) The PROFIBUS communication time as well as the application cycle time must also be taken into account. Incorrect connection causes neither high level nor destruction of the outputs.				

General electrical properties

- Galvanic isolation using optocouplers
- Current limitation to a maximum of 500 mA
- Protection against: short-circuit, overtemperature, and loss of ground
- Automatic disconnection in case of undervoltage

Relay contact: "Ready" signal

The relay contact remains/is **opened** if the module is in one of the following states:

- Initialization of the module after Power ON
- Power failure or hardware interrupt (NMI)
- No cyclic communication to the DP master
- PLL error
- Synchronization error
- Overtemperature

The relay contact is **closed** if both conditions are present:

- Module status "Ready"
- Cyclic communication with the DP master

Connecting cable

The required connecting cables must be provided by the user:

- Supply voltage X6-1, pins 1 and 12 (P24EXT2):
  Wire, conductor cross-section of 1.5 mm² (AWG16)
- Digital outputs X6-1, pins 2...9:
  Wire, conductor cross-section 0.5 to 1.5 mm² (AWG20 - AWG16)
- Ready X6-1, pins 10 and 11:
  Wire, conductor cross-section of 1.5 mm² (AWG16)

NOTICE
The maximum length of the digital signal cable is 30 m.

See also

Technical data (Page 39)

4.2.8 Interface (X6-2): Digital inputs

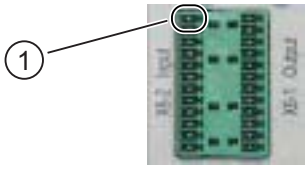
Connection

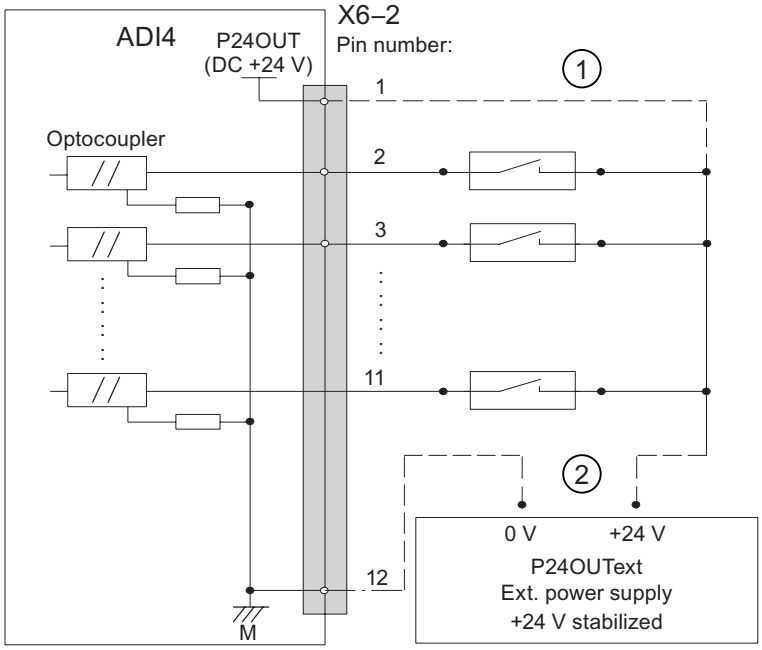
Two 12-pin connectors FK-MCP 1.5/15-ST-3.81 by Phoenix

Pin assignment

Table 4- 12 Pin assignment: Digital input interface (X6-2)

Pin	Designation	Type [1)]	Function
1	P24OUT	VI	24 V DC supply voltage
2	BERO1	DI	Input signal of BERO / external zero mark 1
3	BERO2	DI	Input signal of BERO / external zero mark 2
4	BERO3	DI	Input signal of BERO / external zero mark 3
5	BERO4	DI	Input signal of BERO / external zero mark 4
6	MEPU1	DI	Measuring signal, probe 1 (see "Measuring probe" below)
7	MEPU2	DI	Measuring signal, probe 2 (see "Measuring probe" below)
8	DRV1_RDY	DI	"Drive Ready" signal of axis 1
9	DRV2_RDY	DI	"Drive Ready" signal of axis 2
10	DRV3_RDY	DI	"Drive Ready" signal of axis 3
11	DRV4_RDY	DI	"Drive Ready" signal of axis 4
12	MOUT	VI	Reference of the supply voltage

Pin	Designation	Type [1]	Function
[1]	VI: Voltage Input DI: Digital input (24 V)		 ① PIN 1



① Connection if the internal supply voltage P24OUT is used;
the connection in accordance with ② is no longer required.

② Connection if an external supply voltage P24OUText is used;
the connection in accordance with ① is no longer required.

(SINUMERIK 802D sl)

On an ADI4 module in connection with SINUMERIK 802D sl, the signal: "Measuring signal, probe 2" (pin 7) is **not** available.

Internal supply voltage P24OUT

Specification of the internal supply voltage P24OUT available at X6-2, pin 1 for the digital inputs:

Table 4- 13 Specification of the supply voltage P24OUT

Voltage	
Minimum	20.4 V
Nominal	24 V

Voltage	
Maximum	28.8 V
Ripple	
Maximum	3.6 Vpp
Current load	
Typical	0.1A
Maximum	1A
Power consumption	
Typical	3.02 W
Maximum	30.2W
Insulation Class	A, in accordance with DIN 57110b
Typical output voltage: V_{CC} - I_{OUT} * RON - 0.65 V V_{CC}: Actual P24OUT operating voltage Max. output current I_{OUT}: 1 A Internal resistance R_{ON}: 0.4 Ω The supply voltage P24OUT is short-circuit proof.	

External supply voltage P24OUText

If an external supply voltage is used, its reference ground must be connected to X6-2, pin 12 (M).

X6-2, pin 1 (P24OUT) then remains open.

Electrical specification

Digital inputs	min.	Typical	max.	nominal
Voltage for high-level (V_H)	15 V	1)	30 V	24 V
Input current I_{IN} at V_H	3.7 mA	-	7.5 mA	-
Voltage for low level (V_L)	-30 V	-	+5 V	0 V
Signal delay T_{PHL}, T_{PLH} 2)	-	3 µs	-	-
1) See table "Specification of the supply voltage P24OUT" 2) The PROFIBUS communication time as well as the application cycle time must also be taken into account. Incorrect connection causes neither high level nor destruction of the inputs.				

Connecting cable

The required connecting cables must be provided by the user.

- Supply voltage X6-2, pin 1 (P24OUT), external supply voltage P24OUText:
  Wire, conductor cross-section of 1.5 mm² (AWG16)
- Digital outputs X6-2, pins 2 -11:
  Wire, conductor cross-section 0.5 to 1.5 mm² (AWG20 - AWG16)

General electrical properties

- Galvanic isolation using optocouplers
- Active current limitation of the inputs
- Protection from negative input voltage

Probe

ADI4 supports only measurement of a rising **or** falling edge of the probe. A simultaneous request for measurement of a rising edge and a falling edge of the probe cannot be parameterized.

4.2.9 Interface (H1/H2): Module status

The module status is displayed on the front of the module with four diagnostic LEDs.

Table 4- 14 Diagnostic LEDs (H1/H2)

Designation		Color	Description
H1	POWER	Green	Supply voltage LED = Off: Supply voltage not applied LED = On: Supply voltage is applied
	OVTEMP	Red	Overtemperature display LED = Off: Device temperature < overtemperature limit LED = On: Device temperature ≥ Overtemperature limit
H2	EXCHANGE	Green	Status: Message frame exchange with DP master LED = Off: No message frame exchange with DP master LED = On: Cyclic message frame exchange with DP master
	READY	Red	Ready status: Message frame exchange with DP master LED = Off: Not yet ready LED = On: Ready LED = Off and EXCHANGE = On: Message frame exchange active LED = flashing: Error occurred during message frame exchange

4.3 Control cabinet installation

Installation

For high frequency interference currents, the housing of the ADI4 module must be connected with low-resistance to the back wall of the control cabinet, and this wall in turn must be connected with low-resistance to the motors/machines. The module should be installed on a bare mounting wall. The connection between the mounting wall and the motors/machines must be electrically conductive and have a large surface area. Coated cabinet walls and DIN rails, or similar mounting means with a small contact area, do not meet this requirement.

Cable routing

Power and signal cables must always be routed separately. All I/O interface (X6-1/X6-2) signal lines should exit jointly. Single strands that are related from the signal point of view must be twisted together. Signal cables and encoder cables should be installed separately.

All cables and lines within the control cabinet should always be placed as close as possible to the control cabinet walls. Extended installation through open space can cause interference injections (antenna effect). The proximity to sources of interference (contactors, transformers, etc.) must be avoided by placing a shield plate between the cable and the source of interference, if necessary. Cables and conductors should not be extended using terminals or similar devices. To protect against interference injections from external sources, signal cables must be shielded.

⚠ WARNING
The module has been designed for operation in an enclosed control cabinet. Operation outside an enclosed control cabinet is not permissible.

4.4 Power supply

ADI4 module

To supply the ADI4 module (+24 VDC), an external power source is needed. The power supply is connected through terminal X1 (P24EXT1) on the front panel of the ADI4 module. Refer to Section "Overview of connections (Page 19)" for more information.

Digital outputs

To supply (+24 VDC) the digital outputs, an external power source is needed. The power supply is connected through Terminal X6-1, Pin 1 (P24EXT2). Refer to Section "Overview of connections (Page 19)" for more information.

Digital inputs

If the digital inputs are not supplied with the internal supply voltage of X6-2, Pin 1 (P24OUT), this supply voltage can optionally be replaced with an external power source (+24 VDC, 1 A maximum).

The reference ground (GND) of the external power supply source must be connected with X6-2, Pin 12. X6-2, Pin 1 (P24OUT) remains open.

Specification of the supply voltages (+24 VDC)

The external supply voltages for the ADI4 module, the digital outputs, and optionally the digital inputs must comply with the specifications provided in the "Encoder supply voltages" table.

Table 4- 15 Specification of the external supply voltages

	Supply voltage[1)]		
	P24EXT1	**P24EXT2**	**P24OUText**
Voltage			
• Minimum		18.5 V	
• Nominal		24 V	
• Maximum		30.2 V	
Ripple			
• Maximum		3.6 V_{pp}	
Current load			
• Typical	0.5 A	-	0.1 A
• Maximum	1 A	8 A	1 A
Power consumption			
• Typical	12 W	-	3.02 W
• Maximum	30.2 W	241.6 W	30.2 W

[1)] P24EXT1: Supply voltage of the ADI4 module
P24EXT2: Supply voltage for the digital outputs
P24OUText: Optional supply voltage for the digital inputs

CAUTION
The external supply voltages must each be generated as functional extra-low voltage with safe electrical isolation (DIN EN 60204-1, PELV).

Fuse

On the module side, supply voltages P24EXT1 and P24EXT2 must be protected against the following:

- Overvoltage
- Short-circuit (electrical current limiting of outputs)
- Polarity reversal
- Overload
  - P24EXT1: Fuse 2.5 A / 250 V
  - P24EXT2: Fuse 8 A / 125 V

4.5 Grounding

Grounding

The module must be installed according to EN 60204.

The user must ground each of the supply voltages. To do this, a connection must be established from Terminal X1, Pin 2 (MEXT1) or X6-1, Pin 15 (MEXT2) to a central grounding point of the system.

If a large-area, permanent metallic connection with the central grounding point is not possible using the rear panel, the module must be connected to the grounding rail by means of a wire (cross-section > 10 mm^2).

⚠ CAUTION
A protective conductor must be connected. An M6 screw is provided on the lower right of the front of the housing to connect the protective conductor. See Chapter "Dimension drawing (Page 38)".

4.6 Dimension drawing

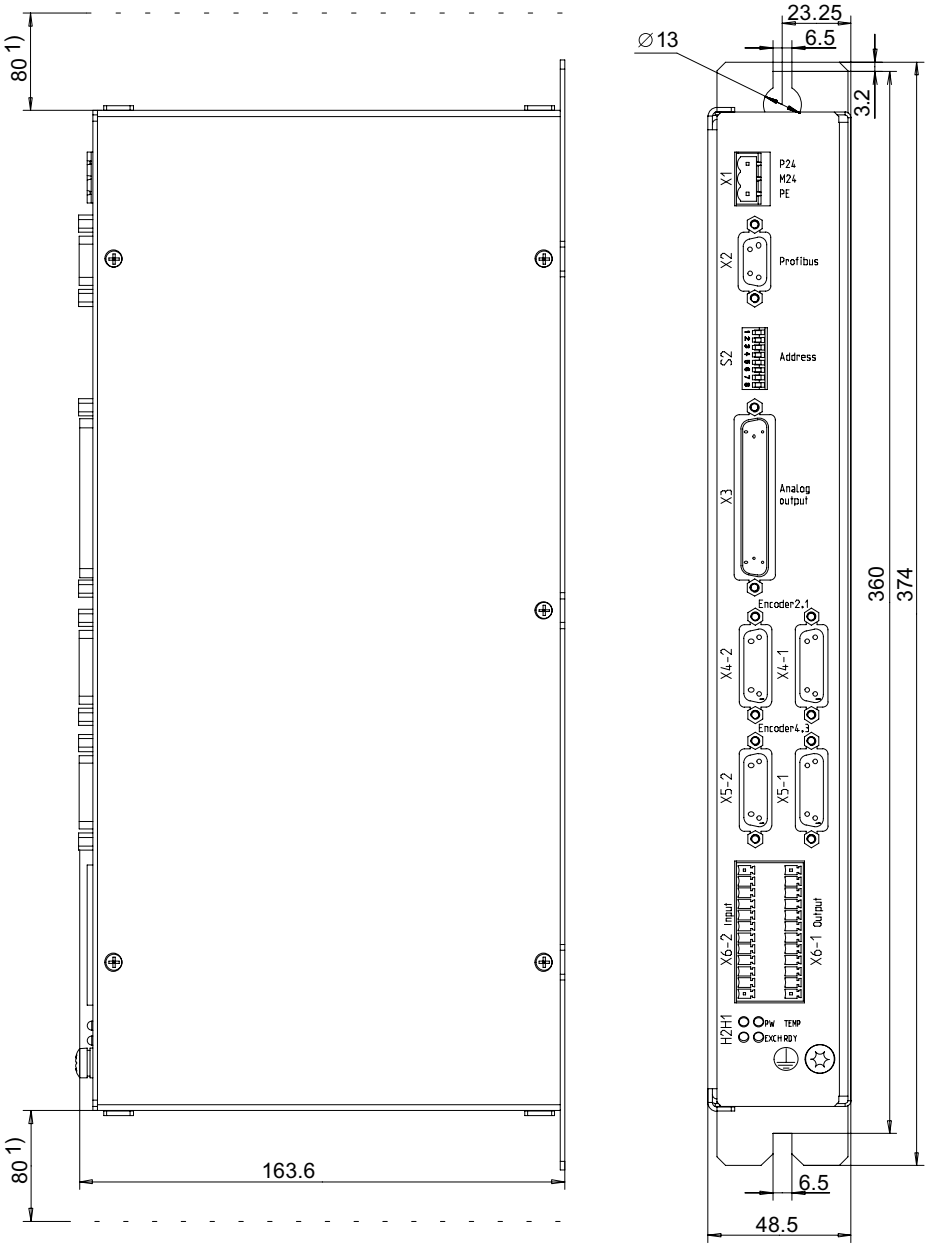


Figure 4-2 Dimension drawing: ADI4

1) Necessary clearance to ensure sufficient ventilation

Maximum tightening torque for all screws: 0.8 Nm

4.7 Technical data

Table 4- 16 Technical data of the ADI4 module

Safety		
Degree of protection	IP20	
Protection class	Protection class I in accordance with VDE 0106 Part 1: 1982 (IEC 536); Protection against ingress of foreign bodies and water in accordance with IEC 529	
Approvals	UL/CSA, CE	
Power consumption		
Nominal load	12 W	
Maximum	30.2 W	
Mechanical specifications		
Dimensions WxHxD [mm]	154.4 x 325 x 48.5	
Weight	Approximately 1.5 kg	
Climatic ambient conditions		
Heat dissipation	Open-circuit-ventilated	
	Operation	**Storage/transport**
Temperature limits	0 … +55° C	-20 to 55 °C/-40 to 70 °C
Relative humidity limits	5 to 95 % without condensation	5 to 95 % without condensation
Condensation	Not permitted	
Atmospheric pressure	700 to 1060 hPa	700 to 1060 hPa
Transportation altitude	-	-1000 to 3000 m
Shock stress during transportation		
Free fall in transport packaging	≤ 1000 mm	

Parameter assignment 5

5.1 Boundary conditions of ADI4 DP slave

NOTICE
The following boundary conditions must be taken into account for the operation of an ADI4 DP slave on the PROFIBUS DP: • An ADI4 DP slave is not a certified DP standard slave as defined by the PROFIDrive profile. For example, an ADI4 DP slave does not enable acyclic communication. Therefore, an ADI4 DP slave can only be operated on a DP master specially released for this purpose. • An ADI4 DP slave can only be operated on an equidistant PROFIBUS DP. The minimum DP cycle is 1 ms.

5.2 Preconditions, SINUMERIK 802D sl

The following components are required for assigning parameters for an ADI4 DP slave:

- SINUMERIK 802D sl system software: from version 01.04.xx

5.3 Preconditions, SINUMERIK 840Di sl

Required components

The following components are required to assign the parameters of SINUMERIK 840Di sl NC and the DP slave ADI4 in SIMATIC STEP7 HW Config:

- References: /HBIsl/ SINUMERIK 840Di sl Manual
- SIMATIC STEP 7, Version 5.3, Service Pack 2 and higher
- SlaveOM (Slave Object Manager) for SINUMERIK 840Di sl

SlaveOM

The SlaveOM for SINUMERIK 840Di sl allows dialog-based parameter assignment of the DP slave:

- DP slave SINAMICS S120
- ADI4 DP slave

Within the scope of generating the configuration with SIMATIC STEP 7 HW Config.

The SlaveOM for SINUMERIK 840Di sl is part of the SINUMERIK 840Di sl toolbox.

Note

When using the SlaveOM for SINUMERIK 840Di sl in connection with other CPUs, a consistency error is reported during the configuration compilation and no system data blocks are generated.

5.4 Preconditions, SINUMERIK 840D sl

Required components

The following components are required to assign the parameters of SINUMERIK 840D sl NC and the DP slave ADI4 in SIMATIC STEP7 HW Config:

- References: Commissioning Manual IBN CNC: NCK, PLC, drive
- SIMATIC STEP7, Version 5.3, Service Pack 3 and higher
- SlaveOM (Slave Object Manager) for SINUMERIK 840D sl

SlaveOM

The SlaveOM for SINUMERIK 840D sl allows dialog-based parameter assignment of the DP slave:

- DP slave SINAMICS S120
- ADI4 DP slave

Within the scope of generating the configuration with SIMATIC STEP 7 HW Config.

The SlaveOM for SINUMERIK 840D sl is part of the SINUMERIK 840D sl toolbox.

Note

When using the SlaveOM for SINUMERIK 840D sl in connection with other CPUs, a consistency error is reported during the configuration compilation and no system data blocks are generated.

5.5 PROFIBUS DP parameter assignment

5.5.1 Parameter assignment sequence

Parameter assignment sequence

The PROFIBUS DP parameter assignment for the ADI4 DP slave can be generally divided into the following steps:

1. Step

   After inserting the ADI4 DP slave in the configuration, the following parameters are assigned on a slave-specific basis:

   – PROFIBUS parameters (see Chapter "PROFIBUS parameters (Page 45)")

   – Function parameters (see Chapter "Function parameters (Page 52)")

   Step 1 should be carried out first for **all** ADI4 DP slaves needed in the configuration.

2. Step

   Parameter assignment of the DP communication (refer to Chapter "Parameterization of the DP communication (Page 62))

   Step 2 can be performed **last** on **any** ADI4 DP slave. These settings can be transferred to all other ADI4 DP slaves using the alignment function.

5.5.2 Inserting an ADI4 DP slave in the configuration

Procedure

1. To insert an ADI4 DP slave in the configuration, open the hardware catalog using the **View > Catalog** menu command.

   The ADI4 DP slave can be found at:

   – Profile: **Standard**

     PROFIBUS DP > SINUMERIK > ADI4

   SIMATIC Technology CPU
   If S7-Technology was installed for the Technology CPU, the ADI4 DP slave is located under:

   – Profile: **SIMATIC Technology CPU**

     PROFIBUS DP (DRIVE) > Other FIELD DEVICES > SINUMERIK > ADI4

2. Using a drag-and-drop operation, select the ADI4 DP slave and move it onto to the DP master system in the station window.

   The DP master system is displayed in the station window with the following symbol:

When you release the left mouse button, the DP slave ADI4 is inserted into the configuration.

Note

As you drag the DP slave, the cursor appears as a circle with a slash through it. When the cursor is positioned exactly over the DP master system, it changes to a plus sign, and the DP slave can be added to the configuration.

5.6 PROFIBUS parameters for SINUMERIK 802D sl

The PROFIBUS parameters are set for SINUMERIK 802D sl by activating one of the defined configurations supplied. The PROFIBUS parameter values of the various configurations as well as the activation of a configuration are described in:

References

SINUMERIK 802D sl Toolbox > Readme: ADI4_SDB.PDF

5.7 PROFIBUS parameters

5.7.1 Parameter components

Configuring the PROFIBUS parameters

The PROFIBUS parameters are a result of the following:

- PROFIBUS address
- Number of axes and encoders (message frame type)
- I/O addresses

5.7.2 PROFIBUS address

Procedure

Inserting an ADI4 DP slave into the configuration will open the "Properties - PROFIBUS Interface ADI4" dialog, "Parameters" tab:

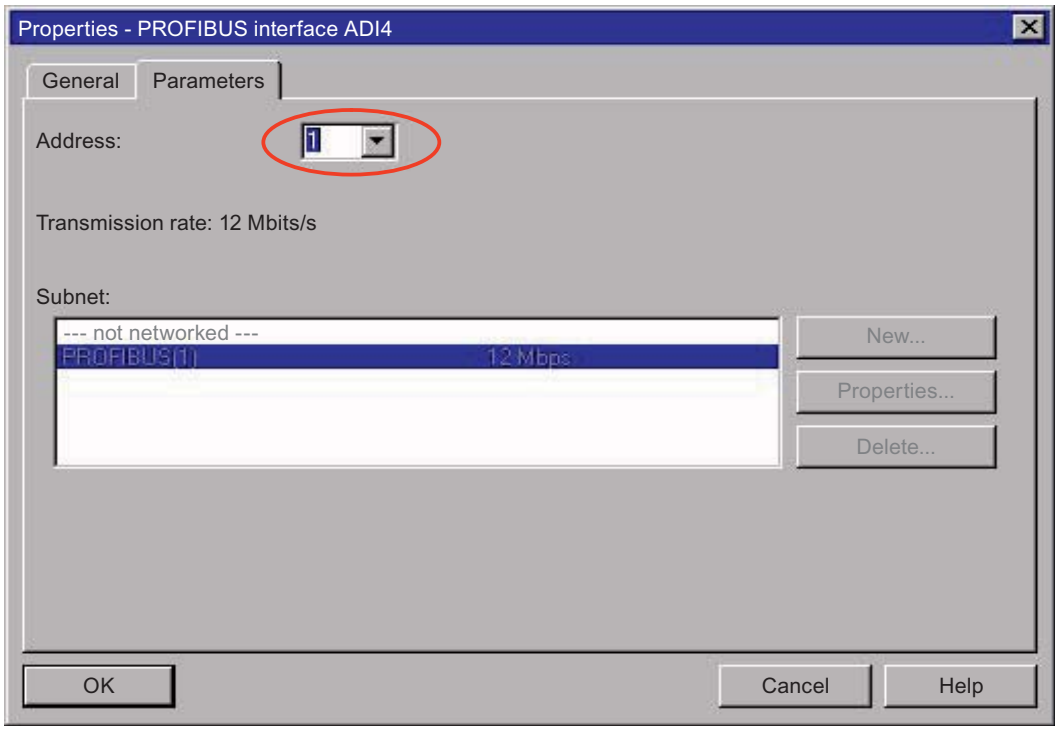


Figure 5-1 PROFIBUS address

The displayed address value was automatically set by HW Config to the next available PROFIBUS address within the configuration.

NOTICE

The PROFIBUS address of the ADI4 DP slave can be set to any value, in principle. However, it must be ensured that the PROFIBUS address setting in HW Config matches the DIP switch setting on the ADI4 DP slave:

There is **no automatic adjustment**!

The following data must agree:

- SIMATIC S7 configuration ADI4 DP slave
  PROFIBUS address
- ADI4 module DIP switch S2
  PROFIBUS address

Note

PROFIBUS address 127

If PROFIBUS address is set to 127, when the module powers up, the firmware release is displayed on the internal module LEDs using a flashing code. It is not recommended to use PROFIBUS address 127 as this lengthens the time that the module requires to power up.

After the dialog is confirmed with "OK", the "DP Slave Properties" dialog box is opened. Continue with the parameter assignment for the message frame type.

5.7.3 Message frame type

Message frame type

The ADI4 DP slave is operated with a specific message frame type:

4 axes, each with one encoder (standard message frame 3) and I/O data

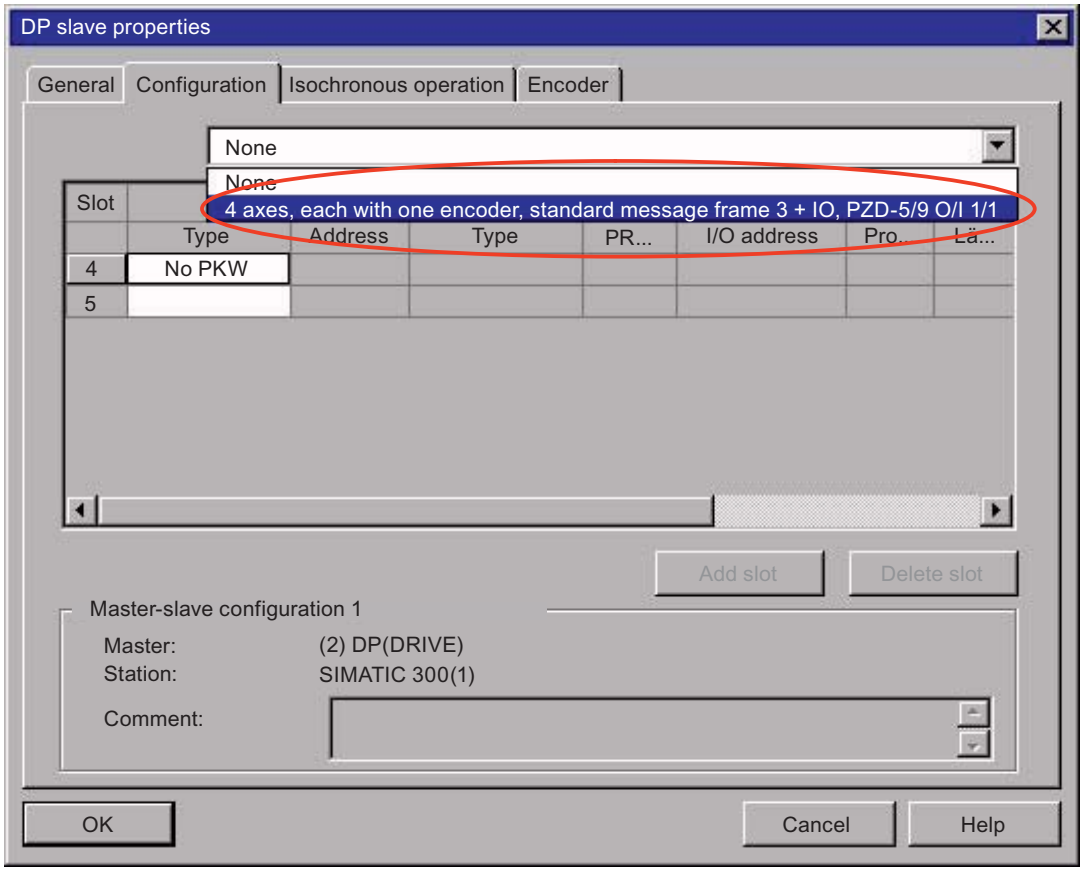


Figure 5-2 Message frame type

Setting the message frame type

By default, no message frame type is selected. The ADI4-specific message frame type must be explicitly selected in the "Configuration" tab.

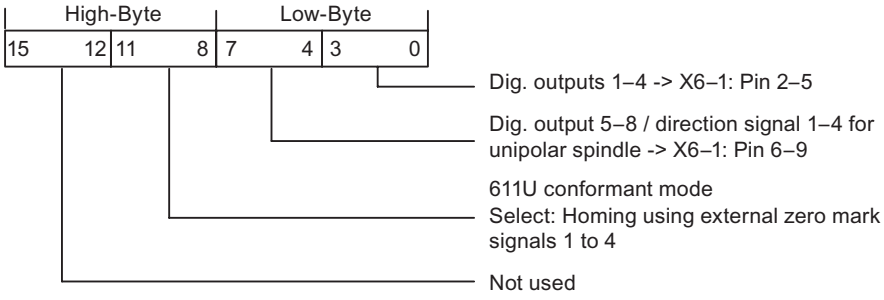
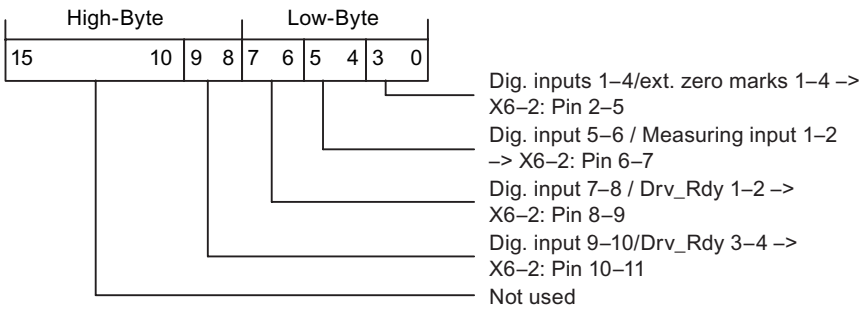
1. In the "DP Slave Properties" dialog box, select the "Configuration" tab.
2. In the "Default" list, select the entry "4 axes, each with one encoder, Standard message frame 3 + IO, PZD-5/9 O/I 1/1".
3. Click "OK".

Message frame structure

The message frame is structured as follows:

Table 5- 1 Message frame structure

Message frame type	Description
4 axes, each with one encoder, Standard message frame 3 + IO, PZD-5/9 O/I 1/1	4 x Standard message frame 3 and 1 PZD word each for digital I/O data
PZD x/y Number of process data words, x: Setpoint, y: Actual value, e.g. PZD-5/9: 5 process data words for setpoints 9 process data words for actual values	
ADI4 message frame structure Axis1 Axis2 Axis3 Axis4 I/O STD 3 STD 3 STD 3 STD 3 O word — Setpoints (master -> slave) Low Axis1 Axis2 Axis3 Axis4 I/O High STD 3 STD 3 STD 3 STD 3 O word — Actual values (slave -> master) STD 3: standard message frame 3 per PROFIDrive Specification V3.0 Q word: digital output data (16 bits) I word: digital input data (16 bits)	
Standard message frame 3: speed setpoint interface 32 bits with 1 encoder PZD1 PZD2 PZD3 PZD4 PZD5 STW1 NSET_B STW2 G1_STW — Setpoint (master -> slave) Low High PZD1 PZD2 PZD3 PZD4 PZD5 PZD6 PZD7 ZSW1 NACT_B ZSW2 G1_ZSW G1_XIST1 PZD8 PZD9 G1_XIST2 — Actual value (slave -> master)	

Message frame type	Description
O word (dig. output data 16 bits)  	
O word (dig. output data 16 bits)  	

NOTICE
The message frame type setting for the ADI4 DP slave in HW Config must agree with the message frame type setting in the controller. There is **no automatic adjustment**.

Encoder control word Gx_STW

Description of the encoder control word (extract) for:

- Find reference mark
- On-the-fly measurement
- Encoder error

Table 5- 2 Encoder control word Gx_STW (extract)

Bit	Name		Signal status, description			
			Find reference mark: Bit 7 = 0			
				Bit	**Meaning**	Homing using:
				0	Function 1:	Encoder zero mark (except in "611U conformant mode")
				1	Function 2:	Rising edge of external zero mark

Bit	Name		Signal status, description		
0	Find reference mark or On-the-fly measure-ment	**Functions**		2	Function 3: Falling edge of external zero mark
				3	Function 4: Not used
1			**On-the-fly measurement**: Bit 7 = 1		
				Bit	**Meaning** Measuring using:
				0	Function 1: Measuring Input 1 rising edge
				1	Function 2: Measuring Input 1 falling edge
				2	Function 3: Measuring Input 2 rising edge
				3	Function 4: Measuring Input 2 falling edge
2			**Note** • Bit 0 to 3 Bit x = 1 Function requested Bit x = 0 Function not requested • If more than one function is enabled, the values for all functions cannot be read until all functions have ended and this has been signaled via the relevant status bit (G1_ZSW, Bit 0 - Bit 3 = 0). • On-the-fly measurement The rising and falling edges of the measuring input can be enabled simultaneously. The measuring input signal is detected according to the direction of the signal change. The measured values are read out consecutively. Notice ADI4 only supports measurement on a rising **or** falling edge. • Find reference mark and on-the-fly measurement Only one of the two functions can be active at a time.		
3					
4		**Command**	**Bit 6, 5, 4**	**Meaning**	
5			000	- -	
6			001	Activate function x	
			010	Read value x	
			011	Cancel function x	
7		**Mode**	0	Find reference mark	
			1	On-the-fly measurement	
:			:		
15	Encoder error		0	No error	
			1	Encoder error pending; error code in Gx_XIST2	

Additional encoder actual value Gx_XIST2

Error codes in Gx_XIST2 where G1_ZSW, Bit 15 = 1

Table 5- 3 Error codes in Gx_XIST2

G1_XIST2	Meaning	Possible causes/description
1_{Hex}	Encoder sum error	The encoder signal levels are too low, faulty (inadequate shielding) or cable breakage monitoring has been tripped.
2_{Hex}	Zero mark monitoring	A fluctuation in the measured rotor position has arisen between two encoder zero marks (encoder pulses may be lost).

5.7.4 I/O addresses

Requirements

For communication between the controller and the individual axes of an ADI4 DP slave, it is necessary that the setpoint and the actual value of an axis have the same I/O address.

HW Config takes this requirement into account automatically when an ADI4 DP slave is inserted in the configuration.

Inserting I/O addresses

1. In the "DP Slave Properties" dialog box, select the "Configuration" tab.
2. Under PROFIBUS partner, I/O addr., enter: **<I/O address>**.
3. Click "OK".

NOTICE
The setpoint and actual value of an axis must have the same I/O address. **I address (actual value) = O address (setpoint)** If an ADI4 DP slave is inserted into an S7 project through a copy operation, e.g., from another S7 project, the I/O addresses are assigned directly by HW Config. This may have the consequence that an axis is assigned different I/O addresses for setpoint and actual values. The I/O addresses must be manually corrected in this case. To avoid access conflicts between the PROFIBUS DP drives and the I/O modules, values **≥ 272** must be used for I/O addresses for the ADI4 DP slave.

5.7.5 Consistency

Consistency setting

The default setting for I/O data consistency is "Total length".

The "Total length" consistency setting means that direct access from the PLC user program (e.g. byte, word, or double word) to this address area of the PLC operating system is not permitted.

5.8 Function parameters for SINUMERIK 802D sl

Parameter values

The function parameters are permanently specified in the preset configuration and cannot be changed.

The following parameter values are set:

- Sensor type: TTL [1)]
- Unipolar spindle: "Inactive"
- Shutdown ramp: 0
- Shutdown delay time: 0
- Tolerable sign-of-life failures: 0
- Reserved bits for fine resolution: 11
- 611U conformant mode: "Active"

[1)] Incremental encoder (TTL) with differential transmission of 5 V square wave signals (RS 422 Standard).

5.9 Function parameters

Parameters

The function-specific parameters of the ADI4 DP slave are entered under the "Encoder" tab:

- Encoder type
- Unipolar spindle (or unipolar motor)
- Shutdown ramp
- Shutdown delay
- Tolerable sign-of-life failures
- Reserved bits for fine resolution
- 611U conformant mode

The figure below shows the corresponding dialog box with sample values for the various encoder types and parameters.

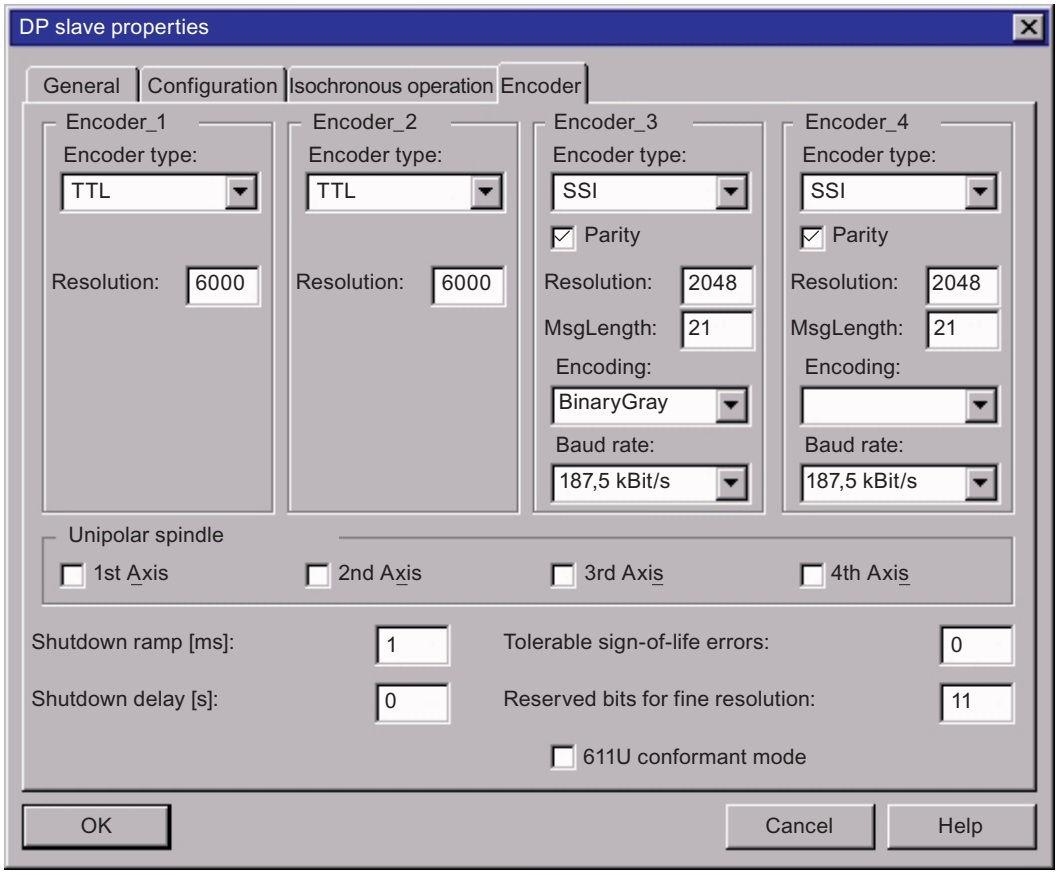


Figure 5-3 "DP Slave Properties" dialog box, "Encoder" tab

5.9.1 Encoder type

Encoder type "not available"

An encoder type setting of "not available" for encoder x means that axis x does not exist, or that it is not to be operated. Net data transmitted for this axis in the PROFIBUS message frame are empty.

Encoder type TTL

Encoder parameter:

- Resolution
  Encoder resolution in encoder pulses per encoder revolution

Note

In the case of spindles with a low-resolution encoder, the actual-value characteristic (incrementing) may be displayed in a non-linear fashion. The grid that is visible on the actual-value display is the result of the speed resolution (RR), where:

RR = 60000 / (Tdp * ER * PM)

- RR (speed resolution): [(revolutions/min) / encoder pulse]
- Tdp (position control cycle clock = PROFIBUS cycle clock): [ms]
- ER (encoder resolution): [Encoder pulse / revolution]
- PM (pulse multiplication)

Example:

Tdp (position control cycle clock = PROFIBUS cycle clock): 2 ms

ER (encoder resolution): 2500 pulses/revolution

PM (pulse multiplication): 4

RR = 60000 / (2 * 2500 * 4) = 3 (revolutions/min) / encoder pulse

(SINUMERIK 840Di sl, SINUMERIK 840D sl)

Smoothing of the actual value for low-resolution encoders via machine data:
MD34990 $MA_ENC_ACTVAL_SMOOTH_TIME (smoothing time constant)

Encoder type SSI

Encoder parameters:

- Parity
  Select this check box if the encoder data are to be transmitted from the encoder to the ADI4 with a parity bit.
- Resolution
  Encoder resolution in encoder pulses per encoder revolution
- MsgLength
  Number of net data bits transmitted from the encoder

- Encoding
  The following encoder codes are supported:
  - Binary
  - Gray
- Baud rate
  The following baud rates are supported:
  - 187.5 kbit/s
  - 375 kbit/s
  - 750 kbit/s

NOTICE
Regarding SSI encoders (absolute encoders), the following limitations should be observed: • The baud rate setting must be identical for all SSI encoders. If baud rate settings are different, the baud rate of the SSI encoder with the highest encoder number is used. • In conjunction with ADI4, only SSI encoders with "Christmas tree" data output format (TSSI) can be operated.

5.9.2 Unipolar spindle or unipolar motor

Introduction

The drive can be moved in two directions. Selecting the "Unipolar spindle" option switches over the voltage range of the analog output voltage.

Unipolar spindle not selected

If the "Unipolar spindle" option button is **not** selected, an analog voltage in the range of **-10 V** to **+10 V** is output as the setpoint.

Unipolar spindle selected

If the "Unipolar spindle" option button **is selected**, an analog voltage in the range of **0 V** to **+10 V** is output as the setpoint. Depending on the actual speed setpoint, the direction of rotation is then output via a digital output of the ADI4:

- Direction of rotation signal for axis 1 -> digital output X6-1, pin 6
- Direction of rotation signal for axis 2 -> digital output X6-1, pin 7
- Direction of rotation signal for axis 3 -> digital output X6-1, pin 8
- Direction of rotation signal for axis 4 -> digital output X6-1, pin 9

Direction of rotation signal

The following voltage level is available at the digital outputs X6-1, pins 6 - 9 depending on the direction of rotation:

- M3 (spindle CW)= 24 V
- M4 (spindle CCW) = 0 V
- M5 (spindle stop) = 24 V

5.9.3 Shutdown ramp

Shutdown ramp

The "Shutdown ramp" parameter specifies a function that is linear with respect to time. If an error is detected in the ADI4, all ADI4 drives are slowed down to Setpoint "0" in accordance with this function.

A parameter value of "0" brings the drives to an immediate stop (braking at the current limit).

- Unit: [ms]

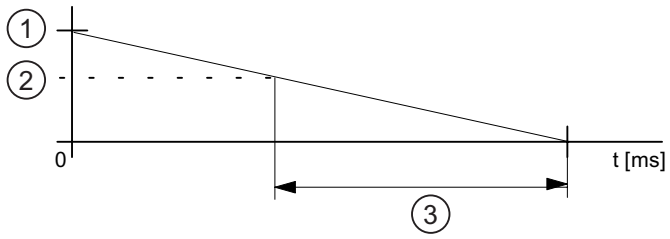


Figure 5-4 Parameter: Shutdown ramp

① Maximum setpoint
② Current setpoint
③ Parameter value: Shutdown ramp

5.9.4 Shutdown delay

Shutdown delay parameter

The "Shutdown delay" parameter can be used to specify a time after which all ADI4 drives are slowed down to the setpoint "0" following a temperature alarm in the ADI4.

After the "Shutdown delay" has elapsed, the "Shutdown ramp" is taken into account.

- Unit: [s]

5.9.5 Tolerable sign-of-life failures

"Tolerable sign-of-life failures" parameter

The "Tolerable sign-of-life failures" parameter specifies the number of sign-of-life failures tolerated for the DP master. If the assigned number is exceeded, the setpoint interfaces of the drives are ramped down to the value "0" using the "Shutdown ramp".

NOTICE
Presently, the "Tolerable sign-of-life failures" parameter may only be used on values in the range of 0 to 13.

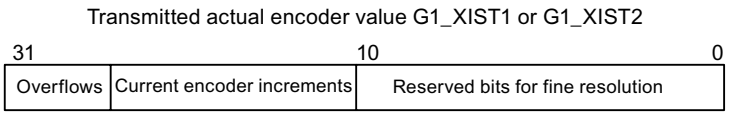
5.9.6 Reserved bits for fine resolution

"Additional substitute bits for fine resolution" parameter

The "Additional substitute bits for fine resolution" parameter specifies the desired pulse multiplication of the encoder increments transmitted in actual encoder values G1_XIST1 and G1_XIST2.

Presently, the number of additional substitute bits for fine resolution must be set permanently to 11. This corresponds to a pulse multiplication of: $2^{11} = 2048$.

NOTICE
The "Reserved bits for fine resolution" parameter must always be set to 11.



(SINUMERIK 840Di sl, SINUMERIK 840D sl)

NOTICE
Corresponding to the "Additional substitute bits for fine resolution" parameter, the following must be entered in the axis-specific machine data: MD30260 $MA_ABS_INC_RATIO (ratio of the absolute resolution to the incremental resolution) the value $2^{\text{"Additional fine bits for fine resolution"}} = 2^{11} = 2048$.

5.9.7 611U conformant mode

Setting options

In 611U conformant mode, the signal source for homing of axes is no longer specified using the PROFIDrive standard message frame (STD3, encoder control word G1_STW), but rather using the additional digital output word in the PROFIBUS message frame of the ADI4 (see table "Message frame structure" in the "Message frame type" section).

611U conformant mode:

- Not selected
  The signal source for homing is specified via the encoder control word Gx_STW in the PROFIDrive standard message frame.
- Selected
  The signal source for homing is specified via the additional digital output word in the PROFIBUS message frame.

Digital output word

The signal sources for the homing are selected on an axis-specific basis via the following bits of the output word (see also output word in the table "Message frame structure" in the "Message frame type" section)

Table 5- 4 Output word: Signal sources for homing

Bit	Value	Signal source for homing
8	0	Axis 1: Zero mark of encoder 1 (X4-1)
	1	Axis 1: **Rising** edge of external zero mark 1 (X6-2, pin 2)
9	0	Axis 2: Zero mark of encoder 2 (X4-2)
	1	Axis 2: **Rising** edge of external zero mark 2 (X6-2, pin 3)
10	0	Axis 3: Zero mark of encoder 3 (X4-3)
	1	Axis 3: **Rising** edge of external zero mark 3 (X6-2, pin 4)
11	0	Axis 4: Zero mark of encoder 4 (X4-4)
	1	Axis 4: **Rising** edge of external zero mark 4 (X6-2, pin 5)

If the 611U conformant mode has been parameterized for an axis to be homed, the axis-specific signal for selection of the signal source must be set in the digital output word of the ADI4 from the PLC user program, before the "Reference mark search" function is requested in the encoder control word.

The following sections show the basic system structure and the respective boundary conditions of the individual homing methods.

Exiting the dialog box

If the "DP Slave Properties" dialog box is exited with "OK", the data are accepted and the dialog box is closed.

Step1: End

Step 1 of the ADI4 DP slave parameterization is now complete.

See also

Message frame type (Page 46)

Boundary conditions (Page 61)

5.9.8 Homing using encoder zero mark

System setup

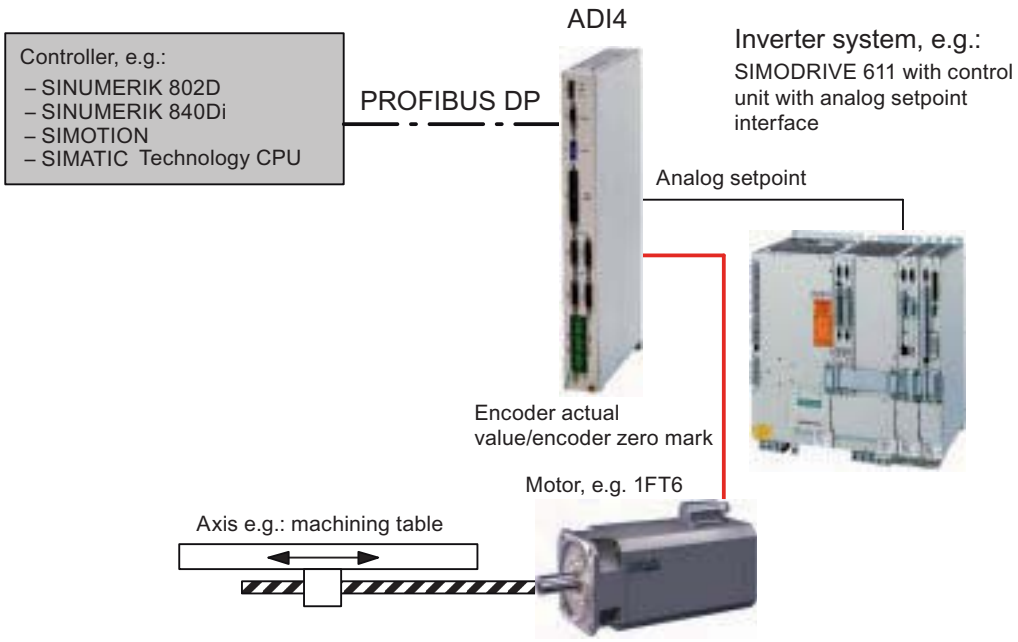


Figure 5-5 Basic system structure: Homing using encoder zero mark

Function

Once the controller requests homing, the ADI4 transmits the actual encoder value to the controller as the home position the next time it detects an encoder zero mark.

Without 611U conformant mode

No further measures are required.

With 611U conformant mode

The relevant signal for the axis to be homed (e.g. axis 1) must be set in the digital output word:

- Digital output word:
  Bit 8: = 0 => "Axis 1: Zero mark of encoder 1 (X4-1)"

5.9.9 Homing using external zero mark

System setup

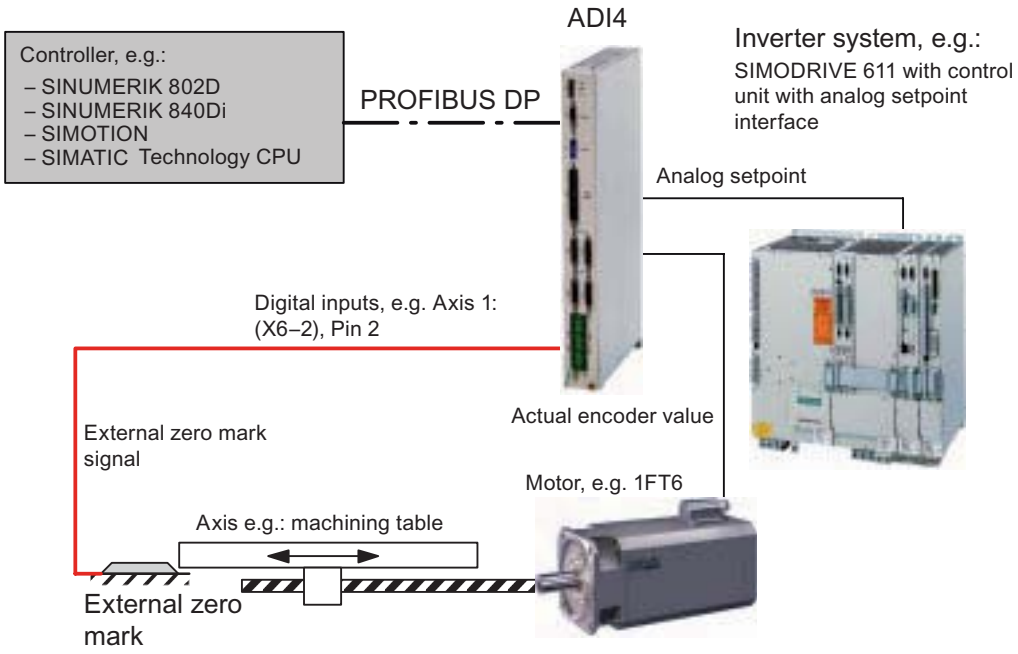


Figure 5-6 Basic system structure: Homing using external zero mark

Function

Once the controller requests homing, the ADI4 transmits the actual encoder value to the controller as the home position the next time it detects an external zero mark signal.

Without 611U conformant mode

The controller must define the relevant function via encoder control word G1_STW:

- Function 2 (homing via rising edge of external zero mark)
- Function 3 (homing via falling edge of external zero mark)

With 611U conformant mode

The relevant signal for the axis to be homed (e.g. axis 1) must be set in the digital output word:

- Digital output word:
  Bit 8: = 1 => "Axis 1: Rising edge of external zero mark 1 (X6-2, pin 2)"

Note

Homing using an external zero mark requires 611U conformant mode to be selected.

5.9.10 Boundary conditions

Probe or on-the-fly measurement

ADI4 supports only measurement using a rising **or** falling edge of the probe. It is not possible to parameterize simultaneous measurement on a rising edge and a negative edge.

Speed actual value

The actual speed value (PZD2/3: NACT_B) contained in standard message frame 3 (see table "Message frame structure" in the "Message frame type" section) is not supported by the ADI4. The ADI4 always sends a value of 0 as the actual speed value.

External encoder interface (encoders without an axis)

If only encoders are connected to the ADI4 without at least one axis being parameterized, i.e. the ADI4 uses the encoder as an external encoder interface only, a "Ready" signal (interface X6-1, pin 10/11) is not output. For information on the "Ready" signal, refer to section "Interface (X6-1): Digital outputs".

See also

Interface (X6-1): Digital outputs (Page 28)

5.10 Parameterization of the DP communication

5.10.1 Parameter assignment of the equidistant cyclic DP communication

Action steps

Once all the DP slaves have been inserted in the configuration and their function parameters have been assigned as described (Step 1), the parameters for the equidistant cyclic DP communication must then be assigned (Step 2).

Parameters are assigned to the equidistant cyclic DP communication in two steps, as well:

Step 1

- Activation of the equidistant DP cycle
- Equidistant master cyclic component T_{DX}

Step 2

- Equidistant DP cycle T_{DP}
- Master application cycle T_{MAPC}
- Actual value acquisition T_i
- Setpoint acceptance T_o

NOTICE
When assigning parameters for DP communication, you must observe the boundary conditions applicable to the individual parameters.

See also

Boundary conditions (Page 78)

5.10.2 Activation of the equidistant DP cycle

Procedure

Double-click an ADI4 DP slave. In the station window of HW Config, the dialog box: "DP Slave Properties" opens.

Note

It is recommended that the equidistant DP cycle be enabled for all ADI4 DP slaves by enabling the equidistant DP cycle within the selected ADI4 DP slave, and then performing an alignment:

During an alignment, all values displayed in the "DP Slave Properties" dialog box, "Isochronous mode" tab are transferred to all DP slaves of the same type, ADI4 DP slave here, of the configuration.

Dialog: Start

Dialog: DP slave properties
Tab: Isochronous operation
Radio button: Synchronize drive to equidistant DP cycle ☑
Button: Alignment

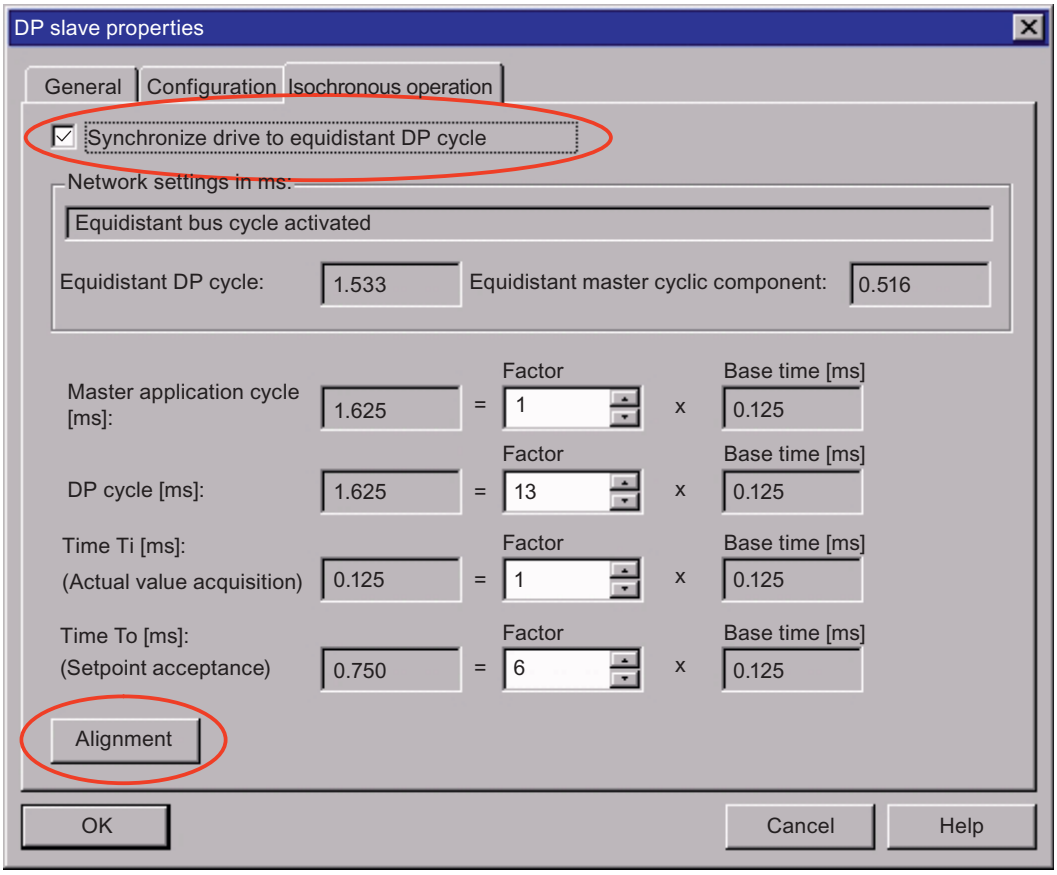


Figure 5-7 "DP Slave Properties" dialog box

5.10.3 Equidistant master cyclic component TDX

Procedure

Once synchronization to the equidistant DP cycle has been enabled for all DP slaves, the time required for the cyclic component of the DP communication must be recalculated.

The calculation is performed automatically by the DP master each time the equidistant bus cycle is enabled. This is performed in the following dialog box by selecting/clearing the "Activate equidistant bus cycle" check box.

Dialog: Continuation

Dialog box: DP slave properties
Tab: General
Group: Node/Master System
Button: PROFIBUS...

Dialog box: Properties - PROFIBUS interface ADI4 ...
Tab: Parameters
Button: Properties...
Dialog box: PROFIBUS properties
Tab: Network settings
Button: Options...
Dialog box: Options
Tab: Equidistance
1. Radio button: Activate equidistant bus cycle ☐ (deselect)
2. Radio button: Activate equidistant bus cycle ☑ (select)

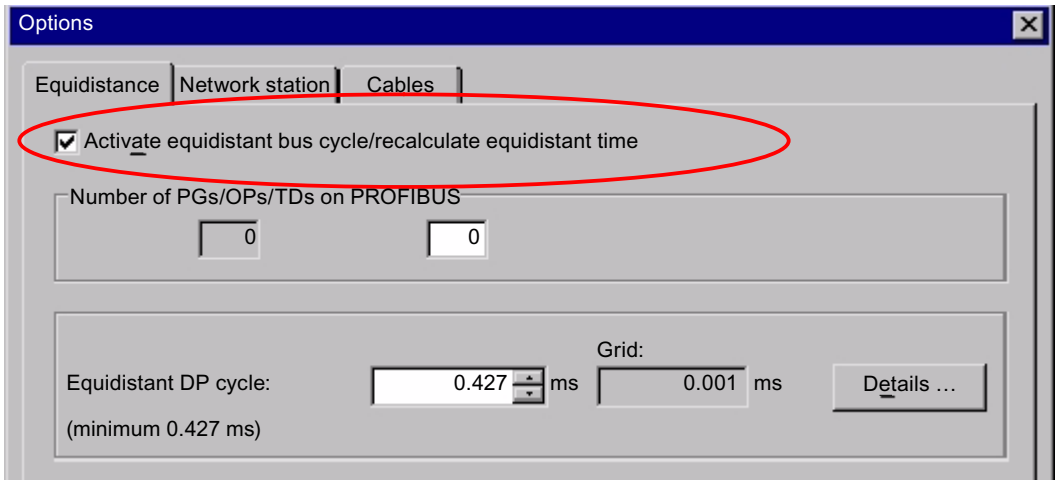


Figure 5-8 "Options" dialog box (excerpt)

Note

If there are different equidistant DP slave types (for example, different SIMODRIVE drives, ADI4, etc.) in an S7 project, you must first perform the following two steps for each DP slave type:

1. Synchronize drive to equidistant DP cycle
2. Perform alignment

You can then continue to set the other parameters.

5.10.4 Equidistant DP cycle TDP

Procedure

When the cyclic component of the DP communication is calculated, the DP master automatically changes the value for the equidistant DP cycle to the minimum required time. This change must be undone by re-entering the intended value for the equidistant DP cycle.

(SINUMERIK 840D sl)

Equidistant DP cycle

For SINUMERIK 840D sl, an ADI4 module is connected via an external PROFIBUS (connection: DP1, X126 or DP2/MPI, X136). The DP cycle - with constant bus cycle time - of the external PROFIBUS must then be set the same as the position controller clock cycle parameterized in the NC or the equidistant DP cycle of the internal PROFIBUS.

Note

The DP cycle of the external PROFIBUS must be the same as that of the internal PROFIBUS:

Equidistant DP cycle (external PROFIBUS) = position controller cycle = equidistant DP cycle (internal PROFIBUS)

Connection to "NCU7x0.2 PN"

If an ADI4 module is connected to NCU module "NCU7x0.2 PN" then a module with the following version and higher must be used: MLFB …-0AA2

Dialog: Continuation

Dialog box: Options
Tab: Equidistance
Entry field: Equidistant DP cycle = 2.000 ms (example value)
OK (close dialog box: Options)
OK (close dialog box: PROFIBUS properties)
OK (close dialog box: Properties - PROFIBUS interface ADI4 ...)

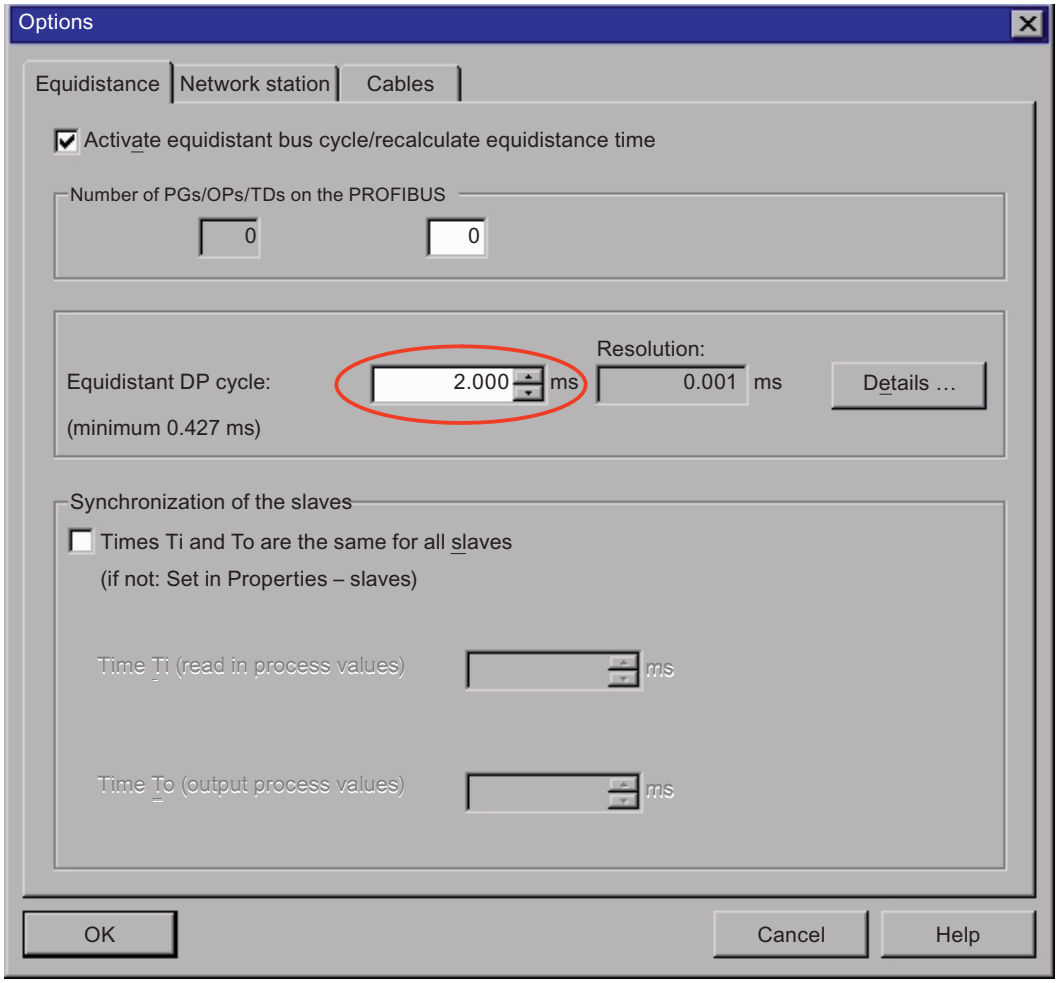


Figure 5-9 "Options" dialog box

5.10.5 DP cycle TDP

Procedure

In the "Factor" entry field of the "DP cycle (ms)", enter a value such that the resulting DP cycle is equal to the equidistant DP cycle.

Dialog: Start

Dialog: DP slave properties
Tab: Isochronous operation
Entry field: Factor = 16 (example value)

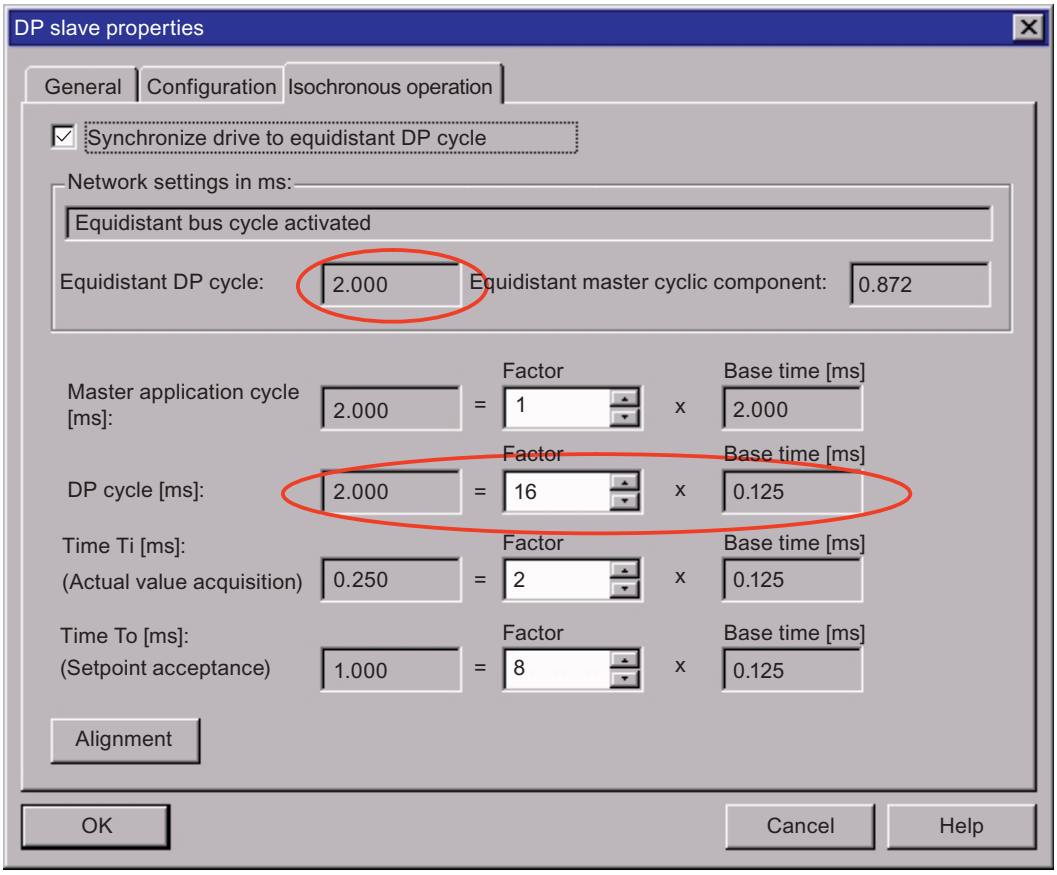


Figure 5-10 "DP Slave Properties" dialog box

Note

The DP cycle time ("DP cycle" parameter) of the ADI4 DP slave must be set to the same value as the DP cycle time setting for the DP master ("Equidistant DP cycle" parameter):

DP cycle = equidistant DP cycle

See also

Boundary conditions (Page 78)

5.10.6 Master application cycle TMAPC

Introduction

The "Master application cycle T_{MAPC}" parameter specifies the integer ratio between the cycle time of the master application (position controller) and the equidistant DP cycle.

Using ratios other then 1:1, the dead times of the position controller can be reduced if control hardware with a lower performance is being used.

Note

(SINUMERIK 840Di sl, SINUMERIK 840D sl)

The ratio between master application cycle T_{MAC} and DP cycle time T_{DP} **must** be 1:1.

(SINUMERIK 802D sl)

The ratio between master application cycle T_{MAC} and DP cycle time T_{DP} **can** be set to a ratio other than 1:1.

Procedure

In the entry field for the factor of the "Master application cycle [ms], enter a value such that the required time ratio is achieved.

Dialog: Continuation

Dialog: DP slave properties
Tab: Isochronous mode
Entry field: Factor = 1 (example value)

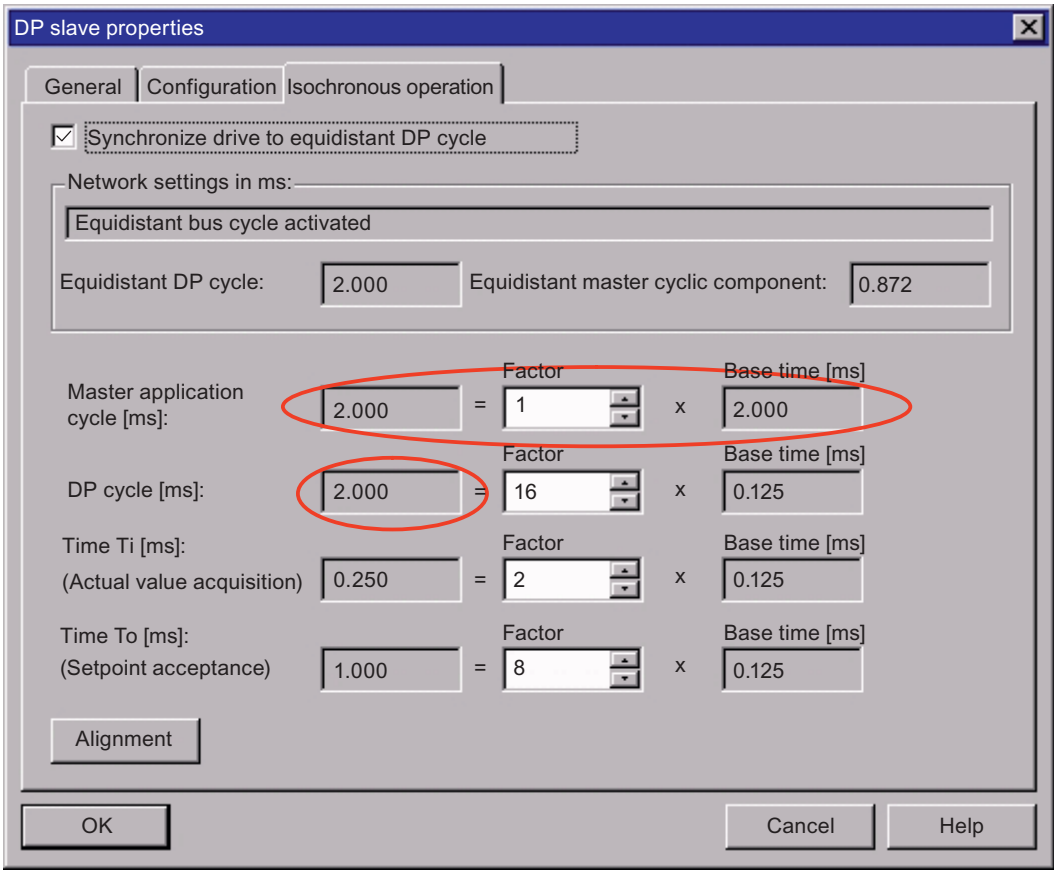


Figure 5-11 Dialog: DP slave properties

Sequence, T_{MAPC} : T_{DP} = 1 : 1

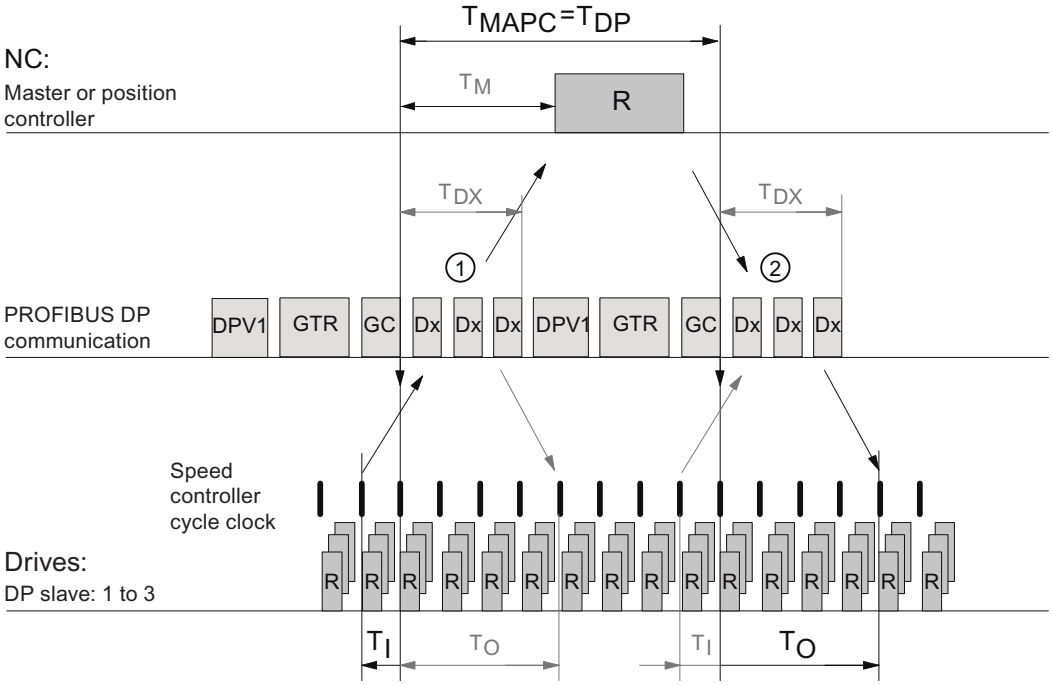


Figure 5-12 Example: optimized DP cycle with TMAPC: TDP = 1:1

Sequence, T_{MAPC} : T_{DP} = 2 : 1

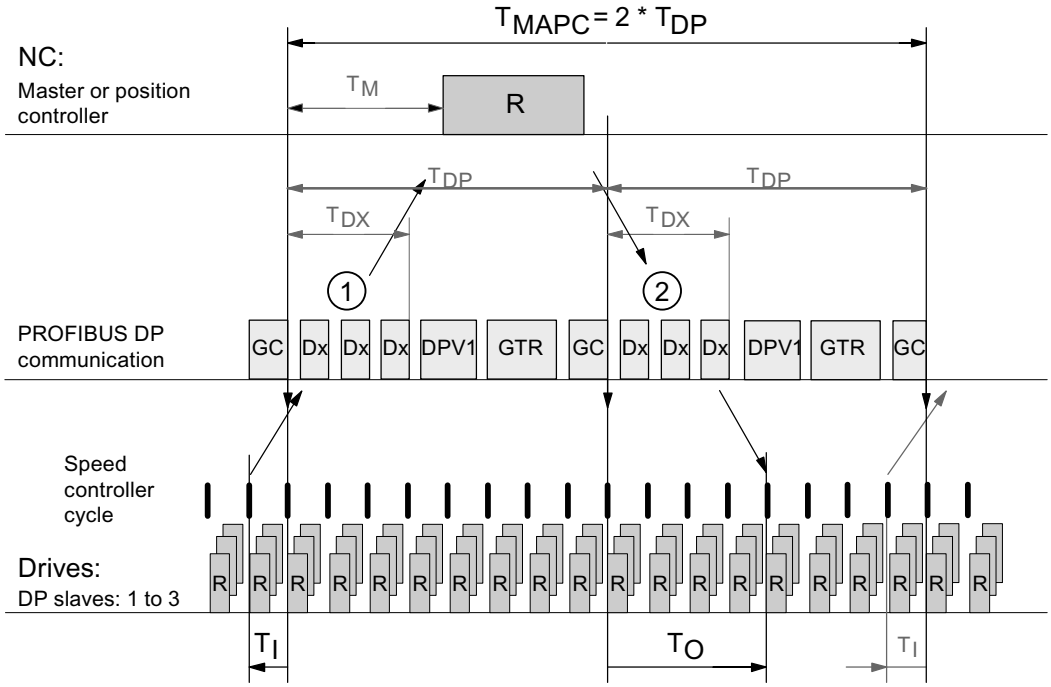


Figure 5-13 Example: optimized DP cycle with TMAPC: TDP = 2:1

T_{MAPC}	Master application cycle: Position controller clock cycle
T_{DP}	DP cycle time: DP cycle time
T_{DX}	Data exchange time: Total transfer time for all DP slaves
T_M	Master time: Offset of the start time for NC position control
T_I	Input time: Time of the actual value acquisition. The actual values are transferred to the DP master in the **next** DP cycle.
T_O	Output time: Time of the setpoint acceptance. The setpoints were generated by the DP master application in the **previous** DP cycle.
GC	Global control telegram (broadcast telegram) for cyclic synchronization of the equidistance between the DP master and DP slaves
R	Computation time for speed or position controller
Dx	Net data exchange between the DP master and DP slaves
DPV1	After cyclic communication, an acyclic service is sent, if the token holding time T_{TH} has not yet been exceeded. T_{TH} is calculated by the engineering system.
GTR	GAP, TOKEN, RESERVE: GAP: An attempt is made during GAP to accept new active stations. TOKEN: The token passing is either to itself or other masters. RESERVE: The reserve is used as an "active pause" for the station to send the token to itself until the equidistant cycle expires.
①	The actual values for the actual DP cycle / position controller cycle are transferred from the DP slave drives to the NC position controller.
②	The setpoints computed by the NC position controller are transferred to the DP slave drives.

See also

Boundary conditions (Page 78)

5.10.7 Actual value acquisition Ti

Introduction

The "Actual value acquisition T_i" parameter specifies the time when an ADI4 DP slave reads in the actual values (actual position value).

It is recommended to specify the same time for the actual value acquisition T_i for all ADI4 DP slaves. Special attention must be paid to this if axes of different ADI4 DP slaves move according to interpolation on a common path.

Procedure

Enter the required value in the entry field for the factor of the actual value acquisition.

Dialog: Start

Dialog: DP slave properties
Tab: Isochronous operation
Entry field: Factor = 2 (example value)

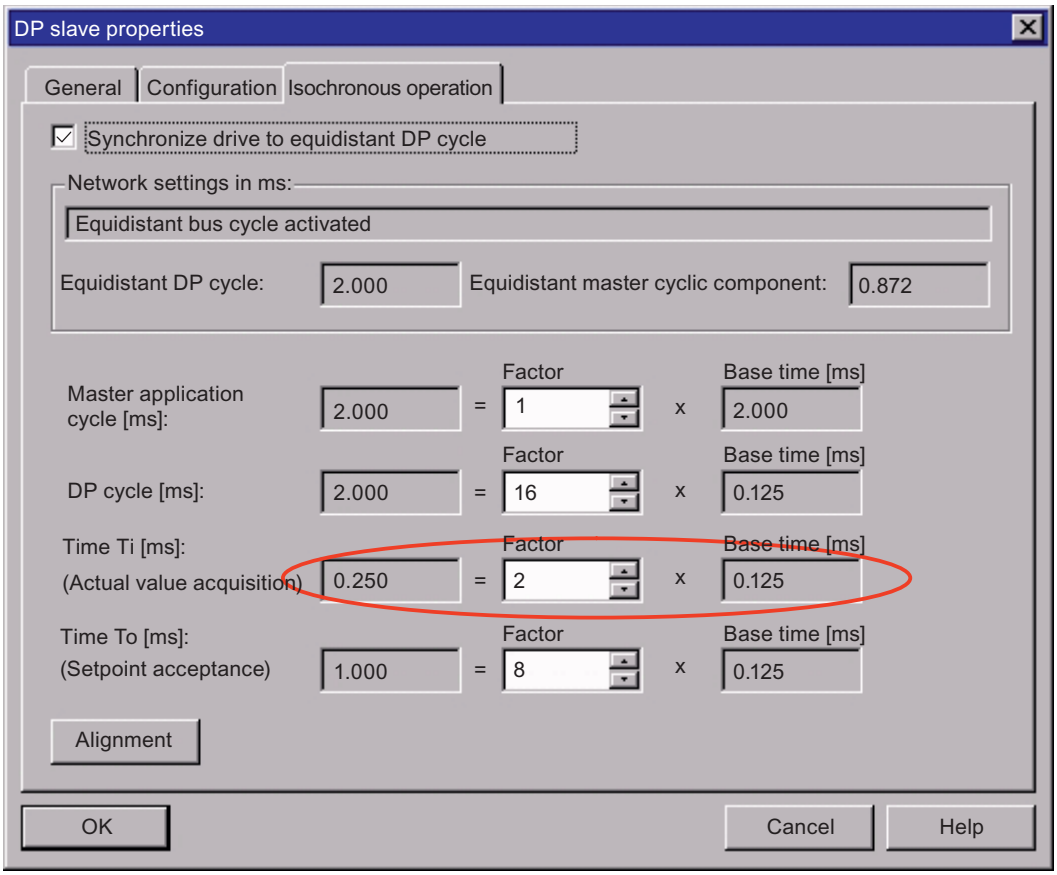


Figure 5-14 "DP Slave Properties" dialog box

Note

The following condition must be observed for the time of actual value acquisition T_i:

Base time ≤ actual value acquisition ≤ DP cycle

See also

Boundary conditions (Page 78)

5.10.8 Setpoint acceptance To

Introduction

The "Setpoint acceptance T_o" parameter specifies the time when the ADI4 DP slave receives the speed setpoint from the position controller.

It is recommended that setpoint acceptance time T_o be the same for all ADI4 DP slaves, particularly if axes are interpolated together.

Procedure

Enter the required value in the entry field for the factor of the setpoint acceptance.

Dialog: Start

Dialog: DP slave properties
Tab: Isochronous operation
Entry field: Factor = 8 (example value)

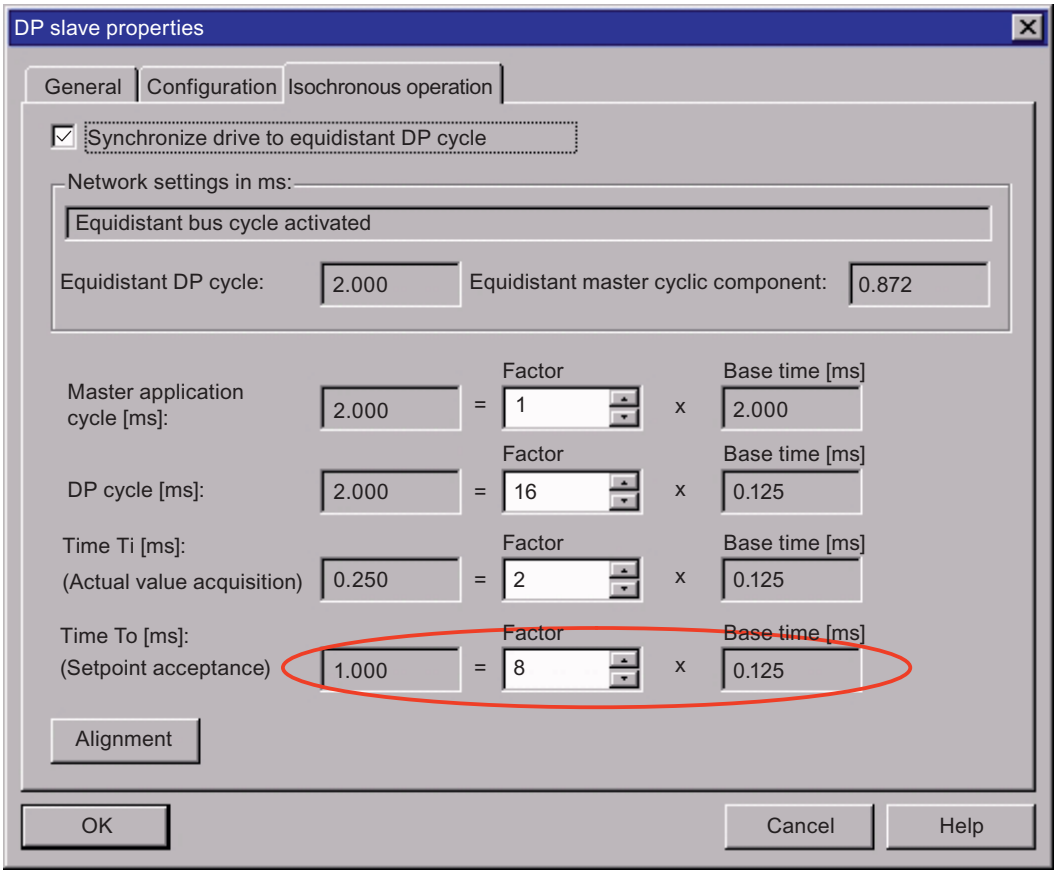


Figure 5-15 "DP Slave Properties" dialog box

Note

The following condition must be observed for the time of setpoint acceptance T_o:

Equidistant master cyclic component + base time ≤ setpoint acceptance ≤ DP cycle

See also

Boundary conditions (Page 78)

5.10.9 Alignment

Procedure

The alignment is used to transfer the values of the current ADI4 DP slave displayed in the "Isochronous operation" tab to all the other ADI4 DP slaves of the configuration.

Dialog: End

Dialog: DP slave properties
Tab: Isochronous operation
Button: Alignment
OK

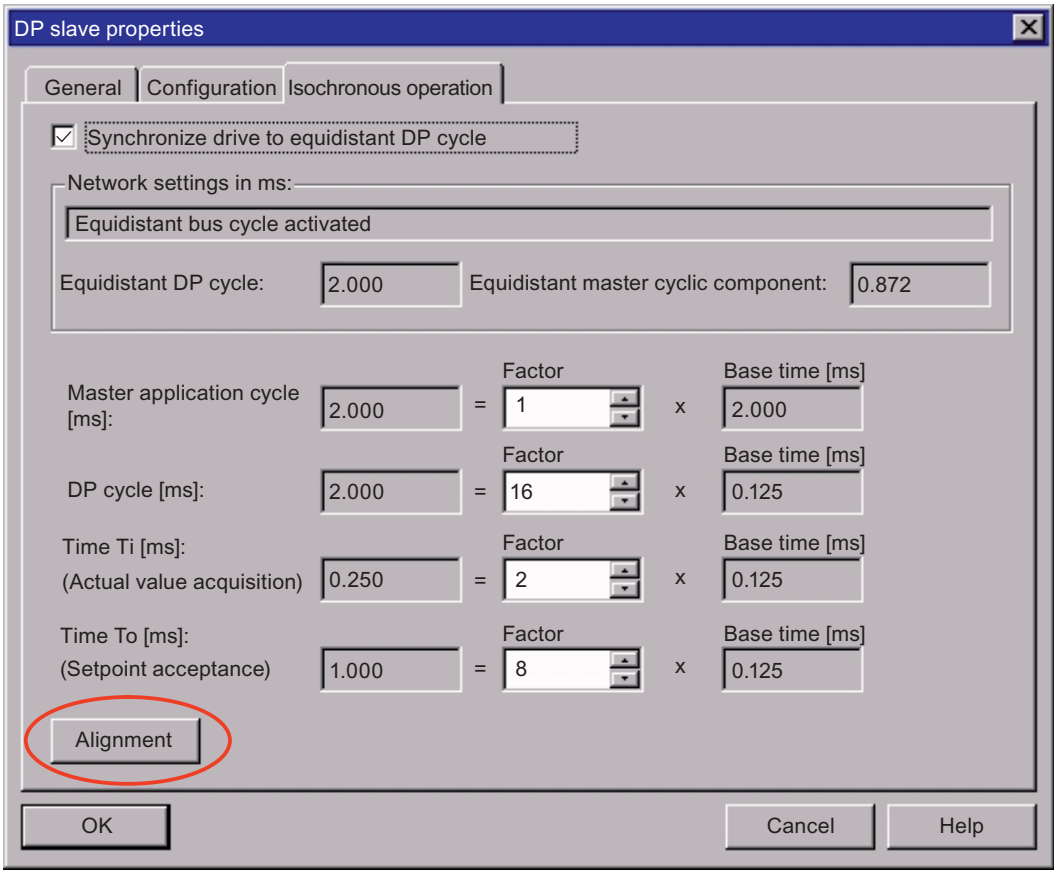


Figure 5-16 "DP Slave Properties" dialog box

Note

If an S7 project includes different equidistant DP slave types, such as different SIMODRIVE drives, ADI4, etc., the following parameter settings must be made for each DP slave type as described above, and an alignment must be performed:

- Equidistant DP cycle T_{DP}
- Master application cycle T_{MAPC}
- Actual value acquisition T_i
- Setpoint acceptance T_o

The alignment only transfers the values displayed in the "Isochronous operation" tab to the DP slaves **of the same** type.

The alignment concludes the parameter assignment of all ADI4 DP slaves with respect to the DP communication.

5.10.10 Boundary conditions

ADI4 from MLFB: 6FC5 211-0BA01-0AA1

The following boundary conditions must be observed when making the final parameter assignment of the equidistant DP cycle in conjunction with ADI4 from the following MLFB onwards: 6FC5 211-0BA01-0AA1:

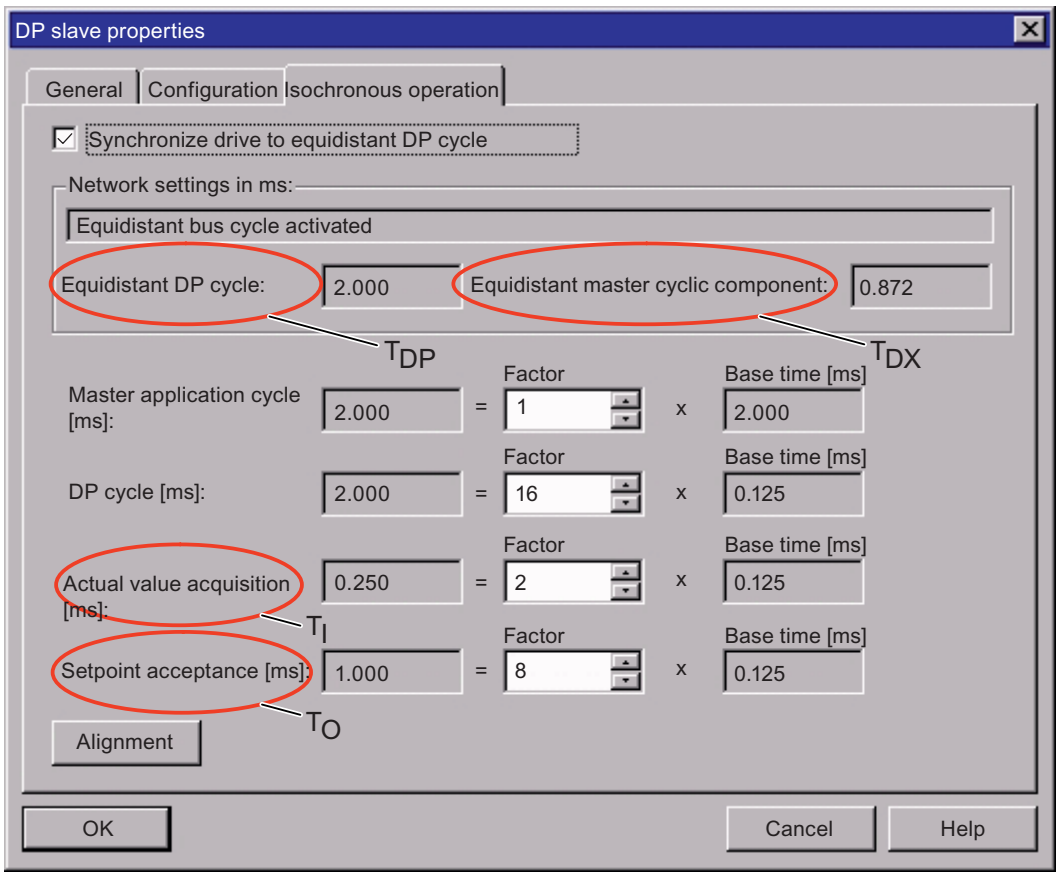


Figure 5-17 Section of the "DP Slave Properties" dialog box

1. Equidistant DP cycle (T_{DP})

   $\mathbf{T}_{DP}$ = 2* n * 125 us;
   with n ≧ 4 (=> minimum T_{DP} = 1 ms)

2. Setpoint acceptance (T_o)

   (TDX + 125 us) ≤$\mathbf{T}_O$ < T_{DP};
   with rounded variable TDX = T_{DX}, rounded to an integer multiple of 125 us

3. Actual value acquisition (T_i)

   250 us ≤ $\mathbf{T}_I$ ≤ 625 us

4. T_I and T_O cannot be in the same 125 us cycle clock

   ΔT ≠ 0; with ΔT = T_{DP} - $\mathbf{T}_I$ - $\mathbf{T}_O$

5. If **T_O** == (T_{DP} - 125 us)

   Then for T_I, the following must apply: **T_I** > 3 * 125 us

6. If **T_O** == (TDX + 125 us)

   Then for (T_I + T_O), the following must apply: (**T_I** + **T_O**) ≠(T_{DP} + 125 us)

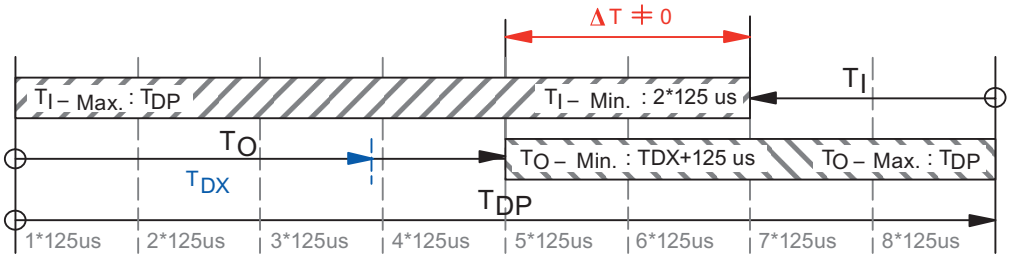


Figure 5-18 Graphic illustration of the boundary conditions

Typical parameter values

Equidistant DP cycle (T_{DP})	2.000 ms
Actual value acquisition (T_i)	0.250 ms
Setpoint acceptance (T_o)	1.000 ms

Note

The ADI4 DP slaves

- Order number (MLFB): 6FC5 211-0BA01-0AA0
- Order number (MLFB): 6FC5 211-0BA01-0AA1 or 0AA2

manifest a different behavior for a parameter assignment deviating from the boundary conditions indicated above for actual value acquisition (T_i) and setpoint acceptance (T_o).

- ADI4 DP slave with MLFB ...-0AA0
  If parameters are assigned that deviate from the boundary conditions indicated above, they are ignored by this ADI4 DP slave, as parameters are fixed internally. The ADI4 DP slave establishes cyclic communication with the DP master using values that differ from the parameterized preset values without an error message.
- ADI4 DP slave with MLFB ...0AA1 or ...0AA2
  If parameters are assigned that deviate from the boundary conditions indicated above and these parameters are downloaded to the ADI4 DP slave, the ADI4 DP slave does **not** establish cyclic communication with the DP master.

Further information 6

6.1 Wiring of drive ready signals

In order that a drive connected to the ADI4 can be switched-on via the S7 function block FB 401 (MC_POWER), the ready signal of the drive must be connected to one of the digital inputs, "Drive Ready" signal, axis x (DRVx_RDY), interface (X6-2) of the ADI4.

The ready signal must still be available at the ADI4 input even after the drive has been switched on.

Note

Drives without ready signal

If a ready signal is not available for a drive, then 24 V can be statically assigned to the corresponding digital ready signal input "Drive Ready" axis x (DRVx_RDY) of the ADI4. However, this approach has the disadvantage that when a drive fails, this is no longer detected by the S7 function block FB 401 (MC_POWER). FB 401 returns the status "TRUE" at its output even after a drive failure.

6.2 Supported SSI encoder formats

SSI encoders with the following formats are supported:

1. "Christmas tree" formats whose net data length (MsgLength, see Chapter "Encoder type (Page 53)") is the **same** as the number of significant data bits:
   - 25 bit with 12-bit multiturn and 13-bit singleturn information (MsgLength = 25)
   - 21 bit with 8-bit multiturn and 13-bit singleturn information (MsgLength = 21)
   - 13 bit with 13-bit singleturn information (MsgLength = 13)
2. Left-justified "Christmas tree" formats whose net data length (MsgLength) is **not equal** to the number of significant data bits:
   - 25 bit with 12-bit multiturn and 12-bit singleturn information (MsgLength = 24)
   - 21 bit with 8-bit multiturn and 12-bit singleturn information (MsgLength = 20)
   - 13 bit with 12-bit singleturn information (MsgLength = 12)

   Note
   SSI encoders with net data lengths not equal to the number of significant data bits can only be used if the complete net data length does not have to be read!
3. All right-justified "Christmas tree" formats, which fulfill the condition under 1.

Examples for Christmas tree formats that are supported

25-bit multiturn encoder, Christmas tree format, multiturn: 12-bit, singleturn: 13 bit ⇒ resolution: 2^{13} = 8192

Multiturn												Singleturn												
SSI Cycle Number																								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13

25-bit multiturn encoder, Christmas tree format (multiturn: 12-bit, singleturn: 12 bit ⇒ resolution: 2^{13} = 8192

Multiturn												Singleturn												
SSI Cycle Number																								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	0

25-bit multiturn encoder, Christmas tree format (multiturn: 8-bit, singleturn: 12 bit ⇒ resolution: 2^{13} = 8192

Multiturn												Singleturn												
SSI Cycle Number																								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	M8	M7	M6	M5	M4	M3	M2	M1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	0

25-bit multiturn encoder, Christmas tree format (multiturn: 9-bit, singleturn: 13 bit ⇒ resolution: 2^{13} = 8192

Multiturn												Singleturn												
SSI Cycle Number																								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	M9	M8	M7	M6	M5	M4	M3	M2	M1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13

21-bit multiturn encoder, Christmas tree format (multiturn: 8-bit, singleturn: 13 bit ⇒ resolution: 2^{13} = 8192

Multiturn								Singleturn												
SSI Cycle Number																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
M8	M7	M6	M5	M4	M3	M2	M1	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13

13-bit singleturn encoder (left aligned) ⇒ resolution: 2^{13} = 8192

Singleturn												
SSI Cycle Number												
1	2	3	4	5	6	7	8	9	10	11	12	13
S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13

6.3 Linear encoder with distance-coded zero marks / reference marks

Machine data

The following machine data must be set for the commissioning of the measuring system of a machine axis with linear encoder and distance-coded zero marks / reference marks:

Number	Identifier: $MA_	Meaning
30240	ENC_TYPE	Encoder type (data transmission)
31000	ENC_IS_LINEAR	Encoder type (type of construction) Linear encoders

Number	Identifier: $MA_	Meaning
31010	ENC_GRID_POINT_DIST	Signal period or scale division / EXE factor
31040	ENC_IS_DIRECT	Encoder mounting method: Direct measuring system
32100	AX_MOTION_DIR	Traversing direction (does not affect the control sense)
32110	ENC_FEEDBACK_POL	Encoder value polarity (affects the control sense)
34090	REFP_MOVE_DIST_CORR	Zero point/reference point offset The offset between the machine zero point and the first reference mark.
34200	ENC_REFP_MODE	Homing mode
34300	ENC_REFP_MARKER_DIST	Reference mark distance (basic distance)
34310	ENC_MARKER_INC	Interval between two reference marks Note Heidenhain: For all linear encoders with distance-coded zero marks / reference marks 20 µm
34320	ENC_INVERS	Orientation of the measuring system in relation to axis motion

Example

The following example illustrates how the mounting conditions of the machine axis and linear encoder have to be taken into account in the machine data for the machine axis concerned.

Type of linear encoder with distance-coded zero marks / reference marks used:

Heidenhain: LS 476 C

Technical characteristics (extract)	Value
Measuring length	270 mm
Reference mark distance	20 mm
Signal period of the incremental signals with scale division of 0.02 and integrated interpolation: 5x	0.004 mm
Distance between two reference marks (specific to Heidenhain)	0.02 mm

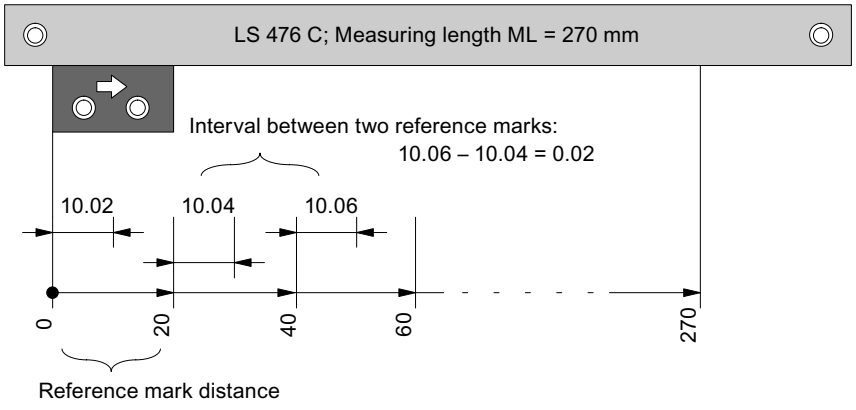


Figure 6-1 Linear encoder: LS 476 C

Because of the various possibilities regarding the orientation of the machine axis and linear encoder (same sense / opposite sense), it is necessary to distinguish between two scenarios.

Machine data remains the same in both cases:

Number	Identifier: $MA_	Value
30240	ENC_TYPE	2
31000	ENC_IS_LINEAR	1
31010 *	ENC_GRID_POINT_DIST	0.004
31040	ENC_IS_DIRECT	1
34200	ENC_REFP_MODE	3
34300 *	ENC_REFP_MARKER_DIST	20
34310 *	ENC_MARKER_INC	0.02
*) Technical characteristics of the encoder		

Scenario 1: Equidirectional orientation

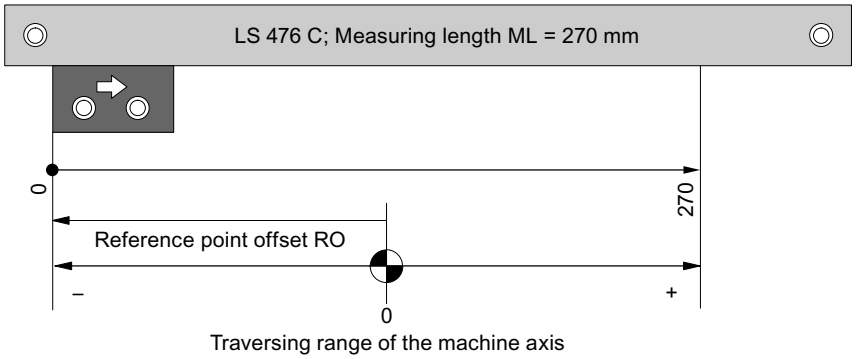


Figure 6-2 Machine axis with linear encoder: Equidirectional orientation

Orientation-dependent machine data

32100	AX_MOTION_DIR	1
32110	ENC_FEEDBACK_POL	1
34090	REFP_MOVE_DIST_CORR	RO
34320	ENC_INVERS	0

Scenario 2: Inverse orientation

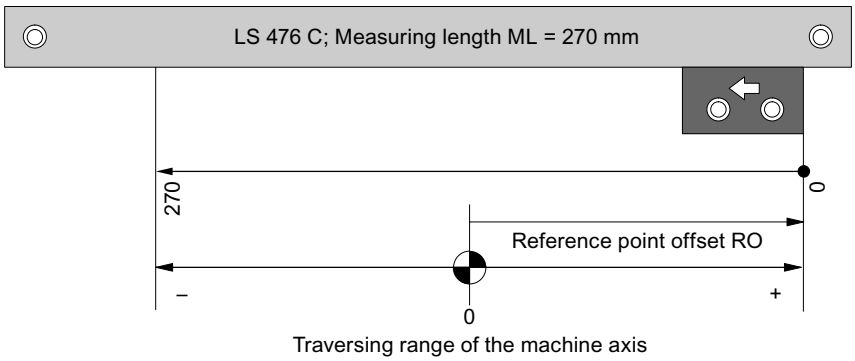


Figure 6-3 Machine axis with linear encoder: Inverse orientation

Orientation-dependent machine data

32100	AX_MOTION_DIR	1
32110	ENC_FEEDBACK_POL	-1
34090	REFP_MOVE_DIST_CORR	RO
34320	ENC_INVERS	1

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