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.General information

ctrlX DRIVE devices can be operated with PROFINET® IO master communication. It is possible to exchange real-time data with a PROFINET® IO controller.

The PROFINET® IO master communication allows the user to flexibly set up cyclic data exchange. The data transfer can be managed via parameters.

This chapter describes aspects of PROFINET® IO communication. Application features are not part of this description.

.Notes on design and commissioning

In the design, assembling and commissioning of an installation, the following guidelines are referred to (designation: PROFINET® IO trilogy):

- PROFINET_Design_Guideline_8062_V138_Sep19.pdf
- PROFINET_Assembling_8072_V28_Sep19.pdf
- PROFINET_Commissioning_8082_V144_Sep19.pdf

The guidelines are provided by the administrative office of the PNO (PROFIBUS Nutzerorganisation e. V.).

- It is recommended that the Industrial Ethernet network not be coupled with a company network (office communications). (Alternatively, a Level 3 router can be used to connect the Industrial Ethernet network to a company network.)
- It is recommended that only switches with cut-through method be used for Industrial Ethernet communication.
- It is recommended that a star topology with cable type AWG22 or shielded cables be used, particularly for cables that exit the control cabinet and for cables longer than 10 meters.
- In the case of topology functions, all switches have to support LLDP (characteristic of managed switches), according to standard even be PROFINET® IO devices themselves.

.PLC function blocks

To simplify field bus communication, there are PLC function blocks for different programmable logic controllers (PLCs) available. The function blocks support the basic functionality of axis-specific process data. The principles applied can be easily used for other PROFINET® IO controllers.

For the PLC function blocks and a related documentation please follow this link:

https://www.boschrexroth.com/en/en/products/productgroups/electric-drives-and-controls/ctrlx-automation/ctrlx-drive/servodrives

.Communication cycle time

As regards the communication cycle time, we distinguish between the bus cycle time and the update cycle.

Within a bus cycle, process data telegrams are transmitted via the bus from the PROFINET® IO controller to the device (or from the device to the PROFINET® IO controller). The bus cycle is calculated from the transmission clock and the reduction quotient, e.g. transmission clock 2 ms and reduction quotient 4 results in a bus cycle of 8 ms.

The transmission clocks that can be set are defined via the GSDML file. The user can select the transmission clocks 1 ms, 2 ms and 4 ms.

The reduction quotient can only be a value of the exponent-of-two series.

The minimum resulting bus cycle is 2 ms.

For configuration, the bus cycle is specified in the Engineering of the PROFINET® IO controller (example: SIEMENS HW configurator).

In the update cycle, the process data received within a bus cycle are applied to parameters of ctrlX DRIVE. The update cycle and the bus cycle are not synchronized.

.Assigning the IP address with the device naming

With the device naming, the IP address can be written besides the device name. In this case, the IP address has to be permanently stored in the device.

This „permanent“ IP address is saved in parameter S-0-1020.0.0 in the device.

Alternatively, the IP address can also be written via the parameter S-0-1020.0.0 (only up to SafeOp state).

.Additional information and details

.Features and communication classes

Functions and features in communication are combined and described in function classes and displayed in parameter „S-0-1000.0.0, List of SCP classes & versions". Two communication classes have been implemented in the PROFINET® IO device of ctrlX DRIVE:

.Identifier for PROFINET® IO general

Identifier	Version	Class name
0x8301	V1.0	PROFINET® IO general

.Characteristics of the communication class

PROFINET® IO general	V1.0
Supported features	■ Conformance Class B ■ T-CLASS_1 ■ Topology – via LLDP and PDEV ■ SNMPv1 ■ VALN priority tagging ■ Shared Device ■ I&M 0-3
In preparation	■ Acyclic parameter access ■ PROFIsafe supported
Unsupported features	■ IRT (RT_CLASS_3) ■ TSN (RT_CLASS_STREAM) ■ RT_CLASS_UDP ■ PTCP (time sync) ■ Dynamic Reconfig ■ DFP - Dynamic Frame Packing ■ DHCP ■ I&M 4-5 ■ System Redundancy ■ Shared Input ■ RSI ■ iPAR ■ MCR ■ FSU Fast Start Up ■ Asset Management

.Identifier for PROFINET® IO device for ctrlX DRIVE

Identifier	Version	Class name
0x8321	V1.0	PROFINET® IO device for ctrlX DRIVE

.Characteristics of the communication class

PROFINET® IO device for ctrlX DRIVE	V1.0

PROFINET® IO device for ctrlX DRIVE	V1.0
Supported features	▪ Up to 2 axes ▪ Per axis one module per data direction (consumer/producer) ▪ Up to 15 parameters per module ▪ Up to 60 bytes I/O data per module

The PROFINET® IO master communication provides modules in which the parameters can be configured as submodules. This section is referred to as cyclic data channel (PROFINET® IO).



The IO cycle updating time is written by the control unit and is the time cycle in which the process data from the PROFINET® IO network are applied to ctrlX DRIVE and written in the other direction.

For the open ports of crtlX DRIVE that can be used under PROFINET® master communication, please see the Security Guideline:
https://www.boschrexroth.com/documents/12605/25344391/R911342562_10.pdf

.Configuration

.Addressing

A node in PROFINET® IO is addressed using the so-called device name. The device name can be assigned locally for ctrlX DRIVE or by way of device naming by a configuration software. The parameter P-0-4089.0.2 is used for this purpose.

In the case of device naming via a configuration tool (example: SIMATIC NCM), the device can be identified through a flashing test (LED next to port flashes 3 times within 3 seconds).

In addition, each device has an unequivocal MAC address by which it can be identified. The MAC address can be read via the parameter S-0-1019.0.0 and cannot be changed.

.Addressing (additional information)

PROFINET® IO works with three device addresses:

- MAC address (3x)
- Station/device name
- IP address

Example:

.Example of a device the addresses of which are displayed in Siemens HW

config

MAC address	Device type	Device name	IP address	Device ID	Manufacturer ID
00-60-87-3S-08	Rexroth ctrlX DRIVE	dut	192.168.0.50	0x2602	0x011F

.Using the MAC addresses

The device MAC address S-0-1019.0.0 is used for cyclic and for acyclic RT communication (e.g., alert telegrams, identification and addressing - DCP), as well as for the other Ethernet-based protocols. A PROFINET® IO telegram is recognized through the Ether type 0x8892.

In addition, there is a port MAC address S-0-1019.140.0 and S-0-1019.141.0 for each network port; they are exclusively used for the LLDP telegrams (Ether type 0x88CC) and serve for topology identification.

.Using the IP address

The IP address is used to establish a connection and for acyclic communication (Read/Write Record services).

In addition, the IP address is used for SNMP topology query and for ICMP network diagnostics.

On how to assign the IP address, see ↘ “Assigning the IP address when establishing the connection” and ↘ “Assigning the IP address with the device naming”

.Using the station/device name

Before establishing the connection from the controller to the device, the controller transmits a DCP Identify Request. The device responds with its device MAC address and IP address.

Thereafter, the station/device name is no longer used for device addressing! After the cyclic communication was established, the station/device name cannot be changed anymore by the device naming!

In the condition as supplied and after a „FactoryReset“ command, the station/device name is blank. After FactoryReset, the device name has to be assigned by the Engineering of the PROFINET® IO controller according to the configuration, so that the device can be identified using the name.

.Assigning the IP address when establishing the connection

When the connection is established, the IP address is assigned that was specified for the configuration (example: SIMATIC NCM). The IP address thus assigned may not be persistently stored by the device; however, the persistent IP address that might have been previously

assigned is deleted. This „temporary“ IP address is not displayed in the device. In parameter S-0-1020.0.0, the IP address 0.0.0.0 is stored, in S-0-1021.0.0 the subnet mask and in S-0-1022.0.0 the gateway address.



Usually, a PLC programmer/configurator does not need to care about the IP address of the device. He or she only assigns the subnet and pulls the PROFINET@ IO Device into the HW config (SIMATIC NCM). The HW config configuration tool automatically generates the IP addresses. When the connection to a controller is established, IP addresses that might have been previously configured in the device are deleted if the configuration differs.

With a new device or after „FactoryReset“ command, it is therefore impossible to communicate via IP, since the IP address is empty. This is also the case if the IP address has not been persistently stored in the device and the controller has not yet assigned an IP address.

.Configuring the process data channel

.Processing the cyclic data

The I/O data are internally processed in a separate cycle that is not synchronous with PROFINET® IO RT.

.Standard process data channel (non-safe)

The user can freely configure the cyclic data in the standard process data channel according to the process requirements.

.Configuration list of cyclic data channel

In parameter "P-0-1050.x.6", the parameters and therefore the structure and length for the process input and output data (device → controller) are mapped. The controller can use this configuration to locate the individual real-time data in PROFINET® IO.

The PROFINET® IO VendorID is displayed in parameter „P-0-1681.0.3“.

The PROFINET® IO DeviceID is displayed in parameter „P-0-1681.0.4“.

The PROFINET® IO (Sub)ModuleIDs of the communication module are displayed in parameter „P-0-1683.0.2“:

List index	Significance/value	Slot	Subslot
0	ModuleID of communication module (DAP)	0	-

List index	Significance/value	Slot	Subslot
1	SubmoduleID of communication module	0	1
2	SubmoduleID of interface	0	0x8000
3	SubmoduleID of ports	0	0x8001/0x8002

.Device data sheets for ctrlX DRIVE

Like any other PROFINET® IO device, ctrlX DRIVE with PROFINET® master communication has to be configured in the PROFINET® IO controller. This requires the corresponding device data sheet (GSDML) "GSDML-V2.4-Bosch Rexroth AG- ctrlXDRIVE -YYYYMMDD-hhmmss.xml" that has to be included in the project ("YYYYMMDD-hhmmss" represents the creation date/time of the GSDML file, the time including ,-, being optional). One of these GSDML files is required for each node when configuring the bus controller.



The respective device data sheet supports all hardware types and enabling of functional packages.

For the appropriate ctrlX DRIVE PROFINET® device description please follow this link:

https://www.boschrexroth.com/en/en/products/productgroups/electric-drives-and-controls/ctrlx-automation/ctrlx-drive/servodrives

In ctrlX Drive Engineering, these files can be found in the installation directory under C:\Program Files\Rexroth\ctrlX WORKS\DeviceDataSheets

Different modules are available for the I/O data. Each module can only have submodules for one direction producer or consumer. In each parameterization there are up to 8 modules. Up to 15 submodules/parameters are possible per module.

For the submodules there is a 1:1 relation between EIDN and SubmoduleID and thus also structure of the data. List parameters are always used with the maximum length; the firmware sets it to the current length on the state transition from PreOp to SafeOp.

The configuration of the ctrlX DRIVE device and the configuration in the PROFINET® IO controller for the corresponding module have to match. Otherwise, the data exchange is blocked, marked as invalid, and an error is transmitted for each submodule that was configured in this module.

For ctrlX DRIVE, the data are arranged in two modules (for single-axis devices), four modules (for double-axis devices) – each axis has an input module and an output module.

Each module can contain suitable parameters as submodules, according to whether input or output.

The order (assignment of the modules to inputs/outputs of the axes) has been specified in the GSDML.

Slot 0: Communication module

Slot 1: Inputs axis 0

Slot 2: Outputs axis 0

Slot 3: Reserved axis 0 (safety inputs)

Slot 4: Reserved axis 0 (safety outputs)

Slot 5: Inputs axis 1

Slot 6: Outputs axis 1

Slot 7: Reserved axis 1 (safety inputs)

Slot 8: Reserved axis 1 (safety outputs)

The data types in the submodule correspond to those of the configured parameters.

Depending on the ctrlX DRIVE type and according to the following pattern, the communication modules (DAP) are generated. They can be read in parameter P-0-1683.0.2.

The ModuleID for the DAP is generated from the first 4 ASCII bytes of parameter S-0-1300.0.5, e.g. „XCD“ results in 0x58434400.

The SubmoduleID for the DAP is always 0x00000001.

The InterfaceSubmoduleID is always 0x00000002.

The PortSubmoduleIDs are always 0x00000003.

.Displaying the station/device name/IP address/device address

The device name of the device assigned with the device naming is displayed in parameter "P-0-4089.0.2, Master communication: Device name". When exchanging a device, the device name can be set manually via this parameter. The IP settings persistently assigned to the device during configuration are displayed in the following parameters:

- S-0-1020.0.0, IP address
- S-0-1021.0.0, Network mask
- S-0-1022.0.0, Gateway address

In the case of "temporary assignment" configuration (assigned by the controller during run-up), the IP address "0.0.0.0" is displayed in the parameters.

.Communication state machine

Using the modules of an instance/slave, the common status is generated – „no connection“ versus „I/O connection active“. The figure below shows the states and transitions of an instance/slave

and how the PROFINET® state machine is connected to the drive state machine:

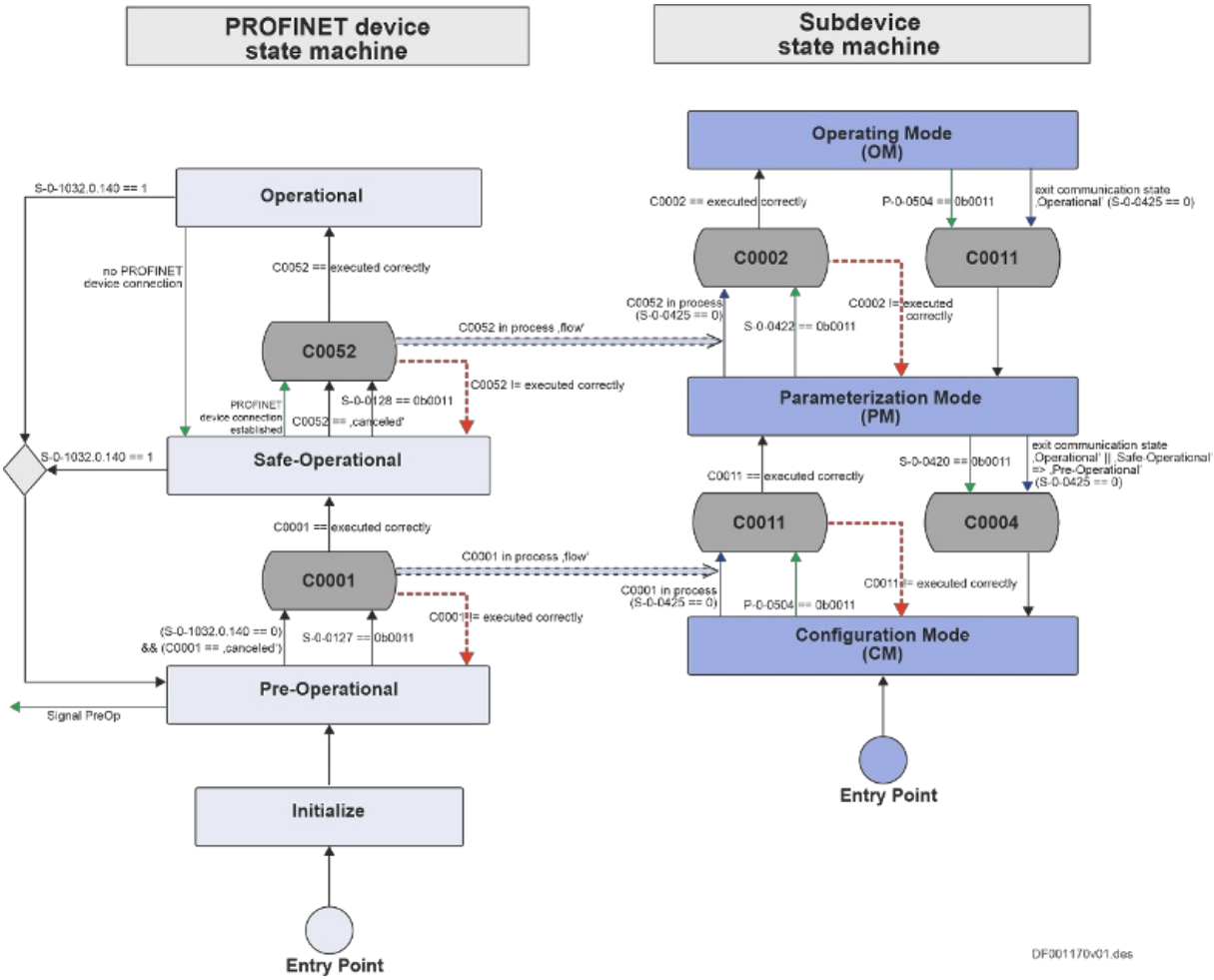


Fig. 88: PROFINET® IO device state machine

State	Description
Initialize	Waiting for Ready message of host – FRAM_Adapt_HostInitEnd
Pre-Operational	Evaluating parameter S-0-1032.0.140 bit 0 whether advancing allowed Parameterizing the PN stack Advancing with command C0001

State	Description
Safe-Operational	Waiting for PN connection (visible at Ethernet via PN services) Advancing with command C0052
Operational	At least one PN connection in data exchange Otherwise fall-back to Safe-Operational

Via the parameter S-0-1032.0.140, the state machine is forced back to Pre-Operational to reconfigure the PN stack.

.Reset to factory settings

With the „Reset to factory settings“ service, the station/device name (P-0-4089.0.2) and the IP suite (S-0-1020.0.0 to S-0-1022.0.0) are reset to the default value (IP address and device name are deleted), and the topology information as well as the I&M data 1-3 are deleted.

.I&M parameter data

I&M functions are divided into 15 different blocks (I&M 0 ... 15). Each certified device has to support I&M 0-3. In the standard, only the blocks 0-5 have been defined.

The I&M data set has been defined as follows (read only)

.Communication class

I&M parameter (PI Guideline)	Description	Parameter
MANUFACTURER_ID	0x011F for Bosch Rexroth	P-0-1681.0.3
ORDER_ID	OrderID	S-0-1300.0.11
SERIAL_NUMBER	SERIAL_NUMBER is set to the serial number of the device	S-0-1300.0.12
HARDWARE_REVISION	HARDWARE_REVISION displays the EPL version (logicware version) of the PROFINET® communication module.	

I&M parameter (PI Guideline)	Description	Parameter
SOFTWARE_REVISION	SOFTWARE_REVISION displays the FW version of the PROFINET® communication module char8: V (T if test version is evaluated by customers) us8: Major: major number used us8: Minor: minor number used us8: Release: release number used	
REVISION_COUNTER	Initially 0, increased at every write access to I&M 1-3; in the case of overflow, 0 is skipped	P-0-1680.0.1
PROFILE_ID	Generic Device: 0	
PROFILE_SPECIFIC_TYPE	Generic Device: 0	
IM_VERSION	Implemented version of the I&M functions: 2.1	
IM_SUPPORTED	Only I&M 0-3 is thus supported: 0x1E	

The I&M1 data set has been defined as follows (read and write):

I&M parameter (PI Guideline)	Description	Parameter
TAG_FUNCTION	Function of the device 32 bytes of printable characters	P-0-1680.0.2
TAG_LOCATION	Location of the device 22 bytes of printable characters	P-0-1680.0.3

The I&M2 data set has been defined as follows (read and write):

I&M parameter (PI Guideline)	Description	Parameter
INSTALLATION_DATE	Date in format YYYY-MM-DD hh:mm, hh:mm being optional	P-0-1680.0.4

The I&M3 data set has been defined as follows (read and write):

I&M parameter (PI Guideline)	Description	Parameter
DESCRIPTOR	Description of the device 54 bytes of printable characters	P-0-1680.0.5

The I&M parameter data are device data. That is to say identical I&M parameter data are returned for all subslots in the case of ctrlX DRIVE. The I&M 0-3 data can be read via the standardized index 0xAFF0-0xAFF3, and the I&M 1-3 data can be written via the same index, but only to slot 0 subslot 0x0001.