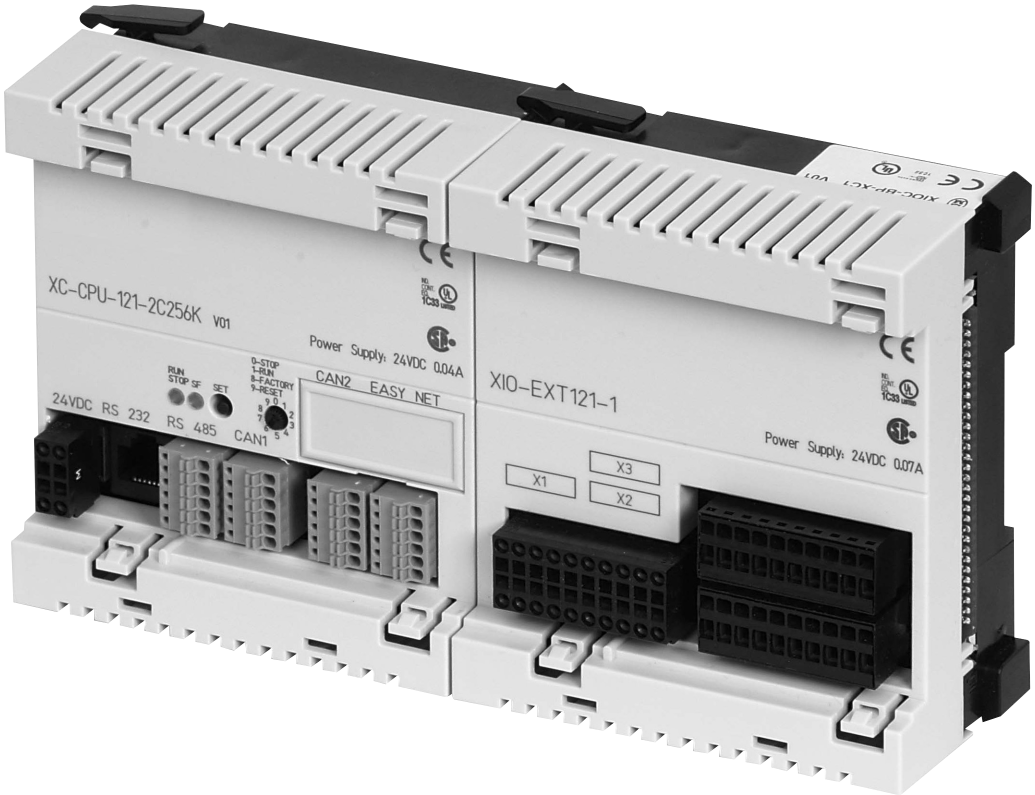
08/10 MN05003002Z-EN
replaces 04/08 AWB2724-1578G

Modular PLC
XC-CPU121-2C256K



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Original Operating Instructions
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original German manual.

1st published 2005, edition date 08/05
2nd edition 2007, edition date 04/07
3rd edition 2007, edition date 05/07
4th edition 2008, edition date 04/08
5th edition 2010, edition date 08/10

see revision protocol in the "About this manual" chapter

Editor: Thomas Kracht
Translation: globaldocs GmbH

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit the device.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (IL04020001E) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the extra-low voltage of the 24 V supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed and with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- Depending on their degree of protection, adjustable frequency drives may contain live bright metal parts, moving or rotating components or hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or adjustable frequency drive may cause the failure of the device and may lead to serious injury or damage.
- The applicable national accident prevention and safety regulations apply to all work carried on live adjustable frequency drives.
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing adjustable frequency drives must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the adjustable frequency drives using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  - Other independent devices for monitoring safety-related variables (speed, travel, end positions etc.).
  - Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
  - Never touch live parts or cable connections of the adjustable frequency drive after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be live after disconnection. Fit appropriate warning signs.

Contents

About this manual

List of revisions

Edition date	Page	Keyword	New	Modification	Omitted
04/07	12	COM2: transparent mode, Signal		✓	
	14	Using the CAN libraries	✓		
	18	Connecting the power supply		✓	
	19	Connecting sensors and actuators		✓	
	53	Delay time		✓	
	54	Pt100	✓		
05/07	18	Connecting the power supply		✓	
04/08	51 - 54	Technical data XC-CPU121, XIO-EXT121-1	✓	✓	✓
	13, 17	Figures		✓	
08/10	20	Pt100-calibrating curve for XC121 (Simulator: burster precision)	✓		
	54	Technical data XIO-EXT121-1, precision	✓		
	12	Assignment of the interface COM2		✓	
		Change to Eaton terminology		✓	

Additional documentation

In some places this manual contains references to more detailed descriptions in other manuals.

With the installation of the product CD these documents will be stored on the computer as PDF file.

To find the documents quickly select the Windows start menu.

Programme → Moeller Software → easy Soft CoDeSys → Documentation…

It is also possible to download the PDF files from the FTP server. The up to date data is always available here.

ftp://ftp.moeller.net/DOCUMENTATION/AWB_MANUALS/

Concrete information regarding communication with CAN stations and their configuration can be found in the following listed documentation:

- AN27K19GB: Communication between two controls using network variables via CANopen (AN2700K19G.pdf)
- AN27K20GB: Coupling multiple autonomous controls (CAN-Device) via CANopen (AN2700K20G.pdf)
- AN27K27GB: Engineering of CAN stations (AN2700K27D.pdf) (To be found in Windows start menu under Moeller Software → easy Soft CoDeSys → Application examples…)
- MN05010001Z (previously AWB2786-1554GB): Library description CANUser.lib, CANUser_Master.lib. (To be found in Windows start menu under Moeller Software → easy Soft CoDeSys → Documentation…)

Reading conventions

Select ‹File → New› means: activate the instruction New in the File menu.

Caution
Indicates a risk of material damage.

Warning!
Warns of the possibility of serious damage and slight injury.

Danger!
Indicates the risk of major damage to property, or serious or fatal injury.

For clarity of layout, we adhere to the following conventions in this manual: at the top of left-hand pages you will find the Chapter heading, at the top of right-hand pages the current Section heading; exceptions are the first pages of Chapters and empty pages at the end of Chapters.

1 Design of the XC121

The PLC XC121 is designed for application in machine and system control units. Software CoDeSys is required for programming.

The CPU XC-CPU121-2C256K can be applied autonomously and connected to the input/output devices via the CANopen interface. The I/O module XIO-EXT121-1 of the same construction design which features analogue and digital I/Os serves as the local expansion module for the CPU with inputs/outputs (I/O). All further X/IOC signal modules can be plugged into the module with the exception of the PROFIBUS-DP modules.

The XC121 PLC consists of the:

- XC-CPU121 with power supply unit
- I/O module XIO-EXT121-1 with power supply unit and digital and analogue I/Os, which are referred to as local I/Os in the following.
- Central XI/OC signal modules.

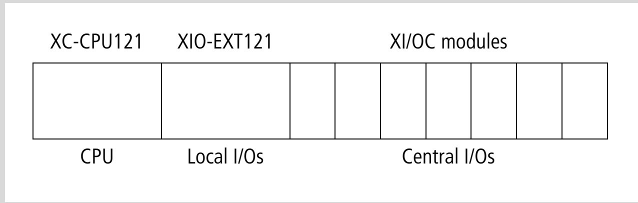


Figure 1: Design architecture

The CPU and the CPU-I/O module have the backplane with three slots as their base platform. Connect the XIO-EXT121 module with the CPU in order to expand the CPU with I/Os. You can then connect the backplanes XIOC-BP-3 and XIOC-BP-2 into which the XI/OC signal modules are inserted. An expansion within the XI/OC backplane is implemented using the backplane XIOC-BP-EXT. In the basic version with the XI/OC backplane a maximum of seven slots are available, with a maximum of 15 slots for the XI/OC signal modules when full expansion is implemented.

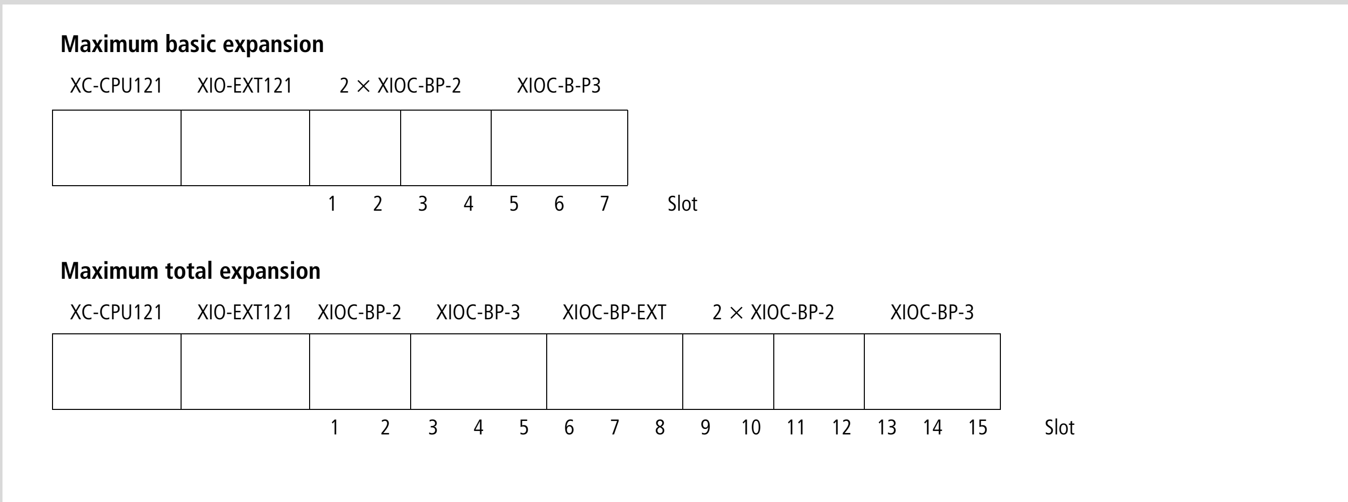


Figure 2: Expansion with XIOC signal modules

Detailed information concerning the backplanes and the XI/OC signal modules can be found in the "XI/OC Signal Modules" manual (MN05002002Z-EN, previously AWB2725-1452GB).

2 XC-CPU121 functions

The functions are described in detail in the following.

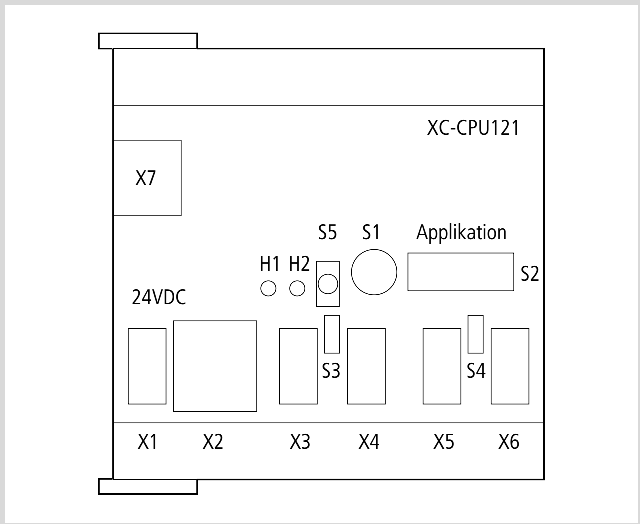


Figure 3: Overview XC-CPU121

Legends to figure 3:

H1	LED display RUN/STOP
H2	LED display SF
S1	Operating mode switch
S2	APPLICATION switch
S3	Switch for bus termination resistor for CAN1 interface
S4	Switch for bus termination resistor for CAN2 interface
S5	SET button
X1	Connection for power supply
X2	COM1 interface (RS232) for connection of a programming device
X3	COM2 interface (RS232/RS485)
X4	CANopen interface CAN1
X5	CANopen interface CAN2
X6	CANopen interface CAN2
X7	Slot for MMC (Multimedia Card)

Operating mode switch (S1)

With the operating mode switch, you can set the functions shown in Table 1.

Table 1: Operating mode switch functions

Switch position	Function
0	STOP
1	RUN Set the operating mode switch to position “1” and then press the set button in order to start the CPU.
2, 3, … , 7	STOP
8	Restore factory default state: When you press the SET button for at least three seconds, the values are read. CPU → STOP 08/10 MN05003002Z-EN! Remove the Multimedia card beforehand otherwise the program will be erased.
9	Perform “Cold reset”: When you press the SET button for at least three seconds, a Reset is performed. CPU → STOP

For further information → chapter “Program START/STOP” from page 24.

SET button (S5)

The SET button is enabled only in connection with setting 1, 8 and 9 of the operating mode switch. If you press the SET button while the switch is in position 8 or 9, the “Cold reset” or “Restore factory default state” are implemented (RUN/STOP LED flashes quickly).

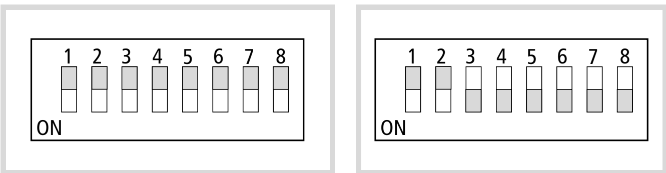
APPLICATION switch (S2)

Using the 8-pole DIP switch, values can be set which are to be evaluated differently to suit the set DIP switch mode. It is possible for example, with mode "Node ID CAN1" that you are dealing with the set node address (Node ID) for channel 1.

The DIP switch mode is set in the "PLC configuration" window (see following section). You can query the set value on the switch in the user program with the "GetApplicationSwitch" function. You can find this function in the library "XC121_Util.lib". It interprets the switch position as a binary value:

- Switch 1 = least significant bit;
- Switch 7 = most significant bit;
- Switch 8 = selection of the CAN interface with Node-ID routing: OFF = CAN1; ON = CAN2.

e.g. provides the function with the switch position value 3 as indicated on the right.



Setting in the default state

Setting for address 3

Figure 4: DIP switch application switch

DIP switch mode

The mode is set in the PLC configuration. Activate the "Other Parameters" tab and select one of the following modes in the "DIP-Switch-Mode" field:

- Application
- Node Id CAN1
- Node Id CAN2
- Node Id Routing.

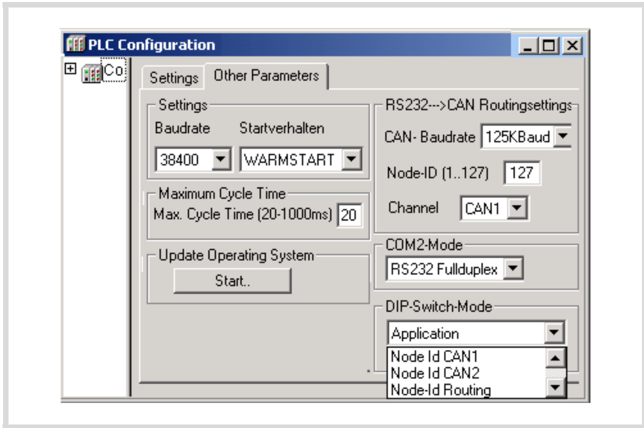


Figure 5: Mode of the application switch

Application: This setting has the effect that the DIP switch modes "Node Id CAN1/CAN2" and Node-Id Routing are not active.

Node Id CAN1/CAN2: The XC121 can operate for the CAN1 and/or CAN2 channel (interfaces) as a device. A Node-ID can be set on one of both "Node Id CAN1" or "Node Id CAN2" channels on the APPLICATION switch. For example, Node-Id 3 has been set in the representation on the right of figure 4.

Further information can be found at Section "CANopen interface CAN1/CAN2" on page 13.

Node-Id Routing: The XC121 can be used as the target control with routing. Access is provided via the CAN1 or CAN2 channel (interface). Set a Routing-Id for the channel on the APPLICATION switch.

In figure 4 Routing-Id "3" has been set on the switch indicated on the right.

Further information can be found at Section "CANopen interface CAN1/CAN2" on page 13.

Memory card MCC

The MMC serves as mass memory. The operating system (OS) supports memory types with the FAT16 file system. The OS can also be transferred onto the MMC in order to transfer it to another XC121 from there.

→ section "Operating system, download/update" on page 32.

> **Caution**
> The file system of the memory card is not transaction-safe. Ensure that all program files are closed before you insert or remove the MMC or switch off the voltage.

Data access on the MMC

Using browser commands and functions you can download and transfer general files as well as the boot project or the source code of the project onto the MMC. Use the "copyprojtomm" browser command for example, to copy the boot project on the MMC.

A short description of the browser commands can be found from page 35.

The files on the MMC can be accessed with the "FileOpen" or "FileRead" functions from the user program. These functions are described in the library "XC121_File.lib" and in the manual "easySoft CoDeSys Function Blocks" (MN05010002Z-EN, previously AWB2786-1456GB).

Erasing functions

If a full reset command is executed in online mode in the PLC Configuration, the operating system and the project on the MMC are deleted. The parameters of the STARTUP.INI file are retained.

You can use the following browser commands:

- "format": deletes the entire content on the MMC
- „removeprojfrommmc": deletes the project and the INI file on the MMC. The data on the CPU is retained, → section "Delete INI file" on page 42.

LED status indication RUN/STOP and SF

Table 2: LED status indicator

LED	Meaning
RUN/STP + SF	
Off + Red	System test being run (up to 6 seconds after start; after 6 seconds if no user program is present). CPU in NOT READY!
Green + Red	System update in progress
Both flashing	System test found a fault
Green flashing + Off	Load user program CPU in STOP!
Green + Off	Load user program CPU in RUN!
Green flashing + Red	Group error/diagnosis message issued.
Green (flashing quickly during Reset) + red (dependent on group error Off/On)	Reset through operating mode switch (switch position 9)

Real-time clock

The XC121 features a real-time clock, which can be referenced in the user program via the functions from the "SysLibRTC" library. The functions are described in the SysLibRTC PDF file. The file can be found in the Windows start menu under "Moeller Software → easy Soft CoDeSys → Documentation…".

You can read and set with the browser commands "getrtc" and "setrtc" respectively. Further information can be found at Section "setrtc" on page 36.

During a voltage loss the clock is backed up for at least 72 hours.

Limit values for memory usage

The data memory of the XC121 is divided into memory segments. The memory size of the individual segments can be found in figure 6. The global data avails of multiple segments. can be specified to suit the size of the loaded program.

To view the specified segment size for a PLC type, select the Resources tab in the object organizer and double-click Target Settings. In the dialog select the Memory Layout tab:

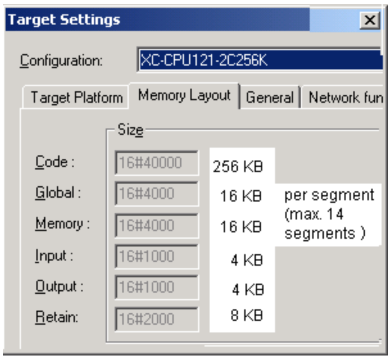


Figure 6: Memory layout

To allow maximum usage of the entire available memory range for global data, set the number of global data segments to 14 when you create a new project. The number of segments is set to 1 by default.

Changing segment allocation

Select in the directory "‹Project Options → Compilation options›" the "Number of data segments" field and enter "14" for the number of segments with the selected PLC type XC121.

Serial interface COM1/COM2

The CPU features two serial interfaces COM1 and COM2.

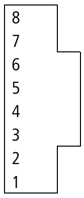
COM1: programming interface/transparent mode

Through the programming interface **COM1** (RS232) communication between CPU and the programming device takes place. The interface is initialised with the following default parameters when the PLC is started.

Data length:	8 bit
Parity:	none
Stop bits:	1
Baud rate:	38400 Baud

→ More detailed information about transparent mode can be found from page 47.

Table 3: Assignment of the programming interface



	Signal
8	RxD
7	GND
6	–
5	TxD
4	GND
3	–
2	–
1	–

COM2: transparent mode

More detailed information about transparent mode can be found from page 47.

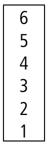
The COM2 interface can be switched between RS232 (full duplex) and RS 485 (half duplex). The setting is performed in the "PLC Configuration".

It is not galvanically isolated and can only be accessed via the function blocks of the user program. You cannot use this interface as a programming interface. It is initialised with the following default parameters:

Data length:	8 bit
Parity:	none
Stop bits:	1
Baud rate:	38400 Baud

Further communication parameters can be found at Section "Technical data" on page 50.

Control lines of the RS232 are not supported.



COM2	RS232	RS485
	Signal	**Signal**
6	RxD	–
5	TxD	–
4	Vcc	–
3	GND	GND
2	–	Tx–/Rx– ①
1	–	Tx+/Rx+ ①

① external bus termination resistor (120 Ω), first and last device at bus

A 6-pole plug-in springloaded terminal block is used as the connector type.

CANopen interface CAN1/CAN2

The PLC features two CANopen interfaces. They are designated as CAN1 and CAN2. The CAN2 interface has assignment designs. It is available on X5 as well as X6.

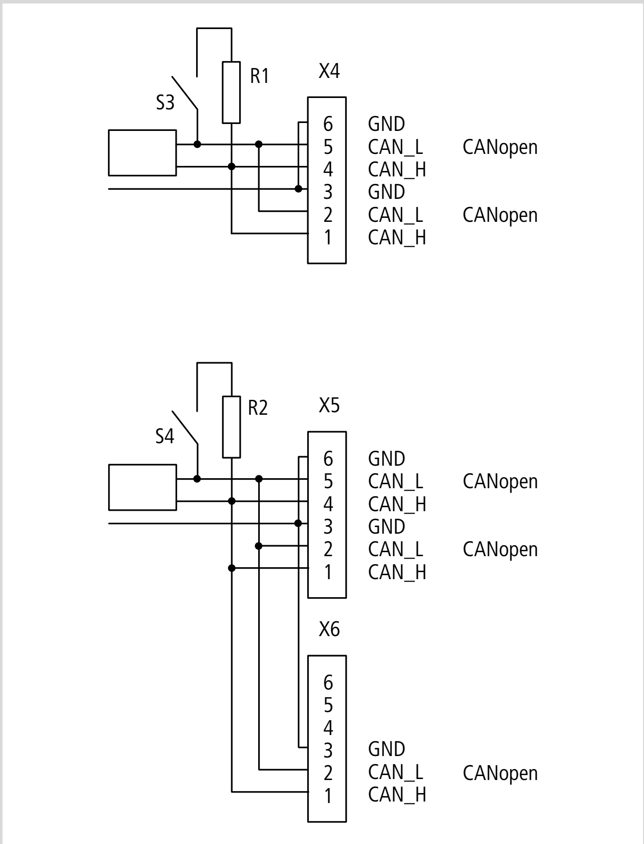


Figure 7: CANopen interface overview

X 4, 5, 6	6-pole, plug-in springloaded terminal block
S 3, 4	Switch for bus termination resistor
R 1, 2	Bus termination resistor 120 Ω

Both CANopen interfaces are designed conform to the CIA specification DS 301 V4.0. The can be operated independently of each other both as a CAN Master as well as a CAN Device.

XC121 as a CAN Device (CAN1 and/or CAN2)

In figure 8 an XC121 has been configured with two CAN Device channels. Each channel used must be assigned with a Node-Id which serves as an address. You can choose between two different methods to set the Node-Id.

- Setting via the PLC Configurator,
- Setting via the APPLICATION switch.

→ The setting on the APPLICATION switch (for Node-Id and Routing-Id) have priority over the configurator setting.

Setting via the PLC Configurator

▶ Open the Other Parameters tab in the PLC Configurator. In the "DIP-Switch-Mode" field (→ figure 5) the operating mode Node ID CAN1 or Node ID CAN2 may not be selected!

▶ Click on the first folder CANDevice[VAR]. The "Base settings" tab is displayed.

→ The first folder CANDevice[VAR] is fundamentally assigned to the channel CAN1. The following folder contains channel CAN2.

▶ Enter any bus name instead of CAN1 (CAN1 has no significance).

▶ Change over to the "CAN settings" tab and set the Node-Id and the baud rate.

▶ Set the parameters on the CAN2 channel using the same method.

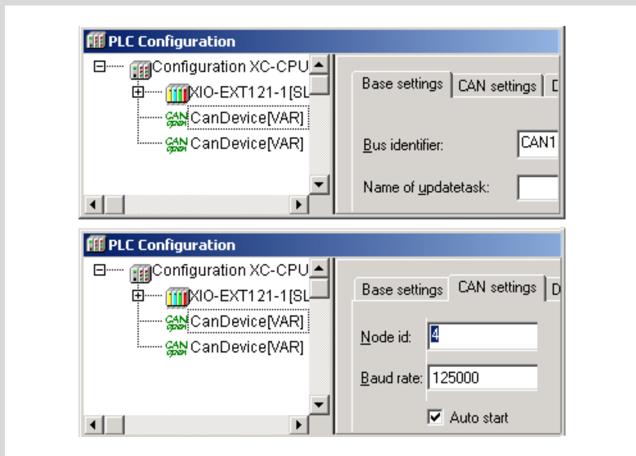


Figure 8: Node-Id setting via configurator (CAN1 = Device)

Setting via the APPLICATION switch

The Node-Id of an interface (CAN1 or CAN2) can be set via the APPLICATION switch, the Node-Id of further interfaces must be set in the PLC Configurator. For this purpose the "Node Id CAN…" must be set in the "DIP-Switch-Mode" (→ figure 5 on page 10). Now set the Node-Id in the APPLICATION switch on switches 1 to 7; switch 8 has no function.

Settings	
Switch 1 – 7	Node Id 1 – 127 (with invalid address 0 the default node Id 127 is used!)
Switch 8	No function

How to set the baud rate:

▶ Click on the folder "CAN Device [Var]", open the "CAN settings" and enter the baud rate.

Setting of the XC121 as a CAN Master/CAN Device

The figure shows an example for the XC121 as a CAN Master and as a CAN Device.

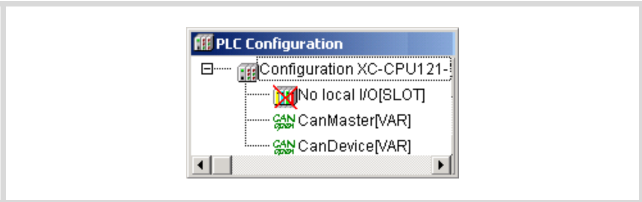


Figure 9: XC121 as CAN Master and as a CAN Device

The first folder CanMaster[VAR] is fundamentally assigned to the channel CAN 1. The second folder "CanDevice[VAR]" is assigned to channel 2. The parameters for channel 2 are set in the PLC Configuration or via the application switch.

→ Transfer rates higher than 500 kbit/s are not possible, even though they are selectable in the PLC configuration.

Using the CAN libraries

The CanUser.lib and CanUser_Master.lib libraries provide the user with cross-control access to CAN objects. These include in particular CAN direct functions/function blocks such as direct read and write of CAN telegrams and further CANopen functionality's such as sending and receiving data via SDO functions, or access to diagnostics information from the user program.

CAN Direct

You can directly access CAN objects via the function blocks of the SysLibCan library (→ Application Note AN2700K27).
Four independent ports are set up for each of both CAN interfaces:

CAN1 – CAN4	Access to the CAN line connected to CAN1
SECOND_CAN1 – SECOND_CAN4	Access to the CAN line connected to CAN2

Bus termination resistors

For each of both CAN interfaces you can switch in or out the bus termination resistor. The changeover switches S3 and S4 are located beside the plug connectors (→ figure 3).

Switched off bus termination resistor

Switched on bus termination resistor

Figure 10: Switching the bus termination resistors

Properties of the CANopen cable

Use only cable approved for CANopen applications and with the following characteristics:

- Characteristic impedance 100 to 120 Ω
- Capacitance < 60 pF/m

The demands placed on the cable, connectors and bus termination resistors are specified in ISO 11898. Following you will find some demands and stipulations listed for the CANopen network.

Table 4 lists default parameters for CANopen networks with fewer than 64 CANopen stations.

Table 4: Standard parameters for CANopen network cable according to the ISO 11898

Bus length [m]	Loop resistance [mΩ/m]	Conductor cross-section [mm²]	Bus termination resistor [Ω]	Transfer rate at cable length [kbit/s]
0 – 40	70	0.25 – 0.34	124	1000 at 40 m
40 – 300	< 60	0.34 – 0.6	150 – 300	> 500 at 100 m
300 – 600	< 40	0.5 – 0.6	150 – 300	> 100 at 500 m
600 – 1000	< 26	0.75 – 0.8	150 – 300	> 50 at 1000 m

3 Mounting

Mounting the XC121 on a top-hat rail

- ▶ Hook the XC-CPU121/XIO-EXT121-1 onto the mounting rail from above.
- ▶ Pull the locking slider downwards [1].
- ▶ Press the bottom of the module against the mounting rail [2].
- ▶ Push the locking slider up again [3].
- ▶ Make sure that the module is securely attached to the top-hat rail.

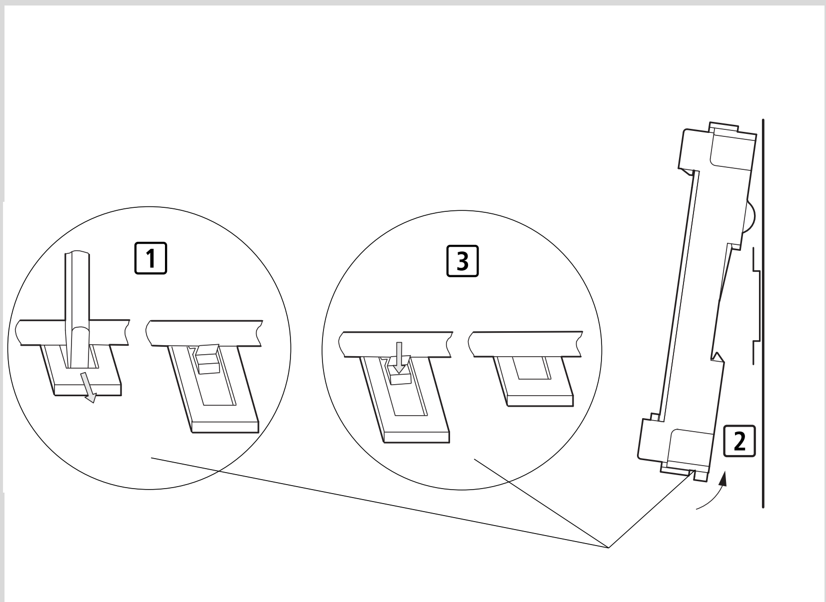


Figure 11: Mounting of the XC121

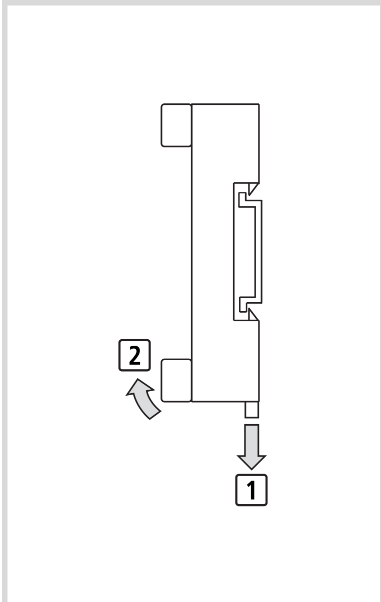


Figure 12: Removing the XC121

Mounting the XIO-EXT121-1

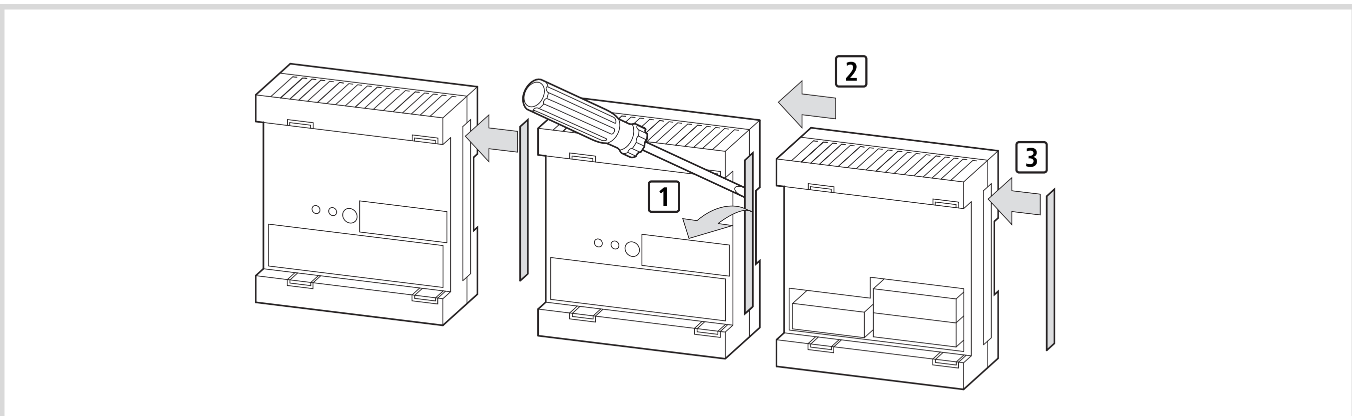


Figure 13: Mounting the XIO-EXT121-1 on the XC121

APPLICATION switch setting

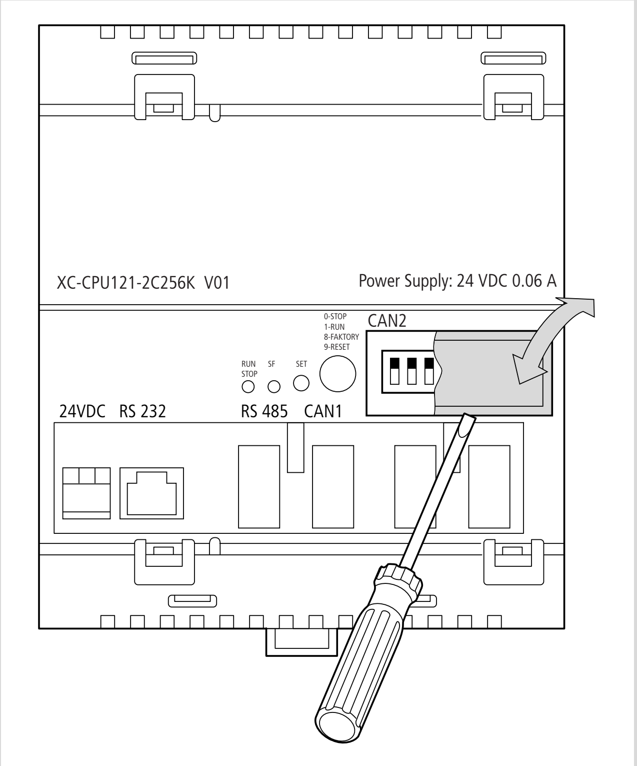


Figure 14: APPLICATION switch setting

Input/output wiring

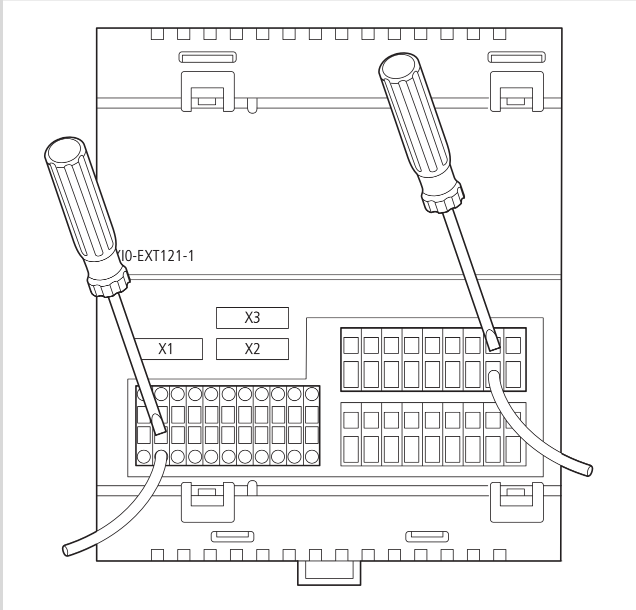


Figure 15: Input/output wiring

4 Engineering

Control panel layout

The layout of the components inside the control panel is a major factor for achieving interference-free functioning of the plant or machinery. During the project planning and design phase, as well as its implementation, care must be taken that the power and control sections are separated. The power section includes:

- Contactors
- Coupling/interfacing components
- Transformers
- Frequency inverters
- Converters

In order to effectively exclude any electromagnetic contamination, it is a good idea to divide the system into sections, according to their power and interference levels. In small switchgear cabinets it is often enough to provided a sheet steel dividing wall, to reduce interference factors.

Ventilation

A clear space of at least 50 mm must be kept between passive components, to ensure adequate ventilation. If the neighbouring components are active elements, such as power supplies or transformers, then the minimum spacing should be 75 mm.
The values given in the technical specifications must be observed.

Layout of units

Mount the PLC horizontally in a control panel:

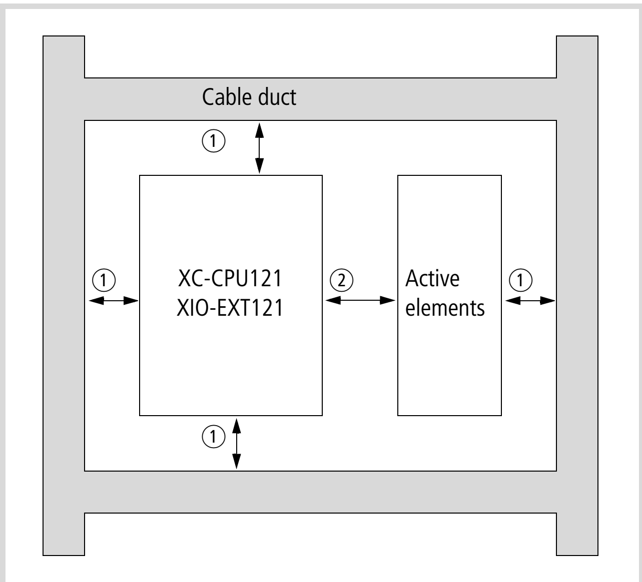


Figure 16: Cabinet layout

① Spacing > 50 mm
② Spacing > 75 mm

Preventing interference

Cable routing and wiring

Cables are divided into the following categories:

- Power cables (e.g. cables that carry high currents, or cables to converters, contactors or solenoids)
- Control and signal cables (e.g. for digital inputs)
- Measurement and signal cables (e.g. for fieldbus connections)

→ Always route power cables and control cables as far apart as possible This avoid capacitive and inductive coupling. If separate routing is not possible, then the first priority must be to shield the cable responsible for the interference.

Take care to implement proper cable routing both inside and outside the control panel, to keep interference as low as possible:

▶ Avoid parallel routing of sections of cable in different power categories.
▶ As a basis rule, keep AC cable separated from DC cables.
▶ Keep to the following minimum spacing:
  – at least 10 cm between power cables and signal cables;
  – at least 30 cm between power cables and data or analog cables.
  – When routing cables, make sure that the outgoing and return leads of a circuit pair are routed together: The currents flowing in opposite directions thus cancel each other out as a summation, and the electromagnetic fields cancel each other out.

Suppressor circuitry for interference sources

▶ Connect all suppressor circuits as close to the source of interference (contactors, relays, solenoids) as possible.

→ Switched inductors should always have suppressor circuitry fitted.

Shielding

▶ Use shielded cables for the connections to the data interfaces. The general rule is: the lower the coupling impedance, the better the shielding effect.

Lighting protection

External lightning protection

All cables that go outside buildings must be shielded. Metal conduit is best for this purpose. Fit signal cables with overvoltage protection, such as varistors or other surge voltage protectors. Where possible, protective elements should be fitted at the point of entry of the cable into the building, but no further away than the control panel.

Internal lightning protection

Internal lightning protection covers all those measures taken to reduce the effects of a lightning strike and the resulting electrical and magnetic fields on metallic installation and electrical plant.

These measures are:

- Equipotential bonding/earthing
- Shielding
- using overvoltage protection devices.

Please consult the following manuals for advice on cable routing and shielding measures:

- AWB27-1287 "EMC Engineering Guidelines for Automation Systems"
- TB27-001-GB "Electromagnetic Compatibility (EMC) for Automation systems"
- TB02-022-GB "Electromagnetic Compatibility (EMC) for Machinery and Plants"

Connections

Connecting the power supply

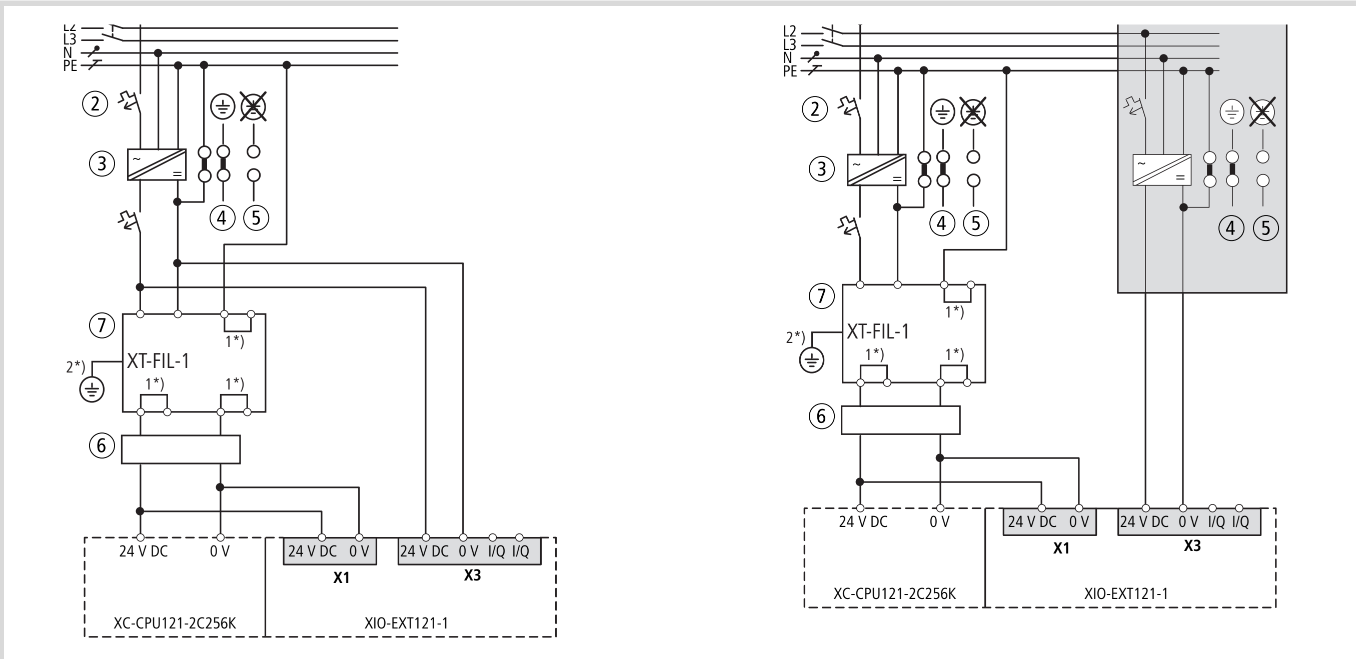


Figure 17: Wiring example: XC-CPU121 and XIO-EXT121-1 (left: common power supply, right separate supplies

① Main switch

② Protective cut-out

③ 24 V DC supply voltage

④ Earthed operation

⑤ In floating (i.e. unearthed) operation, an isolation monitor must be used (IEC 204-1, EN 60204-1, DIN EN 60204-1)

⑥ Ferrite ring

⑦ 24 V DC line filter; ensures that a current of up to 2.2 A (maximum) is available at a rated voltage of 24 V DC. Ensures that the EMC stipulations for devices are fulfilled when the filter is used. The filter is not a component of the CPU and must therefore be ordered separately:
Type: XT-FIL-1, Article no.: 285316 (Supplier: Eaton Industries GmbH)
→ Dimensions on page 50
→ Technical data on page 55

1*) Internal jumper

2*) Additional PE connection via contact spring on rear

→ When the XC-CPU121 is switched on, connected with the XIO-EXT121:

Each device features a separate supply voltage connection. The voltage on both devices must be switched on to start the CPU. If only one of the devices is switched on the CPU will not run a program and the LEDs will remain off.

Connecting the XC-CPU121 supply voltage

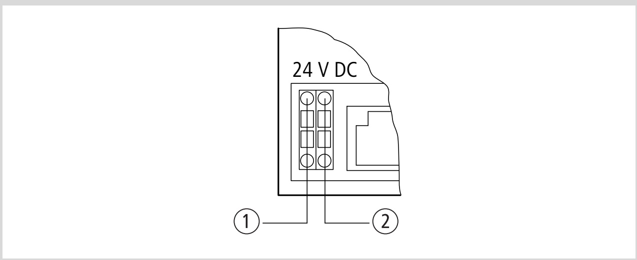


Figure 18: Voltage connection of the XC-CPU121

① 24 V DC

② 0 V

Refer to figure 21 for the voltage supply of the XIO-ETX121-1, plug connector X1.

Connecting sensors and actuators

The digital sensors and actuators can be connected directly to plug connectors X2 and X3:

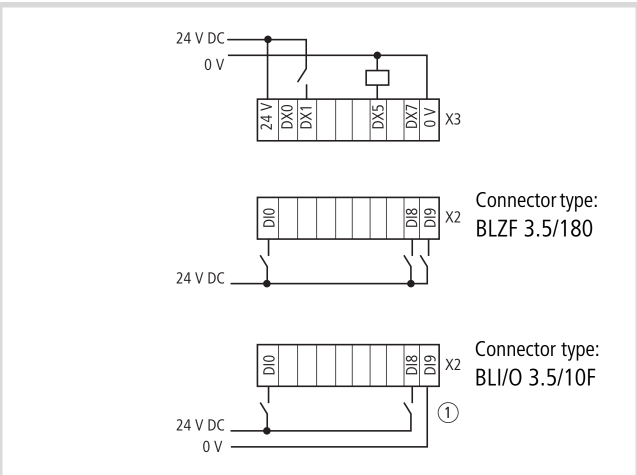


Figure 19: Connecting inputs/outputs to X2/X3

① If you use the connector type with LED display BLI/O3.5/10F on plug connector X2, you have to connect the terminal "DI9" to 0 V.

The sensors and/or actuators can be connected at the terminals DX0 to DX7 of connector X3. Each terminal (connection) can be set (QX0.0 to QX0.7) or read (IX0.0 to IX0.7) from the user program.

Interrogate the inputs of the plug X2 with IX1.0 (DI0) to IX1.7 (DI7) and IX2.0 (DI8), IX2.1 (DI9).

Two connector devices are available:

- without LED
- with LED

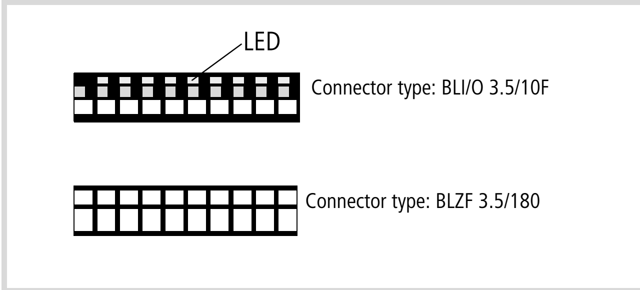


Figure 20: Connector types

You can use both connector types for the adapter extension X2 and/or X3.

The analog sensors/actuators are connected to plug connector X1:

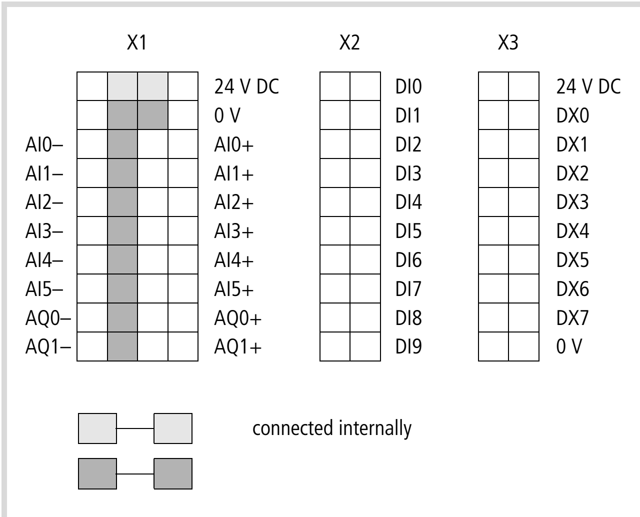


Figure 21: Designation of the plug connector and the inputs/outputs

Table 5: Analog input/output properties

Analog type	Resolution	Operand	Terminal (X1)
Analog inputs			
0 – 10 V	10 Bit	IW4	AI0 -/+
0 – 10 V	10 Bit	IW6	AI1 -/+
0 – 20 mA	10 Bit	IW8	AI2 -/+
0 – 20 mA	10 Bit	IW10	AI3 -/+
Pt100	10 Bit1)	IW12	AI4 -/+
Pt100	10 Bit1)	IW14	AI5 -/+
Analog outputs			
0 – 10 V	12 Bit	QW2	AQ0 -/+
0 – 10 V	12 Bit	QW4	AQ1 -/+

1) Assigned temperature values → fig. 22

Table 6: Analog values

0 – 10 V	0 – 20 mA	dec	hex
Analog inputs			
0	0	0	000
5	10	511	1FF
10	20	1023	3FF
Analog outputs			
0	–	0	000
5	–	2047	7FF
10	–	4095	FFF

① Simulated temperature [°C]
② Measured XC 121 decimal value [dec]

①	②
-200	107
-180	155
-160	203
-140	251
-120	297
-100	344
-80	390
-60	435
-40	480
-20	525
0	569
20	614
40	657
60	701
80	745
100	788
120	831
140	873
160	916
180	958
200	1000

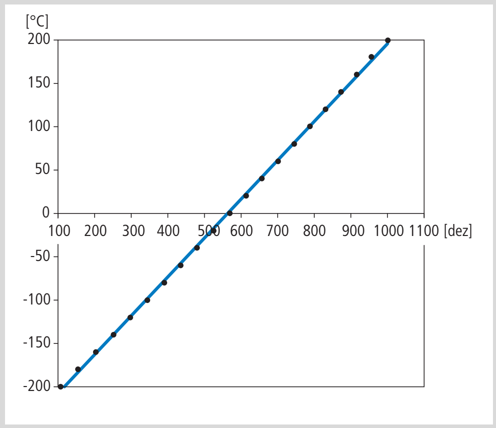


Figure 22: Pt100 calibration curve for XC121 (Simulator: burster precision RTD Simulator 4530)

5 Configuration of the XIO-EXT121-1

In order to expand the XC121 with the I/O module XIO-EXT-121-1 the folder "No local I/O" must be replaced in the PLC Configurator by the element XIO-EXT121-1.

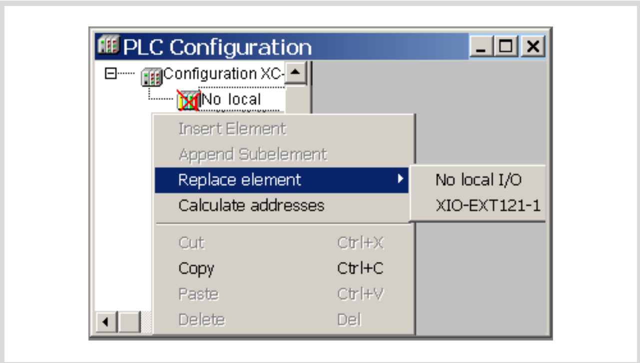


Figure 23: Configuration of XIO-EXT121-1

The new window displays all inputs and outputs of the I/O module.

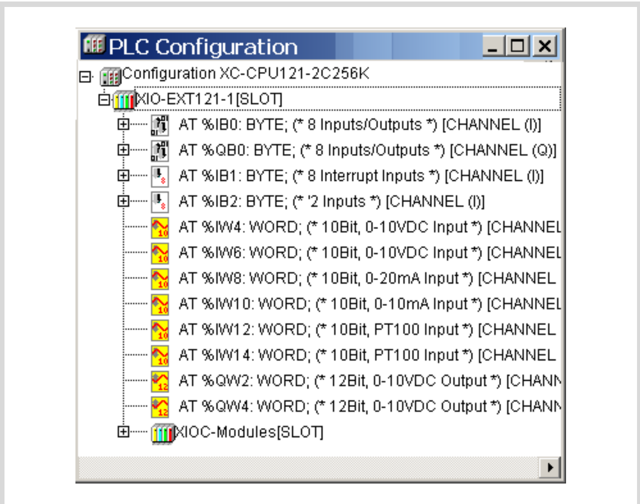


Figure 24: Configuring the inputs and outputs

The following overview indicates the assignment of the input/output syntax as indicated in the configurator to the connections on the plug connector.

Table 7: Overview of the I/O signals (analog)

Plug connector type	Connector I/Q	Operand I Word	Operand Q Word	Type I/Q analog
X1	AI0	IW4		I 0 – 10 V DC
	AI1	IW6		I 0 – 10 V DC
	AI2	IW8		I 0 – 20 mA
	AI3	IW10		I 0 – 20 mA
	AI4	IW12		I Pt100
	AI5	IW14		I Pt100
	AQ0		QW2	Q 0 – 10 V DC
	AQ1		QW4	Q 0 – 10 V DC

Table 8: Overview of the I/O signals (digital)

Plug connector type	Connector I/Q	Operand I Bit	Operand I Byte	Operand Q Bit	Operand Q Byte	Type I/Q digital
X2	DI0	IX1.0	IB1			I
	…	…				
	DI7	IX1.7				
	DI8	IX2.0	IB2			
	DI9	IX2.1				
X3	DX0	IX0.0	IB0	QX0.0	QB0	I/Q
	…	…		…		
	DX7	IX0.7		QX0.7		

See also „Designation of the plug connector and the inputs/outputs", figure 21 on page 19.

6 Operation

Switch-on behaviour

After switching on the supply voltage the CPU performs a system self-test. If the test has been completed successfully, the runtime system starts. The red and green LED flashes if there is a malfunction.

After the start of the runtime system the CPU checks if an operating system update is available on the inserted MMC and also if this must be loaded. As the PLC does not feature a battery for backup of the main (SRAM) memory, after the start of the runtime system it checks if a boot project is available. If this is the case, it is loaded in the main (SRAM) memory and starts dependent on the position of the operating mode selection switch and the set start behaviour. If the flash memory contains no boot project, the PLC remains in NOT READY state.

Switch on behaviour with boot project

When the PLC is started a boot project available on the MMC has priority over a project stored in the system memory (Flash). If the boot projects are different, the boot project from the MMC is copied into the system memory (Flash) and then run. Due to the copy process the PLC start-up phase will be extended by a few seconds.

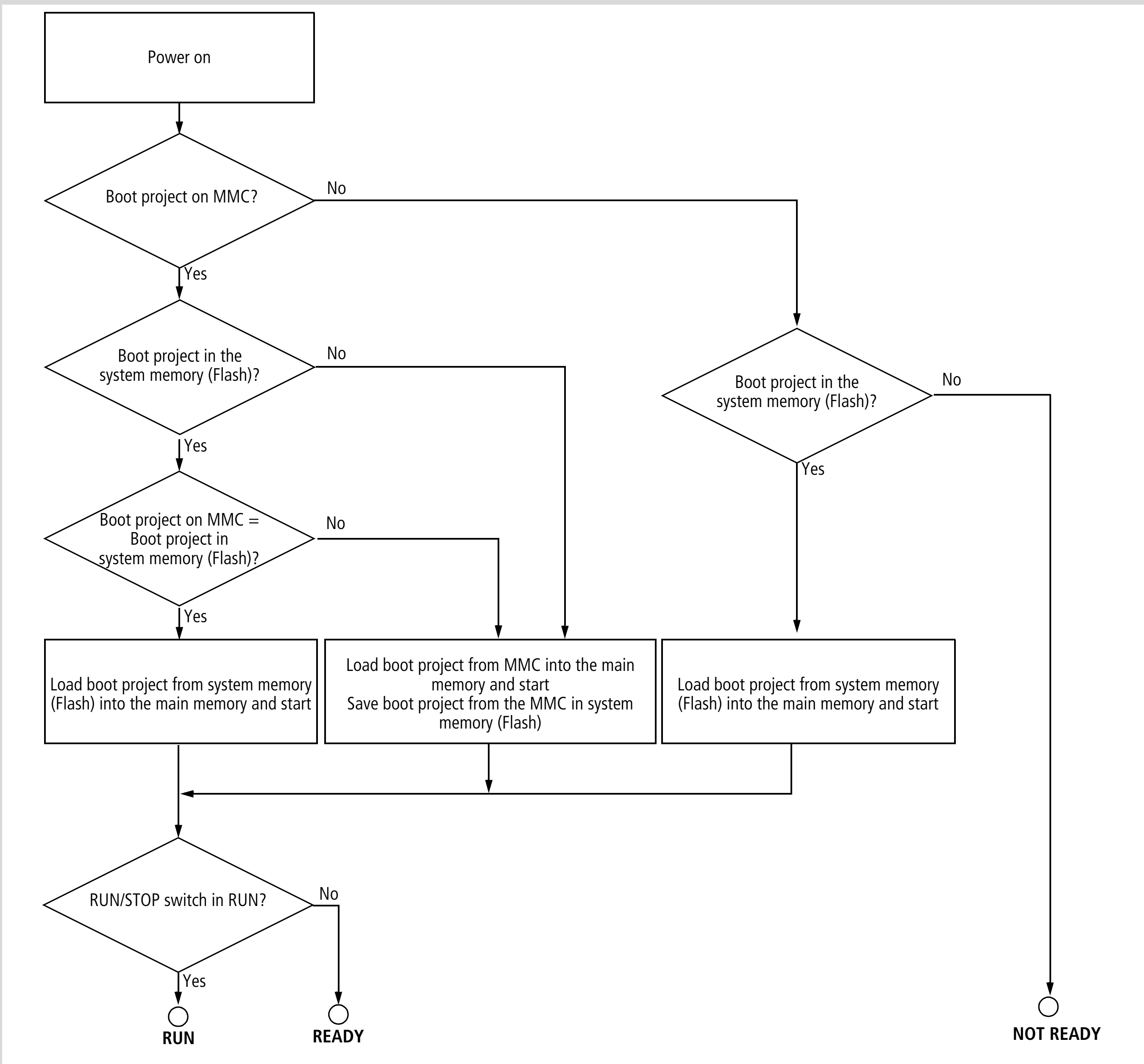


Figure 25: Switch on behaviour with boot project

Configuring the start-up behaviour with CoDeSys

With the setting of the start-up behaviour you determine the start behaviour of the PLC when the supply voltage is switched on.

You can change the settings under PLC Configuration: Activate the "Other Parameters" tab there and select the desired start condition from the dropdown list.

- HALT
- WARMSTART
- COLDSTART

Refer to Table 9 for the behaviour of the variables to suit the set start conditions.

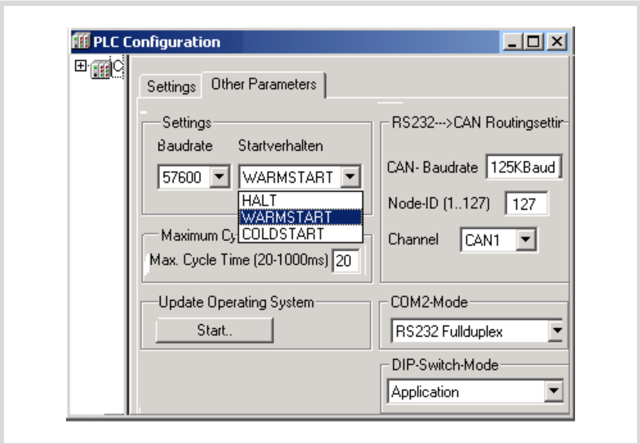


Figure 26: Definition of start behaviour

Program START/STOP

Program start (STOP → RUN)

You can start the program in one of two ways:

- In online operation, issue the START command, for example after loading a program. The CPU must be in STOP state and the operating mode switch in the RUN position.
- Set the operating mode switch to its RUN position.

→ The position of the operating mode switch has priority over the online command.

Table 9: Behaviour of the variables at PLC start

Start-up condition	Variable type	
	Non-retentive	Retentive
COLDSTART	Activation of the initial values	
WARMSTART	Activation of the initial values	Values remain in memory
Program loaded and started in online operation	Activation of the initial values	
Start/Stop/Start…	Values remain in memory	

Behaviour after power off or power interruption

If you switch off or interrupt the (CPU) voltage, the program cycle or task is interrupted immediately. The retentive data integrity is no longer given. All outputs are set to 0 or switched off.

The behaviour of retentive variables in shown in Table 9.

The remaining program cycle will not be completed when power is reconnected!

If inconsistent data is not acceptable in your application, you can, for example, use an uninterruptible power supply (UPS) with back-up.

The PLC restarts as defined by the settings in the PLC Configuration window, → figure 26.

Program stop (RUN → STOP)

When you set the operating mode switch to STOP, the CPU changes to STOP state, as soon as the program cycle is completed. The outputs are set to 0.

You can stop the program in one of two ways:

- In online operation, issue the STOP command.
- Set the operating mode switch to its STOP position.

→ The position of the operating mode switch has priority over the online setting.

Program processing and system time

The user program is processed cyclically. The states of the inputs are read before the start of each program cycle, and the output states are written to the outputs at the end of the cycle.

As a result of the software architecture of the run-time system, timing divergence’s may occur between individual processing cycles.

You can also program application routines that are started by the occurrence of system events → section “System events” on page 27.

Cycle time, monitoring

A hardware timer monitors the cycles of the user program and the individual event tasks. If the cycle time exceeds a user-defined value, the PLC goes into STOP state and the outputs are switched off.

You can specify the timeout value on the “Other Parameters” tab in the “PLC Configuration” window between 20 ms (default value) and 1000 ms.

Reset

There are four different Reset commands:

- Reset (warm)
- Cold reset
- Full reset
- Reset for restoring the factory defaults.

Reset (warm)

- The program is stopped.
- The non-retentive variables are initialised, the “Retain” variables are retained.
- The program can be restarted.

Cold reset

- The program is stopped.
- All variables are initialised.
- The program can be restarted.

Full reset

- The program in the PLC and the boot project are deleted.
- With inserted MMC:
  - All project-specific files and the boot project are erased.
  - All user specific files and the startup.ini file remain unchanged.
- The PLC is set into the NOT READY state.

Reset for restoring the factory defaults.

A prerequisite for the reset is that the operating mode switch is in position 8. If you then press the SET button, all interfaces are initialised with their default parameters. A loaded user program, all variables and the boot project are erased in the system memory (Flash) and on the MMC.

Behaviour of the variables after a Reset

Reset	Variable type Non-retentive	Retain
Warm reset	Activation of the initial values	Values remain in memory
Cold reset	Activation of the initial values	
Full reset[1)]	Activation of the initial values	

1) After a full reset, the program must be reloaded. In online operation, you can then restart the PLC.

Test and commissioning

The PLC supports the following test and commissioning features:

- Breakpoint/single-step mode
- Single-cycle mode
- Forcing
- Online modification
- Progression display (Power Flow).

Breakpoint/single-step mode

You can set breakpoints within the user program. If an instruction has a breakpoint attached, then the program will halt before execution of the program line. The following program instructions can be executed in single-step mode step by step. Cycle-time monitoring is disabled.

Warning!
Any outputs already set when the program reaches the breakpoint remain set!

→ Use breakpoint/single-step mode and single-cycle mode only in the application’s actual main program. Do **not** use them in den event routines, for example for start, stop and interrupt events, as this can cause problems in the control sequence.

The software CoDeSys does not prevent the use of breakpoints in the event routines.

Single-cycle mode

In single-cycle operation, one program cycle is performed in real time. The outputs are enabled during the cycle. The cycle-time monitoring is active.

Warning!
Any outputs already set when the program reaches the breakpoint remain set!

Forcing variables and I/Os

All variables of a user program can be forced into fixed values. Forced local outputs of the XI/ON modules are only switched through to the I/O in the RUN state.

→ The I/O connected through the CANopen field bus can not be forced.

CoDeSys status indication

- The signal states of the physical, Boolean inputs are displayed in both the CPU’s RUN state and in STOP.
- The signal states of the physical, Boolean inputs are only displayed in RUN state; in the STOP state they are designated with FALSE.
- All other variables are displayed with the current variable value.

System events

You can respond to PLC system events with a user application routine (POU) that runs once when a particular event occurs. Its execution is time-monitored. The time base is the configured longest permissible cycle time.

Events are:

STOP	User program stop (does not apply to cycle time timeout or hardware watchdogs)
START	START: User program start (cold and warm start)
COLDSTART	Cold start of the user program
WARMSTART	Warm start of the user program

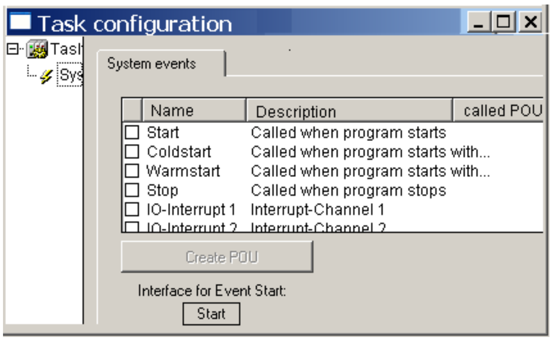


Figure 27: System events

→ Single step mode can not be used for system event program blocks.

Interrupt processing

If an interrupt occurs the operating system runs the POU which is linked to the interrupt source.

Warning!
The execution of the interrupt POU is not time monitored. Inadvertently programmed endless loops cant be exited.

The POU initiated by the interrupt is always run to completion and cannot be interrupted by a new interrupt. A new interrupt is only carried out after the current interrupt has ended.

Caution
All the outputs controlled (H signals) up to this point remain active and cant be switched off.

The interrupts are enabled in the RUN state of the CPU and inhibited in the STOP state. Interrupt sources which are not enabled in the configuration do not initiate an interrupt. If a POU is not assigned to an enabled interrupt source, the interrupt is recognised and executed but without running a POU.

If interrupts occur too frequently during operation of the program the programmed task time may be exceeded and the Watchdog will initiate a RESET.

You can inhibit and release interrupts from the program. The "DisableInterrupt" and "EnableInterrupt" functions are provided for this purpose. A call parameter in the CoDeSys determines if an individual interrupt or all interrupts are enabled or inhibited. Enabling of an inhibited interrupt must be performed with the same parameter used to inhibit it.

Both the "DisableInterrupt" and "EnableInterrupt" functions are components of the "XC121_Util.lib" library. This library must – if not already done so – be integrated into the library manager of the CoDeSys.

DisableInterrupt: With this function, you disable (deactivate) a parameterized physical interrupt by accessing it from the user program.

EnableInterrupt: With this function, the physical interrupt which was deactivated beforehand can now be re-enabled as an active interrupt.

Parametric programming of the inputs

The inputs I 1.0 (DI0) to I 1.7 (DI7) on plug connector X2 can be used as standard or as interrupt inputs. The inputs I 2.0 (DI8) and I 2.1 (DI9) are standard inputs. The individual interrupt inputs are assigned with their interrupt function only after the inputs are allocated with their edge type which triggers the interrupt.

The allocation is implemented in the PLC Configurator in the "Other Parameters" tab under "Local Interrupts".

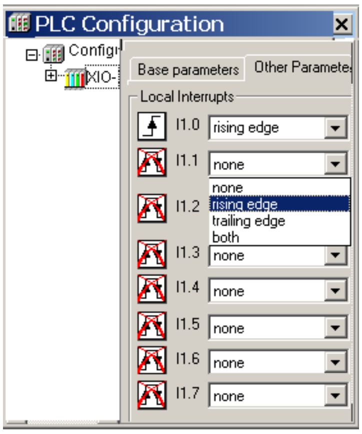


Figure 28: Defining the edge type on the local interrupt

The link between the IO interrupt and POU is made in the task configurator.

The interrupt channels 1 to 8 (channels) are allocated directly to the inputs I1.0 to I1.7. The priority of the inputs is fixed: channel 1 (input 1.0) has the highest priority, channel 8 (input 1.7) has the lowest priority (see the example).

Example for interrupt processing

A "Basic" task contains a POU "PLC_PRG". A further POU "Fastprog" should be processed if an L → H rising edge on the input I1.2 generates an interrupt.

▶ Create the POUs "PLC_PRG" and "Fastprog" as shown in figure 29.

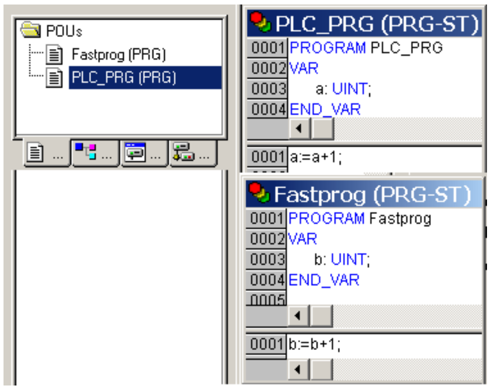


Figure 29: Writing a program

▶ Change over to the PLC Configuration and allocate the "rising edge" type to the input I1.2.

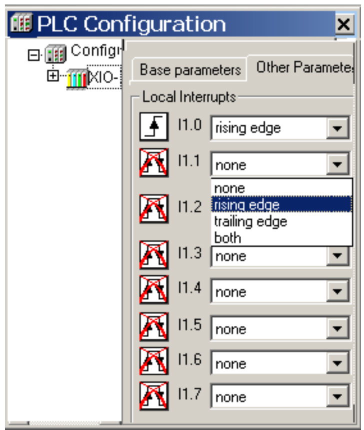


Figure 30: Interrupt edge selection

▶ Change over to the Task configuration and open the "System events" folder.

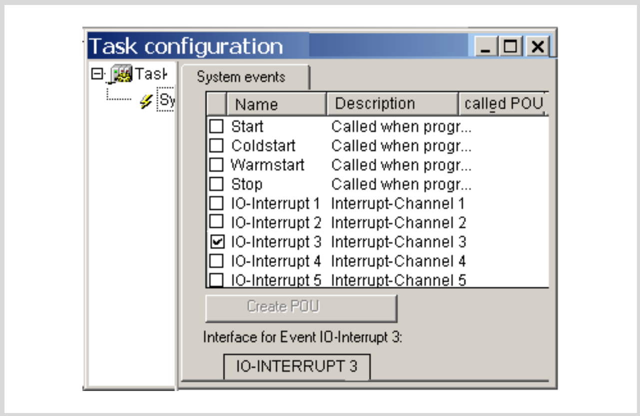


Figure 31: Enabling an interrupt

- ▶ Enable IO-Interrupt 3 by clicking in the checkbox on the left beside the name "IO-Interrupt 3". The box is checked to indicate that it has been activated.
- ▶ Mark the area of column "Called POU" and the area and the line "IO-Interrupt 3".
- ▶ Set the cursor on the marked area and press the function key F2.

The "Help Manager" window opens in which all predefined programs are listed:

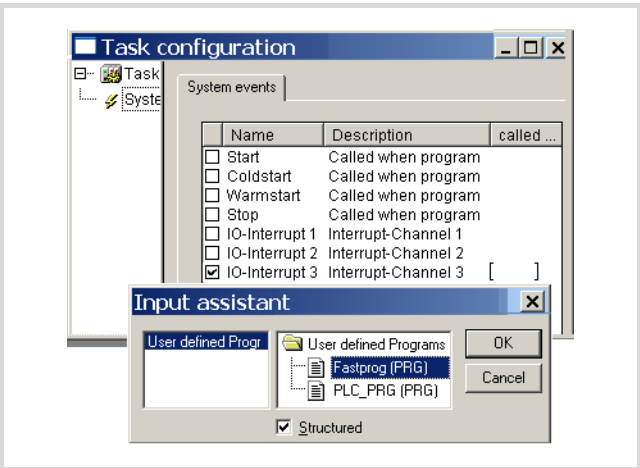


Figure 32: Allocation of Interrupt source → POU

- ▶ Select the "Fastprog" POU and confirm with OK.
- ▶ Save the project. You can now test it.

The variable "b" is incremented by one with every rising edge on input I1.2.

Timer interrupt

With the timer interrupt a periodically active interrupt is triggered. The periodic duration can be set from 500 – 2 500 000 microseconds. The timer starts in dependance on a Boolean variable. It interrupts the user program and executes a user-defined application routine.

You have to include the XC121_UTIL.lib library in your user program to program the "TimerInterruptEnable" function.

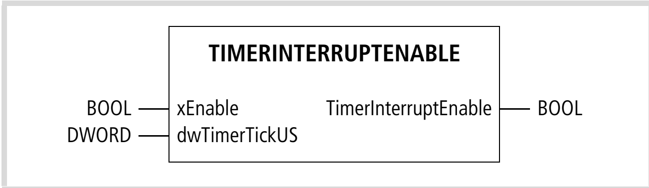


Figure 33: The TimerInterruptEnable function

At input dwTimerTickUS enter the delay time.

The value is accepted with the start of the timer and can not be modified for the run time. If the time falls below 500 or exceeds 2 500 000, the function returns FALSE and the timer is not started.

Creating application routine time_Int:

- ▶ Open the "Task Configuration" sub-directory with a double click in the "Resources" directory.
- ▶ Click on the "System events" folder. The "System events" tab is active:

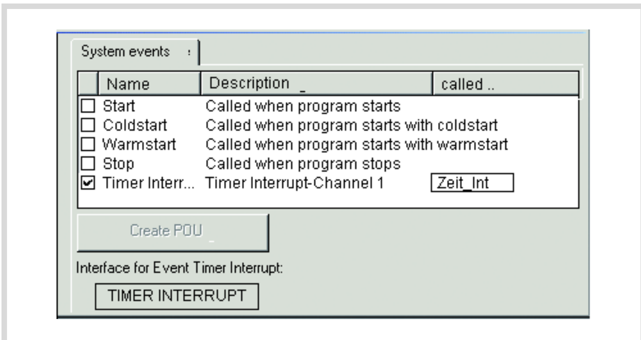


Figure 34: Select the "Timer Interrupt" system event

- ▶ Click the "Timer Interrupt" checkbox to activate the timer interrupt.
- ▶ In the field in the called POU column, enter the name "time_Int" for the application routine.
- ▶ Click again on the name "Timer Interrupt".
  Now the "Create POU" button becomes active and indicates the name of the POU.
- ▶ Click on this button. In the "POUs" window a folder (POU) with the names is added.
- ▶ Open the POU and write your user program.

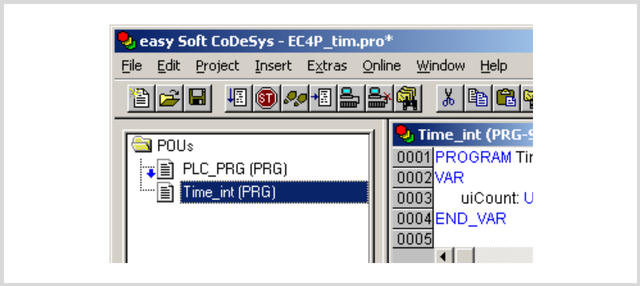


Figure 35: Writing an application routine

The interrupt can be interrupted by higher-priority system interrupts. Cycle time monitoring is active during execution of the timer interrupt.

The Timer interrupt can be inhibited and enabled from the user program. Functions “DisableInterrupt” and “EnableInterrupt” in library “XC121_UTIL.lib” are available for this purpose.

Direct I/O access

Via function “Direct IO access” the CPU directly accesses the local inputs and outputs of the XIO-EXT121-1 module. Access is not implemented via the input/output map.

→ Direct access to the data of the XI/OC modules is not supported.

Use functions such as e.g. “ReadBitDirect” of the library “XC121_Util.lib” for “direct access” to the current IO states and data.

The function “ReadBitDirect” is described as an example for all other functions:

ReadBitDirect

The bit of an input can be read directly with this function. The state of an input bit is stored in the variables, which point to the parameterized pointer “ptr_xValue”. The pointer variable will not be changed when a fault occurs during processing.

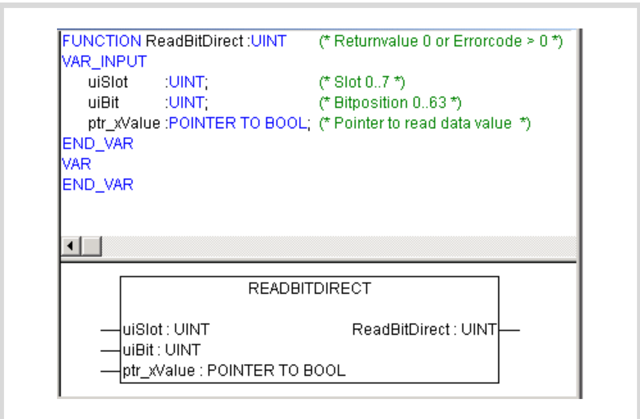


Figure 36: Function READBITDIRECT

Bit access

Function: ReadBitDirect (uiSlot, uiBit, ptr_xValue)

IX0.0 – IX0.7:	uiSlot = 0, uiBit 0 – 7
IX1.0 – IX1.7:	uiSlot = 0, uiBit 8 – 15
IX2.0 – IX2.7:	uiSlot = 0, uiBit 16 – 23

Function: WriteBitDirect(uiSlot, uiBit, xValue)

QX0.0 – QX0.7:	uiSlot = 0, uiBit 0 – 7

Further functions are:

Byte access

Function: ReadByteDirect(uiSlot, uiByte, ptr_byValue)

IB0:	uiSlot = 0, uiByte 0
IB1:	uiSlot = 0, uiByte 1
IB2:	uiSlot = 0, uiByte 2

Function: WriteByteDirect(uiSlot, uiByte, byValue)

QB0:	uiSlot = 0, uiByte 0

WORD access

Function: ReadWordDirect(uiSlot, uiOffset, ptr_wValue)

IW4:	uiSlot = 0, uiOffset 2
IW6:	uiSlot = 0, uiOffset 3
IW8:	uiSlot = 0, uiOffset 4
IW10:	uiSlot = 0, uiOffset 5
IW12:	uiSlot = 0, uiOffset 6
IW14:	uiSlot = 0, uiOffset 7

Function: WriteWordDirect(uiSlot, uiOffset, wValue)

QW2:	uiSlot = 0, uiOffset 1
QW4:	uiSlot = 0, uiOffset 2

"Error code with direct peripheral access"

Verify all functions as far as possible for the validity of the call parameters. Verification is undertaken to determine if the access occurs in dependance on the parameterized signal module and the physical existence of the signal module. If a fault is determined, access is not undertaken and an error code is output. The data fields for the value transfer remain unchanged.
The "DisableInterrupt" and "EnableInterrupt" functions do not generate an error code.

The following return values are possible:

Table 10: Error codes with direct peripheral access

IO_ACCESS_NO_ERROR	No error
IO_ACCESS_INVALIDE_ SLOTNUMBER	Slot = 0 or greater than 15
IO_ACCESS_INVALID_ OFFSET	BitWord offset is too large
IO_ACCESS_DENIED	Invalid access, e.g. write access to input module, read access to output module or access to non-available address range (offset too large)
IO_ACCESS_NO_MODULE	No module available at the parameterized slot
IO_ACCESS_ INVALID _ Buffer	No or incorrect pointer to the output variables
IO_ACCESS_ INVALIDE _Value	Event is not "0" or "1" with "WriteBitDirect"

Creating and transferring boot project

The CPU processes the user program stored in the main memory. As the main memory is not backed-up, the program is erased during a voltage loss. A boot project must be created in order to save the program retentively. The following steps are required:

▶ From the "Online" menu, select "Login".
▶ Select the "Create boot project" command.

The following prompt appears:

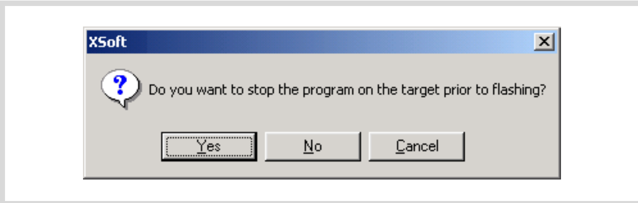


Figure 37: Create bootable project

▶ Click "Yes".

The following dialog appears briefly:

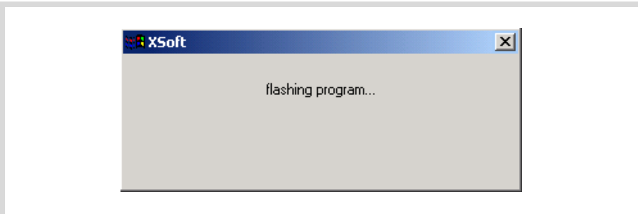


Figure 38: Creating a boot project

The boot project has been created when this dialog disappears again. You can now restart the PLC.

See Section "Switch on behaviour with boot project" on page 23.

Saving boot project on MMC

The boot project in the system memory (Flash) can also be stored on the MMC. This occurs by using the "copyprojtommc" browser command.

Erase boot project

The "Remove" browser command deletes the boot project stored in the system memory (Flash) as well as any project stored on the MMC. The boot project on the MMC is only erased with the "removeprojfrommmc" browser command.

Operating system, download/update

You can replace the XC121 operating system (OS) with a current version. which is always available for download at the Eaton website (http://www.eaton.com/moeller/support). It is also included on each CoDeSys CD.

Caution
When you download the OS, all files saved on the PLC are deleted (the existing boot project as well as the user program).

You have two options to transfer the OS:

- Directly from the PC to the PLC
- From the PC to the MMC.

Transferring the operating system from the PC into the PLC

▶ Open an CoDeSys project and activate under Resources PLC Configuration and select the Other Parameters tab → figure 5.
▶ Click on the "Start" button.

The "Download operating system"dialog opens.

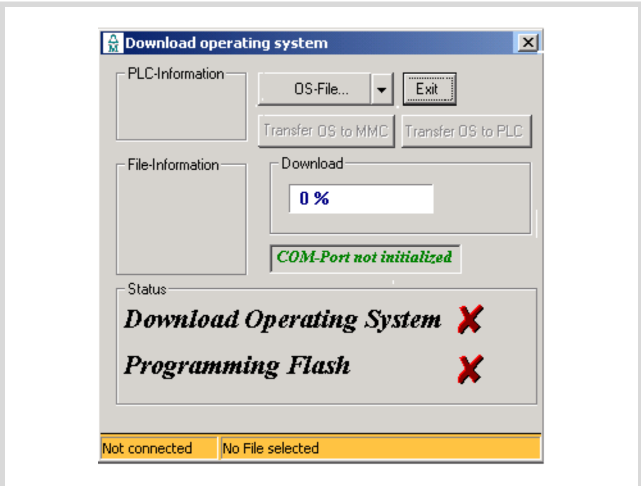


Figure 39: Download operating system

The system reports that the COM port is not initialized.

▶ Click the "OS-File" button and select the required operating system file (*.hex).

→ The files last opened can be selected from the list field (dropdown menu).

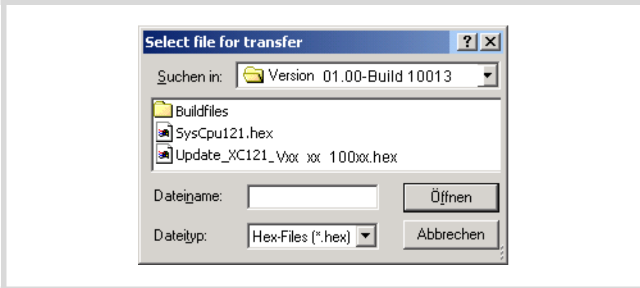


Figure 40: Operating system file selection

The target type and file version are displayed.

▶ Press the "Transfer OS to MMC" button.

The transfer begins. Programming of the flash EPROMs takes about 20 to 30 seconds.

→ Do not switch off the supply voltage during the transfer or while the warning symbol appears with "Programming Flash"!

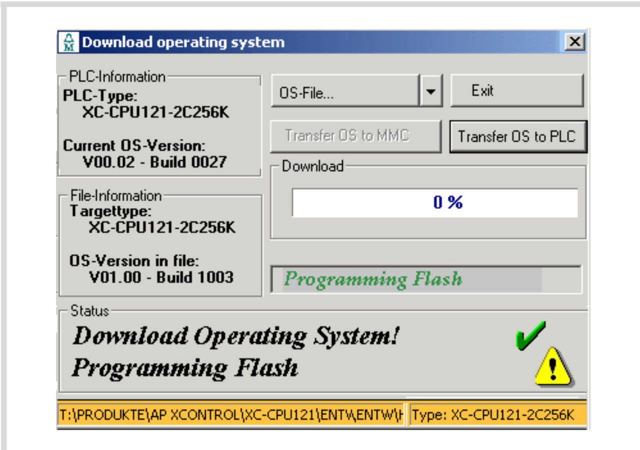


Figure 41: Warning during download

Wait for the following dialog.

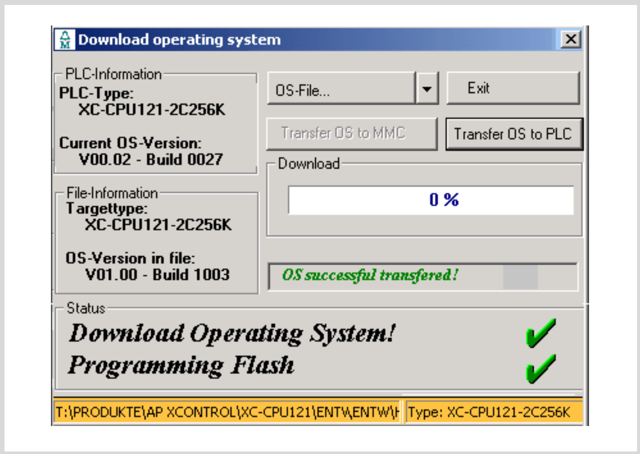


Figure 42: OS successfully transferred to the PLC

▶ Click in this window on the "Exit" button.

Transferring the OS from the PC into the MMC

If an OS is loaded into the MMC, the OS and the boot project on the MMC and the user program in the PLC are deleted. The procedure is similar to the description in Section "Transferring the operating system from the PC into the PLC". Click in this case on the "Transfer OS to MMC" button, → figure 39 on page 32.

Transferring the OS from the MMC into the PLC

▶ Insert the MMC into the PLC when it is switched off.
▶ Switch on the PLC.

The OS of the PLC is updated during the switch on process and a boot project is loaded into the PLC. The transfer can take more than 30 seconds as the CPU must be booted several times.

→ Do not interrupt the process, e.g. by switching off the supply voltage!

User program source code

It is possible, to save the source code of the user program on the MMC.

7 Browser commands

The PLC browser is a text based control monitor. Here the commands to query certain information from the control are entered in the input line and sent as a string to the control. The response string is indicated by a result window of the browser. This functionality can be used for diagnostics and debugging.

→ The browser commands can only be used online.

To run these commands:

▶ Under Resources in the object organiser, double-click PLC Browser.

A new window, PLC-Browser appears in the workspace.

▶ Click ....

The selection field lists the available browser commands.

▶ Double-click the required command to select it.

The selected command now appears in the “PLC Browser” window.

▶ Press the enter button in order to view the response of the PLC to the browser command in the event window.

→ More detailed information concerning the selected browser command can be found if you place a “?” before the selected browser command followed by a space, and press the Enter (Return) key.

The description of the available commands can be found in the programming software manual (MN05010003Z-EN) in the section ‹Resources→ PLC Browser›.

The XC-CPU121 supports the browser commands from Table 11.

Table 11: Browser commands

?	Get a list of implemented commends.
reflect*	Mirror current command line for test purposes.
mem	memory dump, Syntax: mem <start-addr> <end-addr>
memc	As mem, addresses + start address of the code range
memd	As mem, addresses + start address of the data range
pinf	Output project information
ppt	Output module pointer table
dpt	Output data pointer table
pid	Output project ID
cycle	Output cycle time
canload*	Display traffic loading of the local CAN busses (CAN1 + CAN2)
copyprojtommc	Copy the current boot project on the MMC
createstartupini	Generation of the initialisation file on the MMC
format	Format the MMC memory card
GetNodeId	Display of the CANopen Node-IDs of both CAN interfaces
GetRoutingId	Display of the routing Node-ID and the routing interface
metrics	Output PLC information
reload	Load boot project from FLASH to the PLC
remove	Erase boot project in the FLASH
removeprojfrommmc	Delete the boot project from the MMC
removestartupini	Delete the initialisation file from the MMC
getswitchpos	Output switch position
getrtc	Read real-time clock
setrtc*	Set real-time clock

Further information concerning the commands marked with * can be found in the following pages.

reflect

Reflects the command line, for testing communications between browser and PLC.

This command is not transmitted to the PLC!

Example:

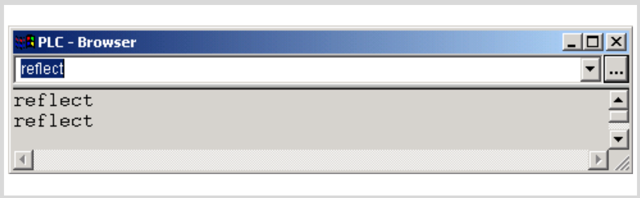


Figure 43: Browser command “reflect”

canload

Displays the utilization of the CANopen field bus.

Example:

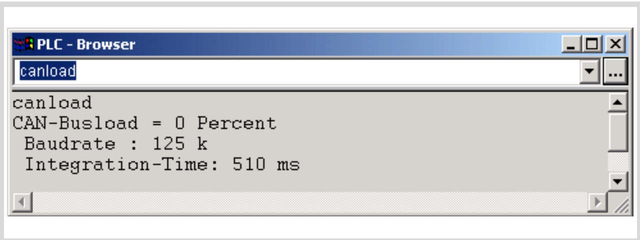


Figure 44: Browser command “canload”

This browser command returns, for example, the following information:

- CAN busload = 0 Percent
- Baud rate 125 Kbit/s
- Integration Time: 510 ms

Caution
With a bus utilization of 75 percent or higher, the warning ATTENTION: HIGH BUSLOAD also appears. Overload of the local CAN bus in conjunction with further short term load peaks can lead to CAN data loss.

→ In addition to the browser command, function CAN_BUSLOAD can be used to determine the CAN bus utilization from the user program, see Section “Function CAN_BUSLOAD” on page 38.

setrtc

Sets or changes the PLC date and/or time.

Syntax:

```
<setrtc_YY:MM:DD:DW_HH:MM:SS>
```

```
Legend:
_   Space
YY  The last two digits of the year (00 F YY F 99)
MM  Month (01 F YY F 12)
DD  Day (01 F DD F 31)
DW  Weekday (01 F DW F 07; 01 = Monday, 07 = Sunday)
HH  Hour (00 F HH F 23)
MM  Minute (00 F MM F 59)
SS  Second (00 F SS F 59)
```

8 Libraries, function blocks and functions

The libraries contain IEC function blocks and functions that you can use, for example, for the following tasks:

- Data exchange through the CANopen bus
- Controlling the real-time clock
- Determining bus load of the CANopen bus
- Triggering interrupts
- Sending/receiving data through the interfaces

The libraries are located in the folders:

- Lib_Common for all PLCs
- Lib_CPU121 for the PLC XC121.

Using libraries

When you open a project, libraries Standard.lib and SYSLIBCALLBACK.lib are copied in to the Library Manager. If you need further libraries for your application, you have to install these manually.

The libraries in the Library Manager are assigned to the project after saving. When you open the project, the libraries are then automatically called up as well.

The following overview lists the documents in which the function blocks and functions are described.

Document	Library
AWB 2700-1437	Standard.lib Util.lib XC121_Util.lib
Online help or PDF files can be found in the Windows start menu under Moeller Software → easy Soft CoDeSys → Documentation…	SysLib… . lib
MN05010002Z-EN (previously AWB2786-1456)	XS40_MoellerFB. lib/ Visu. lib/…
AN2700K20	3S_CANopenDevice. lib 3S_CANopenManager.lib
AN2700K19	3S_CANopenNetVar.lib
AN2700K27	SysLibCan.lib
MN05010001Z-EN (previously AWB 2786-1554GB)	CANUserLib.lib CANUser_Master.lib

Installing additional system libraries

You can install libraries manually as follows:

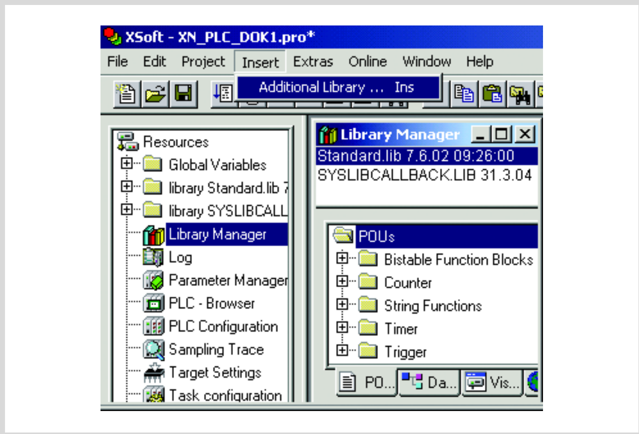


Figure 45: Libraries, installing manually

- ▶ In your project, click the "Resources" tab in the object organiser.
- ▶ Double-click the "Library Manager" element.
- ▶ From the Insert menu, select Additional Library…

The Open dialog appears.

- ▶ Select the library to install and click Open.

The library now appears in the Library Manager.

XC121 specific functions

Library "XC121_Util.lib"

This library contains the functions shown in the illustration below:

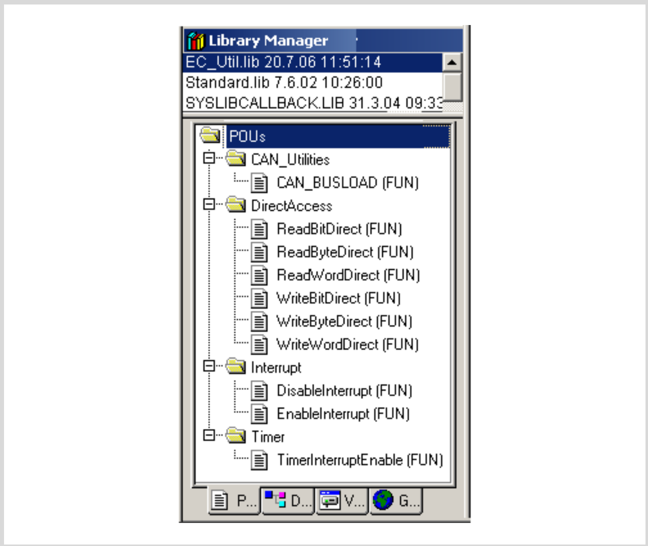


Figure 46: Functions of the library XC121_Util.lib

→ The Timer functions are described in Section "Timer interrupt" on page 29.

Function CAN_BUSLOAD

This function can be called cyclically in a user program. If a read cycle has been completed successfully, the function returns TRUE and writes the determined integration time and the bus utilization values to the passed addresses.

If the bus load calculation is not yet completed or the CAN controller has not yet been initialized, the function returns FALSE.

For information about evaluating the returned value, see „canload" on page 36.

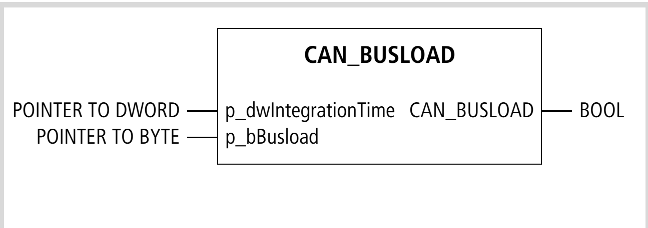


Figure 47: Function CAN_BUSLOAD

Function GETAPPLICATIONSWITCH

With this function you can query the position of the application switch. After an H signal at input "xEnable", the value to which the switch is set, is displayed.

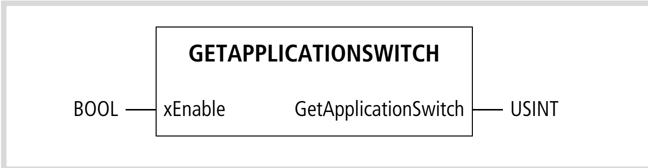


Figure 48: Function GETAPPLICATIONSWITCH

9 Connection set-up PC – XC121

To establish a connection between PC and XC121, the two devices' communication parameters must be the same.

To match them, first adjust the PC's communication settings to the CPU's settings. Use the CPU's default parameters, transferring them as shown in figure 49.

→ If you get an error message, the CPU's default settings have already been changed. In that case try a baud rate of 57600 bit/s.

You can then change the CPU's parameters (→ figure 50), always making sure that you have the same settings on the PC.

Communication settings of the PC

You can use either the COM1 or the COM2 port of the PC. Define the communication parameters of the interface in the software CoDeSys.

- ▶ In the Online menu, select Communication Parameters
- ▶ Specify the port (COM1 or COM2), → section "Changing settings"
- ▶ Use the remaining settings as shown in figure 49.
- ▶ Confirm the settings with OK.
- ▶ Log on to the PLC.

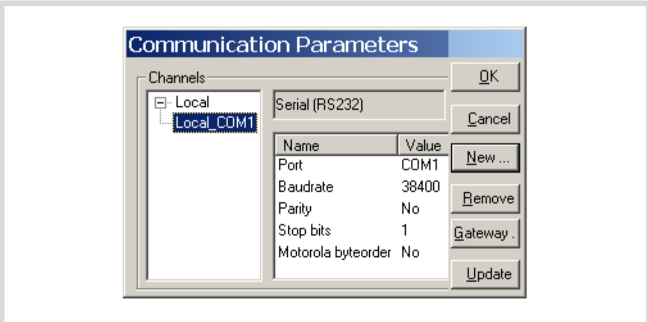


Figure 49: Defining the PC's communication settings

Changing settings

To change settings such as the baud rate or the port, do the following:

- ▶ Double-click the displayed value, for example 38400. The field becomes grey.
- ▶ Enter the desired value.

You can double-click the field again to select the required baud rate, e.g. 57600 bit/s.

Communication settings (baud rate) of the CPU

- ▶ In the Resources tab, select PLC Configuration.
- ▶ In the "PLC Configuration" dialog, click the "Other Parameters" tab.
- ▶ In the "Baudrate" list field, select the baud rate (for example 57600 bit/s as shown in figure 50).

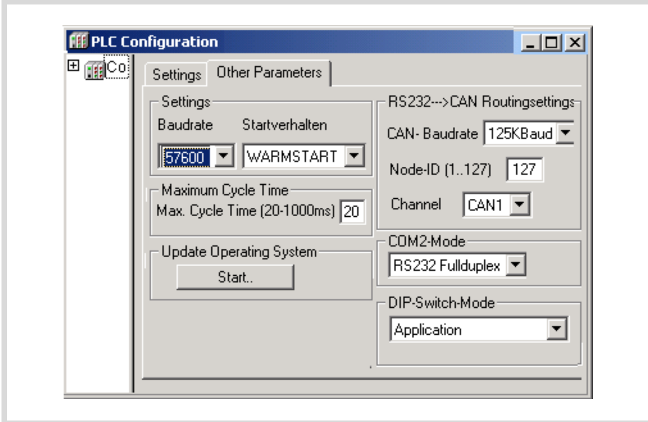


Figure 50: Specifying the CPU's communication settings

- ▶ Log on to the PLC.

The following prompt appears:

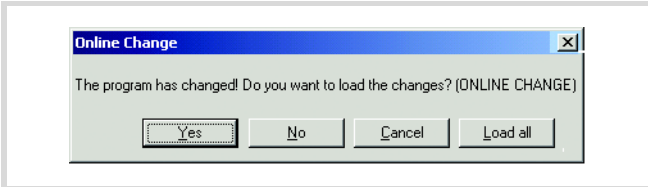


Figure 51: Query concerning program change

- ▶ Click "Yes".

The program is loaded. After a short while, a communication error message appears, since the baud rate settings of PC and CPU are no longer the same:

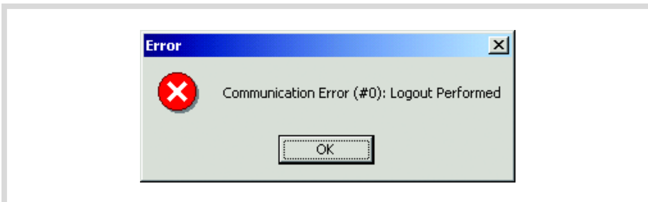


Figure 52: Communications fault

- ▶ Acknowledge the message with "OK".

To reestablish communications, change the PC's baud rate again.

10 Set the system parameters via the STARTUP.INI file

Parameter overview

You can define the system parameters with the INI file and save them on the MMC. The PLC accepts the parameters during start up. The INI file is always generated with all control-specific entries (→ table 12). Parameters which you have specified in the PLC configuration do not receive an entry.

Table 12: Parameters in the INI file

Entries
COM_BAUDRATE
CAN1_BAUDRATE
CAN1_NODEID
CAN2_BAUDRATE
CAN2_NODEID
CAN_ROUTINGID
CAN_ROUTING_CHANNEL

Structure of the INI file

An INI file is a text file with a defined data format. From a section defined with a name (in square brackets), e.g. such as [STARTUP] the system parameters are listed followed by an equals sign and their value. Close the line by pressing RETURN.

```
COM_BAUDRATE=38400 Return
```

Lines commencing with a semicolon are interpreted by the PLC as comments and are ignored:

```
; CAN_ROUTING_CHANNEL=CAN1
```

Example: Default STARTUP.INI for XC121

```
[STARTUP]
TARGET=XC-CPU121-2C256K
COM_Baudrate=38400
CAN1_Baudrate=125
CAN1_NODEID=2
CAN2_Baudrate=125
CAN2_NODEID=2
CAN_ROUTINGID=127
CAN_ROUTING_CHANNEL=CAN1
```

INI file generation

The INI file is generated with the browser command "createstartupini" on the MMC card. The current parameter values are applied to the system parameters. The programming interface is loaded with the following parameter:

```
COM_BAUDRATE=38400
```

The parameters from the program PLC configuration have no default values, e.g.:

```
CAN_ROUTINGID=
CAN_ROUTING_CHANNEL=
CAN1_BAUDRATE=
CAN1_NODEID=
```

A file which already exists cannot be changed or overwritten by the browser command "createstartupini". If you still enter the command, a warning appears. In order to create a new file the existing file must be deleted first.
→ section "Delete INI file" on page 42.

The parameters can be changed with a text editor if you insert the MMC into the MMC slot of a PC. The STARTUP.INI file is located in the "MOELLER/XC-CPU121-2C256K/BOOTPRJ/" directory. During online operation you can execute the "Load file from PLC" and "Write file in PLC" commands in the "Online" menu.

Entries of the INI file

- Entry for specification of the target system.

```
TARGET=XC-CPU121-2C256K
```

- Parameters for programming via the serial communication with CoDeSys:

```
COM_BAUDRATE=38400
```

The parameters from the INI file have priority before the parameters of the PLC configuration. After a program download or after loading of the boot project the parameters from the PLC configuration are not used:

- Parameters of the PLC configuration for CAN Level 2 Route:

```
CAN_ROUTINGID=127
CAN_ROUTING_CHANNEL=CAN1
CAN1_BAUDRATE=125
CAN1_NODEID=
CAN2_BAUDRATE=
CAN2_NODEID=
```

Start behaviour of the XC121 with inserted MMC containing INI file

During switch-on of the XC121 the data of the INI-file are transferred to the XC121. They remain active after a new program is loaded until you run the browser command "removestartupini".

Changing settings

If you insert an MMC with an INI file into the XC121 and switch on the XC121, the XC121 accepts the parameters of the INI file on the MMC. No parameters from the loaded project are accepted.

The parameters are retained until the browser command "removestartupini" has been entered and the XC121 is then switched on or off. The XC121 now operates with the parameters of the project.

Delete INI file

There are two browser commands available to access the MMC.

- removestartupini: Deletes the INI file on the MMC and the data on the CPU. The data from the project is accepted next time the device is switched on.
- removeprojfrommmc: deletes the project and the INI file on the MMC. The data on the CPU is retained.

→ If a full reset command is executed in online mode in the PLC Configuration, the OS and the project on the MMC are deleted. The INI file is retained, → section "Memory card MCC" on page 11.

11 Programming via CANopen network (Routing)

Routing means to establish an online connection from a programming device (PC) to any (routing-capable) PLC in a CAN network without having to directly connect the programming device to the target PLC. The target can instead be connected to any other PLC in the network. All actions that are available through a direct PC–PLC connection can also be implemented through the routing connection:

- Program download
- Online modifications
- Program test (Debugging)
- Generation of boot projects
- Writing files in the PLC
- Reading files from the PLC

Routing offers an advantage which makes it is possible to access all routing capable PLCs on the CAN bus from any PLC which is connected with the programming device. You select the control with which you want to communicate by the project selection. This provides an easy way of controlling remote PLCs.

However, the data transfer from routing connections is significantly slower than with direct (serial or TCP/IP) connections. This results, for example, in slower display refresh rates of variables and longer download times.

Prerequisites

The following prerequisites must be fulfilled to use routing:

- The routing PLC and the target PLC must both support routing.
- Both PLCs must be connected via the CAN bus.
- The PLCs must both have the same active CAN baud rate.
- The valid routing Node ID must be set on both PLCs.

Routing properties of the XC121

The XC121 supports the routing via the CAN bus.

Routing can be implemented without prior download of a user program (default: CAN1, 125 kBaud, Node-Id 127). The target PLC must not be configured as a CAN Master or CAN Device for this purpose.

You can for example load a program from the PC via a PLC of the XC device series into the XC121. Assign a Routing Node-Id to the XC121 (target PLC) in this case.

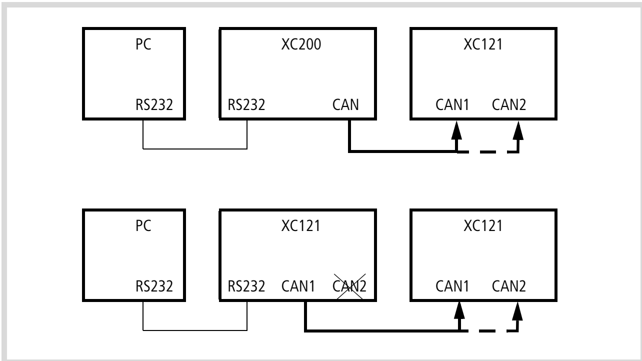


Figure 53: Program download per Routing

You can optionally connect the target PLC via the interfaces CAN1 or CAN2.

→ If you use the XC121 as the routing PLC you may only use the CAN1 channel for the connection leading further.

You can choose between two different methods to set the routing Node-Id:

- Setting via the PLC Configurator
- Setting via the APPLICATION switch

Setting via the PLC Configurator

▶ Click on the “Other Parameters” tab in the “Configurator” folder (→ figure 5).

“Node-Id-Routing” may not be selected in the DIP-Switch-Mode field!

▶ Enter the CAN baud rate in the “RS232->CAN Routing settings” field, as well as the Node-Id and the Channel CAN1 or CAN2.

Setting via the APPLICATION switch

- ▶ Click on the "Other Parameters" tab in the "PLC Configurator" tab (→ figure 5 on page 10).
- ▶ Set the "Node-Id Routing" mode in the "DIP-Switch-Mode" field.
- ▶ Set the baud rate in the "RS232->CAN Routing" field. The following baud rates are possible: 50, 100, 125, 250 and 500 kBaud (default: 125 kBaud)
- ▶ Set the Routing-Node-Id and the CAN interface on the APPLICATION switch:

Switch 1 – 7:	(Routing-) Node ID 1 – 127; with invalid address 0 the default node Id 127 is used.
Switch 8:	OFF = CAN1, ON = CAN2

→ The settings on the APPLICATION switch have priority over the configurator setting.

For further information chapter "APPLICATION switch (S2)" on page 10.

Routing through XC200

To perform a program transfer or routing using TCP/IP through a connection between XC200 and PC, you must first set the block size for the transferred data. The packet size (4 KByte or 128 KByte) depends on the transfer type (program transfer or routing) and the operating system, → table 13.

Table 13: Block size for data transfer

	Program/file transfer		**Routing**	
	OS < V1.03.03	**OS ≧ V1.03.03**	**OS < V1.03.03**	**OS ≧ V1.03.03**
Block size Default: 128 Kbyte	128 Kbyte	4/128 kByte	Routing not possible	4 Kbyte

Caution
The program download with a block size of 4 Kbyte to a PLC with an operating system version earlier than V1.03.03 will cause faulty behaviour!

If a program download is performed, the progress bar on the programming device monitor will only change erratically (about every 10 seconds).

The block size can be changed only directly in the Windows Registry.

→ You can change this setting only if you have administrator rights on your PC.

Changing the block size

- ▶ Close all CoDeSys applications.
- ▶ Close the CoDeSys gateway server.

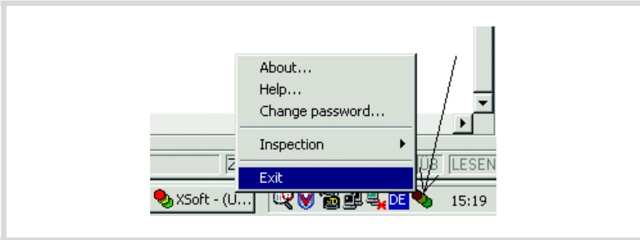


Figure 54: Closing the CoDeSys gateway server

- ▶ Change the block size to the required value.

The CoDeSys installation folder contains the following *.reg files for entering the block size in the Windows Registry:

BlockSizeDefault.reg	Enters a block size of 20000_{hex} =128 KByte (default value) in the Registry.
BlockSizeRout.reg	Enters a block size of 1000_{hex} = 4 Kbyte in the Registry.

Alternatively, you can use the BlockSizeEditor application to change the block size.

The download block size is defined in the following Registry key:

```
[HKEY_LOCAL_MACHINE\SOFTWARE\3S-Smart Software Solutions
GmbH\Gateway Server\Drivers\Standard\Settings\Tcp/Ip (Level 2
Route)]
"Blocksize"=dword:00020000
```

The default block size is 20000_{hex} (= 128 KByte), the block size for routing is 1000_{hex} (= 4 KByte).

Notes

- If large files are written to the target PLC or read from the PLC, it is possible that the online connection will be interrupted after the transfer process has been completed. Renewed connection is possible.
- If a program with a modified routing node ID is loaded into the target PLC, the target PLC accepts the modified routing node ID; however, the communication connection will be interrupted. Reconnection with a corrected routing Node ID is possible.
- If a PLC receives a program without valid routing parameters (Baud rate / Node ID), this PLC cannot be connected via a routing connection.
- The routing is independent of the configuration (master/slave): a target PLC that has not been configured as a master or as a slave can be accessed. It must only receive the basic parameters such as Node ID and baud rate, as well as a simple program.

Addressing

PLCs on the CANopen bus can be configured as a master or as a device. The PLCs are assigned with a node ID/node number (address) in order to uniquely identify them. To use the routing function to access a target PLC, you must assign a further node ID to the PLC.

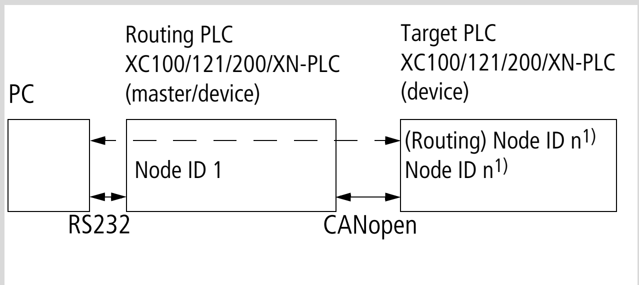


Figure 55: XC100/121/200, XN-PLC on the CANopen bus, routing principle

1) The following applies for the Node ID of the device function and the Node ID of the routing function:

– The (Routing-) Node-ID must **not be equal to** the Node-ID (Device)!

Procedure

▶ Connect the PC to the routing PLC.
▶ Select the target PLC with which you want to communicate for the project.
▶ First of all determine the communication parameters for the connection between the PC and the PLC which is connected to the PC.
▶ Enter the target PLC's target ID (target ID = node ID!) as shown in the example and log on.

You can run the following functions:

- Program download
- Online modification
- Program test (Debugging)
- Create bootable project
- Filing source code.

Note for project creation:

The Node ID/Node number and the baud rate of the target PLC to the routing function can be defined in the

→ figure 56"Additional parameters" window in the PLC Configuration:

▶ Enter the baud rate on the CANopen bus and the Node-ID/node number in the "RS232 → CAN routing settings" field.

Node ID and baud rate are transferred with the project download.

→ To guarantee a fast data transfer, the routing should be performed only with a CANopen baud rate of at least 125 Kbit/s.

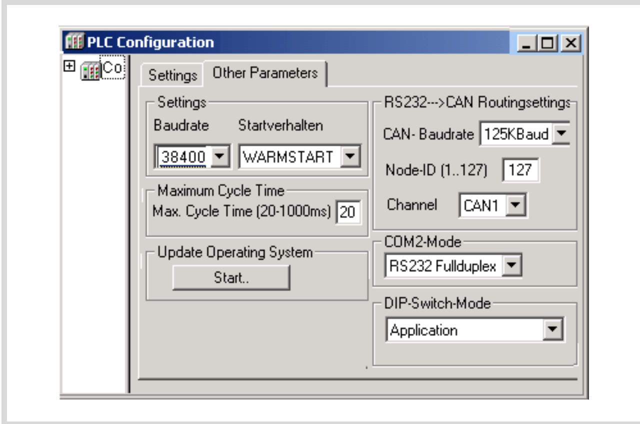


Figure 56: CANopen routing settings

The following illustrations indicate – independently of the routing settings – where the baud rate and the Node ID of the PLCs which have been configured as masters or devices are to be entered. The settings are to made in the master PLC in the "CAN Parameters" tab or with the device PLC in the "CAN Settings" tab.

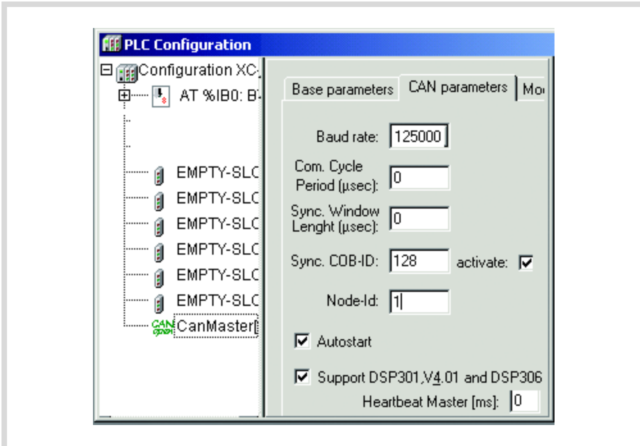


Figure 57: CAN master parameters

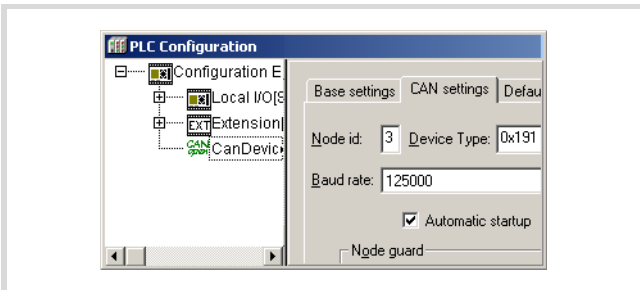


Figure 58: CAN device parameters

Example

The example below illustrates the procedure for accessing a PLC program.

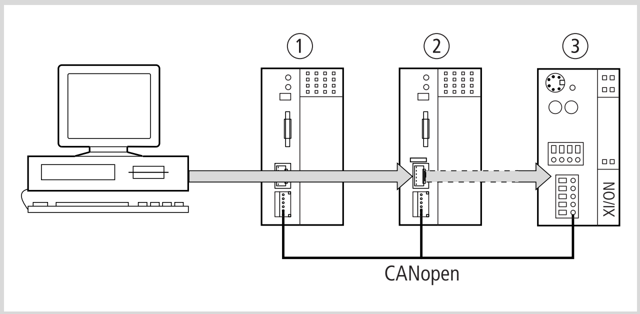


Figure 59: Diagnostics possibilities

① XC100 with node ID 1

② XC200 with node ID 2

③ XN-PLC with Node-ID 3 (instead of the XN-PLC you can also use an XC121)

You have connected the PC to the PLC with node ID “2” and want to access the target PLC with node ID “3”.

▶ Open the project of the target PLC (Node ID 3) whose program you wish to edit or test.
▶ First configure the parameters for the hardware connection PC ↔ PLC (node ID 2).
▶ From the Online menu select “Communication Parameters“.
▶ Click the New button under “local” channels.

The “New Channel” window appears.

▶ Select the channel in the Device field. XC200: Serial [RS232] [Level 2 Route] or TCP/IP [Level 2 Route].
▶ In the Name field you can assign a new name, e.g. “Rout_232”.
▶ Confirm with OK and return to the original window.

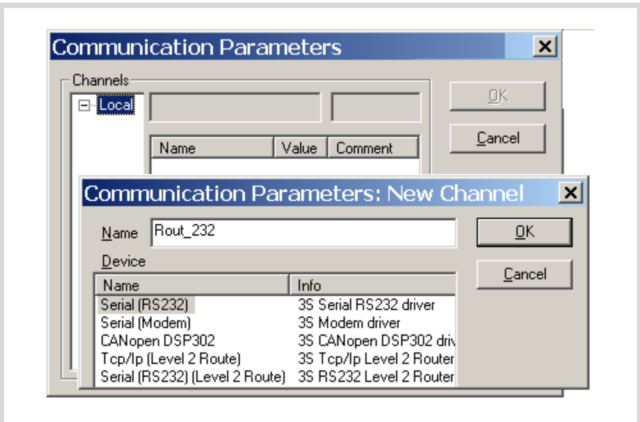


Figure 60: Channel parameter setting

You have now determined the parameters for the hardware connection between the PC and the PLC (node ID 2).

▶ Call up the communications parameters in the “Online” menu once again and select the control which you want to program/test.
▶ Enter the number 3 as the target ID in the example. The target ID is identical to the Node ID! Click in the field on the “Value” column on the right beside the target ID term in order to enter the target ID. Enter the figure 3 and confirm with OK.
▶ Log on and carry out the action.

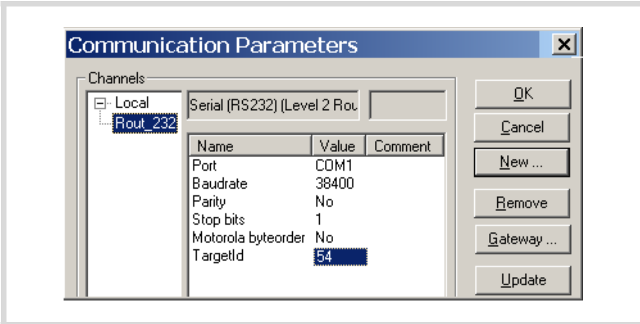


Figure 61: Setting the target ID of the target PLC

PLC combinations for routing

The following PLC support routing:

From P To O	XC100	XC121	XC200	XN-PLC-CANopen
XC100	×	×	×	×
XC121	×	×	×	×
XC200	×	×	×	×
XN-PLC-CANopen	×	×	×	×

12 RS232 interface in transparent mode

In transparent mode the data transfer occurs between the XC121 and data terminals (e.g. terminals, printers, PCs, measurement devices) without interpretation of the data. Switch the RS232 serial interface of the XC121 (COM1) into transparent mode with the user program.

For running the transparent mode there are functions available for opening and closing the interface, for sending and receiving data and for setting the interface parameters.

→ Because the interface's control lines are not active, you can not use the "SysComReadControl" and "SysComWriteControl" functions.

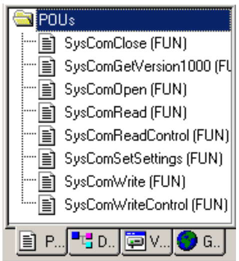


Figure 62: Function summary

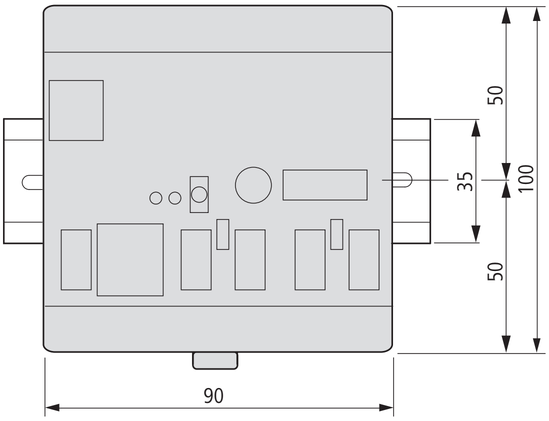
The transparent mode functions are contained in the "XC121_SysLibCom.lib" library. The library must therefore be included in the Library Manager. You can find the descriptions of the function blocks in the manual "CoDeSys Function Blocks for XSoft" (MN05010002Z-EN, previously AWB2786-1456GB).

→ If the RS232 interface (COM1) of the XC121 is in transparent mode, programming via this interface is not possible. Transparent mode must first be disabled. When transparent mode is closed, the original communication parameters are reinitialised. The transparent mode is forcibly deactivated when the PLC state changes to the STOP mode or when the "SysComClose" function is accessed.

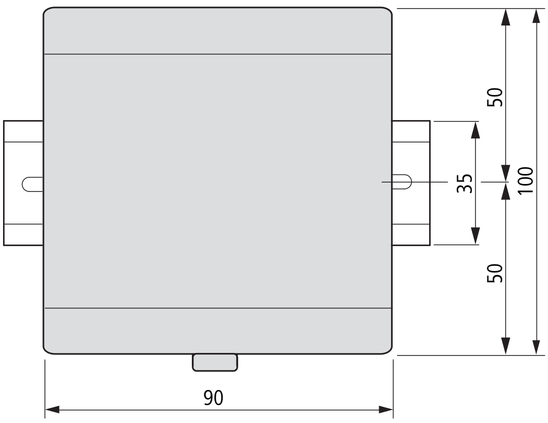
Appendix

Dimensions

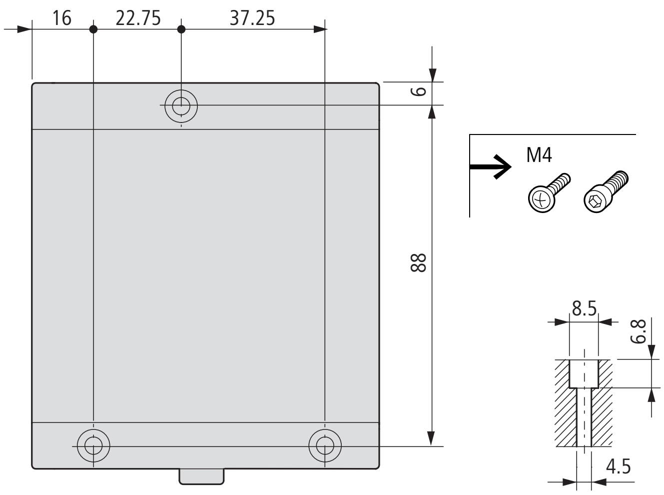
XC-CPU121



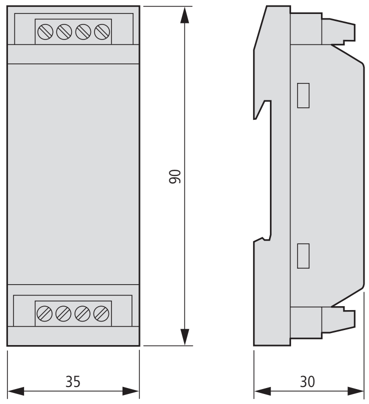
XIO-EXT121-1



XC-CPU121, XIO-EXT121-1



24 V DC line filter XT-FIL-1



Technical data

XC-CPU121/XIO-EXT121-1

General		
Standards and regulations		IEC/EN 61131-2 EN 50178
Ambient temperature	°C	0 – +55
Storage	°C	–25 – +70
Mounting position		Horizontal
Relative humidity, no condensation (IEC/EN 60068-2-30)	%	10 to 95
Air pressure (in operation)	hPa	795 to 1080
Vibration resistance		Frequency 5 to 9 Hz; amplitude 3.5 mm 9 to 150 Hz; 1.0 g constant acceleration
Mechanical shock resistance		15 g/11 ms
Overvoltage category		II
Pollution degree		2
Enclosure protection		IP20
Rated insulation voltage	V	500
Interference emission (Industry)		EN 61000-6-4
Interference immunity (Industry)		EN 61000-6-2
Back-up of the clock		at least 72 hours
Weight	kg	0.15
Dimensions (W x H x D)	mm	90 × 100 x 47

Electromagnetic Compatibility (EMC)		
Electrostatic discharge IEC/EN 61000-4-2, Level 3, ESD)		
Contact discharge	kV	4
Air discharge	kV	8
Radiated (IEC/EN 61 000-4-3, RFI)	V/m	10
Burst Impulse (IEC/EN 61000-4-4, Level 3)		
Supply cables	kV	2
Signal cables	kV	1
Surge (IEC/EN 61 000-4-5)	kV	0.5
Conducted (IEC/EN 61 000-4-6)	V	10

XC-CPU121

Connection by		
Supply voltage		
Plug		Springloaded terminal block, 4-pole
Terminal capacity	mm^2	0.14 – 1 (AWG28-18)
COM1 interface		
Plug		RJ45
COM2, CAN1, CAN2 interfaces		
Plug		Springloaded terminal block, 6-pole
Terminal capacity	mm^2	0.14 – 0.5 (AWG28-20)
Supply voltage (24 V/0 V)		
Input voltage	V DC	24
Permissible range	V DC	20.4 – 28.8
Power consumption	W	Up to 1.44
Input current	mA	60
Residual hum and ripple	%	$\leqq$ 5
Overvoltage protection		Yes
Polarity protection		Yes
Switch-on current surge		Not limited, (limiting only by a supply-side 24 V DC PSU)
Hold-up time on supply drop-out		
Dropout duration	ms	10
Repeat rate	s	1
External supply filter		Type: XT-FIL-1, see the technical data on page 55
Internal supply filter		Yes

CPU		
Microprocessor		Infineon XC161
Memory		
Program code	kByte	256
Program data	kByte	14 segments of 16 KB each
Marker/Input/Output/Retain data	kByte	16/4/4/8
Cycle time for 1 k instructions (Bit, Byte)	ms	< 0.3
Interfaces		
COM1 (RS232) interface without handshake line		
Data transfer rate for programming Character format: 8 bit data, no parity, 1 stop bit	bit/s	19 200, 38 400 (Default), 57 600 Bit/s
Connection by		RJ45 socket
Electrical isolation		none
in the transparent mode		
Data transfer rate	bit/s	300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 38 400, 57 600, 115 200 Bit/s
Character formats		8E1, 8O1, 8N1, 8N2, 7E2, 7O2, 7N2, 7E1
Number of transmission bytes in a block		190 bytes
Number of received bytes in a block		190 bytes
COM2 (RS232/RS485) without handshake lines		
Data transfer rate (transparent mode) Setting via function blocks	bit/s	300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 38 400, 57 600 Bit/s
Character formats		8E1, 8O1, 8N1, 8N2, 7E2, 7O2, 7N2, 7E1 Setting via FB
Electrical isolation		None
Bus termination resistors for RS485		External
CAN1/CAN2 interface		
Data transmission rate	Kbit/s	10 – 500[1)]
Electrical isolation		No
Participant		126
Bus terminator		Can be switched in for each interface (CAN1/CAN2)
PDO type		Asynchronous, cyclic, acyclic

1) Higher transfer rates that are selectable in the PLC configuration are not possible!

XIO-EXT121-1

Connection by		
X1 connector		
Connector type		Springloaded terminal block, 20-pole, B2L 3.5 (Weidmüller)
Terminal capacity (solid)	mm^2	0.5 – 1
X2/X3 connector		
Connector type		Springloaded terminal block, 10-pole, BLZF 3.5/180 or BLI/O 3.5/10F with LEDs (Weidmüller)
Terminal capacity (solid)	mm^2	0.5 – 1
Supply voltage (24 V/0 V)		
Hold-up time on supply drop-out		
Dropout duration	ms	10
Repeat rate	s	1
Input voltage	V DC	24
Permissible range	V DC	20.4 – 28.8
Power consumption	W	max. 1.68 + XI/OC signal modules requirement
Input current	mA	70 + XI/OC signal modules requirement
Signal module output voltage		
Rated value	V DC	5
Output current	A	2.5
Short-circuit rating		Yes
Electrically isolated from the supply voltage		No
Residual hum and ripple	%	≦ 5
Overvoltage protection		Yes
Polarity protection		Yes
Switch-on current surge	A	max. 1
Digital inputs		
Number with X2		9 with connector BLI/O 3.5/10F 10 with connector BLZF 3.5/180
Number with X3		8 (can also be used as outputs)
rated voltage	V DC	24
for 0 signal	V	< 5
for 1 signal	V	> 15
Rated current with 1 signal	mA	3.3
Delay time		
X2: DI0…DI3	µs	20
X2: DI4…DI9	µs	250
X2: DX0…DX7	ms	20
Electrical isolation		No
Digital outputs		
Number with X3		8 (can also be used as inputs)
rated voltage U_e	V DC	24
Permissible range	V DC	20.4 – 28.8
Residual hum and ripple	V	≦ 5 %

rated current I_e with 1 signal	A	0.5 at 24 V DC
Simultaneity factor		1
Relative ON time	ms	100 %
Lamp load without R_v	W	5
Electrical isolation		Yes
Residual current per channel with 0 signal	mA	< 0.1
Max. output voltage		
At 0 ext. load < 10 MΩ	V	2.5
at 1 with I_e = 0.5 A		$U = U_e - 1$ V
Short-circuit protection		Yes
Short-circuit detection threshold		
for R_a < 10 MΩ		$0.7 \leqq I_e \leqq 2$ per output
Total short-circuit current	A	16
Peak short-circuit current	A	32
max. operating frequency	ops./h	40000
Can be switched in parallel		Yes, in groups: Q0 - Q3 or Q4 - Q7)
Data for the analog I/O		
Analog inputs 0 … 10 V		
Number of channels		2
Input voltage range	V	0 – 10
Resolution	Bit	10
Conversion time	ms	≦ 5
Overall accuracy		≦ ±1 % (of end of scale)
Input resistance	kΩ	200
Analog inputs 0 … 20 mA		
Number of channels		2
Input voltage range	mA	0 – 20
Resolution	Bit	10
Conversion time	ms	≦ 5
Overall accuracy		≦ ±1 % (of end of scale)
Input resistance	Ω	50
Pt100		
Number of channels		2
Temperature range	°C	–200 – +200
Resistance range	Ω	18.5 – 175.8
Precision		±10 digits[1)]
Analog outputs		
Number of channels		2
Output voltage range	V	0 – 10
Resolution	Bit	12
Conversion time	ms	≦ 5
Overall accuracy		≦ ±1 % (of end of scale)
External load resistance	kΩ	10

1) Assigned temperature values → fig. 22

24 V DC line filter XT-FIL-1

General		
Standards and regulations		IEC/EN 61131-2 EN 50178
Ambient temperature	°C	0 – +55
Storage	°C	–25 – +70
Mounting position		Horizontal/vertical
Relative humidity, no condensation (IEC/EN 60068-2-30)	%	10 to 95
Air pressure (in operation)	hPa	795 to 1080
Vibration resistance		Frequency 5 to 9 Hz; amplitude 3.5 mm 9 to 150 Hz; 1.0 g constant acceleration
Mechanical shock resistance		15 g/11 ms
Impact resistance		500 g/∅ 50 mm ±25 g
Overvoltage category		II
Pollution degree		2
Enclosure protection		IP20
Rated impulse voltage	V	850
Interference emission (Industry)		EN 61000-6-4
Interference immunity (Industry)		EN 61000-6-2
Weight	g	95
Dimensions (W × H × D)	mm	35 × 90 × 30
Connecting terminals		Screw terminal
Conductor cross-section		
Screw terminals		
Stranded, with bootlace ferrule	mm2	0.2 – 2.5 (AWG22-12)
solid core	mm2	0.2 – 2.5 (AWG22-12)
Power supply		
Input voltage	V DC	24
Permissible range	V DC	20.4 – 28.8
Residual hum and ripple	%	≦ 5
Overvoltage protection		Yes
Electrical isolation		
Input voltage to PE		Yes
Input voltage to output voltage		No
Output voltage to PE		Yes
Output voltage	V DC	24
Output current	A	2.2

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