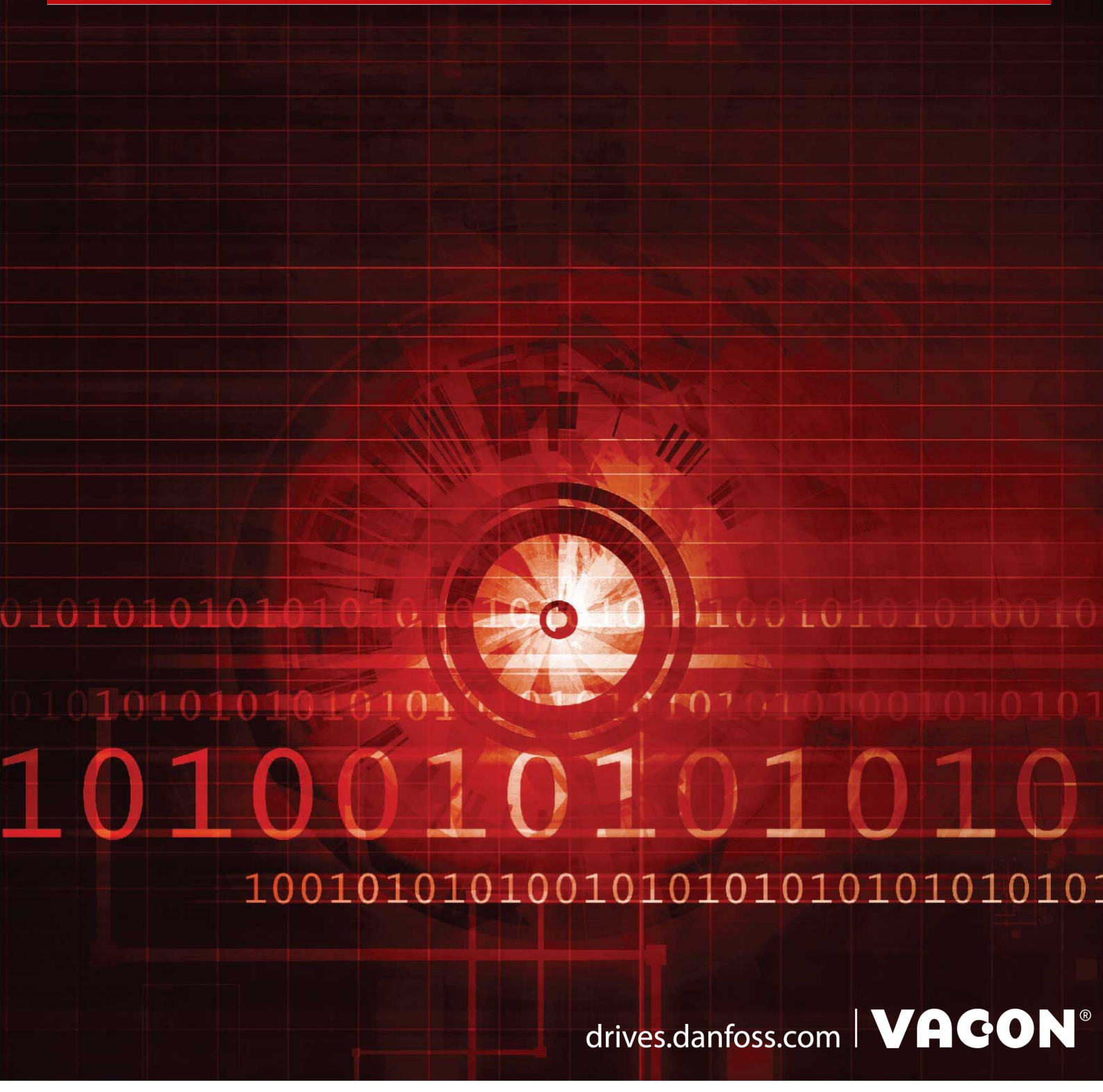
ENGINEERING TOMORROW

User Guide

VACON® OPTEA/OPTE9 Ethernet Board



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Contents

1 Introduction

1.1 Purpose of the Manual

The EtherNet/IP user guide provides information about configuring the system, controlling the drive, accessing parameters, programming, troubleshooting, and some typical application examples.

The user guide is intended for use by qualified personnel, who are familiar with the VACON® drives, EtherNet/IP technology, and with the PC or PLC that is used as a master in the system.

Read the instructions before commissioning and programming and follow the procedures in this manual.

1.2 Additional Resources

Resources available for the drive and optional equipment are:

- VACON® Ethernet Installation Guide provides the necessary information to install the option board to the AC drive.
- The Operating Guide of the AC drive provides the necessary information to get the drive up and running.
- The Application Guide of the AC drive provides more details on working with parameters and many application examples.

Supplementary publications and manuals are available from drives.danfoss.com/knowledge-center/technical-documentation/.

For US and Canadian markets:

NOTE! Download the English and French product manuals with applicable safety, warning and caution information from https://www.danfoss.com/en/service-and-support/.
REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site https://www.danfoss.com/en/service-and-support/.

1.3 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this manual is English.

Table 1: Manual and Software Version

Manual version	New features	Firmware version
DPD01583C (for OPTE9)	• EtherNet/IP protocol • Ethernet ring support (RSTP) • Address Conflict Detection (ACD)	V004 (OPTE9)
DPD01583D (for OPTE9)	• Media Redundancy Protocol (MRP) • Simple Network Management Protocol (SNMP) • LLDP-MIB, LLDP-EXT-DOT3-MIB, LLDP-EXT-PNO-MIB • EDD files SIMATIC PDM	V006 (OPTE9)
DPD01583E (for OPTE9)	• Fast communication modes in VACON® NXP • PROFINET Alarms.	V007 (OPTE9)
DPD01583F (for OPTE9)	• Simple Network Time Protocol (SNTP). • Fast MRP support verified	V008 (OPTE9)
	Device Level Ring (DLR)	V009 (OPTE9)
DPD01583G (for OPTEA/OPTE9)	• PROFINET + PROFIsafe for VACON® NXP	V001 (OPTEA)

Manual version	New features	Firmware version
	• Support for all features supported by OPTE9 board including EtherNet/IP and Modbus TCP/UDP protocols • Improved emulation mode with OPTCP, OPTCQ, and OPTCI boards when installed to VACON® NXP • PROFINET System Redundancy "S2"	V002 (OPTEA)
DPD01583H (for OPTEA/OPTE9)	• The structure of the manual updated. Installation information removed (see VACON® Ethernet Installation Guide).	
	Support for 32-bit process data items with VACON® 100 family AC drives.	V003 (OPTEA)
	• Shared Device	V005 (OPTEA)

1.4 Type Approvals and Certifications

The following list is a selection of possible type approvals and certifications for Danfoss drives:

NOTICE

The specific approvals and certification for the drive are on the nameplate of the drive. For more information, contact the local Danfoss office or partner.

1.5 Trademarks

EtherNet/IP© is a trademark of ODVA, Inc.

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1.6 Product Overview

1.6.1 Ethernet Networks with VACON® AC drives

The VACON® AC drives can be connected to the Ethernet networks using the VACON® OPTEA Advanced Dual Port Ethernet fieldbus option board (OPTEA), or the VACON® OPTE9 Dual Port Ethernet fieldbus option board (OPTE9).

OPTEA supports all the features described in this manual. Features that are not supported by OPTE9, are marked with extra (OPTEA) on the title.

The option boards support PROFINET I/O, EtherNet/IP, Modbus TCP, and Modbus UDP fieldbus protocols. In addition, the Advanced Dual Port Ethernet board (OPTEA) supports PROFINET I/O with PROFIsafe when the OPTBL/OPTBM/OPTBN option board is also installed. OPTEA also supports advanced features such as PROFINET System Redundancy "S2".

OPTEA can be used alone as PROFINET I/O device. However, PROFIsafe always requires OPTBL/OPTBM/OPTBN option board and VACON® NXP control, too.

The drives can be daisy chained by utilizing two Ethernet ports. The following network topologies are supported. See details in Ethernet Board Installation Guide.

- Star
- Daisy chain
- Ring

Every appliance connected to an Ethernet network has two identifiers: a MAC address and an IP address. The MAC address (Address format: xx:xx:xx:xx:xx:xx) is unique for each appliance and cannot be changed. The MAC address of the Ethernet board can be found on the sticker attached to the board.

In a local network, the user can define the IP addresses as long as all the units connected to the network are given the same network portion of the address. Overlapping IP addresses cause conflicts between appliances. For more information about setting IP addresses, see 3.2.3 Configuring with VACON® NCIPConfig, 3.2.4.1 Setting the Drive Parameters with VACON® NCDrive, or 3.2.4.2 Setting the Drive Parameters with VACON® Live.

1.6.2 Fieldbus Protocols

1.6.2.1 Modbus TCP/Modbus UDP

Modbus is a communication protocol developed by Modicon systems. In simple terms, it is a way of sending information between electronic devices. The device requesting the information is called the Modbus Master (or the Client in Modbus TCP/UDP) and the devices supplying information are Modbus Slaves (in Modbus TCP/UDP servers).

In a standard Modbus network, there is one Master and up to 247 Slaves, each with a unique Slave Address from 1 to 247. The Master can also write information to the Slaves. Modbus is typically used to transmit signals from instrumentation and control devices back to the main controller or data gathering system.

The Modbus communication interface is built around messages. The format of these Modbus messages is independent of the type of physical interface used.

The same protocol can be used regardless of the connection type. Because of it, Modbus gives the possibility to upgrade easily the hardware structure of an industrial network, without the need for large changes in the software. A device can also communicate with several Modbus nodes at once, even if they are connected with different interface types. There is no need to use a different protocol for every connection.

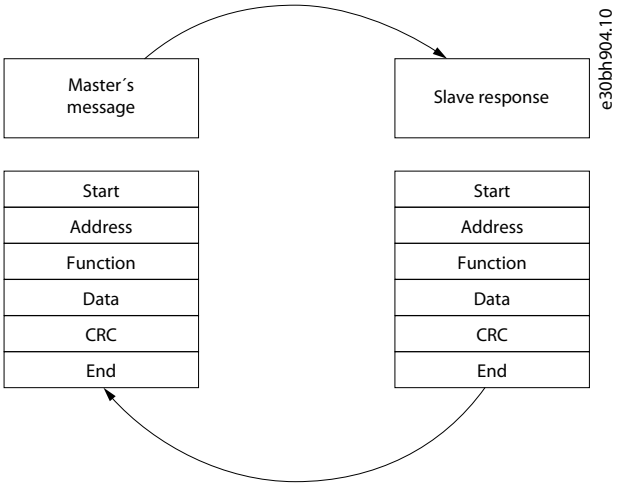


Illustration 1: Basic Structure of Modbus Frame

On simple interfaces like RS485, the Modbus messages are sent in plain form over the network. In this case, the network is dedicated to Modbus. When using more versatile network systems like TCP/IP over Ethernet, the Modbus messages are embedded in packets with the format necessary for the physical interface. In that case Modbus and other types of connections can co-exist at the same physical interface at the same time. Although the main Modbus message structure is peer-to-peer, Modbus is able to function on both point-to-point and multidrop networks.

Each Modbus message has the same structure. Four basic elements are present in each message. The sequence of these elements is the same for all messages, to make it easy to parse the content of the Modbus message. In the Modbus network, the master always starts the conversation. A Modbus master sends a message and depending on the contents of the message, a slave reacts to it. There can be more than one master in a Modbus network. Addressing in the message header is used to define which device must respond to a message. If the address field does not match their own address, all other nodes on the Modbus network ignore the message.

Modbus UDP vs TCP

In addition to TCP, the option boards also support UDP (from OPTE9 firmware version V006). We recommend using UDP when reading and writing rapidly and repetitively (cyclically) same data as with process data. Use TCP for single operations, like service data (for example, reading or writing parameter values).

The main difference between UDP and TCP is that when using TCP, the receiver must acknowledge every Modbus frame (see Illustration 2). It adds extra traffic to the network and more load to the system (PLC and drives) because software must follow sent frames to make sure that they have reached their destination.

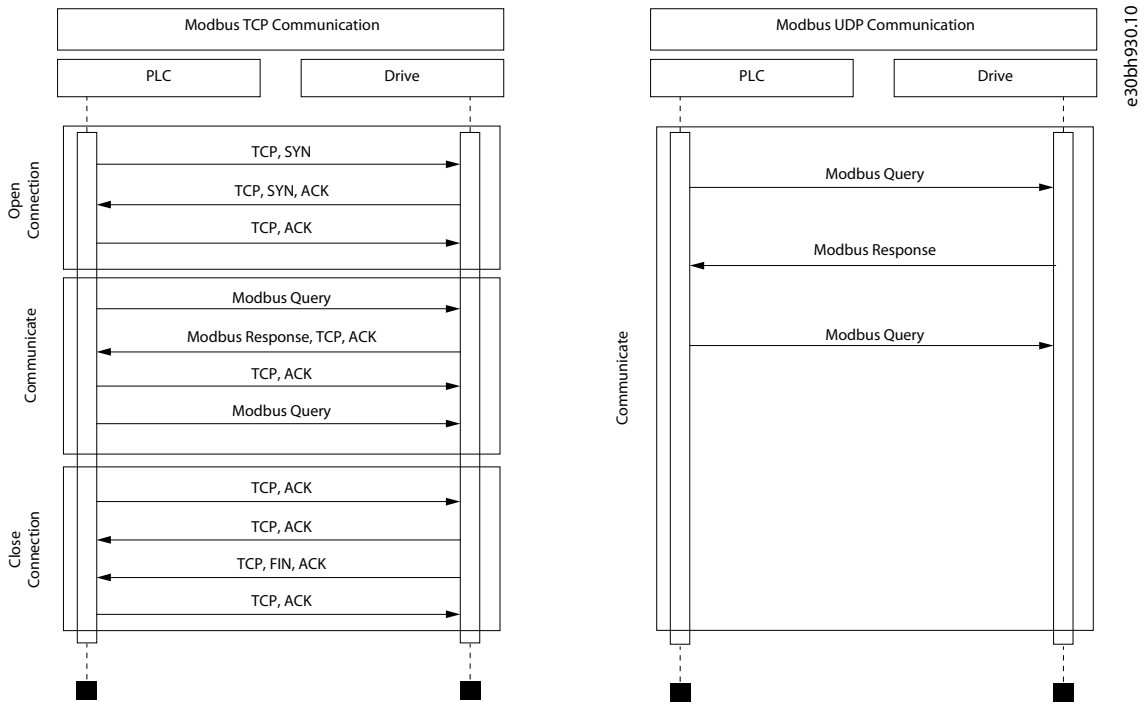


Illustration 2: Modbus TCP and UDP Communication Comparison

Another difference between TCP and UDP is that UDP is connectionless. TCP connections are always opened with TCP SYN messages and closed with TCP FIN or TCP RST. With UDP, the first packet is already a Modbus query. The option board treats IP address and port combination as a connection. If port changes, it is considered as a new connection or as a second connection if both stay active.

When using UDP, it is not guaranteed that the sent frame reaches is destination. PLC must follow the Modbus requests by using the Modbus transaction id-field. It actually must do it also when using TCP. If PLC does not receive response in time from drive in UDP connection, it must send the query again. When using TCP, the TCP/IP stack keeps resending the request until receiver has acknowledged it (see Illustration 3). If PLC sends new queries during this time, some of them can not be sent to network (by TCP/IP stack) until previous sent package(s) has been acknowledged. It can cause small packet storms when the connection is resumed between PLC and drive (See Illustration 4).

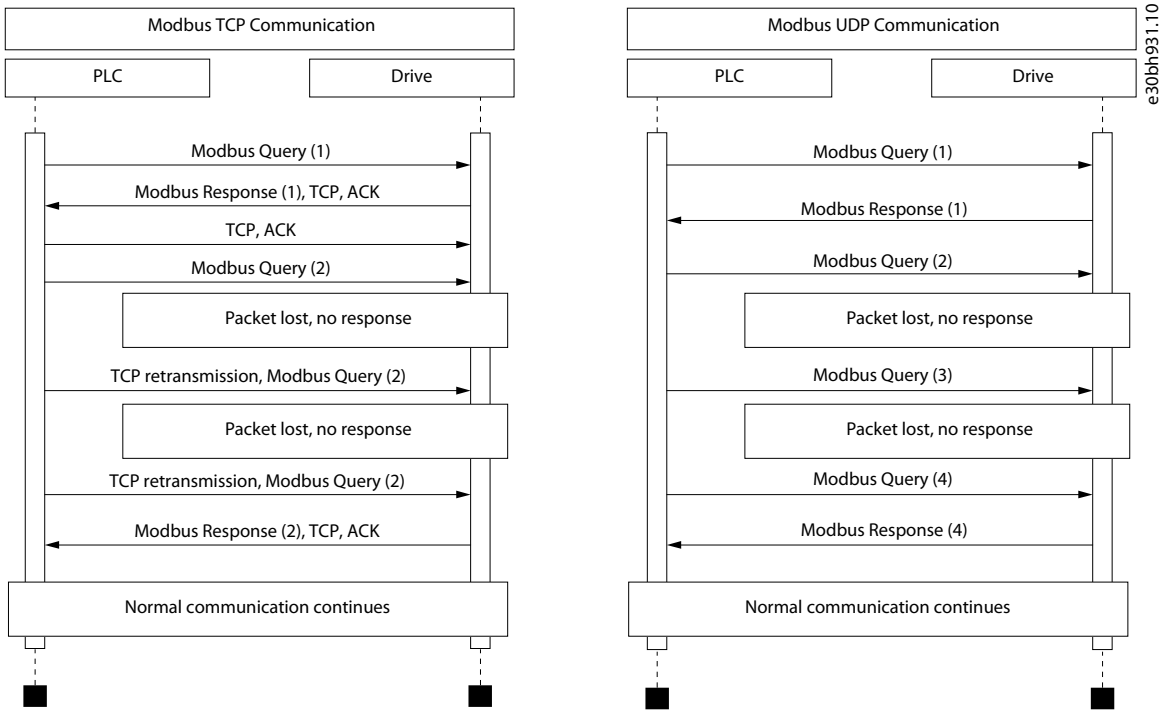


Illustration 3: Modbus TCP and UDP Communication Errors Comparison

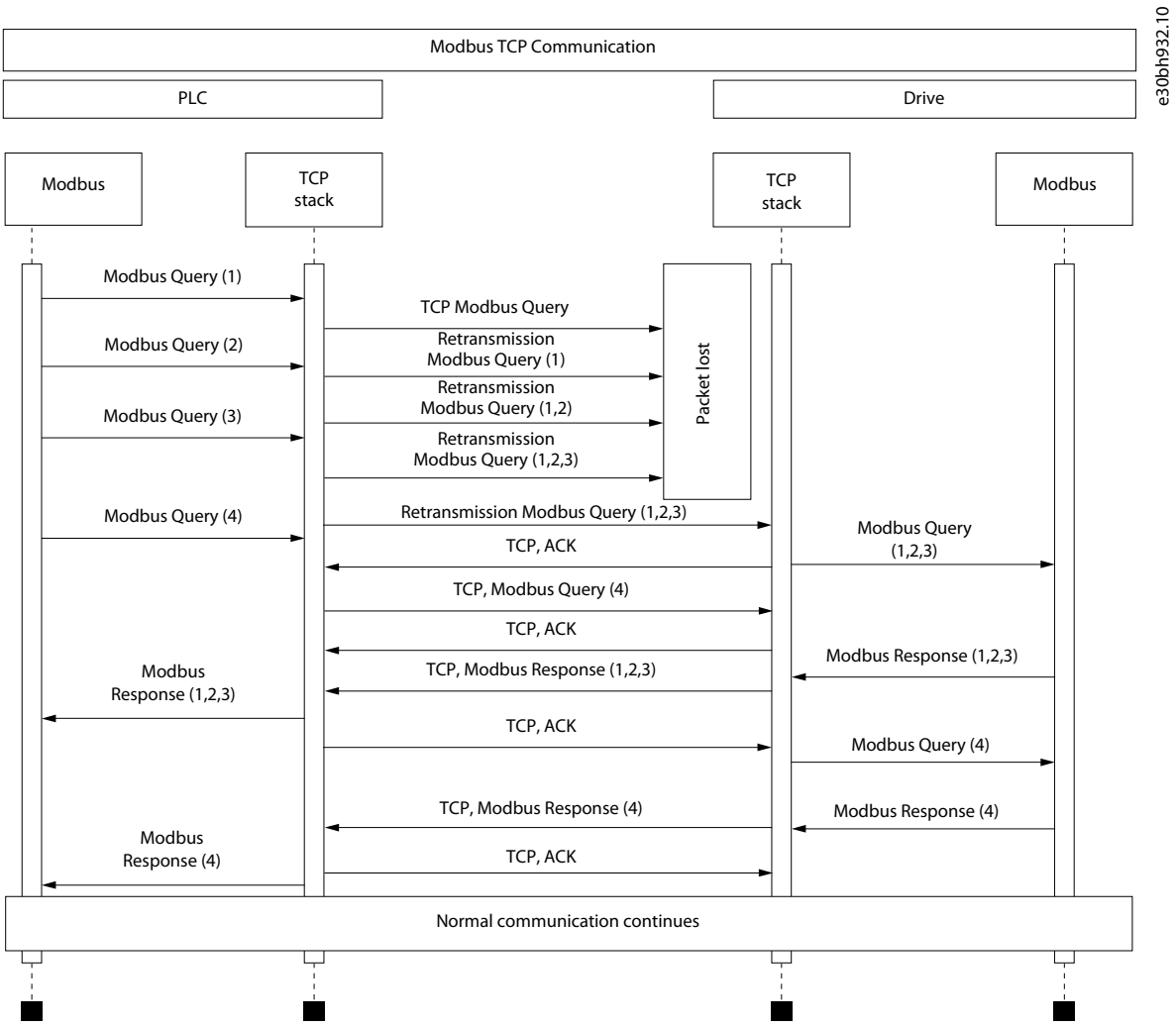


Illustration 4: Modbus TCP Retransmissions

Losing one packet is not a fatal because the same request can be sent again after timeout. In TCP, the packages always reach their destination but if network congestion causes retransmissions, those packages contain most likely old data or instructions when they reach their destination.

1.6.2.2 PROFINET I/O

PROFINET is the Ethernet-based automation standard of PROFIBUS International for the implementation of an integrated and consistent automation solution based on Industrial Ethernet. PROFINET supports the integration of simple distributed field devices and time-critical applications in (switched) Ethernet communication. It also supports the integration of component-based distributed automation systems for vertical and horizontal integration of networks.

The option boards implement the following features:

- PROFINET I/O version 2.4
- PROFINET RT
- Conformance class B (PA)
- Highest netload class (class III)
- Standard diagnosis for VACON® AC drive faults and alarms

The Advanced Dual Port Ethernet option board (OPTEA) implements also

- PROFINET system redundancy (S2)
- PROFIsafe over PROFINET
- OPTCP-emulation (OPTCx) mode when installed to VACON® NXP
- Shared Device

1.6.2.3 EtherNet/IP

The EtherNet/IP© is an industrial Ethernet network solution available for manufacturing automation. The CIP© (Common Industrial Protocol) encompasses a comprehensive suite of messages and services for various manufacturing automation applications, including control, safety, synchronization, motion, configuration, and information. The CIP provides users with a unified communication architecture throughout the manufacturing enterprise.

More information on the EtherNet/IP can be found at http://www.odva.org.

1.6.3 Redundancy Protocols

1.6.3.1 Rapid Spanning Tree Protocol (RSTP)

To use the RSTP protocol, add a managed Ethernet switch that supports the RSTP protocol. If a single link is broken, the RSTP switch notices it and start sending data from the PLC to both directions effectively creating two daisy chains. When the link has been repaired, the switch notices it, too, and reverts to normal operating mode. Compared to the star topology, the ring topology adds more network traffic to almost all drives. Damage to two cables always creates an isolated subnetwork.

In the RSTP configuration, one of the ports in the switch is "Designated Port" (DP) and the other "Alternative Port" (AP). When the network is functioning properly, the traffic flows through the designated port. Only the BPDU (Bridge Protocol Data Unit) packets are transferred through the AP port. The BPDU packets are used by the switch to determine if the network is working properly. If it detects that the BPDU packets do not go through the ring, it changes the alternative port to a second designated port. Now the switch sends packets to both directions in the broken ring (see Illustration 6).

Each designated port has a list of MAC addresses which are behind that port. Only frames directed to the device in the MAC list are forwarded into that designated port. The broadcast and multicast frames are sent to all designated ports.

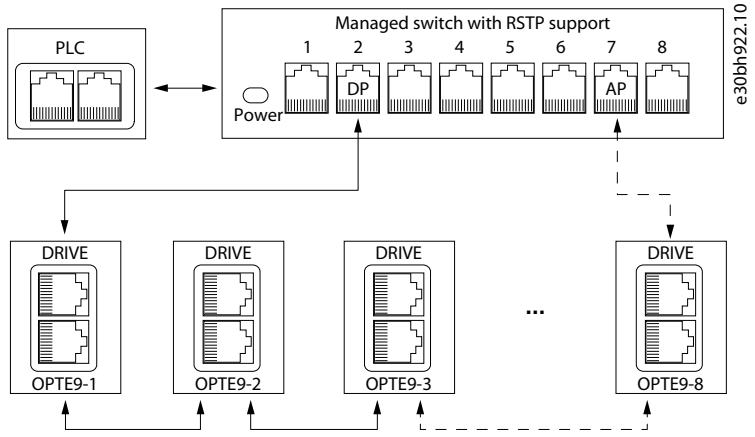


Illustration 5: Ring Topology

In the example below, the Ethernet communication is interrupted to device number 3 and other devices after that when the link is broken. The Fieldbus communication maybe faulted when the link is broken, but when the switch enables the second designated port, the connections can be reopened. In the RSTP protocol, it generally takes few seconds before the second designated port is activated. The time depends on the BPDU exchange cycle, which is 2 seconds by default.

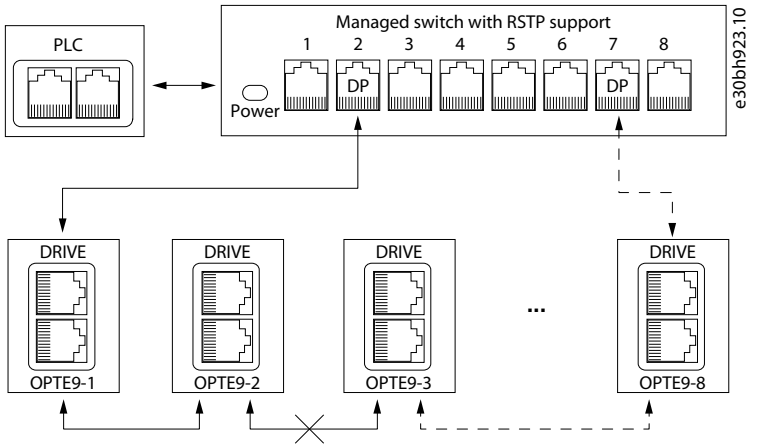


Illustration 6: Ring Topology: Error in Network

NOTE! The switch itself in Ethernet boards does not implement the RSTP protocol, so the network always needs a third party switch to support it.

NOTE! Do not use RSTP together with PROFIsafe. Recovery time in RSTP network can be several seconds, and recovery time in STP network can be several tens of seconds. To compensate the recovery time, the PROFIsafe watchdog time must be set long enough so that slow recovery time of RSTP network can be tolerated. However, for example, in Siemens TIA portal, the longest PROFIsafe watchdog time setting is 1920 ms, and it is too short for RSTP.

Configuration Example

The screenshots (Illustration 7, Illustration 8) show one example of configuring the RSTP in the switch (in this case an EtherWAN switch). Port two is the designated port and port one is the alternative port. The PLC was connected to port nine (the laptop taking the screenshots was in port 16). When configuring your switch, refer to the manual of the switch manufacturer.

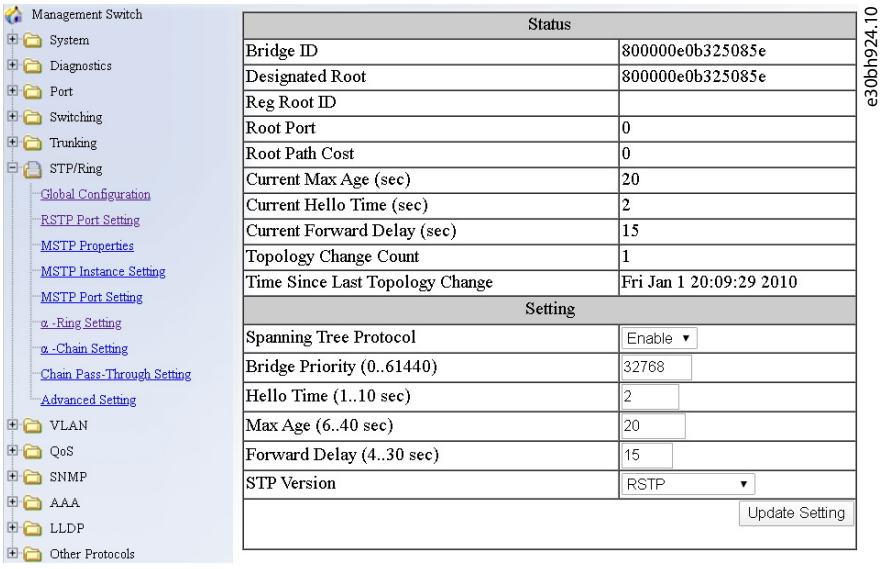
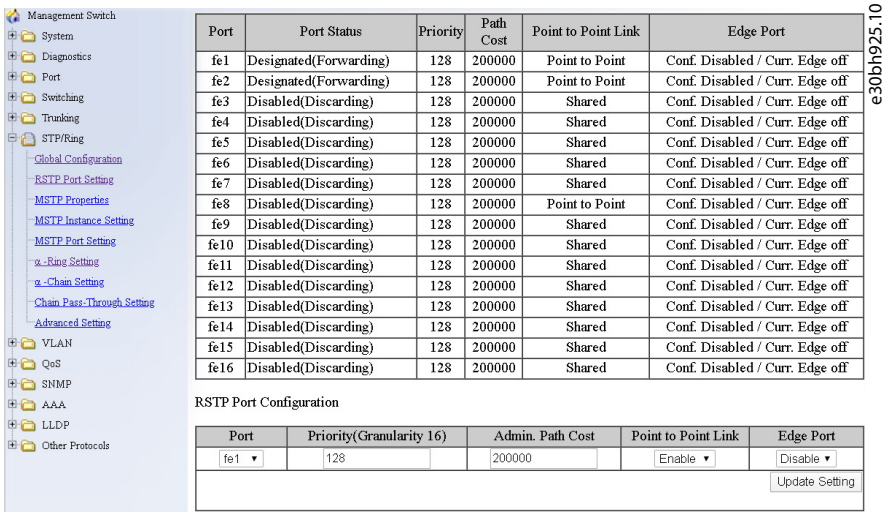


Illustration 7: EtherWAN Switch RSTP Configuration Example



Port	Port Status	Priority	Path Cost	Point to Point Link	Edge Port
fe1	Designated(Forwarding)	128	200000	Point to Point	Conf. Disabled / Curr. Edge off
fe2	Designated(Forwarding)	128	200000	Point to Point	Conf. Disabled / Curr. Edge off
fe3	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe4	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe5	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe6	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe7	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe8	Disabled(Discarding)	128	200000	Point to Point	Conf. Disabled / Curr. Edge off
fe9	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe10	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe11	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe12	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe13	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe14	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe15	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off
fe16	Disabled(Discarding)	128	200000	Shared	Conf. Disabled / Curr. Edge off

RSTP Port Configuration

Port	Priority(Granularity 16)	Admin. Path Cost	Point to Point Link	Edge Port
fe1	128	200000	Enable	Disable
				Update Setting

Illustration 8: EtherWAN Switch RSTP Configuration Example - Port Settings

1.6.3.2 Media Redundancy Protocol (MRP)

The MRP is designed to react deterministically on a cable failure. It makes it suitable to be used in process automation. One of the nodes in the network has the role of Media Redundancy Master (MRM), which observes and controls the ring topology to react to network faults. Usually this device is PLC or network switch.

Other nodes in the network are called Media Redundancy Clients (MRC), and they react on received configuration frames from the MRM and can detect link changes on its ring ports. OPTEA and OPTE9 boards support only MRC functionality.

The MRM and MRC have two ring ports, which take one of the following states:

- DISABLED - All frames are dropped
- BLOCKING - All frames are dropped, except the following frames:
  - MRP frames (for example, MRP_test and MRP_TopologyChange)
  - Frames specified to pass ports in "Discarding" state, for example, LLDP frames
- FORWARDING - All frames are forwarded according to normal behavior

The MRM sends MRP_Test frames in a configured time period to monitor the state of the ring topology. If the MRM receives its own MRP_Test frames (network is closed), one of the ring ports is set to FORWARDING state and the other to BLOCKED state (see Illustration 9). If the MRM does not receive the MRP_Test frames (network is open), it sets both of its ring ports to FORWARDING state (see Illustration 10).

The following figure shows an example of an MRP network, where the PLC acts as an MRM. The dotted line shows Blocked connection.

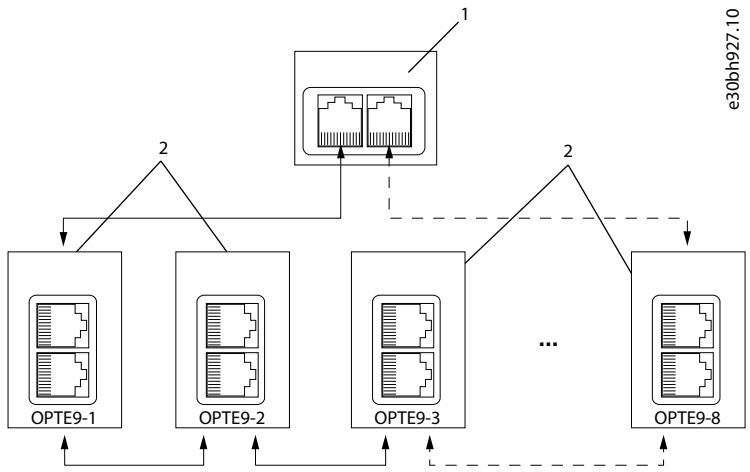


Illustration 9: MRP Ring: Closed Network

1	PLC/MRM
2	Drive/MRC

In the example below, the Ethernet communication is interrupted to device number 3 and other devices after that when the link is broken.

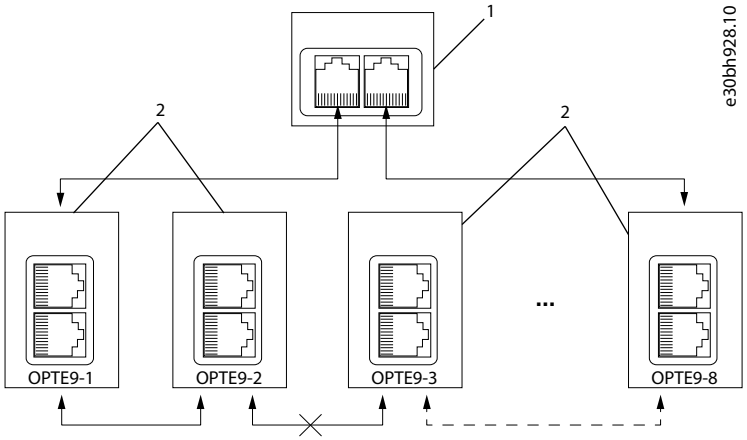


Illustration 10: MRP Ring: Error in Network

1	PLC/MRM
2	Drive/MRC

NOTE! MRP (as MRC) can only be used when PROFINET is the selected protocol. MRP is available in all versions of OPTEA board and in OPTE9 since V006 firmware.

MRP Recovery Times and Fast MRP

MRP can be configured to send test frames with different time periods, depending on the maximum allowed recovery time for the network. These times are set as the guaranteed time for a network of 50 nodes to recover from a ring error.

Typically, in PROFINET systems the recovery time is defined as 200 ms. However, the MRP specification allows for recovery times of 500, 200, 30, and 10 ms. OPTEA and OPTE9 boards can be used in systems with the lowest recovery time of 10 ms. It is often called “Fast MRP”.

When using MRP in a PROFINET network, the recommendation is to set the watchdog time of each device in the ring to the maximum recovery time, usually 200 ms. It guarantees that a cable failure does not interrupt the fieldbus connection.

1.6.3.3 Device Level Ring (DLR)

Device Level Ring (DLR) protocol provides a way to detect, manage, and recover from faults in a ring-based network. It supports a single-ring topology. Multiple or overlapping rings are not supported. Other features include "Sign on process" used to identify all ring participants, and "Neighbor check process" which allows nodes to check the health of their adjacent nodes.

One device acts as a ring supervisor, monitoring the state of the ring while other devices act as DLR nodes. Only one device can act as an active supervisor, although back-up supervisors are possible. Nodes can be divided into Beacon- and Announce-based nodes depending on which frames the nodes process. OPTEA and OPTE9 boards support Announce-based functionality.

DLR nodes have three states:

- IDLE_STATE: indicating linear topology for non-supervisor nodes
- FAULT_STATE: initial state for enabled ring supervisor, or when ring fault has been detected
- NORMAL_STATE: normal function in ring topology mode

The active ring supervisor sends Beacon frames from both its ring ports once per beacon interval (400 µs by default) to monitor the state of the ring. It also sends an Announce frame once per s. If the Beacon frames are received back at the supervisor, one of its ports is set to blocking and the other to forwarding state (Illustration 11). Only the following packets are processed from the blocked port:

- Beacon frames from self and other supervisors
- Link_Status/Neighbor_Status frames
- Neighbor_Check request or response and Sign_On frames

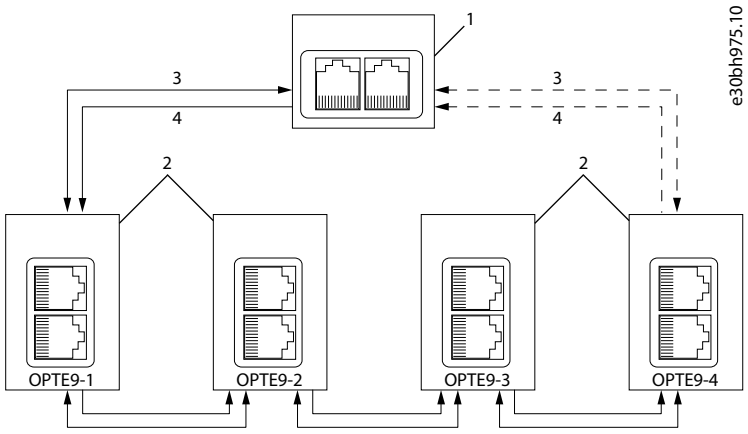


Illustration 11: DLR Ring: Network Configuration when Ring is Closed (NORMAL_STATE)

1	Ring Supervisor	3	Beacon
2	DLR Node	4	Announce

If a network error occurs to DLR-capable nodes, the nodes send Link_Status frames to inform the ring supervisor immediately which port(s) have a failure (Illustration 12).

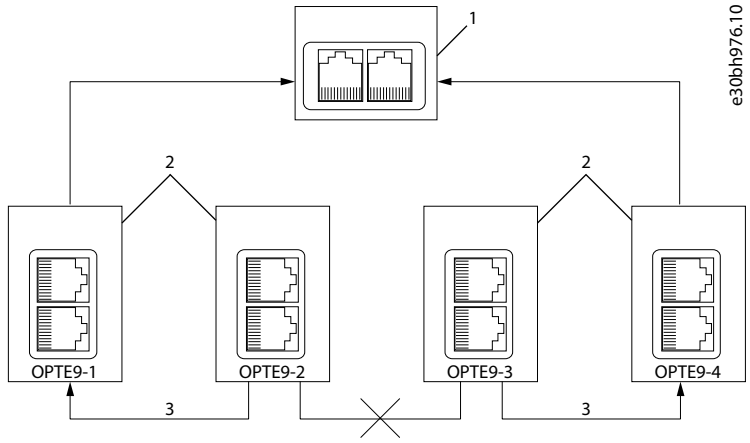


Illustration 12: DLR Ring: Failure in Network

1	Active Ring Supervisor	3	Link Status
2	DLR Node		

A Link_Status frame triggers an error response in active ring supervisor, which unblocks traffic on its previously blocked port (Illustration 13). If there is an uncommon failure (for example, if a cable breaks between two non-DLR capable devices), the error is noticed from Beacon timeout value, and not from Link_Status frames. Therefore, a recovery in a network with non-DLR capable devices can take longer.

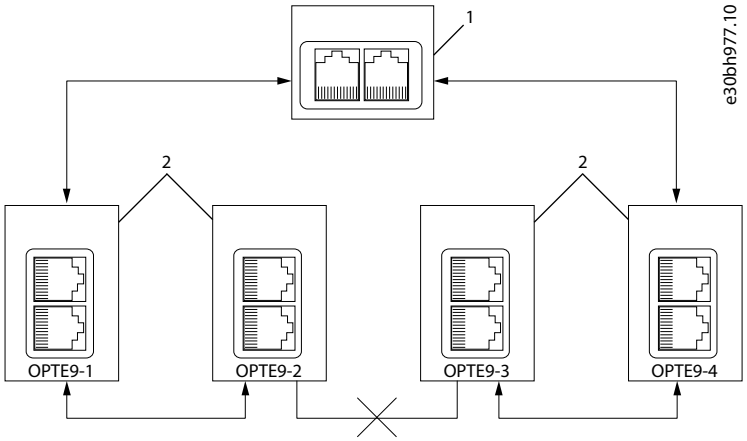


Illustration 13: DLR Ring: Network Configuration after Failure (FAULT_STATE)

1	Active Ring Supervisor
2	DLR Node

The ring recovers after Beacon frames again are received from both of the active ring supervisors ring ports. Ring recovers back to its original state (Illustration 11).

NOTE! DLR is active only when EtherNet/IP is the selected protocol. DLR is available since V002 firmware for OPTEA and since V009 firmware for OPTE9 board.

DLR Recovery Times

DLR allows setting of the beacon interval and the beacon timeout values, with lower beacon interval providing faster ring recovery performance. With default values (400 µs interval and 1960 µs timeout), DLR can reach much faster ring recovery times than, for example, Media Redundancy Protocol. Typically, these times are around 3 ms for Beacon-based and 4 ms for Announce-based nodes.

When using DLR, we recommend that the watchdog time is set to a value greater than 4 ms. It ensures that a properly configured ring network recovers from a network failure within the watchdog time.

1.6.3.4 PROFINET System Redundancy (OPTEA)

Redundancy is a requirement in process automation systems for high availability and reduced production downtimes. PROFINET System Redundancy provides a solution to build a system with redundant PN controllers, devices, and communication.

PROFINET System Redundancy fulfills among others the following requirements:

- Highly reliable communication
- Short take over time
- Bumpless I/O data during fault recovery
- Monitoring of the back-up connection

System redundancy implements two redundant PN controllers, one working as primary and other as back-up. These controllers can be connected via a redundant network to PN devices. It is, however, not mandatory as system redundancy has different levels which are independent from each other. Thus, PN controller, Ethernet media, and PN device can have different redundancy configurations.

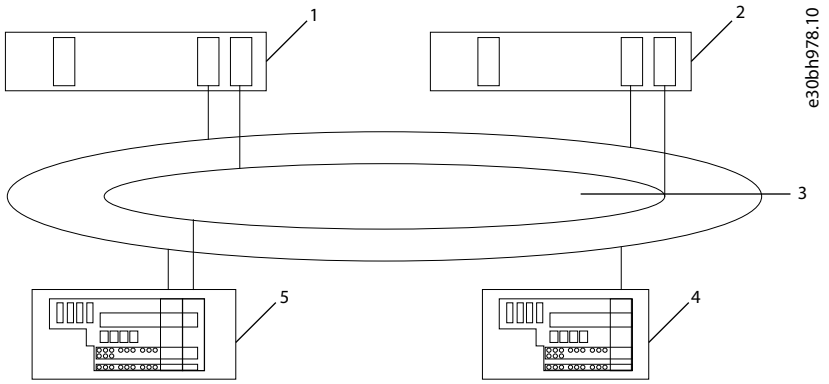


Illustration 14: System Redundancy Overview

1	Primary	4	Device with redundant connectivity
2	Back-up	5	Device with singular connectivity
3	Redundant network		

OPTEA supports "S2" level of System Redundancy and Media Redundancy Protocol (MRP) for redundant connectivity.

S2 uses a single PROFINET interface (NAP = Network Access Point), and two SR-ARs (System Redundancy Application Relations = connections), one to each PN controller. Redundant PN controllers have parallel access to an SR PN device, but only one AR acts as a primary (SR-ARa) and the other is back-up (SR-ARb).

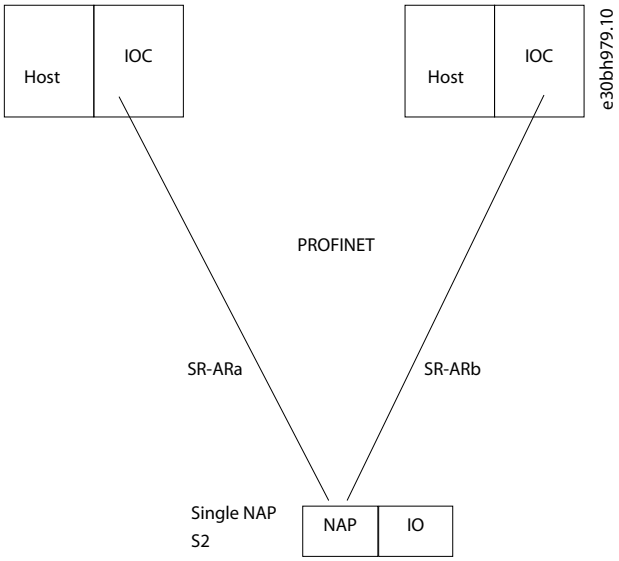


Illustration 15: NAP S2, Connected to 2 IOCs

In case the primary AR fails, the IOC initiates a switch for the back-up SR-AR to become primary. This switchover cannot take longer than the Redundancy Data Hold Time (RDHT) configured by the IOC. During the transition, the input data is hold and the output data frozen to ensure a bumpless transition. OPTEA does not create a fault during this time when a back-up connection is available. A fault is created after this time elapses and no Primary is available.

NOTE! System Redundancy is available in OPTEA version V002 or later and requires the use of GSDML file dated 21.06.2018 or later.

1.6.4 PROFINET Shared Device (OPTEA)

OPTEA supports Shared Device feature where multiple PLCs can connect to same device. PLC A can connect to PROFIdrive module and PLC B can connect to PROFIsafe module. It is also possible to have System Redundancy connections (two PLCs) and PROFIsafe from third PLC at the same time.

This kind of setup generates up to three times more Ethernet traffic than connecting with single PLC, so consider the cycle times and number of devices in the system. Connections to multiple PROFIdrive or PROFIsafe modules are not supported.

Shared device feature also enables adding of PROFIsafe to existing systems. Notice that PROFIsafe has its own configuration requirements (see 4.5 PROFIsafe (OPTEA)).

1.6.5 Address Conflict Detection (ACD)

The OPTEA and OPTE9 option boards implement ACD algorithm (IETF RFC 5227). The implementation includes requirements from the EtherNet/IP protocol.

The ACD algorithm tries to detect actively if another device is using the IP address in the same network. The ACD sends 4 ARP request packets when the Ethernet interface of the device activates, or when its IP address changes.

ACD prevents the use of the Ethernet interface until the ARP probing finishes. This delays the start-up of fieldbus protocols about 1 s. During the delay or after it, the ACD passively checks incoming ARP messages for use of the IP address of the device.

If another device with the same IP address is detected, the ACD tries to defend its IP address with a single ARP message. If the other device with the same IP address also supports ACD, it must stop using the address. If it does not, the ACD closes the Ethernet connection and indicates the situation with LEDs. This is done according the "DefendWithPolicyB". Other policies are not supported.

If the fieldbus protocol has been active, it can activate a fieldbus fault (depends on the fieldbus and drive application configuration).

1.6.6 Technical Data

Table 2: OPTEA/OPTE9 Option Board Technical Data

Technical item or function		Technical data
General	Board name	OPTEA/OPTE9
Ethernet connections	Interface	Two RJ-45 connectors
	Transfer cable	Shielded Twisted Pair (STP) CAT5e[1]
Communications	Speed	10 / 100 Mb
	Duplex	half / full
	Default IP-address	By default the board is in DHCP mode.
Protocol	Modbus TCP, Modbus UDP, Profinet I/O, EtherNet/IP	
Environment	Ambient operating temperature	-10°C…50° C
	Storing temperature	-40°C…70° C
	Humidity	<95%, no condensation allowed
	Altitude	Maximum 1000 m
	Vibration	0.5 G at 9…200 Hz
Safety	Fulfills EN 50178 standard	

[1] For connecting the fieldbus Ethernet boards, use only Ethernet cables that meet at least the requirements of category 5 (CAT5) according to EN 50173 or ISO/IEC 11801.

1.6.7 VACON® PC Tools

With VACON® PC tools, it is possible to do following operations for OPTEA/OPTE9 Ethernet board:

- Update firmware into OPTEA/OPTE9 board (with VACON® Loader), see 3.2.1 Updating Fieldbus Firmware with VACON® Loader
- Set parameters for OPTEA/OPTE9 Ethernet board (with VACON® NCDrive or VACON® Live), see 3.2.4.1 Setting the Drive Parameters with VACON® NCDrive and 3.2.4.2 Setting the Drive Parameters with VACON® Live
- Read monitor values of OPTEA/OPTE9 Ethernet board (with VACON® NCDrive or VACON® Live)

For instructions on downloading and installing the tools, see 3.1.1 Installing VACON® PC Tools.

The following table describes what PC tools are supported in each AC drive type.

Table 3: The Supported PC Tools with Different AC Drives

Tool	VACON® 100 family	VACON® NXS/NXP	VACON® 20 family
VACON® Loader	Serial[1]	Serial[1]	Serial[1]
VACON® Live	Serial[1], Ethernet[2]	-	Serial[1]
VACON® NCIPConfig	Ethernet[2]	Ethernet[2]	Ethernet[2]
VACON® NCDrive	-	Ethernet[2]	-
VACON® NCLoad	Not supported; use VACON® Loader.		

[1] The connection type "serial" is a direct serial connection to the AC drive.

[2] The connection type "Ethernet" is an Ethernet connection, for example, VACON® 100 family built-in Ethernet interface, or a connection via OPTEA/OPTE9 Dual Port Ethernet option board.

1.7 AC Drive Support

1.7.1 VACON® OPTEA Advanced Dual Port Ethernet Drive Support

The VACON® OPTEA Advanced Dual Port Ethernet option board can be used with the following VACON® AC drives. Option board can be used for PROFINET with PROFIsafe communication in slot E, when OPTBL/OPTBM/OPTBN is installed to slot D. If PROFIsafe is not used, then OPTEA can be installed to slot D too.

Table 4: OPTEA-supported AC Drives and Slots

AC drive	Slots	From AC drive software version on	From OPTEA software version on
VACON® NXP	D, E	NXP00002V196	V001
VACON® NXS	D, E	NXS00002V184	V003
VACON® 100 INDUSTRIAL and 100 X	D, E	FW0072V028	V002
VACON® 100 FLOW	D, E	FW0159V018	V002

VACON® 100 Family Support

The VACON® 100 family AC drives are supported from the OPTEA firmware version V002. The process data in VACON® 100 family AC drives is 32 bit. PROFIsafe features are supported only in VACON® NXP drives.

EtherNet/IP and Modbus TCP/UDP Support

Support for EtherNet/IP, Modbus TCP/UDP, and other features which were in OPTE9, were added to OPTEA firmware V002. Table below shows required minimum AC drive firmware version.

Table 5: Required Minimum AC Drive Firmware Versions

AC Drive	From AC drive software version on
VACON® NXP	NXP00002V197
VACON® 100 INDUSTRIAL and 100 X	FW0072V028
VACON® 100 FLOW	FW0159V018

1.7.2 VACON® OPTE9 Dual Port Ethernet Drive Support

The VACON® OPTE9 Dual Port Ethernet option board can be used with the following VACON® AC drives.

Table 6: OPTE9-supported AC Drives and Slots

AC drive	Slots	From AC drive software version on	From OPTE9 software version on
VACON® NXP	D, E	NXP00002V188	V001
VACON® NXS	D, E	NXS00002V179	V001
VACON® 100 INDUSTRIAL and 100 X	D, E	FW0072V018	V003
VACON® 100 FLOW	D, E	FW0159V012	V003
VACON® 20	-	FW0107V011	V002
VACON® 20 X and CP	-	FW0117V007	V002

VACON® 100 Family Support

The VACON® 100 family AC drives are supported from the OPTE9 firmware version V003. The process data in VACON® 100 family AC drives is 32 bit.

EtherNet/IP and Modbus TCP/UDP Support

EtherNet/IP protocol was added to OPTE9 firmware version V004. The following table shows required minimum AC drive firmware version.

Table 7: Required Minimum AC Drive Firmware Versions

AC Drive	From AC drive SW version on
VACON® NXP	NXP00002V191
VACON® NXS	NXS00002V181
VACON® 100 INDUSTRIAL and 100 X	FW0072V018
VACON® 100 FLOW	FW0159V012
VACON® 20	FW0107V012
VACON® 20 X and CP	FW0117V009

1.8 Symbols and Abbreviations

Table 8: Symbols and Abbreviations

Abbreviation	Definition
ACD	Address Conflict Detection
ARP	Address Resolution Protocol
CIP	Common Industrial Protocol
CRC	Cyclic Redundancy Check is an error-detecting code commonly used in fieldbusses to detect accidental changes to raw data.
CW	Control word
DCP	Discovery and Basic Configuration Protocol
DHCP	Dynamic Host Configuration Protocol is used for dynamical resolving of network configuration parameters like an IP address.
DLR	Device Level Ring
DU	Data unit
EDD	Electronic Device Description

Abbreviation	Definition
EDS	Electronic Data Sheet
EMC	Electromagnetic compatibility
FB	Fieldbus
FD	Full Duplex
GSDML	General Station Description Markup Language
GW	Gateway
HD	Half Duplex
HI	Upper 8/16 bits in a 16/32-bit value.
LED	Light emitting diode
LLDP	Link Layer Discovery Protocol
LO	Lower 8/16 bits in a 16/32-bit value.
MIB	Management Information Base
Modbus TCP / Modbus UDP	Simple and vendor-neutral communication protocol intended for monitoring and controlling of field devices.
MRC	Media Ring Client
MRM	Media Ring Master
MRP	Media Ring Protocol
NSOLL	Sollwert (German for reference value)
NIST	Istwert (German for actual value)
PC	Personal computer
PDI	Process Data In
PDO	Process Data Out
PHY(X)	Ethernet physical interface X, where X shows the number of interfaces
PLC	Programmable logic controller
PNU	Parameter number
PPO	Process parameter object
PROFINET I/O	PROFINET is a standard for industrial automation in Ethernet network. PROFINET I/O describes the exchange of data between controllers and field devices.
RDHT	Redundancy Data Hold Time
RPM	Revolutions per minute
RSTP	Rapid Spanning Tree Protocol
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol

Abbreviation	Definition
STW1	Steuerwort 1 (German for control word 1)
SW	Status word
TCP	Transmission Control Layer provides reliable, ordered, and error-checked delivery of data streams between computers that are connected to a local area network.
UTC	Coordinated Universal Time
ZSW1	Zustandwort 1 (German for status word 1)

Table 9: Data Types

Type name	Bit size	Explanation
INT8	8	Signed short integer
UINT8	8	Unsigned short integer
INT16	16	Signed integer
UINT16	16	Unsigned integer
INT32	32	Signed long integer
UINT32	32	Unsigned long integer
FLOAT32	32	32-bit floating point
STRING3	24	3 byte string
STRING5	40	5 byte string

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

⚠ D A N G E R ⚠

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G ⚠

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N ⚠

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

N O T I C E

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Danger and Warnings

⚠ D A N G E R ⚠

SHOCK HAZARD FROM POWER UNIT COMPONENTS

The power unit components are live when the drive is connected to mains. A contact with this voltage can lead to death or serious injury.

- Do not touch the components of the power unit when the drive is connected to mains. Before connecting the drive to mains, make sure that the covers of the drive are closed.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM TERMINALS

The motor terminals U, V, W, the brake resistor terminals, or the DC terminals are live when the drive is connected to mains, also when the motor does not operate. A contact with this voltage can lead to death or serious injury.

- Do not touch the motor terminals U, V, W, the brake resistor terminals, or the DC terminals when the drive is connected to mains. Before connecting the drive to mains, make sure that the covers of the drive are closed.

⚠ D A N G E R ⚠

SHOCK HAZARD FROM DC LINK OR EXTERNAL SOURCE

The terminal connections and the components of the drive can be live 5 minutes after the drive is disconnected from the mains and the motor has stopped. Also the load side of the drive can generate voltage. A contact with this voltage can lead to death or serious injury.

- Before doing electrical work on the drive:
  Disconnect the drive from the mains and make sure that the motor has stopped.
  Lock out and tag out the power source to the drive.
  Make sure that no external source generates unintended voltage during work.
  Wait 5 minutes before opening the cabinet door or the cover of the AC drive.
  Use a measuring device to make sure that there is no voltage.

⚠ WARNING ⚠

SHOCK HAZARD FROM CONTROL TERMINALS

The control terminals can have a dangerous voltage also when the drive is disconnected from mains. A contact with this voltage can lead to injury.

- Make sure that there is no voltage in the control terminals before touching the control terminals.

⚠ WARNING ⚠

ACCIDENTAL MOTOR START

When there is a power-up, a power break, or a fault reset, the motor starts immediately if the start signal is active, unless the pulse control for Start/Stop logic is selected. If the parameters, the applications or the software change, the I/O functions (including the start inputs) can change. If you activate the auto reset function, the motor starts automatically after an automatic fault reset. See the Application Guide. Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage.

- Disconnect the motor from the drive if an accidental start can be dangerous. Make sure that the equipment is safe to operate under any condition.

⚠ WARNING ⚠

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the drive properly can result in death or serious injury.

- Ensure the correct grounding of the equipment by a certified electrical installer.

⚠ WARNING ⚠

SHOCK HAZARD FROM PE CONDUCTOR

The drive can cause a DC current in the PE conductor. Failure to use a residual current-operated protective (RCD) device Type B or a residual current-operated monitoring (RCM) device can lead to the RCD not providing the intended protection and therefore can result in death or serious injury.

- Use a type B RCD or RCM device on the mains side of the drive.

2.3 Cautions and Notices

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM INCORRECT MEASUREMENTS

Doing measurements on the AC drive when it is connected to mains can damage the drive.

- Do not do measurements when the AC drive is connected to mains.

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM INCORRECT SPARE PARTS

Using spare parts that are not from the manufacturer can damage the drive.

- Do not use spare parts that are not from the manufacturer.

⚠ CAUTION ⚠

DAMAGE TO THE AC DRIVE FROM INSUFFICIENT GROUNDING

Not using a grounding conductor can damage the drive.

- Make sure that the AC drive is always grounded with a grounding conductor that is connected to the grounding terminal that is identified with the PE symbol.

⚠ C A U T I O N ⚠

CUT HAZARD FROM SHARP EDGES

There can be sharp edges in the AC drive that can cause cuts.

- Wear protective gloves when mounting, cabling, or doing maintenance operations.

⚠ C A U T I O N ⚠

BURN HAZARD FROM HOT SURFACES

Touching surfaces, which are marked with the 'hot surface' sticker, can result in injury.

- Do not touch surfaces which are marked with the 'hot surface' sticker.

N O T I C E

DAMAGE TO THE AC DRIVE FROM STATIC VOLTAGE

Some of the electronic components inside the AC drive are sensitive to ESD. Static voltage can damage the components.

- Remember to use ESD protection always when working with electronic components of the AC drive. Do not touch the components on the circuit boards without proper ESD protection.

N O T I C E

DAMAGE TO THE AC DRIVE FROM MOVEMENT

Movement after installation can damage the drive.

- Do not move the AC drive during operation. Use a fixed installation to prevent damage to the drive.

N O T I C E

DAMAGE TO THE AC DRIVE FROM INCORRECT EMC LEVEL

The EMC level requirements for the AC drive depend on the installation environment. An incorrect EMC level can damage the drive.

- Before connecting the AC drive to the mains, make sure that the EMC level of the AC drive is correct for the mains.

N O T I C E

RADIO INTERFERENCE

In a residential environment, this product can cause radio interference.

- Take supplementary mitigation measures.

N O T I C E

MAINS DISCONNECTION DEVICE

If the AC drive is used as a part of a machine, the machine manufacturer must supply a mains disconnection device (refer to EN 60204-1).

N O T I C E

MALFUNCTION OF FAULT CURRENT PROTECTIVE SWITCHES

Because there are high capacitive currents in the AC drive, it is possible that the fault current protective switches do not operate correctly.

N O T I C E

VOLTAGE WITHSTAND TESTS

Doing voltage withstand tests can damage the drive.

- Do not do voltage withstand tests on the AC drive. The manufacturer has already done the tests.

2.4 Grounding

Ground the AC drive in accordance with applicable standards and directives.

⚠ C A U T I O N ⚠

DAMAGE TO THE AC DRIVE FROM INSUFFICIENT GROUNDING

Not using a grounding conductor can damage the drive.

- Make sure that the AC drive is always grounded with a grounding conductor that is connected to the grounding terminal that is identified with the PE symbol.

⚠ W A R N I N G ⚠

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the drive properly can result in death or serious injury.

- Ensure the correct grounding of the equipment by a certified electrical installer.

The standard EN 61800-5-1 tells that 1 or more of these conditions for the protective circuit must be true.

The connection must be fixed.

- The protective earthing conductor must have a cross-sectional area of minimum 10 mm^2 Cu or 16 mm^2 Al. OR
- There must be an automatic disconnection of the mains, if the protective earthing conductor breaks. OR
- There must be a terminal for a second protective earthing conductor in the same cross-sectional area as the first protective earthing conductor.

Cross-sectional area of the phase conductors (S) [mm^2]	The minimum cross-sectional area of the protective earthing conductor in question [mm^2]
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S$	S/2

The values of the table are valid only if the protective earthing conductor is made of the same metal as the phase conductors. If this is not so, the cross-sectional area of the protective earthing conductor must be determined in a manner that produces a conductance equivalent to that which results from the application of this table.

The cross-sectional area of each protective earthing conductor that is not a part of the mains cable or the cable enclosure, must be a minimum of:

- 2.5 mm^2 if there is mechanical protection, and
- 4 mm^2 if there is not mechanical protection. With cord-connected equipment, make sure that the protective earthing conductor in the cord is the last conductor to be interrupted, if the strain-relief mechanism breaks.

Obey the local regulations on the minimum size of the protective earthing conductor.

N O T I C E

MALFUNCTION OF FAULT CURRENT PROTECTIVE SWITCHES

Because there are high capacitive currents in the AC drive, it is possible that the fault current protective switches do not operate correctly.

N O T I C E

VOLTAGE WITHSTAND TESTS

Doing voltage withstand tests can damage the drive.

- Do not do voltage withstand tests on the AC drive. The manufacturer has already done the tests.

⚠ W A R N I N G ⚠

SHOCK HAZARD FROM PE CONDUCTOR

The drive can cause a DC current in the PE conductor. Failure to use a residual current-operated protective (RCD) device Type B or a residual current-operated monitoring (RCM) device can lead to the RCD not providing the intended protection and therefore can result in death or serious injury.

- Use a type B RCD or RCM device on the mains side of the drive.

3 Commissioning

3.1 Before Commissioning

VACON® OPTEA/OPTE9 Ethernet can be commissioned through the control panel of the AC drive or by using the VACON® PC tools.

Before starting the commissioning, check the following:

- When using the control panel of the AC drive for commissioning: for instructions on how to use the control panel, see the Operating Guide for VACON® NXP products or the Application Guide for the VACON® 100 family.
- When using VACON® PC tool for commissioning: the correct tool installed.
  - For a list of supported PC tools, see 1.6.7 VACON® PC Tools.
  - For instructions on installing the tools, see 3.1.1 Installing VACON® PC Tools.
- VACON® AC drive in which OPTEA/OPTE9 Ethernet option board installed. See Ethernet Boards Installation Guide for instructions.
- The IP addresses of the Ethernet option board are set according to the network. By default, the option board uses a DHCP Server to get an IP address. If your network does not have a DHCP Server, set an IP address manually and change the "IP Mode" to "static". See instructions in 3.2.3 Configuring with VACON® NCIPConfig.

  For more information about IP addresses or a DHCP Server, contact your network administrator.
- Ethernet cable is connected to the Ethernet interface of the option board.

  The PC can also be connected directly to the device using a crossover cable. This option can be needed if your PC does not support Automatic crossover function.

  With VACON® 100 family AC drive, Ethernet cable can also be connected to the Ethernet port of the control board. The instructions are the same for both connections. Another option is to use the serial cable converter and the panel connector for commissioning.

3.1.1 Installing VACON® PC Tools

Prepare for commissioning by installing the needed VACON® PC Tools.

Procedure

1. Go to www.danfoss.com/.
2. Select *Downloads* from *Service and Support* drop-down menu.
3. Select Drives as business unit.
4. Download the VACON® PC tool depending on the used AC drive.

   - VACON® 100 family AC drive: VACON® Loader and VACON® Live
   - VACON® 20 AC drive: VACON® Loader and VACON® Live
   - VACON® NXP AC drive: VACON® NCDrive and VACON® Loader
5. Start the installation program and follow the on-screen instructions.
6. After installation, launch VACON® PC tool from Windows Start menu.
7. For more information about software features, go to *Help* drop-down menu and select *Contents*.

3.1.2 Downloading Fieldbus Option Firmware

Prepare for commissioning by downloading the Fieldbus Option Firmware.

Procedure

1. Go to www.danfoss.com/.
2. Select Downloads from Service and Support drop-down menu.
3. Select Drives as business unit.
4. Download file Fieldbus firmware.

3.1.3 Downloading Function Blocks for PLC

Danfoss provides samples of function blocks and add-on-instructions to support commissioning of drive fieldbus interfaces. They are published with source code.

Procedure

1. Go to www.danfoss.com/.
2. Select Downloads from Service and Support drop-down menu.
3. Select Drives as business unit.
4. Select Fieldbus configuration files for VLT® and VACON® drives.
5. Download file VACON® TIA Portal Function Blocks, VACON® TIA PORTAL PROFIsafe Funct. Block, or VACON® OPTE9/EA EtherNet/IP AOI.

3.2 Commissioning with VACON® PC tools

3.2.1 Updating Fieldbus Firmware with VACON® Loader

Use these instructions to upload the fieldbus firmware with VACON® Loader.

NOTE! Screenshots in these instructions are examples only. The product information shown in them is different depending on which option board is used.

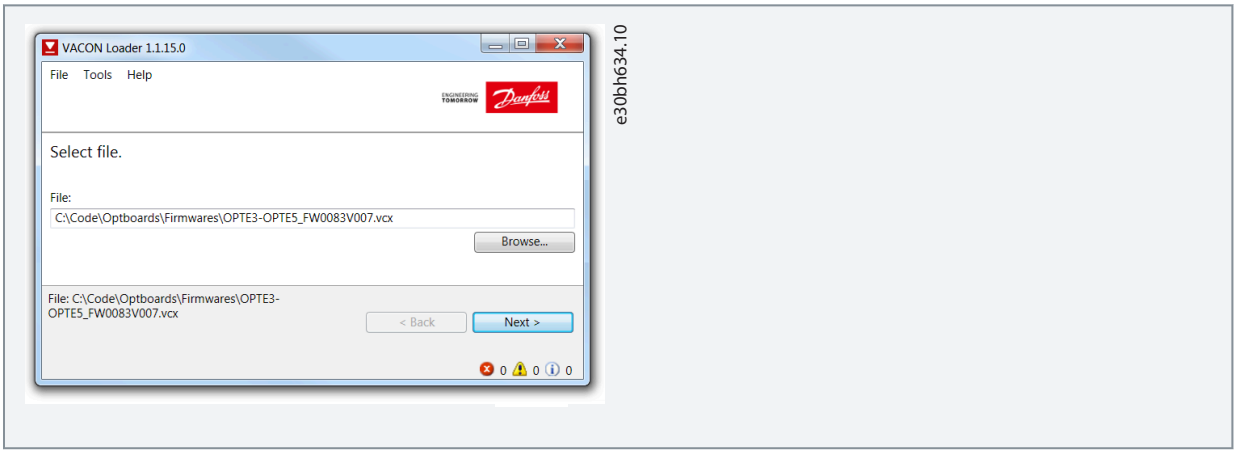
Check the list in Before commissioning.

Adjust the baud rate if needed:

- With VACON® 20, use the baud rate 9600.
- With VACON® 20 X and VACON® 20 CP, the following baud rates are supported: 9600, 19200, 38400 or 57600.
- With VACON® 100 family and VACON® NXP drives, VACON® Loader selects a correct baud rate automatically.

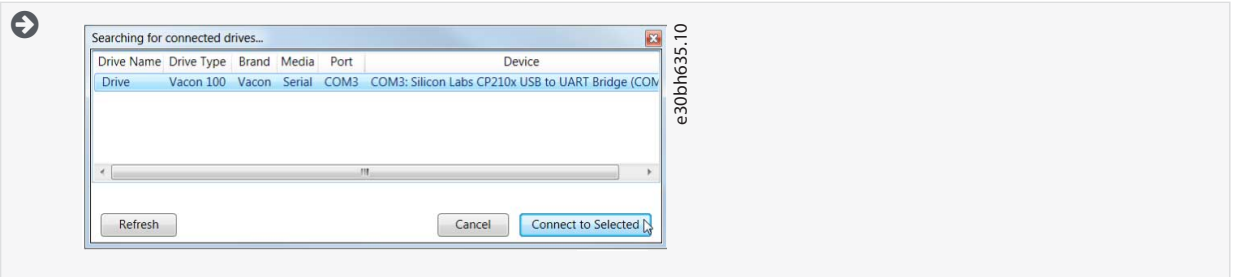
Procedure

1. Connect your PC to the controller by using the serial cable.
2. Open the **File Explorer** and select the firmware file to be updated to the option board and double-click it.



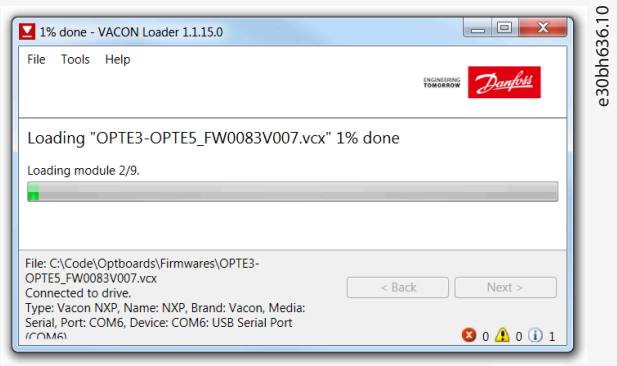
VACON® Loader software opens.

3. Press *Next* and wait for the loader to find the network drives.
4. Select a drive from the list and press *Connect to Selected*.



5. Select the modules to be updated, and press *Next*.

Firmware starts to load:



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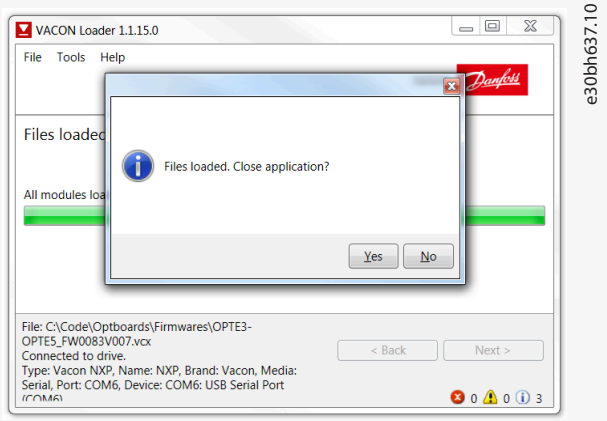
Loading is finished:



e30bh637.10

3.2.2 Updating Firmware over Ethernet with VACON® Loader

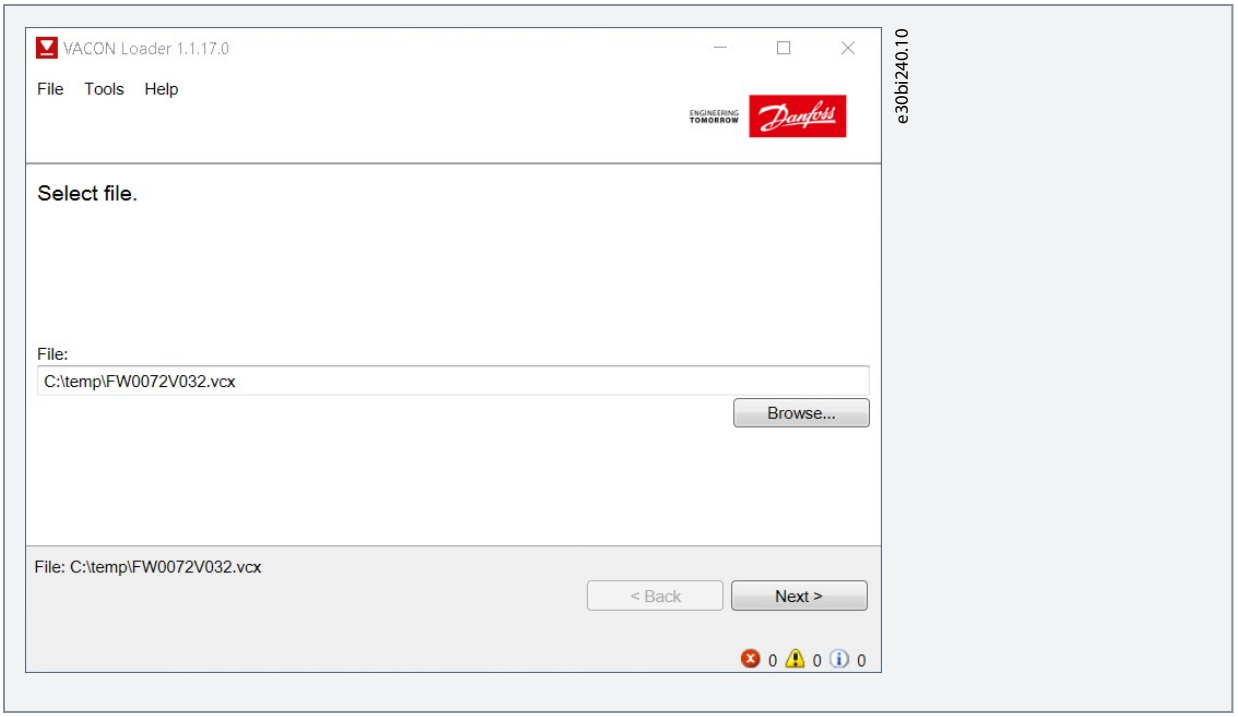
Use these instructions to upload the fieldbus or VACON® control firmware over Ethernet with VACON® Loader.

OPTEA and OPTE9 boards enable updating VACON® 100 control and option board firmware over Ethernet with VACON® Loader. The option board works as gateway for the firmware update. It means that it is not possible to update the firmware of the option board which is being used as the update gateway.

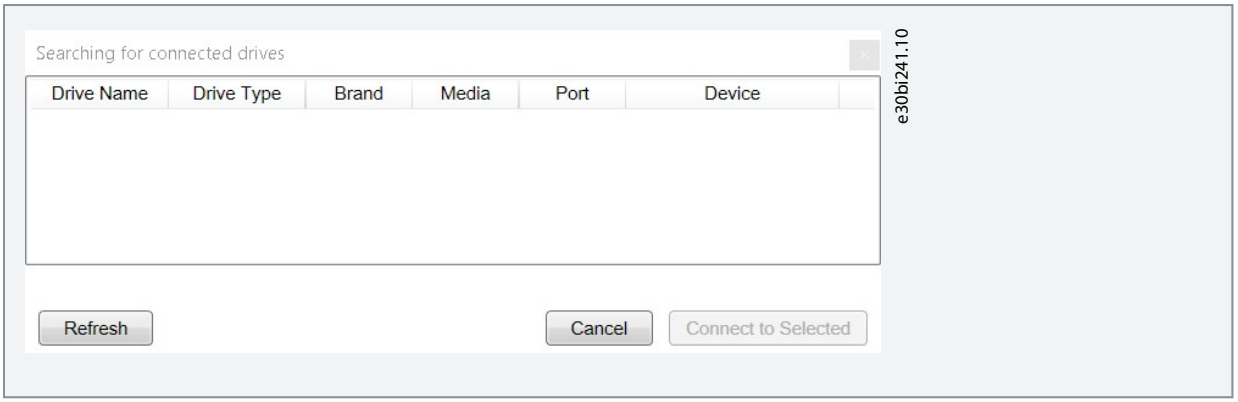
If the firmware loading fails (for example, network is lost during update), the option board remembers used Ethernet settings and remains in state waiting for reconnection and firmware update.

Procedure

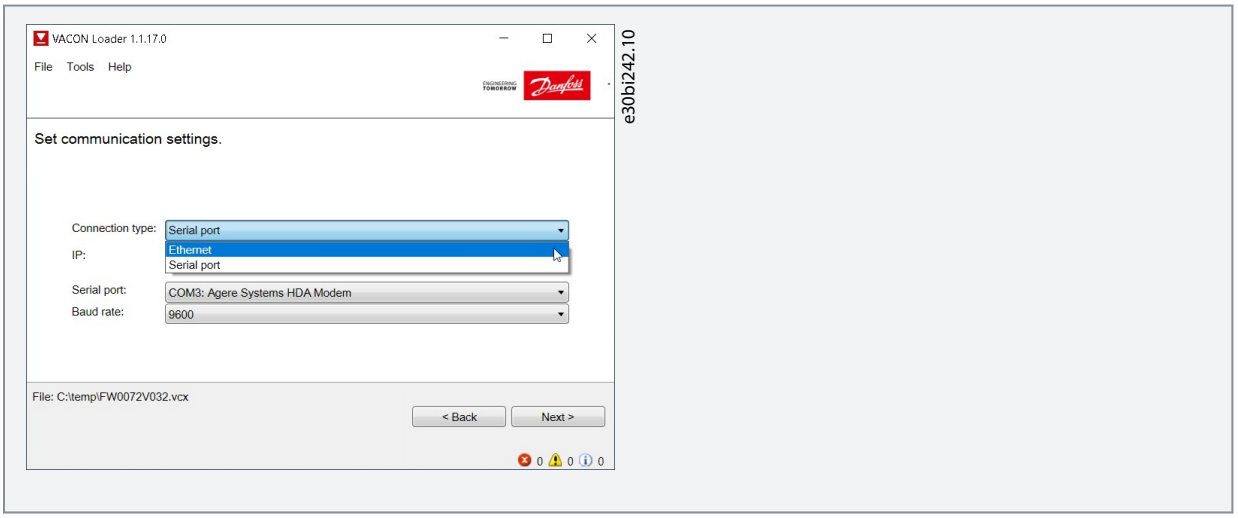
1. Start VACON® Loader and select the firmware file to be updated.



2. Press *Next*. VACON® Loader starts to scan for serial connections. At this point press *Cancel*.

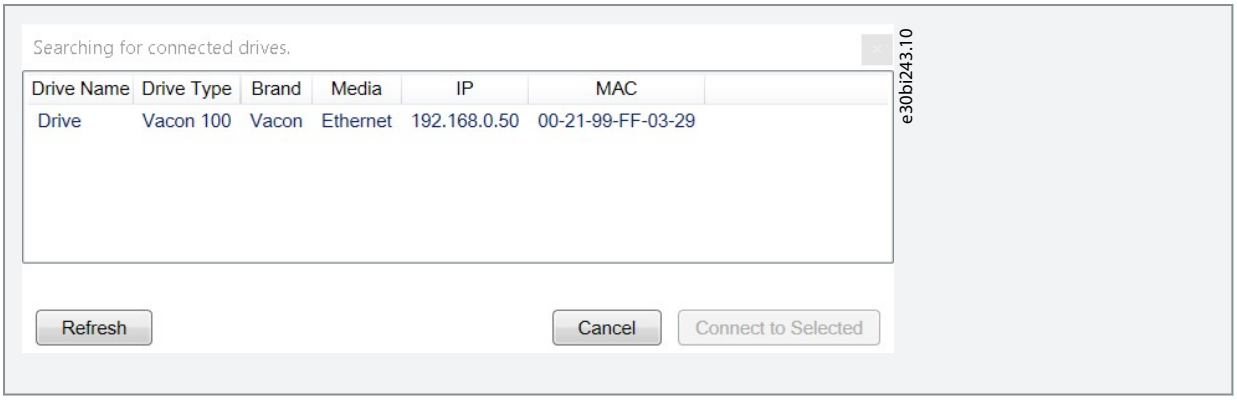


3. From the communication settings, change connection type to Ethernet.



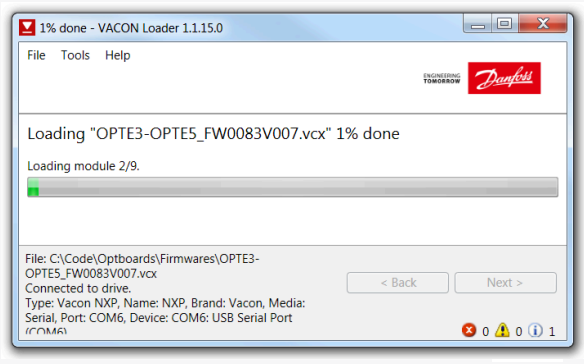
VACON® Loader starts to scan drives from Ethernet networks.

4. When the drive is found, select it and press *Connect to selected*. From this point on, load prosess is identical with serial connection.



e30bi243.10

Firmware starts to load:



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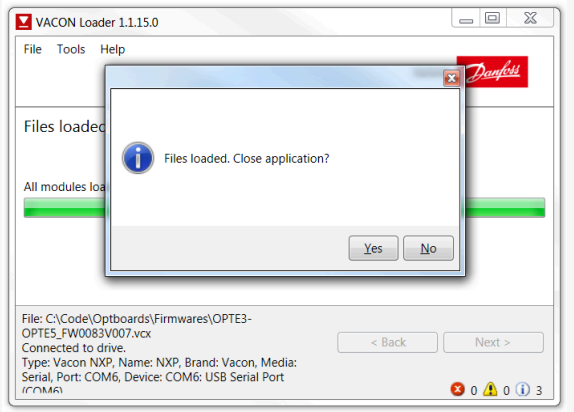
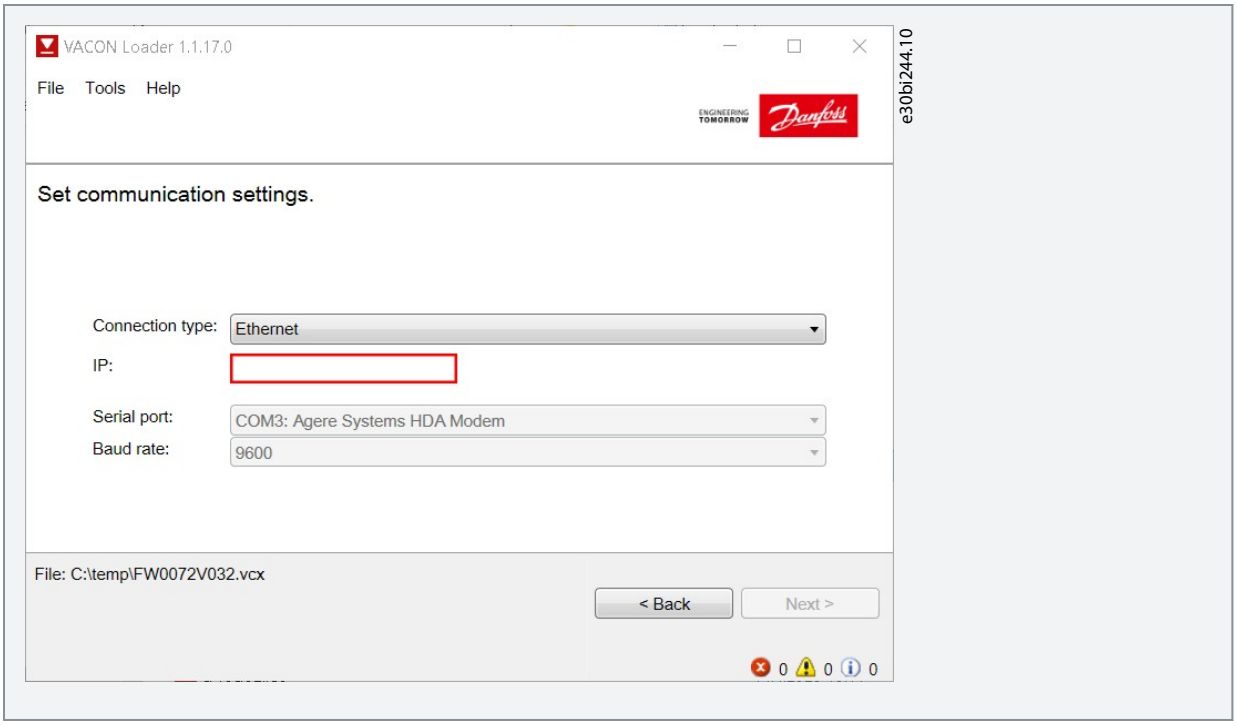
Loading is finished:



e30bh637.10

5. If the scan does not find the device but the IP address of the drive is available, press cancel to scan dialog and enter the correct IP address in the *IP* field. Then press *Next*.



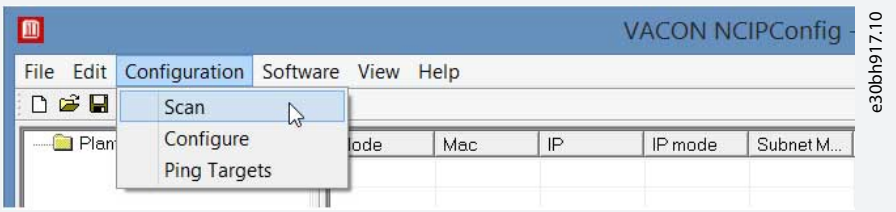
3.2.3 Configuring with VACON® NCIPConfig

Use these instructions to set the IP addresses for the option board with VACON® NCIPConfig. To find more information about the software features, select *Help* --> *Manual*.

Check the list in 3.1 Before Commissioning.

Procedure

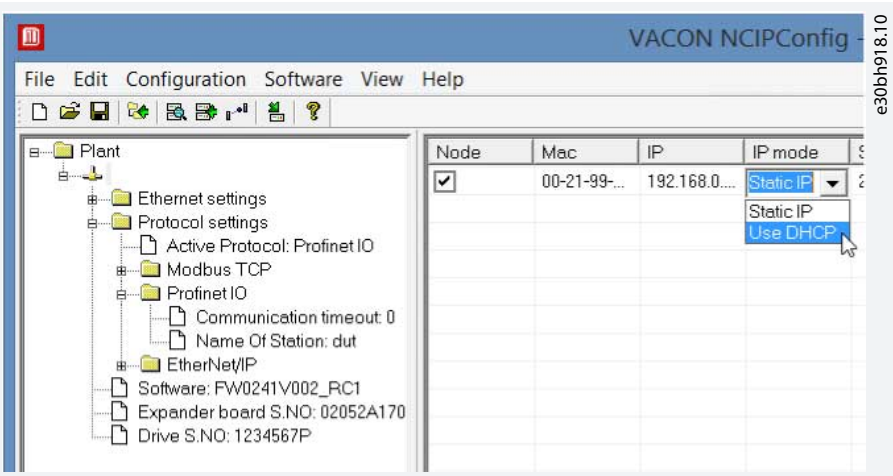
1. To launch the VACON® NCIPConfig, go to the Windows Start menu and select VACON® NCIPConfig.
2. Select *Configuration* --> *Scan* and wait until the devices connected to the bus display on the left side of the screen in the tree structure.



NOTE! The VACON® NCIPConfig uses broadcast messages for scanning devices. Some network switches can block the broadcast messages. In this case, each network node must be scanned separately.

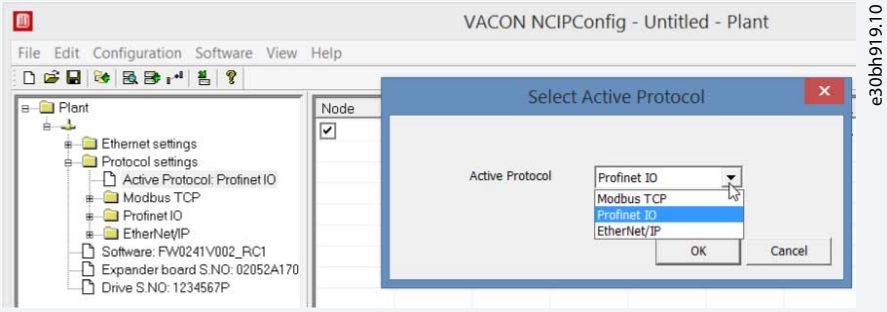
3. Set the option board settings.

- To change the board name, select the cell in the column *Node* and enter the name of the node. Notice that it changes the name seen only in VACON® PC tools. PROFINET I/O Name Of Station value must be changed via protocol settings or over PROFINET I/O DCP protocol.
- To change the node IP settings, select the cell in the right column and enter the value according to the network IP settings. The program reports conflicts with a red color in table cells.
- To change the IP Mode, click the cell and select the correct mode from the drop-down list.

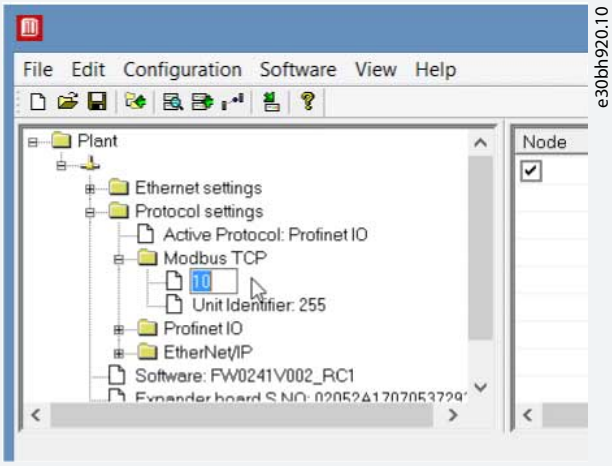


- To commit the changes, mark the checkbox and select *Configuration --> Configure* from the menu.

4. To change the currently active protocol, select the setting from the tree structure and click *OK*.



5. To change other settings, edit the information in the tree structure.



See 6.1 Option Board Parameters for more information about the settings.

3.2.4 Setting the Drive Parameters

3.2.4.1 Setting the Drive Parameters with VACON® NCDrive

Use these instructions to set the drive parameters with VACON® NCDrive.

Also option board parameters can be configured with VACON® NCDrive (except for the PROFINET NameOfStation parameter). However, we recommend using the VACON® NCIPConfig tool to configure the option board in the VACON® NXS/P AC drives.

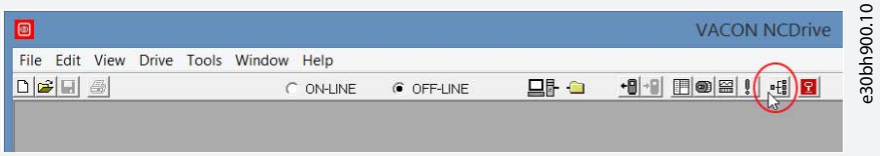
Check the list in 3.1 Before Commissioning.

Make sure that the option board IT settings are configured with VACON®NCIPConfig. See instructions in 3.2.3 Configuring with VACON® NCIPConfig.

NOTE! The VACON® NCDrive software is recommended to be used in LAN (Local Area Network) only.

Procedure

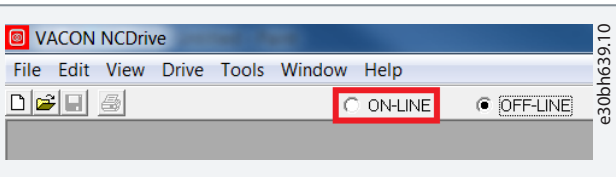
1. To find drives for connections, press the Drive Select button to scan the network drives.



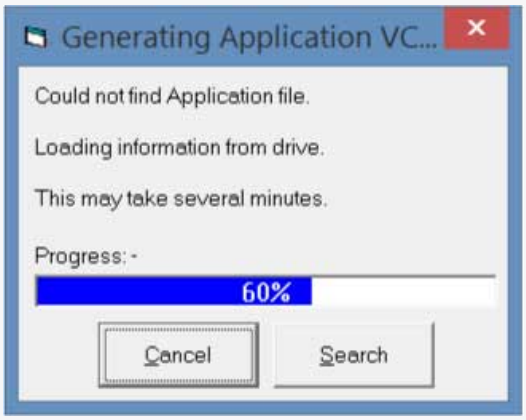
2. In the *Select the active drive* dialog, select the drive for the connection, press the *Set Active Drive* button and press *Close*.

The IP information presented in the dialog comes from the option board, other information comes from the drive.

3. Press the *ON-LINE* button.

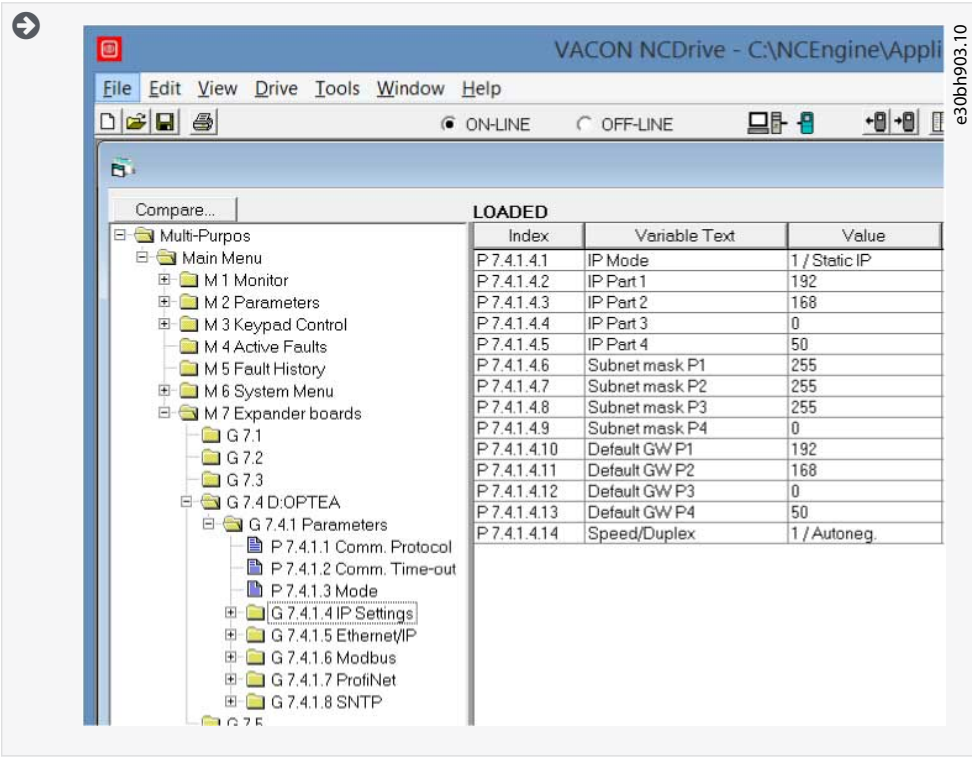


The NCDrive connects to the drive and starts loading parameter information.



4. To change the option board settings, navigate to the *M7 Expander boards* menu, and select the slot to which OPTEA/OPTE9 is connected.

It is possible to change parameters defined in 6.1 Option Board Parameters. If the IP address, network mask, and default gate address are changed, "IP Mode" must be changed to "Fixed IP" to activate the settings.



3.2.4.2 Setting the Drive Parameters with VACON® Live

Use these instructions to set the Drive Parameters with VACON® Live.

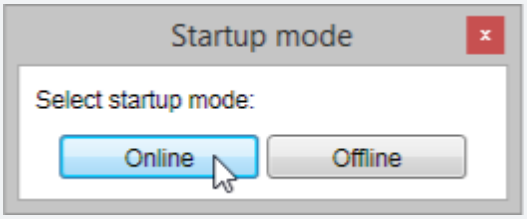
With VACON® Live, it is possible to modify OPTEA/OPTE9 Ethernet parameters and view monitor values.

Check the list in 3.1 Before Commissioning.

NOTE! VACON® 20, VACON® 20 X, and VACON® 20 Cold Plate do not support VACON® Live connection over the OPTE9 Ethernet port. OPTEA does not support VACON® 20, VACON® 20 X, and VACON® 20 CP drives.

Procedure

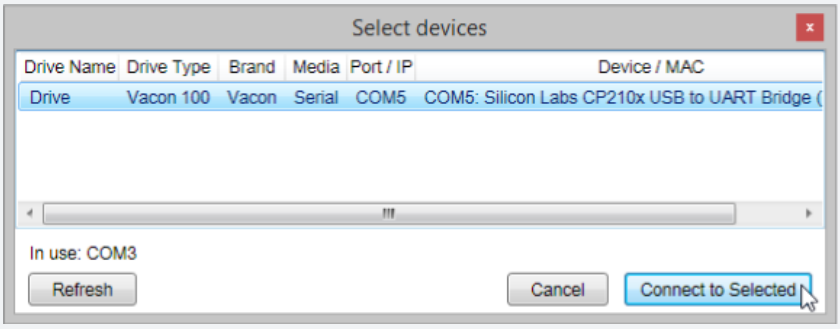
1. Open VACON® Live. When the program starts, it asks *Select startup mode*. Select *Online*.



e30bi011.10

The program scans your network for compatible drives, and adds them to the list.

2. Select the drive that the option board is connected to and press *Connect to Selected*.



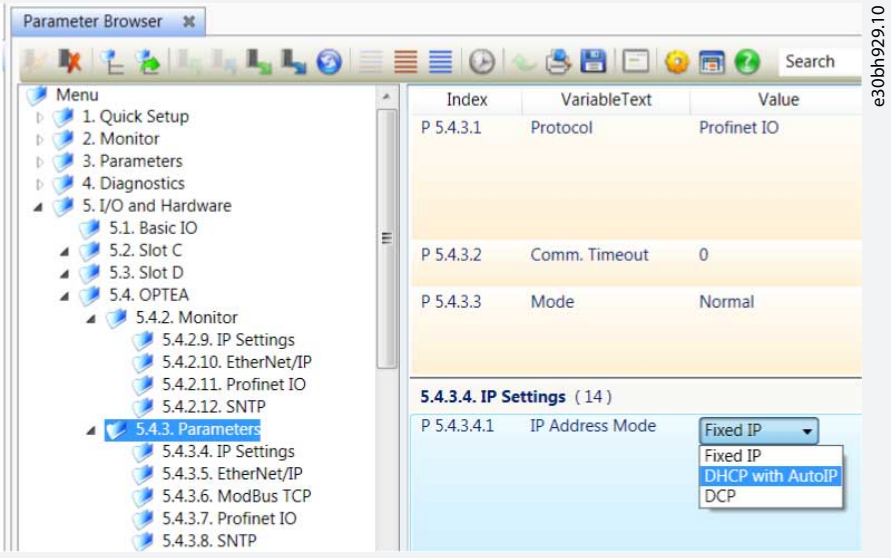
e30bi012.10

NOTE! The first column is the name of the drive. However, the information about IP and MAC addresses come from the option board (if the device on the list is an option board).

NOTE! Some switches block broadcast messages. In this case, each network node must be scanned separately.

3. Navigate to *M5 I/O and Hardware* menu. Check at least the IP Settings.

It is possible to change parameters defined in 6.1 Option Board Parameters. If the IP address, network mask, and default gate address are changed, "IP Mode" must be changed to "Fixed IP" to activate the settings.



e30bh929.10

3.3 OPTCx Emulation Mode (OPTEA)

OPTEA Advanced Dual Port Ethernet board has emulation mode for OPTC-series Ethernet boards. When OPTEA is installed to NXP drive, it has "Mode" parameter. If value "OPTCx" is selected, then OPTEA emulates behavior of old C-series Ethernet option boards (OPTCI, OPTCP, OPTCQ) as accurately as possible.

Emulation mode can be used when old installation is expanded with few new drives and when modifying PLC logic is possible. In emulation mode, OPTEA board identifies itself as, for example, OPTCP board. It allows in PLC setup, to add new OPTCP board when the drive actually has OPTEA board, and control it with same logic as real OPTCP boards.

Also damaged OPTCP installation can be replaced with OPTEA emulating OPTCP. Later, when replacing all drives, these emulating boards can be reused. Update the PLC programming to use OPTEA boards and change "Mode" parameter to "normal". It allows to use all the advanced features of OPTEA board (for example: MRP, System Redundancy).

For OPTEA the "Mode" parameter has different content when installed to VACON® 100 or to NXP family drive. When installed to VACON® NXP family drive and "OPTCx" mode is selected, OPTEA emulates behavior of old C-series Ethernet option boards as accurately as possible.

To use emulation mode, use OPTEA with firmware version V002 or later and VACON® NXP drive with V197 firmware or later.

Modbus in emulation mode

NX Mode:

- Currently this mode has no effect on Modbus functionality

OPTCx Mode:

- Modbus supports all the same coils as OPTCI board does
- Measurement table indexes are supported

PROFINET in emulation mode

NX Mode:

- PLC must use OPTCP GSDML.
- Device id is OPTCP "1".
- Vendor id is OPTCP "0x9500" instead of "0x01BA".
- Device type text is "OPTCP".
- Telegrams use FBSpeedReference/FBSpeedActual types instead of NSOLL_A/NIST_A.
- Parameter channel used with Simatic PDM does not work in NX Mode.
- In OPTCP Name Of Station can be set with VACON® NCIPConfig from the "node" field. It is not supported, but there is separate parameter for Name Of Station in VACON® NCIPConfig when using OPTEA or OPTE9 board.
- OPTCP's Vendor PPO3, PPO4, and PPO6 telegrams are supported.

OPTCx Mode:

- All same changes as in NX Mode.
- FBDIN control word bits are as in OPTCP.

VACON® 100 Mode:

- PLC must use VACON® 100 family GSDML.
- Device ID is "1".
- Device type text is "VACON100".

EtherNet/IP in emulation mode

NX Mode:

- PLC must use OPTCQ EDS.
- AC/DC Drive Object: Parameter "Drive" mode always returns the actual drive mode.
- In "normal" mode "process drive" mode value is returned when the instance number is 25.
- Drive identifier text is "OPTCQ" instead of being based on the drive where the option board is installed (for example: "VACON® 100 INDUSTRIAL").
- Product code is "2" instead of being based on the drive where the option board is installed.
- Revision number (major, minor) is OPTCQ 3.5.
- Connection instance is OPTCQ "1" instead of "103" which is used by OPTEA/OPTE9 and VACON® 100 family AC drive.
- Motor Data Object: "Rated Current" attribute returns the value in units of 10 milliamperes (1.9A => 190). In Normal mode, the value unit is 100 milliamperes (1.9A => 19). The same conversion is expected when setting the attribute value.
- The Motor Data Object: "Rated Frequency" attribute returns value with two decimals (50.00 Hz => 5000). In normal mode, the value has no decimals (50.00 Hz => 50 Hz). The same conversion is expected when setting the attribute value.

- ControlFromNet bit is set to 1 when NetControl is set to 1. In normal mode, it is set only if Control Place-parameter is set to fieldbus.
- ReferenceFromNet bit is set to 1 when NetworkReference is set to 1. In normal mode, it is set only if Reference Place-parameter is set to fieldbus.

OPTCx Mode:

- All same changes as in NX Mode.

VACON® 100 Mode:

- PLC must use VACON 100 EDS.
- Drive identifier text is "VACON® 100" instead of being based on the drive where the option board is installed (for example: "VACON® 100 INDUSTRIAL").
- Product code is "100" instead of being based on the drive where the option board is installed.
- Revision number (major, minor) is always 2.1.

4 Control Interface and Communication

4.1 Ethernet Communication Overview

The OPTEA and OPTE9 option boards support multiple communication modes to AC drive. These modes, among other features, enable transmitting and receiving 16 process data items at 1 ms interval. These advanced communication modes are supported when installed to VACON® NXP family drive. See 4.2 Fieldbus Option Board Communication Modes for details.

4.2 Fieldbus Option Board Communication Modes

The VACON® fieldbus option boards support the following fieldbus board communication modes:

- Normal mode, for most commonly used setups (see 4.2.3 Normal Fieldbus Communication)
- Normal extended mode, for setups that requires 16 process data items
- Fast mode, with low latency process data (see 4.2.4 Fast Fieldbus Communication)
- Fast safety mode with safety "black channel" (see 4.2.5 Fast Safety Fieldbus Communication)
- Fast PROFIBUS mode. Use other modes with new installations.

NOTE! Not all boards support all modes. For details, see 4.2.1 Requirements for Communication Modes.

The fast communication modes can be enabled to get minimum communication delay between the fieldbus and application.

4.2.1 Requirements for Communication Modes

Table 10: Requirements for Different Fieldbus Communication Modes for VACON® NXP

Software or hardware	Fast/Normal Extended	Fast safe
Control Board	NXP (serial number 761 or later)	NXP (serial number 761 or later)
System Software	NXP00002V196.vcn	NXP00002V196.vcn
Applications[1]	Multipurpose V236 or later (Normal Extended Mode)	Any[2]
Fieldbus option firmware version	OPTE3/E5 V006 or later	OPTE3-E5_FW0083V006.vcx or later
	OPTE9 V007 or later	-
	OPTEA V001 or later	OPTEA V001 or later[3]
	OPTEC V003 or later	-
	OPTE6 V010 or later	-
	OPTE7 V006 or later	-
Advanced safety option	-	OPTBL_FW0227V001 or later

[1] For latest information about application support for fieldbus communication modes, refer to application-specific manuals.

[2] If safety option is configured to use a safety fieldbus, the fast safe mode is automatically enabled regardless of used application. However, the availability of 16 process items is limited by the application in use. Also the process data application cycle is normally set to 10 ms, instead of 1 ms for fast application.

[3] Only with Advanced Safety Option

Table 11: Requirements for Normal Extended Communication Mode for VACON® 100 Family

Software	Normal Extended
System Software	• INDUSTRIAL FW0072V030 • FLOW FW0159V022
Fieldbus option firmware version	OPTE9: V010
	OPTEA: V003

Software	Normal Extended
	OPTE7: V006
	OPTE3/OPTE5: V008

4.2.2 Fieldbus Communication Mode Features and Limitations

Fast mode

- 1 ms process data interval
- Available in VACON® NXP slots D and E
  - Possible to run both slots simultaneously
  - Have similar process data latency in both slots
- Service data latency is also reduced
  - Running multiple service data queries at high interval can cause high CPU load in VACON® NXP AC drive.

Fast safe mode

- 1 ms process data interval
- Includes safety "black channel"
- Activated/deactivated automatically, not available for setting
- Safety fieldbus must be activated in safety configuration
  - Advanced safety option board must be installed into slot D
  - Safety fieldbus must be activated in safety configuration

16 process data items

- 16 process data items always require support from application
- Available in Fast, Fast safe, and Normal extended mode
- If no support is available in the application, the process data out is always '0', while incoming process data items 9–16 are discarded

4.2.3 Normal Fieldbus Communication

The normal fieldbus communication between option board and the AC drive application is shown in Illustration 16. In normal communication, both process data, and service data are transferred in succession at 5 ms interval.

Communication delay for process data can be calculated by summing all delays together:

$$t = t_{\text{IO data cycle}} + t_{\text{update interval}} + 2 \cdot t_{\text{communication delay}} + t_{\text{application cycle}}$$

Example: With fieldbus cycle time of 4 ms and application cycle of 10 ms, the delay is:

$$t = 4\ \text{ms} + 10\ \text{ms} + (2 \cdot 5)\ \text{ms} + 10\ \text{ms} = 34\ \text{ms}$$

NOTE!: This value does not include delays of the fieldbus master, jitter in the process data cycle of the communication protocol or resending due to electronic interference.

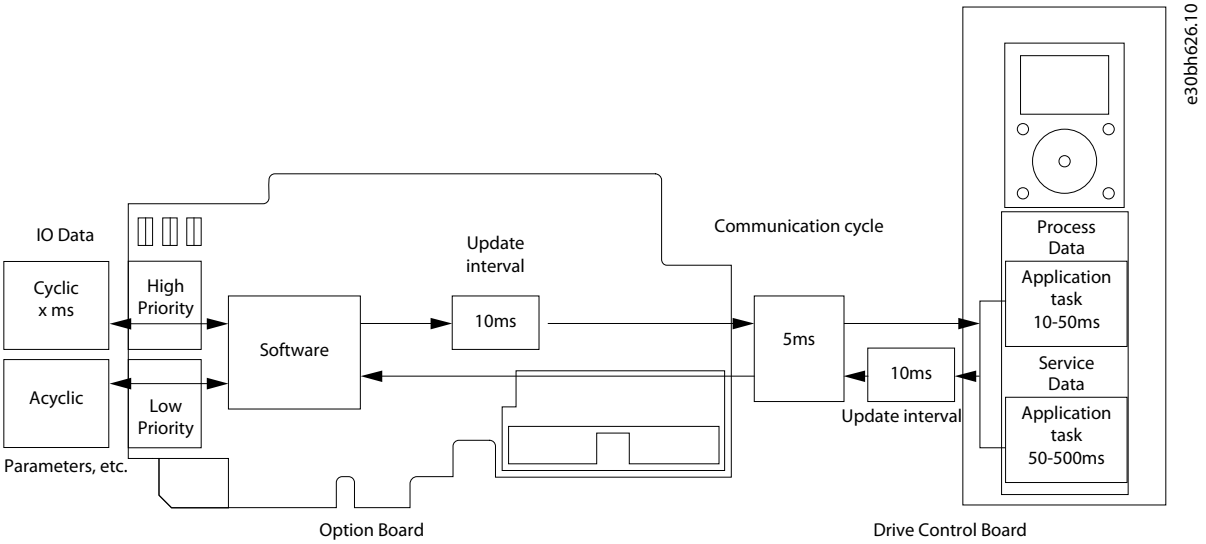


Illustration 16: Normal Fieldbus Communication

4.2.4 Fast Fieldbus Communication

The fast mode decreases the communication delay between the PLC and the AC drive application significantly by using two communication channels separately for process and service data. The process data interval is set to 1 ms, while other data is sent acyclically. When the fast mode is activated, the application can be synchronized to run with the communication cycle. The Fast communication mode is shown in Illustration 17. This mode also includes the ability to transfer 16 process data items.

The communication delay for process data in fast communication mode is (when application task is synchronized with communication):

$$t = t_{\text{IO data cycle}} + t_{\text{update interval}} + t_{\text{application cycle}}$$

Example: With fieldbus cycle time of 1 ms, an application cycle of 1 ms the delay is:

$$t = 1\ \text{ms} + 1{+}1\ \text{ms} = 3\ \text{ms}$$

NOTE: This value does not include delays of the fieldbus master, jitter in the process data cycle of the communication protocol or resending due to electronic interference.

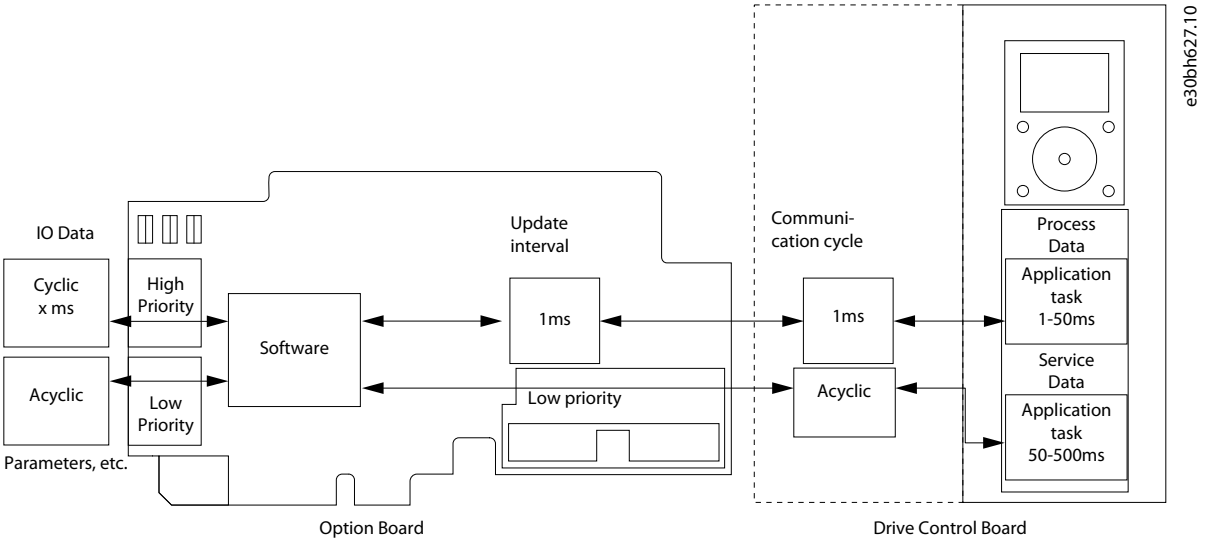


Illustration 17: Fast Fieldbus Communication

4.2.5 Fast Safety Fieldbus Communication

The fast safety mode uses the same communication methods as in "Fast mode" (Illustration 17), but also transfers safety "black channel" data used to the advanced safety option board.

NOTE: This mode is automatically enabled, if an advanced safety option board is connected to slot D and the safety fieldbus is activated and is not available for setting. This mode is also automatically turned off when the advanced safety option board is removed.

4.2.6 Normal Extended Mode

The normal extended mode uses the same communication method as in "Fast mode", but reduces the communication cycle to 10 ms. This mode can be used in applications where 16 process data items are required but the lowest possible communication delay is not needed. It can also be used in these applications when the increased CPU load of Fast mode to VACON® NXP drives is undesirable.

NOTE! This mode can be automatically enabled in VACON® applications supporting 16 process data items.

4.3 Drive Control with Modbus TCP/UDP

4.3.1 Modbus Communication Overview

The Modbus-VACON® interface has the following features:

- Direct control of VACON® AC drive (for example, Run, Stop, Direction, Speed reference, Fault reset)
- Access to VACON® parameters
- VACON® status monitoring (for example, Output frequency, Output current, and Fault code)

4.3.2 Quick Setup for Modbus Connection

Use these instructions to set up the Modbus connection.

Procedure

1. In the AC drive application, select Fieldbus as the active control place (see the AC drive Operating Guide for instructions).
2. In the Master software, set the following:
   a. Set the Control Word to *0* (2001).
   b. Set the Control Word to *1* (2001).

   Drive is in status RUN.
3. In the Master software, set the Reference value to *5000* (50.00%) (2003).

   Actual speed is 5000 (25.00 Hz if MinFreq is 0.00 Hz and MaxFreq is 50.00 Hz).
4. In the Master software, set the Control Word to *0* (2001).

   Drive is in status STOP.

4.3.3 Data Addresses and Modbus Memory Map

All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero.

Examples:

- The coil known as 'Coil 1' in a programmable controller is addressed as 'Coil 0000' in the data address field of a Modbus message.
- Coil 127 decimal is addressed as 'Coil 007E hex' (126 decimal).
- Holding register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a 'holding register' operation. Therefore the '4XXXX' reference is implicit.
- Holding register 40108 is addressed as register 006B hex (107 decimal).

Modbus Memory Map

The VACON® variables and fault codes as well as the parameters can be read and written from Modbus. The parameter addresses are determined in the application. Every parameter and actual value has been given an ID number in the application. The ID numbering of the parameters and the parameter ranges and steps can be found in the application manual in question. The parameter values are given without decimals. If several parameters/actual values are read with one message, the addresses of the parameters/actual values must be consecutive.

NOTE! Broadcasting is not supported in TCP.

Table 12: Supported Functions

Function code	Current terminology	Access type	Address range (hex)
1 (0x01)	Read coils	Discrete	00000–0FFFF
2 (0x02)	Read Input Discrete	Discrete	10000–1FFFF
3 (0x03)	Read holding registers	16-bit	40000–4FFFF
4 (0x04)	Read input registers	16-bit	30000–3FFFF
5 (0x05)	Force single coils	Discrete	00000–0FFFF
6 (0x06)	Write single register	16-bit	40000–4FFFF
15 (0x0F)	Force multiple coils	Discrete	00001–0FFFF
16 (0x10)	Write multiple registers	16-bit	40000–4FFFF
23 (0x17)	Read/Write multiple registers	16-bit	40000–4FFFF

4.3.4 Coil Registers

Coil registers contain binary data (Read/Write).

Table 13: Defined Coil Registers

Address	Function	Purpose
0001	RUN/STOP	Control Word, bit 0
0002	Direction	Control Word, bit 1
0003	Fault reset	Control Word, bit 2
0017	Reset	Clears operation days trip counter
0018	Reset	Clears energy trip counter

4.3.5 Resettable Trip Counters

The VACON® AC drives have trip counters for operation days and energy. These counters can be reset to zero.

To reset the trip counters, write value '1' to addresses defined in Table 14. Resetting the counters is not supported in VACON® 20, VACON® 20 X, or VACON® 20 CP.

Table 14: Resettable Trip Counters

Address	Function	Purpose
40101	Reset	Clears operation days trip counter
40301	Reset	Clears energy trip counter

In OPTCI, to clear the resettable trip counters, write '1' to the addresses listed in Table 15.

Table 15: Resettable Trip Counters for OPTCI

Address	Function	Purpose
0017	Reset	Clears operation days trip counter
0018	Reset	Clears energy trip counter

4.3.6 Input Discrete Registers

Input discrete registers contain binary data (Read).

Table 16: Defined Input Discrete Registers

Address	Function	Purpose
1	Ready	Status Word, bit 0
2	Run	Status Word, bit 1
3	Direction	Status Word, bit 2
4	Fault	Status Word, bit 3
5	Alarm	Status Word, bit 4
6	At reference	Status Word, bit 5
7	Zero speed	Status Word, bit 6
8	Flux ready	Status Word, bit 7

4.3.7 Input Registers

The values can be read with function code 4. They are for compatibility with the OPTCI option board. They return the same values as holding register counterparts.

Table 17: Input Registers

Address range	Purpose	Access type	Details	R/W	Max R/ W size
1–5	Operation day counter	16-bit	See Table 25	RO	5/0
101–105	Resettable operation day counter	16-bit	See Table 27	R, Write 1 to first index to reset	5/0
201–203	Energy counter	16-bit	See Table 29	RO	5/0
301–303	Resettable energy counter	16-bit	See Table 31	R, Write 1 to first index to reset	5/0
401–430	Fault history	16-bit	See Table 32	RO	30/0

4.3.8 Holding Registers

The values can be read with function code 3. Modbus registers are mapped to drive IDs as listed in Table 18.

Table 18: Defined Holding Registers

Address range	Purpose	Access type	Details	R/W	Max R/W size
0001–2000	VACON® Application IDs	16-bit	See Table 19	RW	30/30
2001–2019	FBProcessDataIN	16-bit	See Table 20	RW	19/19
2051–2086	FBProcessDataIN	32-bit(1)	See Table 20	RW	36/36
2101–2119	FBProcessDataOUT	16-bit	See Table 21	RO	19/0
2151–2186	FBProcessDataOUT	32-bit(1)	See Table 21	RO	36/0
2200–10000	VACON® Application IDs	16-bit	See Table 19	RW	30/30
10501–10530	IDMap	16-bit	See Illustration 18	RW	30/30

Address range	Purpose	Access type	Details	R/W	Max R/W size
10601–10630	IDMap Read/Write	16-bit	See Table 22	RW	30/30[2]
10701–10760	IDMap Read/Write	32-bit[1]	See Table 22	RW	30/30
20001–40000	VACON® Application IDs	32-bit[1]	See Table 19	RW	30/30
40001–40005	Operation day counter	16-bit	See Table 25	RO	5/0
40011–40012	Operation day counter	32-bit[1]	See Table 24	RO	2/0
40101–40105	Resettable operation day counter	16-bit	See Table 27	R, Write 1 to first index to reset	5/0
40111–40112	Resettable operation day counter	32-bit	See Table 26	RO	2/0
40201–40203	Energy counter	16-bit	See Table 29	RO	3/0
40211–40212	Energy counter	32-bit	See Table 28	RO	2/0
40301–40303	Resettable energy counter	16-bit	See Table 31	R, Write 1 to first index to reset	3/0
40311–40312	Resettable energy counter	32-bit	See Table 30	RO	2/0
40400	Reset fault history	16-bit		RW	1/1
40401–40430	Fault history	16-bit	See Table 32	RO	30/0
40501	Communication timeout	16-bit	See Table 35	RW	1/1
40511–40568	Fault history with 16-bit fault codes	16-bit	See Table 33	RO	30/0
40601–40801	Fault history with time stamps	16-bit	See Table 34	RO	30/0

[1] These items are supported only in VACON® 100 family AC drives. Not supported in current version. See 1.7.1 VACON® OPTEA Advanced Dual Port Ethernet Drive Support and 1.7.2 VACON® OPTE9 Dual Port Ethernet Drive Support.

[2] In VACON® 20, VACON® 20 X / CP, the maximum R/W size for IDmap operations is 12/30.

4.3.8.1 VACON® Application IDs

Application IDs are parameters that depend on the application of the drive. These parameters can be read and written by pointing the corresponding memory range directly or by using the so-called ID map. The easiest way to read a single parameter value or parameters with consecutive ID numbers is to use a straight address. It is possible to read 30 consecutive ID addresses. Notice that the operation fails when just one of the consecutive IDs does not exist.

Parameters which have 32-bit value can be read from their own range. For example, to read the value for ID 864 (FB Status Word), the address must be set to 21726. This address value comes from values: 20000 + ((ID -1) * 2). The ID value is reduced with one because of zero-based addressing and the result is multiplied by 2 because one 32bit value takes two (16-bit) addresses.

Table 19: Parameter IDs

Address range	Purpose	ID range
0001–2000	16-bit application parameters	1–2000
2200–10000	16-bit application parameters	2200–10000
20001–40000	32-bit application parameters	1–10000

4.3.8.2 FB Process Data In

The process data fields are used to control the AC drive (for example, Run, Stop, Reference, Fault Reset) and quickly to read actual values (for example, Output frequency, Output current, Fault code). The values in these indexes can be read and written. The structure of the fields is described in Table 20.

Table 20: FB Process Data In

16-bit address	32-bit address	Name	Range/Type
2001	2051 = High data 2052 = Low data	FB Control Word	Binary coded
2002	–	FB General Control Word	Binary coded
2003	2053 = High data 2054 = Low data	FB Speed Reference	0…10000 (100%)
2004	2055 = High data 2056 = Low data	FB Process Data In 1	see 4.7 VACON® Process Data Description
2005	2057 = High data 2058 = Low data	FB Process Data In 2	
2006	2059 = High data 2060 = Low data	FB Process Data In 3	
2007	2061 = High data 2062 = Low data	FB Process Data In 4	
2008	2063 = High data 2064 = Low data	FB Process Data In 5	
2009	2065 = High data 2066 = Low data	FB Process Data In 6	
2010	2067 = High data 2068 = Low data	FB Process Data In 7	
2011	2069 = High data 2070 = Low data	FB Process Data In 8	
2012	2071 = High data 2072 = Low data	FB Process Data In 9	see 4.7 VACON® Process Data Description
2013	2073 = High data 2074 = Low data	FB Process Data In 10	
2014	2075 = High data 2076 = Low data	FB Process Data In 11	
2015	2077 = High data 2078 = Low data	FB Process Data In 12	
2016	2079 = High data 2080 = Low data	FB Process Data In 13	
2017	2081 = High data 2082 = Low data	FB Process Data In 14	
2018	2083 = High data	FB Process Data In 15	

16-bit address	32-bit address	Name	Range/Type
	2084 = Low data		
2019	2085 = High data 2086 = Low data	FB Process Data In 16	

Control word bits

See 4.7 VACON® Process Data Description for control word bit descriptions.

Control Word Monitoring Values

Drive Control Word and Protocol Control Word monitoring values always shows the same value when using Modbus. It is the same value as received from network. The only exception to this is that when using the VACON® NXP AC drives, the bit 15 of the Control word is changed to indicate the "Master connection status". The bit 15 is set to 1 when master device has written process data and the bit is cleared when the connection is closed/lost.

4.3.8.3 FB Process Data Out

Values in these indexes can be only read, not written.

Table 21: Fieldbus Process Data OUT

16-bit address	32-bit address	Name	Range/Type
2101	2151 = High data 2152 = Low data	FB Status Word	Binary coded
2102	–	With 16-bit, FB General Status Word (High data)	Binary coded
2103	2153 = High data 2154 = Low data	FB Actual Speed	0…10000 (100.00%)
2104	2155 = High data 2156 = Low data	FB Process Data Out 1	See 4.7 VACON® Process Data Description
2105	2157 = High data 2158 = Low data	FB Process Data Out 2	
2106	159 = High data 2160 = Low data	FB Process Data Out 3	
2107	2161 = High data 2162 = Low data	FB Process Data Out 4	
2108	2163 = High data 2164 = Low data	FB Process Data Out 5	
2109	2165 = High data 2166 = Low data	FB Process Data Out 6	
2110	2167 = High data 2168 = Low data	FB Process Data Out 7	
2111	2169 = High data 2170 = Low data	FB Process Data Out 8	
2112	2171 = High data 2172 = Low data	FB Process Data Out 9	See 4.7 VACON® Process Data Description

16-bit address	32-bit address	Name	Range/Type
2113	2173 = High data 2174 = Low data	FB Process Data Out 10	
2114	2175 = High data 2176 = Low data	FB Process Data Out 11	
2115	2177 = High data 2178 = Low data	FB Process Data Out 12	
2116	2179 = High data 2180 = Low data	FB Process Data Out 13	
2117	2181 = High data 2182 = Low data	FB Process Data Out 14	
2118	2183 = High data 2184 = Low data	FB Process Data Out 15	
2119	2185 = High data 2186 = Low data	FB Process Data Out 16	

Status Word bits

See 4.7 VACON® Process Data Description for status word bit descriptions. The use of process data depends on the application. In a typical situation, the device is started and stopped with the Control Word (CW) written by the Master and the Rotating speed is set with Reference (REF). With PD1…PD16, the device can be given other reference values (for example, Torque reference). With the Status Word (SW) read by the Master, the status of the device can be seen. Actual Value (ACT) and PD1…PD16 show the other actual values.

Status Word Monitoring Values

The Drive Status Word and Protocol Status Word monitoring values always shows the same value when using Modbus. It is the same value than what is sent to the network.

4.3.8.4 ID Map

The ID map makes it possible to read consecutive memory blocks that contain parameters whose IDs are not in a consecutive order. The address range 10501–10530 is called 'IDMap', and it includes an address map in which it is possible to write the parameter IDs in any order. The address range 10601–10630 is called 'IDMap Read/Write', and it includes values for parameters written in the IDMap. When one ID number has been written in the map cell 10501, the corresponding parameter value can be read and written in the address 10601, and so on. The address range 10701–10760 contains the ID Map for 32-bit values. Maximum of 30 IDs and ID values can be written and read with single request. In VACON® 20 and 20 X/CP it is possible to access only 12 ID value items at a time.

NOTE! 32-bit data not supported in the current version. See 1.7.1 VACON® OPTEA Advanced Dual Port Ethernet Drive Support and 1.7.2 VACON® OPTE9 Dual Port Ethernet Drive Support.

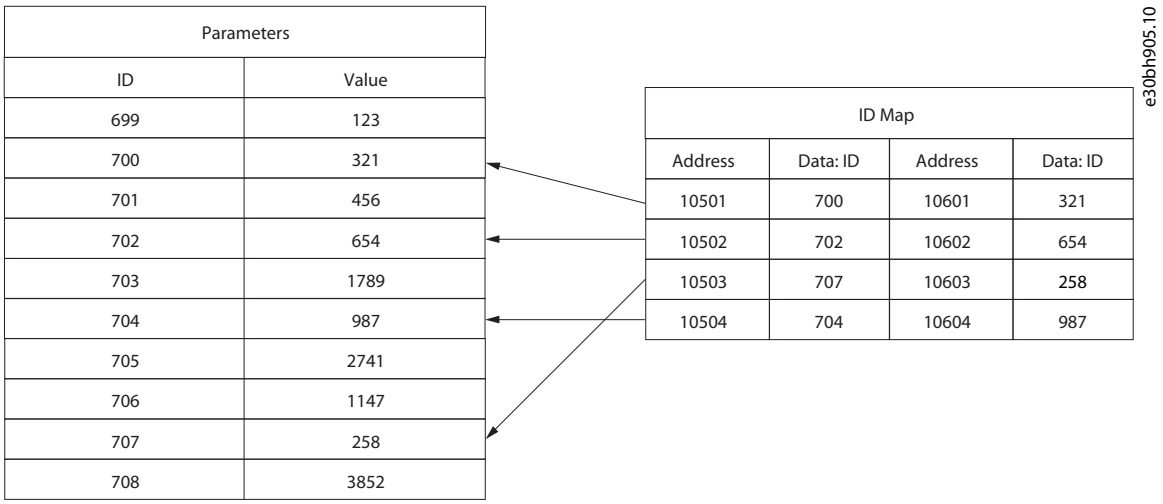


Illustration 18: ID Map Initialization Example

Once the ID Map address range has been initialized with the parameter IDs, the parameter values can be read and written in the IDMap Read/Write address range address (IDMap address + 100).

Table 22: Parameter Values in 16-bit IDMap Read/Write Registers

Address	Data
10601	Data included in parameter ID700
10602	Data included in parameter ID702
10603	Data included in parameter ID707
10604	Data included in parameter ID704

If the ID Map table has not been initialized, all the fields show index as '0'. If it has been initialized, the parameter IDs included in it are stored in the flash memory of the option board.

Table 23: Example of Parameter Values in 32-bit IDMap Read/Write Registers

Address	Data
10701	Data High, parameter ID700
10702	Data Low, parameter ID700
10703	Data High, parameter ID702
10704	Data Low, parameter ID702

4.3.8.5 Operation Day Counter

Control unit operating time counter (total value). This counter cannot be reset. The values are read only.

NOTE! The feature Operation day counter does not work with VACON® 20, VACON® 20 X, or VACON® 20 CP AC drives.

Table 24: Operation Day Counter as Seconds

Address	Description
40011 High data 40012 Low data	The counter in registers 40011d to 40012d holds the value of operation days as seconds in a 32-bit unsigned integer.

The operation day counter in registers 40001d to 40005d holds the value of operation days counter. The values are read only.

For compatibility with VACON® 100 family internal Modbus TCP/UDP and the OPTCI option board, this counter is found from two different register areas: holding registers 40001d to 40005d and input registers 1d to 5d.

Table 25: Operation Day Counter

Holding register address	Input register address	Purpose
40001	1	Years
40002	2	Days
40003	3	Hours
40004	4	Minutes
40005	5	Seconds

4.3.8.6 Resettable Operation Day Counter

This register holds the value for resettable control unit operating time counter (trip value). The values are read only.

For resetting this counter, see 4.3.5 Resettable Trip Counters.

NOTE! The feature Resettable operation day counter does not work with VACON® 20, VACON® 20 X, or VACON® 20 CP AC drives.

Table 26: Resettable Operation Days Counter as Seconds

Address	Description
40111 High data 40112 Low data	This counter in registers 40111d to 40112d holds the value of resettable operation days as seconds in a 32-bit unsigned integer.

The resettable operation day counter in registers 40101d to 40105d holds the value of operation days counter. For compatibility with VACON® 100 family internal Modbus TCP/UDP and the OPTCI option board, this counter is found from two different register areas: holding registers 40101d to 40105d and input registers 30101d to 30105d.

Table 27: Resettable Operation Day Counter

Holding register address	Input register address	Purpose
40101	101	Years
40102	102	Days
40103	103	Hours
40104	104	Minutes
40105	105	Seconds

4.3.8.7 Energy Counter

This counter holds the value of total amount of energy taken from a supply network. This counter cannot be reset. The values are read only.

Table 28: Energy Counter as kWh

Address	Description
40211 High data 40212 Low data	The counter is in registers 40211d to 40212d. It is a 32-bit floating point (IEEE 754) value containing the number of kilowatt-hours (kWh) that is in the energy counter of the drive. This value is read-only.

These registers hold three values for the energy counter, amount of energy used, format of the energy value and unit of the energy value.

For compatibility with VACON® 100 family internal Modbus TCP/UDP and the OPTCI option board, this counter is found from two different register areas: holding registers 40201d to 40203d and input registers 201d to 203d.

Example: If energy = 1200, format = 52, unit = 1, then actual energy is 12.00 kWh.

Table 29: Energy Counter

Holding register address	Input register address	Purpose	Description
40201	201	Energy	Amount of energy taken from a supply network.
40202	202	Format	The last number of the Format field indicates the decimal point place in the Energy field. **Example**: 40 = 4 number of digits, 0 fractional digits 41 = 4 number of digits, 1 fractional digit 42 = 4 number of digits, 2 fractional digits
40203	203	Unit 1 =kWh 2 =MWh 3 =GWh 4 =TWh	Unit of the value.

4.3.8.8 Resettable Energy Counter

This counter holds the value of total amount of energy taken from a supply network since the counter was last reset. For resetting this counter, see 4.3.5 Resettable Trip Counters. The values are read only.

Table 30: Resettable Energy Counter as kWh

Address	Description
40311 High data 40312 Low data	The counter is in registers 40311d to 40312d. It is a 32-bit floating point (IEEE 754) value containing the number of kilowatt-hours (kWh) from the resettable energy counter of the drive.

These registers hold three values for the energy counter, amount of energy used, format of the energy value and unit of the energy value.

For compatibility with VACON® 100 family internal Modbus TCP/UDP and the OPTCI option board, this counter is found from two different register areas: 40301d to 40303d and 301d to 303d.

Example: If energy = 1200, format = 52, unit = 1, then actual energy is 12.00 kWh.

Table 31: Resettable Energy Counter

Holding register address	Input register address	Purpose	Description
40301	301	Energy	Amount of energy taken from a supply network.
40302	302	Format	The last number of the Format field indicates the decimal point place in the Energy field. **Example**: 40 = 4 number of digits, 0 fractional digits 41 = 4 number of digits, 1 fractional digit 42 = 4 number of digits, 2 fractional digits
40303	303	Unit 1 =kWh 2 =MWh 3 =GWh	Unit of the value.

Holding register address	Input register address	Purpose	Description
		4 =TWh	

4.3.8.9 Fault History

The fault history is readable from address 40401 onward. The faults are listed in chronological order so that the latest fault is mentioned first and the oldest last. The fault history can contain 29 faults at the same time. (In VACON® 20, VACON® 20 X, and VACON® 20 CP it is possible to read 9 faults). For compatibility with VACON® 100 family internal Modbus TCP/UDP and the OPTCI option board, this counter is also found from input register area: 401d to 403d.

NOTE! Reading the fault history items is slow. Reading all 30 items at once can take up to 3 s depending on drive type and firmware versions.

The fault history contents are shown in Table 32.

Table 32: Fault History

Holding register address	Input register address	Purpose
40401	401	Upper byte is a fault code, lower byte is a subcode
40402	402	-
40403	403	-
...	...	-
40429	429	-

4.3.8.10 Fault History with 16-bit Error Codes

The fault history is readable from address 40511 onward. The faults are listed in a chronological order so that the latest fault is mentioned first and the oldest last. These addresses contain the fault code and the subcode for the fault. Reading can be started from any address. (In VACON® 20, VACON® 20 X, and VACON® 20 CP it is possible to read 9 faults).

NOTE! Reading the fault history items is slow. Reading all 30 items at once can take up to 3 s depending on drive type and firmware versions.

Table 33: Fault History with 16-bit Error Codes

Holding register address	Purpose	Description
40511	Fault code 1	16-bit fault code in index 1.
40512	Subcode 1	16-bit subcode for the fault in index 1.
40513	Fault code 2	16-bit fault code in index 2.
40514	Subcode 2	16-bit subcode for the fault in index 2.
...	...	-
40567	Fault code 29	-
40568	Subcode 29	-

4.3.8.11 Reset Fault History

Drive fault history can be reset by writing "1" to address 40400. Value in this address can be read but it is always zero. Notice that fault history cannot be reset when there is an active fault.

4.3.8.12 Reset Fault with Time Stamps

The fault history with time stamps is readable from address 40601 onward. The faults are listed in a chronological order so that the latest fault is mentioned first and the oldest last. These addresses contain fault code, subcode, and time stamp for the fault. Reading

can be started from any address. (In VACON® 20, VACON® 20X, and VACON® 20CP it is possible to read 9 faults. In VACON® NXP family AC drives it is possible to read 30 faults).

NOTE! Only 25 items can be read with single request. Reading the fault history items is slow. Reading 25 items at once can take up to 3 s depending on drive type and firmware versions.

Table 34: Fault History with Time Stamps

Holding register address	Purpose	Description
40601	Fault Code 1	16-bit fault code in index 1
40602	Subcode 1	16-bit fault subcode in index 1
40603	Time stamp HI 1	32-bit time stamp in seconds high byte in index 1
40604	Time stamp LO 1	32-bit time stamp in seconds low byte in index 1
40605	Time stamp ms 1	Time stamp milliseconds in index 1
40606	Fault Code 2	16-bit fault code in index 2
...	...	...
40801	Time stamp ms 40	Time stamp milliseconds in index 40

4.3.9 Connection Timeout in Modbus Communication

It is possible to open up to three connections to the option board. One of the connections could be used for process data and other just for reading monitoring data. Usually it is desirable that if "monitor" connection gets disconnected, no fault is generated. However when the connection is handling the process data, a fault must be generated in the time specified.

This register address enables custom communication timeout for each connection. If a custom timeout value is used, it must be given every time a connection is opened. Timeout can be set only to the connection used to access this register. By default the connection uses the communication timeout value given via panel parameters.

If the cable is disconnected, a fieldbus fault is activated after the timeout period. When communication timeout is zero, no fault is activated.

Table 35: Communication Timeout Register

Holding register address	Purpose	Description
40501	Communication timeout	Connection timeout value for this connection in seconds.

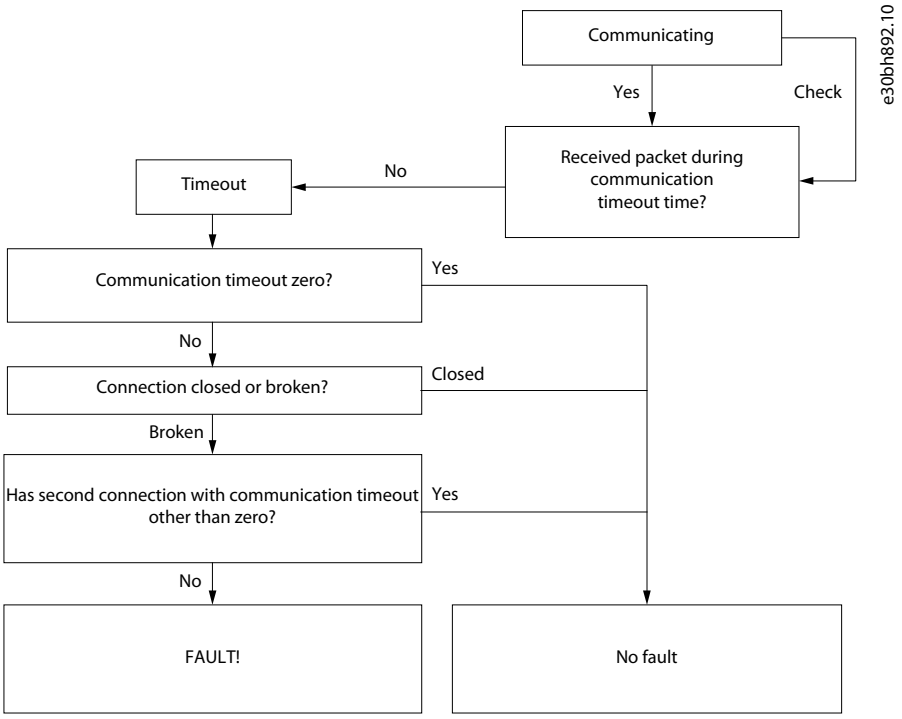


Illustration 19: The Connection Timeout in Modbus TCP/UDP

4.3.10 Example Messages

4.3.10.1 Write Process Data

Write the process data 42001…42003 with command 16 (Preset Multiple Registers).

Table 36: Command Master–Slave

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 10 hex (= 16)
DATA	Starting address HI	07 hex	Starting address 07D0 hex (= 2000)
	Starting address LO	D0 hex	
	Number of registers HI	00 hex	Number of registers 0003 hex (= 3)
	Number of registers LO	03 hex	
	Byte count	06 hex	Byte count 06 hex (= 6)
	Data HI	00 hex	Data 1 = 0001 hex (= 1). Setting control word run bit to 1.
	Data LO	01 hex	
	Data HI	00 hex	Data 2 = 0000 hex (= 0).
	Data LO	00 hex	
	Data HI	13 hex	Data3 = 1388 hex (= 5000), Speed Reference to 50.00%
	Data LO	88 hex	
ERROR CHECK	CRC HI	C8 hex	CRC field C8CB hex (= 51403)
	CRC LO	CB hex	

Table 37: Message Frame

01	10	07	D0	00	03	06	00	01	00	00	13	88	C8	CB

The reply to the message of Preset Multiple Register is the echo of 6 first bytes.

Table 38: Answer Slave - Master

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 10 hex (= 16)
DATA	Starting address HI	07 hex	Starting address 07D0 hex (= 2000)
	Starting address LO	D0 hex	
	Number of registers HI	00 hex	Number of registers 0003 hex (= 3)
	Number of registers LO	03 hex	
ERROR CHECK	CRC HI	80 hex	CRC 8085 hex (= 32901)
	CRC LO	85 hex	

Table 39: Reply Frame

01	10	07	D0	00	03	80	85

4.3.10.2 Read Process Data

Read the Process Data 42103…42104 with command 4 (Read Input Registers).

Table 40: Command Master–Slave

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 4 hex (= 4)
DATA	Starting address HI	08 hex	Starting address 0836 hex (= 2102)
	Starting address LO	36 hex	
	Number of registers HI	00 hex	Number of registers 0002 hex (= 2)
	Number of registers LO	02 hex	
ERROR CHECK	CRC HI	C8 hex	CRC 93A5 hex (= 37797)
	CRC LO	CB hex	

Table 41: Message Frame

01	04	08	36	00	02	93	A5

The reply to the Read Input Registers message contains the values of the read registers.

Table 42: Answer Slave–Master

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Byte count	04 hex	Byte count 4 hex (= 4)
	Data HI	13 hex	Speed reference = 1388 hex (=5000 => 50.00%)
	Data LO	88 hex	

	Data HI	09 hex	Output Frequency = 09C4 hex (=2500 =>25.00 Hz)
	Data LO	C4 hex	
ERROR CHECK	CRC HI	78 hex	CRC 78E9 hex (= 30953)
	CRC LO	E9 hex	

Table 43: Reply Frame

01	04	04	13	88	09	C4	78	E9

4.3.10.3 Exception Response

In an exception response, the Slave sets the most-significant bit (MSB) of the function code to 1. The Slave returns an exception code in the data field.

Table 44: Command Master–Slave

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Starting address HI	17 hex	Starting address 1770 hex (= 6000)
	Starting address LO	70 hex	
	Number of registers HI	00 hex	Invalid number of registers 0005 hex (= 5)
	Number of registers LO	05 hex	
ERROR CHECK	CRC HI	34 hex	CRC 3466 hex (= 13414)
	CRC LO	66 hex	

Table 45: Message Frame

01	04	17	70	00	05	34	55

Exception response

Table 46: Answer Slave–Master

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		84 hex	Most significant bit set to 1
DATA	Error code	04 hex	Error code 04 => Slave device failure
ERROR CHECK	CRC HI	42 hex	CRC 42C3 hex (= 17091)
	CRC LO	C3 hex	

Table 47: Reply Frame

01	84	04	42	C3

4.4 Drive Control with PROFINET

4.4.1 PROFINET Communication Overview

The PROFIdrive profile specifies telegrams used for process communication. The option boards support four types of different telegrams with and without extra process data items. These telegrams contain either PROFIdrive or VACON® specific signals or a combination of both.

It is also possible to use up to eight (8) Process Data fields, or sixteen (16) when using extended or fast communication mode. If the normal communication mode is used, the upper 8 Process Data items (9–16) are either zeroes (actual data) or not used (setpoint data). See 4.1 Ethernet Communication Overview for more details. For descriptions of different types of telegrams and the signals that form them, see 4.4.5 Telegram Types.

4.4.2 Quick Setup for PROFINET Connection

Use these instructions to set up the PROFINET connection.

In the instruction, telegram ST1 with STW1/ZSW1 and NSOLL_A/NIST_A is used as example.

Procedure

1. In the AC drive application, select Fieldbus as the active control place (see the AC drive Operating Guide for instructions).
2. In the Master software, set the following:
   a. Set the Control Word value to 0 hex.
   b. Set the Control Word value to 47E hex.
   c. Set the Control Word value to 47F hex.

   Drive is in status RUN.
3. In the Master software, set the Reference value to 2000 Hex (=50.00%).

   Actual speed is 5000 (25.00 Hz if MinFreq is 0.00 Hz and MaxFreq is 50.00 Hz).
4. In the Master software, set the Control Word value to 47E hex.

   Drive is in status STOP.

4.4.3 PROFIdrive 4.1 Profile Overview

To provide interoperability between devices from different manufacturers, a "standard" must be defined so that:

- The devices behave in the same way.
- The devices produce and/or consume the same basic set of I/O data.
- The devices contain the same basic set of configurable attributes.

The formal definition of this information is known as a device profile. Some AC drives support only some of the functionalities. See 4.7 VACON® Process Data Description.

4.4.4 PROFIdrive 4.1 State Machine

STW1 (Control Word) and ZSW1 (Status Word) follow the state machine described in Illustration 20.

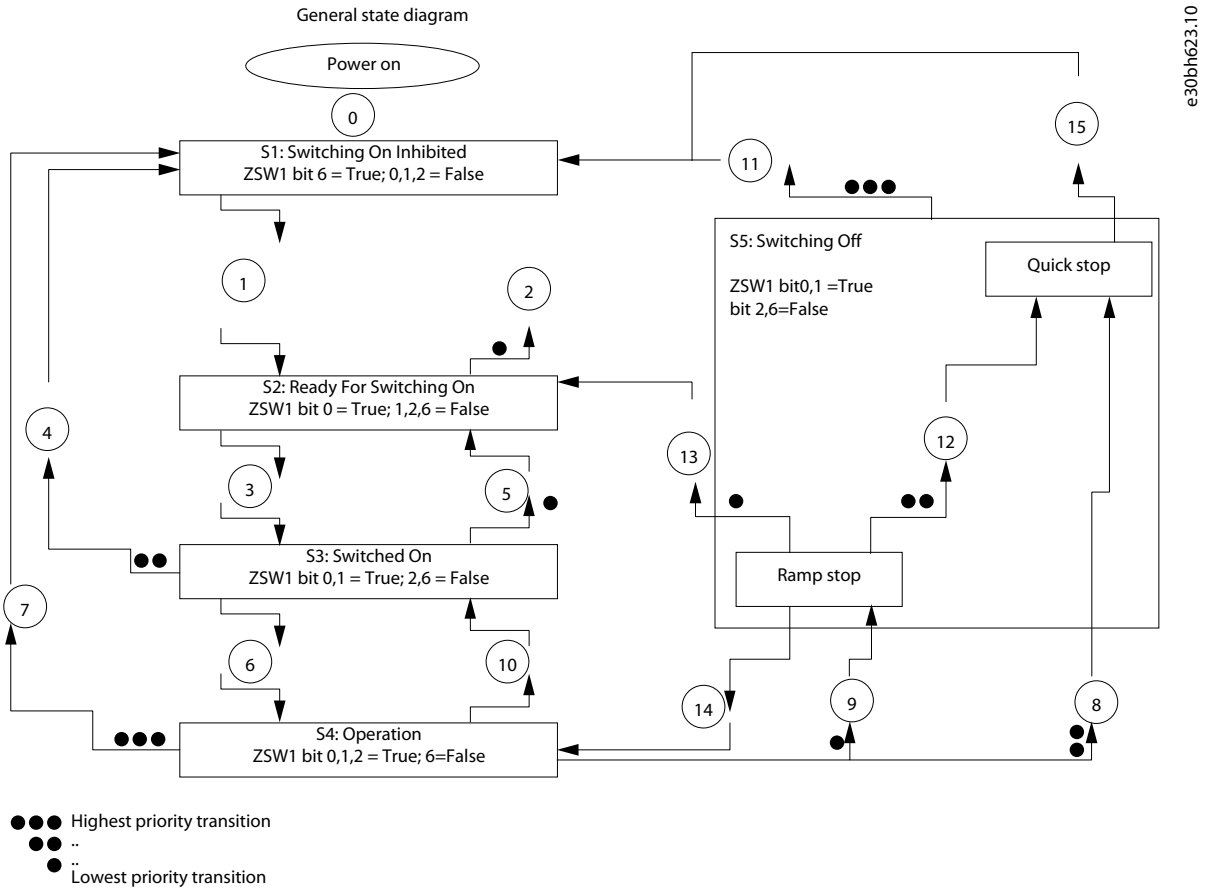


Illustration 20: General State Diagram

Table 48: PROFIdrive State Machine Commands

#	Bits of control word	Value (hex)	Action in VACON® 100 family & VACON® 20X/CP	Action in VACON® 20	Action in VACON® NXP(1)
0	-	-	Self-initiation is performed		
1	OFF AND No Coast Stop AND No Quick Stop STW1 bit 0 = False; 1, 2 = True	0x47E	None, requires that Drive is READY (ZSW1 status word bit 13)		
2	Coast Stop OR Quick Stop STW1 bit 1 = False OR bit 2 = False	-	None		
3	ON STW1 bit 0 = True	0x477	None		
4	Coast Stop OR Quick Stop	-	None		
5	STW1 bit 1 = False OR bit 2 = False	-	None		
6	Enable operation STW1 bit 3 = True	0x47F	Drive function is enabled, requires that Drive is in fieldbus control (ZSW1 status word bit 9)		
7	Coast stop	0x47D	Stop by coast		Stop function

#	Bits of control word	Value (hex)	Action in VACON® 100 family & VACON® 20X/CP	Action in VACON® 20	Action in VACON® NXP[1]
	STW1 bit 1 = False				
8, 12	Quick stop STW1 bit 2 = False	0x47B	Quick stop[2]	Stop by ramp	Stop function
9	Ramp stop STW1 bit 0 = False	0x47E	Stop by ramp		Stop function
10	Disable operation STW1 bit 3 = False	0x477	Drive function is disabled, stop by stop function		
11	Coast stop STW1 bit 1 = False	0x47D	Stop by coast		Stop function
13, 15	Standstill detected OR Disable operation STW1 bit 3 = False	0x477	Drive function is disabled, stop by stop function		
14	ON (Re-enable operation)	0x47F	Drive function is re-enabled		

[1] When using VACON® NXP series AC drives and option board in "PROFIdrive" mode, the stop command always follows configured stop mode and not the stop command given from fieldbus.

[2] Quick stop only occurs if the application supports it. If the application does not support quick stop, a normal ramp stop is executed.

4.4.5 Telegram Types

For a list of different telegram types and their description, see the following:

- 4.4.5.1 Standard Telegram 1 and Variants
- 4.4.5.2 VACON®-specific Telegram 1 and Variants
- 4.4.5.3 VACON®-specific Telegram 2 and Variants
- 4.4.5.4 VACON®-specific Telegram 3 and Variants
- 4.4.5.5 VACON®-specific Telegram 4 and Variants
- 4.4.5.7 VACON®-specific Telegram Vendor PPO and Variants

Consider the following issues when selecting the telegram type:

- Combination of devices in the network (multiple manufactureres/only VACON® devices.
- How the motor speed is controlled.
- Number of process data items needed.

When selecting a telegram for PROFINET communication, consider if PROFIdrive control/status word (STW1/ZSW1) is needed or if VACON® control/status word can be used. See comparison of used Control and Status Word monitoring values in Table 49.

Table 49: Comparison of Control and Status Word Monitoring Values in Different Telegram Types

	Value in Standard Telegram 1	Value in VACON®-specific Telegram 1	Value in VACON®-specific Telegram 2	Value in VACON®-specific Telegram 3	Value in VACON®-specific Telegram 4
Drive CW	FBFixedControlWord	FBFixedControlWord	FBFixedControlWord	FBFixedControlWord	FBFixedControlWord
Drive SW	FBFixedStatusWord	FBFixedStatusWord	FBFixedStatusWord	FBFixedStatusWord	FBFixedStatusWord
Protocol CW	STW1	FBFixedControlWord	FBGeneralControlWord	STW1	FBFixedControlWord

	Value in Standard Telegram 1	Value in VACON®-specific Telegram 1	Value in VACON®-specific Telegram 2	Value in VACON®-specific Telegram 3	Value in VACON®-specific Telegram 4
Protocol SW	STW1	FBFixedStatusWord	FBGeneralStatusWord	STW1	FBGeneralStatusWord

If the network has devices from multiple manufactures which all can be controlled with PROFIdrive control word, we recommend using telegram type with status word STW1. It makes writing the PLC application easier, especially when the PLC has PROFIdrive block available.

If the network consists of only VACON® devices controlled by PLC over PROFINET, it is better to use VACON® control/status word. State machine for VACON® control/status word is simpler than in the PROFIdrive and therefore controlling the drive is also easier in the PLC application.

Telegram selection also affects the motor speed control. With VACON® control word, the motor direction can be controlled with a single bit. PROFIdrive motor direction is controlled with negative/ positive values. Telegrams with PROFIdrive control/status word generally have also PROFIdrive speed reference/actual (NIST_A/NSOLL_A). Other telegrams have VACON® speed reference/actual (FBSpeedReference/FBSpeedActual). The main difference between these types is the integer value which means maximum allowed motor speed (100%). In VACON® FBSpeedReference, the value is between 0d–10000d (100.00%) and in PROFIdrive NIST_A the value is between -16384d–16384d.

NOTE! When using NSOLL_A, our minimum and maximum frequency parameters affect the speed reference differently than when using the FBSpeedReference directly. With NSOLL_A, the PROFINET gives zero reference to the application until NSOLL_A exceeds the minimum reference. With FBSpeedReference, the given value is always scaled between the minimum and maximum frequency. For example, if the Minimum Frequency is 30 Hz and the Maximum Frequency is 50 Hz, the NSOLL_A value between 0 and 9830 runs 30 Hz. With FBSpeedReference, the example value 1000 (10%) runs 32 Hz.

Different telegrams contain different number of process data items. The number of items vary from none to 16 items. Process data can be 16 or 32 bits in size. Process data in VACON® NXP drives is only 16-bit, so telegrams which use 32-bit process data have the upper 16 bits always as zero.

When using more than 8 process data items, the fieldbus option board communication mode must be 'Fast mode with safety "black channel"', 'Fast Mode' or 'Normal Extended' mode. See 4.2 Fieldbus Option Board Communication Modes for more information on the communication mode.

4.4.5.1 Standard Telegram 1 and Variants

Standard Telegram 1 types are used when a standard VACON® application is used and PROFIdrive functionality is required. Telegrams listed in Table 50 use PROFIdrive-defined control word, status word, speed setpoint value, and speed actual value. When using these telegrams, the process data fields are communicated as 16-bit values.

STW1 forces edge sensitive run control.

NOTE! When a board is connected to VACON® 100 family AC drive and its mode parameter is set to “NX Mode”, the option board uses FBSpeedReference/FBSpeedActual instead of NSOLL_A/ NIST_A as backward compatibility for OPTCP option board.

Table 50: Standard Telegram 1 and Variants

Telegram number	Telegram	Abbreviation
1	Standard Telegram 1	ST1
102	Standard Telegram 1 + 1 Process Data	ST1 + 1 PD
103	Standard Telegram 1 + 2 Process Data	ST1 + 2 PD
104	Standard Telegram 1 + 3 Process Data	ST1 + 3 PD
100	Standard Telegram 1 + 4 Process Data	ST1 + 4 PD
105	Standard Telegram 1 + 5 Process Data	ST1 + 5 PD
106	Standard Telegram 1 + 6 Process Data	ST1 + 6 PD
107	Standard Telegram 1 + 7 Process Data	ST1 + 7 PD
101	Standard Telegram 1 + 8 Process Data	ST1 + 8 PD
138	Standard Telegram 1 + 12 Process Data(1)	ST1 + 12 PD

Telegram number	Telegram	Abbreviation
139	Standard Telegram 1 + 16 Process Data[1]	ST1 + 16 PD

[1] 12 and 16 process data items are available in VACON® NXP AC Drive. See 4.2 Fieldbus Option Board Communication Modes.

Table 51: Standard Telegram 1 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1...2	STW1	4.4.6.1 PROFIdrive 4.1 Control Word (STW1)	ZSW1	4.4.6.2 PROFIdrive 4.1 Status Word (ZSW1)
3...4	NSOLL_A	4.4.6.3 Setpoint Value	NIST_A	4.4.6.4 Actual Speed Value
5...6	PDI1	4.7.5 Process Data	PDO1	4.7.5 Process Data
7...8	PDI2		PDO2	
...	...		...	
19...20	PDI8		PDO8	
21...22	PDI9[1]		PDO9[1]	
...	...		...	
35...36	PDI16[1]		PDO16[1]	

[1] See 4.4.5 Telegram Types.

For Control and Status Word monitoring values in this telegram, see Table 49.

4.4.5.2 VACON®-specific Telegram 1 and Variants

These telegrams (Table 52) use VACON® defined control word, status word, speed setpoint value, and speed actual value to directly access the AC drive application. When using these telegrams, the process data fields are communicated as 16-bit values.

Table 52: Vendor Telegram 1 and Variants

Telegram number	Telegram	Abbreviation
108	Vendor Telegram 1	Vendor 1
109	Vendor Telegram 1 + 1 Process Data	Vendor 1 + 1 PD
110	Vendor Telegram 1 + 2 Process Data	Vendor 1 + 2 PD
111	Vendor Telegram 1 + 3 Process Data	Vendor 1 + 3 PD
112	Vendor Telegram 1 + 4 Process Data	Vendor 1 + 4 PD
113	Vendor Telegram 1 + 5 Process Data	Vendor 1 + 5 PD
114	Vendor Telegram 1 + 6 Process Data	Vendor 1 + 6 PD
115	Vendor Telegram 1 + 7 Process Data	Vendor 1 + 7 PD
116	Vendor Telegram 1 + 8 Process Data	Vendor 1 + 8 PD
140	Vendor Telegram 1 + 12 Process Data[1]	Vendor 1 + 12 PD
141	Vendor Telegram 1 + 16 Process Data[1]	Vendor 1 + 16 PD

[1] 12 and 16 process data items are available in VACON® NXP AC Drive. See 4.2 Fieldbus Option Board Communication Modes.

Table 53: Vendor Telegram 1 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1...2	FB FIXED CW	4.7.1 Control Word Overview	FB FIXED SW	4.7.2 Status Word Overview
3...4	FB SPEED REF	4.7.5 Process Data	FB SPEED ACT	4.7.4 Speed Reference and Actual Speed
5...6	PDI1	4.7.5 Process Data	PDO1	4.7.5 Process Data
7...8	PDI2		PDO2	
...	...		....	
19...20	PDI8		PDO8	
21...22	PDI9(1)		PDO9(1)	
...	...		...	
35...36	PDI16(1)		PDO16(1)	

[1] See 4.4.5.1 Standard Telegram 1 and Variants.

For Control and Status Word monitoring values in this telegram, see Table 49.

4.4.5.3 VACON®-specific Telegram 2 and Variants

These telegrams (Table 54) use VACON® defined control word, status word, speed setpoint value, and speed actual value to access the AC drive application directly. The difference to vendor telegram 1 types are the added general control and status words.

Table 54: Vendor Telegram 2 and Variants

Telegram Number	Telegram	Abbreviation
117	Vendor Telegram 2	Vendor 2
118	Vendor Telegram 2 + 1 Process Data	Vendor 2 + 1 PD
119	Vendor Telegram 2 + 2 Process Data	Vendor 2 + 2 PD
120	Vendor Telegram 2 + 3 Process Data	Vendor 2 + 3 PD
121	Vendor Telegram 2 + 4 Process Data	Vendor 2 + 4 PD
122	Vendor Telegram 2 + 5 Process Data	Vendor 2 + 5 PD
123	Vendor Telegram 2 + 6 Process Data	Vendor 2 + 6 PD
124	Vendor Telegram 2 + 7 Process Data	Vendor 2 + 7 PD
125	Vendor Telegram 2 + 8 Process Data	Vendor 2 + 8 PD
142	Vendor Telegram 2 + 12 Process Data(1)	Vendor 2 + 12 PD
143	Vendor Telegram 2 + 16 Process Data(1)	Vendor 2 + 16 PD

[1] 12 and 16 process data items are available in VACON® NXP AC Drive. See 4.2 Fieldbus Option Board Communication Modes.

When using these telegrams, the process data fields are communicated as 32-bit values. However, when using VACON® NX or VACON® 20 family AC drives, the data is actually 16-bit and transferred in the lower bytes.

Table 55: Process Data Item Definition when Using Vendor Telegram 2

Bytes	VACON® NXP	VACON® 20	VACON® 100 family
1...2	16-bit Process data	16-bit Process data	32-bit process data

Bytes	VACON® NXP	VACON® 20	VACON® 100 family
3...4	Not used	Not used	

Table 56: Vendor Telegram 2 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1...2	FB FIXED CW	4.7.1 Control Word Overview	FB FIXED SW	4.7.2 Status Word Overview
3...4	FB GENERAL CW	4.7.1 Control Word Overview	FB GENERAL SW	4.7.2 Status Word Overview
5...6	FB SPEED REF	4.7.4 Speed Reference and Actual Speed	FB SPEED ACT	4.7.4 Speed Reference and Actual Speed
7...10	PDI1[1]	4.7.5 Process Data	PDO1[1]	4.7.5 Process Data
11...14	PDI2[1]		PDO2[1]	
...	...		...	
35...38	PDI8[1]		PDO8[1]	
39...42	PDI9[2]		PDO9[2]	
...	...		...	
67...70	PDI16[2]		PDO16[2]	

[1] 32-bits. See Table 55.

[2] See 4.4.5 Telegram Types.

For Control and Status Word monitoring values in this telegram, see Table 49.

4.4.5.4 VACON®-specific Telegram 3 and Variants

The telegrams listed in Table 57 use PROFIdrive-defined control word, status word, speed setpoint value, and speed actual value with VACON® general control and status words for added functionality.

NOTE! When board is connected to VACON® 100 family AC drive and its mode parameter is set to "NX Mode", the option board uses FBSpeedReference/FBSpeedActual instead of NSOLL_A/ NIST_A as backward compatibility for OPTCP option board.

Table 57: Vendor Telegram 3 and Variants

Telegram Number	Telegram	Abbreviation
126	Vendor Telegram 3	Vendor 3
127	Vendor Telegram 3 + 1 Process Data	Vendor 3 + 1 PD
128	Vendor Telegram 3 + 2 Process Data	Vendor 3 + 2 PD
129	Vendor Telegram 3 + 3 Process Data	Vendor 3 + 3 PD
130	Vendor Telegram 3 + 4 Process Data	Vendor 3 + 4 PD
131	Vendor Telegram 3 + 5 Process Data	Vendor 3 + 5 PD
132	Vendor Telegram 3 + 6 Process Data	Vendor 3 + 6 PD
133	Vendor Telegram 3 + 7 Process Data	Vendor 3 + 7 PD
134	Vendor Telegram 3 + 8 Process Data	Vendor 3 + 8 PD
144	Vendor Telegram 3 + 12 Process Data[1]	Vendor 3 + 12 PD

Telegram Number	Telegram	Abbreviation
145	Vendor Telegram 3 + 16 Process Data[1]	Vendor 3 + 16 PD

[1] 12 and 16 process data items are available in VACON® NXP AC Drive. See 4.2 Fieldbus Option Board Communication Modes.

When using these telegrams, the process data fields are communicated as 32-bit values. However, when using VACON® NXP or VACON® 20 family AC drives, the data is actually 16 bits and transferred in the lower bytes.

Table 58: Process Data Item Definition when Using Vendor Telegram 3

Bytes	VACON® NXP	VACON® 20 / 20 X	VACON® 100 family
1...2	16-bit Process data	16-bit Process data	32-bit process data
3...4	Not used	Not used	

Table 59: Vendor Telegram 3 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1...2	STW1	4.4.6.1 PROFIdrive 4.1 Control Word (STW1)	ZSW1	4.4.6.2 PROFIdrive 4.1 Status Word (ZSW1)
3...4	FB GENERAL CW	4.7.1 Control Word Overview	FB GENERAL SW	4.7.2 Status Word Overview
5...6	NSOLL_A	4.4.6.3 Setpoint Value	NIST_A	4.4.6.4 Actual Speed Value
7...10	PDI1[1]	4.7.5 Process Data	PDO1[1]	4.7.5 Process Data
11...14	PDI2[1]		PDO2[1]	
...	...		...	
35...38	PDI8[1]		PDO8[1]	
39...42	PDI9[2]		PDO9[2]	
...	...		...	
67...70	PDI16[2]		PDO16[2]	

[1] 32-bit. See Table 58.

[2] See 4.4.5 Telegram Types.

For Control and Status Word monitoring values in this telegram, see Table 49.

4.4.5.5 VACON®-specific Telegram 4 and Variants

Use the telegram types listed in Table 60 as a replacement for the OPT-CP option board, when using "Bypass mode".

These telegram types can also be used when the PROFIdrive functionality is required and a VACON® application with PROFIdrive state machine is activated (for example, VACON® NXP Advanced Application).

Table 60: Vendor Telegram 4 and Variants

Telegram Number	Telegram	Abbreviation
135	Vendor Telegram 4	Vendor 4
136	Vendor Telegram 4 + 4 Process Data	Vendor 4 + 4 PD
137	Vendor Telegram 4 + 8 Process Data	Vendor 4 + 8 PD
146	Vendor Telegram 4 + 12 Process Data	Vendor 4 + 12 PD

Telegram Number	Telegram	Abbreviation
147	Vendor Telegram 4 + 16 Process Data	Vendor 4 + 16 PD

Table 61: Vendor Telegram 4 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1...2	FB FIXED CW	4.7.1 Control Word Overview	FB GENERAL SW	4.7.2 Status Word Overview
3...4	FB SPEED REF	4.7.4 Speed Reference and Actual Speed	FB SPEED ACT	4.7.4 Speed Reference and Actual Speed
5...6	PDI1	4.7.5 Process Data	PDO1	4.7.5 Process Data
7...8	PDI2		PDO2	
...	...		...	
19...20	PDI8		PDO8	
21...22	PDI9[1]		PDO9[1]	
...	...		...	
35...36	PDI16[1]		PDO16[1]	

[1] See 4.4.5 Telegram Types.

For Control and Status Word monitoring values in this telegram, see Table 49.

4.4.5.6 VACON®-specific Telegram 5 and Variants

These telegrams (Table 62) contains only FB General Control Word / FB General Status Word and process data items to allow the application to define fully the content of the telegram, that is, "Free". Practical use of this telegram requires custom application in the drive.

Table 62: Vendor Telegram 5 and Variants

Telegram Number	Telegram	Abbreviation
151	Vendor Telegram 5	Vendor 5
152	Vendor Telegram 5 + 4 Process Data	Vendor 5 + 4 PD
153	Vendor Telegram 5 + 8 Process Data	Vendor 5 + 8 PD
154	Vendor Telegram 5 + 12 Process Data	Vendor 5 + 12 PD
155	Vendor Telegram 5 + 16 Process Data	Vendor 5 + 16 PD

Table 63: Vendor Telegram 5 Setpoint and Actual Data

Bytes	Setpoint		Actual value	
1..2	FB GENERAL CW	4.7.1 Control Word Overview	FB GENERAL SW	4.7.2 Status Word Overview
3..4	PDI 1	4.7.5 Process Data	PDI 1	4.7.5 Process Data
…	…		…	
33..34	PDI 16		PDO 16	

4.4.5.7 VACON®-specific Telegram Vendor PPO and Variants

This telegram is usable only in NX Mode and in OPTCx Mode. These telegrams are defined in OPTCP GSDML. These telegrams use PROFIdrive 2.0 state machine from OPTCP.

Table 64: Vendor Telegram Vendor PPO and Variants

Telegram Number	Telegram	Abbreviation
148	Vendor PPO3	Vendor PPO3
149	Vendor PPO4	Vendor PPO3 + 4 PD
150	Vendor PPO6	Vendor PPO3 + 8 PD

Table 65: Vendor Telegram Vendor PPO Setpoint and Actual Data

Bytes	Setpoint	Actual value
1...2	Vendor PPO control word	Vendor PPO status word
3...4	Vendor PPO speed reference	Vendor PPO actual speed

Vendor PPO Speed Reference/Actual Speed allows values from -10000 to +10000. Value is scaled between minimum and maximum frequency parameters.

Table 66: Control Word for the OPTCP Vendor PPO Telegrams

Bit	Description for Value = 0	Description for Value = 1
0	STOP 1 (by ramp)	ON 1
1	STOP 2 (by coast)	ON 2
2	STOP 3 (by ramp)	ON 3
3	RUN DISABLE	ENABLE
4	No action	START
5	No action	START
6	No action	START
7	No action	FAULT RESET (0 ->1)
8	No action	No action
9	No action	No action
10	Disable fieldbus control	Enable fieldbus control
11	Fieldbus DIN 1=OFF	Fieldbus DIN 1=ON
12	Fieldbus DIN 2=OFF	Fieldbus DIN 2=ON
13	Fieldbus DIN 3=OFF	Fieldbus DIN 3=ON
14	Fieldbus DIN 4=OFF	Fieldbus DIN 4=ON
15	Fieldbus DIN 5=OFF	Fieldbus DIN 5=ON

Table 67: Status Word for the OPTCP Vendor PPO Telegrams

Bit	Description for Value = 0	Description for Value = 1
0	Not Ready (initial)	READY 1[(1)]
1	Not Ready	READY 2[(1)]
2	DISABLE	ENABLE[(1)]

Bit	Description for Value = 0	Description for Value = 1
3	NO FAULT	FAULT ACTIVE[1]
4	STOP 2	NO STOP 2[1]
5	STOP 3	NO STOP 3[1]
6	START ENABLE	START DISABLE[1]
7	No Warning	Warning[2]
8	Reference ≠ Actual value	Reference = Actual value[2]
9	Fieldbus control OFF	Fieldbus control ON[2]
10	Not used	Not used
11	Not used	Not used
12	FC stopped	Running
13	FC not ready	FC ready[2]
14	Not used	Not used
15	Not used	Not used

[1] Bits of the State Machine

[2] Comes straight from the drive

4.4.6 Telegram Building Blocks

4.4.6.1 PROFIdrive 4.1 Control Word (STW1)

NOTE! OPTEA in OPTCx mode does the same FBDIN bit mapping as OPTCP option board does.

Table 68: PROFIdrive 4.1 Control Word (STW1)

Bits	Title	Value = 1	Value = 0	Description
0	Switching ON/OFF	1 = Switch ON	0 = Switch OFF	This bit is used with other bits to enable operation of the drive. When this bit is set to 0 during operation, the drive performs a ramp stop.
1	Coast stop command	1 = No coast stop	0 = Perform coast stop	This bit is used to request a coast stop to be executed. When it is set to 0 during operation, the drive performs a coast stop.
2	Quick stop command	1 = No quick stop	0 = Perform quick stop	This bit is used to request a quick stop to be executed. When it is set to 0 during operation, the drive quickly ramps down to zero speed and stops.
3	Enabling of operation	1 = Enable operation	0 = Disable operation	This bit is used with other bits to enable operation of the drive. When it is set to 0 during operation, the drive performs a coast stop.
4	Enabling of ramp generator	1 = Enable ramp generator	0 = Reset ramp generator	This bit is used with other bits to enable operation of the drive. When it is set to 0 during operation, the drive quickly decelerates to zero speed.
5	Freezing of setpoint value	1 = Unfreeze setpoint value	0 = Freeze setpoint value	This bit can be used to freeze the setpoint value used by the drive. The value is frozen if this bit is set to 0. If the bit is 1, the setpoint value provided by the PROFIBUS DP master is continuously updated.

Bits	Title	Value = 1	Value = 0	Description
6	Enabling of setpoint value	1 = Enable setpoint value	0 = Disable setpoint value	This bit can be used to disable the fieldbus setpoint value. If this bit is set to 0, the PROFIBUS DP option board ignores the setpoint value by the master and instead uses a setpoint value of 0. During operation, if this bit is set to 0, the drive decelerates to a standstill.
7	Fault acknowledge	1 = Acknowledge fault (0 -> 1)		This bit is used to acknowledge faults in the drive. When a rising edge (0 -> 1) is seen in this bit by the PROFIBUS DP option board, it requests the drive to acknowledge present faults. The functionality of this bit is rising-edge sensitive only.
8	Reserved			
9	Reserved			
10[1]	Control by PLC	1 = Control by PLC	0 = No Control by PLC	This bit is used by the PROFIBUS DP master to indicate that it is in control of the slave and that the commands sent via fieldbus are valid. During operation, this bit must be 1. If the drive is not operating and this bit is 0, the drive cannot be started. If the drive is operating, and this bit becomes 0, the option board freezes the process data provided to the drive, and sets its state to FAULT. The drive reaction to this fieldbus fault depends on the drive parameterization.
11–15	Reserved			

[1] Bits in a control word do not have any effect unless bit 10 is enabled.

4.4.6.2 PROFIdrive 4.1 Status Word (ZSW1)

Table 69: PROFIdrive 4.1 Status Word (ZSW1)

Bits	Title	Value = 1	Value = 0	Description
0	Readiness to switch on	1 = Ready to switch on	0 = Not ready to switch on	This bit indicates whether the drive is ready to switch on the power electronics. When the bit has the value 0, the drive is not ready to switch on the power electronics. When the bit has the value 1, the drive is ready to switch on the power electronics.
1	Readiness to operate	1 = Ready to operate	0 = Not ready to operate	This bit indicates whether the drive is ready to begin operation. When the bit has the value 0, the power electronics is switched off and the drive is unable to begin operation. When the bit has the value 1, the power electronics is switched on and the drive can begin operation when requested by the master.
2	State of operation	1 = Operation enabled (drive follows setpoint)	0 = Operation disabled	This bit indicates whether the drive is operating or not. When the bit has the value 0, the drive is not operating. When the bit has the value 1, the drive is operating.
3	Presence of fault	1 = Fault present	0 =No Fault	This bit indicates the presence of unacknowledged faults in the drive. When the bit has the value 0, no unacknowledged faults are present in the drive. When the bit has the value 1, at least one unacknowledged fault is present in the drive.
4	Coast stop activated	1 =Coast stop not activated	0 = Coast stop activated	This bit indicates whether a coast stop command is active or not. When the bit has the value 0, a coast stop command is active. When the bit has the value 1, no coast stop command is active.

Bits	Title	Value = 1	Value = 0	Description
5	Quick stop activated	1 = Quick stop not activated	0 = Quick stop activated	This bit indicates whether a quick stop command is active or not. When the bit has the value 0, a quick stop command is active. When the bit has the value 1, no quick stop command is active.
6	Switching on inhibition	1 = Switching on inhibited	0 = Switching on not inhibited	This bit indicates whether the power electronics can be switched on or not. When the bit has the value 0, the power electronics can be switched on. When the bit has the value 1, the power electronics are prevented from switching on.
7	Presence of warning	1 = Warning present	0 = No warning present	This bit indicates the presence of warning/alarm information in the drive. When the bit has the value 0, no warning is present. When the bit has the value 1, a warning is present.
8	Running at setpoint	1 = Speed error within tolerance range	0 = Speed error out of tolerance range	This bit indicates whether the drive is operating and the actual speed value matches the setpoint value. When the bit has the value 0, the actual speed value does not match the setpoint value. When the bit has the value 1, the actual speed value matches the setpoint value.
9	Request control by master	1 = Control by PLC requested	0 = Control by PLC not requested	This bit indicates whether the fieldbus master must take control of the drive. When this bit has the value 0, the master need not take control of the drive. When this bit has the value 1, the master is requested take control of the drive. In OPTEA and OPTE9 , this bit depends on the configuration for the drive control place. If the control place is assigned to fieldbus, the bit has the value 1. If the control place is elsewhere, the bit has the value 0.
10	Setpoint reached or exceeded	1 = f or n reached or exceeded	0 = f or n not reached	This bit indicates whether the setpoint value has been reached or exceeded. When this bit has the value 0, the setpoint value has not been reached or exceeded. When this bit has the value 1, the setpoint value has been reached or exceeded.
11	Reserved			
12	Running indication	1 = Drive is running	0 = Drive is stopped	This bit indicates whether the drive is in the RUN state or not. When this bit has the value 0, the drive is not running. When this bit has the value 1, the drive is in the RUN state.
13	Readiness to operate	1 = Drive is ready for operation	0 = Drive is not ready for operation	This bit indicates whether the drive is in the READY state or not. When this bit has the value 0, the drive is not ready to operate. When this bit has the value 1, the drive is in the READY state.
14-15	Reserved			

4.4.6.3 Setpoint Value

Normalized 16-bit speed setpoint (containing a sign bit and a 15-bit integer).

Table 70: PROFIdrive Speed Setpoint Value NSOLL_A

Setpoint value	Speed	Direction of rotation	Description of command
0xC000 (-16384d)	-100.00%	REVERSE	Full speed in REVERSE direction
0x0000 (0d)	0.00%	N/A	Minimum speed
0x4000 (16384d)	+100.00%	FORWARD	Full speed in FORWARD direction

PNU 10111 shows the "100%" speed as RPM.

NOTE! When the board is connected to VACON® 100 family AC drive and its mode parameter is set to "NX Mode", the option board uses FBSpeedReference instead of NSOLL_A as backward compatibility for OPTCP option board. It results in value range 0d–10000d. See 4.7.4 Speed Reference and Actual Speed for details.

4.4.6.4 Actual Speed Value

Normalized 16-bit speed actual value (containing a sign bit and a 15-bit integer).

Table 71: PROFIdrive Speed Actual Value NIST_A

Actual value	Speed	Direction of rotation	Description of value
0xC000 (-16384d)	-100.00%	REVERSE	Full speed in REVERSE direction
0x0000 (0d)	0.00%	N/A	Standstill
0x4000 (16384d)	+100.00%	Status Word dependent	Full speed in FORWARD direction

PNU 10111 shows the "100%" speed as RPM.

NOTE! When the board is connected to VACON® 100 family AC drive and its mode parameter is set to "NX Mode", the option board uses FBSpeedActual instead of NIST_A as backward compatibility for OPTCP option board. It results in value range 0d–10000d. See 4.7.4 Speed Reference and Actual Speed for details.

4.4.7 PROFIdrive Signal Numbers

Table 72: PROFIdrive Signal Numbers

Signal number	Signal name	PNU	PNU name
1	Control word 1	10100	PROFIdrive control word (STW1)
2	Status word 1	10102	PROFIdrive status word (ZSW1)
5	Speed setpoint A	10101	PROFIdrive speed setpoint value (NSOLL_A)
6	Speed actual value A	10103	PROFIdrive speed actual value (NIST_A)
51	Output current	10104	Always returns zero.
52	Active current (torque proportional)	10105	Always returns zero.
54	Active power	10106	Always returns zero.
57	Speed actual value A	10107	Always returns zero.
58	Drive status/fault word	10108	Always returns zero.
90	Safety control word 1	10200	PROFISAFE safety control word 1 (S_STW1)
91	Safety status word 1	10201	PROFISAFE safety status word 1 (S_ZSW1)
93	Safety control word 2	10202	PROFISAFE safety control word 2 (S_STW2)
94	Safety status word 2	10203	PROFISAFE safety status word 2 (S_ZSW2)
100	VACON® PDO1	10110	VACON® 16-bit Process Data Out
101	VACON® PDO2	10110	VACON® 16-bit Process Data Out
102	VACON® PDO3	10110	VACON® 16-bit Process Data Out
103	VACON® PDO4	10110	VACON® 16-bit Process Data Out
104	VACON® PDO5	10110	VACON® 16-bit Process Data Out
105	VACON® PDO6	10110	VACON® 16-bit Process Data Out

Signal number	Signal name	PNU	PNU name
106	VACON® PDO7	10110	VACON® 16-bit Process Data Out
107	VACON® PDO8	10110	VACON® 16-bit Process Data Out
110	VACON® PDI1	10109	VACON® 16-bit Process Data In
111	VACON® PDI2	10109	VACON® 16-bit Process Data In
112	VACON® PDI3	10109	VACON® 16-bit Process Data In
113	VACON® PDI4	10109	VACON® 16-bit Process Data In
114	VACON® PDI5	10109	VACON® 16-bit Process Data In
115	VACON® PDI6	10109	VACON® 16-bit Process Data In
116	VACON® PDI7	10109	VACON® 16-bit Process Data In
117	VACON® PDI8	10109	VACON® 16-bit Process Data In
118	VACON® fixed control word	10112	VACON® Fixed Control Word
119	VACON® fixed status word	10113	VACON® Fixed Status Word
120	VACON® fixed reference value	10114	VACON® Speed reference
121	VACON® fixed actual value	10115	VACON® Speed Actual value
122	VACON® general control word	10120	VACON® General control word
123	VACON® general status word	10121	VACON® General status word
124	VACON® DW PDO1	10123	VACON® 32-bit Process Data Out
125	VACON® DW PDO2	10123	VACON® 32-bit Process Data Out
126	VACON® DW PDO3	10123	VACON® 32-bit Process Data Out
127	VACON® DW PDO4	10123	VACON® 32-bit Process Data Out
128	VACON® DW PDO5	10123	VACON® 32-bit Process Data Out
129	VACON® DW PDO6	10123	VACON® 32-bit Process Data Out
130	VACON® DW PDO7	10123	VACON® 32-bit Process Data Out
131	VACON® DW PDO8	10123	VACON® 32-bit Process Data Out
132	VACON® DW PDI1	10123	VACON® 32-bit Process Data Out
133	VACON® DW PDI2	10123	VACON® 32-bit Process Data Out
134	VACON® DW PDI3	10122	VACON® 32-bit Process Data In
135	VACON® DW PDI4	10122	VACON® 32-bit Process Data In
136	VACON® DW PDI5	10122	VACON® 32-bit Process Data In
137	VACON® DW PDI6	10122	VACON® 32-bit Process Data In
138	VACON® DW PDI7	10122	VACON® 32-bit Process Data In
139	VACON® DW PDI8	10122	VACON® 32-bit Process Data In

Signal number	Signal name	PNU	PNU name
140	VACON® PDO9	10110	VACON® 16-bit Process Data Out
141	VACON® PDO10		
142	VACON® PDO11		
143	VACON® PDO12		
144	VACON® PDO13		
145	VACON® PDO14		
146	VACON® PDO15		
147	VACON® PDO16		
148	VACON® PDI9	10109	VACON® 16-bit Process Data In
149	VACON® PDI10		
150	VACON® PDI11		
151	VACON® PDI12		
152	VACON® PDI13		
153	VACON® PDI14		
154	VACON® PDI15		
155	VACON® PDI16		
156	VACON® DW PDO9	10123	VACON® 32-bit Process Data Out
157	VACON® DW PDO10		
158	VACON® DW PDO11		
159	VACON® DW PDO12		
160	VACON® DW PDO13		
161	VACON® DW PDO14		
162	VACON® DW PDO15		
163	VACON® DW PDO16		
164	VACON® DW PDI9	10122	VACON® 32-bit Process Data In
165	VACON® DW PDI10		
166	VACON® DW PDI11		
167	VACON® DW PDI12		
168	VACON® DW PDI13		
169	VACON® DW PDI14		
170	VACON® DW PDI15		

Signal number	Signal name	PNU	PNU name
171	VACON® DW PDI16		

4.4.8 User-specific Record Data

For easy access to drive parameters and monitoring values, the option boards map the PROFINET user specific record indexes 0x0000 - 0x7FFF directly into the application IDs of the drive. It is based on the IEC 61131 standard. Both read and write access is supported.

NOTE! The response data is in raw format. See application manual for available IDs, amount of decimals and the unit used for the parameters.

IDs can be read/written as VACON® NX scaled values in all AC drives, or, in VACON® 100 family AC drives, also as actual raw value.

Table 73: Application ID Access Settings

Slot	Subslot	Description	Note
1	1	Access IDs as VACON® NX scaled values	-
	2	Access IDs as VACON® 100 family actual data type	Only available in VACON® 100 family AC drives

In the following examples, the following index values are used:

- 102 = Maximum frequency (Hz)
- 600 = Motor control mode

Table 74: Example 1: Reading Values from Different AC Drives

AC drive	Read command: Slot	Read command: Subslot	Read command: Index	Response: Hex	Response: Dec	Response: Actual value
Any	1	1	102	13 88	5000	50.00 Hz
			600	00 01	1	1 = OL Speed
VACON® 100 family	1	2	102	00 07 A1 20	500000	50.0000 Hz
			600	00 00 00 01	1	1 = OL Speed

Table 75: Example 2: Writing Values for Different AC Drives

AC drive	Write command: Slot	Write command: Subslot	Write command: Index	Write command: Length	Write command: Value (Hex)	Actual value
Any	1	1	102	2	11 94	45.00 Hz
			600	2	00 00	0 = OL Frequency
VACON® 100 family	1	2	102	4	00 06 DD D0	45.0000 Hz
			600	4	00 00 00 00	0 = OL Frequency

4.4.9 Connection Timeout in PROFINET

The PROFINET declares a watchdog time within which both master and slave must send I/O back to each other. This watchdog time is a factor of the communication cycle time. The master sets the watchdog time. Minimum cycle time for PROFINET is 1 millisecond.

In normal communication mode, 4 ms is the fastest recommended cycle time for PROFINET. Faster cycle times (1 ms and 2 ms) are recommended in Fast Mode. See 4.2 Fieldbus Option Board Communication Modes for more details.

The PROFINET also declares the process data validity on a submodule level. This validity is informed between provider and consumer with the IOPS (Input/Output Provider State) byte. If the incoming data validity is other than GOOD, this data is ignored and last valid data is used.

When the data state toggles from GOOD to BAD or an I/O message is not received within the watchdog time, the timeout setting value is activated. After the set time, a fault is created. In other words, that the panel parameter "Communication timeout" (see 6.1.2 Comm. Timeout) is used as an extra timeout value. The same behavior applies if a connection is closed or the cable disconnects (link loss). See for the timeout fault logic.

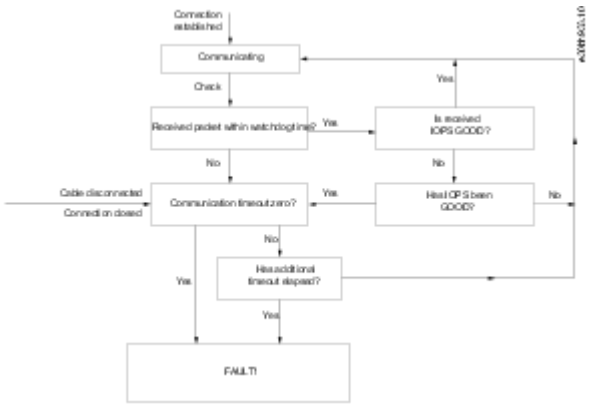


Illustration 21: PROFINET Communication and Timeout Fault

The option board sets its data status to GOOD when it receives valid data from the AC drive. Unless the communication to the AC drive breaks, the data remains GOOD. The IOCs are GOOD when the option board is able to receive and handle I/O data.

4.4.10 Examples with Siemens Controller

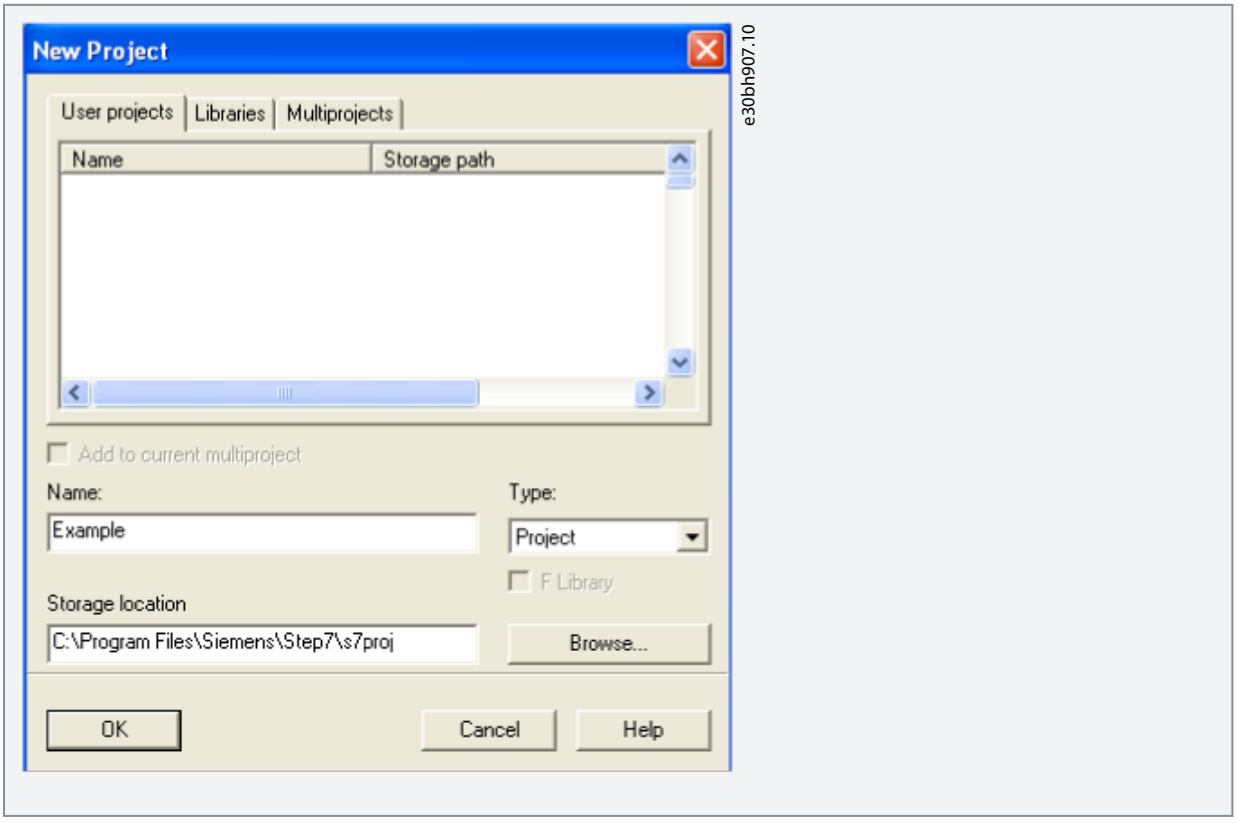
4.4.10.1 Configuring with Step 7

Follow these instructions when configuring the PROFINET connection with Siemens Step 7.

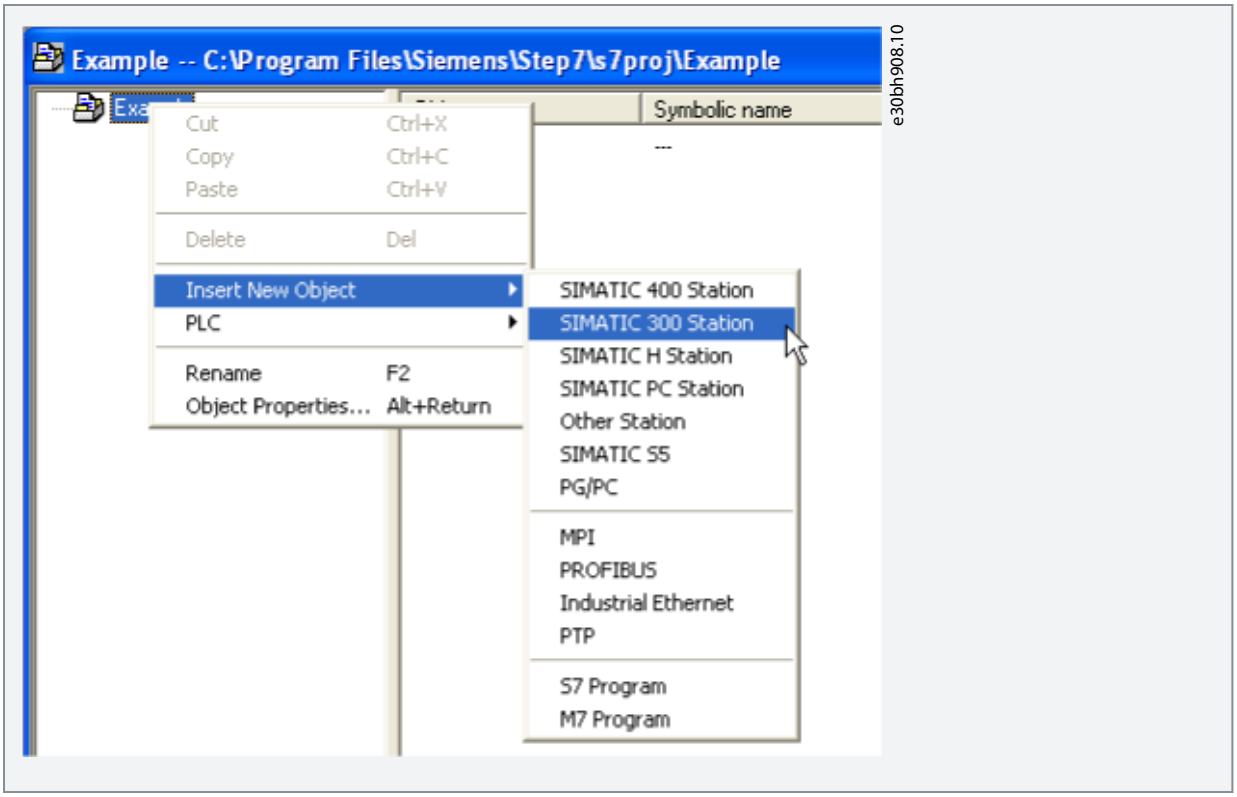
This example is with the OPTEA board. Process is identical with the OPTE9 board without the PROFIsafe related material.

Procedure

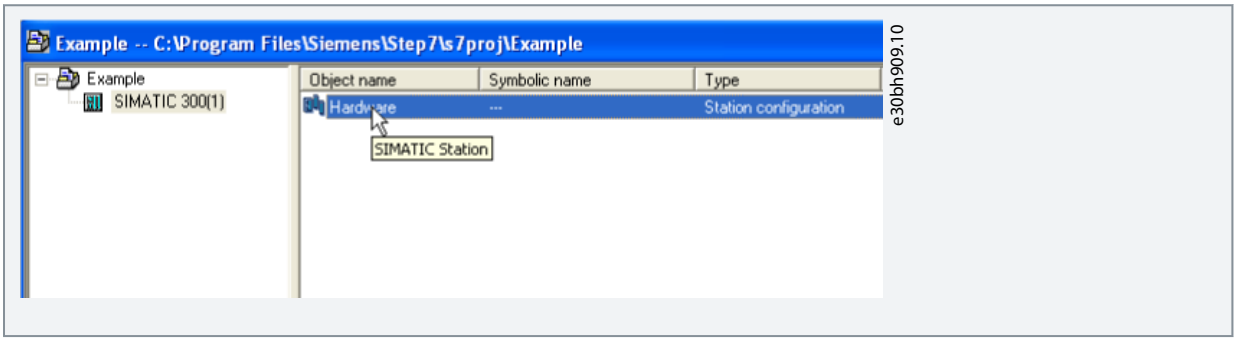
1. Create a project.



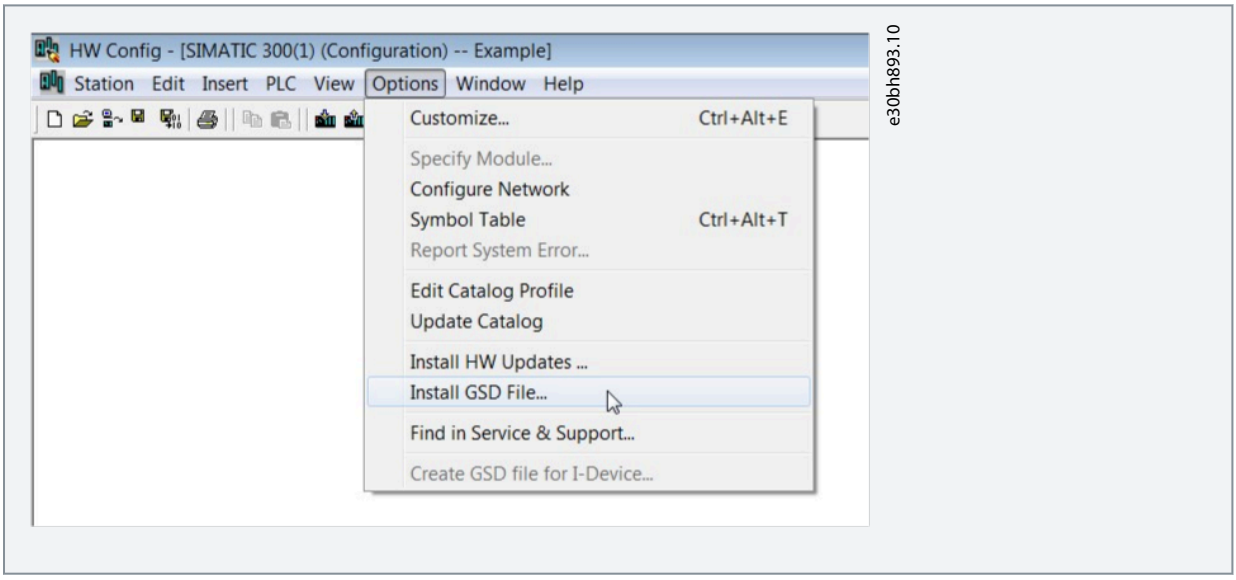
2. Insert the station.



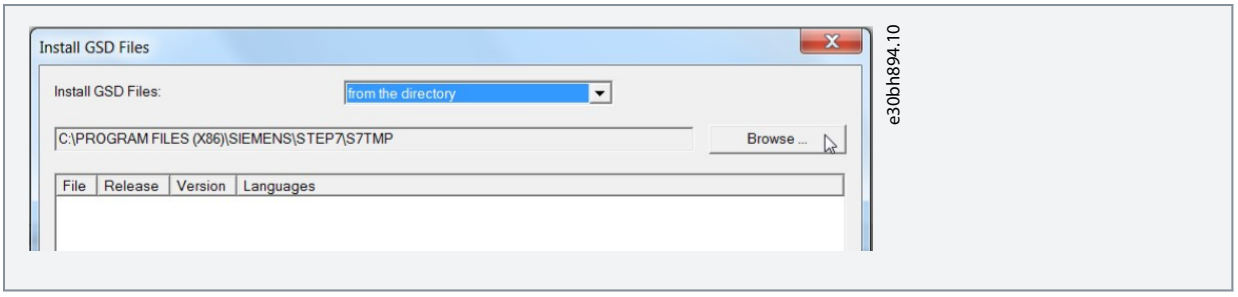
3. To open the *HW config* window, double-click *Hardware*.



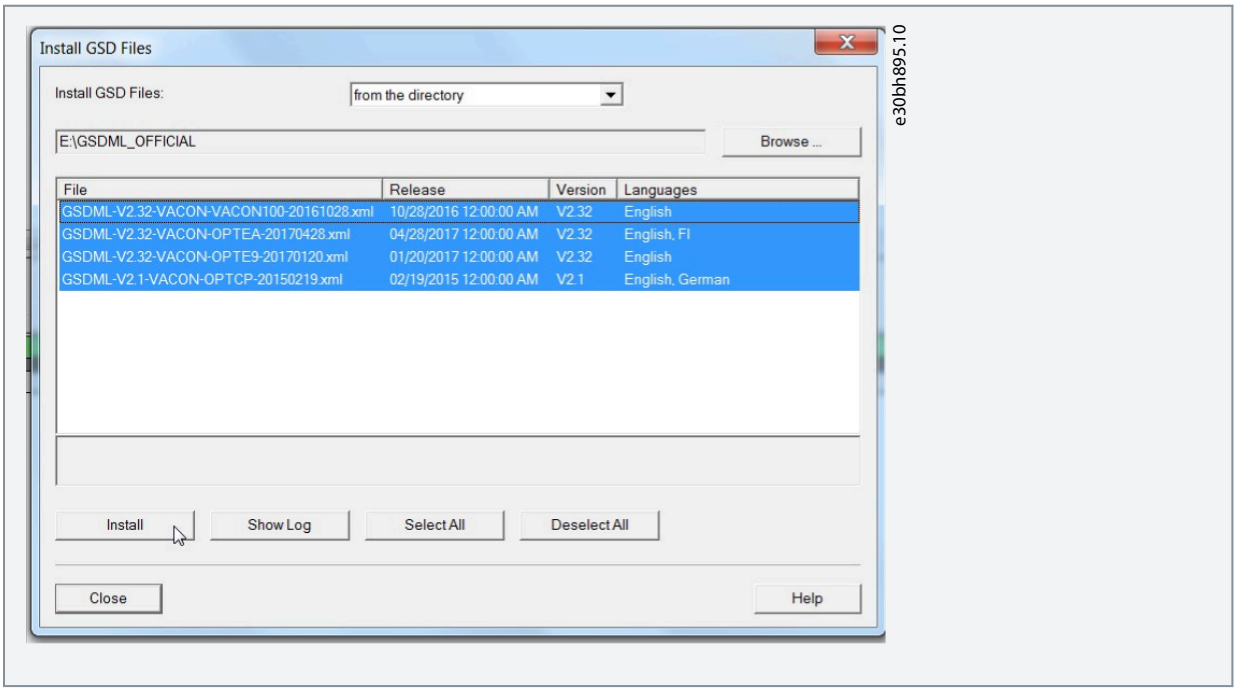
4. Install GSDML for VACON® device. Select Options-> Install GSD File…



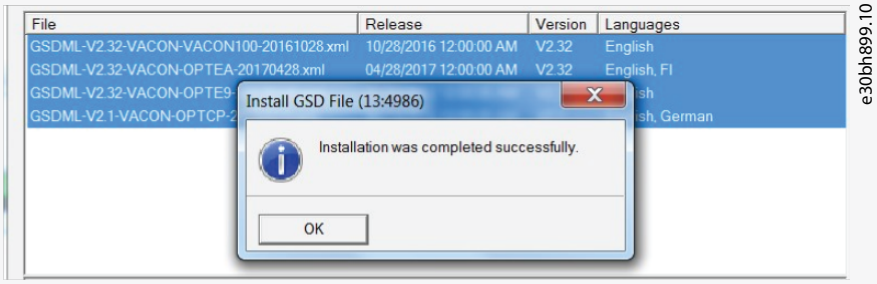
5. Browse to folder where you have stored GSDML files.



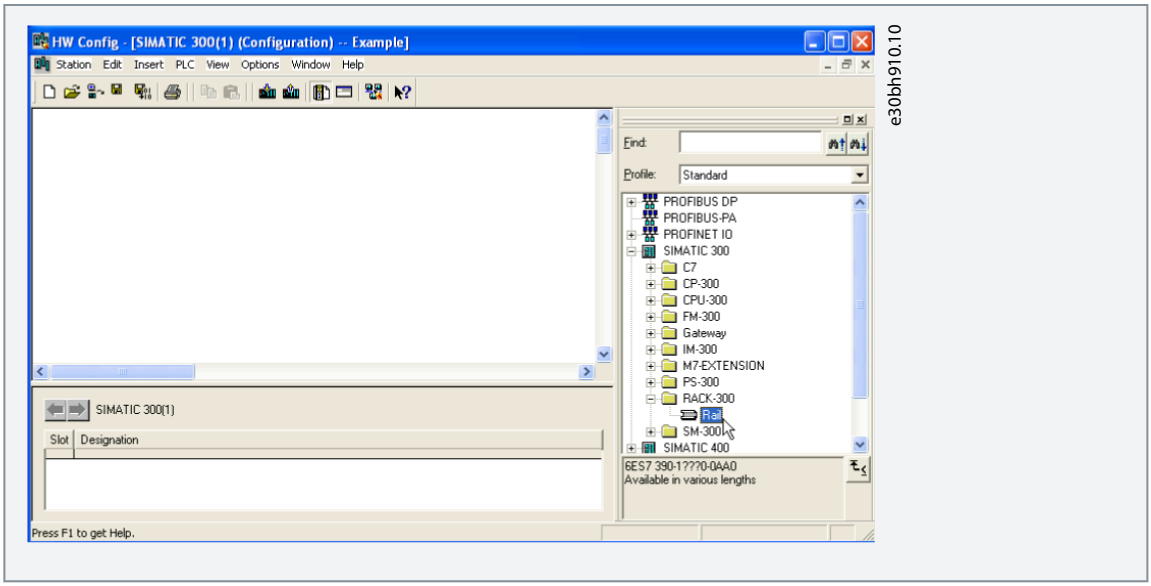
6. Select the required GSDML file(s) and click Install.



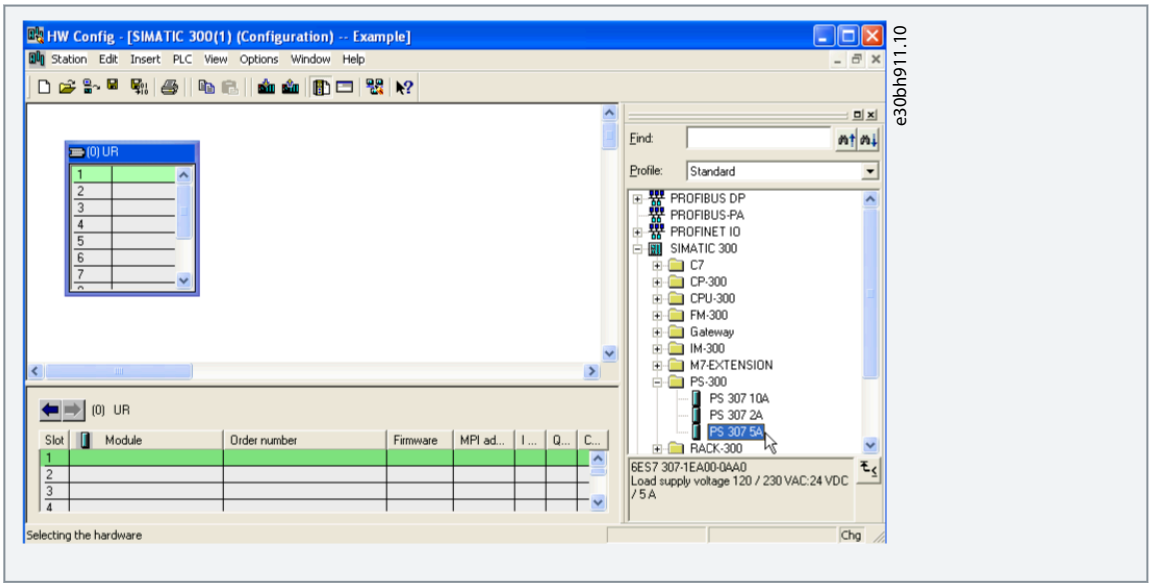
After successful installation, this pop-up opens.



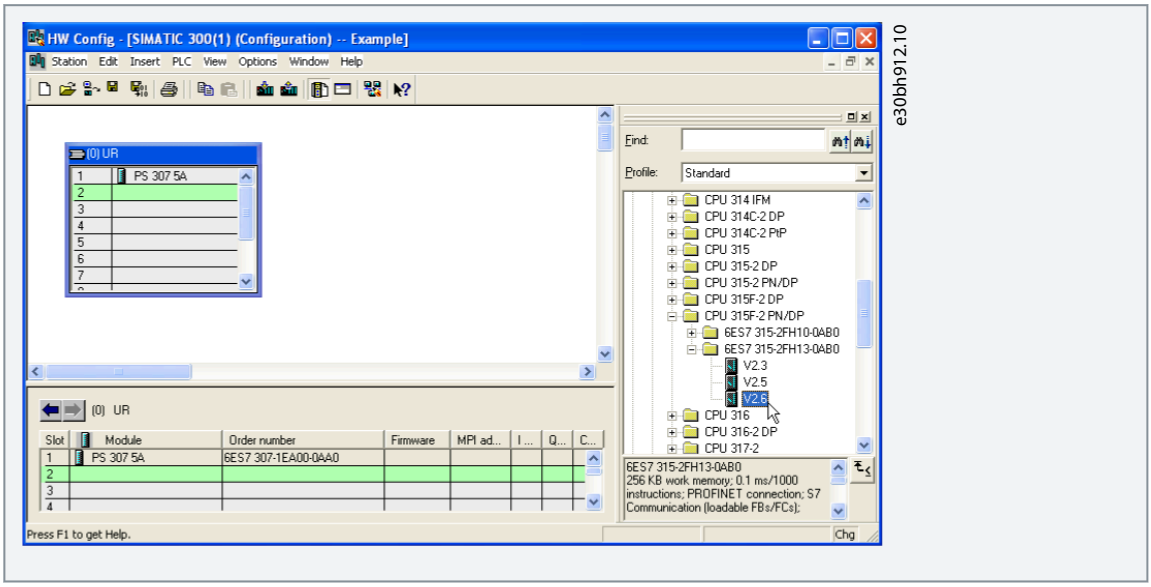
7. Insert hardware information:
   a. Insert the rail.



b. Insert the supply.



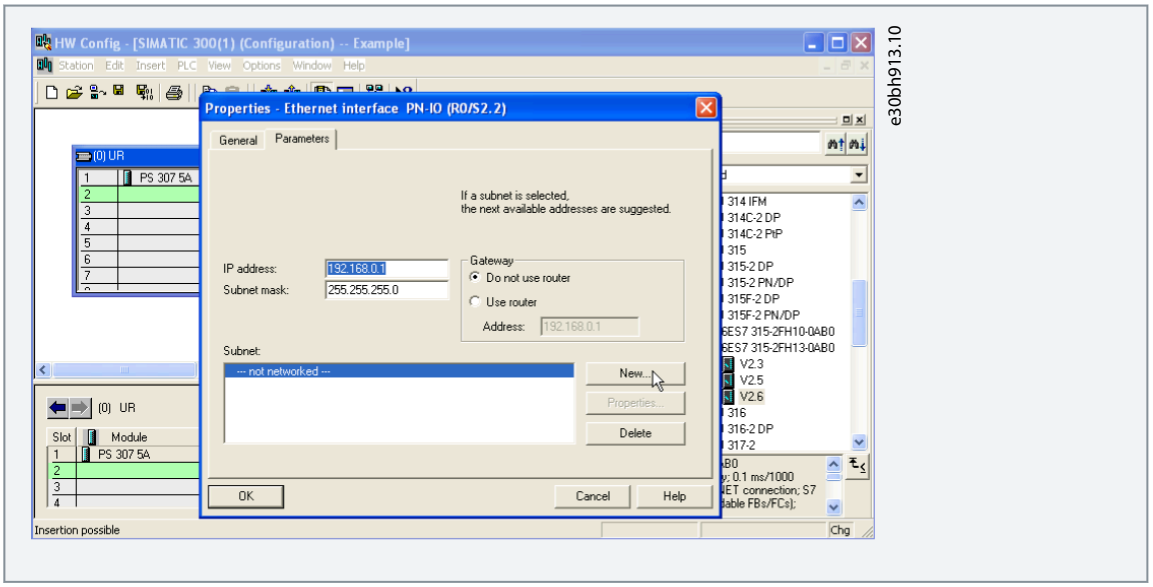
c. Insert the CPU.



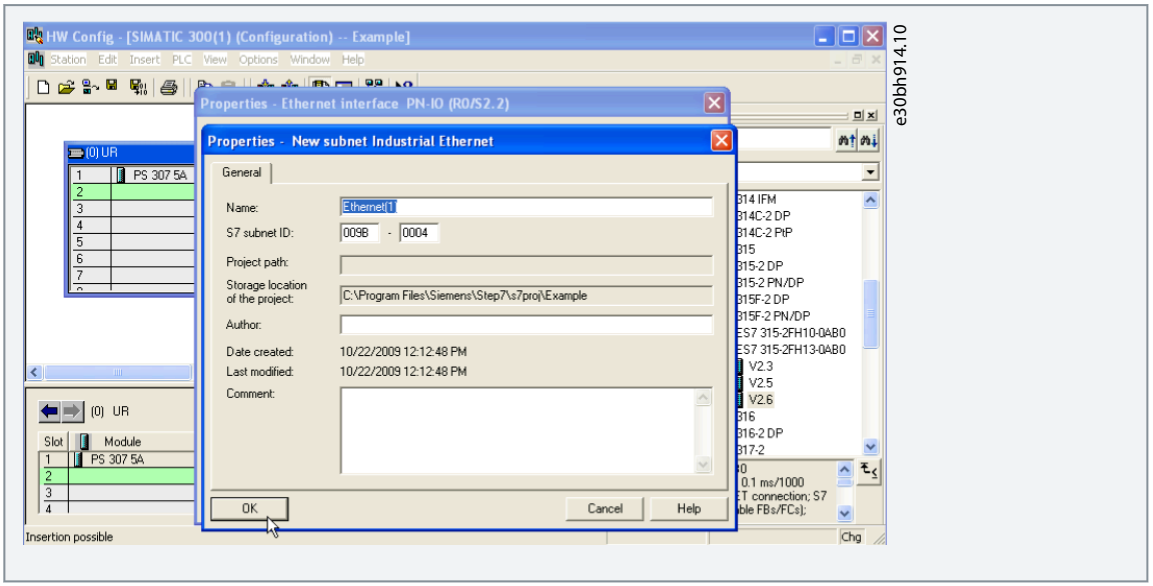
8. Set the Ethernet interface properties:

a. Change the IP address.

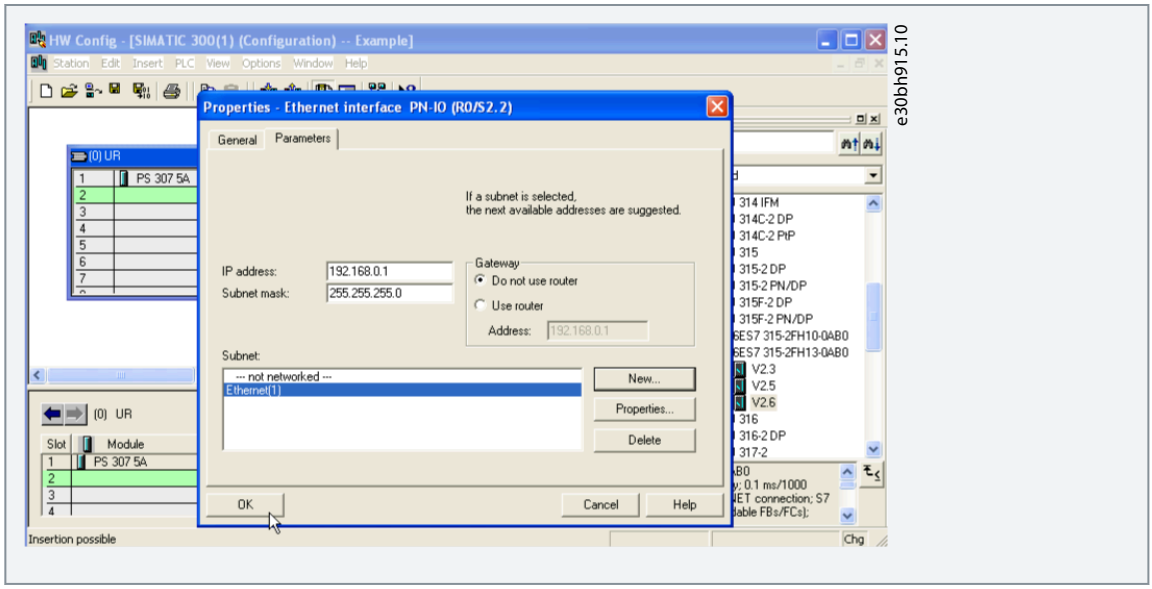
b. To select the subnet, click *New*.

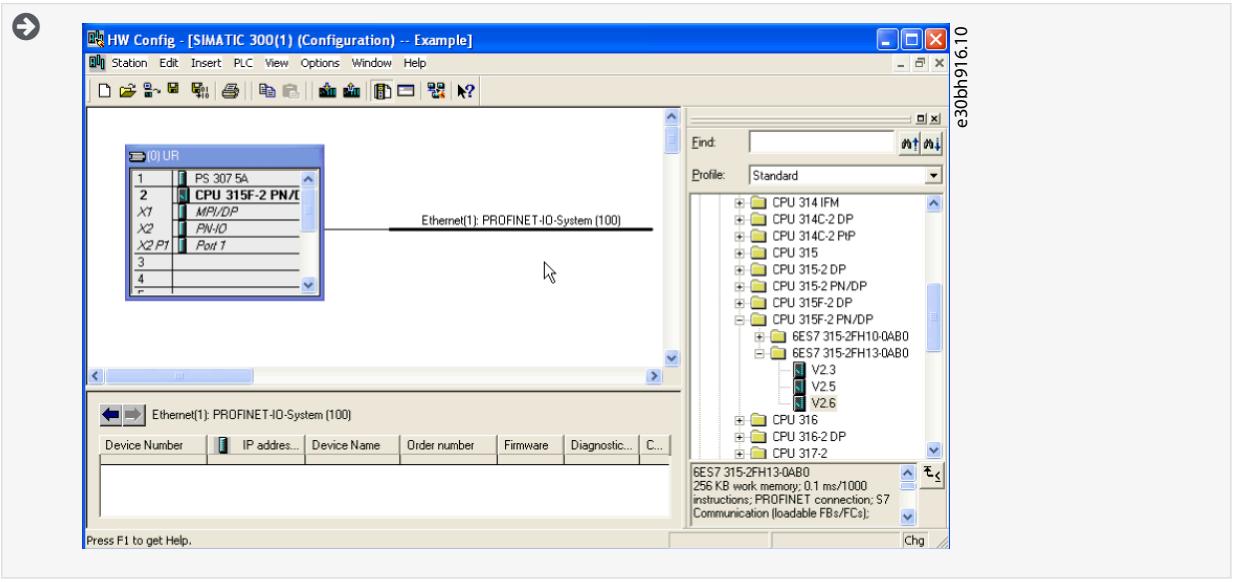


c. Click *OK*.

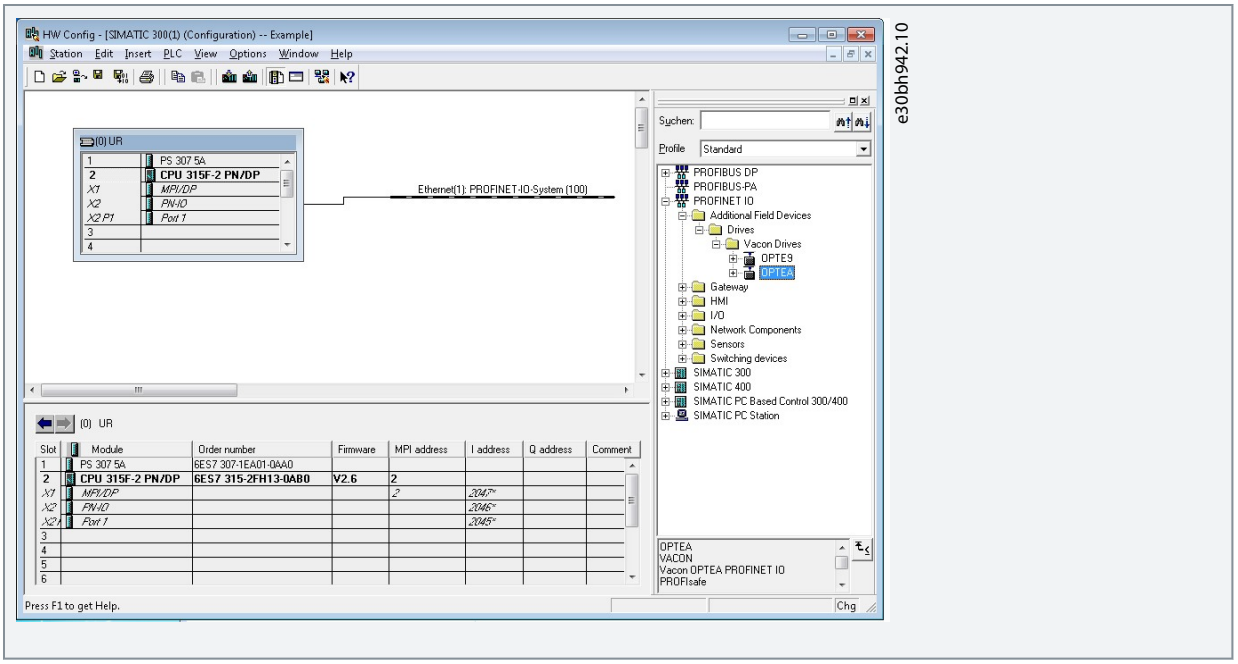


d. Click *OK*.



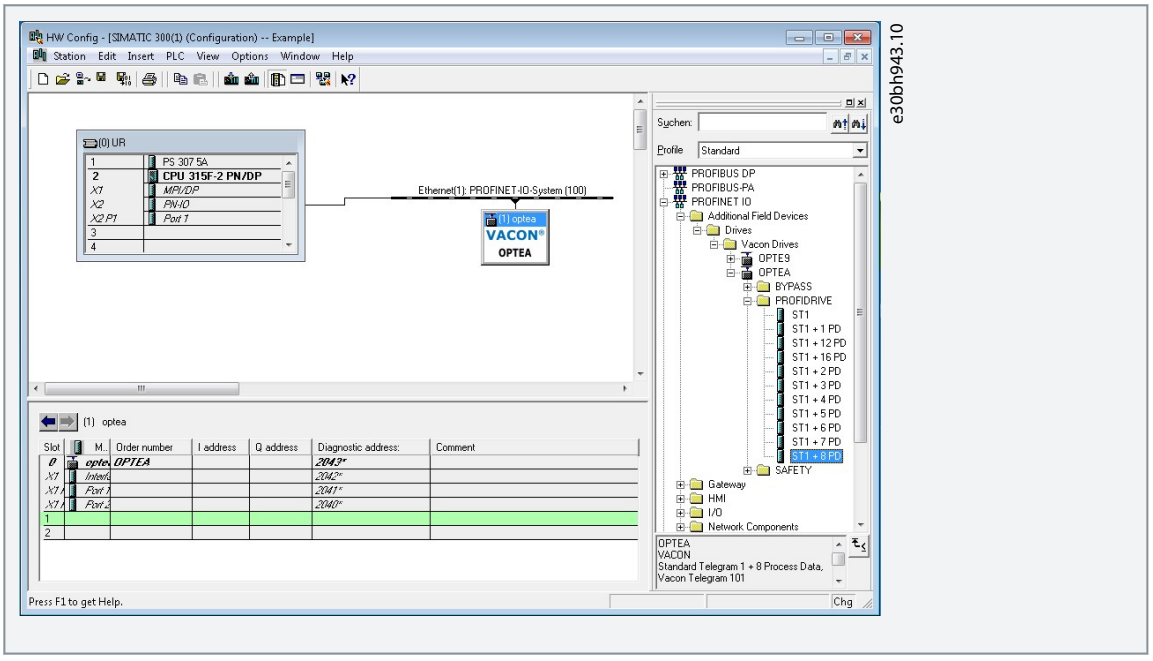


9. Drag and drop the OPTEA to PROFINET I/O system.

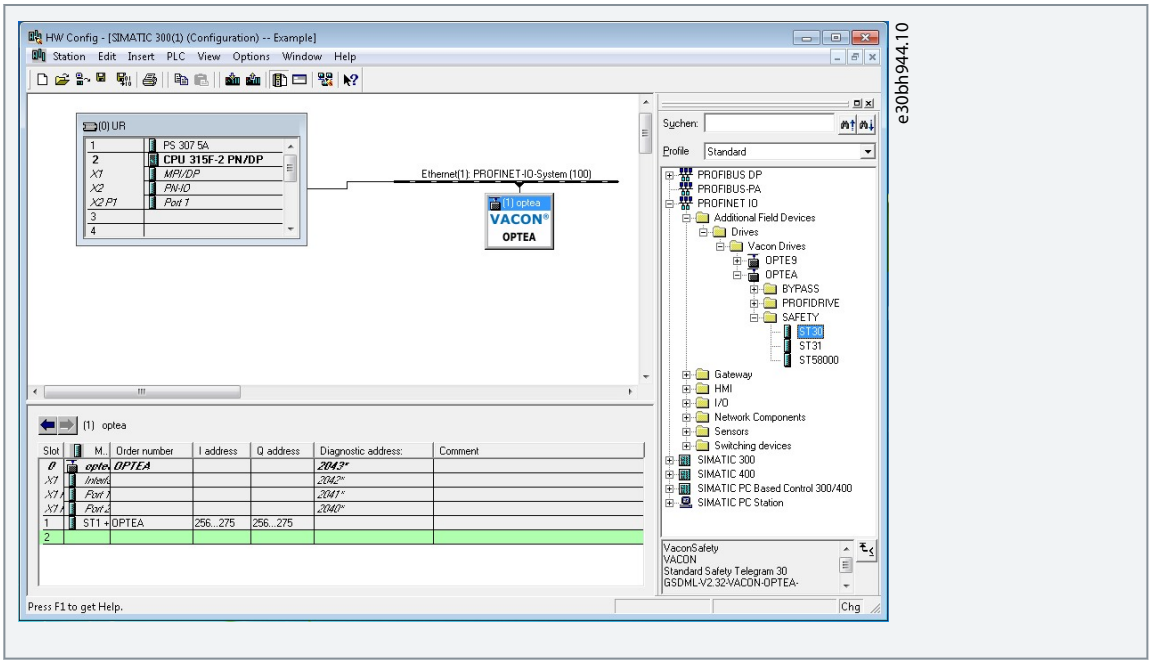


10. Select communication profiles:

    a. Select a PROFIdrive communication profile.



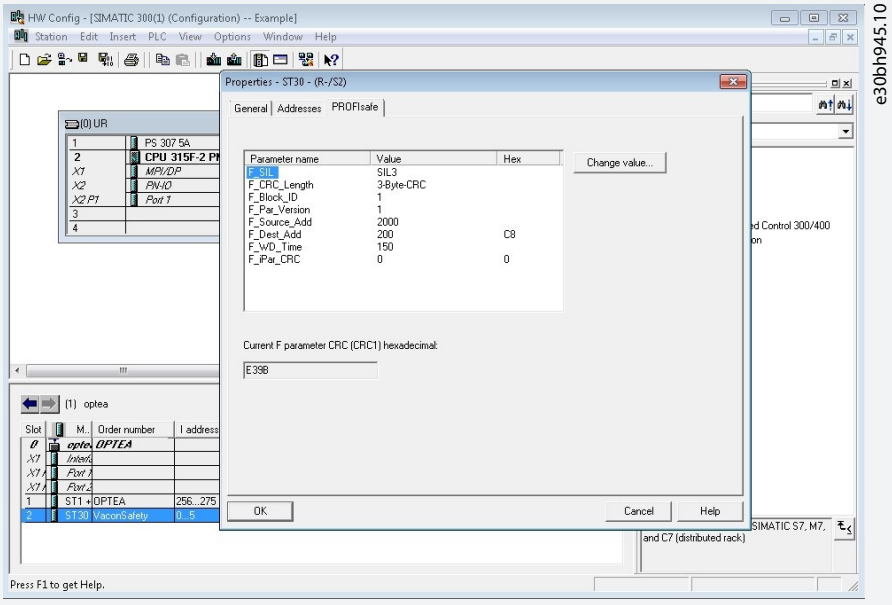
    b. Select a PROFIsafe communication profile.



e30bh944.10

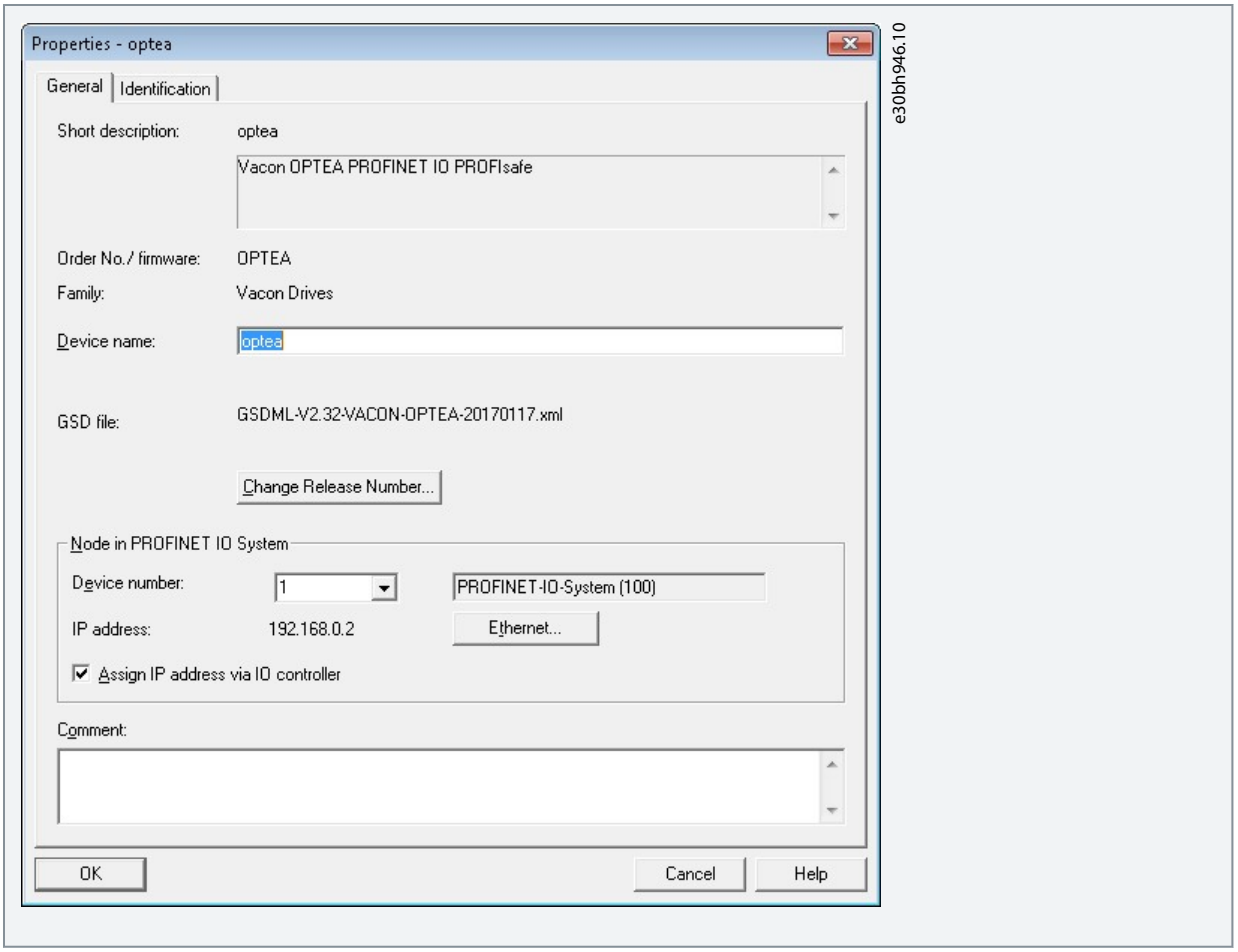
11. To set up PROFISafe parameters, double-click the inserted safety telegram.

Set the same safe fieldbus parameters as when creating the safety configuration with VACON® Safe PC tool. For example, the F_iPar_CRC was calculated with the VACON® Safe PC tool.

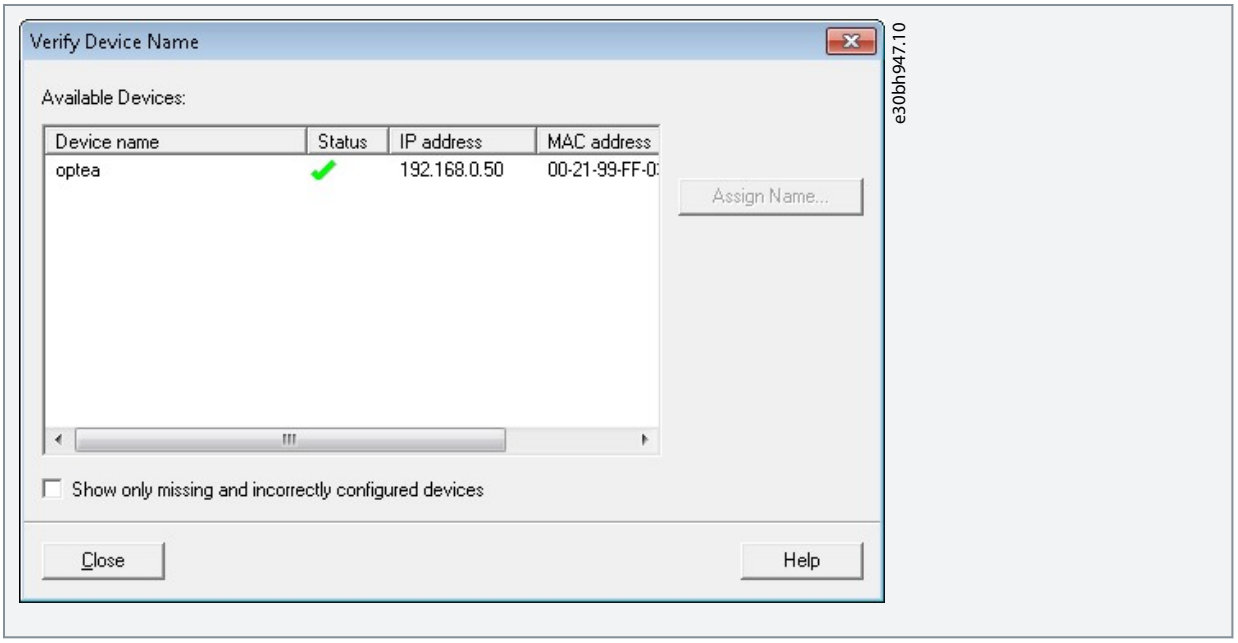


e30bh945.10

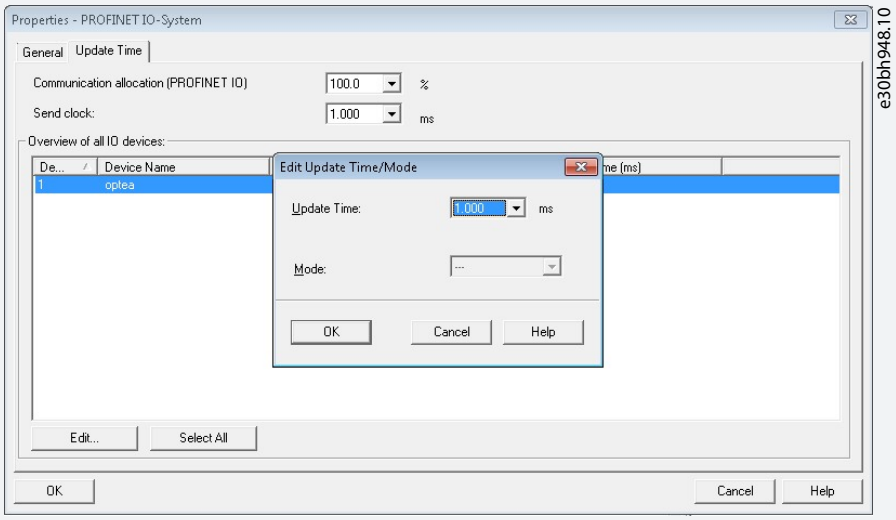
12. Change the option board properties.



13. To verify the Device Name, select *PLC -> Ethernet -> Verify Device Name*.



14. Set the I/O cycle.



For details, see 4.4.9 Connection Timeout in PROFINET.

4.4.10.2 Configuring with TIA Portal

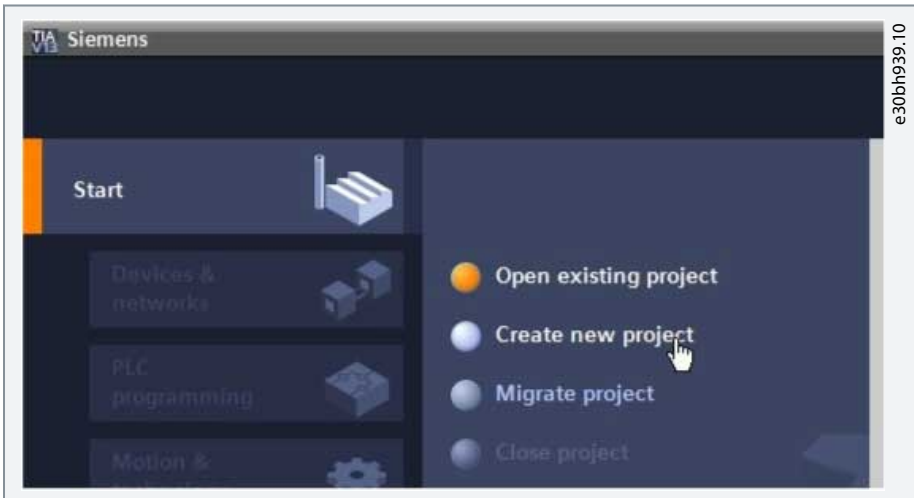
Follow these instructions when configuring the Siemens S7-300 PLC series to use the VACON® OPTEA option board with the Siemens TIA Portal programming tool.

This example is with the OPTEA board. Process is identical with the OPTE9 board.

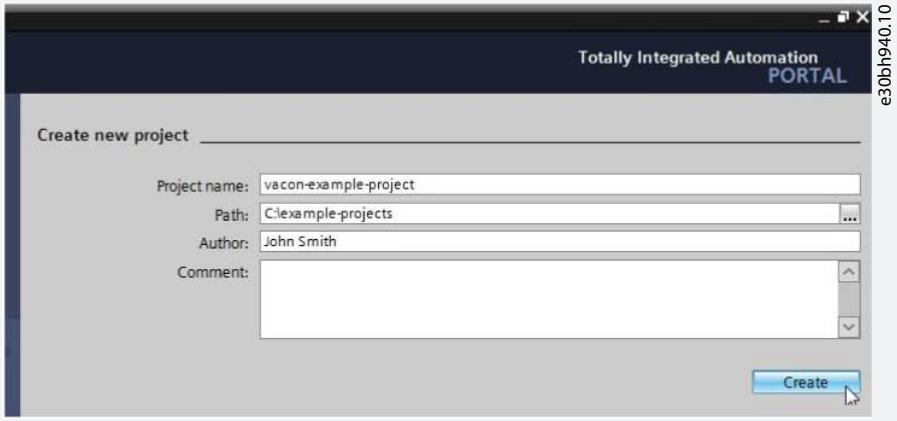
Check your individual PLC information. The information used in this example probably differs from local setup.

Configuring with TIA Portal

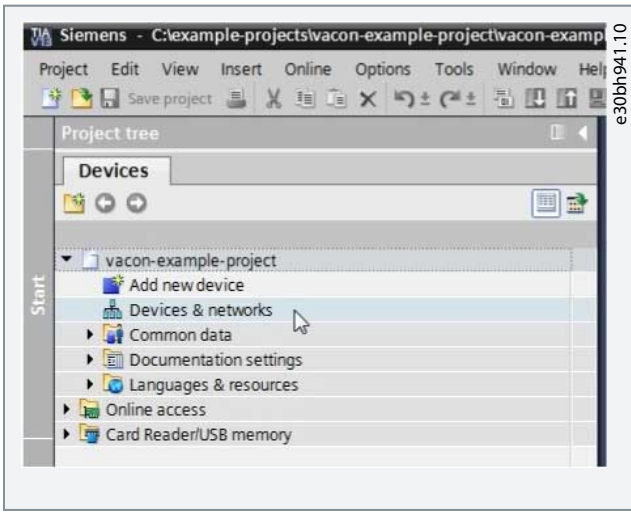
1. Create a project.



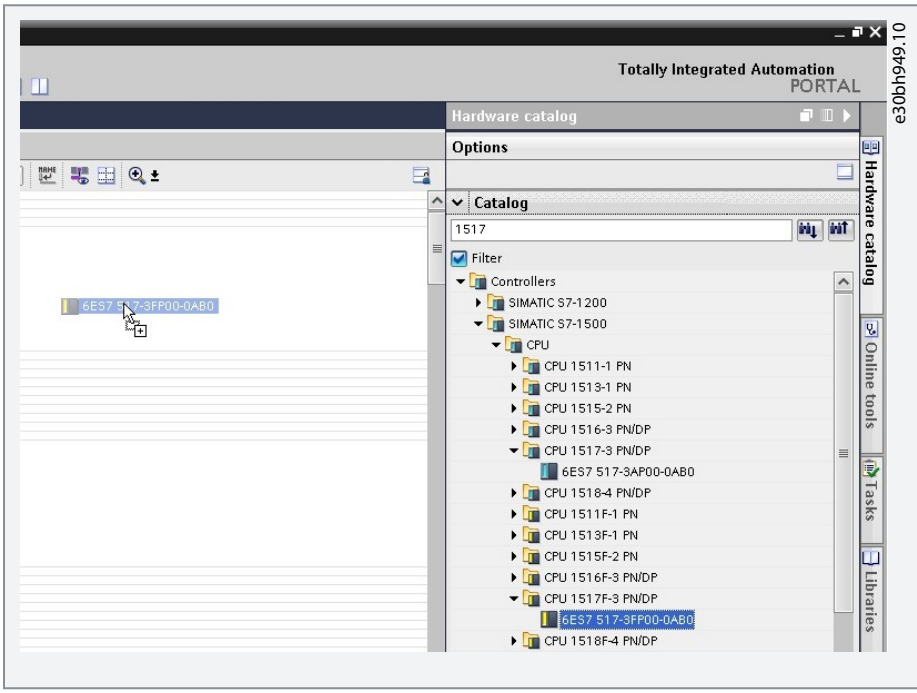
2. In the Create new project dialog, add name and location for the project and click *Create*.



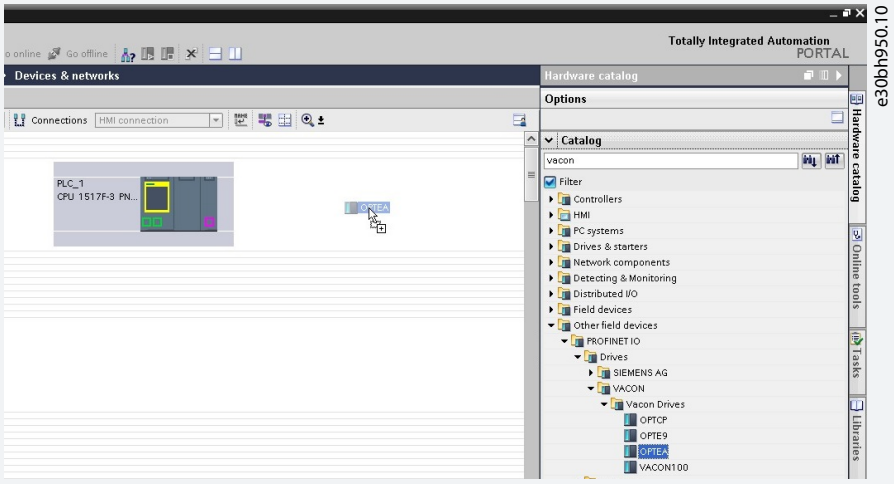
3. When the project is created, click *Project View* from the lower left corner of the screen.
4. Double-click *Devices & networks* .



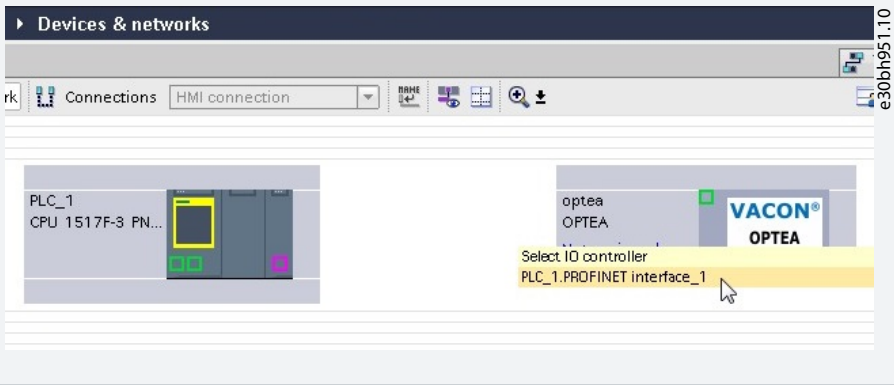
5. Drag and drop the used Safety PLC.



6. Add OPTEA option board.

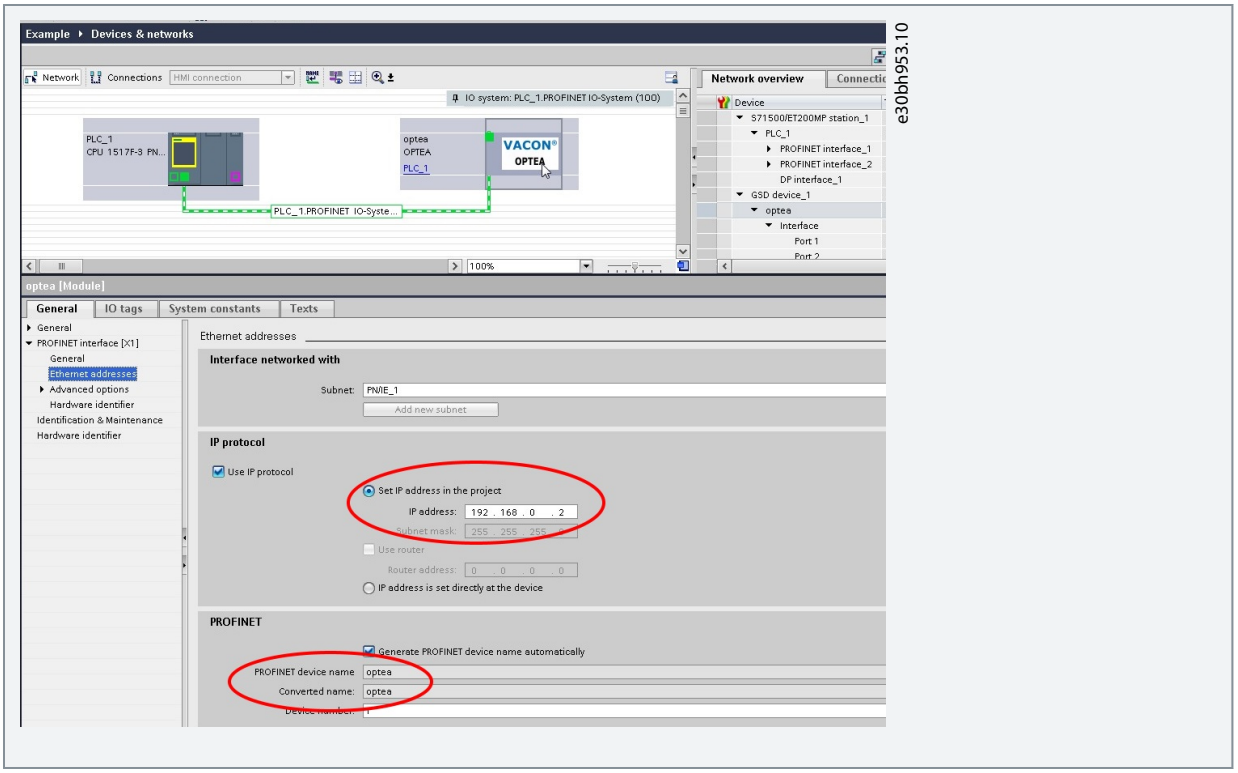


7. To assign I/O controller, click the blue text *Not assigned*.

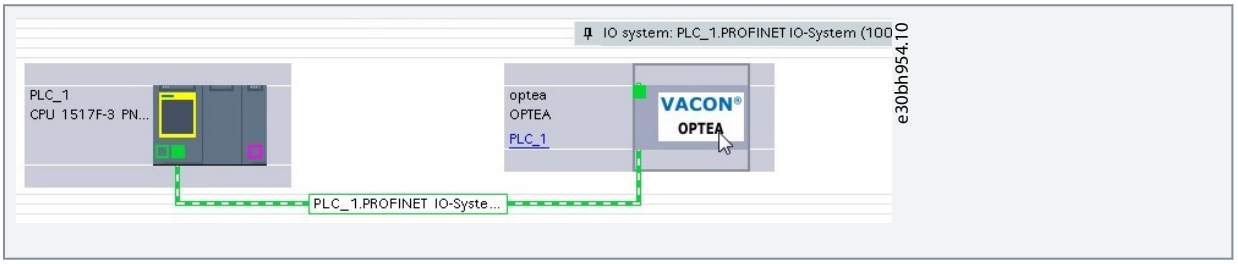


8. Assign the connections between the Ethernet ports in *Topology view*.

9. Assign IP settings and Name of Station to the OPTEA option board.

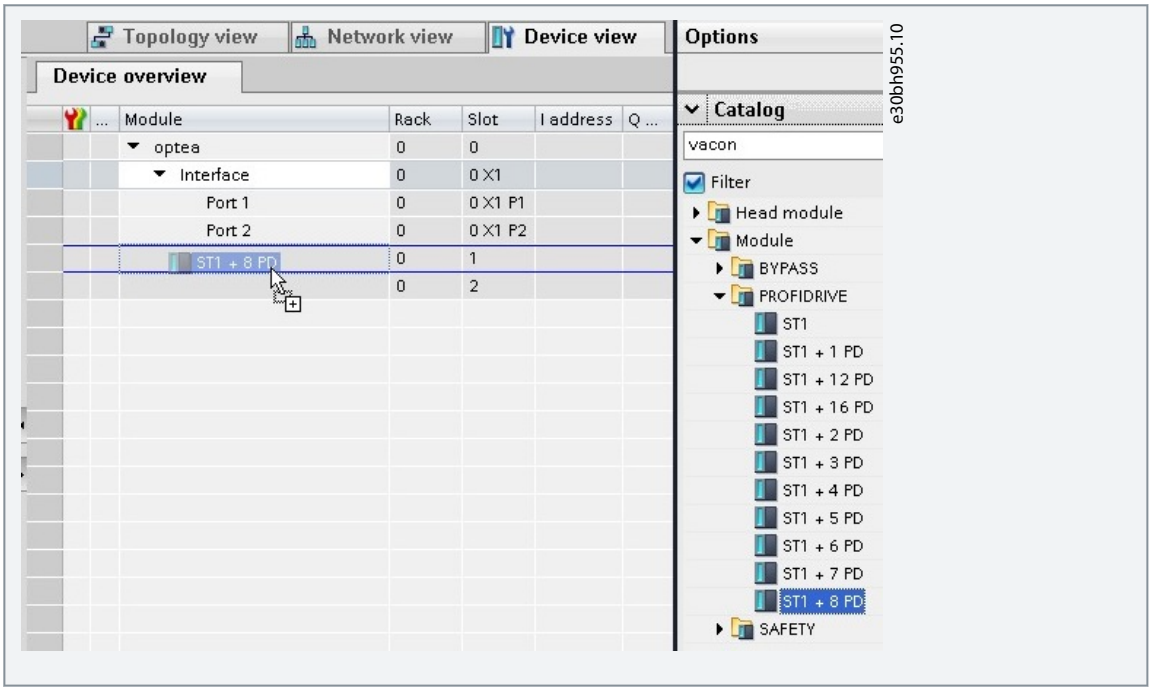


10. To open *Device view*, double-click *OPTEA*.

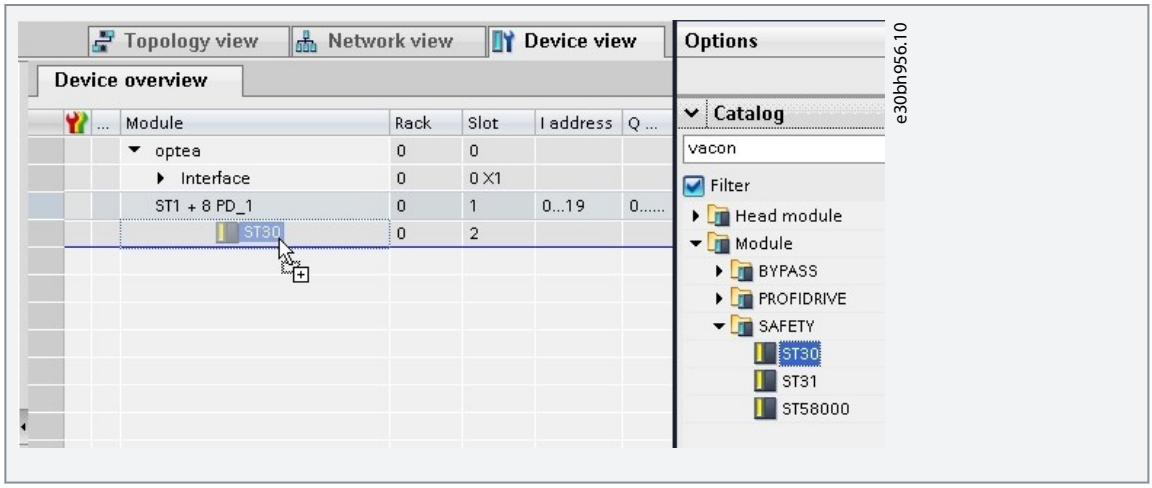


11. Add the used telegrams to the *Device overview*:

    a. Drag and drop the used telegram to the configuration.

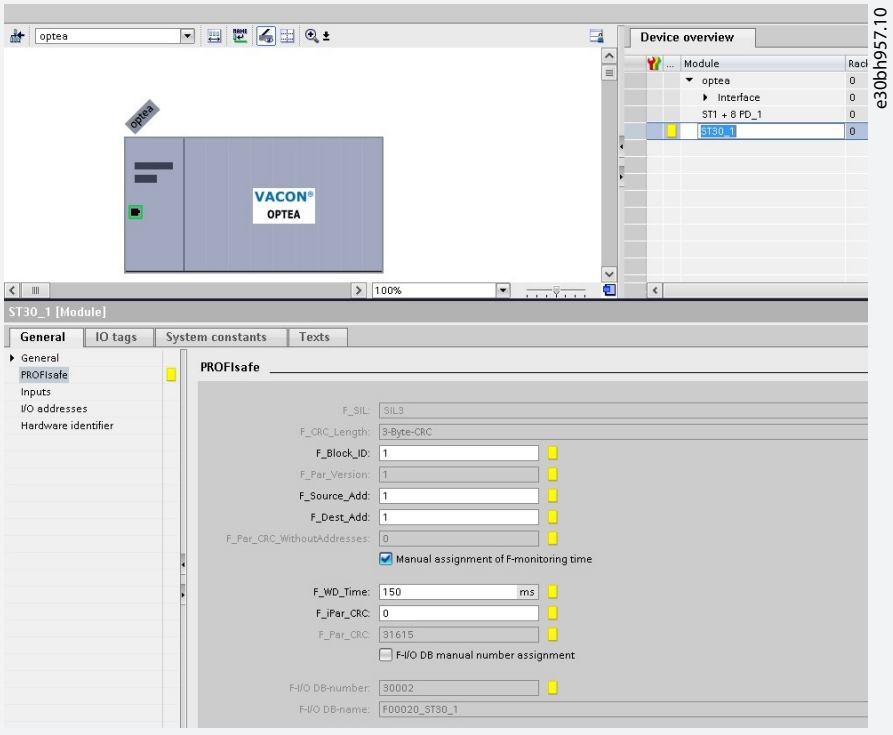


    b. Drag and drop used safety telegram to configuration.

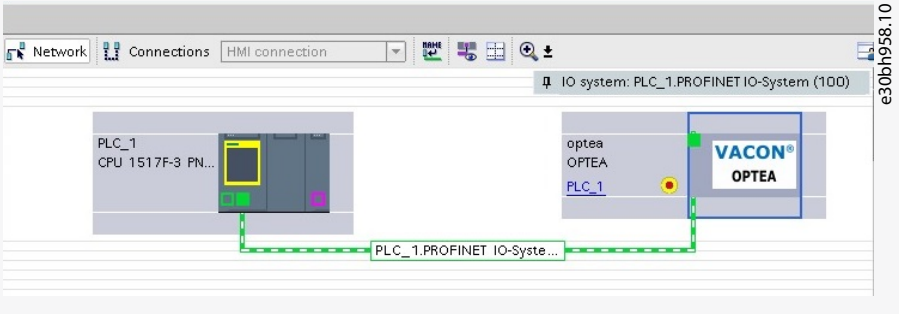


12. Select the inserted safety telegram and set the safe fieldbus parameters.

Set the same safe fieldbus parameters as when creating the safety configuration with VACON® Safe PC tool. For example, the F_iPar_CRC was calculated with the VACON® Safe PC tool.

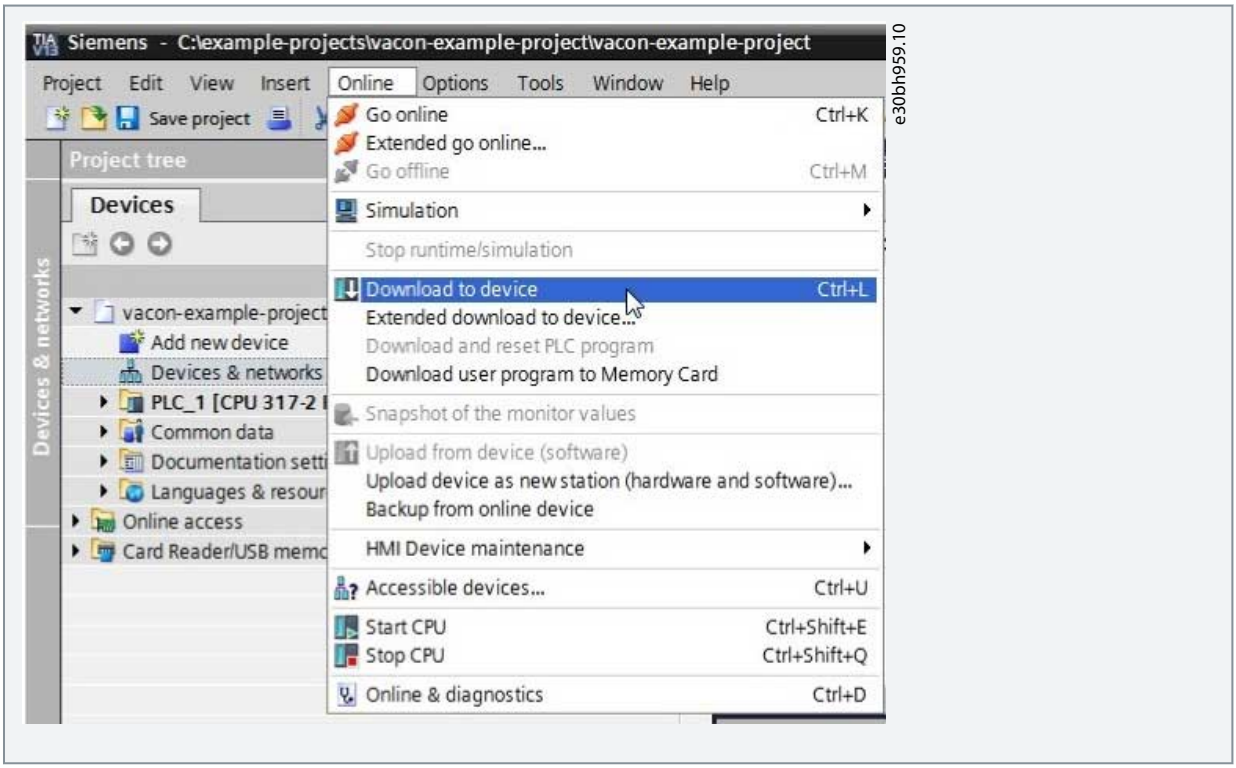


When the safety telegram is added, TIA Portal shows a yellow circle with a red dot to indicate that safety features are used with this device.



Loading the configuration to the PLC

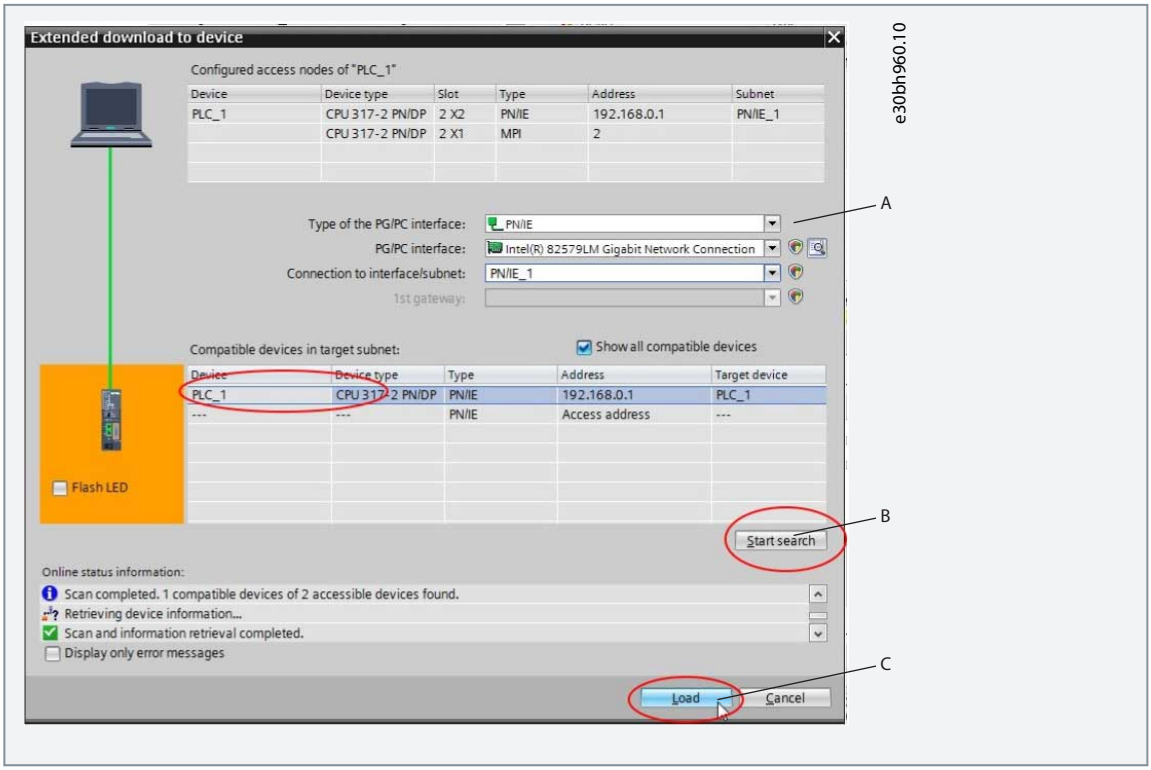
1. Select *Online -> Download to device*.



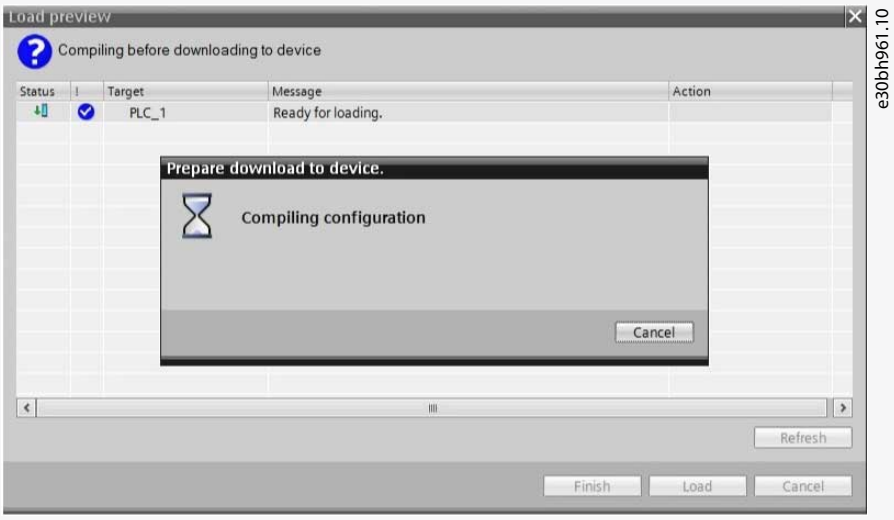
2. Select the PLC for loading:
   a. Use the dropdown menus to select the connection interface (how the PC with TIA Portal is connected to network with the PLC).
   b. Click *Search*.

   The PLC shows in the list.

   c. Select the PLC and click *Load*.

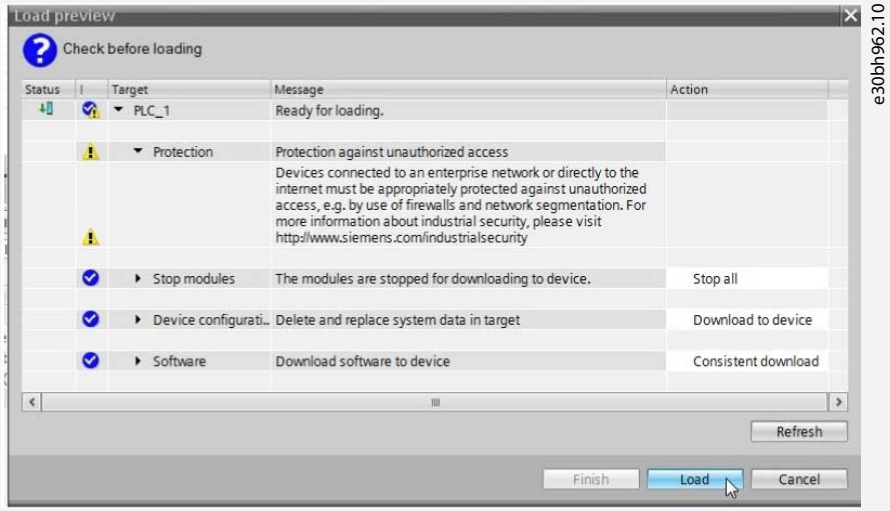


TIA portal compiles the program.

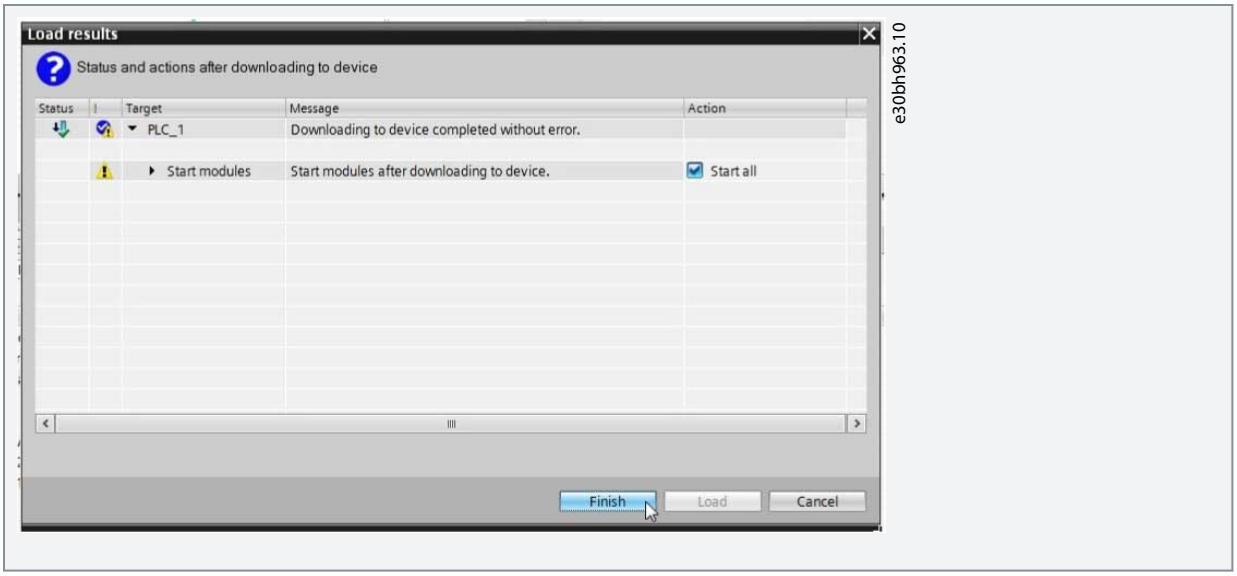


3. To load the program to the PLC, click *Load*.

This view can contain more information when using safety.



4. When the loading is ready, click *Finish*.



The PLC starts communicating with the option board.

4.4.10.3 Configuring with SIMATIC PDM

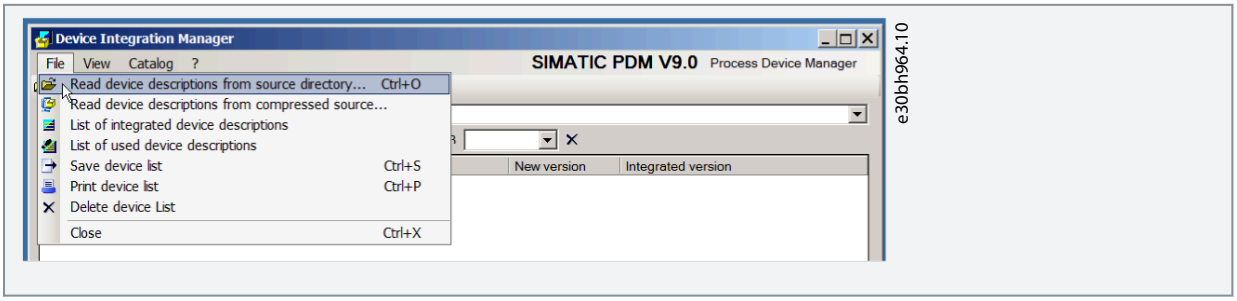
Follow these instructions when configuring the PROFINET connection with Siemens SIMATIC PDM.
This example is with the OPTEA board. Process is identical with the OPTE9 board.

Downloading EDD files

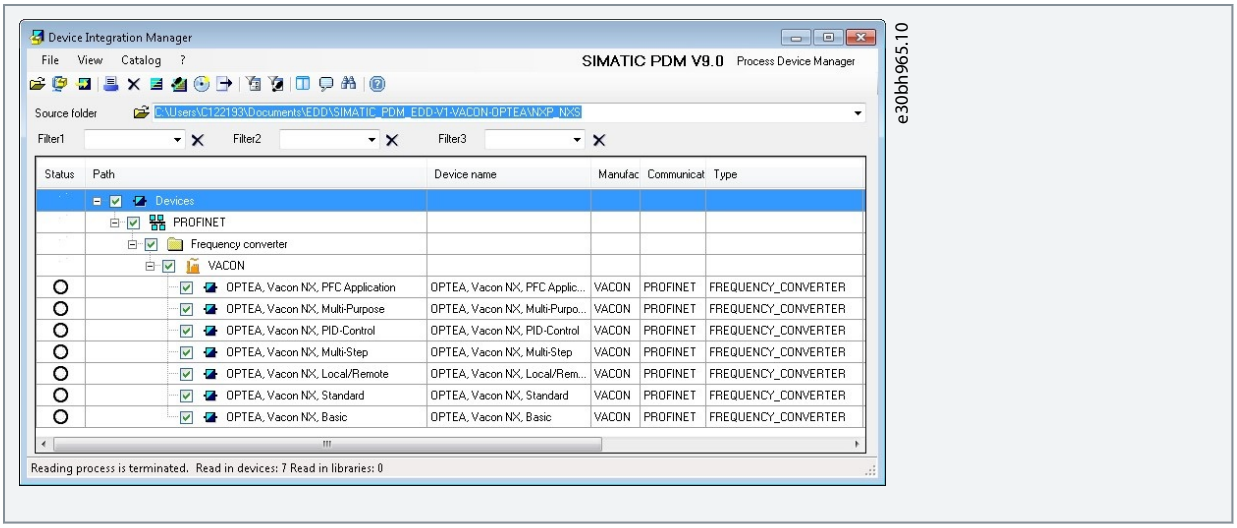
1. Go to www.danfoss.com/.
2. Select Downloads from Service and Support drop-down menu.
3. Select Drives as business unit.
4. Go to VLT® and VACON® fieldbus configuration files.
5. Download the EDD files for Siemens SIMATIC PDM.

Configuring with SIMATIC PDM

1. Extract the zipped EDD files.
2. Use PDM Device Integration Manager to read the EDD files into PDM catalog.

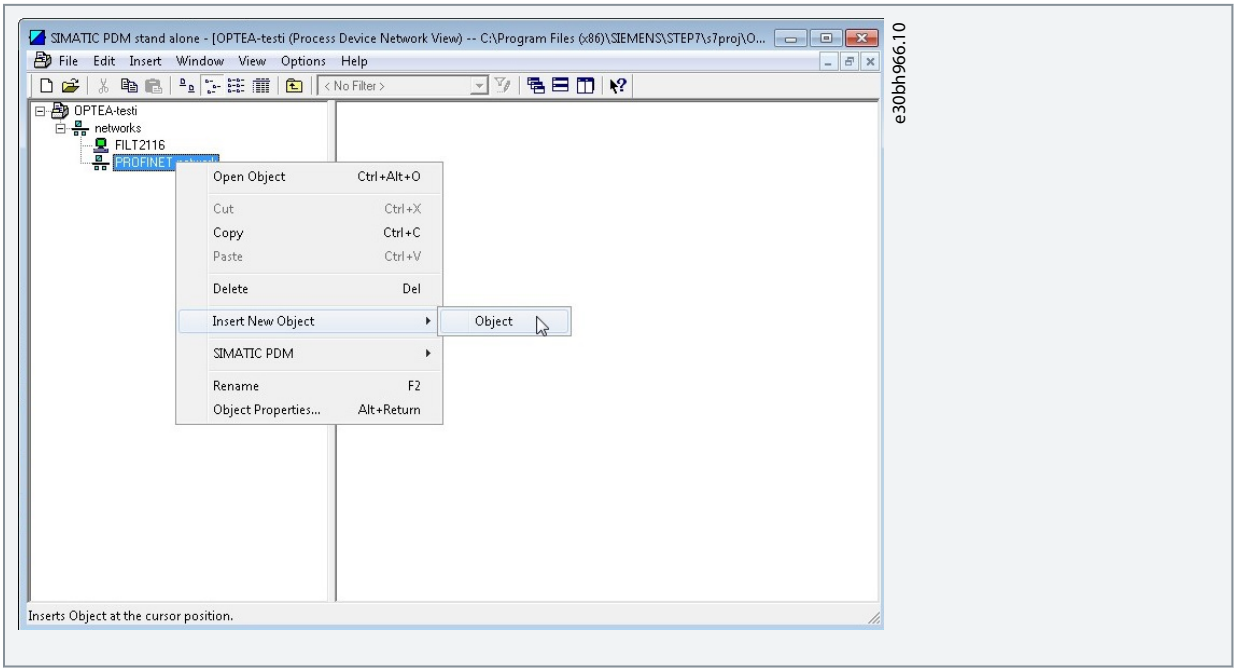


3. Click the *Integration* button.

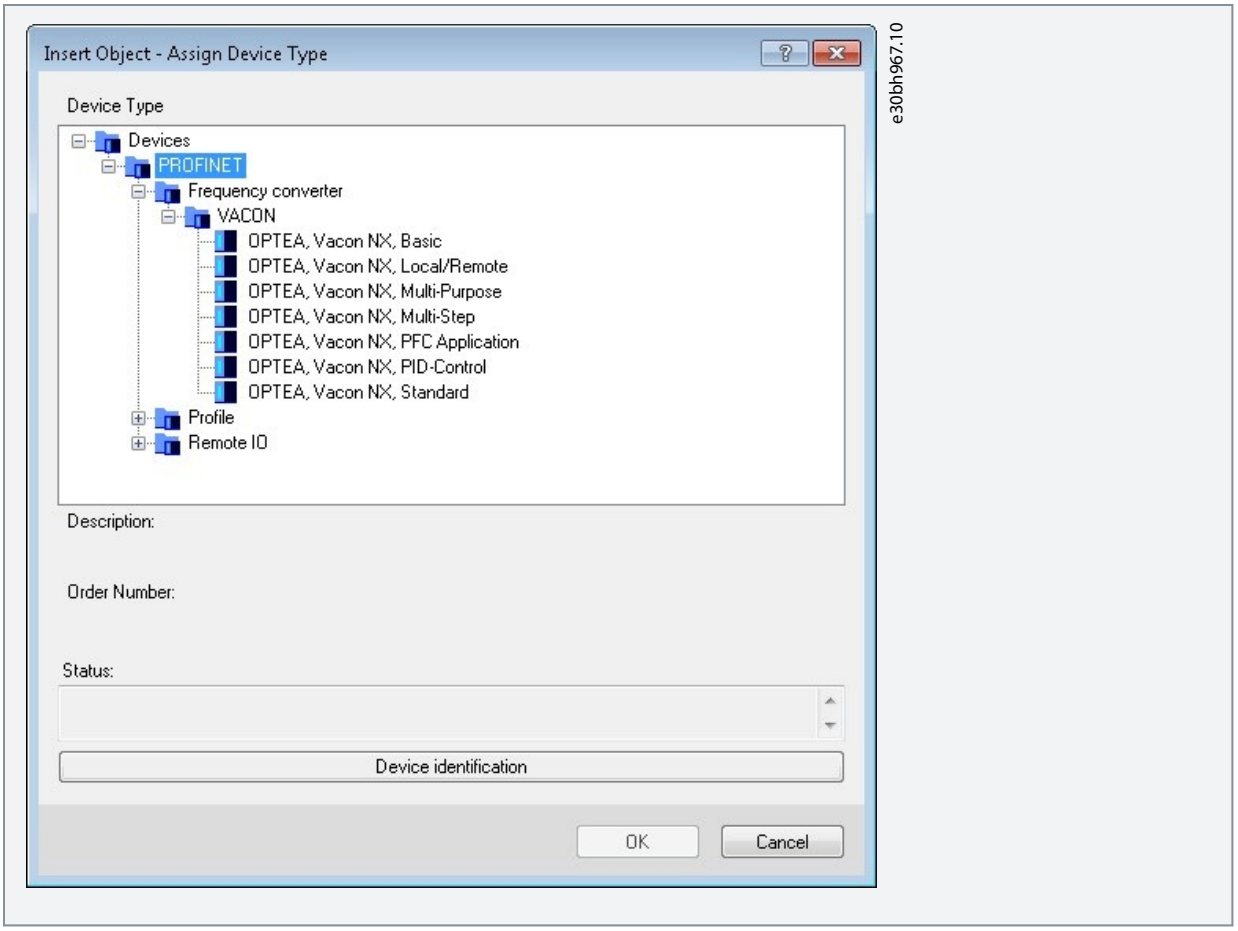


OPTEA can now be used in PDM.

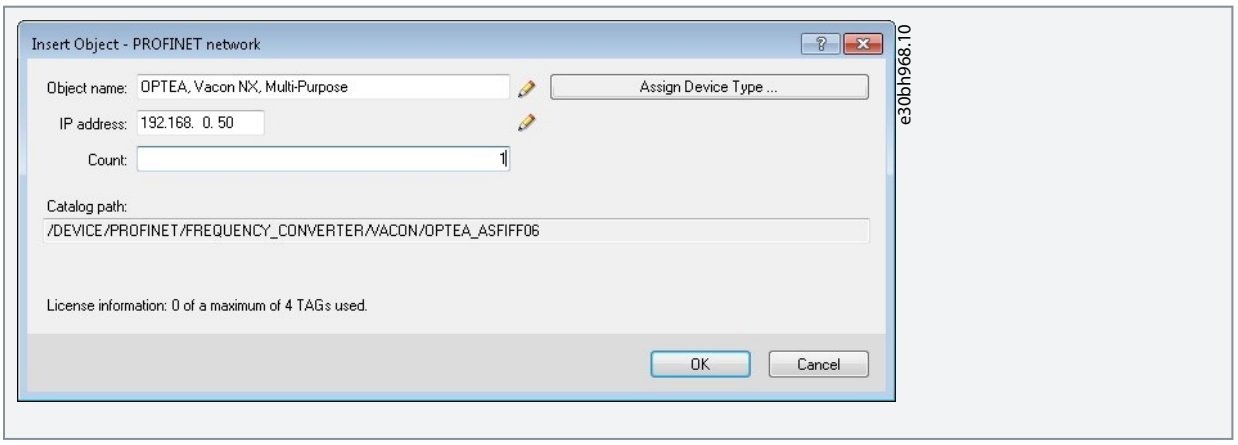
4. To add OPTEA into a PDM project, select *Profinet network* and right-click and select *Insert New Object*.



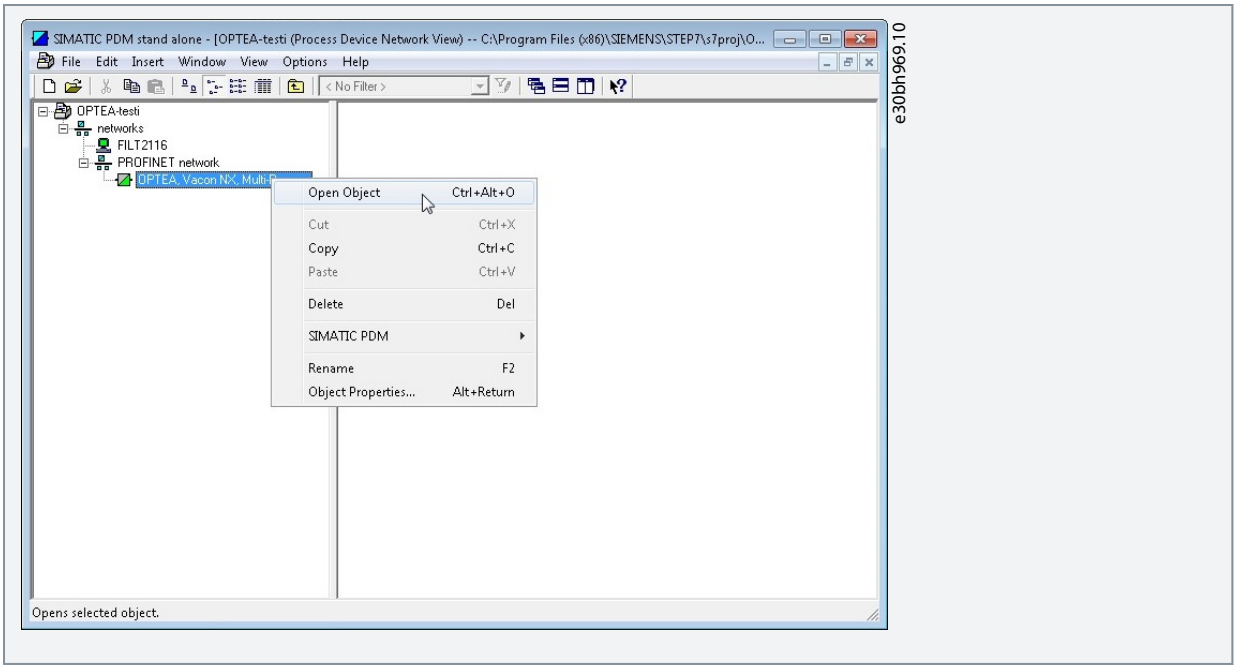
5. Assign the Device Type, and select, for example, *OPTEA, Vacon NX, Multi-Purpose*.



6. Set up the correct IP address that is used with the OPTEA option board.

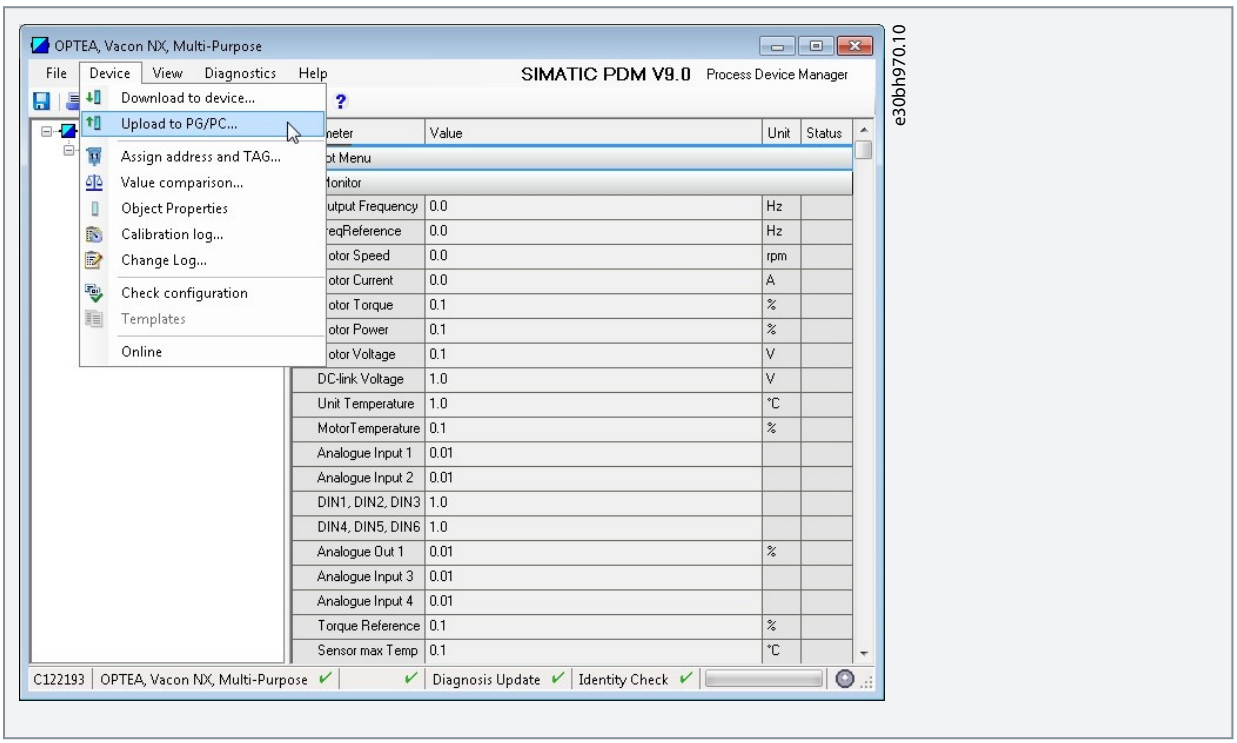


7. To access the drive parameters, open an object.

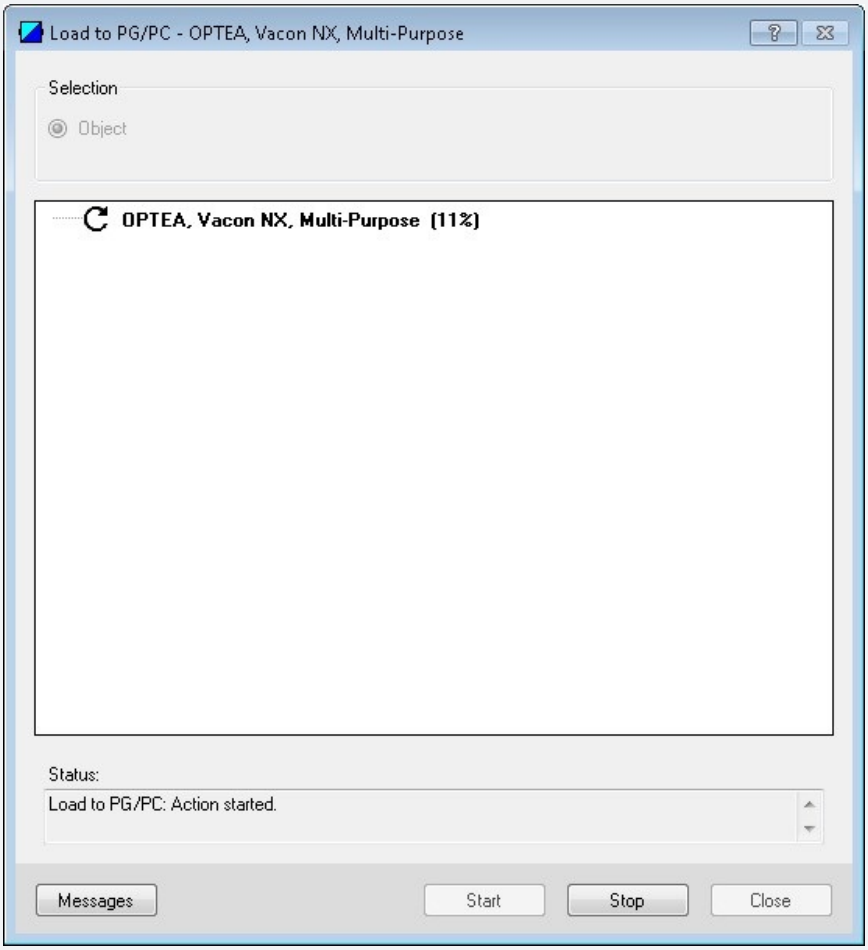


A view of uninitialized drive parameters opens.

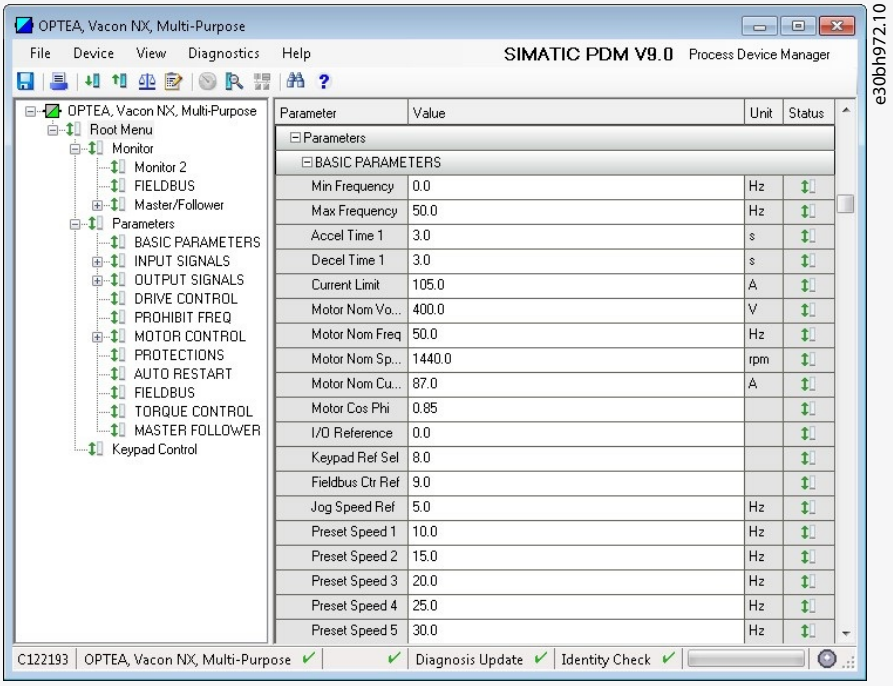
8. To download parameters into the PDM, select *Device-> Upload to PG/PC*.



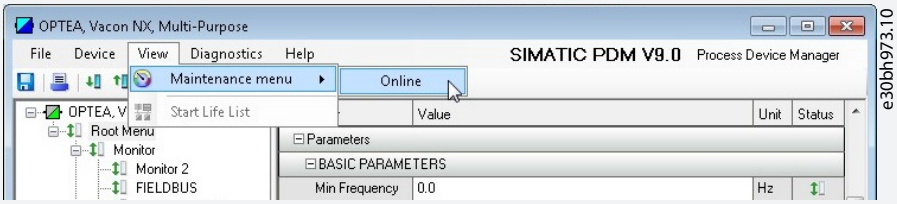
9. To start loading the parameter values, click *Start*. Then click *Close* after the process has finished.



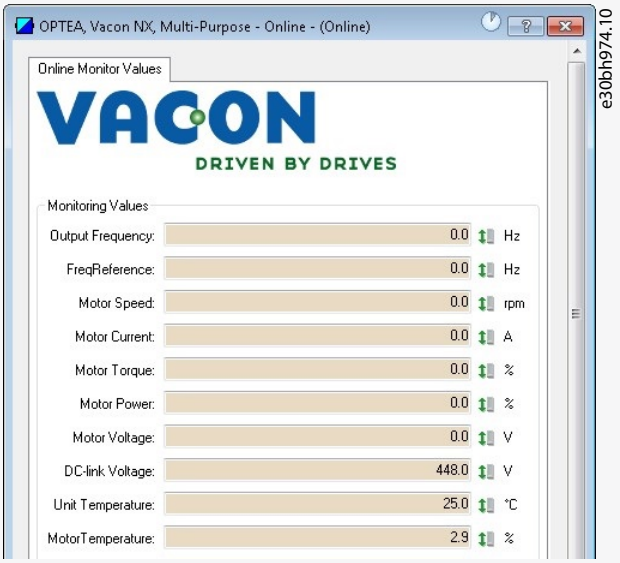
Updated values are now available and can also be downloaded to the device.



10. To monitor Basic monitor menu, go to *Maintenance menu -> Online*.



The *Online Monitor Values* view opens with updated values from the drive.



4.5 PROFIsafe (OPTEA)

The OPTEA supports a black channel PROFIsafe interface via PROFINET to Advanced safety option board to support safety functions. For more detailed information, see VACON® NXP Advanced Safety Options Operating Guide.

PROFIsafe functionality is supported only when installed to VACON® NXP family AC drive with firmware that supports PROFIsafe. OPTBL/OPTBM/OPTBN board is also always required.

See also 5.1.5.3 Safety Parameters.

4.5.1 Introduction to PROFIsafe

The following figure shows the PROFIsafe system overview, when using PROFIsafe over PROFINET.

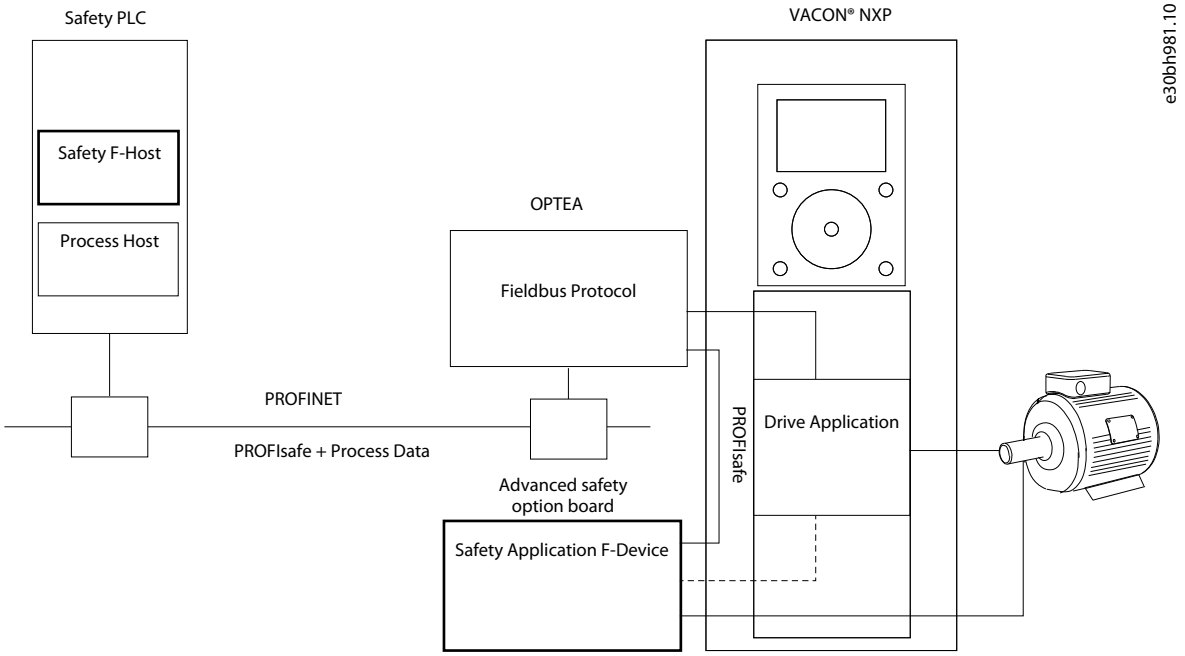


Illustration 22: PROFIsafe System Overview

The option board communicates with the safety PLC via PROFINET. The exchanged data includes PROFIsafe data and non-safe process data. The option board extracts the process data and the safety frame from the received message and forwards them. The process data is sent to the drive application, and the safety frame is sent to the Advanced safety option board.

The Advanced safety option board receives and sends the PROFIsafe safety enclosures and implements the configured safety functions.

The Advanced safety option board can also interact with the drive application, which can be parameterized to react to safety functions.

See VACON® NXP Advanced Safety Options Operating Guide for more details.

4.5.2 PROFIdrive on PROFIsafe

The VACON® Advanced Safety Options support three safety telegrams consisting of both standard PROFIdrive on PROFIsafe functionality and vendor-specific functionality. These telegrams are Standard Telegram 30, Standard Telegram 31, and VACON®- specific Telegram 58000. The content (signals) of these telegrams are described in the following table.

Table 76: Supported Safety Telegrams

Telegram	Setpoint	Actual value
30	S_STW1	S_ZSW1
31	S_STW2	S_ZSW2
58000	VS_CW	VS_SW

For details on the safety signal bit definitions and the related safety functions, and for mapping the PROFIsafe data to PROFIBUS DP, see VACON® NXP Advanced Safety Options Operating Guide.

4.6 Drive Control with EtherNet/IP

4.6.1 EtherNet/IP Communication Overview

The EtherNet/IP (Ethernet/Industrial Protocol) is a communication system suitable for use in industrial environments. The EtherNet/IP allows industrial devices to exchange time-critical application information. These devices include simple I/O devices such as sensors/actuators, and complex control devices such as robots, programmable logic controllers, welders, and process controllers.

The EtherNet/IP uses CIP (Control and Information Protocol), the common network, transport, and application layers also shared by ControlNet and EtherNet/IP. The EtherNet/IP then uses standard Ethernet and TCP/IP technology to transport CIP communications packets. The result is a common, open-application layer on top of open and highly popular Ethernet and TCP/IP protocols.

The EtherNet/IP Messaging Forms:

- Unconnected Messaging is used for connection establishment and for infrequent, low-priority messages.
- Connected Messaging utilizes resources which are dedicated in advance to a particular purpose such as real-time I/O data transfer. EtherNet/IP Messaging Connections.
- Explicit Messaging Connections are general purpose point-to-point connections. Messages are sent through the TCP protocol.
- Implicit (I/O Data) Connections are established to move application specific I/O Data at regular intervals. They are often set up as one-to-many relationships to take full advantage of the producer-consumer multicast model. Implicit messages are sent through the UDP protocol.

4.6.2 Quick Setup for EtherNet/IP Connection

Use these instructions to set up the EtherNet/IP connection.

Procedure

1. Set the EtherNet/IP as the active protocol from the panel parameters.
2. Set proper IP settings.
3. Open a connection with the settings described in the following table.
4. Before trying to run motor, see 6.2.1 AC Drive Parameters for Fieldbus Control and Reference Selection for information on how to configure the drive.
5. In the Master software, set the following:
   a. Set the Control Word value to 0x0 (00000000).
   b. Set the Control Word value to 0x61 (01100001) (NetRef, NetCtrl, and Run Fwd enabled).

   Drive is in status RUN.
6. In the Master software, set the Speed Reference to 0x05EE (=25%).

   Actual speed is 0x05EE (= 25% if MinFreq is 0 Hz and MaxFreq is 50 Hz).
7. In the Master software, set the Control Word value to 0x60 (01100000).

   Drive is in status STOP.

Example

Table 77: Connection Settings

Description	Instance	Size
Configuration instance	103_d / 67_h	0
Output instance	21_d / 15_h	4
Input instance	71_d / 47_h	4

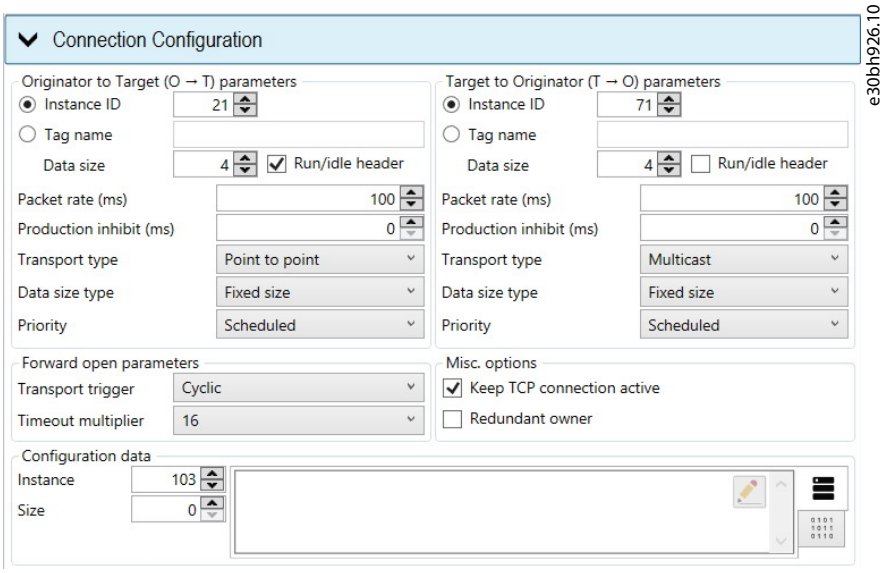


Illustration 23: Configuration Example from EIPScan Tool

4.6.3 AC/DC Drive Profile

The option boards implement CIP AC/DC drive profile.

To provide interoperability between devices from different manufacturers, there must be a defined "standard" in which those devices:

- Exhibit the same behavior
- Produce and/or consume the same basic set of I/O data
- Contain the same basic set of configurable attributes. The formal definition of this information is known as a device profile.

4.6.4 EDS File

To provide configuration support for your device, use a specially formatted ASCII file, referred to as the EDS (Electronic Data Sheet). An EDS provides information about the device configuration.

The information in an EDS allows configuration tools to provide informative screens that guide through the steps necessary to configure a device. An EDS provides all information necessary to access and alter the configurable parameters of a device.

The option boards have multiple EDS files, at least one per AC drive type. Download the AC drive specific EDS from www.danfoss.com/. Also, see 6.1.9 EIP Product Code Offset.

EDS files are split into two formats: static and dynamic. Only difference between these types is that the static versions list all assembly pairs and all Listen Only and Input Only connections. PLC application development tools usually show it as a list where to select the wanted pair.

To mix assembly pairs, for example, to command the drive with assembly 21 and get assembly 117 back, use the dynamic-version. With it, manually used assembly instances and their sizes can be set.

4.6.5 CIP Objects

4.6.5.1 Identity Object, Class 0x01

The Identity Object provides identification of and general information about the device.

Table 78: Class Name and Identifier

Class name	Class identifier
Identity Object	1

Table 79: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (1)

ID	Access rule	Name	Data type	Description
2	Get	Max Instance	UINT	Maximum instance number (1)
3	Get	Number of Instances	UINT	Number of object instances(1)

Table 80: Class Services

ID	Name	Description
1	Get_Attributes_All	Get all attributes
14_d $0E_h$	Get_Attribute_Single	Get single attribute

Table 81: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get	Vendor ID	UINT	Vendor identification
2	Get	Device Type	UINT	General type of product
3	Get	Product Code	UINT	Product identification
4	Get	Revision	STRUCT of	Revision of the item the Identity Object represents
		Major Revision	USINT	
		Minor Revision	USINT	
5	Get	Status	WORD	Summary status of device
6	Get	Serial number	UDINT	Serial number of the device
7	Get	Product Name	SHORT STRING	Human readable identification

Table 82: Instance Services

ID	Name	Description
1	Get_Attributes_All	Get all attributes
5	Reset	Only reset type 0
14_d $0E_h$	Get_Attribute_Single	Get single attribute

Instance Attributes

Instance Attribute "Vendor ID" is assigned to vendors of CIP devices by the ODVA user organization. The vendor ID for VACON® is $01BB_h(443_d)$.

Instance Attribute "Device Type" indicates which device profile the device is implementing. For VACON® AC drives this device number is 02_h ("AC Drive" profile).

Instance Attribute "Product Code" reveals the vendor-assigned product code for a particular product within a device type. Separate products must have different product codes when their configuration and/or run-time options are different. Option board returns the product code value based on the AC drive where it has been installed.

This value can also be modified with the "Product Code Offset" parameter (see 6.1.9 EIP Product Code Offset). When the "Mode" setting is set to "NX Mode" or to "OPTCx Mode", setting the "Product Code Offset" has no effect. In this case, the board emulates the OPTCQ option board and return value to 2. The same functionality applies to the "V100 Mode", except that the product code is 100.

Table 83: AC Drive Type Specific Product Code Values

AC drive type	OPTEA	OPTE9
VACON® 20	-	1000
VACON® 100 INDUSTRIAL	2100	1100
VACON® NXP	2200	1200
VACON® 20 x	-	1300
VACON® 100 FLOW	2400	1400
VACON® 100 X	2500	1500
VACON® NXS	2600	1600
Emulating OPTCQ	2	2
Emulating VACON® 100	100	100

Instance Attribute "Revision" consists of the Major and Minor Revision fields. It identifies the revision of the item/device that the Identity Object represents. The Major Revision is limited to values between 1 and 127. CIP reserves the eighth bit and its value is zero.

The value of **Instance Attribute "Status"** presents the status of the entire device. The coding of the field is defined in the following table.

Table 84: Status Bit Descriptions

Bit	Called	Definition
0	Owned	TRUE, if device has owner
1	-	Reserved, is zero
2	Configured	TRUE, if device has been configured (always true)
3	-	Reserved, is zero
4–7	Extended Device Status	See Table 85.
8	Minor Recoverable fault	TRUE, if recoverable problem detected.
9	Minor Unrecoverable Fault	TRUE, if unrecoverable problem detected.
10	Major Recoverable Fault	TRUE, if recoverable problem detected.
11	Major Unrecoverable Fault	TRUE, if unrecoverable problem detected.
12–15	Extended Device Status 2	Reserved, is zero

Table 85: Values for Extended Device Status

Value	Description
0	Self-testing or unknown
1	Firmware upgrade in progress
2	At least one faulted I/O connection
3	No I/O connections established
4	Non-Volatile configuration bad

Value	Description
5	Major fault - either bit 10 or bit 11 is true
6	At least one I/O connection in run mode
7	At least one I/O connection established, all in idle mode
8	The Status attribute is not applicable to this instance. Valid only for instances greater than one (1).
9	Reserved
10–15	Vendor specific, not used by VACON®

The option boards implement bits 0, 2, and 4–11 according to the specification (Extended Device Status values 1, 4 and 8–15 are not used by VACON®). The bits 8–11 must be set according to the faults occurring in the drive.

Instance Attribute "Serial Number" can be used with the Vendor ID to form a unique identifier for each device on any CIP network. The serial number is formed so that the first octet is 00 and the last 3 octets are taken from the end of the MAC address of the drive. For example, when the MAC address is 00:21:99:AA:BB:CC, then the serial number would be 00AABBCCh.

Instance Attribute "Product Name" contains human readable name identification for this instance. The option board returns the value which is combined from the drive and board type. For example:

- "OPTEA - VACON NXP"
- "OPTEA - VACON 100 INDUSTRIAL"
- "OPTEA - VACON 100 FLOW"
- "OPTE9 - VACON 20"
- "OPTE9 - VACON 20 X"

When emulating the OPTCQ option board, text "OPTCQ" is returned, and when emulating VACON® 100 family AC drive: "VACON 100".

Services

Instance Service "Reset". Only reset type 0 is supported. The reset type 0 means that the device represented by the Identity Object as closely as possible emulates the cycling of power. If an error is detected, an error response is returned. Otherwise a successful Reset response is returned.

4.6.5.2 Message Router Object, Class 0x02

The Message Router Object is mandatory in all CIP devices. It provides a messaging connection point through which a Client can address a service to any object class or instance in a target device. Although the object is mandatory, there are no mandatory attributes or services.

None of the services or attributes of the object are currently implemented.

Table 86: Class Name and Identifier

Class name	Class identifier
Message Router Object	2

Table 87: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 88: Class Services

ID	Name	Description
-	-	-

Table 89: Instance Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 90: Instance Services

ID	Name	Description
-	-	-

4.6.5.3 Connection Manager Object, Class 0x06

The communication characteristics between the applications in different devices are modelled using Connection Objects. The entities (devices) involved in a connection are referred to as endpoints. A Connection Manager is required in some CIP networks to control the aspects of Connection object instances.

The Connection Manager class allocates and manages the internal resources associated with both I/O and Explicit Messaging connections.

Table 91: Class Name and Identifier

Class name	Class identifier
Connection Manager Object	6

Table 92: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (1)
2	Get	Max Instance	UINT	Maximum instance number (1)
3	Get	Number of Instances	UINT	Number of object instances(1)

Table 93: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 94: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get	Open Requests	UINT	Number of Forward Open service requests received.
2	Get	Open Format Rejects	UINT	Number of Forward Open service requests which were rejected due to bad format.
3	Get	Open Resource Rejects	UINT	Number of Forward Open service requests which were rejected due to lack of resources.
4	Get	Open Other Rejects	UINT	Number of Forward Open service requests which were rejected for other reasons.
5	Get	Close Requests	UINT	Number of Forward Close service requests received.
6	Get	Close Format Rejects	UINT	Number of Forward Close service requests which were rejected due to bad format.

ID	Access rule	Name	Data type	Description
7	Get	Close Other Rejects	UINT	Number of Forward Close service requests which were rejected for other reasons
8	Get	Connection Timeouts	UINT	Total number of connection timeouts that have occurred in connections controlled by this Connection Manager.

Table 95: Instance Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the instance
14_d $0E_h$	Get_Attribute_Single	Used to read the single attribute value
78_d $4E_h$	Forward_Open	Opens a connection (maximum data size is 511 bytes)
84_d 54_h	Forward_Close	Closes a connection

Services

Instance Service "Forward Open". The Forward Open service is used to open a connection to a target device. If the path between devices consists of multiple links, then local connections between these are also established. The minimum time for the RPI (Request Packet Interval) is 1 ms. The connection object instance number is 103_d (67_h) except when emulating the OPTCQ option board. Then connection object instance number is 1.

Instance Service "Forward Close". The Forward Close service is used to close a connection between two devices (and all nodes in the connection path).

4.6.5.4 TCP/IP Interface Object, Class 0xF5

The TCP/IP Interface Object provides an interface to configure the TCP/IP settings of the device. Use this object to configure, for example, the IP address, and network mask of the device.

Table 96: Class Name and Identifier

Class name	Class identifier
TCP/IP object	245_d / $F5_h$

Table 97: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (4)
2	Get	Max Instance	UINT	Maximum instance number (1)
3	Get	Number of Instances	UINT	Number of object instances(1)

Table 98: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 99: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get	Status	DWORD	Interface status
2	Get	Configuration Capability	DWORD	Interface capability flags
3	Get/set	Configuration Control	DWORD	Interface control flags
4	Get	Physical Link Object	STRUCT of	Path to physical link object
		Path size	UINT	Size of the path
		Path	Padded EPATH	Logical segments identifying the physical link object
5	Get/set	Instance Configuration	STRUCT of	TCP/IP network interface configuration
		IP Address	UDINT	The IP address of the device
		Network Mask	UDINT	The network mask of the device
		Gateway Address	UDINT	Default gateway address
		Name Server	UDINT	Primary name server
		Name Server 2	UDINT	Secondary name server
		Domain Name	STRING	Default domain name
6	Get/set	Host Name	STRING	Host name
10_d/ $0A_h$	Get/set	Select ACD	BOOL	Activates the use of ACD (enabled by default)
11_d/ $0B_h$	Get	Last Conflict Detected	STRUCT of:	Structure containing information related to the last conflict detected.
		ACD activity	USINT	State of ACD activity
		Remote MAC	Array of 6 USINT	MAC address of last conflict source.
		ARP PDU	Array of 28 USINT	Copy of the last ARP PDU in which a conflict was detected.
13_d/ $0D_h$	Set	Encapsulation Inactivity Timeout	UINT	Number of seconds of inactivity before TCP connection is closed

Table 100: Instance Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the instance
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "Status" presents the status of the TCP/IP network interface.

Table 101: Status Bit Descriptions

Bit	Called	Definition
0–3	Interface Configuration Status	Indicates the status of the interface configuration attribute; see values in Table 102.
4	Mcast Pending	Indicates a pending configuration change in the TTL Value and/ or Mcast Config attributes.
5	Interface Configuration Pending	Indicates a pending configuration change in the Interface Configuration attribute.
6	AcdStatus	Set(1) Address Conflict Detected, Clear(0) No Address Conflict Detected
7–31	Reserved	Always zero

Table 102: Values for Interface Configuration Status

Value	Description
0	The Interface Configuration Attribute has not been configured
1	The Interface Configuration Attribute contains valid configuration obtained from BOOTP, DHCP, or non-volatile storage.
2	The IP address member of the Interface Configuration Attribute contains valid configuration, obtained from hardware settings
3–15	Reserved for future use

Instance Attribute "Configuration Capability" presents the capability flags (that is, the support for the optional network configuration capability) of the TCP/IP network interface.

Table 103: Configuration Capability Bit Descriptions

Bit	Called	Definition
0	BOOTP Client	Supports BOOTP (FALSE)
1	DNS Client	Supports capable of resolving DNS names (FALSE)
2	DHCP Client	Supports DHCP (TRUE)
3	DHCP-DNS Update	Always zero
4	Configuration Settable	TRUE, if configuration settable
5	Hardware Configurable	Configuration can be obtained from hardware settings (FALSE)
6	Interface Configuration Change Requires Reset	Configuration change results in reset (FALSE)
7	AcdCapable	Supports ACD (TRUE)
8–31	Reserved	Reserved, always zero

Instance Attribute "Configuration Control"allows control of the TCP/IP network interface configuration. When using the Configuration Control attribute, the device can be configured to use statically assigned IP values or DHCP. If the value is changed from DHCP to statically assigned, the device continues using the current IP address. When changing from statically assigned to DHCP, the drive tries to get an IP address from the DHCP Server. If it fails, the communication with the drive cannot be reopened and the IP address must be set manually from the panel. Other possibility is to enable the DHCP Server in the network. Changing the Configuration Control is not allowed when the I/O connection is open.

If the "IP Address Mode" panel parameter is "Fixed IP", the value of the Configuration Control is 0. If the "IP Address Mode" is "DHCP", the value of the Configuration Control is 2. Features BOOTP and DNS are not supported.

Table 104: Configuration Control Bit Descriptions

Bit	Called	Definition
0–3	Configuration Method	Determines how the device obtains its IP related configuration, see values in Table 105.
4	DNS Enable	If TRUE, the device resolves host names by querying a DNS server
5–31	Reserved	Reserved, always zero

Table 105: Values for Configuration Method

Value	Definition
0	The device uses statically assigned IP configuration values.
1	The device obtains its interface configuration values via BOOTP
2	The device obtains its interface configuration values via DHCP
3–15	Reserved for future use.

Instance Attribute "Physical Link Object" identifies the object which is associated with the underlying physical communications interface (with Ethernet, for example, the IEEE 802.3 interface). The attribute consists of two components; a Path Size, which reveals the number of UINT values in the path, and the Path itself.

The path points to an instance of the EtherNet Link Object. The value of the Path Size is 2 (total of four octets). The value of the Path is 20_h $F6_h$ 24_h XX_h, where XX is the instance number of the EtherNet Link object.

Instance Attribute "Instance Configuration" contains the configuration parameters required for a device to operate as a TCP/IP node. The contents of the attribute depend on how the device has been configured to obtain its IP parameters (the "Configuration Method" field in the Configuration Control attribute). If the device uses a static IP address (Configuration Method value is 0), the values in the Interface Configuration are statically assigned and stored in the non-volatile memory. If the device uses DHCP (or BOOTP) (Configuration Method value is 1 or 2), the Interface Configuration values contain the configuration obtained through this channel. Until the BOOTP/DHCP reply is received, the values are 0.

Changing the Instance Configuration is not allowed when the I/O connection is open or Configuration Control-attribute is not set to "statically assigned".

The IP address, Network Mask, and Gateway address consists of 4 bytes. For example, the IP address 192.168.0.10 would be in format: $C0_h$, $A8_h$, 00_h, $0A_h$.

Table 106: Instance Configuration

Interface Configuration	STRUCT of:	Description	Semantics of the value
IP address	UDINT	The IP address of the device	Value of 0 indicates that no IP address has been configured. Otherwise, the IP address must be set to a valid Class A, B, or C address and must not be set to the loopback address (127.0.0.1).
Network Mask	UDINT	The network mask of the device	Value of 0 indicates that no network mask address has been configured.
Gateway Address	UDINT	Default gateway address	Value of 0 indicates that no IP address has been configured. Otherwise, the IP address must be set to a valid Class A, B, or C address and must not be set to the loopback address (127.0.0.1).
Name Server	UDINT	Primary name server	Value of 0 indicates that no name server address has been configured. Otherwise, the name server address must be set to a valid Class A, B, or C address.
Name Server 2	UDINT	Secondary name server	Value of 0 indicates that no secondary name server address has been configured. Otherwise, the name server address must be set to a valid Class A, B, or C address.

Interface Configuration	STRUCT of:	Description	Semantics of the value
Domain Name	STRING	Default domain name	ASCII characters. Maximum length is 48 characters. Must be padded to an even number of characters (pad not included in length). A length of 0 indicates that no Domain Name is configured.

Instance Attribute "Host Name" contains the host name of the device. The maximum length is 64 ASCII characters. The name is padded to an even number of characters. The Attribute Host Name is used only for information purpose.

Instance Attribute "Encapsulation Inactivity Timeout" is used to enable the TCP socket cleanup (closing) when the defined number of seconds have elapsed with no Encapsulation activity. The default value is 120 s. The TCP keep-alive traffic does not count as Encapsulation activity.

Table 107: Encapsulation Inactivity Timeout

Value	Description
0	Disable
1–3600	Timeout in seconds

Instance Attribute "Select ACD" is used to enable or disable ACD (Address Conflict Detection) functionality. For more information, see 1.6.5 Address Conflict Detection (ACD).

Instance Attribute "Last Conflict Detected"contains information of the last IP address conflict. The content of this attribute can be reset by writing zero to this attribute.

The struct member "ACD Activity" tells the state of ACD algorithm when the last conflict was detected. Possible values are defined in the following table.

Table 108: ACD Activity Values

Value	ACD Mode	Description
0	No conflict detected (default)	No conflict has been detected since this attribute was last cleared.
1	Probe IPV4 address	Last conflict detected during IPV4 address probe state
2	Ongoing detection	Last conflict detected during OngoingDetection-state or subsequent DefendWithPolicyB state
3	Semi active probe	Last conflict detected furint SemiActiveProbe-state or subsequent DefendWithPolicyB-state

The struct member "Remote MAC" tells the MAC address the source of the last IP address conflict.

The struct member "ARP PDU" contains the ARP message (raw copy) received from the source of the IP address conflict. Content of the ARP message is described in the following table.

Table 109: The ARP PDU in Binary Format

Field size (bytes)	Field Description
2	Hardware type (1 for Ethernet HW)
2	Protocol type (0x800 for IP)
1	Hardware size (6 for Ethernet HW)
1	Protocol size (4 for IP)
2	Operation code (1 for request or 2 for response)
6	Sender MAC address
4	Sender IP address

Field size (bytes)	Field Description
6	Target MAC address
4	Target IP address

4.6.5.5 Ethernet Link Object, Class 0xF6

Ethernet Link Object provides interface to Ethernet link counters and attributes. With this object, for example, the link speed can be retrieved.

Table 110: Class Name and Identifier

Class name	Class identifier
Ethernet Link object	246_d / $F6_h$

Table 111: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (4)
2	Get	Max Instance	UINT	Maximum instance number (2)
3	Get	Number of Instances	UINT	Number of object instances (2)

Table 112: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 113: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get	Interface Speed	UDINT	Interface speed currently in use
2	Get	Interface Flags	DWORD	Interface status flags
3	Get	Physical Address	ARRAY of 6 USINTs	MAC layer address
4	Get	Interface Counters	STRUCT of 11 UDINTs	Interface counters. See Table 117.
5	Get	Media Counters	STRUCT of 12 UDINTs	Media specific counters. See Table 118.
7	Get	Interface Type	USINT	Type of interface: twisted pair, fiber, internal, and so on
8	Get	Interface State	USINT	Current state of the interface: operational, disabled, and so on
9	Get/Set	Admin State	USINT	Administrative state: enable, disable
10_d $0A_h$	Get	Interface Label	SHORT STRING	Human readable identification

Table 114: Instance Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the instance

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.
76_d $4C_h$	Get_and_Clear	Gets then clears the specified attribute (Interface Counters, Media Counters). Not instance/class dependent service.

Instance Attributes

Instance Attribute "Interface Speed" reveals the currently used speed in the interface. The speed is announced as an integer number, with the unit Mbps, for example, 0, 10, 100. The value 0 indicates that the interface speed is indeterminate.

Instance Attribute "Interface Flags" contains status and configuration information about the physical interface.

Table 115: Status Bit Descriptions

Bit	Called	Definition
0	Link Status	One, if link is active
1	Half/Full Duplex	One, if full duplex
2–4	Negotiation Status	See values in Table 116.
5	Manual Setting Requires Reset	0 indicates the interface can automatically activate changes to link parameters (auto-negotiate, duplex mode, interface speed). 1 indicates the device requires a Reset service be issued to its Identity Object in order for the changes to take effect.
6	Local Hardware Fault	0 indicates the interface detects no local hardware fault; 1 indicates a local hardware fault is detected.
7–31	Reserved	Always zero

Table 116: Values for Negotiation Status

Value	Description
0	Auto-negotiation in progress
1	Auto-negotiation and speed detection failed. Using default values for speed and duplex.
2	Auto-negotiation failed but detected speed. Duplex was defaulted.
3	Successfully negotiated speed and duplex.
4	Auto-negotiation not attempted. Forced speed and duplex.

Instance Attribute "Physical Address" reveals the MAC layer address of the physical interface.

Instance Attribute "Interface Counters" is a collection of counters related to the Ethernet physical interface. The dual port option board has only single MAC address and therefore implements only single set of counter values. Only packets sent or received by the device itself are counted.

Table 117: Interface Counters

Field name	Data type	Description
In Octets	UDINT	The number of octets received on the inter- face (including framing characters).
In Unicast Packets	UDINT	The number of unicast packets received on the interface.

Field name	Data type	Description
In NonUnicastPackets	UDINT	The number of non-unicast packets received on the interface.
In Discards	UDINT	Inbound packets received on the interface but which were discarded.
In Errors	UDINT	Inbound packets received on the interface but which contained errors (excluding Discards).
In Unknown Protocols	UDINT	Inbound packets received on the interface which belonged to unknown protocols.
Out Octets	UDINT	The number of octets sent on the interface (including framing characters).
Out Unicast Packets	UDINT	The number of unicast packets requested to be transmitted on the interface, including the ones that were discarded or not sent.
Out NonUnicast Packets	UDINT	The number of non-unicast packets requested to be transmitted on the interface, including the ones that were discarded or not sent.
Out Discards	UDINT	Outbound packets which were discarded.
Out Errors	UDINT	Outbound packets which contained errors (excluding Discards).

Instance Attribute "Media Counters" is a collection of counters related to the Ethernet physical interface.

Table 118: Media Counters

Field name	Data type	Description
Alignment Errors	UDINT	Frames received that are not an integral number of octets in length.
FCS Errors	UDINT	Frames received that do not pass the FCS check.
Single Collisions	UDINT	Successfully transmitted frames which experienced exactly one collision.
Multiple Collisions	UDINT	Successfully transmitted frames which experienced more than one collision.
SQE Test Errors	UDINT	The number of times SQE test error message is generated.
Deferred Transmissions	UDINT	Frames for which the first transmission attempt is delayed because the medium is busy.
Late Collisions	UDINT	Number of times a collision is detected later than 512 bit-times into the transmission of a packet.
Excessive Collisions	UDINT	Frames for which transmission fails due to excessive collisions.
MAC Transmit Errors	UDINT	Frames for which transmission fails due to an internal MAC sub layer transmit error.
Carrier Sense Errors	UDINT	Times that the carrier sense condition was lost or never asserted when attempting to transmit a frame.
Frame Too Long	UDINT	Frames received that exceed the maximum permitted enclosure size.
MAC Receive Errors	UDINT	Frames for which reception on an interface fails due to an internal MAC sub layer receive error.

Instance Attribute "Interface Type" indicates the type of the Ethernet interface, that is, twisted-pair cable, optical fiber, device-internal, and so on. Value "twisted-pair cable" (2) is always returned.

Instance Attribute "Interface State" indicates the current state of the Ethernet interface, that is, operational, disabled and so on.

Table 119: Interface State

Value	Interface state
0	Unknown interface state

Value	Interface state
1	The interface is enabled and is ready to send and receive data
2	The interface is disabled
3	The interface is testing
4–255	Reserved

Instance Attribute "Admin State" indicates the ability to use the Ethernet interface for administration, for example, for changing the settings.
For this attribute, only value "administration enabled" (01_h) is supported. An attempt to disable the administration (by writing value 02_h) results in an error.

4.6.5.6 Assembly Object, Class 0x04

The assembly object groups (or assembles) the attribute values into a single block of data.

Table 120: Class Name and Identifier

Class name	Class identifier
Assembly object	4

Table 121: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (2)
2	Get	Max Instance	UINT	Maximum instance number (167_d)
3	Get	Number of Instances	UINT	Number of object instances (23)

Table 122: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 123: Instance Attributes

ID	Access rule	Name	Data type	Description
3	Set	Data	ARRAY of BYTE	Assembly data
4	Get	Size	UINT	Number of bytes in attribute 3 (assembly data)

Table 124: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value

Instance Attributes

Instance Attribute "Data" can be used to get assembly data. The content and length of the data depends on the configuration of the assembly instance.

Instance Attribute "Size" can be used to get assembly data size.

4.6.5.7 Motor Data Object, Class 0x28

Motor Data Object provides interface to the motor data attributes, for example "motor type".

Table 125: Class Name and Identifier

Class name	Class identifier
Motor data object	40_d / 28_h

Table 126: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 127: Class Services

ID	Name	Description
-	-	-

Table 128: Instance Attributes

ID	Access rule	Name	Data type	Description
3	Get/Set	MotorType	USINT	Motor type
6	Get/Set	RatedCurrent	UINT	Rated Stator Current Units: [100 mA]
7	Get/Set	RatedVoltage	UINT	Rated Base Voltage Units: [V]
9	Get/Set	RatedFreq	UINT	Rated Electrical Frequency Units: [Hz]
12_d $0C_h$	Get	PoleCount	UINT	Number of poles in the motor.
15_d $0F_h$	Get/Set	Base Speed	UINT	Nominal speed at rated frequency from nameplate Units: [RPM]

Table 129: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "MotorType". Values 3 (Permanent Magnet Synchronous Motor) and 7 (Squirrel Cage Induction Motor) are supported.

Instance Attribute "RatedCurrent" allows reading and writing of the motor rated current. The unit of the attribute is 100 milliamperes.

Instance Attribute "RatedVoltage" allows reading and writing of the motor rated voltage. The unit of the attribute is 1 volt.

Instance Attribute "RatedFreq" allows reading and writing of the motor rated electrical frequency. The unit of the attribute is 1 hertz.

Instance Attribute "PoleCount" allows reading and writing of the number of poles in the motor. The unit of the attribute is 1.

Instance Attribute "Base Speed" allows reading and writing of the nominal speed at rated frequency. The unit of the attribute is 1 RPM.

4.6.5.8 Control Supervisor Object, Class 0x29

Control Supervisor Object provides an interface for drive management. For example, the motor can be started and stopped with this object.

Table 130: Class Name and Identifier

Class name	Class identifier
Control supervisor object	41_d / 29_h

Table 131: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 132: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 133: Instance Attributes

ID	Access rule	Name	Data type	Description
3	Get/Set	Run1	BOOL	Run forward
4	Get/Set	Run2	BOOL	Run reverse
5	Get/Set	NetCtrl	BOOL	Request Run/Stop control to be local or from network
6	Get	State	USINT	State. See Table 136.
7	Get	Running1	BOOL	True, when running forward
8	Get	Running2	BOOL	True, when running in reverse
9	Get	Ready	BOOL	True, when Ready or Enabled or Stopping
10_d $0A_h$	Get	Faulted	BOOL	True, when fault is active
11_d $0B_h$	Get	Warning	BOOL	True, when warning/alarm is active
12_d $0C_h$	Get/Set	FaultRst	BOOL	Resets fault when transits from zero to one
13_d $0D_h$	Get	FaultCode	UINT	If in Faulted state, Fault Code indicates the active fault. Otherwise last error or zero after start-up.

ID	Access rule	Name	Data type	Description
15_d $0F_h$	Get	CtrlFromNet	BOOL	True, control is from network False, control is local.
21_d 15_h	Get/Set	NetIdleMode	USINT	Mode on reception of CIP communication IDLE event.

Table 134: Instance Services

ID	Name	Description
5	Reset	Resets drive to start up state.
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "Run1" affects the run/stop behavior of the drive. See Table 135.

Instance Attribute "Run2" affects the run/stop behavior of the drive. See Table 135.

Table 135: Run/Stop Event Matrix

Run1	Run2	Trigger event	Run type
0	0	Stop	N/A
0 -> 1	0	Run	Run1
0	0 -> 1	Run	Run2
0 -> 1	0 -> 1	No Action	N/A
1	1	No Action	N/A
1 -> 0	1	Run	Run2
1	1 -> 0	Run	Run1

Instance Attribute "NetCtrl" allows the network to request the run/stop control to be assigned to the network. If the bit is 0, given control word is not updated to the drive. If the bit is 1, the run/stop control is requested to this network interface.

NOTE! The actual assignment of the run/stop control to this network interface is reflected in attribute 15_d. Fieldbus control is not forced on when this bit is set. Change the control location (fieldbus/IO/keypad) from the drive parameters.

Instance Attribute "State" reveals the state of the device according to the following table. See also Illustration 24.

Table 136: State Value Descriptions

Value	Definition
0	Vendor Specific
1	Startup
2	Not_Ready
3	Ready
4	Enabled

Value	Definition
5	Stopping
6	Fault_Stop
7	Faulted

Instance Attribute "Running1" is used to describe the run state of the drive. The value of the attribute is 1, if one of the following conditions is fulfilled:

- The "State" attribute has the value 4 ("Enabled") and the bit "Run1" has the value 1, or
- The "State" attribute has the value 5 ("Stopping") and the bit "Running1" has the value 1, or
- The "State" attribute has the value 6 ("Fault_Stop") and the bit "Running1" has the value 1.

Otherwise, the value of this attribute is 0.

Instance Attribute "Running2" is used to describe the run state of the drive. The value of the attribute is 1, if one of the following conditions is fulfilled:

- The "State" attribute has the value 4 ("Enabled") and the bit "Run2" has the value 1, or
- The "State" attribute has the value 5 ("Stopping") and the bit "Running2" has the value 1, or
- The "State" attribute has the value 6 ("Fault_Stop") and the bit "Running2" has the value 1.

Otherwise, the value of this attribute is 0.

Instance Attribute "Ready" is used to signal the state of the drive that it is ready for operation. The value of the attribute is 1 if the value of the "State" attribute is either 3 ("Ready"), 4 ("Enabled") or 5 ("Stopping"). Otherwise the value of this attribute is 0.

Instance Attribute "Faulted" is used to signal that one or several faults have occurred in the drive. The value of the attribute is 1 if a fault has occurred and has not been acknowledged. Otherwise, the attribute has the value 0 indicating that no faults are present.

Instance Attribute "Warning" is used to signal that one or several warnings have appeared in the drive. The value of the attribute is 1 if a warning has appeared and has not been acknowledged. Otherwise, the attribute has the value 0 indicating that no warnings are present.

Instance Attribute "FaultRst" is used to reset faults and warnings in the drive. The attribute is write-only. Changing the value of the attribute from 0 to 1 (rising-edge) resets the faults in the drive. If the value is static 0, no reset action is started.

Instance Attribute "FaultCode" is used to read the kind of fault which has caused the device to transition into the "Faulted" state. With multiple faults occurring simultaneously, only one code is reported. If the device is not in the Faulted state, the FaultCode attribute indicates the fault which caused the last transition to the Faulted state.

Instance Attribute "CtrlFromNet" indicates whether the run/stop control is assigned to the local interface or to this network interface. When the value of the attribute is 0, the control is local. When the value of the attribute is 1, the run/stop control is assigned to the network interface.

Instance Attribute "NetIdleMode" establishes the mode of operation on reception of network idle communication. Default value for this attribute is zero. Possible values are listed in the following table.

Table 137: NetIdleMode Values

Mode	Action	Error/Warning
0	Stops motor	Fault
1	Ignored. I/O data is not used, drive stays in state which was active before reception of IDLE	-
2	Vendor specific, fieldbus fault is activated (actual behavior depends on drive application and parametrization).	Fault
Other values are not supported		

Services

Instance Service "Reset" . The Control Supervisor Object has an instance service named "Reset" which has the Service Code 05_h. The service resets the drive to the start-up state. If an error is detected, an error response is returned. Otherwise a successful Reset response is returned.

Control Supervisor State Machine

The Control Supervisor Object defines a state machine for governing the behavior of devices. The following figure describes the states and transitions of the state machine.

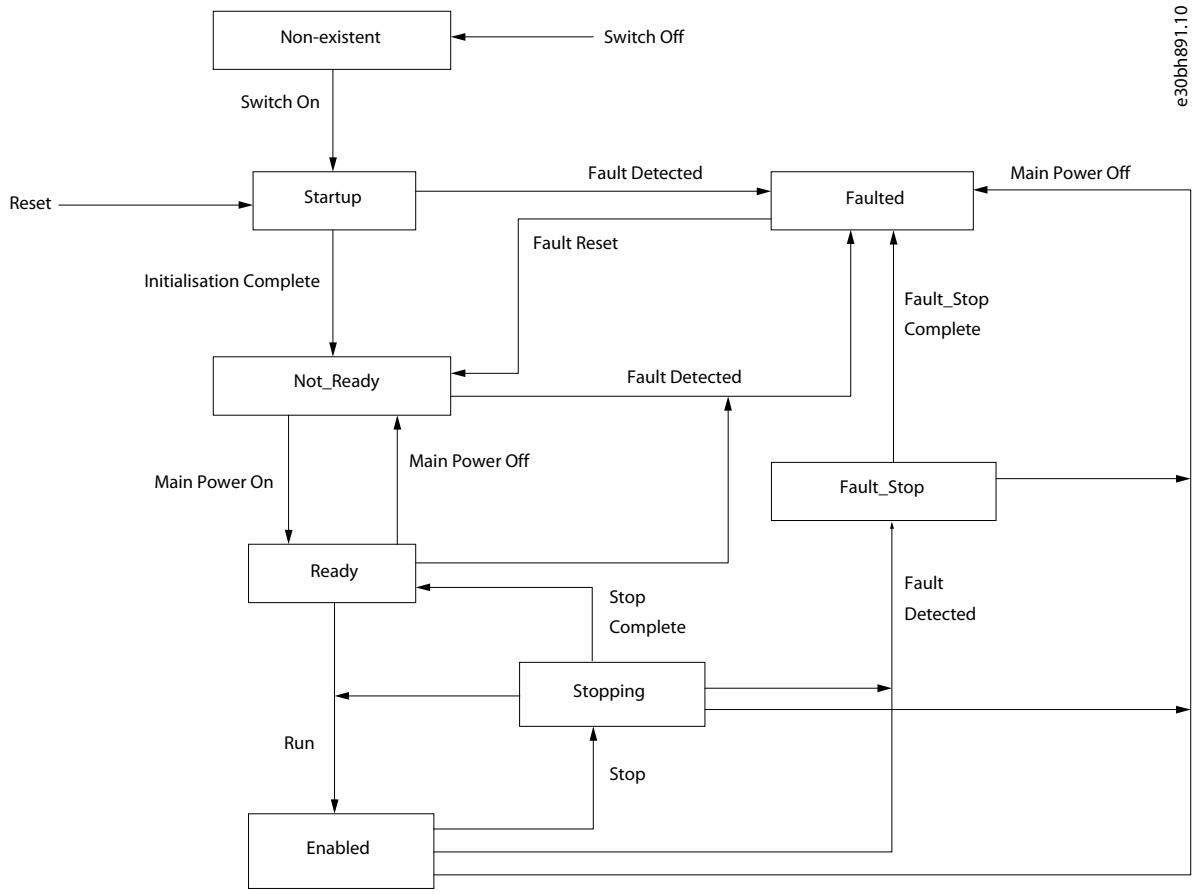


Illustration 24: Control Supervisor State Machine

4.6.5.9 AC/DC Drive Object, Class 0x2A

The AC/DC Drive Object models the functions specific to an AC or DC drive.

Table 138: Class Name and Identifier

Class name	Class identifier
AC/DC drive object	42_d / $2A_h$

Table 139: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 140: Class Services

ID	Name	Description
-	-	-

Table 141: Instance Attributes

ID	Access rule	Name	Data type	Description
3	Get/Set	AtReference	BOOL	True, when drive actual at reference (speed or torque reference) based on mode
4	Get/Set	NetRef	BOOL	Requests torque or speed reference to be from the network. False, when Set Reference not DN Control

ID	Access rule	Name	Data type	Description
				True, when Set Reference at DN Control
5	Get/Set	NetProc	BOOL	Requests process control reference to be from the network. False, when Set Process not DN Control True, when Set Process at DN Control
6	Get	DriveMode	USINT	Drive mode. See Table 143.
7	Get	SpeedActual	INT	Actual drive speed Units: RPM/$2^{SpeedScale}$ where SpeedScale is attribute 22_d
8	Get	SpeedRef	INT	Speed reference Units: RPM/$2^{SpeedScale}$ where SpeedScale is attribute 22_d
11_d $0B_h$	Get	TorqueActual	INT	Actual torque Units: Nm/$2^{TorqueScale}$ where TorqueScale is attribute 24_d
12_d $0C_h$	Get/Set	TorqueRef	INT	Torque reference Units: Nm/$2^{TorqueScale}$ where TorqueScale is attribute 24_d
13_d $0D_h$	Get	ProcessActual	INT	Actual process control value Units: % ProcessScale is not supported.
14_d $0E_h$	Get/Set	ProcessRef	INT	Process control reference setpoint. Units: % ProcessScale is not supported
22_d 16_h	Get/Set	SpeedScale	SINT	Speed scaling factor. Scaling is accomplished as follows: ScaledSpeed = RPM/$2^{SpeedScale}$. Range: -4...7
24_d 18_h	Get/Set	TorqueScale		Torque scaling factor. Scaling is accomplished as follows: ScaledTorque = Nm/$2^{TorqueScale}$ Range: -8...7
29_d $1D_h$	Get	RefFromNet	BOOL	Status of torque/speed reference False, when local torque/speed reference. True, when network torque/ speed reference

Table 142: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "AtReference" indicates whether the actual value is at the reference value (for example, the drive actual speed is the same as what is requested in the speed reference). If the bit is 1, the drive actual value is at the reference value.

Instance Attribute "NetRef". When the bit is 1, the torque or speed reference is requested to be allocated to this network interface. If the bit is 0, then no such request is made.

NOTE! The actual assignment of the reference to this network interface is reflected in the attribute 29d.

Instance Attribute "NetProc" is used to request torque or speed reference to be local or from network. Values are:

- 0 = Set reference not DN control
- 1 = Set reference at DN control

Instance Attribute "DriveMode". Allowed values for Drive Mode defined in the following table.

NOTE! The actual drive mode support depends on the used drive and application. Check the actual drive mode support from the drive application manual.

Table 143: Supported Drive Modes

Value	Name	Supported
0	Vendor-specific mode	Yes (Open loop frequency)
1	Open loop speed	Yes (Open loop speed)
2	Closed loop speed control	Yes (Closed loop speed)
3	Torque control	Yes (Open loop torque)
4	Process control (for example, PI control)	No
5	Position control	No

Changes to DriveMode attribute must be reflected in the "Motor Control Mode Object". The drive responds with "Invalid attribute value" status code 0x09, when other values are written.

Instance Attribute "SpeedActual" allows reading of the speed actual value. The unit of the attribute must be (RPM/$2^{SpeedScale}$), where the SpeedScale is attribute 22_d. If the SpeedScale attribute is not used by the master, the default unit [1 RPM] is assumed. It is equivalent to the value 0 being used for the SpeedScale.

Instance Attribute "SpeedRef" allows reading and writing of the speed reference setpoint. The unit of the attribute must be (RPM/$2^{SpeedScale}$), where SpeedScale is attribute 22_d. If the SpeedScale attribute is not used by the master, the default unit [1 RPM] is assumed. It is equivalent to the value 0 being used for SpeedScale.

Instance Attribute "TorqueActual" allows reading of the torque actual value. The unit of the attribute must be (Nm/$2^{TorqueScale}$), where the TorqueScale is attribute 24_d. If the TorqueScale attribute is not used by the master, the default unit [1 Nm] is assumed. It is equivalent to the value 0 being used for the TorqueScale.

Instance Attribute "TorqueRef" allows reading and writing of the torque reference setpoint. The unit of the attribute must be (Nm/$2^{TorqueScale}$), where the TorqueScale is attribute 24_d. If the TorqueScale attribute is not used by the master, the default unit [1 Nm] must be assumed. It is equivalent to the value 0 being used for TorqueScale. To set the drive to the torque control, see 6.2.1 AC Drive Parameters for Fieldbus Control and Reference Selection.

Instance Attribute "ProcessActual" allows reading of the process actual value. The unit of the attribute must be (% / $2^{ProcessScale}$), where the ProcessScale is attribute 25_d. The actual process scale mode is not supported. See 4.6.8.1 CIP Output Instances for details.

Instance Attribute "ProcessRef" allows reading and writing of the process reference setpoint. The unit of the attribute must be (% / $2^{ProcessScale}$), where ProcessScale is attribute 25_d. The actual process scale mode is not supported. See 4.6.8.1 CIP Output Instances for details.

Instance Attribute "SpeedScale". The SpeedActual and SpeedRef values are scaled according to the value of this attribute. The default value is 0_d.

The largest allowed value for this attribute is 7 (allowing resolution of 0.0078 RPM) and the minimum allowed value is -4 (allowing resolution of 16 RPM). The maximum speed value for input/ output is thus circa 524000 RPM.

Instance Attribute "TorqueScale". The TorqueActual and TorqueRef values are scaled according to the value of this attribute. The default value is 0_d.

The largest allowed value for this attribute is 7 (allowing resolution of 0.0078 Nm) and the minimum allowed value is -8 (allowing resolution of 256 Nm). The maximum torque value for input/output is thus circa 8.4 MNm.

Instance Attribute "RefFromNet" reveals whether the torque or speed reference is local or from the network. If the reference is local, the value of the attribute is 0. If the reference is from the network, then the value of the attribute is 1.

4.6.6 Vendor-specific Objects

4.6.6.1 Vendor Parameters Object, Class 0xA0

The Vendor Parameters Object is a vendor-specific object which allows to access any application parameter from the drive.

Table 144: Class Name and Identifier

Class name	Class identifier
Vendor parameter object	160_d / $A0_h$

Table 145: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 146: Class Services

ID	Name	Description
-	-	-

Table 147: Instance Attributes

ID	Access rule	Name	Data type	Description
XX	Get/Set	Parameter Value	UINT	Parameter Value

Table 148: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "Parameter Value". To read the value of a drive parameter, for example „"Motor control mode" ID600_d, set the instance attribute to value 600_d and the instance number to 1 to the request. The attribute data type in request must be 16 bits. If 8-bit data type is used, then the old method is used.

The old method from OPTCQ option board is also supported. It can be used when the PLC supports only 8-bit instance attributes. This method is more complex.

In this mode, set the instance number to high octet of the ID, and the instance attribute as low octet of the ID. For example, to read the value of ID 2291_d ($08F3_h$), the Get_Attribute_Single service request is targeted at the Vendor Parameters class, instance 08_h, and attribute $F3_h$.

Services

Instance Service "Get_Attribute_Single". When invoked in an instance, the parameter ID to be fetched from the drive is calculated. The read operation is started and once available, a response is provided to the master. The format of the message is as follows:

Table 149: Format of the Response to Get_Attribute_Single

Field	Data
Service Code	$0E_h$
Class Code	$A0_h$
Instance Number	01_h

Field	Data
Attribute ID	$XXXX_h$

The old format of the message is as follows (OPTCQ option board):

Table 150: Old Format of the Response to Get_Attribute_Single

Field	Data
Service Code	$0E_h$
Class Code	$A0_h$
Instance Number	YY_h
Attribute ID	XX_h

Instance Service "Set_Attribute_Single". When invoked in an instance, the parameter ID to be modified in the drive is calculated. The data type, write permission, and so on, are verified before the write operation is started. When the operation finishes, or if an error occurs, an appropriate response is provided to the master. The format of the message is as follows:

Table 151: Format of the Response to Set_Attribute_Single

Field	Data
Service Code	10_h
Class Code	$A0_h$
Instance Number	01_h
Attribute ID	$XXXX_h$
Attribute Data	Parameter-specific

The old format of the message is as follows (OPTCQ option board):

Table 152: Old Format of the Response to Set_Attribute_Single

Field	Data
Service Code	10_h
Class Code	$A0_h$
Instance Number	YY_h
Attribute ID	XX_h
Attribute Data	Parameter-specific

4.6.6.2 Assembly Instance Selector Object, Class 0xBE

The Assembly Instance Selector Object is a vendor-specific object. It allows to get and to set the input and output instances used.

The option board changes automatically the current assembly instances by what is requested in the connection opening. So, it is not required to pre-set assembly instances.

Table 153: Class Name and Identifier

Class name	Class identifier
Assembly instance selector object	190_d / BE_h

Table 154: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 155: Class Services

ID	Name	Description
-	-	-

Table 156: Instance Attributes

ID	Access rule	Name	Data type	Description
3	Get/Set	InputInstance	USINT	Input assembly instance
4	Get/Set	OutputInstance	USINT	Output assembly instance

Table 157: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "InputInstance" shows the currently active (or what was last used) input assembly instance id.

Instance Attribute "OutputInstance" shows the currently active (or what was last used) output assembly instance id.

Services

Instance Service "Get_Attribute_Single". The format of the message is as follows:

Table 158: Format of the Get_Attribute_Single

Field	Data
Service Code	$0E_h$
Class Code	BE_h
Instance Number	01_h
Attribute ID	03_h or 04_h

Instance Service "Set_Attribute_Single". The format of the message is as follows:

Table 159: Format of the Set_Attribute_Single

Field	Data
Service Code	10_h
Class Code	BE_h
Instance Number	01_h
Attribute ID	03_h or 04_h
Attribute Data	(Assembly number)

Rejection OF Set_Attribute_Single Request

If an I/O connection has been established with a master through the Forward_Open request and a successful response, any request to set the selected assembly through the Assembly Instance Selector object is rejected. These attributes can only be changed when no I/O connection is established, that is, before the Forward_Open request.

4.6.6.3 Motor Control Mode Object, Class 0xA1

The Motor Control Mode Object is a vendor-specific object which more clearly indicates which motor control mode is used, and allows to configure this mode.

Table 160: Class Name and Identifier

Class name	Class identifier
Motor Control Mode Object	161_d / $A1_h$

Table 161: Class Attributes

ID	Access rule	Name	Data type	Description
-	-	-	-	-

Table 162: Class Services

ID	Name	Description
-	-	-

Table 163: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get/Set	ControlMode	USINT	Motor control mode
2	Get/Set	FeedbackMode	USINT	Motor feedback mode

Table 164: Instance Services

ID	Name	Description
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.
16_d 10_h	Set_Attribute_Single	Used to write a single attribute value.

Instance Attributes

Instance Attribute "ControlMode" is used to detect or change the used motor control mode. The values allowed for this attribute are listed in the following table.

Table 165: Motor Control Mode Values

Value	Description
0_d	Frequency control
1_d	Speed control
2_d	Torque control

Instance Attribute "FeedbackMode" is used to detect or change the used feedback mode. The values allowed for this attribute are listed in the following table. After changing the feedback mode, set the control mode, too. Only after that, the new feedback mode value is activated.

Table 166: Motor Feedback Mode Values

Value	Description
0_d	Open Loop
1_d	Closed Loop

ControlMode and FeedbackMode combinations depend on used drive and application. Check the actual mode support from the application guide of the AC drive.

Services

Instance Service "Get_Attribute_Single". The service is used to get the value of an instance attribute. The format of the message is as follows.

Table 167: Format of the Get_Attribute_Single

Field	Data
Service Code	$0E_h$
Class Code	BE_h
Instance Number	01_h
Attribute ID	01_h or 02_h

Instance Service "Set_Attribute_Single". The service is used to set the value of an instance attribute. The format of the message is as follows.

Table 168: Format of the Set_Attribute_Single

Field	Data
Service Code	10_h
Class Code	BE_h
Instance Number	01_h
Attribute ID	01_h or 02_h
Attribute Data	(Mode number)

Link to AC/DC Drive Object "DriveMode" Attribute

The Motor Control Mode Object is linked to the "DriveMode" attribute of the AC/DC Drive Object so, that changes in one affects the values in the other. The following table shows the relation between the AC/DC Drive Object "DriveMode" attribute and the Motor Control Mode Object attributes.

Table 169: AC/DC Drive Object "DriveMode" Attribute and the Motor Control Mode Object Attributes

Set DriveMode value	ControlMode value	FeedbackMode value
0_d (Vendor specific)	0_d (Frequency control)	0_d (Open Loop)
1_d (Open loop speed)	1_d (Speed control)	0_d (Open Loop)
2_d (Closed loop speed)	1_d (Speed control)	1_d (Closed Loop)
3_d (Torque control)	2_d (Torque control)	[1]

[1] Feedback mode does not change. CIP does not define is torque control open or closed loop.

The following table shows the relation between Motor Control Mode Object "ControlMode" and "FeedbackMode" attributes to the the AC/DC Drive Object "DriveMode" attribute.

Table 170: Motor Control Mode Object "ControlMode" and "FeedbackMode" Attributes in Relation to the AC/DC Drive Object "DriveMode" Attribute

Set Motor Control Mode Object value ControlMode	Set Motor Control Mode Object value FeedbackMode	DriveMode Value
0_d (Frequency)	0_d (Open loop)	1_d (Vendor/frequency)
1_d (Speed)	0_d (Open loop)	1_d (Open loop speed)
1_d (Speed)	1_d (Closed loop)	2_d (Closed loop speed)
2_d (Torque)	0_d (Open loop) or 1_d (Closed loop)	3_d (Torque control)

4.6.6.4 Fault History Object, class 0xA2

The Fault History Object is a vendor-specific object which allows access to the contents of the fault history over the EtherNet/IP network.

Each entry in a fault history is represented by an instance of the Fault History Object. Low instance numbers correspond to the most recent fault entries.

Table 171: Class Name and Identifier

Class name	Class identifier
Fault history object	162_d / $A2_h$

Table 172: Class Attributes

ID	Access rule	Name	Data type	Description
1	Get	Revision	UINT	Class revision (2)
2	Get	Max Instance	UINT	Maximum instance number (40)
3	Get	Number of Instances	UINT	Number of object instances. Depends on drive type.

Table 173: Class Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the class.
5	Reset	Reset fault history
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value.

Table 174: Instance Attributes

ID	Access rule	Name	Data type	Description
1	Get	FaultCode	UINT	Fault code
2	Get	FaultID	UINT	Fault ID
3	Get	FaultYear	UINT	Fault date: Year
4	Get	FaultMonth	USINT	Fault date: Month
5	Get	FaultDay	UINT	Fault date: Day
6	Get	FaultMillisAfter Midnight	UDINT	Fault date: Time, milliseconds after midnight

Table 175: Instance Services

ID	Name	Description
1	Get_Attributes_All	Returns content of all (implemented) attributes in the instance
14_d $0E_h$	Get_Attribute_Single	Used to read single attribute value

Changes from Revision 1 to Revision 2
The attributes FaultCode and FaultDay were changed from 8-bit to 16-bit.

Class Attributes
Class Attribute "Revision" presents the revision of the Fault History Object implemented by the device. The current revision is 2.

Class Attribute "Max Instance" presents the maximum number of instances that can exist of the Fault History Object in the device. The maximum value is 40.

Class Attribute "Number of Instances" presents the number of instances that currently exist of the Fault History Object in the device.

Table 176: Fault History Object - Number Of Instances

Drive	Maximum number of faults
VACON® 20 VACON® 20X VACON® 20 CP	10
VACON® NXP	30
VACON® NXS	30
VACON® 100 family	40

Instance Attributes
Instance Attribute "FaultCode". The value returns the fault code of a fault entry shown by the Fault History Object instance.

Instance Attribute "FaultID". The value returns the fault ID of a fault entry shown by the Fault History Object instance. This value more exactly specifies which kind of fault is in question.

With VACON® NXP and VACON® 20 family AC drives, the FaultID is the subcode of the fault.

Instance Attribute "FaultYear". In VACON® 100 family AC drive, the attribute contains the year in which the fault occurred (according to the fault history). In other drives, it contains the number of years the drive had been running until the fault occurred.

Instance Attribute "FaultMonth". In VACON® 100 family AC drive and in VACON® NXP drive (if real DateTime has been set), the attribute contains the month in which the fault occurred (according to the fault history). In other drives, it is always zero.

Instance Attribute "FaultDay". In VACON® 100 family AC drive and in the VACON® NXP drive (if real DateTime has been set), the attribute contains the day-of-month in which the fault occurred (according to the fault history). In other drives, it contains the number of days the drive had been running since beginning of the year until the fault occurred.

Instance Attribute "FaultMillisAfterMidnight" contains the number of milliseconds after midnight when the fault is time-stamped. The purpose of this format is to provide high accuracy and give the possibility of representation according to 24-hour or 12-hour clock.

Class Services
Class Service "Reset". This service is used to reset the fault history of the drive.

4.6.7 Supported Assembly Instances Overview

The following table contains a simple listing of supported assembly instances. For more detailed description of each assembly instance, see 4.6.8 CIP I/O Assembly Instances for AC/DC Drive and 4.6.10 Mapping of Standard Output Assemblies onto VACON® Data. As the detailed descriptions can contain exceptions based on the drive type, application version, and so on, read them before taking any assembly instance into use.

Table 177: Quick Reference Table for Assembly Instances

Type	Instance ID	Size (bytes)	Control/status word type	Speed reference/ actual type	Process data items
OUTPUT	20	4	CIP	CIP	0
OUTPUT	21	4	CIP	CIP	0
OUTPUT	23	6	CIP	CIP	0
OUTPUT	25	6	CIP	CIP	1
OUTPUT	101	8	CIP	Vacon	2
OUTPUT	111	20	Vacon	Vacon	8
OUTPUT	128	20	Vacon	Vacon	8
OUTPUT	131	40	Vacon	Vacon	8 (32-bit)
OUTPUT	151	38	Vacon	Vacon	16
OUTPUT	161	36	CIP	Vacon	16
INPUT	70	4	CIP	CIP	0
INPUT	71	4	CIP	CIP	0
INPUT	73	6	CIP	CIP	0
INPUT	75	6	CIP	CIP	1
INPUT	107	8	CIP	Vacon	2
INPUT	117	34	Vacon	Vacon	8
INPUT	127	20	Vacon	Vacon	8
INPUT	137	40	Vacon	Vacon	8 (32-bit)
INPUT	157	38	Vacon	Vacon	16
INPUT	167	36	CIP	Vacon	16
INPUT ONLY	253	0	N/A	N/A	N/A
LISTEN ONLY	254	0	N/A	N/A	N/A

4.6.8 CIP I/O Assembly Instances for AC/DC Drive

Supported standard Output/Input Assembly instance pairs are 20/70, 21/71, 23/73 and 25/75. The control word bits are mapped to the object data according to the following table.

Table 178: CIP Control Word Mapping To Object Data

Bit	Bit name	Object	Attribute name	Attribute ID
0	RunFwd	Control Supervisor Object	Run1	3_d
1	RunRev	Control Supervisor Object	Run2	4_d
2	FaultRst	Control Supervisor Object	FaultRst	12_d
3	-	-	-	-
4	-	-	-	-

Bit	Bit name	Object	Attribute name	Attribute ID
5	NetCtrl	Control Supervisor Object	NetCtrl	5_d
6	NetRef	AC/DC Drive Object	NetRef	4_d
7	NetProc	AC/DC Drive Object	NetProc	5_d

The status word bits are mapped to the object data according to the following table.

Table 179: CIP Status Word Mapping to Object Data

Bit	Bit name	Object	Attribute name	Attribute ID
0	Faulted	Control Supervisor Object	Faulted	10_d
1	Warning	Control Supervisor Object	Warning	11_d
2	Running1	Control Supervisor Object	Running1	7_d
3	Running2	Control Supervisor Object	Running2	8_d
4	Ready	Control Supervisor Object	Ready	9_d
5	CtrlFromNet	Control Supervisor Object	CtrlFromNet	15_d
6	RefFromNet	AC/DC Drive Object	RefFromNet	29_d
7	AtReference	AC/DC Drive Object	AtReference	3_d

The process data IN is mapped according to the following table.

Table 180: Process Data IN Mapping To Object Data

Parameter name	Object	Attribute name	Attribute ID
Speed Reference	AC/DC Drive Object	SpeedRef	8_d
Torque Reference	AC/DC Drive Object	TorqueRef (ProcessDataIn1)	12_d
Process Reference	AC/DC Drive Object	ProcessRef If Drive Mode is: 0 =ProcessDataIn1 4 =ProcessDataIn2	14_d
Drive Mode	AC/DC Drive Object	DriveMode	6_d

The process data OUT is mapped according to the following table.

Table 181: Process Data OUT Mapping To Object Data

Parameter name	Object	Attribute name	Attribute ID
Speed Actual	AC/DC Drive Object	SpeedActual	7_d
Torque Actual	AC/DC Drive Object	TorqueActual	11_d
Process Actual	AC/DC Drive Object	ProcessActual (ProcessDataOut1)	13_d
Drive State	Control Supervisor Object	State	6_d

The Speed Reference is updated to the drive only when the NetRef bit is set to 1. The torque reference is updated to the drive only when the motor control mode is "Torque Control".

4.6.8.1 CIP Output Instances

When using these telegrams, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 182: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	CIP Control Word

Table 183: Assembly Instance 20 - Basic Speed Control Output

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
20 (length 4)	0	-	-	-	-	-	Fault Reset	-	Run Fwd
	1	-	-	-	-	-	-	-	-
	2	Speed Reference (Low Octet)							
	3	Speed Reference (High Octet)							

Table 184: Assembly Instance 21 – Extended Speed Control Output

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
21 (length 4)	0	-	NetRef	NetCtrl	-	-	Fault Reset	Run Rev	Run Fwd
	1	-	-	-	-	-	-	-	-
	2	Speed Reference (Low Octet)							
	3	Speed Reference (High Octet)							

Table 185: Assembly Instance 23 – Extended Speed and Torque Control Output

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
23 (length 6)	0	-	NetRef	NetCtrl	-	-	Fault Reset	Run Rev	Run Fwd
	1	-	-	-	-	-	-	-	-
	2	Speed Reference (Low Octet)							
	3	Speed Reference (High Octet)							
	4	Torque Reference (Low Octet)							
	5	Torque Reference (High Octet)							

Table 186: Assembly Instance 25 – Extended Process Control Output

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
23 (length 6)	0	Netproc	NetRef	NetCtrl	-	-	Fault Reset	Run Rev	Run Fwd
	1	Drive Mode							
	2	Speed Reference (Low Octet)							
	3	Speed Reference (High Octet)							
	4	Process Reference (Low Octet)							

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	5	Process Reference (High Octet)							

The extended process control assembly can be used to send process reference value directly to the application. The value destination of the Process Reference can be selected with the Drive Mode byte according to the following table. It must be configured in the application as the receiving input. To the other direction (input assembly instance 75), the ProcessDataOut1 is always mapped to the Process Actual. The process reference value is sent to the drive only when NetProc bit is set.

The VACON® AC drives do not support the actual "Process Control"-mode. Therefore the Drive Mode cannot be set to the Process Control by using the AC/DC Drive Object attribute. The Drive Mode parameter in this assembly is only used to select the process reference. With these mappings, the Process Reference, and Process Actual can be used with an application that supports the PID control.

Table 187: Drive Mode Selection in Process Control

Drive Mode	Process reference mapping
0	ProcessDataIn1
4	ProcessDataIn2
Other	Not valid

4.6.8.2 CIP Input Instances

When using these telegrams, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 188: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	CIP Status Word

Table 189: Assembly Instance 70 - Basic Speed Control Input

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
70 (length 4)	0	-	-	-	-	-	Running1	-	Faulted
	1	-	-	-	-	-	-	-	-
	2	Speed Actual (Low Octet)							
	3	Speed Actual (High Octet)							

Table 190: Assembly Instance 71 – Extended Speed Control Input

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
71 (length 4)	0	AtReference	RefFromNet	Ctrl- From-Net	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Octet)							
	3	Speed Actual (High Octet)							

Table 191: Assembly Instance 73 – Extended Speed and Torque Control Input

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
73 (length 6)	0	AtReference	RefFromNet	Ctrl FromNet	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Octet)							
	3	Speed Actual (High Octet)							
	4	Torque Actual (Low Octet)							
	5	Torque Actual (High Octet)							

Table 192: Assembly Instance 75 – Extended Process Control Input

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
75 (length 6)	0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Octet)							
	3	Speed Actual (High Octet)							
	4	Process Actual (Low Octet)							
	5	Process Actual (High Octet)							

For details on Assembly Instance 75 – Extended Process Control Input, see 4.6.8.1 CIP Output Instances.

4.6.9 Vendor-specific I/O Assembly Instances

In addition to standard assemblies, we also support multiple vendor-specific assemblies.

Few of the instances use the CIP control and status words. Others use the vendor-specific control and status words. All items started with "FB" are sent directly to the AC drive without any modifications.

Some of the vendor assemblies use the 32-bit process data values. They are supported only in the VACON® 100 family AC drive. These assemblies can be used in other AC drives too, but the data is always only 16-bit.

NOTE: Current firmware versions do not support transferring 32-bit process data with the control. Only the lower 16 bits are transferred. Also, only in VACON® NXP it is possible to transfer 16-bit process data items with the new communication modes.

4.6.9.1 Vendor Output Instances

Assembly Instance 101

Table 193: Assembly Instance 101

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
101 (length 8)	0	-	NetRef	NetCtrl	-	-	Fault Reset	Run Rev	Run Fwd
	1	-	-	-	-	-	-	-	-
	2	FBSpeedReference (Low Octet) in %							
	3	FBSpeedReference (High Octet) in %							
	4	FBProcessDataIn1 (Low Octet)							
	5	FBProcessDataIn1 (High Octet)							
	6	FBProcessDataIn2 (Low Octet)							

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	7	FBProcessDataIn2 (High Octet)							

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 194: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	CIP Control Word

Assembly Instance 111

Table 195: Assembly Instance 111

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
111 (length 20)	0	FBFixedControlWord (Low Octet)							
	1	FBFixedControlWord (High Octet)							
	2	FBSpeedReference (Low Octet) in %							
	3	FBSpeedReference (High Octet) in %							
	4	FBProcessDataIn1 (Low Octet)							
	5	FBProcessDataIn1 (High Octet)							
	6	FBProcessDataIn2 (Low Octet)							
	7	FBProcessDataIn2 (High Octet)							
	8	FBProcessDataIn3 (Low Octet)							
	9	FBProcessDataIn3 (High Octet)							
	10	FBProcessDataIn4 (Low Octet)							
	11	FBProcessDataIn4 (High Octet)							
	12	FBProcessDataIn5 (Low Octet)							
	13	FBProcessDataIn5 (High Octet)							
	14	FBProcessDataIn6 (Low Octet)							
	15	FBProcessDataIn6 (High Octet)							
	16	FBProcessDataIn7 (Low Octet)							
	17	FBProcessDataIn7 (High Octet)							
	18	FBProcessDataIn8 (Low Octet)							
	19	FBProcessDataIn8 (High Octet)							

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 196: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	FBFixedControlWord

Assembly Instance 128

Table 197: Assembly Instance 128

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
128 (length 20)	0	FBFixedControlWord (Low Octet)							
	1	FBGeneralControlWord (High Octet)							
	2	FBSpeedReference (Low Octet) in %							
	3	FBSpeedReference (High Octet) in %							
	4	FBProcessDataIn1 (Low Octet)							
	5	FBProcessDataIn1 (High Octet)							
	6	FBProcessDataIn2 (Low Octet)							
	7	FBProcessDataIn2 (High Octet)							
	8	FBProcessDataIn3 (Low Octet)							
	9	FBProcessDataIn3 (High Octet)							
	10	FBProcessDataIn4 (Low Octet)							
	11	FBProcessDataIn4 (High Octet)							
	12	FBProcessDataIn5 (Low Octet)							
	13	FBProcessDataIn5 (High Octet)							
	14	FBProcessDataIn6 (Low Octet)							
	15	FBProcessDataIn6 (High Octet)							
	16	FBProcessDataIn7 (Low Octet)							
	17	FBProcessDataIn7 (High Octet)							
	18	FBProcessDataIn8 (Low Octet)							
	19	FBProcessDataIn8 (High Octet)							

The contents of the assembly are otherwise identical to the output assembly 111, except that the second octet of the assembly is the high octet of FBGeneralControlWord instead of FBFixedControlWord.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 198: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	FBGeneralControlWord

Assembly Instance 131

Table 199: Assembly Instance 131

Instance	Offset	Octet 0	Octet +1	Octet +2	Octet +3
131 (length 40)	0	FBFixedControl- Word (Low Octet)	FBFixedControl-Word (High Octet)	FBGeneralCon- trolWord (Low Octet)	FBGeneralCon- trolWord (High Octet)
	4	Reserved	Reserved	FBSpeedRef (Low Octet)	FBSpeedRef (High Octet)
	8	FBProcessDataIn 1 Bits 7:0	FBProcessDataIn 1 Bits 15:8	FBProcessDataIn 1 Bits 23:16	FBProcessDataIn 1 Bits 31:24
	12	FBProcessDataIn 2 Bits 7:0	FBProcessDataIn 2 Bits 15:8	FBProcessDataIn 2 Bits 23:16	FBProcessDataIn 2 Bits 31:24
	16	FBProcessDataIn 3 Bits 7:0	FBProcessDataIn 3 Bits 15:8	FBProcessDataIn 3 Bits 23:16	FBProcessDataIn 3 Bits 31:24
	20	FBProcessDataIn 4 Bits 7:0	FBProcessDataIn 4 Bits 15:8	FBProcessDataIn 4 Bits 23:16	FBProcessDataIn 4 Bits 31:24
	24	FBProcessDataIn 5 Bits 7:0	FBProcessDataIn 5 Bits 15:8	FBProcessDataIn 5 Bits 23:16	FBProcessDataIn 5 Bits 31:24
	28	FBProcessDataIn 6 Bits 7:0	FBProcessDataIn 6 Bits 15:8	FBProcessDataIn 6 Bits 23:16	FBProcessDataIn 6 Bits 31:24
	32	FBProcessDataIn 7 Bits 7:0	FBProcessDataIn 7 Bits 15:8	FBProcessDataIn 7 Bits 23:16	FBProcessDataIn 7 Bits 31:24
	36	FBProcessDataIn 8 Bits 7:0	FBProcessDataIn 8 Bits 15:8	FBProcessDataIn 8 Bits 23:16	FBProcessDataIn 8 Bits 31:24

NOTE: Current firmware versions do not support transferring of 32-bit process data. Only the lower 16 bits are transferred.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 200: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	FBGeneralControlWord

Assembly Instance 151

Table 201: Assembly Instance 151

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
151 (length 28)	0	FBFixedControlWord (Low Octet)							
	1	FBFixedControlWord (High Octet)							
	2	FBGeneralControlWord (Low Octet)							
	3	FBGeneralControlWord (High Octet)							
	4	FBSpeedReference (Low Octet) in %							
	5	FBSpeedReference (High Octet) in %							
	6	FBProcessDataIn1 (Low Octet)							
	7	FBProcessDataIn1 (High Octet)							

Instance	Octet	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	...	...							
	20	FBProcessDataIn8 (Low Octet)							
	21	FBProcessDataIn8 (High Octet)							
	22[1]	FBProcessDataIn9 (Low Octet)							
	23[1]	FBProcessDataIn9 (High Octet)							
	...	...							
	36[1]	FBProcessDataIn16 (Low Octet)							
	37[1]	FBProcessDataIn16 (High Octet)							

[1] FBProcessDataIn9-16 are available in VACON® NXP AC drive. See 4.2 Fieldbus Option Board Communication Modes.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 202: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	FBGeneralControlWord

Assembly Instance 152

Table 203: Assembly Instance 152

Instance	Octet	Bit 7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
152 (length 72)	0	FbFixedControlWord (low Octet)							
	1	FbFixedControlWord (high Octet)							
	2	FbGeneralControlWord (low Octet)							
	3	FbGeneralControlWord (high Octet)							
	4	Reserved							
	5	Reserved							
	6	FBSpeedReference (low octect)							
	7	FBSpeedReference (high octect)							
	8	FBProcessDataIn1 (Bits 7:0)							
	9	FBProcessDataIn1 (Bits 15:8)							
	10	FBProcessDataIn1 (Bits 23:16)							
	11	FBProcessDataIn1 (Bits 31:24)							
	..								
	68	FBProcessDataIn16 (Bits 7:0)							
	69	FBProcessDataIn16 (Bits 15:8)							

Instance	Octet	Bit 7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	70	FBProcessDataIn16 (Bits 23:16)							
	71	FBProcessDataIn16 (Bits 31:24)							

Table 204: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	FBGeneralControlWord

Assembly Instance 161

Table 205: Assembly Instance 161

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
161 (length 36)	0	-	NetRef	NetCtrl	-	-	Fault Reset	RunRev	RunFwd
	1	-	-	-	-	-	-	-	-
	2	FBSpeedReference (Low Octet) in %							
	3	FBSpeedReference (High Octet) in %							
	4	FBProcessDataIn1 (Low Octet)							
	5	FBProcessDataIn1 (High Octet)							
	...	...							
	18	FBProcessDataIn8 (Low Octet)							
	19	FBProcessDataIn8 (High Octet)							
	20[1]	FBProcessDataIn9 (Low Octet)							
	21[1]	FBProcessDataIn9 (High Octet)							
	...	...							
	34[1]	FBProcessDataIn16 (Low Octet)							
	35[1]	FBProcessDataIn16 (High Octet)							

[1] FBProcessDataIn9-16 are available in VACON® NXP AC drive. See 4.2 Fieldbus Option Board Communication Modes.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used input instance.

Table 206: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	CIP Control Word

Assembly Instance 162

Table 207: Assembly Instance 162

Instance	Octet	Bit 7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
162 (length 68)	0		NetRef	NetCtrl			Fault rst	Run Rev	Run Fwd
	1	Reserved							
	2	FBSpeedReference (low octect)							
	3	FBSpeedReference (high octect)							
	4	FBSpeedReference (low octect)							
	5	FBSpeedReference (high octect)							
	6	FBProcessDataIn1 (Bits 7:0)							
	7	FBProcessDataIn1 (Bits 15:8)							
	8	FBProcessDataIn1 (Bits 23:16)							
	9	FBProcessDataIn1 (Bits 31:24)							
	..								
	64	FBProcessDataIn16 (Bits 7:0)							
	65	FBProcessDataIn16 (Bits 15:8)							
	66	FBProcessDataIn16 (Bits 23:16)							
	67	FBProcessDataIn16 (Bits 31:24)							

Table 208: Control Word Monitoring Values

Name	Value
Drive CW	FBFixedControlWord
Protocol CW	CIP Control Word

4.6.9.2 Vendor Input Instances

Assembly Instance 107

Table 209: Assembly Instance 107

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
107 (length 8)	0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	FBSpeedActual (Low Octet) in %							
	3	FBSpeedActual (High Octet) in %							
	4	FBProcessDataOut1 (Low Octet)							
	5	FBProcessDataOut1 (High Octet)							
	6	FBProcessDataOut2 (Low Octet)							
	7	FBProcessDataOut2 (High Octet)							

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 210: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	CIP Status Word

Assembly Instance 117

Table 211: Assembly Instance 117

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
117 (length 34)	0	FBFixedStatusWord (Low Octet)							
	1	FBFixedStatusWord (High Octet)							
	2	FBSpeedActual (Low Octet) in %							
	3	FBSpeedActual (High Octet) in %							
	4	RPMSpeedActual (Low Octet) in RPM							
	5	RPMSpeedActual (High Octet) in RPM							
	6	RPM With Slip SpeedActual (Low Octet) in RPM							
	7	RPM With Slip SpeedActual (High Octet) in RPM							
	8	Reserved (=0)							
	...	Reserved (=0)							
	17	Reserved (=0)							
	18	FBProcessDataOut1 (Low Octet)							
	19	FBProcessDataOut1 (High Octet)							
	20	FBProcessDataOut2 (Low Octet)							
	21	FBProcessDataOut2 (High Octet)							
	22	FBProcessDataOut3 (Low Octet)							
	23	FBProcessDataOut3 (High Octet)							
	24	FBProcessDataOut4 (Low Octet)							
	25	FBProcessDataOut4 (High Octet)							
	26	FBProcessDataOut5 (Low Octet)							
	27	FBProcessDataOut5 (High Octet)							
	28	FBProcessDataOut6 (Low Octet)							
	29	FBProcessDataOut6 (High Octet)							
	30	FBProcessDataOut7 (Low Octet)							
	31	FBProcessDataOut7 (High Octet)							
	32	FBProcessDataOut8 (Low Octet)							

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	33	FBProcessDataOut8 (High Octet)							

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 212: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	FBFixedStatusWord

Assembly Instance 127

Table 213: Assembly Instance 127

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
127 (length 20)	0	FBFixedStatusWord (Low Octet)							
	1	FBGeneralStatusWord (High Octet)							
	2	FBSpeedActual (Low Octet) in %							
	3	FBSpeedActual (High Octet) in %							
	4	FBProcessDataOut1 (Low Octet)							
	5	FBProcessDataOut1 (High Octet)							
	6	FBProcessDataOut2 (Low Octet)							
	7	FBProcessDataOut2 (High Octet)							
	8	FBProcessDataOut3 (Low Octet)							
	9	FBProcessDataOut3 (High Octet)							
	10	FBProcessDataOut4 (Low Octet)							
	11	FBProcessDataOut4 (High Octet)							
	12	FBProcessDataOut5 (Low Octet)							
	13	FBProcessDataOut5 (High Octet)							
	14	FBProcessDataOut6 (Low Octet)							
	15	FBProcessDataOut6 (High Octet)							
	16	FBProcessDataOut7 (Low Octet)							
	17	FBProcessDataOut7 (High Octet)							
	18	FBProcessDataOut8 (Low Octet)							
	19	FBProcessDataOut8 (High Octet)							

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 214: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	FBGeneralStatusWord

Assembly Instance 137

Table 215: Assembly Instance 137

Instance	Offset	Octet 0	Octet +1	Octet +2	Octet +3
137 (length 40)	0	FBFixedStatus- Word (Low Octet)	FBFixedStatus- Word (High Octet)	FBGeneralStatus- Word (Low Octet)	FBGeneralStatus- Word (High Octet)
	4	Reserved	Reserved	FBSpeedActual (Low Octet)	FBSpeedActual (High Octet)
	8	FBProcessDataO ut1 Bits 7:0	FBProcessDataO ut1 Bits 15:8	FBProcessDataOu t1 Bits 23:16	FBProcessDataOu t1 Bits 31:24
	12	FBProcessDataO ut2 Bits 7:0	FBProcessDataO ut2 Bits 15:8	FBProcessDataOu t2 Bits 23:16	FBProcessDataOu t2 Bits 31:24
	16	FBProcessDataO ut3 Bits 7:0	FBProcessDataO ut3 Bits 15:8	FBProcessDataOu t3 Bits 23:16	FBProcessDataOu t3 Bits 31:24
	20	FBProcessDataO ut4 Bits 7:0	FBProcessDataO ut4 Bits 15:8	FBProcessDataOu t4 Bits 23:16	FBProcessDataOu t4 Bits 31:24
	24	FBProcessDataO ut5 Bits 7:0	FBProcessDataO ut5 Bits 15:8	FBProcessDataOu t5 Bits 23:16	FBProcessDataOu t5 Bits 31:24
	28	FBProcessDataO ut6 Bits 7:0	FBProcessDataO ut6 Bits 15:8	FBProcessDataOu t6 Bits 23:16	FBProcessDataOu t6 Bits 31:24
	32	FBProcessDataO ut7 Bits 7:0	FBProcessDataO ut7 Bits 15:8	FBProcessDataOu t7 Bits 23:16	FBProcessDataOu t7 Bits 31:24
	36	FBProcessDataO ut8 Bits 7:0	FBProcessDataO ut8 Bits 15:8	FBProcessDataOu t8 Bits 23:16	FBProcessDataOu t8 Bits 31:24

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 216: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	FBGeneralStatusWord

Assembly Instance 157

Table 217: Assembly Instance 157

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
157 (length 38)	0	FBFixedStatusWord (Low Octet)							
	1	FBFixedStatusWord (High Octet)							
	2	FBGeneralStatusWord (Low Octet)							
	3	FBGeneralStatusWord (High Octet)							

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	4	FBSpeedActual (Low Octet) in %							
	5	FBSpeedActual (High Octet) in %							
	6	FBProcessDataOut1 (Low Octet)							
	7	FBProcessDataOut1 (High Octet)							
	...	...							
	20	FBProcessDataOut8 (Low Octet)							
	21	FBProcessDataOut8 (High Octet)							
	22[1]	FBProcessDataOut9 (Low Octet)							
	23[1]	FBProcessDataOut9 (High Octet)							
	...	...							
	36[1]	FBProcessDataOut16 (Low Octet)							
	37[1]	FBProcessDataOut16 (High Octet)							

[1] FBProcessDataIn9-16 are available in VACON® NXP AC drive. See 4.2 Fieldbus Option Board Communication Modes.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 218: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	FBGeneralStatusWord

Assembly Instance 158

Table 219: Assembly Instance 158

Instance	Octet	Data
158 (length 72)	0	FBFixedStatusWord (Low Octet)
	1	FBFixedStatusWord (High Octet)
	2	FBGeneralStatusWord (Low Octet)
	3	FBGeneralStatusWord (High Octet)
	4	Reserved
	5	Reserved
	6	FBSpeedActual (Low Octet) in %
	7	FBSpeedActual (High Octet) in %
	8	FBProcessDataOut1 (Bits 7:0)
	9	FBProcessDataOut1 (Bits 15:8)
	10	FBProcessDataOut1 (Bits 23:16)

Instance	Octet	Data
	11	FBProcessDataOut1 (Bits 31:24)
	..	
	68	FBProcessDataOut16 (Bits 7:0)
	69	FBProcessDataOut16 (Bits 15:8)
	70	FBProcessDataOut16 (Bits 23:16)
	71	FBProcessDataOut16 (Bits 31:24)

Table 220: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	FBGeneralStatusWord

Assembly Instance 167

Table 221: Assembly Instance 167

Instance	Octet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit0
167 (length 36)	0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	FBSpeedActual (Low Octet) in %							
	3	FBSpeedActual (High Octet) in %							
	4	FBProcessDataOut1 (Low Octet)							
	5	FBProcessDataOut1 (High Octet)							
	...	...							
	18	FBProcessDataOut8 (Low Octet)							
	19	FBProcessDataOut8 (High Octet)							
	20[1]	FBProcessDataOut9 (Low Octet)							
	21[1]	FBProcessDataOut9 (High Octet)							
	...	…							
	34[1]	FBProcessDataOut16 (Low Octet)							
	35[1]	FBProcessDataOut16 (High Octet)							

[1] FBProcessDataIn9-16 are available in VACON® NXP AC drive. See 4.2 Fieldbus Option Board Communication Modes.

When using this telegram, monitoring values contains values as shown in the following table. Status word values depend on used output instance.

Table 222: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord

Name	Value
Protocol SW	CIP Status Word

Assembly Instance 168

Table 223: Assembly Instance 168

Instance	Octet	Bit 7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
168 (length 68)	0	At ref	RefFromNet	CtrlFromNet	ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive state							
	2	FBSpeedActual (Low Octet) in %							
	3	FBSpeedActual (High Octet) in %							
	4	FBProcessDataOut1 (Bits 7:0)							
	5	FBProcessDataOut1 (Bits 15:8)							
	6	FBProcessDataOut1 (Bits 23:16)							
	7	FBProcessDataOut1 (Bits 31:24)							
	…								
	64	FBProcessDataOut16 (Bits 7:0)							
	65	FBProcessDataOut16 (Bits 15:8)							
	66	FBProcessDataOut16 (Bits 23:16)							
	67	FBProcessDataOut16 (Bits 31:24)							

Table 224: Status Word Monitoring Values

Name	Value
Drive SW	FBFixedStatusWord
Protocol SW	CIP Status Word

4.6.10 Mapping of Standard Output Assemblies onto VACON® Data

VACON® I/O Data

See 4.7 VACON® Process Data Description for detailed information about VACON® control word, status word, speed reference, speed actual and process data items.

Start/Stop Bit in VACON® FBFixedControlWord

If one of the "RunFwd" or "RunRev" bits in an Output Assembly has the value 1, the "Start/Stop" bit 0 in the VACON® FBFixedControlWord is set to 1. Otherwise the bit is set to 0.

If both the "RunFwd" and "RunRev" bits have the value 1, no changes are done to FBFixedControlWord.

Direction Bit in VACON® FBFixedControlWord

If the "RunRev" bit in an Output Assembly has the value 1, and the "RunFwd" bit in the assembly has the value 0, the "Direction" bit 1 in the VACON® FBFixedControlWord is set to 1. Otherwise the bit is set to 0.

Fault Reset Bit in VACON® FBFixedControlWord

The "Fault Reset" bit in an Output Assembly is mapped to the "Fault Reset" bit 2 in the VACON® FBFixedControlWord. Both bits are rising-edge sensitive.

Request Fieldbus Control Bit in VACON® FBFixedControlWord

The "NetCtrl" bit in an Output Assembly is not mapped to the "Request Fieldbus Control" bit 8 in the VACON® FBFixedControlWord. Thus, the drive can be placed to the I/O or keypad control while fieldbus is active.

Request Fieldbus Reference Bit in VACON® FBFixedControlWord

The "NetRef" bit in an Output Assembly is not mapped to the "Request Fieldbus Reference" bit 9 in the VACON® FBFixedControlWord.

Master Connection State bit in VACON® FBFixedControlWord

If the EtherNet/IP communication with the master device is functional, the bit 15 in the VACON® FBFixedControlWord is set to 1. If the communication with the master device is not working, the bit 15 in the FBFixedControlWord is set to 0.

4.6.11 Mapping of VACON® Data onto Standard Input Assemblies

FBFixedStatusWord

For details on FBFixedStatusWord, see 4.7.2 Status Word Overview.

Ready Indication Bit in VACON® FBFixedStatusWord

The "Ready Indication" bit 0 in the VACON® FBFixedStatusWord is mapped to the "Ready" bit in an Input Assembly which supports this bit.

Run/Stop Indication Bit in VACON® FBFixedStatusWord

The "Run/Stop Indication" bit 1 in the VACON® FBFixedStatusWord is mapped to the "Running1" and "Running2" bits in an Input Assembly which supports these bits. The state of the Running1 and Running2 bits depends further on the "Direction Indication" bit 2 of the VACON® FBFixedStatusWord as follows:

Table 225: Run/Stop Bit Indication Map

	Direction = X, Run/Stop = 0	Direction = 0, Run/Stop = 1	Direction = 1, Run/Stop = 1
Running1	0	1	0
Running2	0	0	1

Direction Indication Bit in VACON® FBFixedStatusWord

See Run/Stop Indication bit in VACON® FBFixedStatusWord.

Fault Indication Bit in VACON® FBFixedStatusWord

The "Fault Indication" bit 3 in the VACON® FBFixedStatusWord is mapped to the "Faulted" bit in an Input Assembly which supports this bit.

Alarm Indication Bit in VACON® FBFixedStatusWord

The "Alarm Indication" bit 4 in the VACON® FBFixedStatusWord is mapped to the "Warning" bit in an Input Assembly which supports this bit.

Setpoint Reached Indication bit in VACON® FBFixedStatusWord

The "Setpoint Reached Indication" bit 5 in the VACON® FBFixedStatusWord is mapped to the "AtReference" bit in an Input Assembly which supports this bit.

Fieldbus Control Indication in Input Assemblies

The selected control place is indicated in the Input Assemblies which contain the "CtrlFromNet" bit. If the control place is assigned to fieldbus, this bit is set to 1, else it is 0.

Fieldbus Reference Indication in Input Assemblies

The selected reference is indicated in Input Assemblies which contain the "RefFromNet" bit. If the reference is assigned to fieldbus, this bit is set to 1, otherwise it is 0.

FBSpeedReference in Percentage

The reference 1 to the AC drive. The allowed scaling is from 0 to 10000. In the application, the value is scaled in percentage of the frequency area between set minimum and maximum frequency.

4.6.12 Special Assembly Instances

In addition to the normal connection (Exclusive Owner) where certain input and output instances are used, the PLC can also open INPUT ONLY and LISTEN ONLY connections to the drive. When using the INPUT ONLY connection, the PLC opens a connection where it only receives data from the drive. It does not send any commands to the drive. When opening the INPUT only connection, set the output instance to 253 and the size to 0. The input instance can be selected freely.

The INPUT ONLY connection can be the only connection to the drive, whereas the LISTEN ONLY connection always requires a normal "Exclusive Owner" connection. When opening the LISTEN ONLY connection, set the output instance to 254 and the size to 0. The input instance in LISTEN ONLY connection and the Data cycle (packet rate) must match to the one used in the Exclusive Owner connection.

4.6.13 Connection Timeout in EtherNet/IP Communication

The EtherNet/IP declares a watchdog the time within which both master and slave must send I/O back to each other. This watchdog time is a factor of the communication cycle time (cycle time x timeout multiplier). The master sets it. Minimum cycle time for EtherNet/IP is 1 millisecond.

In normal communication mode, 4 ms is the fastest recommended cycle time for EtherNet/IP. Faster cycle times (1 ms and 2 ms) are recommended in Fast Mode. See 4.1 Ethernet Communication Overview for more details.

When an I/O message is not received within the watchdog time, the timeout setting value is activated and a fault is created after it elapses. Thus, the panel parameter "Communication timeout" (see 6.1.2 Comm. Timeout) is used as an extra timeout value. The same logic applies if a connection is closed or the cable disconnects (link loss).

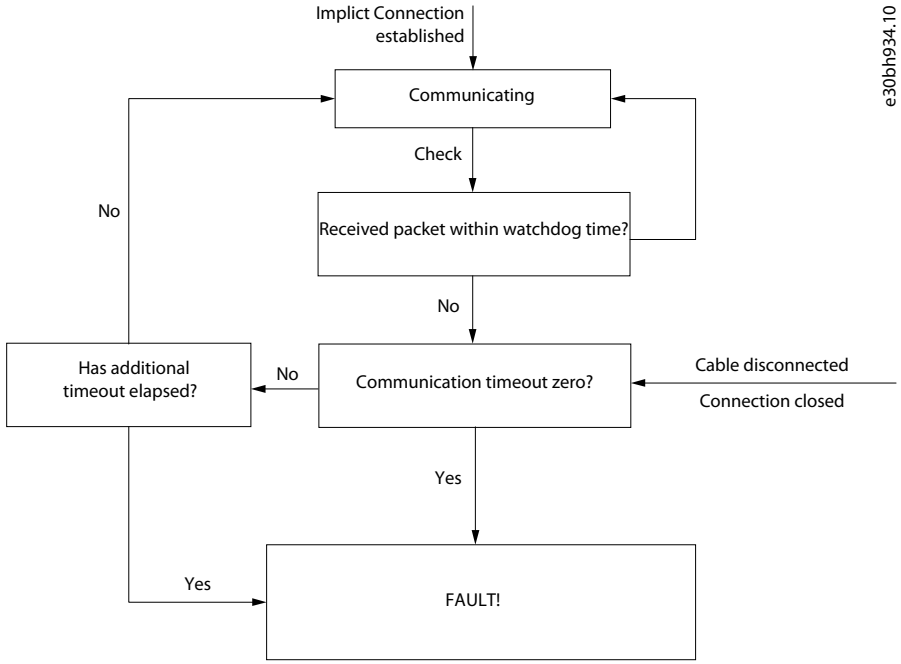


Illustration 25: EtherNet/IP Timeout Logic with Implicit Connection (I/O Connection)

Explicit connection is a TCP connection where PLC/user reads and writes data via CIP objects. These connections generate fieldbus fault only if the connection is used to write process data over Assembly, Control Supervisor, or AC/DC object. The explicit connection timeout is defined with the attribute 13d of TCP/IP Object "Encapsulation Inactivity Timeout".

We recommend that implicit connection is used for motor control and explicit connections for "service data".

Illustration 26: EtherNet/IP Timeout Logic with Explicit Connection

4.7 VACON® Process Data Description

4.7.1 Control Word Overview

The VACON® Control Word is composed of 32 bits. This control data is split into two words: FBFixedControlWord consist of the first 16 bits and FBGeneralControlWord consist of the remaining 16 bits.

While functionality of the FBFixedControlWord is fixed in VACON® standard applications, functionality of the FBGeneralControlWord is application-specific and can vary even in VACON® standard applications.

FBFixedControlWord bit definitions are described in the tables:

- VACON® 100 Family: Table 226
- VACON® NXP: Table 227
- VACON® 20: Table 228
- VACON® 20 X/CP: Table 229

.

Set all unused bits to zero.

Table 226: Definition of FBFixedControlWord in VACON® 100 Family

Bit	Function	Value	Description
0	Start/Stop	0	Stop request from fieldbus
		1	Run request from fieldbus
1	Direction	0	Requested direction is "FORWARD"
		1	Requested direction is "REVERSE"
2	Fault reset	0	No action
		1	Rising edge (0-->1) resets active faults, alarms, and info
3	Stop mode 1	0	Stop mode is unmodified
		1	Stop mode is overridden to "Ramping"
4	Stop mode 2	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
5	Quick ramp time	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
6	Freeze setpoint	0	Changes in the setpoint value from fieldbus (FB Speed Reference) are taken into use by the application
		1	Changes in the setpoint value from fieldbus (FB Speed Reference) are not taken into use by the application
7	Setpoint to Zero	0	The setpoint value from fieldbus is taken from FB Speed Reference
		1	The setpoint value from fieldbus is changed to 0
8	Request Fieldbus Control	0	Control Place is as parameterized in the drive (unchanged)
		1	Control Place is overridden to Fieldbus Control
9	Request Fieldbus Reference	0	Source of the setpoint value is as parameterized in the drive (unchanged)
		1	Source of the setpoint value is overridden to Fieldbus
10	Jogging 1	0	No action
		1	Jogging request with jogging reference 1
11	Jogging 2	0	No action
		1	Jogging request with jogging reference 2
12	Quick stop	0	No action
		1	Drive executes quick stop/emergency stop

Bit	Function	Value	Description
13–15	Reserved	-	-

Table 227: Definition of FBFixedControlWord in VACON® NXP

Bit	Function	Value	Description
0	Start/Stop	0	Stop request from fieldbus
		1	Run request from fieldbus
1	Direction	0	Requested direction is "FORWARD"
		1	Requested direction is "REVERSE"
2	Fault reset	0	No action
		1	Rising edge (0-->1) resets active faults, alarms, and info
3	Fieldbus DIN 1	0	Fieldbus DIN 1 off
		1	Fieldbus DIN 1 on
4	Fieldbus DIN 2	0	Fieldbus DIN 2 off
		1	Fieldbus DIN 2 on
5	Fieldbus DIN 3	0	Fieldbus DIN 3 off
		1	Fieldbus DIN 3 on
6	Fieldbus DIN 4	0	Fieldbus DIN 4 off
		1	Fieldbus DIN 4 on
7	Fieldbus DIN 5	0	Fieldbus DIN 5 off
		1	Fieldbus DIN 5 on
8	Request Fieldbus Control	0	Control Place is as parameterized in the drive (unchanged)
		1	Control Place is overridden to Fieldbus Control
9	Request Fieldbus Reference	0	Source of the setpoint value is as parameterized in the drive (unchanged)
		1	Source of the setpoint value is overridden to Fieldbus
10	Not supported	-	-
11	Not supported	-	-
12	Not supported	-	-
13–14	Reserved	-	-
15	Master connected[(1)]	0	Fieldbus sets this bit to zero when it detects that there is no connection to master.
		1	Fieldbus sets this bit to one when it detects valid connection from the master.

[1] Use drive parameters in the application to enable/disable this functionality.

Table 228: Definition of FBFixedControlWord in VACON® 20

Bit	Function	Value	Description
0	Start/Stop	0	Stop request from fieldbus
		1	Run request from fieldbus
1	Direction	0	Requested direction is "FORWARD"
		1	Requested direction is "REVERSE"
2	Fault reset	0	No action
		1	Rising edge (0-->1) resets active faults, alarms, and info
3	Not supported	-	-
4	Not supported	-	-
5	Quick ramp time	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
6	Not supported	-	-
7	Not supported	-	-
8	Not supported	-	-
9	Not supported	-	-
10	Not supported	-	-
11	Not supported	-	-
12	Not supported	-	-
13–15	Reserved	-	-

Table 229: Definition of FBFixedControlWord in VACON® 20 X/CP

Bit	Function	Value	Description
0	Start/Stop	0	Stop request from fieldbus
		1	Run request from fieldbus
1	Direction	0	Requested direction is "FORWARD"
		1	Requested direction is "REVERSE"
2	Fault reset	0	No action
		1	Rising edge (0-->1) resets active faults, alarms, and info
3	Stop mode 1	0	Stop mode is unmodified
		1	Stop mode is overridden to "Ramping"
4	Stop mode 2	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
5	Quick ramp time	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal

Bit	Function	Value	Description
6	Freeze setpoint	0	Changes in the setpoint value from fieldbus (FB Speed Reference) are taken into use by the application
		1	Changes in the setpoint value from fieldbus (FB Speed Reference) are not taken into use by the application
7	Setpoint to Zero	0	The setpoint value from fieldbus is taken from FB Speed Reference
		1	The setpoint value from fieldbus is changed to 0
8	Request Fieldbus Control	0	Control Place is as parameterized in the drive (unchanged)
		1	Control Place is overridden to Fieldbus Control
9	Request Fieldbus Reference	0	Source of the setpoint value is as parameterized in the drive (unchanged)
		1	Source of the setpoint value is overridden to Fieldbus
10	Not supported	-	-
11	Not supported	-	-
12	Quick stop	0	No action
		1	Drive executes quick stop/emergency stop
13–15	Reserved	-	-

4.7.2 Status Word Overview

The VACON® Status Word is composed of 32 bits. This status data is split into two words: FBFixedStatusWord consist of the first 16 bits and FBGeneralStatusWord consist of the remaining 16 bits.

While functionality of the FBFixedStatusWord is fixed in VACON® standard applications, functionality of the FBGeneralStatusWord is application-specific and can vary even in VACON® standard applications.

FBFixedStatusWord bit definitions are described in the tables. Unused bits are set to zero.

- VACON® 100 Family: Table 230
- VACON® NXP: Table 231
- VACON® 20: Table 232
- VACON® 20 X/CP: Table 233

Table 230: Definition of FBFixedStatusWord for VACON® 100 Family

Bit	Function	Value	Description
0	Ready	0	Drive is not ready
		1	Drive is ready to run
1	Run	0	Motor is not running
		1	Motor is running
2	Direction	0	Motor is running clockwise
		1	Motor is running counterclockwise
3	Fault(1)	0	No fault active
		1	Drive has an active fault
4	Alarm(1)	0	No alarm active

Bit	Function	Value	Description
		1	Drive has an active alarm
5	At reference	0	Motor is not running at reference speed
		1	Motor is running at reference speed
6	Zero speed	0	Motor is not at zero speed
		1	Motor is running at zero speed
7	Flux ready	0	Motor is not magnetized
		1	Motor is magnetized
8	Info[1]	0	No info active
		1	Drive has an active info
9–15	Reserved	-	-

[1] Drive faults have three levels: fault, alarm, and info. Bits 3, 4, and 8 are set to 1 when given fault type is activated.

NOTE! In VACON® NXP series AC drives, the FBFixedStatusWord comes from firmware variable "MCStatus".

Table 231: Definition of FBFixedStatusWord for VACON® NXP

Bit	Function	Value	Description
0	Ready	0	Drive is not ready
		1	Drive is ready to run
1	Run	0	Motor is not running
		1	Motor is running
2	Direction	0	Motor is running clockwise
		1	Motor is running counterclockwise
3	Fault[1]	0	No fault active
		1	Drive has an active fault
4	Alarm[1]	0	No alarm active
		1	Drive has an active alarm
5	At reference	0	Motor is not running at reference speed
		1	Motor is running at reference speed
6	Zero speed	0	Motor is not at zero speed
		1	Motor is running at zero speed
7	Flux ready	0	Motor is not magnetized
		1	Motor is magnetized
8	Not supported	-	-

Bit	Function	Value	Description
9–15	Reserved	-	-

[1] Drive faults have three levels: fault, alarm, and info. Bits 3 and 4 are set to 1 when given fault type is activated.

Table 232: Definition of FBFixedStatusWord for VACON® 20

Bit	Function	Value	Description
0	Ready	0	Drive is not ready
		1	Drive is ready to run
1	Run	0	Motor is not running
		1	Motor is running
2	Direction	0	Motor is running clockwise
		1	Motor is running counterclockwise
3	Fault(1)	0	No fault active
		1	Drive has an active fault
4	Alarm(1)	0	No alarm active
		1	Drive has an active alarm
5	At reference	0	Motor is not running at reference speed
		1	Motor is running at reference speed
6	Not supported	-	-
7	Not supported	-	-
8	Not supported	-	-
9–15	Reserved	-	-

[1] Drive faults have three levels: fault, alarm, and info. Bits 3 and 4 are set to 1 when given fault type is activated.

Table 233: Definition of FBFixedStatusWord for VACON® 20 X/CP

Bit	Function	Value	Description
0	Ready	0	Drive is not ready
		1	Drive is ready to run
1	Run	0	Motor is not running
		1	Motor is running
2	Direction	0	Motor is running clockwise
		1	Motor is running counterclockwise
3	Fault(1)	0	No fault active
		1	Drive has an active fault
4	Alarm(1)	0	No alarm active

Bit	Function	Value	Description
		1	Drive has an active alarm
5	At reference	0	Motor is not running at reference speed
		1	Motor is running at reference speed
6	Zero speed	0	Motor is not at zero speed
		1	Motor is running at zero speed
7	Not supported	-	-
8	Not supported	-	-
9–15	Reserved	-	-

[1] Drive faults have three levels: fault, alarm, and info. Bits 3 and 4 are set to 1 when given fault type is activated.

4.7.3 Control and Status Word Monitoring Values

The following tables describe how the control/status words can be read from different drives via panel or PC-tool.

- VACON® 100 Family: Table 234
- VACON® NXP: Table 236
- VACON®20 Family: Table 236

For VACON® 100 family, VACON® 20, and VACON® 20X/CP, VACON® Live PC tool is used for accessing drive parameters. VACON® NCDrive PC tool is used with VACON® NXP drive.

To monitor in VACON® NCDrive, do the following settings:

- View --> Monitoring
- Type: Firmware

Table 234: Monitoring of Control and Status Words for VACON® 100 Family

Signal	Index in panel tree	VACON® Live Monitoring Values
FBFixedControlWord	V2.12.1 (Low Word)	FB Control Word (Low Word)
FBGeneralControlWord	V2.12.1 (High Word)	FB Control Word (High Word)
FBFixedStatusWord	V2.12.11 (Low Word)	FB Status Word (Low Word)
FBGeneralStatusWord	V2.12.11 (Low Word)	FB Status Word (High Word)

Table 235: Monitoring of Control and Status Words for VACON® NXP

Signal	Index in panel tree	VACON® NCDrive Monitoring Values
FBFixedControlWord	V1.24.1[(1)]	FBFixedControlWord
FBGeneralControlWord	-	FBGeneralControlWord
FBFixedStatusWord	V1.24.16[(1)]	MCStatus
FBGeneralStatusWord	V1.24.3[(1)]	FBGeneralStatusWord

[1] Advanced Application only

Table 236: Monitoring of Control and Status Words for VACON®20 Family

Signal	Index in panel tree for VACON®20	VACON® Live Monitoring Values
FBFixedControlWord	-	-
FBGeneralControlWord	-	-
FBFixedStatusWord	V3.1	Drive status word
FBGeneralStatusWord	V3.2	Application status word

4.7.4 Speed Reference and Actual Speed

The FBSpeedReference value is signed in the range of -10000...10000d (d8f0...2710h). The given reference is scaled in percentage between minimum and maximum frequency parameters by application. The value 0 corresponds to minimum frequency and the value 10000d corresponds to maximum frequency. The scale of the value is 0.01%. Negative value indicates direction. If direction bit in control word is set (the direction must be counterclockwise) and reference is negative, motor runs to clockwise spite the direction bit.

The FBActualSpeed value is signed in the range of -10000...10000d (d8f0...2710h). Actual speed is scaled in percentage between minimum and maximum frequency parameters by application. The value 0 corresponds to minimum frequency and the value 10000d corresponds to maximum frequency. The scale of the value is 0.01%.

4.7.5 Process Data

The Process Data variables are vendor-specific variables that can be communicated to and from the AC drive. Eight process data items can be communicated between PLC and drive. Some drives and firmware versions can support up to 16 process data items in single telegram. If drive does not support 9–16 PD items, then PDI 9–16 are ignored and PDO 9–16 are zeros. For details, see 4.2 Fieldbus Option Board Communication Modes and 6.3 VACON® NXP System Software Parameters for Application Developers.

Values sent from the drive to the PLC are called ProcessDataOut variables, while the values sent from the PLC to the drive are called ProcessDataIn variables. The contents of the ProcessDataOut variables can be parameterized in the AC drive using a feature known as Fieldbus Process Data mapping. See 4.7.6 Fieldbus Process Data for details.

4.7.6 Fieldbus Process Data

This chapter describes how standard applications map process data out items by default. For further details, see the application manual of the AC drive, especially when not using standard application.

Table 237: Default Process Data Mapping for VACON® 100 Family

PD	Mapped Application Data	ID	Unit	Scale
1	Output Frequency	1	Hz	0.01 Hz
2	Motor Speed	2	RPM	1 RPM
3	Motor Current	3	A	Varies[1]
4	Motor Torque	4	%	0.1%
5	Motor Power	5	%	0.1%
6	Motor Voltage	6	V	0.1 V
7	DC-link voltage	7	V	1 V
8	Last Active Fault Code	37	-	-

[1] Scaling is based on drive nominal power, see Table 241.

Table 238: Default Process Data Mapping for VACON® NXP Multipurpose Application

PD	Mapped Application Data	ID	Unit	Scale
1	Output Frequency	1	Hz	0.01 Hz

PD	Mapped Application Data	ID	Unit	Scale
2	Motor Speed	2	RPM	1 RPM
3	Motor Current	45	A	0.1 A
4	Motor Torque	4	%	0.1%
5	Motor Power	5	%	0.1%
6	Motor Voltage	6	V	0.1 V
7	DC-link voltage	7	V	1 V
8	Last Active Fault Code	37	-	-

Table 239: Default Process Data Mapping for VACON® 20 X/CP

PD	Mapped Application Data	ID	Unit	Scale
1	Output Frequency	1	Hz	0.01 Hz
2	Motor Speed	2	RPM	1 RPM
3	Motor Current	3	A	Varies[1]
4	Motor Torque	4	%	0.1%
5	Motor Power	5	%	0.1%
6	Motor Voltage	6	V	0.1 V
7	DC-link voltage	7	V	1 V
8	Last Active Fault Code	37	-	-

[1] Scaling is based on drive nominal power, see Table 241.

Table 240: Default Process Data Mapping for VACON® 20

PD	Mapped Application Data	ID	Unit	Scale
1	Frequency Reference	25	Hz	0.01 Hz
2	Output Reference	1	Hz	0.01 Hz
3	Motor Speed	2	RPM	1 RPM
4	Motor Voltage	6	V	0.1 V
5	Motor Torque	4	%	0.1%
6	Motor Current	3	A	Varies[1]
7	Motor Power	5	%	0.1%
8	DC-link voltage	7	V	1 V

[1] Scaling is based on drive nominal power, see Table 241.

Table 241: Current Scaling Based on Nominal Power

Nominal power	Current scale
< 5 kW	0.01 A

Nominal power	Current scale
5–100 kW	0.1 A
> 100 kW	1 A

Default process data out mapping can be changed in standard applications.

Table 242: Fieldbus Process Data Selection Indexes in Panel Tree for VACON® AC drives

Parameter name	ID	Index in panel tree for VACON® 100 family	Index in panel tree for VACON® NXP Multipurpose application[1]	Index in panel tree for VACON® 20	Index in panel tree for VACON® 20 X/CP
FB DataOut 1 Selection	852	P3.6.1	P2.13.3	P10.1	P11.1
FB DataOut 2 Selection	853	P3.6.2	P2.13.4	P10.2	P11.2
...	...	...	...	...	...
FB DataOut 8 Selection	859	P3.6.8	P2.13.10	P10.8	P11.8
FB DataOut 9 Selection[2][3]	VACON® 100: 890 VACON® NXP: 558	P3.6.9	P2.9.12	-	-
FB DataOut 10 Selection[2][3]	VACON® 100: 891 VACON® NXP: 559	P3.6.10	P2.9.13	-	-
...	...	...	...	-	-
FB DataOut 16 Selection[2][3]	VACON® 100: 897 VACON® NXP: 565	P3.6.16	P2.9.18	-	-

[1] For other applications, see the application manuals.

[2] Only in applications and option boards supporting fast or extended communication modes with VACON® NXP. See 4.2 Fieldbus Option Board Communication Modes.

[3] Currently only in VACON® 100 family internal protocols.

Process data in can also be mapped in VACON® NXP drives.

Table 243: FB Process data in mapping in VACON® NXP drives

Parameter name	Path	ID[1]
FB DataIn 1 Selection	P2.9.19	879
FB DataIn 2 Selection	P2.9.20	878
...	...	...
FB DataIn 8 Selection	P2.9.26	883
FB DataIn 9 Selection[2]	P2.9.27	550
FB DataIn 10 Selection[2]	P2.9.28	551
...	...	...

Parameter name	Path	ID[1]
FB DataIn 16 Selection[2]	P2.9.34	557

[1] In Multipurpose Application. For other applications, see the application manuals.

[2] Only in applications and option boards supporting fast or extended communication modes with VACON® NXP. See 4.2 Fieldbus Option Board Communication Modes.

4.8 Time Synchronization

4.8.1 System Time Update with ID 2551

To update system time in VACON® 100 family and VACON® NXP/NXS AC drives, write 32-bit unsigned value to ID 2551. This value is seconds since 1.1.1970 (Unix time).

In VACON® 100 family, the default time zone is UTC. To configure local time, change the time zone and set the daylight saving mode.

VACON® NXP/NXS AC drive does not have time settings, so value written to this ID must be local time.

4.8.2 Simple Network Time Protocol (SNTP)

Simple Network Time Protocol enables usage of network time servers. Date and time information is requested from the time server and set as system time. Use SNTP to keep all devices in your network in same time. This device acts as SNTP client. With SNTP, for example, fault history time stamps can be compared between drives. This way fault tracing can be improved, for example, by detecting in which order the drives were faulted. Synchronized date, and time also enables drives to do automatically programmed operations based on time information.

SNTP has two modes: Poll and Listen Only. Both also have modes where failure to update time generates fieldbus fault. In Poll mode, option board requests new time information periodically. Default interval is 200 seconds. Lowest possible value is 30 seconds. This time can be adjusted from SNTP parameters. In Listen only mode, time broadcast from server is expected every interval. Two SNTP server addresses can be set. For Poll mode, at least one SNTP server address must be defined. No server addresses are needed in Listen Only mode, but in that case, the time broadcasts are accepted from anyone who sends them.

When the SNTP client fails to receive time update from server within the time interval, it first waits (or request, depending on mode) the interval time again for the update. If it again does not receive time update, it changes server and request (or wait for broadcast) from the second server. If it receives the response from the second server, this server is used until it fails. After device restart, the SNTP always first tries the server number 1 (if its address has been defined). If the second server also fails twice, the SNTP moves back to the server number one. If the selected mode is Poll Fault or Listen Only Fault, a fieldbus fault is generated at this point.

SNTP also has port setting. By default, the SNTP port is 123, but it can be changed. In Poll mode, the requests are sent to this port on the time server. In Listen Only mode, the broadcasts are listened in this port.

The SNTP monitoring values show the currently used SNTP server and the time since the last received update. The SNTP status value tells status of the time synchronization. For example, if the SNTP mode is Poll and no SNTP server addresses are defined, the SNTP status is "Invalid configuration (3)".

5 Parameter Access

5.1 Parameter Access with PROFINET

5.1.1 Parameter Access Sequence

The PROFIdrive parameters are accessed according to the model presented in Illustration 27:

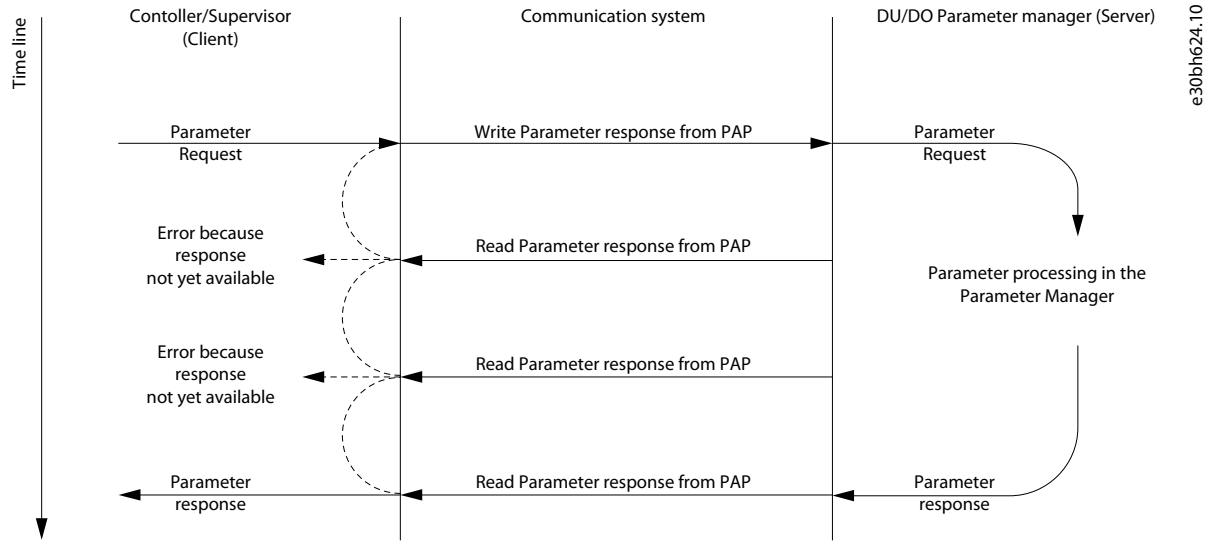


Illustration 27: PROFIdrive Parameter Access Model

Both indexes can be used to access PROFIdrive parameters. There is no difference in operation between them with current implementation.

Table 244: Parameter Access Services

Parameter access service	Index
Base Mode Parameter - Local	0xB02E
Base Mode Parameter - Global	0xB02F

5.1.2 Parameter Requests

There are two types of parameter requests in PROFIdrive:

- read requests for reading parameters from the device
- change requests for writing parameters to the device

Each parameter request consists of three elements:

- Request header
- Parameter address
- Parameter value (only in Change requests)

Request header	Parameter address(es)	Parameter value(s)

The structure of parameter requests is described in Table 245.

Table 245: Parameter Request

Block definition	Byte n+1	Byte n	n
Request Header	Request Reference	Request ID	0
-	Axis Number/DO-ID	Number of Parameters = n	2

Block definition	Byte n+1	Byte n	n
1st Parameter Address	Attribute	Number of Elements	4
-	Parameter Number (PNU)	-	-
-	Sub-index	-	-
nth Parameter Address	...	-	4 + 6 x (n - 1)
1st Parameter Value(s) (only for request "Change parameter")	Format	Number of Values	4 + 6 x n
-	Values	-	-
-	...	-	-
-	-	-	-
nth Parameter Values	...	-	-
-	-	-	4+ 6 x n + ... + (Format_n x Qty_n)

5.1.2.1 Request Header

The request header consists of 4 fields, each one octet in size.

Table 246: Structure of the Request Header

Octet number	Field name	Description	Allowed values
1	Request Reference	Unique number for each request/response pair. The master changes this value for each new request. Slave mirrors it in the response.	A bitmask with information about the parameter characteristics.
2	Request ID	Defines the type of request.	• Use 0x01 for Read requests. • Use 0x02 for Change requests. • Do not use other values.
3	Axis Number	Not used, must be set to 1.	• Use value 1. • Do not use other values.
4	Requested number of parameters	The number of parameters affected by the request.	• Values 1–39 are allowed. • The value 0 is not allowed. • Values 40–255 are not allowed.

5.1.2.2 Parameter Address

The parameter address consists of 4 fields, totaling six octets in size.

Table 247: Structure of the Parameter Address

Octet number	Field name	Description	Allowed values
1	Attribute	Describes which part of a parameter to access.	• Use 0x10 for reading/writing the value of a parameter. • Use 0x20 for reading the description of a parameter. • Use 0x30 for reading the text of a parameter (not supported). • Do not use other values in OPTE5/OPTE3.
2	Number of elements	Specifies the number of elements which are addressed in an array.	• Values 0 and 1 are allowed for non-array parameters. • Values 1–234 are allowed for array parameters. • Do not use other values.
3...4	Parameter number	The number of the parameter to be addressed.	Allowed values are those of supported parameters, see 5.1.3.2 PROFIdrive 4.1 Error Classes and Codes.
5...6	Subindex	Defines the first array element of the parameter to be accessed.	• Values 0–65535 are allowed. • Do not use other values.

The "Parameter number" and "Subindex" fields are two-octet fields, while the "Attribute" and "No. of elements" fields are one-octet fields.

5.1.2.3 Parameter Value

The parameter value field is included only in Change requests (not in Read requests). The parameter value field consists of a two-octet parameter value header followed by a list of values. Depending on the format of the parameter, the octet size of a single value is one, two, or four octets. The total size of the parameter value field thus depends on the format and number of values in the message.

Table 248: Structure of the Parameter Value

Octet number	Field name	Description	Allowed values
1	Format	Describes the data type of the parameter.	• Use 0x41 for Byte. • Use 0x42 for Word. • Use 0x43 for Double Word. • Value 0x44 is used for Error. • Do not use other values.
2	Number of values	Defines the number of values in the parameter value field.	Values 0–234 are possible. Subject to limitations as described below.
3	Value	The value of the parameter.	• Values 0–65535 are allowed. • Do not use other values

5.1.3 Parameter Responses

There are two types of parameter responses in PROFIdrive:

In addition to response header, a request response content depends on request type and request result:

- Write Response header

- Nothing (Success response), or
- Error Response

- Read Response header
  - Parameter Value, or
  - Parameter Description, or
  - Error Response

The structure of parameter responses is described in Table 249.

Table 249: Parameter Response

Block definition	Byte n+1	Byte n	n
Response header	Request Ref. mirrored	Response ID	0
-	Axis Number/DO-ID mirrored	Number of Parameters = n	2
1st Parameter Value(s) (only for request "Request")	Format	Number of Values	4
-	Values or Error Values	-	-
-	...	-	-
-	-	-	-
nth Parameter Values	...	-	-
-	-	-	4 + ...+ (Format_nx Qty_n)

5.1.3.1 Error Response

If an error occurred in the Parameter Access, the response provided by the slave is an error response. An error response contains 4 octets as described in the table.

Table 250: Structure of the Error Response

Octet number	Field name	Description	Allowed values
1	Function Number	Operation number.	• The slave returns 0xDE to indicate an error read response. • The slave returns 0xDF to indicate an error write response. • Other values are not allowed in the Parameter Access.
2	Error Decode	Defines how the error information in the following two fields must be decoded.	• Always 128 in PROFIdrive. • Other values are not used in the Parameter Access.
3	Error Code 1	High 4 bits indicate error class, 4 lower bits indicate error code.	See 5.1.3.3 PROFIdrive Parameter Access Errors.
4	Error Code 2	Application-specific.	Always 0 in PROFIdrive.

5.1.3.2 PROFIdrive 4.1 Error Classes and Codes

Table 251: PROFIdrive 4.1 Error Classes and Codes

Error class	Error codes	Explanation in PROFIdrive
0x0...0x9 = reserved (not used)	-	-

Error class	Error codes	Explanation in PROFIdrive
0xA = application	0x0 = read error 0x1 = write error 0x2 = module failure 0x3…0x7 = reserved (not used) 0x8 = version conflict 0x9 = feature not supported 0xA…0xF = user-specific (not used)	-
0xB = access	0x0 = invalid index	0xB0 = parameter requests are not supported
-	0x1 = write lengtherror 0x2 = invalid slot 0x3 = type conflict 0x4 = invalid area	-
-	0x5 = state conflict	0xB5 = parameter access is temporarily not possible due to internal processing status
-	0x6 = access denied	-
-	0x7 = invalid range	0xB7 = Write request with error in the parameter request header
-	0x8 = invalid parameter 0x9 = invalid type 0xA…0xF = user-specific (not used)	-
0xC = resource	0x0 = read constraint conflict 0x1 = write constraint conflict	-
-	0x2 = resource busy	-
-	0x3 = resource unavailable	-
-	0x4…0x7 = reserved (not used) 0x8…0xF = user-specific (not used)	-
0xD…0xF = userspecific (not used)	-	-

5.1.3.3 PROFIdrive Parameter Access Errors

In addition to the error indications in the error response field, details about the error are provided in the parameter value field. The third octet in the parameter value is set to 0x00 and the fourth octet is assigned the error number, as described in the table.

Table 252: PROFIdrive Parameter Access Errors

Error number	Description	When used
0x00	Impermissible parameter number	Access to unavailable parameter
0x01	Parameter value cannot be changed	Change request to a read-only parameter
0x02	0x0 = invalid index	0xB0 = parameter requests are not supported.
0x03	Invalid sub-index	Access to an unavailable sub-index of an array parameter
0x04	Non-array parameter	Attempt to access sub-index of a non-array parameter

Error number	Description	When used
0x05	Incorrect data type	Change request containing invalid data type for the accessed parameter
0x06	Setting not permitted (must only be reset)	Change request to non-zero value, where it is not allowed
0x07	Description element cannot be changed	Change request to a read-only parameter description element
0x08	Reserved (not used)	-
0x09	No description data available	Access to unavailable parameter description
0x0A	Reserved (not used)	-
0x0B	No operation priority	Change request without access rights to perform the change
0x0C...0x0E	Reserved (not used)	-
0x0F	No text array available	Access to unavailable parameter text array
0x10	Reserved (not used)	-
0x11	Request cannot be executed	Access is temporarily not possible due to unspecified reasons
0x12...0x13	Reserved (not used)	-
0x14	Value impermissible	Change request with a value within the allowed range, but is otherwise not allowed.
0x15	Response too long	The length of the response exceeds the maximum transmittable length
0x16	Impermissible parameter address	Error in the parameter address field
0x17	Illegal format	Illegal format was provided in write request
0x18	Number of values are not consistent	Number of values in the write request does not match the number of values in the parameter
0x19	Axis non-existent	Access to non-existent axis number
0x20	Parameter text cannot be changed	Change request to unavailable parameter text
0x21	Invalid request ID	If a parameter request does not have the request ID 01h or 02h, this error code is returned.
0x22...0x64	Reserved (not used)	-
0x65	Invalid request reference	Unallowed value for request reference
0x66	Invalid request ID	Unallowed value in request ID (not Request Parameter nor Change Parameter)
0x67	Reserved (not used)	-
0x68	Invalid number of parameters	Invalid number of parameters in request (0 or greater than 39)
0x69	Invalid attribute	Invalid attribute specified in request
0x6A	Reserved (not used)	-
0x6B	Request is too short	Not enough parameter value data was transmitted in a Change request. Alternatively, the request did not contain a complete parameter address.

Error number	Description	When used
0x6C	Drive parameter was not found	Parameter was not found or error occurred while accessing it.
0x6D	An invalid change request was provided	Issue with request was found and request was not handled.
0x6E	General error	General error occurred.
0x6F...0xFF	Reserved (not used)	-

5.1.3.4 Response Header

The response header consists of 4 fields, each one octet in size.

Table 253: Structure of the Response Header

Octet number	Field name	Description	Allowed values
1	Request Reference	Unique number for each request/response pair.	Mirrored by the slave.
2	Response ID	Defines the type of response. An error in the execution of a request is indicated by setting bit 7 in this field.	• Uses 0x01 for successful request parameter operation. • Uses 0x02 for successful change parameter operation. • Uses 0x80 to indicate that an invalid request ID was received. • Uses 0x81 for unsuccessful request parameter operation. • Uses 0x82 for unsuccessful change parameter operation. Other values are not used.
3	Axis Number	Not used, must be set to 1 in OPTE5/E3.	Mirrored by the slave.
4	Requested number of parameters	The number of parameters affected by the request.	Number of parameters in the response. Mirrored from the request.

5.1.3.5 Parameter Values

Parameter values are included in the response only if the request was of "Request parameter" type. For details on the contents of this field, see 5.1.2.3 Parameter Value.

5.1.3.6 Parameter Description Elements

When parameter description (attribute 0x20) is requested, the response contains elements described in the table.

Table 254: Parameter Description Elements

Sub-index	Field name	Data type	Description
1	Identifier (ID)	Unsigned16	A bitmask with information about the parameter characteristics.
2	Number of array elements	Unsigned16	For array parameters, the number of elements in the array.
3	Standardization factor	FloatingPoint (IEEE 754)	If the information shown by the parameter can be converted into a standardized form, this field contains a factor for this conversion.
4	Variable attribute	Array of two Unsigned8	Contains two index numbers for describing the parameter information.

Sub-index	Field name	Data type	Description
5	Reserved	Array of four Unsigned8	Reserved, always 0.
6	Name	ASCII string, 16 characters	Symbolic name of the parameter.
7	Low limit	Array of four Unsigned8	Limit for valid values of the parameter.
8	High limit	Array of four Unsigned8	Limit for valid values of the parameter.
9	Reserved	Array of two Unsigned8	Reserved, always 0.
10	ID extension	Unsigned16	Not used, always 0.
11	Normalization reference parameter	Unsigned16	Parameter number, the value of which is used as normalization reference for the parameter whose description it is.
12	Normalization field	Unsigned16	Contains information about normalization of this parameter.

5.1.4 Drive Parameter Access Using Application ID

It is possible to read and write drive parameters using the application ID number using the PNU 10001. The targeted application ID is put into the sub-index field.

5.1.5 PROFINET Parameters

5.1.5.1 PROFIdrive Parameters

Table 255: PROFIdrive Basic Parameters

PNU	Significance	Data type	Explanation
915	Selection switch for DO I/O Data in the setpoint telegram	Array[n] Unsigned16	Describes the data in the setpoint telegram. The parameter is an array of the numbers of the signal that creates the setpoint telegram.
916	Selection switch for DO I/O Data in the actual value telegram	Array[n] Unsigned16	Describes the data in the actual value telegram. The parameter is an array of numbers of the signals that creates the actual value telegram.
922	Telegram selection	Unsigned16	Currently selected standard telegram is read. It returns, for example, 1 for ST1. See 4.4.5 Telegram Types for possible values.
923	List of all parameters for signals	Array[n] Unsigned16	The parameter is an array. The index of the array indicates for a signal number and its value for corresponding parameter number. Not supported standard signals, in range 1–99, have values set to 0. Gaps between the device-specific signals are also filled with 0. See Table 72.
930	Operating mode	Unsigned16	1 = Speed control mode
944	Fault message counter	Unsigned16	The fault message counter is incremented each time that the fault buffer changes. It means that it is guaranteed that the fault buffer is consistently readout. Without this parameter, it is not guaranteed that the fault buffer does not change while reading-out.
947	Fault number	Array[n] Unsigned16	The parameter is an array of 40 elements. The first element indicates an active unacknowledged fault. The following elements contain acknowledged ones. The latest acknowledged fault number is at index 1 and oldest one at index 39.

PNU	Significance	Data type	Explanation
964	Drive Unit Identification	Array[n] Unsigned16	An array is structured in the following way (index meaning): 0 = Manufacturer code (0x01BA) 1 = Drive Unit Type (0x0002): 1 = VACON® NXP series, 2 = VACON® 100 series, 3 = VACON® 20 series 2= Software version - XXYYd (XX - major revision, YY - minor revision) 3 = Firmware date (year) - YYYYd 4 = Firmware date (day/month) - DDMMd 5 = Number of Drive Objects (0x0001)
965	Profile identification number	OctetString2	2 bytes to identify the profile that is used. 1st - profile number; PROFIdrive (3d) 2nd - profile version number; 4.1 (41d)
975	DO identification	Array[n] Unsigned16	An array is structured in the following way (index meaning): 0 = Manufacturer code (0x01BA) 1 = Drive Unit Type (0x0003) 2 = Software version - XXYYd (XX - major revision, YY - minor revision) 3 = Firmware date (year) - YYYYd 4 = Firmware date (day/month) - DDMMd 5 = Drive Object Type Class - Axis (0x0001) 6 = Drive Object Subclass 1 - Only Application Class 1 (0x0001) 7 = Drive Object ID (value 1)
980–989	Number list of defined parameter	Array[n] Unsigned16	980: A list of the parameter numbers of all the implemented parameters. The list does not contain the number 980–989. Parameters are listed in the ascending (growing) order. Value 0 indicates end-of-list. 981–989: Not used. Length of each is 1 and value is 0, indicating an empty list.

Table 256: PROFIdrive Parameters for PROFINET Communication Interface

PNU	Significance	Data type	Explanation
61000	NameOfStation	Octet- String[240] without null termination	Name of Station for the PROFINET Network Interface, which is related to this Drive Unit.
61001	IpOfStation	Unsigned32	IP Address of the Station for the PROFINET Network Interface.
61002	MacOfStation	OctetString [6]	MAC Address of the Station for the PROFINET Network Interface
61003	DefaultGatewayOfStation	Unsigned32	Default Gateway for the Station for the PROFINET Network Interface.
61004	SubnetMaskOfStation	Unsigned32	Subnet Mask of the Station for the PROFINET Network Interface.

5.1.5.2 Vendor-specific PROFIdrive Parameters

Table 257: PROFIdrive Vendor-specific Parameters

PNU	Significance	Data type	Explanation
9900	Test parameter (non-array)	Unsigned16	For testing purposes. Does not affect the operation of the drive.
9901	Test parameter (array)	Array[n] Unsigned16	An array of 16 elements. Used only for testing purposes. Does not affect the operation of the drive.
10001	Drive parameter access	Array[n] Special case; the data type de-	A parameter used to access parameters from the drive application. Put the desired drive parameter ID into the sub-index field of the parameter request. See 5.1.6 Parameter Channel Examples.

PNU	Significance	Data type	Explanation
		pends on the sub-index	
10100	Profile control word (STW1)	Unsigned16	PROFIdrive 4.1 control word (STW1).
10101	Profile speed setpoint value (NSOLL_A)	Integer16	PROFIdrive 4.1 speed setpoint value (NSOLL_A).
10102	Profile status word (ZSW1)	Unsigned16	PROFIdrive 4.1 status word (ZSW1).
10103	Profile speed actual value (NIST_A)	Integer16	PROFIdrive 4.1 speed actual value (NIST_A).
10109	VACON® 16-bit Process Data In	Array[n] Unsigned16	An array of 16 elements. From PDI1 (index 0) to PDI16 (index 15).
10110	VACON® 16-bit Process Data Out	Array[n] Unsigned16	An array of 16 elements. From PDO1 (index 0) to PDO16 (index 15).
10111	Speed physical reference parameter	Unsigned16	The parameter describes how many RPM is meant by 100% in the PROFIdrive 4.1 speed setpoint and actual value fields. If value is greater than what fits in Unsigned16 data type, this PNU returns zero. For high speed applications, use PNU 10129.
10112	VACON® Fixed Control Word	Unsigned16	Fixed control word.
10113	VACON® Fixed Status Word	Unsigned16	Fixed status word.
10114	VACON® Speed reference	Unsigned16	Speed reference.
10115	VACON® Speed Actual value	Unsigned16	Actual speed value.
10118	Clear VACON® fault history	Unsigned16	To clear the fault history, write a value to the parameter.
10119	Read VACON® fault history	Array[n] Unsigned16	An array of 40 elements consisting of VACON® fault history fault codes.
10120	VACON® General control word	Unsigned16	General control word.
10121	VACON® General status word	Unsigned16	General status word.
10122	VACON® 32-bit Process Data In	Array[n] Unsigned32	An array of 16 elements. From PDI1 (index 0) to PDI16 (index 15).
10123	VACON® 32-bit Process Data Out	Array[n] Unsigned32	An array of 16 elements. From PDO1 (index 0) to PDO16 (index 15).
10124	Drive operation time counter	Unsigned32	Drive operation time in seconds as 32-bit unsigned integer.
10125	Drive operation time trip counter	Unsigned32	Drive operation time trip counter in seconds as 32-bit unsigned integer. Writing zero resets the trip counter.
10126	Drive energy counter	Float32	Drive energy counter in kWh as 32 bit float (IEEE 754).
10127	Drive energy trip counter	Float32	Drive energy trip counter in kWh as 32 bit float (IEEE 754). Writing zero resets the trip counter.
10128	Fault history with time stamps	Array[n] Unsigned16	List of fault history items containing: Fault code, subcode, 32-bit timestamp high word, 32-bit timestamp low word, and timestamp milliseconds. Maximum of faults that can be read: 40 in VACON® 100 family, 30 in VACON® NXP family and 9 in VACON® 20 family. Reading the fault history items is slow. Reading all items can take

PNU	Significance	Data type	Explanation
			up to three seconds depending on drive type and firmware versions.
10129	Speed physical reference parameter for High speed applications	Unsigned16	The parameter describes how many RPM is meant by 100% in the PROFIdrive 4.1 speed setpoint and actual value fields. It is based on the same value as in PNU 10111. However, as the RPMs for high speed application are too large to fit in Unsigned16 value, this PNU returns RPMs divided by 100.

5.1.5.3 Safety Parameters

When a PROFIsafe connection is used, extra safety parameters (F-Parameters) must be provided for the safety module to verify the safety connection settings. All F-Parameters must match the parameterization of the safety system. If any of the parameters are incorrectly parameterized, a system fault and a channel-related diagnosis are triggered.

NOTE! In addition, the configured Safety Telegram number must match the configuration with the Advanced Safety option board. The Safety PLC is not allowed to select the used Safety Telegram. If the safety telegram does not match, an error and channel-related diagnosis is triggered.

For more details on PROFIsafe parameterization and commissioning, refer to VACON® NXP Advanced Safety Options Operating Guide.

5.1.6 Parameter Channel Examples

The parameter channel operations follow the same process every time. See Illustration 28 for an example of successful operation. It is important to wait long enough after "Write request" before doing "Read request". If read operation is done too soon, drive has not finished processing the operation and responds with error (see Illustration 27). Then the PLC must try to read again after some time. Time between write and read requests depends on the operation. See Illustration 29 for an example of parameter request in Wireshark. See Illustration 30for an example of "PROFINET Master Simulator" tool.

Parameter operations sent to the AC drive must be directed to: slot 0, subslot 1 and to index 0xB02E.

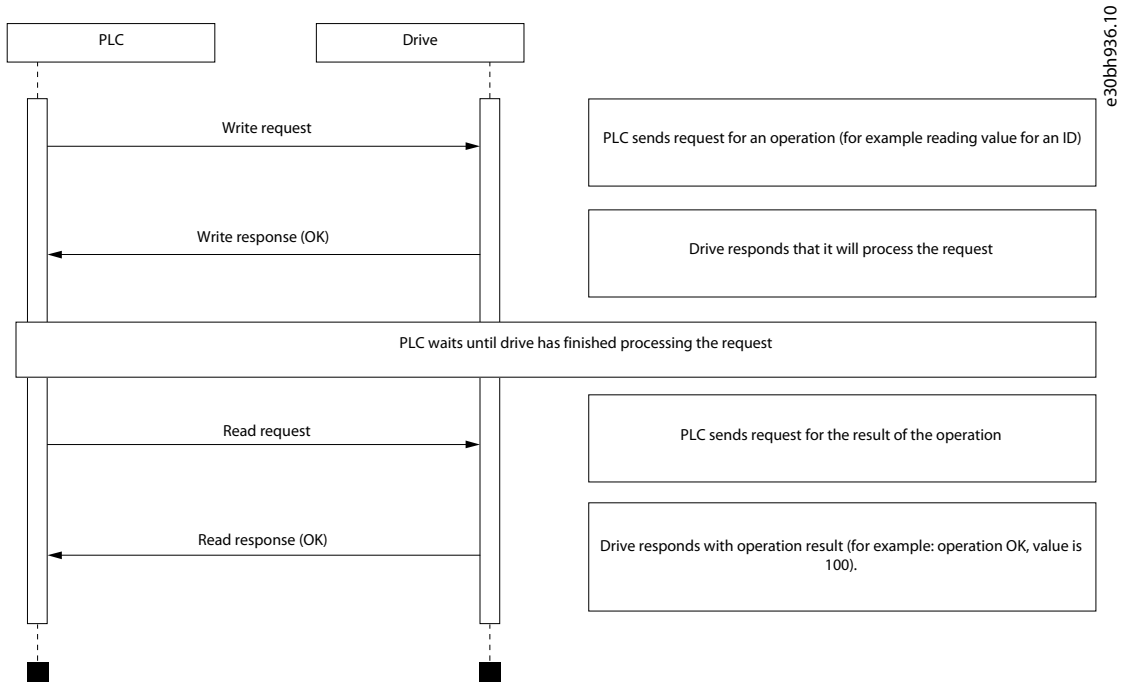


Illustration 28: Successful Parameter Channel Operation

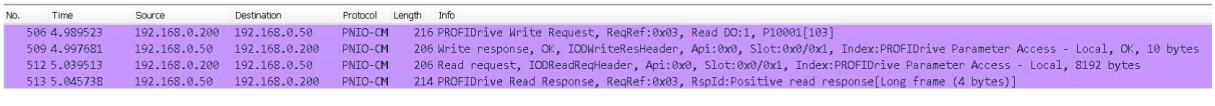


Illustration 29: Requesting Value for ID 103 in Wireshark

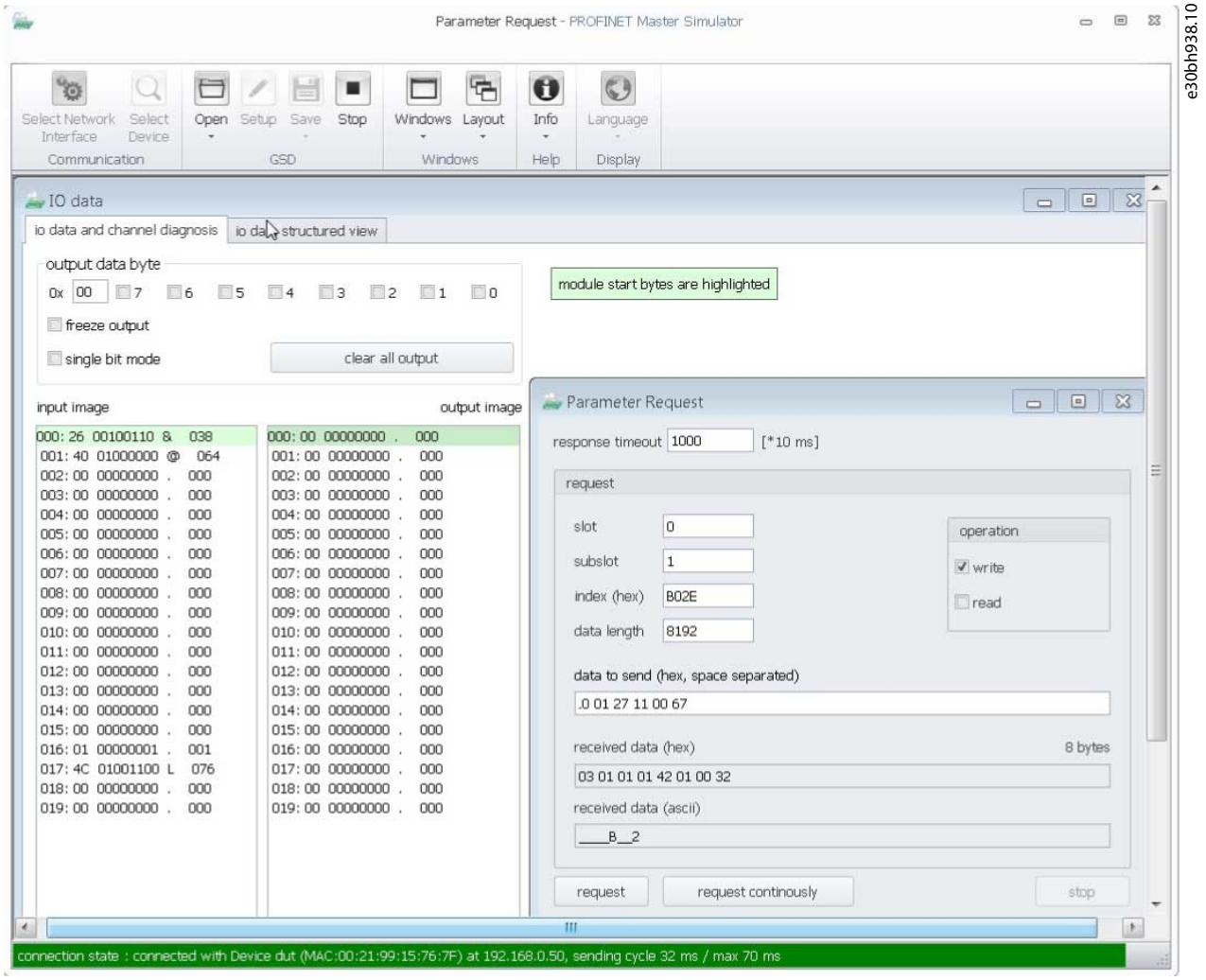


Illustration 30: Requesting Value for ID 103 in "PROFINET Master Simulator"

5.1.6.1 Request First Element of PNU964 Value

Table 258: Information Used for Request Parameter PNU964 Value

Field	Contents
Request reference	0x01
Request ID	0x01 = Request parameter
Axis Number	0x01
Number of Parameters	0x01
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x03C4 (964d)
Sub-index	0x0000 (0d)

Table 259: Messages Sent and Received during Requesting Value for PNU964

Message	Operation	Data	
1	**Write request**	**Request header**	0x01 0x01 0x01 0x01
		Parameter address	0x10 0x01 0x03 0xC4 0x00 0x00
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x01 0x01 0x01 0x01
		Parameter value	0x42 0x01 0x01 0xBA

The parameter value reveals that the format of the value is "Word" (0x42), there is one value in the response (0x01) and the actual value is 0x01BA.

5.1.6.2 Request All Elements of Parameter PNU964

Table 260: Information Used for Request All Elements of PNU 964

Field	Contents
Request reference	0x02
Request ID	0x01 = Request parameter
Axis Number	0x01
Number of Parameters	0x01
Attribute	0x10 = Value
Number of elements	0x06
Parameter Number	0x03C4 (964d)
Sub-index	0x0000 (0d)

Table 261: Messages Sent and Received during Requesting All Values for PNU964

Message	Operation	Data	
1	**Write request**	**Request header**	0x02 0x01 0x01 0x01
		Parameter address	0x10 0x06 0x03 0xC4 0x00 0x00
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x02 0x01 0x01 0x01
		Parameter value	0x42 0x06 0x01 0xBA 0x00 0x020x00 0x64 0x07 0xDE 0x00 0x65 0x000x01

The returned value consists of six words (0x42 is Word, 0x06 is the number of values returned), and the values are 0x01BA, 0x0002, 0x0064, 0x07DE, 0x0065, and 0x0001. Thus the following information can be determined about the device:

- Manufacturer code is 0x01BA
- Drive Unit type is 0x0002
- Software version is 1.0 (0x0064 = 0100d)
- Firmware date (year) is 2014 (0x07DE)
- Firmware date (day/month) is 1/1 (0x0065 = 101d)
- The device contains one axis

5.1.6.3 Request the Value of Parameter ID 103

Table 262: Information Used for Request Value of Parameter ID 103

Field	Contents
Request reference	0x03
Request ID	0x01 = Request parameter
Axis Number	0x01
Number of Parameters	0x01
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x2711 (10001d)
Sub-index	0x0067 (103d)

Table 263: Messages Sent and Received during Requesting Value for ID 103

Message	Operation	Data	
1	**Write request**	**Request header**	0x03 0x01 0x01 0x01
		Parameter address	0x10 0x01 0x27 0x11 0x00 0x67
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x03 0x01 0x01 0x01
		Parameter value	0x42 0x01 0x00 0x0A

The parameter value reveals that the format of the value is "Word" (0x42), there is one value in the response (0x01) and the actual value is 0x000A. Because this value was read from the AC drive application, the Drive Application Manual contains details on how to interpret the value. In this example, the acceleration time would be 1 s.

5.1.6.4 Change the Value of Drive Parameter ID 103 (Successful)

Table 264: Information Used to Write the Value of Parameter ID 103

Field	Contents
Request reference	0x04
Request ID	0x02 = Write parameter
Axis Number	0x01
Number of Parameters	0x01

Field	Contents
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x2711 (10001_d)
Sub-index	0x0067 (103_d)
Parameter data type	0x42 = WORD
Number of parameters	0x01
Value: HI byte	0x00
Value: LOW byte	0x28

Table 265: Messages Sent and Received during Writing Value to ID 103

Message	Operation	Data	
1	**Write request**	**Request header**	0x04 0x02 0x01 0x01
		Parameter address	0x10 0x01 0x27 0x11 0x00 0x67
		Parameter value	0x42 0x01 0x00 0x28
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x04 0x02 0x01 0x01

Answer indicates a successful operation.

5.1.6.5 Change the Value of Drive Parameter ID 103 (Unsuccessful)

This example shows behavior in case where ID modification fails. PLC writes request to change ID 103 value to 0d (Acceleration Time = 0.0s, not allowed).

Table 266: Information Used to Write Value of Parameter ID 103

Field	Contents
Request reference	0x05
Request ID	0x02 = Write parameter
Axis Number	0x01
Number of Parameters	0x01
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x2711 (10001d)
Sub-index	0x0067 (103d)
Parameter data type	0x42 = WORD
Number of parameters	0x01

Field	Contents
Value: HI byte	0x00
Value: LOW byte	0x00

Table 267: Messages Sent and Received during Unsuccessful Writing Value to ID 103

Message	Operation	Data	
1	**Write request**	**Request header**	0x05 0x02 0x01 0x01
		Parameter address	0x10 0x01 0x27 0x11 0x00 0x67
		Parameter value	0x42 0x01 0x00 0x00
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x05 0x82 0x01 0x01
		Parameter value	0x44 0x01 0x00 0x02

Answer indicates an unsuccessful operation with error "Low or high limit exceeded".

5.1.6.6 Change the Values of Multiple Drive Parameters (ID 103 and ID 104)

Table 268: Information Used to Write Value of Parameter ID 103 and ID 104

Field	Contents
Request reference	0x06
Request ID	0x02 = Write parameter
Axis Number	0x01
Number of Parameters	0x02 (two parameters, ID 103 andID104)
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x2711 (10001d)
Sub-index	0x0067 (103d, ID 103)
Attribute	0x10 = Value
Number of elements	0x01
Parameter Number	0x2711 (10001d)
Sub-index	0x0068 (104d, ID 104)
Parameter data type	0x42 = WORD
Number of parameters	0x01
Value	0x0028 (Value for ID 103)
Parameter data type	0x42 = WORD

Field	Contents
Number of parameters	0x01
Value	0x0028 (Value for ID 104)

Table 269: Messages Sent and Received during Unsuccessful Writing Value to ID 103 and ID 104

Message	Operation	Data	
1	**Write request**	**Request header**	0x06 0x02 0x01 0x02
		Parameter address	0x10 0x01 0x27 0x11 0x000x67 0x10 0x01 0x27 0x11 0x000x68
		Parameter value	0x42 0x01 0x000x28 0x42 0x01 0x000x28
2	Write request response from AC drive to PLC		
-	PLC waits until AC drive has finished processing the requested operation		
3	PLC sends read request		
4	**Read request response**	**Response header**	0x06 0x02 0x01 0x01

Answer indicates a successful operation.

5.2 Parameter Access with EtherNet/IP

5.2.1 Explicit Messaging

Explicit Messaging is used in commissioning and parameterizing of the EtherNet/IP board.

The explicit messages provide multipurpose, point-to-point communication paths between two devices. They provide the typical request/response-oriented network communication used to perform node configuration and problem diagnosis. The explicit messages typically use low-priority identifiers and contain the specific meaning of the message right in the data field. It includes the service to be performed and the specific object attribute address.

NOTE! If Class 1 connection (cyclic data) has been established, the Explicit Messages must not be used to control the Output Data. However this restriction does not apply for the I/O Data reading.

5.2.2 List of Data Types

The elementary data types in CIP are (among others) are listed in the following table.

Table 270: EtherNet/IP Data Types

Name	Description	Bit size	Minimum	Maximum
BOOL	Boolean	8	0 = FALSE	1 = TRUE
SINT	Short Integer	8	-128	127
INT	Integer	16	-32768	32767
DINT	Double Integer	32	-231	231–1
LINT	Long Integer	64	-263	263–1
USINT	Unsigned Short Integer	8	0	255
UINT	Unsigned Integer	16	0	65535
UDINT	Unsigned Double Integer	32	0	232–1

Name	Description	Bit size	Minimum	Maximum
ULINT	Unsigned Long Integer	64	0	264–1
REAL	Floating Point	32	See IEEE 754	
LREAL	Long Floating Point	64	See IEEE 754	
STRING[1]	Character string (1 octet per char.)	N	-	
SHORT_STRING[1]	Character string (1 octet per character, 1 octet length indicator)	N+1	-	
BYTE	Bit string (8 bits)	8	-	
WORD	Bit string (16 bits)	16	-	
DWORD	Bit string (32 bits)	32	-	
LWORD	Bit string (64 bits)	44	-	

[1] ISO/IEC-8859-1 encoding.

5.2.3 General CIP Error Codes

The following table contains the error codes used by the EtherNet/IP implementation.

Table 271: General CIP Error Codes

Code	Status name	Description
0	Success	The specified object has successfully performed the service.
1	Connection failure	A connection related service failed along the connection path.
2	Resource unavailable	Resources needed for the object to perform the requested service were unavailable.
3	Invalid parameter value	See Status Code 0x20, which is the preferred value to use for this condition.
4	Path segment error	The processing node did not understand the path segment identifier or the segment syntax.
5	Path destination unknown	The path is referencing an object class, instance, or structure element that is not known or is not contained in the processing node.
6	Partial transfer	Only part of the expected data was transferred.
8	Service not supported	The requested service was not implemented or was not defined for this Object Class/ Instance.
9	Invalid attribute value	Invalid attribute data detected.
12_d / $0C_h$	Object state conflict	The object cannot perform the requested service in its current mode/state.
14_d / $0E_h$	Attribute not settable	A request to modify a non-modifiable attribute was received.
15_d / $0F_h$	Privilege violation	A permission/privilege check failed.
16_d / 10_h	Device state conflict	The current mode/state of the device prohibits the execution of the requested service.
17_d / 11_h	Reply data too large	The data to be transmitted in the response buffer is larger than the allocated response buffer.
19_d / 13_h	Not enough data	The service did not supply enough data to perform the specified operation.

Code	Status name	Description
20_d / 14_h	Attribute not supported	The attribute specified in the request is not supported.
21_d / 15_h	Too much data	The service supplied more data than was expected.
30_d / $1E_h$	Embedded service error	An embedded service resulted in an error.
31_d / $1F_h$	Vendor specific error	A vendor specific error has been encountered. The Additional Code Field of the Error Response defines the particular error encountered.
32_d / 20_h	Invalid parameter	A parameter associated with the request was invalid.
38_d / 26_h	Path Size Invalid	The size of the path which was sent with the Service Request is either not large enough to allow the Request to be routed to an object. Or, too much routing data was included.
29_h	Member not settable	A request to modify a non-modifiable member was received.
46_d / $2E_h$	Service Not Supported for Specified Path	The object supports the service, but not for the designated application path (for example, attribute).

5.2.4 Connection Manager Object Error Codes

These extended status codes used when the general status code is 1.

Table 272: Connection Manager Object Error Codes

Extended Status	Descriptions
256_d / 100_h	Connection in use or duplicate forward open
259_d / 103_h	Transport class and trigger combination not supported
262_d / 106_h	Ownership conflict
263_d / 107_h	Target connection not found
264_d / 108_h	Invalid network connection parameter
265_d / 109_h	Invalid connection size
272_d / 110_h	Target for connection not configured
273_d / 111_h	RPI not supported
274_d / 112_h	RPI value(s) not acceptable
275_d / 113_h	Out of connections
276_d / 114_h	Vendor id or product code mismatch
277_d / 115_h	Product type mismatch
278_d / 116_h	Revision mismatch
279_d / 117_h	Invalid produced or consumed application path
280_d / 118_h	Invalid or inconsistent configuration application path
281_d / 119_h	Non-listen only connection not opened
283_d / $11B_h$	RPI is smaller than the production inhibit time
294_d / 126_h	Invalid configuration size

Extended Status	Descriptions
295_d / 127_h	Invalid originator to target size
296_d / 128_h	Invalid target to originator size
297_d / 129_h	Invalid configuration application path
298_d / $12A_h$	Invalid consuming application path
299_d / $12B_h$	Invalid producing application path
306_d / 132_h	Null forward open function not supported
517_d / 205_h	Parameter error in unconnected request service
789_d / 315_h	Invalid segment in connection path
Range 320_h – $7FF_h$ are vendor specific	
800_d / 320_h	Internal: Connection disabled
64258_d / $FB02_h$	Internal: Bad socket
64259_d / $FB03_h$	Internal: Bad originator to target net parameter
64260_d / $FB04_h$	Internal: Bad target to originator net parameter
64261_d / $FB05_h$	Internal: Bad UDP port
64262_d / $FB06_h$	Internal: Join multicast
64263_d / $FB07_h$	Internal: Prepare I/O packet
64267_d / $FB0B_h$	Internal: Consumption
64268_d / $FB0C_h$	Internal: FW close
64270_d / $FB0E_h$	Internal: Adapter stopped

5.2.5 Supported CIP and Vendor Objects

The Communication Interface supports the following object classes.

Table 273: CIP Objects

Type	Class	Object	Details
Required by EtherNet/IP	1	Identity Object	See 4.6.5.1 Identity Object, Class 0x01
	2	Message Router Object	See 4.6.5.2 Message Router Object, Class 0x02
	4	Assembly Object	See 4.6.5.6 Assembly Object, Class 0x04
	6	Connection Manager Object	See 4.6.5.3 Connection Manager Object, Class 0x06
	245_d / $F5_h$	TCP/IP Interface Object	See 4.6.5.4 TCP/IP Interface Object, Class 0xF5
	246_d / $F6_h$	Ethernet Link Object	See 4.6.5.5 Ethernet Link Object, Class 0xF6
Required by Drive Profile	40_d / 28_h	Motor Data Object	See 4.6.5.7 Motor Data Object, Class 0x28
	41_d / 29_h	Control Supervisor Object	See 4.6.5.8 Control Supervisor Object, Class 0x29
	42_d / $2A_h$	AC/DC Drive Object	See 4.6.5.9 AC/DC Drive Object, Class 0x2A

Type	Class	Object	Details
Vendor-Specific	160_d / $A0_h$	Vendor Parameters Object	See 4.6.6.1 Vendor Parameters Object, Class 0xA0
	161_d / $A1_h$	Motor Control Mode Object	See 4.6.6.3 Motor Control Mode Object, Class 0xA1
	162_d / $A2_h$	Fault History Object	See 4.6.10 Mapping of Standard Output Assemblies onto VACON® Data
	190_d / BE_h	Assembly Instance Selector Object	See 4.6.6.2 Assembly Instance Selector Object, Class 0xBE

6 Parameters

6.1 Option Board Parameters

The following table contains panel parameters for OPTEA and OPTE9 boards. Basic parameters are identical but the Advanced Dual Port Ethernet board (OPTEA) has special settings.

Notice that the following table lists parameters with latest option board firmware. Older firmware versions do not contain all parameters listed here.

Table 274: Parameters Menu Structure

Name	Default	Range	Description
Comm. Protocol(1)	OPTEA: Profinet OPTE9: Modbus	None (0), Modbus (1), PROFINET I/O (2), EtherNet/IP (3)	Active protocol. If "None" is selected, then there is no active fieldbus protocol in option board. See 6.1.1 Comm. Protocol.
Comm. Timeout	10 s	0…65535 s	Communication timeout in seconds. For PROFINET and EtherNet/IP, we recommend to use zero value. See 6.1.2 Comm. Timeout.
Mode(1)	Normal	Normal (1), NX Mode (2), V100 Mode (3) Normal (1), OPTCx Mode (2)	Only when installed to VACON® 100 family. After this setting is changed, drive must be restarted. Only in OPTEA and when installed to VACON® NXP family. After this setting is changed, drive must be restarted. See 6.1.3 Mode/Emulation.
Sub menu: IP Settings			
IP Address Mode(1)	DHCP	Fixed IP (1), DHCP (2), DCP (3)	See 6.1.4 IP Address Mode.
IP Part 1(1)	192	1…223	IP Address Part 1
IP Part 2(1)	168	0…255	IP Address Part 2
IP Part 3(1)	0	0…255	IP Address Part 3
IP Part 4(1)	10	0…255	IP Address Part 4
Subnet mask P1(1)	255	0…255	Subnet Mask Part 1
Subnet mask P2(1)	255	0…255	Subnet Mask Part 2
Subnet mask P3(1)	255	0…255	Subnet Mask Part 3
Subnet mask P4(1)	255	0…255	Subnet Mask Part 4
Default GW P1(1)	192	0…255	Default Gateway Part 1
Default GW P2(1)	168	0…255	Default Gateway Part 2
Default GW P3(1)	0	0…255	Default Gateway Part 3
Default GW P4(1)	1	0…255	Default Gateway Part 4
Speed/Duplex(1)	Autonegotiation	Autoneg. (1), 10 HD(2), 10 FD(3), 100 HD(4),	Ethernet link speed/duplex selection. We recommend to use autonegotiation. See 6.1.5 Speed and Duplex.

Name	Default	Range	Description
		100 FD(5)	
IP Port Filter	0	0...65535	Port filter. For details, see 6.1.6 IP Port Filtering.
Vacon PC Tool		Full (0) Configuration (1) Disabled (2)	VACON® PC tool access filter. For details, see 6.1.6 IP Port Filtering.
Sub menu: EtherNet/IP			
EIP Output Instance(1)	21	"20"(1), "21"(2), "23"(3), "25"(4), "101"(5), "111"(6), "128"(7), "131"(8) "151"(9), "161"(10)	EtherNet/IP output assembly instance. Shows the active output instance. The instance is selected during the I/O connection open request. This parameter was removed in newer firmware versions and replaced with monitoring value. See 6.1.7 EIP Output Instance.
EIP Input Instance(1)	71	"70"(1), "71"(2), "73"(3), "75"(4), "107"(5), "117"(6), "127"(7), "137"(8) "157"(9), "167"(10)	EtherNet/IP input assembly instance. Shows the active input instance. The instance is selected during the I/O connection open request. This parameter was removed in newer firmware versions and replaced with monitoring value. See 6.1.8 EIP Input Instance.
EIP Product Code Offset	0	0…99	See 6.1.9 EIP Product Code Offset.
Sub menu: Modbus			
Modbus Unit Identifier(1)	255	1…247, 255	Modbus Unit Identifier. Used only with Modbus UDP. See 6.1.10 Modbus Unit Identifier.
Sub menu: PROFINET I/O			
PNIO Name Of Station	""	1...240 char	For PROFINET only. Only visible in VACON® 100 family AC drives. See 6.1.11 PNIO Name of Station.
NOS Device ID	0	0…65535	Name Of Station device identification number. Not visible in VACON® 100 family AC drives.
Sub menu: SNTP			
SNTP Mode	Disabled	Disabled (1), Poll (2), Listen Only (3), Poll Fault (4), Listen Only Fault (5)	SNTP mode, see 6.1.12 SNTP Mode.

Name	Default	Range	Description
Server 1 IP P1	0	255	SNTP Server 1 IP address part 1, see 6.1.13 SNTP IP Address.
Server 1 IP P2	0	255	SNTP Server 1 IP address part 2
Server 1 IP P3	0	255	SNTP Server 1 IP address part 3
Server 1 IP P4	0	255	SNTP Server 1 IP address part 4
Server 2 IP P1	0	255	SNTP Server 2 IP address part 1
Server 2 IP P2	0	255	SNTP Server 2 IP address part 2
Server 2 IP P3	0	255	SNTP Server 2 IP address part 3
Server 2 IP P4	0	255	SNTP Server 2 IP address part 4
SNTP port	123	0…65535	SNTP server of client port depending on SNTP mode, see 6.1.14 SNTP Port.
Time Interval	200	30…65535	Time interval in seconds for time information polling and receiving, see 6.1.15 Time Interval.
Time Offset H	0	-13…15	Time offset Hours. Only visible in VACON® NXP family AC drives. See 6.1.16 Time Offset.
Time Offset M	0	-59…59	Time offset Minutes Only visible in VACON® NXP family AC drives. See 6.1.16 Time Offset.

[1] These parameters are locked when either PROFINET connection, EtherNet/IP implicit connection, or a Modbus connection is established to write process data. That is, when fieldbus can be used to control the process).

6.1.1 Comm. Protocol

The OPTEA and OPTE9 option boards come with several fieldbus protocols. Select the one used in your network from the list. Only one protocol can be active at a time. Since OPTEA firmware version V002 and OPTE9 firmware version V008, it is also possible to select "none" from the list. With this selection, no fieldbus protocol is active in option board. It also means that the option board does not generate fieldbus timeout fault when the Ethernet cable is not connected. The PC tool connections and SNTP time updates are possible in this mode.

6.1.2 Comm. Timeout

This parameter defines how much time can pass from the last received message from the Master Device before a fieldbus fault is generated. The functionality of this value is protocol-specific.

A fieldbus fault is also generated when the Ethernet link is down for over 60 s after the device start-up. The Ethernet link status is being checked until the fieldbus communication is activated.

After that the active fieldbus protocol controls the activation of the fieldbus fault. The functionality of this value is protocol-specific.

Modbus

For Modbus, this value defines a time in which a message must be received (from Client in Modbus TCP/UDP) before a fieldbus fault is generated. If timeout is set to zero, no fault is created.

See 4.3.9 Connection Timeout in Modbus Communication.

PROFINET and EtherNet/IP

For these protocols, this value is considered as an extra timeout which works on top the timeout mechanism of the protocol. When a connection loss is noticed, a fault activation is started. If communication timeout value is zero, the fault is activated immediately, otherwise the fault activates after a specified time. If the connection is reopened before the specified time has elapsed, no fault is created.

See 4.4.9 Connection Timeout in PROFINET for more details on how a timeout is created while using PROFINET protocol.

See 4.6.13 Connection Timeout in EtherNet/IP Communication for more details on how a timeout is created while using EtherNet/IP protocol.

6.1.3 Mode/Emulation

For OPTEA, the "Mode" parameter has different content when installed to VACON® 100 or to NXP family drive. When installed to VACON® NXP family drive and "OPTCx" mode is selected, OPTEA emulates behavior of old C-series Ethernet option boards as accurately as possible.

Table 275: Emulation Mode with to VACON® NXP Drive

Value	Emulation mode	Description
1	Normal	Normal operation
2	OPTCx	Emulating OPTC-series Ethernet boards as accurately as possible

When installed to VACON® 100 family drive and “NX” mode is selected, OPTEA also emulates C-series Ethernet option boards. With “VACON100” mode, it emulates the VACON® 100 family internal implementations.

Table 276: Emulation Mode with VACON® 100 Family Drive

Value	Emulation mode	Description
1	Normal	Normal operation
2	NX	Emulating OPTC-series Ethernet boards in VACON® 100 family type drive
3	V100	Emulating VACON® 100 family drive

It is required to restart the AC drive after changing the emulation mode. See 3.3 OPTCx Emulation Mode (OPTEA) for more details.

6.1.4 IP Address Mode

The IP mode determines how the option board IP settings are set. There are three IP modes available: DHCP, Fixed IP, and DCP. By default, the option board is in DHCP mode.

IP is divided into 4 parts (octets). The parameters menu shows stored IP settings. The monitoring values always show the currently used IP settings.

IP mode: DHCP

If a DHCP mode is selected, the option board tries to retrieve its IP settings from the DHCP Server connected to the local network. If the option board is unable to retrieve its IP settings, it sets a link-local address as the current IP address after about one minute (for example 169.x.x.x). Changing the IP settings (IP address, subnet mask or gateway) does not affect anything when IP mode is "DHCP".

If PROFINET is used and the IP settings are set via DCP protocol, the IP mode is changed to "Fixed IP". Also, IP settings from DCP are taken in to use. In this IP mode, the IP settings are stored permanently even if DCP protocol sets values as temporary.

IP mode: Fixed IP

In this mode, the IP settings are taken from the parameters, and monitoring values always shows the same settings when the Ethernet link is up. The IP settings can be changed from the control panel, PC tools or via fieldbus. If PROFINET is used and the IP settings are set via DCP protocol, the IP settings are stored permanently even if DCP protocol sets values as temporary.

IP mode: DCP

Since OPTEA firmware version V002 and OPTE9 version V008, it is also possible to set the mode to "DCP". Use this mode with PROFINET as it usually uses DCP protocol for the IP settings. It can also be used it with other protocols. DCP protocol itself is available in option board only when PROFINET is used.

The PROFINET DCP protocol can be used to set temporary IP settings. It means that after the device is restarted, the option board does not have IP settings. The PLC then must set the IP address again before starting the communication. When temporary IP settings are set, those values are shown only in monitoring view. Parameters show whatever IP settings were previously stored. When device is restarted, option board uses 0.0.0.0 as its IP address. Permanent IP settings are always stored and used after device restart.

IP settings are locked after they have been set by using DCP protocol and can be only modified via DCP. After device restart, IP settings can be modified from panel, PC tools, and so on, until they have been set by using DCP protocol. It enables changing IP address locally even in DCP mode when, for example, PLC is offline.

6.1.5 Speed and Duplex

Ethernet link speed and duplex can be set by changing this parameter. We always recommend to use "autonegotiation"-mode. Change this value only if there are specific needs. If Ethernet link in one end is in fixed mode (for example, 100 Mb Full Duplex) and the other end is using autonegotiation, the autonegotiation end can detect speed. However, it is unable to detect duplex. Option board reverts to Half Duplex mode when autonegotiation of duplex mode fails. Communication problems can be expected if the ends of the link are in different modes.

Note also that "100 Mb full duplex" is required for fast paced fieldbus process control. Lower speed or half duplex generates communication problems when shortest cycle times for process data are used.

Possible parameter values are listed in the following table.

Table 277: Possible Parameter Values

Mode	Description
Autonegotiation	Ethernet link speed and duplex are automatically detected. Default and recommend mode.
10 Half Duplex	10 Mb half duplex
10 Full Duplex	10 Mb full duplex
100 Half Duplex	100 Mb half duplex
100 Full Duplex	100 Mb full duplex

Monitoring values show the current speed and duplex value. Possible values are listed in the following table.

Table 278: Possible Monitoring Values

Mode	Description
Undefined	Ethernet link is not up. For example, cable is not connected.
10 Half Duplex	10 Mb half duplex
10 Full Duplex	10 Mb full duplex
100 Half Duplex	100 Mb half duplex
100 Full Duplex	100 Mb full duplex

6.1.6 IP Port Filtering

Parameters “IP Port Filter” and “VACON® PC Tool” can be used to block access to some of the open ports in the option board. Some of these ports can be critical for the operation of used protocol, so be careful when closing ports. By default, no ports are closed. Notice that protocol specific ports are always closed when the protocol is not selected.

Values for “IP Port Filter”. This value is a bit mask. In VACON® Live, each checkbox can be selected individually. When setting this value by writing to ID, the bit mask must be built separately.

Table 279: Possible Values for IP Port Filter

Bit	Protocol/port	Description
0	TFTP	TFTP port. Only open when PROFINET is used and board is in OPTCx mode.
1	SNMP	SNMP port
2	PROFINET RPC	PROFINET RPC port. Only open when PROFINET is used. Critical usually to PROFINET functionality.
3	EIP I/O data	EtherNet/IP I/O data port. Only open when EtherNet/IP is used. Critical usually to EtherNet/IP functionality. Closing makes sense only if Explicit messaging is used.
4	Modbus TCP	Modbus TCP port. Only open when Modbus is used. Can be closed if only Modbus UDP is used.
5	Modbus UDP	Modbus UDP port. Only open when Modbus is used. Can be closed if only Modbus TCP is used.

Bit	Protocol/port	Description
6–10	Reserved	-
11	DLR	Ring protocol. Can be filtered out when DLR is not used with EtherNet/IP.
12	MRP	Ring protocol. Can be filtered out when MRP is not used with PROFINET.
13	ICMP	ICMP, can be used to disable PING to the option board.
14	LLDP	LLDP protocol. Can be filtered out when topology features of PROFINET are not used.
15	DCP	DCP protocol. Critical usually for the functionality of PROFINET

Table 280: Values for Parameter VACON® PC tool

Value	Name	
1	Full	Default value. Allows VACON® Live, VACON® Loader, NCDrive, or other VACON® PC tool access.
2	Configuration	Disables VACON® Loader access. Allows connections from VACON® configuration tools.
3	Disabled	Disables access from Ethernet for all VACON® PC tools.

6.1.7 EIP Output Instance

This parameter shows what instances are being used now. The instances used are taken from the I/O connection open request. So, although these values are parameters they act more like monitoring values. Input and output parameters were removed in newer firmware version and replaced with monitoring values. The monitoring values show currently used instance numbers.

6.1.8 EIP Input Instance

This parameter shows what instances are being used now. The instances used are taken from the I/O connection open request. So, although these values are parameters they act more like monitoring values. Input and output parameters were removed in newer firmware version and replaced with monitoring values. The monitoring values show currently used instance numbers.

6.1.9 EIP Product Code Offset

This value can be used to differentiate drives for the PLC program. For example, if one drive is running a different application (with different parameters) than other drives, this offset in the product code enables the PLC to use a different EDS file to read those parameters from this drive.

Remember that when changing this value, also the EDS file used, or the product code value in your EDS file must be changed.

6.1.10 Modbus Unit Identifier

This value is used to select Modbus unit identifier/slave address. When using Modbus TCP the value 255 must be used, and this field is ignored as the IP address is used to access the correct device. When using Modbus UDP, the values and their significance is explained in the following table. Values 1–247 and 255 can be set.

Table 281: Modbus Unit Identifier Field Description when Using Modbus UDP

#	Unit identifier	Description
0	Broadcast	Broadcast address, all devices accept the messages
1...247	Slave address	Messages with this unit identifier and broadcast (0) are accepted
255	Non-significant	Messages with all unit identifiers are accepted (setting is ignored)

The value 0 can be used to control several devices with a broadcast message, for example, to command all devices to stop at the same time. This feature also works when all devices have the unit identifier value 255.

6.1.11 PNIO Name of Station

The PROFINET I/O "Name of Station" parameter can be set via VACON® Live or NCIPConfig. Other possibility is to set this name by writing it over Ethernet with the DCP protocol. The name is empty if no name is set, or if the name has been set as "temporary" by network device with DCP protocol. Maximum length for this parameter is 240 characters.

Because VACON® NXP, VACON® 20, VACON® 20 X, and VACON® 20 CP drives do not support parameters with string datatype, a parameter with integer value (NOS Device ID) can be used instead. When a non-zero value is set, the option board generates the Name Of Station value using application id and this new parameter. This integer value can then be backed up and restored when needed. This way the AC drive can be replaced and it retains the same Name Of Station value after parameters are restored.

If NOS Device ID parameter is used, the option board always generates the Name Of Station value during drive start-up. The used value can be overwritten by PLC or PC tools, but the written value is active only until the AC drive is restarted again.

For example if Multi-purpose application is used and NOS Device ID is set to '7', the Name Of Station is "apfiff06-7". When using "NOS Device ID" if drive application changes, generated Name Of Station value also changes.

We recommend using LLDP capable devices and the topology feature in (for example) Siemens TIA Portal. This way, the PLC always sets the Name Of Station and IP settings based on devices location in Ethernet network. This way there is no need to set manually Name Of Station or use "NOS Device ID" parameter.

The Name Of Station value is shown in monitoring view (except for of VACON® 20, VACON® 20 X, and VACON® 20 CP). Shown value is limited to 12 characters in VACON® NXP and to 18 characters in VACON® 100 family.

For example, "auxpump22tower4" is shown as "..mp22tower4" in VACON® NXP.

6.1.12 SNTP Mode

This parameter is used to set SNTP client mode.

Table 282: SNTP Client Modes

Mode	Description
Disabled	SNTP feature is disabled
Poll	Option board polls with certain interval for new time from the time server
Listen Only	Option board listens time updates (broadcasts) from time server
Poll Fault	Same as poll-mode, but if retrieving time updates fails, a fault is generated.
Listen Only Fault	Same as Listen Only -mode, but if time updates are not received, a fault is generated.

6.1.13 SNTP IP Address

To use the SNTP in poll mode, set at least one server address. In Listen Only -mode, the IP addresses can be zero, and all time broadcasts are accepted. When server address(es) are set, only the broadcasts from the set addresses are accepted.

6.1.14 SNTP Port

By default SNTP port is 123 but it can be changed with this parameter. In Poll-mode, the option board sends requests to this port in the time server, and in the Listen Only -mode it listens to the broadcasts to this port.

6.1.15 Time Interval

This setting is used to define how often the option board must request time updates from the time server in Poll-mode. In the Listen Only -mode, this setting defines how often the broadcasts must be received.

6.1.16 Time Offset

These settings are visible only in VACON® NXS and NXP family drives. When the option board is installed to a VACON® 100 family AC drive, the internal time settings of the drive are used. See VACON® 100 Industrial application manual on how to set time offset in VACON® 100 Industrial drive.

By default, the time updates from the time server are in UTC. Use these settings to change that value to local time by adding or reducing hours and minutes stored to these parameters.

6.2 AC Drive Parameters

6.2.1 AC Drive Parameters for Fieldbus Control and Reference Selection

The following tables list the parameters that must be set in the AC drive in order for the motor to be controllable via fieldbus. The tables cover some basic applications. See the application-specific manuals for more detailed information and latest updates.

In order for the AC drive to accept commands from the fieldbus network, the control place of the AC drive has to be set to fieldbus. The default value of the parameter "Control Place" is usually I/O. If the control unit software is updated, the default settings are restored.

Some applications can also have the remote speed reference selection set by default to other than fieldbus. In these cases, set the speed reference selection to fieldbus, so that the speed reference can be controlled via fieldbus.

NOTE! The motor control mode must be selected to support the used process and profile.

The parameters can be read and written by using:

- the drive panel
- PC Tools
- fieldbus protocol.

6.2.2 Protocol-related ID Reading and Writing

The following table contains links to chapters where the ID value reading is described.

Table 283: Links to ID Value Descriptions

Protocol	Chapter
Modbus	See 4.3.8.1 VACON® Application IDs. See 4.3.8.4 ID Map.
PROFINET	See 5.1.4 Drive Parameter Access Using Application ID
EtherNet/IP	See 4.6.6.1 Vendor Parameters Object, Class 0xA0

6.2.3 Fieldbus Parameters for VACON® 100 Family Standard Application

Table 284: Fieldbus Parameters for VACON® 100 Family (Standard Application)

Index in panel tree	Parameter name	ID	Default	Value	Description
P3.1.2.1	Control mode	600	0	0 = Frequency 1 = Speed 2 = Torque	-
P3.2.1	Remote control place	172	0	1 = Fieldbus CTRL	-
P3.2.2	Local/remote	211	0	0 = Remote	-
P3.3.1.10	Fieldbus ref. sel.	122	3	3 = Fieldbus	-
P5.13.1	Controlling fieldbus	2539	1	1 = Automatic 2 = Slot D 3 = Slot E	See Controlling Fieldbus Parameter

Controlling Fieldbus Parameter

The "Controlling Fieldbus" parameter is available in VACON® 100 family products for situations when multiple fieldbus options or protocols are active at the same time. Use the "Controlling Fieldbus" parameter for selecting the instance from which the process data is sent to the drive application. This parameter is located under I/O and Hardware/Fieldbus General (5.13.1).

By default, the setting is in "Automatic" and the functionality (when receiving process data from multiple sources) is application-dependent.

For example, if a fieldbus option board has been installed to slot E and it is used to control the drive, select "Slot E" as value for this parameter. With this setting, only the process data from the option board in slot E is forwarded to the application. All other fieldbuses still receive process data out. It prevents the monitoring fieldbuses from accidentally writing process data in.

Table 285: Selections for Controlling Fieldbus Parameter

Value name	Value	Description
Automatic	1	Process data from all sources is forwarded to application
Slot D	2	Only process data from slot D is forward to application. Value is visible only, if option board is installed to slot D.
Slot E	3	Only process data from slot E is forward to application. Value is visible only, if option board is installed to slot E.
RS485	4	Only process data from VACON® 100 family internal RS485 protocol is forwarded to application
PROFINET I/O	5	Only process data from VACON® 100 family internal PROFINET I/O protocol is forwarded to application
EtherNet/IP	6	Only process data from VACON® 100 family internal EtherNet/IP protocol is forwarded to application
Modbus TCP/UDP	7	Only process data from VACON® 100 family internal Modbus TCP/UDP protocol is forwarded to application
BACnet/IP	8	Only process data from VACON® 100 family internal BACnet/IP protocol is forwarded to application

6.2.4 Fieldbus Parameters for VACON® 20 Standard Application

Table 286: Fieldbus Parameters for VACON® 20 (Standard Application)

Index in panel tree	Parameter name	ID	Value	Default
P17.2	Disable showing of quick menu	-	0 = Advanced menu 1 = Quick set-up parameters	1
P1.8	Motor control mode	600	0 = Frequency 1 = Speed 2 = Torque	0
P2.1	Rem. Control place 1 sel.	172	1 = Fieldbus CTRL	0
P2.5	Local/remote	211	0 = Remote	0
P3.3	Rem. Control place 1 freq. ref. sel.	122	3 = Fieldbus	7

6.2.5 Fieldbus Parameters for VACON® 20 X Multipurpose Application

Table 287: Fieldbus Parameters for VACON® 20 X Multipurpose Application

Index in panel tree	Parameter name	ID	Value	Default
P8.1	Motor control mode	600	0 = Frequency 1 = Speed	0
P1.11	Control place selection	125	2 = Fieldbus	0
P1.12	Frequency ref. sel.	1819	5 = Fieldbus	0

6.2.6 Fieldbus Parameters for VACON® NXP Multipurpose Application

Table 288: Fieldbus Parameters for VACON® NXP Multipurpose Application

Index in panel tree	Parameter name	ID	Value	Default
P2.6.1	Motor control mode	600	0 = Frequency 1 = Speed	0

Index in panel tree	Parameter name	ID	Value	Default
			2 = Torque	
P3.1	Control place selection	125	3 = Fieldbus	1
P2.1.13	Fieldbus control reference	122	9 = Fieldbus	3

6.2.7 Torque Control Parameterization

Some extra parameterization must be done to control the frequency control with torque control. The following instructions are for the VACON® 100 family and VACON® NXP application, see the application-specific manual for more detailed information.

- Motor control mode (ID 600) must be configured to "Torque control" (2).

To configure the drive to use the correct torque reference, select the parameter "Torque Reference Selection" to ProcessDataIn1 (9). It can be done with:

- PC-tool or panel (VACON® 100 family: P3.3.2.1, VACON® NXP: P2.10.4) / ID 641
- Vendor Parameter Object

6.3 VACON® NXP System Software Parameters for Application Developers

The application developers and system integrators can use these VACON® NXP system software variables to activate and control different fieldbus communication modes and features.

See 4.2 Fieldbus Option Board Communication Modes for information about supported modes and required firmware versions on given option board and control unit.

NOTE! Changing of mode while running the motor is not supported because of security reasons.

Table 289: System Software Variables

Parameter	Value	De-fault	Description
FBMode-SlotD_fwu8	0 = Normal mode 1 = Fast safety mode[1] 2 = Fast mode 3 = Fast PROFIBUS DP mode[2] 4 = Normal extended mode	0	See 6.3.1 System Software Variables for Selecting Communication Modes.
FBMode-SlotE_fwu8		0	
FBModeSlotD-SupMo-des_fwu16	0x00 = Not yet updated. Read again later 0x01 = Fieldbus communication not supported 0x02 = Normal mode supported 0x04 = Fast safety mode supported[1] 0x08 = Fast mode supported 0x10 = Fast PROFIBUS DP mode supported 0x20 = Normal extended mode supported	0	See 6.3.2 System Software Variables for Monitoring Supported Communication Modes.
FBMode-SlotE_fwu8		0	
FBControlSlotSelector_fwu8[3]	0 = All slots 4 = Slot D only 5 = Slot E only 6 = Fast PROFIBUS DP D slot 7 = Fast PROFIBUS DP E slot	0	See 6.3.3 System Software Variables for Selecting the Input Process Data Slot.

[1] Automatically enabled/disabled by system software. This value cannot be set.

[2] Fast PROFIBUS DP mode is not supported in OPTE3/5 PROFIBUS DP.

[3] Selections 6 and 7 are for backward compatibility only. Same as FBModeSlotX_fwu8 variable setting '3'. Fast PROFIBUS DP is not supported in OPTE3/5 PROFIBUS DP.

6.3.1 System Software Variables for Selecting Communication Modes

FBModeSlotX_fwu8 variables are used to select the active fieldbus option board communication mode. If no fieldbus option board is connected to the related slot, the selection of the FBModeSlot parameter is set to 0 = Normal mode.

6.3.2 System Software Variables for Monitoring Supported Communication Modes

FBModeSlotXSupModes_fwu16 variables can be used to determine the different supported modes of the fieldbus option boards. All features are set as bit fields as multiple modes can be supported.

Value '0' is returned while the feature set of the option board is not yet retrieved. Value must be asked again. Any option board not supporting fieldbus communication returns value '1'.

Example 1: OPTE3-E5_FW0083V006 PROFIBUS DP board returns value: 0x2A, indicating support for Normal, Fast, and Normal extended modes.

Example 2 (PROFIsafe is used): OPTE3-E5_FW0083V006 board returns value: 0x04, indicating that only Fast safe mode is allowed to be set.

Example 3: OPTE9_FW0196V006 Dual Port Ethernet board returns value: 0x0A, indicating support for Normal and Fast modes.

6.3.3 System Software Variables for Selecting the Input Process Data Slot

FBControlSlotSelector_fwu8 variable is used to select the controlling fieldbus option board slot. When selected (other than '0'), process data is accepted only from the selected slot and all other process data is discarded. Process data out is still updated normally to all slots.

This selector can be used to support redundant fieldbus connection. In fieldbus redundancy mode, 2 fieldbus option boards are installed to VACON® NXP option board slots D and E. The application selects with FBControlSlotSelector_fwu8 variable which fieldbus option board can deliver process data from fieldbus master to the application.

Default value for FBControlSlotSelector_fwu8 is '0' which means that process data is accepted from both fieldbus option boards.

7 Monitoring Values

7.1 Option Board Monitoring Values

The monitor menu shows the currently active IP settings. For example, these values show '0' when a DHCP Server is trying to get an IP address. After the address is received, these values are updated.

Table 290: Option Board Monitoring Values

Name	Range	Description
Fieldbus protocol status	Initializing (1), Stopped (2), Operational (3), Faulted (4), Failing (5)	When device has started, it stays in "Initializing" status until the connection is opened to the device. At that point, the status changes to "operational". If the connection is closed or lost, the status changes to "Failing" until communication time- out time has elapsed. Then the status changes to "Faulted".
Communication status	0.0…64.999	0–64 Number of messages with errors 0–999 Number of messages without communication errors
Drive control word	-	Control word in drive format
Drive status word	-	Status word in drive format
Protocol control word	-	Control word in protocol format
Protocol status word	-	Status word in protocol format
Drive speed Ref	-	Speed reference in drive format
Drive speed Act	-	Actual Speed in drive format
Protocol speed Ref	-	Speed reference in protocol format
Protocol speed Act	-	Actual Speed in protocol format
MAC Address	-	Used device MAC address. Available in VACON® NXP, NXS, and VACON® 100 family AC drives. See 7.1.1 MAC Address.
Media Redundancy	None (0) MRP Ring Init (1) MRP Ring Ok (11) MRP Ring Fault (21) DLR Ring Init (4) DLR Ring Ok (14) DLR Ring Fault (24) DLR Ring Stopped (25)	State of active media redundancy protocol. See 7.1.2 Media Redundancy.
Sub menu: IP Settings		
IP Part 1	1…223	Current IP Address Part 1
IP Part 2	0…255	Current IP Address Part 2
IP Part 3	0…255	Current IP Address Part 3
IP Part 2	0…255	Current IP Address Part 4
Subnet mask P1	0…255	Current Subnet Mask Part 1
Subnet mask P2	0…255	Current Subnet Mask Part 2
Subnet mask P3	0…255	Current Subnet Mask Part 3

Name	Range	Description
Subnet mask P4	0…255	Current Subnet Mask Part 4
Default GW P1	0…223	Current Default Gateway Part 1
Default GW P2	0…255	Current Default Gateway Part 2
Default GW P1	0…255	Current Default Gateway Part 3
Default GW P4	0…255	Current Default Gateway Part 4
Speed/Duplex	Undefined (1), 10 HD (2), 10 FD (3), 100 HD (4), 100 FD (5)	Shows current Ethernet link speed and duplex value.
Sub menu: EtherNet/IP		
EIP Product Code	-	Currently used EtherNet/IP Product Code
EIP Output Instance	0–161	Currently used output instance. Zero is shown if EtherNet/IP is not the active protocol
EIP Input Instance	0–167	Currently used input instance. Zero is shown if EtherNet/IP is not the active protocol|
Sub menu: PROFINET I/O		
Name Of Station	-	Name of station value truncated to be shown in panel. It shows partial Name Of Station value. This value is visible only in VACON® NXP family drives.
IOC NOS	-	Name Of Station of the I/O controller, that is, the PLC connected to this board
System Redundancy	None(1), Fault (2), Back-up (3), Primary only (4), Redundant (5)	State of system redundancy if active. Visible with OPTEA board. See 7.1.3 System Redundancy (OPTEA).
Sub menu: SNTP		
SNTP status	Stopped (1), Internal error (2), Invalid configuration (3), Finding server (4), Failed (5), Synchronized Time (6), Lost connection (7)	Shows current SNTP status. Value is stopped when SNTP is not enabled. See 7.1.4 SNTP Status.
Server IP P1	0…255	Currently active SNTP server address part 1. See 7.1.5 SNTP Server IP.
Server IP P2	0…255	Currently active SNTP server address part 2. See 7.1.5 SNTP Server IP.
Server IP P3	0…255	Currently active SNTP server address part 3. See 7.1.5 SNTP Server IP.
Server IP P4	0…255	Currently active SNTP server address part 4. See 7.1.5 SNTP Server IP.

Name	Range	Description
Last Update time	0…65535	Seconds since time update was received from network. Value shows zero until first update since drive start-up. See 7.1.6 Last Update Time.

7.1.1 MAC Address

This value shows the device MAC address of the option board. The format differs between used VACON® AC drive. In VACON® 100 family AC drives, the format is 00:11:22:33:44:55, and in VACON® NXS and NXP, the value is 001122334455. This value is not visible in VACON® 20 family AC drives.

Example for VACON® 100 family AC drive: 00:21:99:1a:00:24

Example for VACON® NXS/NXP: 0021991a0024

7.1.2 Media Redundancy

This value shows the current state of the active media redundancy protocol. DLR can be active only when EtherNet/IP is the active protocol and MRP when PROFINET has been selected.

The values are mapped in the following way:

- 0 = No ring protocol
- 0# = Ring protocol initializing
- 1# = Ring protocol status ok
- 2# = Ring protocol failure
- #1-#3 = MPR
- #4-#6 = DLR

The value definitions and how they map to media redundancy specification states (in MRP MRC state machine and in DLR announce based node state machine) are defined in Table 291.

Table 291: Values for MPR

Value	Name	Description	Standard state
0	None	• No active ring protocol	-
1	MRP (Ring) Init	• Protocol is initializing	Power up
11	MRP (Ring) Ok	• Ring ports are ok • MRP_Test frames are received from both ports	PT_IDLE
21	MRP (Ring) Fault	• One of the ring ports have a failure • Transitioning from one state to another • MRP_Test frames are not received from both ports	PT_IDLE, DE_IDLE, DE, PT
22	MRP (Ring) Stopped	• Both ring ports have a failure • Can be active briefly during a transition between states	AC_STAT1
4	DLR (Ring) Init	• No announce-based DLR frames have been received after starting up DLR protocol	IDLE_STATE
14	DLR (Ring) Ok	• Ring is closed and without fault	NORMAL_STATE
24	DLR (Ring) Fault	• Ring is open because of a ring failure	FAULT_STATE

Value	Name	Description	Standard state
25	DLR (Ring) Stopped	• DLR protocol has transitioned back to IDLE_STATE • Either both ports have no link or no Announce frames received within timeout time	IDLE_STATE

7.1.3 System Redundancy (OPTEA)

Table 292: Monitoring Value System Redundancy

Value	Name	Description
1	None	No system redundancy connections active
2	Faulted	Redundancy data hold time elapsed, switchover from Primary to Back-up failed
3	Back-up	Back-up connection. This connection happens only briefly during a transition from back-up to primary in case primary is lost.
4	Primary Only	Primary connection active, no back-up connection available
5	Redundant	Both primary and back-up connections are active

7.1.4 SNTP Status

This value shows current SNTP status. Status is Stopped when SNTP is disabled.

Table 293: SNTP Statuses

Status	Description
Stopped	SNTP feature is disabled.
Internal error	Internal SNTP error has occurred.
Invalid configuration	Invalid configuration. For example mode is Poll but no server address is set.
Finding server	SNTP is trying to connect to server
Failed	SNTP was not able to connect to any server
Synchronized Time	SNTP has received time update from server
Lost Connection	SNTP was receiving time updates but now it is unable to communicate with any server.

7.1.5 SNTP Server IP

This value shows the IP address of the SNTP server to which the option board is trying to connect or which is sending the time updates.

7.1.6 Last Update Time

This value shows the number of seconds since the last received time update. It shows zero until the first received time update.

7.2 Monitoring Values of Control and Status Words

Drive Control Word always shows the internal control word (FBFixedControlWord) which is written to the drive by the option board. If the control word written by the PLC does not use FBFixedControlWord (for example, STW1 or CIP CW), the control word along with profile-specific state machine is used to generate the FBFixedControlWord. If the used telegram is already using FBFixedControl-Word, it is shown directly in this monitoring value. Only exception to this is that, in the VACON® NXP AC drives, the bit 15 is set/removed to indicate "Master Connection state".

The Drive status word always shows the FBFixedStatusWord received from the drive.

The Protocol Control Word shows the value sent by the PLC to the option board. It always shows protocol specific control word (ZSW1, CIP CW) when it is in the used telegram. Otherwise the FBGeneralControlWord is shown. However, if the telegram contains only the FBFixedControlWord, then it is shown in both control word monitoring values.

The Protocol Status word shows the value sent by the option board to the PLC. It always shows protocol specific status word (STW1, CIP SW) when it is in the used telegram. Otherwise the FBGeneralStatusWord is shown. However, if telegram contains only FBFixed-StatusWord, then it is shown in both status word monitoring values.

See telegram specific configuration in their own chapter in this manual. For example, for PROFINET ST1 see 4.4.5.1 Standard Telegram 1 and Variants.

8 Fault Tracing

8.1 LED Indications on VACON® OPTEA/OPTE9 Option Boards

The LED indications are the same on both OPTEA and OPTE9 option boards. When the EtherNet/IP is active, the option board follows CIP standard for LED indications. Therefore, the indications described in Table 294 do not apply. See 8.2 LED Indications with EtherNet/IP.

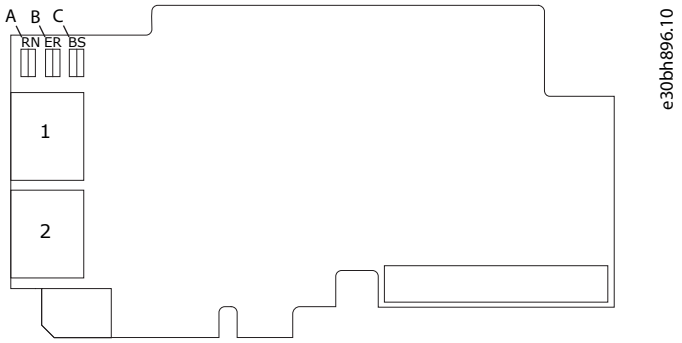


Illustration 31: LED Indications on VACON® OPTEA/OPTE9 Option Board

A	RN = Network status indicator	C	BS = Module status indicator
B	ER = I/O connection indicator		

Table 294: List of Possible LED Combinations

LED combinations	Description
RN ER BS	No power. All LEDs are OFF.
RN ER BS	Option board firmware is corrupted or its software is missing. ER is blinking red (0.25 s ON, 0.25 s OFF)
RN ER BS	Option board failure. Option board is not operational. BS is steady red and ER is possibly blinking red (2.5 s ON, 2.5 s OFF)
RN ER BS	Option board is operational. BS is steady green.
RN ER BS	Protocol is ready for communications. RN is blinking green (2.5 s ON, 2.5 s OFF), BS is steady green.

LED combinations	Description
	Protocol is communicating, RN and BS are steady green.
	Protocol communication fault. ER is blinking red to indicate a fault. RN is blinking green to indicate that protocol is again ready for communications. BS is steady red.
	Protocol is communicating with an active fault. ER is blinking red. RN and BS are steady green.
	Duplicate IP address detected. RN is blinking red. BS is steady green.
	PROFINET only! In node flashing test, all 3 LEDs are blinking green.
	If option board detects hardware failure or some other non-recoverable fault situation, it generates a slot fault (F54), and all 3 LEDs are steady red. Try to update option board firmware. If situation is not resolved with the update, replacing the option board can help.

Node Flashing Test function

To determine to which device the station is directly connected, use the "Node Flashing Test" function.

For example, in Siemens S7, go to the menu command *PLC* > *Diagnostics/Setting* > *Node Flashing Test*.... If all 3 LEDs are flashing green, the station is directly connected to the PG/PC.

8.2 LED Indications with EtherNet/IP

The LED indications of the option board follow the CIP standard when the EtherNet/IP is set as the active protocol. The labels of the LEDs on the option board differ from the CIP definitions. Check the corresponding LED labels in the following tables.

Module Status LED

The Module status LED is labeled on the board as "BS". It shows the status of the module, that is, if a fault has occurred or if the module has been configured. The MS LED functionality is described in the following table.

Table 295: EtherNet/IP Module Status LED Functionality

CIP definition	LEDs	Description
MS		No power is supplied to the device.

CIP definition	LEDs	Description
		Device operational. The device is operating correctly. LED is green.
		Standby. The device has not been configured. The module status indicator is blinking green.
		Minor fault. The device has detected a recoverable minor fault and the module status indicator is blinking red.
		Major fault. The device has detected a non-recoverable major fault. LED is red.
		Self-test. The device is performing its power up testing and the module status indicator is blinking red and green.

Network Status LED

The Network status LED is labeled on the board as "RN". It shows the connectivity status of the device, that is, if there is a connection to the device, or the IP settings status. The NS LED functionality is described in the following table.

Table 296: EtherNet/IP Network Status LED Functionality

CIP definition	LEDs	Description
NS		Not powered, no IP address. The device is powered off, or is powered on but with no IP address configured (Interface Configuration attribute of the TCP/IP Interface Object).
		No connections. An IP address is configured, but no CIP connections are established, and an Exclusive Owner connection has not timed out. The network status indicator blinks green.
		Connected. At least one CIP connection (any transport class) is established, and an Exclusive Owner connection) has not timed out. LED is green.
		Connection timeout. An Exclusive Owner connection for which this device is the target has timed out. The LED returns to steady green only when all timed out Exclusive Owner connections are re-established. Timeout of connections other than Exclusive Owner connections do not the network status indicator to blink red.
		Duplicate IP. The device has detected that its IP address is already in use by another device in the network. LED is red.

CIP definition	LEDs	Description
	RN	Self-test. The device is performing its power-up testing and the network status indicator is blinking red and green.

I/O Indicator LED

IO Indicator LED is labeled on board as "ER". It shows the status of IO connection. This functionality was added in OPTE9 firmware V009 and in OPTEA firmware V002. The LED functionality is described in the following table.

Table 297: I/O Indicator LED Functionality

LEDs	Description
ER	I/O connection is not opened or it has been closed.
ER	I/O connection is open and in RUN state. LED is green.
ER	I/O connection is open but in IDLE state. LED is red.

8.3 PROFINET Alarm System

OPTEA and OPTE9 implement PROFINET alarm system where VACON® faults and alarms are seen on bus as PROFINET alarms. The alarms use module specific channel diagnostic and extended channel diagnostic data. The GSDML file contains a description and help texts for the alarms. Texts are in English and Finnish. Automation systems can use these texts to show helpful diagnostics to end users when there are faults.

The following figures show how Siemens TIA portal shows the diagnostics.

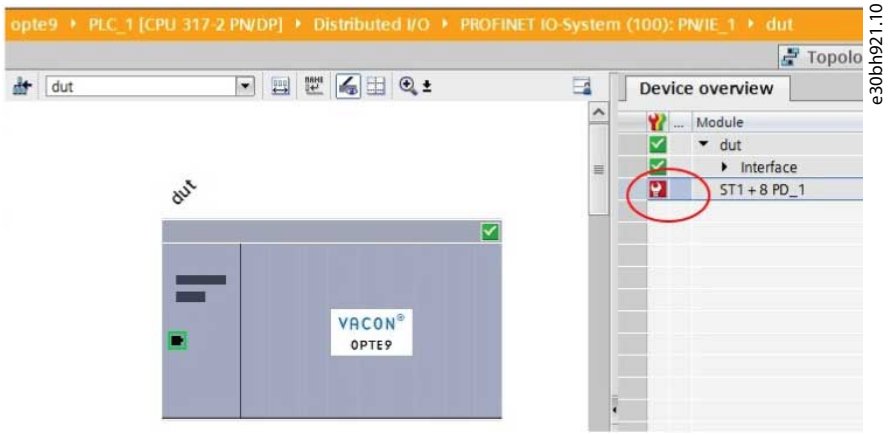


Illustration 32: Siemens TIA Portal - Alarm Indicator

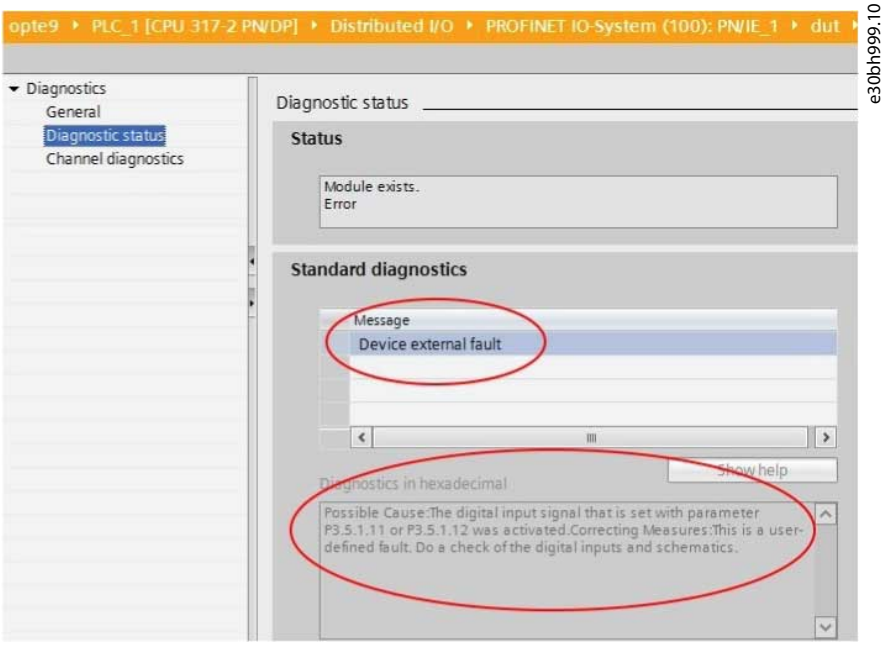


Illustration 33: Siemens TIA Portal - Alarm Description and Help Text

The VACON® data (faults, alarms, infos) mapped to PROFINET alarms is slightly different based on the used AC drive:

Table 298: VACON® Data in Different AC Drives

AC drive type	Fault	Alarm	Info
VACON® NXP/NXS	Yes	Yes	No
VACON® 100 family	Yes	Yes, from version: • FW0072V026(INDUSTRIAL) • FW0159V017(FLOW)	No
VACON® 20 family	Yes	No	No

Diagnostic messages are always sent from the PROFINET module (slot 1). Exception to this is that PROFIsafe diagnostics are sent from PROFIsafe module (slot 2).

Table 299: VACON® Fault Mapping to PROFINET Alarms

AC drive type	Channel Error	Extended Channel Error
VACON® NXP/NXS	1000 + fault code	Subcode
VACON® 100 family	2000 + fault code	Fault ID
VACON® 20 family	3000 + fault code	Subcode
PROFIsafe	4000 + fault code	Subcode

For example, the fieldbus timeout fault (Fault code 53) in different drives have the following channel error codes:

Table 300: Channel Error Codes for Fieldbus Timeout Fault

AC drive type	Channel Error	Extended Channel Error
VACON® NXP/NXS	1053	1
VACON® 100 family	2053	1053

AC drive type	Channel Error	Extended Channel Error
VACON® 20 family	3053	0

The customized applications can use customized fault IDs which are not described in the GSDML file. The PROFINET alarms are however generated for all faults that have a fault code between 0 and 1000.

8.4 Fault Handling

When the option board or the AC drive control diagnostics detect an unusual operating condition, the drive opens a notification, for example, on the keypad. The keypad shows:

- the ordinal number of the fault
- the fault code
- a short fault description.

The fault can be reset with the Reset button on the control panel, via the I/O terminal, or via the used fieldbus protocol.
The faults are stored in the Fault history menu, which can be browsed.

8.5 Gathering Diagnostic Data

This topic explains how to gather all the needed information for getting support in fault situation.

Procedure

1. Write down all the texts and codes on the keypad display.
2. Read the Drive Info (Service Info) File from the drive with PC-tool.

   - VACON® Live: connect to the drive and select from VACON® Live menu bar: Drive - > Service information…
   - NCDrive: connect to the drive and select from NCDrive menu bar: File -> Service Info…
3. If possible, also get fieldbus communication log from the fault situation if applicable.

   Table 301: Fieldbus Communication Log Tools

Recommended Tool	Fieldbus Option	Boards
Wireshark	Ethernet-based fieldbuses	OPTEA, OPTE9
ProfiTrace	PROFIBUS	OPTE3-E5
CANalyzer	CAN-based boards	OPTE6, OPTE7
4. Send the problem description together with the gathered files to the local distributor.

   For contact information, go to: www.danfoss.com/ -> Contact us -> Distributors. Select "Drives" as Business unit.

8.6 Typical Fault Conditions

Table 302: Typical Fieldbus Fault Conditions

Fault condition	Possible cause	Remedy
Cabling	Supply or motor cables are located too close to the fieldbus cable	
	Wrong type of fieldbus cable	
	Too long cabling	
Grounding	Inadequate grounding	Ensure grounding in all the points on the net
Connections	Faulty connections: Excessive stripping of cables	
	Faulty connections: Conductors in wrong terminals	

Fault condition	Possible cause	Remedy
	Faulty connections: Too loose connections of conductors	
Parameter	Faulty address	
	Overlapping slave addresses	
	Wrong control place selected	

8.7 Other Fault Conditions

The following fault tracing diagram helps to locate and fix some of the most usual problems. If the problem persists, contact your local distributor.

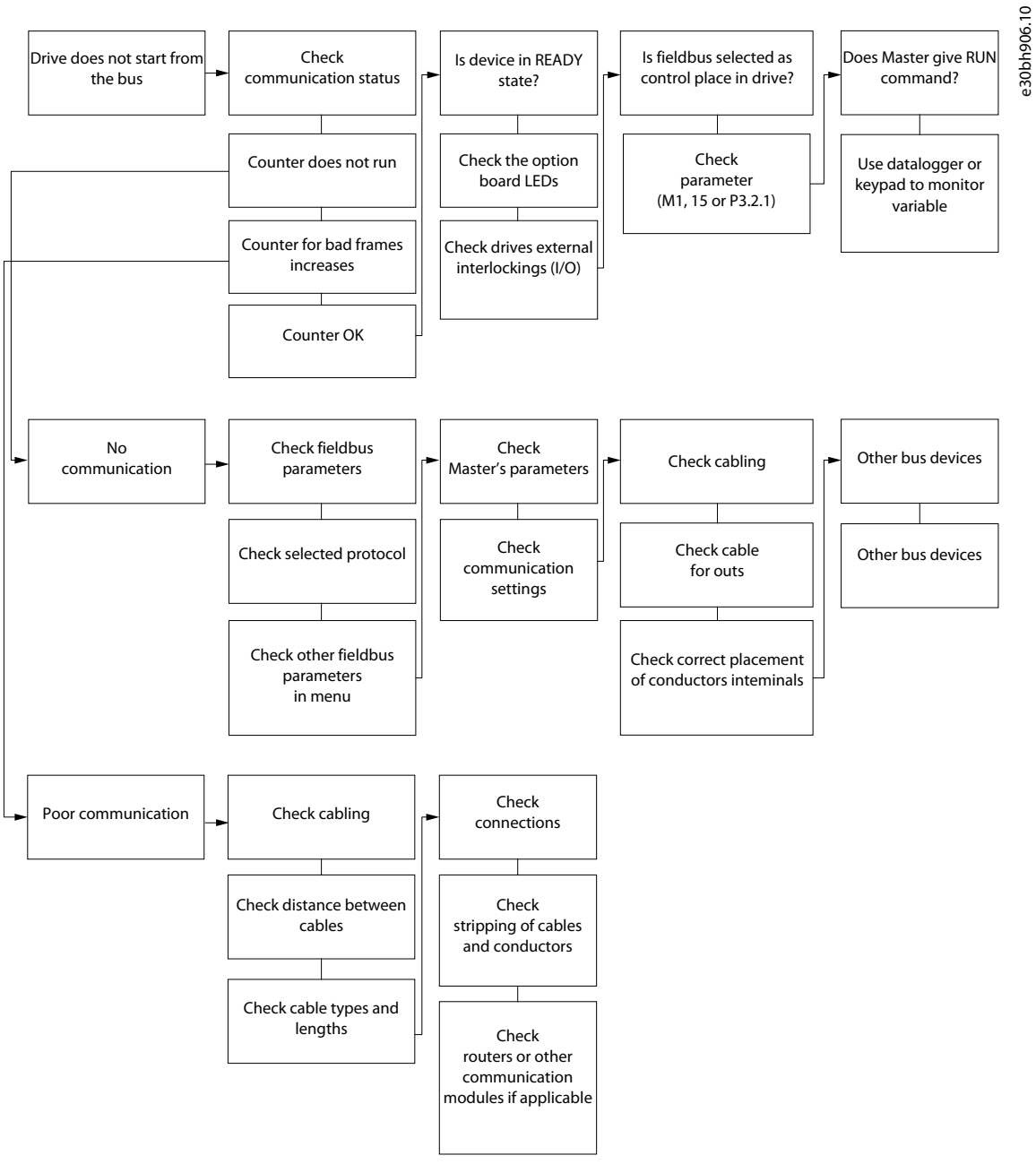


Illustration 34: Fault Tracing Diagram

8.8 Fieldbus Fault Codes

Option board can report only Fieldbus communications fault (F53). It does not identify what actually went wrong and why option board activated this fault. To that end, more information is now added to fault activation. Currently it works only with VACON® 100 family AC drives.

When a fieldbus fault (F53 specifically) activates in VACON® 100 family AC drive with default applications, the new information is added to the faults "source" fields, when the source fields are empty.

Table 303: Description of the Fault Fields

Fault field	Descriptions
Source 1	Activation source. Always "Control"
Source 2	Slot where option board is installed (slot D or slot E)
Source 3	Extra fault code

The following table contains "source 3" extra fault codes. Notice that all subcodes listed here are not applicable for all fieldbuses/ option boards.

Table 304: Extra Fault Codes

Fault code	Fault name	Description
1	I/O watchdog	I/O connection timeout noticed by watchdog
2	I/O master closed connection	I/O connection was closed (gracefully) by master
3	EM watchdog	Explicit messaging connection timeout noticed by watchdog
4	EM master closed connection	Explicit messaging connection was closed (gracefully) by master
5	Cable disconnected	Fieldbus cable was disconnected after communications had been started
6	Cable not connected	Fieldbus cable was not connected after device start-up
7	IOPS changed to BAD	PROFINET master data status changed from GOOD to BAD
8	Idle state activated	EtherNet/IP I/O connection status changed to IDLE when motor is controlled
9	Internal system fault	General fieldbus failure. For example, when converting speed reference to drive format
10	Too many bad messages	Fieldbus protocol has received too many bad messages in row and has closed the connection
11	CAN bus-off	CAN driver is in BUS-off state
12	CAN passive	CAN driver is in passive state
13	No external power	No external power (+24 V) detected
14	Heartbeat timeout	Heartbeat consumer timeout
15	Node guard timeout	Node guard timeout
16	PDO timeout	PDO timer event timeout
17	SNTP timeout	SNTP failed to get time update from time server
18	Ethercat state change fault	Ethercat state change fault
19	RDH timeout	PROFINET Redundant Data Hold Time elapsed

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