VACON® NX

AC DRIVES

OPTCQ

ETHERNET IP OPTION BOARD

USER MANUAL

VACON®

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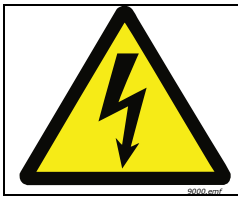
1. INTRODUCTION

The VACON® NX AC drive can be connected to Ethernet by using an EtherNet/IP fieldbus board OPTCQ. The OPTCQ is installed in the card slot D or E. EtherNet/IP™ is a trademark of ODVA, Inc

Every appliance connected to an Ethernet network has two identifiers; a MAC address and an IP address. The MAC address (Address format: 00:21:99:xx:yy:zz) is unique to the appliance and cannot be changed. The EtherNet/IP board's MAC address is found on the sticker attached to the board or by using the VACON® IP tool software NCIPConfig. VACON® PC software can be downloaded from http://drives.danfoss.com website.

In a local network, IP addresses can be defined by the user as long as all units connected to the network are given the same network portion of the address. For more information about IP addresses, contact your Network Administrator. Overlapping IP addresses cause conflicts between appliances. For more information about setting IP addresses, see Chapter 3.



DANGER! When the AC drive is connected to the power source, the internal components and circuit boards are at high potential. Coming into contact with this voltage can cause death or severe injury.

If you need further information related to EtherNet/IP, contact your local support. See local contacts: http://drives.danfoss.com/danfossdrives/local-contacts/.

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from http://drives.danfoss.com/knowledge-center/technical-documentation/.

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 http://drives.danfoss.com/knowledge-center/technical-documentation/.

2. ETHERNET/IP BOARD TECHNICAL DATA

2.1 Overview

Table 1. EtherNet/IP board technical data

General	Card Name	OPTCQ
Ethernet connections	Interface	RJ-45 connector
Communications	Transfer cable	Shielded Twisted Pair
	Speed	10 / 100 Mb
	Duplex	half / full
	IP address	Static IP or DHCP (firmware version dependent) V004 and newer: Default is DHCP V003 and older: Default is static IP 192.168.0.10
Protocols	EtherNet/IP	
Environment	Ambient operating temperature	-10°C...50°C
	Storing temperature	-40°C...70°C
	Humidity	<95%, no condensation allowed
	Altitude	Max. 1000 m
	Vibration	0.5 G at 9...200 Hz
Safety		Fulfils EN50178 standard

2.2 LED indications

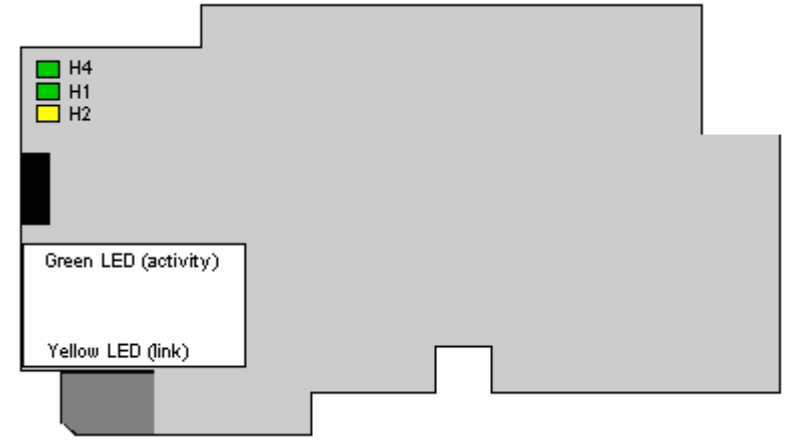


Figure 1.

Table 2. Meaning of the LED indications

LED	Meaning
H4	LED is ON when board is powered.
H1	Blinking 0.25s ON / 0.25s OFF when board firmware is corrupted (see Chapter 3.2). OFF when board is operational.
H2	Blinking 2.5s ON / 2.5s OFF when board is ready for external communication. OFF when board is not operational.

2.3 EtherNet/IP

EtherNet/IP is a member of a family of networks that implements the Common Industrial Protocol (CIP™) at its upper layers. CIP encompasses a comprehensive suite of messages and services for a variety of manufacturing automation applications, including control, safety, synchronization, motion, configuration and information. As a truly media-independent protocol that is supported by hundreds of vendors around the world, CIP provides users with a unified communication architecture throughout the manufacturing enterprise.

Common use-cases of Ethernet devices are 'human to machine' and 'machine to machine'. Basic features of these two use-cases are presented in Figures 2 and 3 below.

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

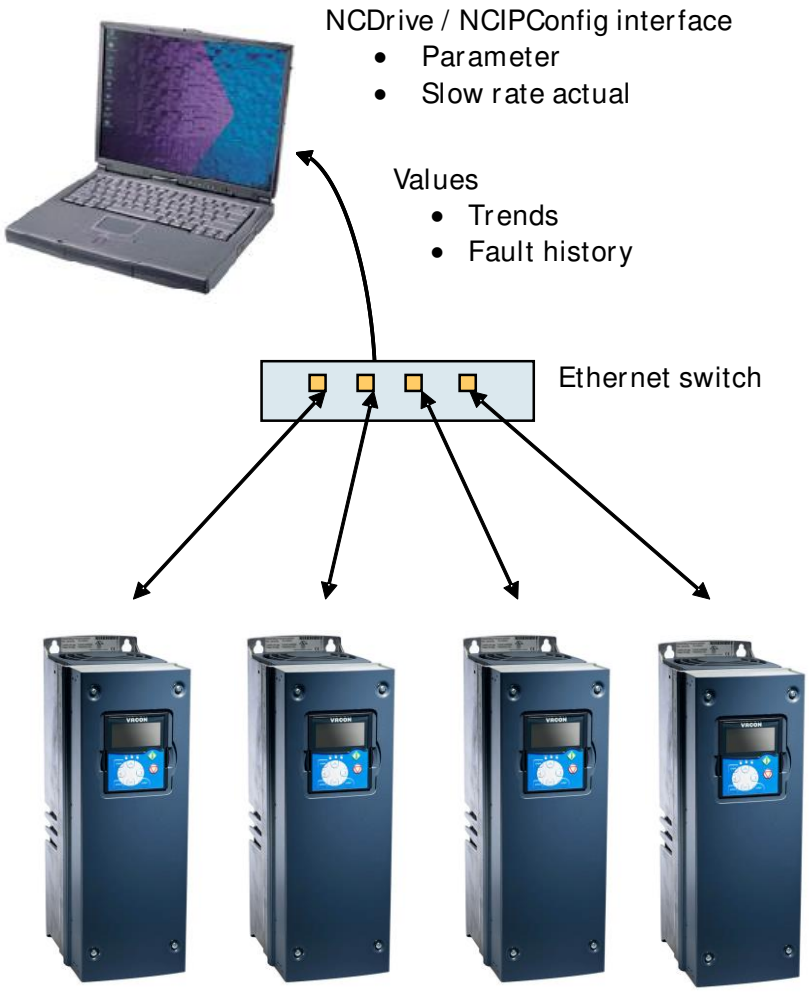


Figure 2. Human to machine (graphical user interface, relatively slow communication)

NOTE! The VACON® NCDrive can be used in VACON® NXS and NXP drives via Ethernet. In VACON® NXL drives this is not possible.

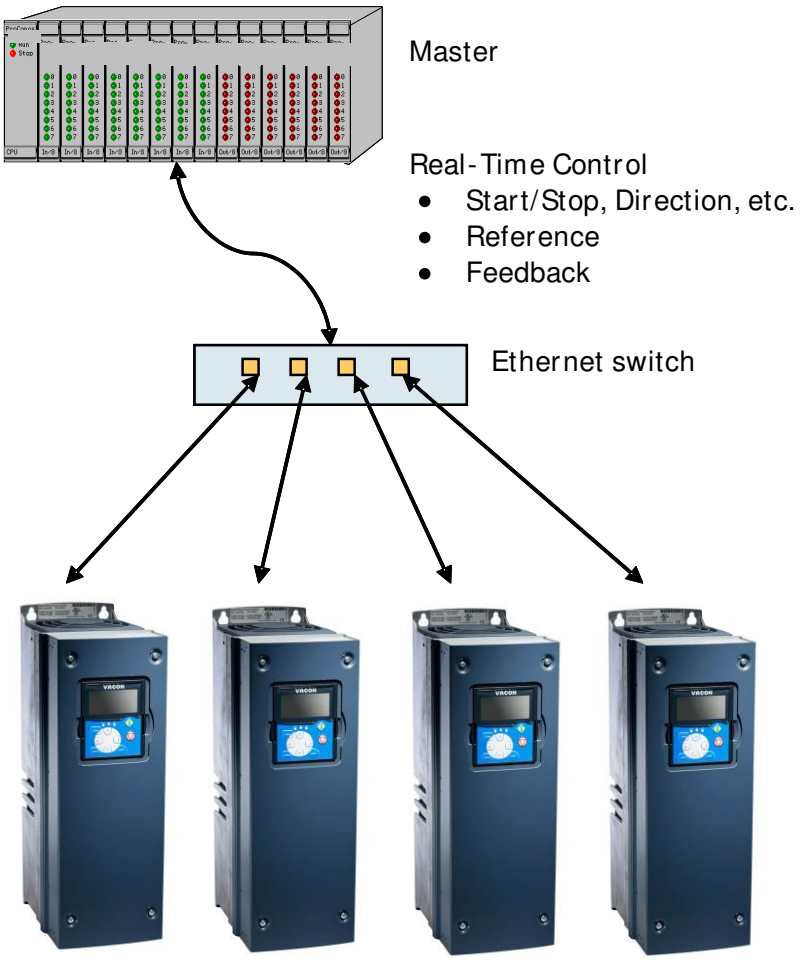


Figure 3. Machine to machine (industrial environment, fast communication)

2.4 Connections and wiring

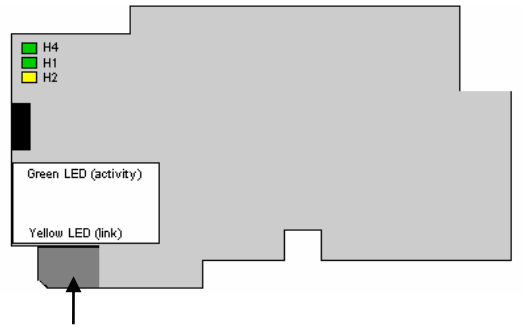
The EtherNet/IP board supports 10 and 100Mb speeds in both Full and Half-duplex modes. The boards must be connected to the Ethernet network with a shielded CAT-5e cable. Use a so-called crossover cable (at least CAT-5e cable with STP, Shielded Twisted Pair) if you want to connect the EtherNet/IP option board directly to the master appliance. Use only industrial standard components in the network and avoid complex structures to minimize the length of response time and the amount of incorrect dispatches.

3. INSTALLATION

3.1 Installing the EtherNet/IP option board in a VACON® NX unit

	CAUTION! Before an option or fieldbus board is changed or added, make sure that the AC drive is switched off.

1	The VACON® NX AC drive.	
2	Remove the cable cover.	
3	Open the cover of the control unit.	

4	Install EtherNet/IP option board in slot D or E on the control board of the AC drive. Make sure that the grounding plate (see below) fits tightly in the clamp. 	
5	Make an opening for your cable by cutting the grid as wide as necessary.	
6	Close the cover of the control unit and the cable cover.	

3.2 NCDrive

The VACON® NCDrive software can be used with the EtherNet/IP board in VACON® NXS and NXP drives. However, it does not work with with NXL drives.

It is recommended that you use the VACON® NCDrive software only in LAN (Local Area Network).

NOTE! If an OPTCQ Ethernet option board is used for an NC Tools connection, like VACON® NCDrive, the OPT-D3 board cannot be used.

NCLoad does not work via Ethernet. See VACON® NCDrive Help for further information.

3.3 IP tool NCIPConfig

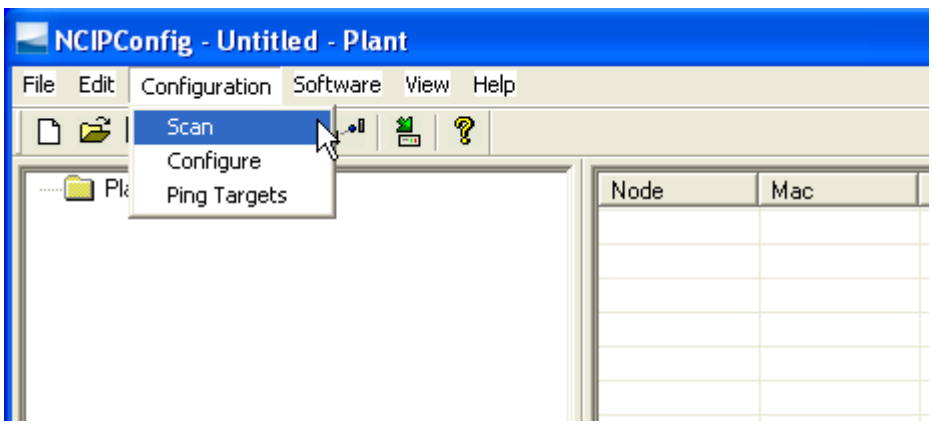
To start using the VACON® EtherNet/IP board, the IP address must be correctly configured. The OPTCQ board has static IP as default (firmware V003 and older) or DHCP as default (firmware V004 or newer).

If static IP is used, the correct IP address must be set before connecting the board to the network. If DHCP is used, the board can be connected to the network, and when there is a DHCP server in the network, the OPTCQ board will obtain its IP address from the DHCP server.

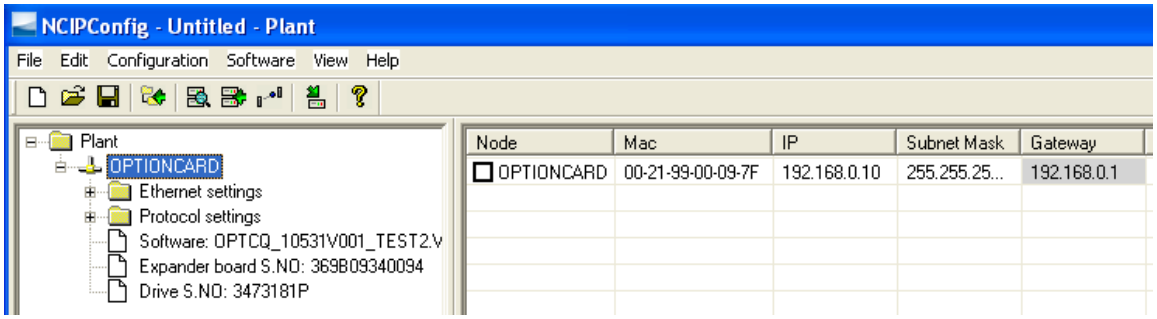
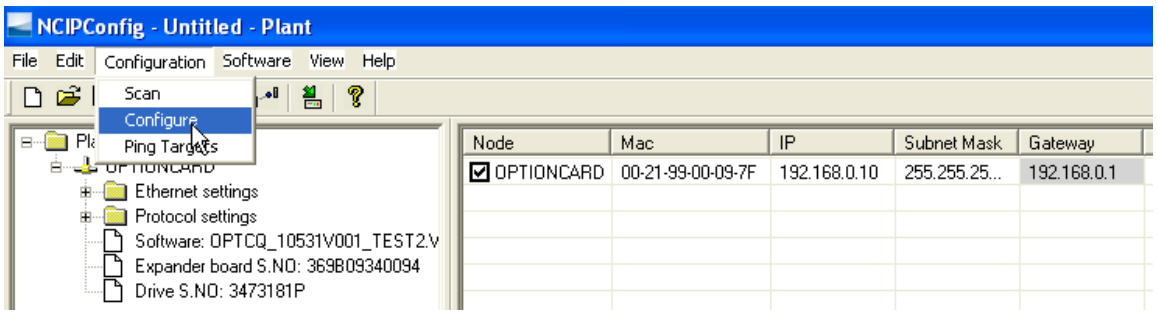
You need a PC with an Ethernet connection and the NCIPConfig tool installed to set the EtherNet/IP board's IP addresses. To install the NCIPConfig tool, start the installation program from CD or download it from the http://drives.danfoss.com website. After starting the installation program, follow the on-screen instructions.

When the program is installed successfully, launch it by selecting it in the Windows Start menu. Follow these instructions to set the IP addresses. Select *Help --> Manual* if you want more information about the software features.

1	Connect your PC to the Ethernet network with an Ethernet cable. You can also connect the PC directly to the device using a crossover cable. This option may be needed if your PC does not support the Automatic crossover function.

2	Scan the network nodes. Select *Configuration --> Scan* and wait until the devices connected to the bus in the tree structure are displayed to the left of the screen. 

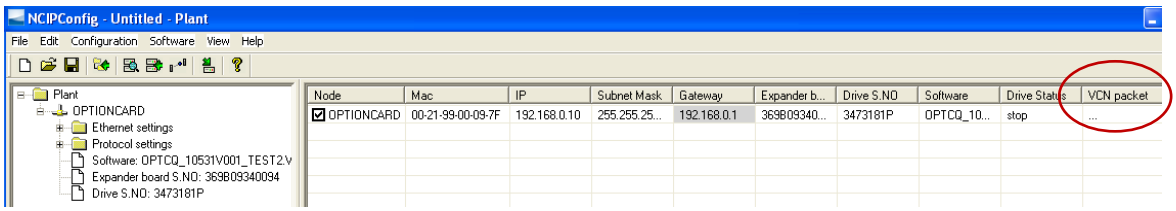
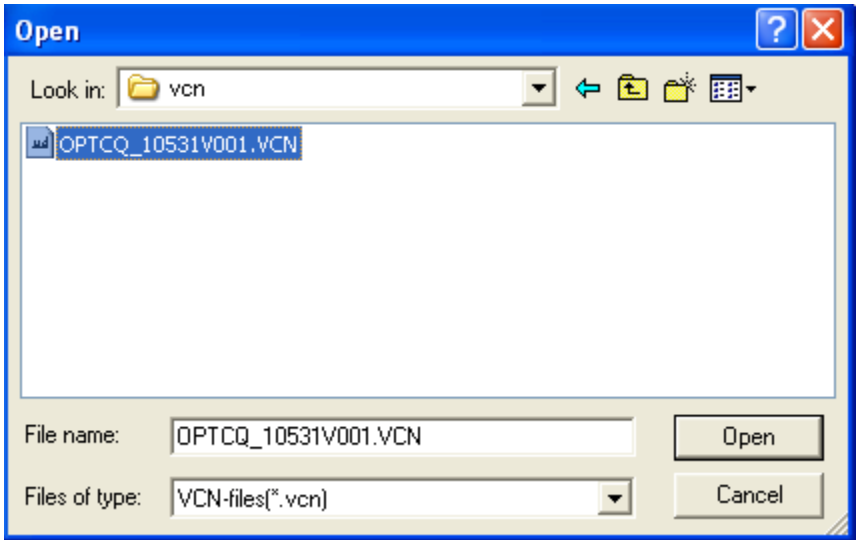
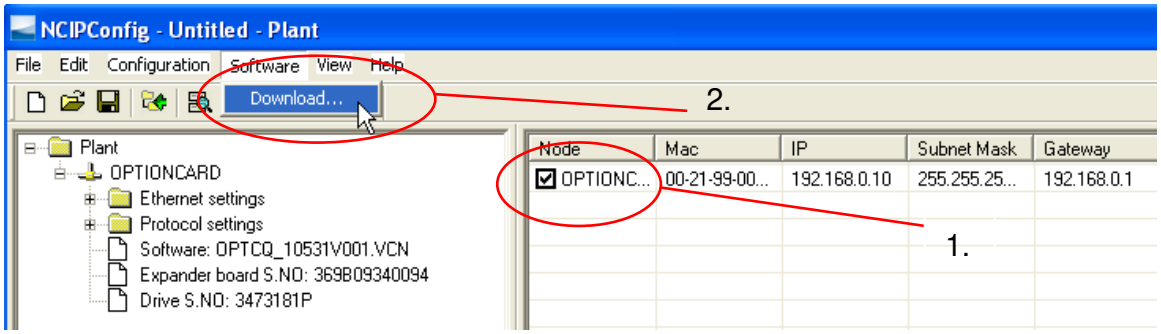
NOTE! Some switches block broadcast messages. In this case, each network node must be scanned separately. Read the manual under Help menu.

3	Set the IP addresses. Change the node's IP settings according to the network IP settings. The program reports conflicts with a red colour in a table cell. Read the manual under *Help* menu. 
4	Send configuration to boards. In the table view, tick the boxes for boards whose configuration you want to send. Select *Configuration*, then *Configure*. Your changes are sent to the network and will be valid immediately. 

NOTE! Only the symbols **A-Z, a-z and 0-9** can be used in the drive name. Do not use special characters or Scandinavian letters (ä, ö, etc.). The drive name can be freely formed using the allowed characters.

3.3.1 Updating the OPTCQ option board program with the NCIPConfig tool

In some cases it may be necessary to update the option board's firmware. Differing from other VACON® option boards, the EtherNet/IP option board's firmware is updated with the VACON® NCIPConfig tool. The IP addresses of the PC and the option board must be in the same area when the software is loaded.

1	To start the firmware update, scan the nodes in the network according to the instructions in Chapter 7. When you can see all nodes in the view, update the new firmware by clicking the **VCN packet** field on the right in the table view of VACON® NCIPConfig. 
2	Choose a new firmware packet in the window that opens. 
3	Tick the new firmware packet's box in the **VCN Packet** field at the right corner of the table view. Select all nodes to be updated by ticking the boxes. Send the new firmware to the board by selecting *Software --> Download*. 

NOTE! Do not do a power up cycle within 1 minute after downloading the option board software. This can cause the option board to go to Safe Mode. This situation can only be solved by re-downloading the software. The Safe Mode triggers a fault code (F54). The Board slot error F54 can also appear due to a faulty board, a temporary malfunction of the board or a disturbance in the environment.

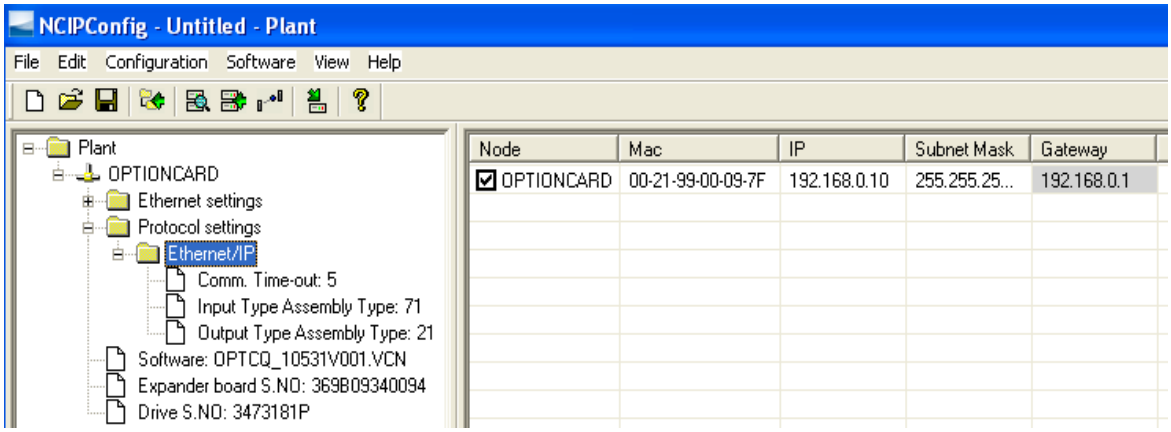
NOTE! If the OPTCQ board firmware is updated from V003 (or older) to V004 (or newer), the static IP address assigned to the board will remain after the update. To activate the DHCP mode manually, see Chapter 4.

3.4 Configuring the option board parameters

These features are available in the VACON® NCIPConfig tool version 1.6.

1	In the tree-view, expand the folders until you reach the board parameters.

2	Slowly double-click the parameter (*Comm. Time-out* in the figure below) and enter a new value. When the modification is complete, the new parameter values are automatically sent to the option board.



NOTE! If the fieldbus cable is broken or removed, a fieldbus error is generated. Reset the fault by checking the installation. If the installation is correct, contact your local contacts. See VACON® NX All in One Application Manual for resetting faults.

4. COMMISSIONING

The VACON® EtherNet/IP board is commissioned with the control keypad by giving values to appropriate parameters in menu M7 (or with the VACON® NCIPConfig tool, see Chapter 3.3). Keypad commissioning is only possible with the VACON® NXP and NXS type AC drives. The VACON® NXL AC drives require the VACON® NCIPConfig tool.

In the Expander board menu (M7) you can see which expander boards are connected to the control board. You can also edit the parameters associated with the expander board.

1	Enter the following menu level (G#) with the arrow button right. Browse through slots A to E with the arrow buttons up/down to see which expander boards are connected.
2	On the last line of the display, you see the number of parameter groups associated with the board. Press the arrow button right once more to reach the parameter group level where there is only one group in the EtherNet/IP board case: Parameters.
3	To go to Parameter group, press the arrow button right again.

Table 1. EtherNet/IP monitoring values

No	Name	Description
1	Speed/duplex	See chapter 4.1 for details.

Table 2. EtherNet/IP parameters

No	Name	Default	Range	Description
1	Comm. Timeout	0	0...255 s	0 = RPI (Requested Packet Interval) x CTM (Connection Timeout Multiplier)
2	IP Part 1	192	1...223	IP Address Part 1
3	IP Part 2	168	0...255	IP Address Part 2
4	IP Part 3	0	0...255	IP Address Part 3
5	IP Part 4	10	0...255	IP Address Part 4
6	SubNet Part 1	255	0...255	Subnet Mask Part 1
7	SubNet Part 2	255	0...255	Subnet Mask Part 2
8	SubNet Part 3	0	0...255	Subnet Mask Part 3
9	SubNet Part 4	0	0...255	Subnet Mask Part 4
10	DefGW Part 1	192	0...255	Default Gateway Part 1
11	DefGW Part 2	168	0...255	Default Gateway Part 2
12	DefGW Part 3	0	0...255	Default Gateway Part 3
13	DefGW Part 4	1	0...255	Default Gateway Part 4
14	OutputAssembly	21	0...255	See Chapter 7
15	InputAssembly	71	0...255	See Chapter 7
16	Speed/duplex	Autoneg.	-	Speed and duplex of the Ethernet port. See chapter 4.1 for details.

NOTE! The default value of parameter 1 is 0 in firmware versions V004 and newer. In earlier versions the default value is 10 seconds.

NOTE! The default value of parameters 2-13 is 0 in firmware versions V004 and newer, because DHCP is enabled by default.

4.1 Speed and duplex

Speed and duplex parameter can be used to set Ethernet port to use specific value, but it is recommended that auto-negotiation is always used. Possible values are listed in table below.

No	Name	Description
1	autoneg.	Ethernet port speed and duplex is detected automatically
2	10M HD	10 Mb half duplex
3	10M FD	10 Mb full duplex
4	100M HD	100 Mb half duplex
5	100M FD	100 Mb full duplex

Monitoring view shows current speed and duplex of the Ethernet port. If there is no connection then value is "undefined". Possible values are listed in table below.

No	Name	Description
1	undefined	Ethernet port is not up. Speed and duplex have not been detected.
2	10M HD	10 Mb half duplex
3	10M FD	10 Mb full duplex
4	100M HD	100 Mb half duplex
5	100M FD	100 Mb full duplex

4.2 IP address

The IP address is divided into four octets. The value is 0.0.0.0 when DHCP is used until the board has been assigned an IP address. A static IP address is entered by editing the parameters from the keypad or using NCIPConfig. This disables DHCP mode.

When the board has static IP, and the IP address is changed to *.0.0.0 through VACON® NCIPConfig or the keypad, then DHCP mode will be re-enabled after the next power-up.

Changing the IP address to *.255.255.255 causes the board to change to static IP address 192.168.0.10 after the next power-up.

4.3 Communication timeout

With firmware version V004 or newer, when this parameter is assigned the value 0, the communication timeout is the value of the Requested Packet Interval (RPI) multiplied with the Connection Timeout Multiplier (CTM) as defined in the EtherNet/IP master. RPI for the OPTCQ board is at minimum 16 milliseconds. If a value other than 0 is used as the communication timeout, this means the total time (in seconds) including the RPI x CTM timeout. If communication with the EtherNet/IP master device is inactive for a period longer than the defined communication timeout, the drive generates a fieldbus fault.

With firmware version V003 or older, when this parameter is assigned the value 0, the communication timeout is disabled. In this case a fieldbus fault is generated only if the Ethernet link is lost (for example, if the cable is disconnected). You can change the Communication timeout value from the keypad or with the VACON® NCIPConfig tool. See Chapter 3.3.

NOTE! If the fieldbus cable is broken or removed, a fieldbus error is generated. Reset the fault by checking the installation. If the installation is correct, contact your local contacts. See VACON® NX All in One Application Manual for resetting faults.

4.4 Input/Output assemblies

The I/O assemblies are changed in the keypad, through VACON® NCIPConfig, or in the EtherNet/IP master. The same assembly must be selected in both the drive and the EtherNet/IP master. The configuration assembly for the OPTCQ board must be set to 1 in the EtherNet/IP master.

All EtherNet/IP parameters are saved to the EtherNet/IP board (not to the control board). If the new EtherNet/IP board is changed into the control board, you must configure the new EtherNet/IP board. The option board parameters can be saved to the keypad, with the VACON® NCIPConfig tool or with VACON® NCDrive.

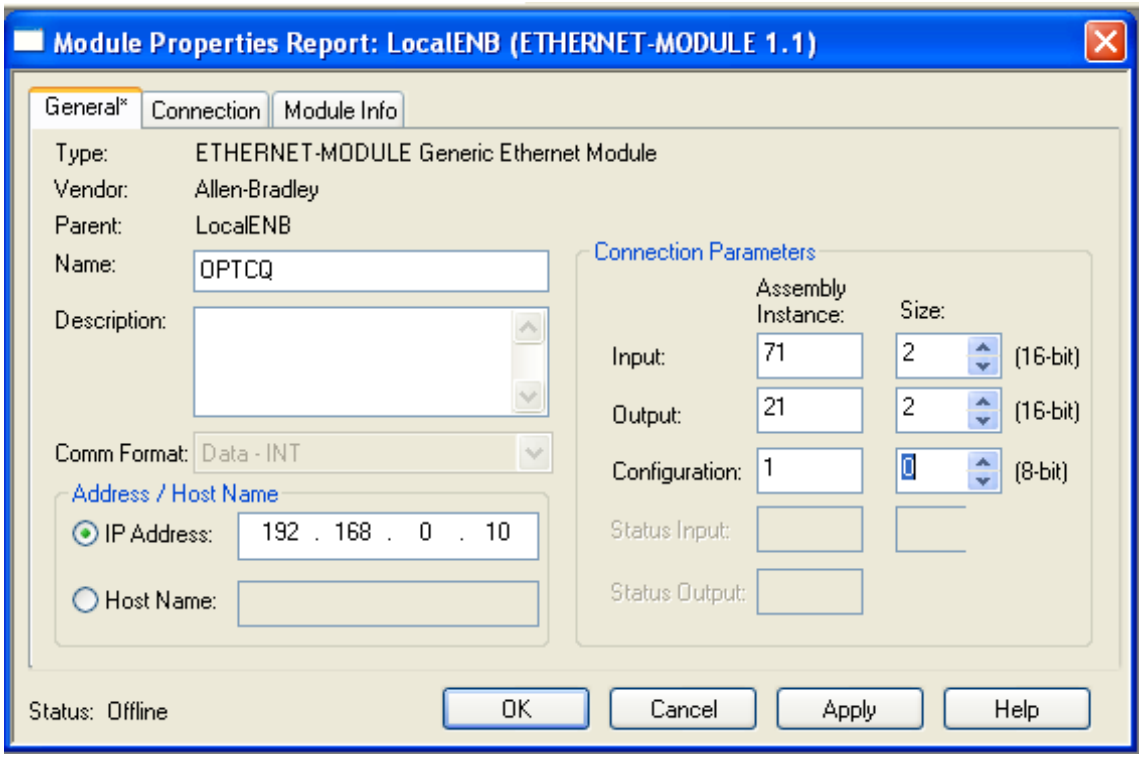


Figure 4. Configuration example from Rockwell PLC.

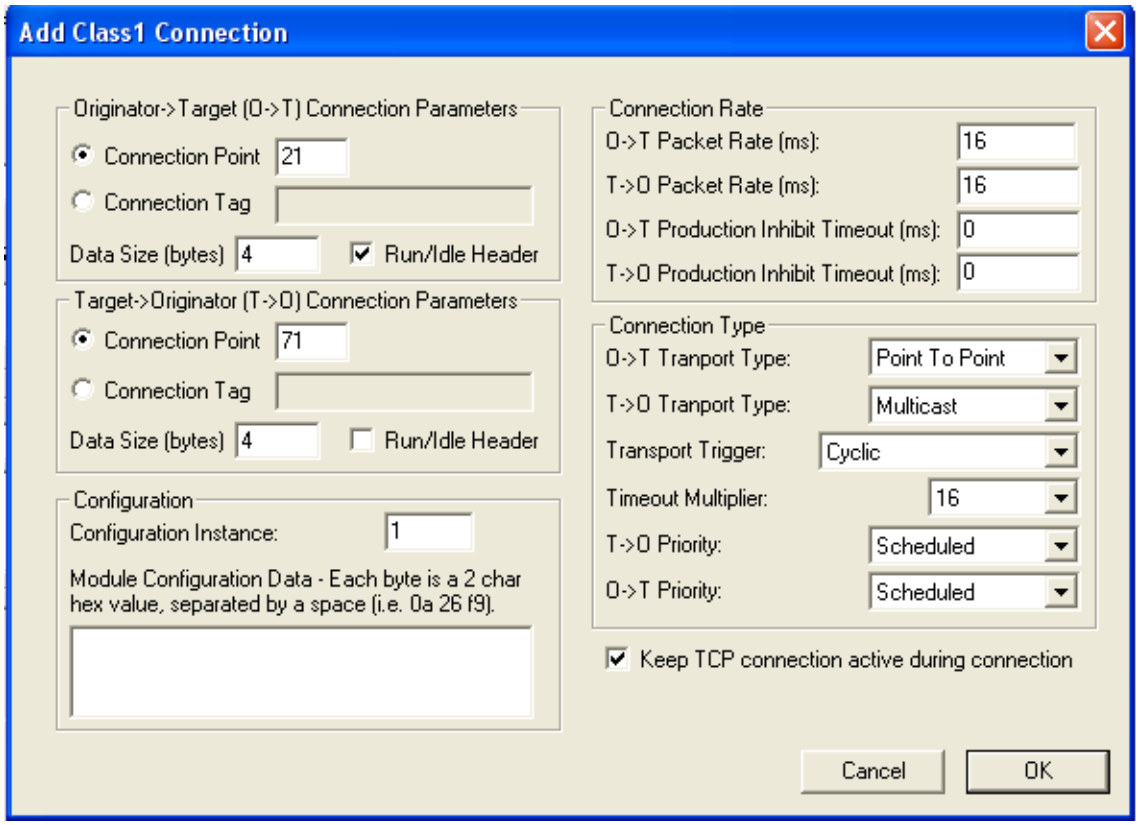


Figure 5. Configuration example from EIPScan tool.

5. ETHERNET/IP

5.1 Overview

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

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

EtherNet/IP Messaging Forms:

- Unconnected Messaging is used for connection establishment and for infrequent, low-priority messages.
- Connected Messaging uses resources that 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 TCP protocol.
- Implicit (I/O Data) Connections are established to transfer 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 UDP protocol.

5.2 AC/DC drive profile

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

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

This information is called the device profile.

5.3 EDS file

The Electronic Data Sheet (EDS) is a specially formatted ASCII text file that contains configuration data for specific device types. The EDS provides information about the context, content and format of the device configuration data.

The information in the EDS allows configuration tools to provide informative screens that guide you through the steps that are needed to configure a device.

The EDS provides all of the information necessary to access and alter the configurable parameters of a device. This information matches the information provided by instances of the Parameter Object Class. The CIP Object Library describes the Parameter Object Class in detail.

5.4 Explicit messaging

Explicit Messaging is used in commissioning and parametrising of the EtherNet/IP board. 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. Explicit messages typically use low priority identifiers and contain the specific meaning of the message right in the data field. This includes the service to be performed and the specific object attribute address.

NOTE! If Class 1 connection (cyclic data) has been established, Explicit Messages cannot be used to control Output Data. However, this restriction does not apply for I/O Data reading.

5.4.1 List of object classes

The Communication Interface supports the following object classes:

Table 3.

Class	Object
0x01	Identity Objects
0x04	Assembly Object
0x06	Connection Manager Object
0x28	Motor Data Object
0x29	Control Supervisor Object
0x2A	AC/DC Drive Object
0xA0	Vendor Parameters Object
0xBE	Assembly Instance Selector Object
0xF5	TCP/IP Interface Object
0xF6	Ethernet Link Object

5.4.2 List of services

The services supported by the object classes in Table 4 are shown below.

Table 4.

Service Code (in hex)	Service Name	Identity object		Connection manager		TCP/IP interface		Ethernet link		Assembly		Motor Data		Control Supervisor		AC/DC Drive		Vendor parameter		Assemly instance selector	
		Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst	Class	Inst
01	Get_Attributes_All		Y	Y	Y	Y	Y	Y													
05	Reset (Type 0)		Y												Y						
0E	Get_Attribute_Single	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y		Y		Y		Y		Y
10	Set_Attribute_Single						Y				Y		Y		Y		Y		Y		Y
4E	Forward Close				Y																
52	Unconnected_Send				Y																
54	Forward_Open				Y																

See Chapter 6 for the Interface Object profiles.

5.4.3 List of data types

The attribute list that follows includes information on the Data Type of each attribute. The following tables explain the Data, Structure, and Array Type codes used in the Data Type column.

Table 5. Elementary Data Types

Data Type Name	Data Type Code (in hex)	Data Type Description
BOOL	C1	Logical Boolean with values TRUE and FALSE
SINT	C2	Signed 8-bit integer value
INT	C3	Signed 16-bit integer value
USINT	C6	Unsigned 8-bit integer value
UINT	C7	Unsigned 16-bit integer value
UDINT	C8	Unsigned 32-bit integer value
BYTE	D1	Bit string - 8 bits
WORD	D2	Bit string - 16 bits
SHORT_STRING	DA	Character string (1 byte per character, 1 byte length indicator)

Table 6. Constructed Data Types

Type Code	Description
A1	Abbreviated array type encoding
A2	Formal structure type encoding

5.4.4 Reset service

The following table lists the different types of resets supported by the Identity Object. Resetting the OPTCQ interface to its out-of-box configuration sets all the attributes to their default values. It also changes the response of the drive to a loss of communications with the OPTCQ. The device has to be re-configured for your application before resuming normal operation.

Table 7.

Value	Type of Reset
0	Emulate as closely as possible the cycling of power to the OPTCQ EtherNet/IP Interface. This value is the default if this parameter is omitted. The VACON® AC drive stops if it is running.

6. COMMON INDUSTRIAL OBJECTS IMPLEMENTED BY THE OPTION BOARD

6.1 Common required objects of the CIP

6.1.1 Identity object, class 0x01

Table 8.

Class Attributes				
Id	Description	Data Type	Access Rule	
01h	Revision		Get	
02h	Max Instances	UINT	Get	
Class Services				
Id	Service			
0Eh	Get_Attribute_Single			
Instance Attributes				
Id	Description	Data Type	Access Rule	
01h	Vendor ID	UINT	Get	
02h	Device Type	UINT	Get	
03h	Product Code	UINT	Get	
04h	Revision	STRUCT of:	Get	
	Major Revision	USINT		
	Minor Revision	USINT		
05h	Status	WORD	Get	Byte struct: (Bit's meaning when True) Bit0 = Owned Bit2 = Configured Bit8 = Minor Revocerable fault Bit9 = Minor Unrecovable fault Bit10 = Major Recoverable fault Bit11 = Major Unrecoverable fault Bit4 – 7: 0011 = No I/O connection established 0110 = At least one I/O connection in run mode
06h	Serial Number	UDINT	Get	
07h	Product Name	SHORT_ STRING	Get	
Instance Services				
Id	Service			
01h	Get_Attributes_All			
05h	Reset*			
0Eh	Get_Attribute_Single			

*Only reset type 0 – reset of the Option Board

6.1.2 Connection manager object, class 0x06

Table 9.

Class Attributes				
Id	Description	Data Type	Access Rule	
01h	Revision		Get	
02h	Max Instance		Get	
Class Services				
Id	Service			
01h	Get_Attributes_All			
0Eh	Get_Attribute_Single			
Instance Attributes				
Id	Description	Data Type	Access Rule	
01h	Open Requests	UINT	Get	
02h	Open Format Rejects	UINT	Get	
03h	Open Resource Rejects	UINT	Get	
04h	Open Other Rejects	UINT	Get	
05h	Close Requests	UINT	Get	
06h	Close Format Requests	UINT	Get	
07h	Close Other Requests	UINT	Get	
08h	Connection Timeouts	UINT	Get	
Instance Services				
Id	Service			
01h	Get_Attributes_All			
0Eh	Get_Attribute_Single			
4Eh	Forward Close			
52h	Unconnected_Send			
54h	Forward_Open	RPI = Requested Packet Intervall, minimum time is 16ms		

6.1.3 TCP/IP interface object, class 0xF5

Table 10.

Class Attributes				
Id	Description	Data Type	Access Rule	
01h	Revision		Get	
02h	Max Instance	UINT	Get	
Class Services				
Id	Service			
01h	Get_Attributes_All			
0Eh	Get_Attribute_Single			
Instance Attributes				
Id	Description	Data Type	Access Rule	
01h	Status	DWORD	Get	
02h	Configuration Capability	DWORD	Get	
03h	Configuration Control	DWORD	Get / Set	
04h	Physical Link	STRUCT of:	Get	
	Path Size	UINT		
	Path	Padded EPATH		
05h	Interface Configuration	STRUCT of:	Get / Set	
	IP Address	UDINT		
	Network Mask	UDINT		
	Gateway Address	UDINT		
	Name Server	UDINT		
	Name Server 2	UDINT		
	Domain Name	STRING		
06h	Host Name	STRING	Get / Set	
Instance Services				
Id	Service			
01h	Get_Attributes_All			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			

Attribute Configuration Control supports only the value 0 (device is using configuration values that are stored in non-volatile memory).

Attribute Host Name is used only for information purposes.

6.1.4 Ethernet link object, class 0xF6

Table 11.

Class Attributes				
Id	Description	Data Type	Access Rule	
01h	Revision	UINT	Get	
02h	Max Instance	UINT	Get	
03h	Number of Instances	UINT	Get	
Class Services				
Id	Service			
01h	Get_Attributes_All			
0Eh	Get_Attribute_Single			
Instance Attributes				
Id	Description	Data Type	Access Rule	
01h	Interface Speed	UDINT	Get	
02h	Interface Flags	DWORD	Get	
03h	Physical Address	ARRAY of 6 USINTs	Get	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			

6.2 Objects present in an AC/DC drive

6.2.1 Assembly object, class 0x04

Table 12.

Class Attributes				
Id	Description		Access Rule	
NOT SUPPORTED				
Class Services				
Id	Service			
NOT SUPPORTED				
Instance Attributes				
Id	Description	Data Type	Access Rule	
03h	Data	ARRAY of BYTE	Get / Set	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			

6.2.2 Motor data object, class 0x28

Table 13.

Class Attributes				
Id	Description	Access Rule		
NOT SUPPORTED				
Class Services				
Id	Service		Requirements	
NOT SUPPORTED				
Instance Attributes				
Id	Description	Data Type	Access Rule	
03h	Motor Type	USINT	Get	
06h	Rated Current	UINT	Get / Set	
07h	Rated Voltage	UINT	Get / Set	
09h	Rated Frequency	UINT	Get / Set	
0Ch	Pole Count	UINT	Get	
0Fh	Base Speed	UINT	Get / Set	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			

6.2.3 Control supervisor object, class 0x29

Table 14.

Class Attributes				
Id	Description		Access Rule	
NOT SUPPORTED				
Class Services				
Id	Service		Requirements	
NOT SUPPORTED				
Instance Attributes				
Id	Description	Data Type	Access Rule	
03h	Run1	BOOL	Get / Set	
04h	Run2	BOOL	Get / Set	
05h	NetCtrl *	BOOL	Get / Set	
06h	State	USINT	Get	
07h	Running1	BOOL	Get	
08h	Running2	BOOL	Get	
09h	Ready	BOOL	Get	
0Ah	Faulted	BOOL	Get	
0Bh	Warning	BOOL	Get	
0Ch	FaultRst	BOOL	Get / Set	
0Fh	CtrlFromNet**	BOOL	Get	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			
05h	Reset			

* Network Control (When Bit is set to 1 and control place is fieldbus, the drive gets control from the network).
NOTE! Does not force the drive to fieldbus control.
** Indicates the status of NetCtrl.

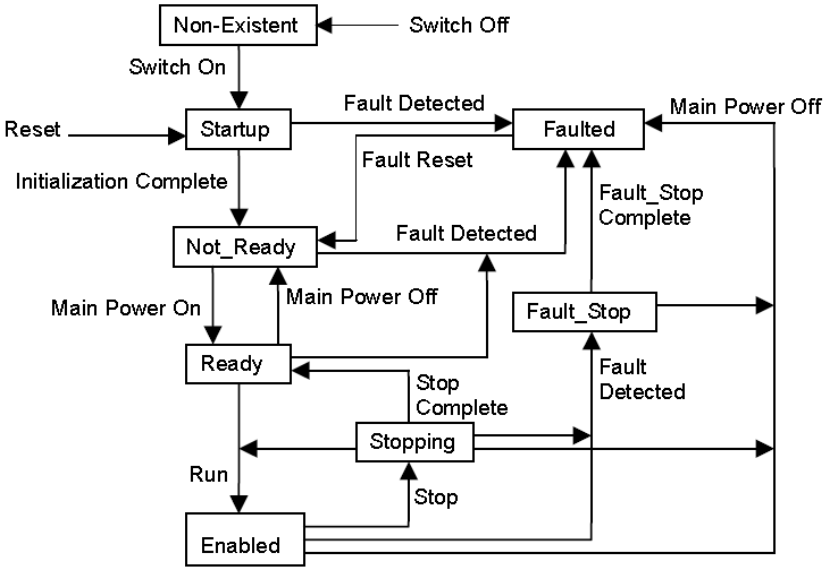


Figure 6. When both Run attributes (Run1 & Run2) are set, no action is taken.

6.2.4 AC/DC drive object, class 0x2A

Table 15.

Class Attributes				
Id	Description		Access Rule	
NOT SUPPORTED				
Class Services				
Id	Service			
NOT SUPPORTED				
Instance Attributes				
Id	Description	Data Type	Access Rule	
03h	AtReference	BOOL	Get	
04h	NetRef*	BOOL	Get / Set	
05h	NetProc**	BOOL	Get / Set	
06h	DriveMode	USINT	Get / Set	
07h	SpeedActual	INT	Get	
08h	SpeedRef	INT	Get / Set	
0Bh	TorqueActual	INT	Get	
0Ch	TorqueRef	INT	Get / Set	
0Dh	ProcessActual	INT	Get	
0Eh	ProcessRef	INT	Get / Set	
1Dh	RefFromNet***	BOOL	Get	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			

* Network Reference (When Bit is 1 and control place is fieldbus, the drive gets reference from the network).
** Network Process (used to write process reference)

- When Netproc = 1 & Drive mode = 0 (Vendor-specific), Process Reference is sent to the Drive as Process Data 1
- When Netproc = 1 & Drive mode = 4 (Process Control), Process Reference is sent to the Drive as Process Data 2
- When NetProc = 0, Process Reference must fail.

*** Indicates the status of NetRef.

6.3 Vendor-specific objects

6.3.1 Vendor parameter object, class 0xA0

Vendor Parameter Object is used to get access to the drive parameters. Because drive parameters are identified by a 16-bit ID number, it is impossible to use only an Attribute ID, which is 8 bits in length. To overcome this issue the following method is used to calculate the requested Drive Parameter ID:

Drive Parameter ID = Instance ID (Higher Byte) + Attribute ID (Lower Byte).

Table 16.

Class Attributes			
Id	Description	Access Rule	
NOT SUPPORTED			
Class Services			
Id	Service		
NOT SUPPORTED			
Instance Attributes			
Id	Description	Access Rule	
LOWER BYTE OF THE PARAMETER ID			
Instance Services			
Id	Service		
0Eh	Get_Attribute_Single		
10h	Set_Attribute_Single		

6.3.2 Assembly instance selector object, class 0xBE

Table 17.

Class Attributes				
Id	Description		Access Rule	
NOT SUPPORTED				
Class Services				
Id	Service			
NOT SUPPORTED				
Instance Attributes				
Id	Description	Data Type	Access Rule	
03h	InputInstance	USINT	Get / Set	
04h	OutputInstance	USINT	Get / Set	
Instance Services				
Id	Service			
0Eh	Get_Attribute_Single			
10h	Set_Attribute_Single			

7. ASSEMBLY INSTANCES IMPLEMENTED BY THE OPTION BOARD

7.1 Output instances

The output instances of the drive are the following:

- Assemblys 20-25 ODVA AC/DC Profile
- Assemblys 71-75 ODVA AC/DC Profile
- Assemblys 100-> Vacon Profile.

7.1.1 Assembly instance 20

Table 18.

Instance 20 (Output) Length = 4 Bytes								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						FaultReset		RunFwd
1								
2	Speed Reference (Low Byte), rpm							
3	Speed Reference (High Byte), rpm							

7.1.2 Assembly instance 21 (default)

Table 19.

Instance 21 (Output) Length = 4 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	NetCtrl			FaultReset	RunRev	RunFwd
1								
2	Speed Reference (Low Byte), rpm							
3	Speed Reference (High Byte), rpm							

7.1.3 Assembly instance 23

Table 20.

Instance 23 (Output) Length = 6 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	NetCtrl			FaultReset	RunRev	RunFwd
1								
2	Speed Reference (Low Byte), rpm							
3	Speed Reference (High Byte), rpm							
4	Torque Reference (Low Byte), Nm							
5	Torque Reference (High Byte), Nm							

Torque Reference is not sent to the drive if Motor Control Mode (Parameter ID 600) is set to values other than:

- 2 – Torque Control
- 4 – Closed Loop Torque Control.

Torque Reference is sent to the drive as a Process Data 1.

NOTE! Torque reference is not functional in NXL.

7.1.4 Assembly instance 25

Table 21.

Instance 25 (Output) Length = 6 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	NetProc	NetRef	NetCtrl			FaultReset	RunRev	RunFwd
1	Drive Mode							
2	Speed Reference (Low Byte), rpm							
3	Speed Reference (High Byte, rpm							
4	Process Reference (Low Byte)							
5	Process Reference (High Byte)							

The following drive modes are supported:

- 0 (Vendor-specific) – Process Reference is sent to the drive as Process Data 1.
- 4 (Process Control) – Process Reference is sent to the drive as Process Data 2 (see Chapter 8.5.3).

Other drive modes are not supported. If they are used, the Process Reference is not handled.

7.1.5 Assembly instance 101

Table 22.

Instance 101 (Output) Length = 8 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	NetCtrl			FaultReset	RunRev	RunFwd
1								
2	FBSpeed Reference (Low Byte), %							
3	FBSpeed Reference (High Byte), %							
4	FBProcessDataIn1(Low Byte)							
5	FBProcessDataIn1(High Byte)							
6	FBProcessDataIn2(Low Byte)							
7	FBProcessDataIn2(High Byte)							

Process Data is sent to the drive independently of the NetRef bit and the NetCtrl bit settings.

7.1.6 Assembly instance 111

Table 23.

Instance 111 (Output) Length = 20 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	FBFixedControlWord (Low Byte)							
1	FBFixedControlWord (High Byte)							
2	FBSpeedReference (Low Byte) *							
3	FBSpeedReference (High Byte) *							
4	ProcessDataIn1 (LowByte)							
5	ProcessDataIn1 (HighByte)							
6	ProcessDataIn2 (LowByte)							
7	ProcessDataIn2 (HighByte)							
8	ProcessDataIn3 (LowByte)							
9	ProcessDataIn3 (HighByte)							
10	ProcessDataIn4 (LowByte)							
11	ProcessDataIn4 (HighByte)							
12	ProcessDataIn5 (LowByte)							
13	ProcessDataIn5 (HighByte)							
14	ProcessDataIn6 (LowByte)							
15	ProcessDataIn6 (HighByte)							
16	ProcessDataIn7 (LowByte)							
17	ProcessDataIn7 (HighByte)							
18	ProcessDataIn8 (LowByte)							
19	ProcessDataIn8 (HighByte)							

* Reference 1 to the AC drive. Used normally as Speed reference. The allowed scaling is 0...10000. In the application, the value is scaled in percentage of the frequency area between set minimum and maximum frequency.
0 = 0.00 %, 10000 = 100.00 %

7.1.7 Assembly instance 128

Table 24.

Instance 128 Length = 20 Bytes								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
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)

7.1.7.1 Control word

Table 25.

Bit	Description		
		0	1
0	Start/Stop	Stop request from fieldbus	Run request from fieldbus
1	Direction	Requested direction is "FORWARD"	Requested direction is "REVERSE"
2	Fault Reset	No action	No action. Rising edge (0->1) = Active faults, alarms and infos are reset
3	Not in use		
4	Not in use		
5	Not in use		
6	Not in use		
7	Not in use		
8	Request Fieldbus Control	Control Place is as parameterised in the drive (unchanged)	Control Place shall be overridden to Fieldbus Control
9	Request Fieldbus Reference	Source of setpoint value shall be as parameterised in the drive (unchanged)	Source of setpoint value shall be overridden to Fieldbus
10	Not in use		
11	Not in use		
12	Not in use		
13	Not in use		
14	Not in use		
15	Master connection state	Offline	Active

7.2 Input instances

7.2.1 Assembly instance 70

Table 26.

Instance 70 (Input) Length = 4 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running1		Faulted
1								
2	Speed Actual (Low Byte), rpm							
3	Speed Actual (High Byte), rpm							

7.2.2 Assembly instance 71 (default)

Table 27.

Instance 71 (Input) Length = 4 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2	Running1	Warning	Faulted
1	Drive State, see Chapter 7.2.6							
2	Speed Actual (Low Byte), rpm							
3	Speed Actual (High Byte), rpm							

7.2.3 Assembly instance 73

Table 28.

Instance 73 (Input) Length = 6 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2	Running1	Warning	Faulted
1	Drive State, see Chapter 7.2.6							
2	Speed Actual (Low Byte), rpm							
3	Speed Actual (High Byte), rpm							
4	Torque Actual (Low Byte), Nm							
5	Torque Actual (High Byte), Nm							

NOTE! Torque reference is not functional in VACON® NXL.

7.2.4 Assembly instance 75

Table 29.

Instance 75 (Input) Length = 6 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2	Running1	Warning	Faulted
1	Drive State, see Chapter 7.2.6							
2	Speed Actual (Low Byte), rpm							
3	Speed Actual (High Byte), rpm							
4	Process Actual (Low Byte)							
5	Process Actual (High Byte)							

7.2.5 Assembly instance 107

Table 30.

Instance 107 (Input) Length = 8 Bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AtReference	RefFromNet	CtrlFromNet	Ready	Running2	Running1	Warning	Faulted
1	Drive State, see Chapter 7.2.6							
2	% Speed Actual (Low Byte) *							
3	% Speed Actual (High Byte) *							
4	Process DataOut1 (Low Byte)							
5	Process DataOut1 (High Byte)							
6	Process DataOut2 (Low Byte)							
7	Process DataOut2 (High Byte)							

7.2.6 Drive state

0x00 DN_NON_EXISTANT
0x01 DN_STARTUP
0x02 DN_NOT_READY
0x03 DN_READY
0x04 DN_ENABLED
0x05 DN_STOPPING
0x06 DN_FAULT_STOP
0x07 DN_FAULTED

7.2.7 Assembly instance 117

Table 31.

Instance 117 (Input): EIP Drive Status Length = 34 bytes								
Byte	Bit 7	Bit 6	Bit .5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	FBStatusWord (Low Byte)							
1	FBStatusWord (High Byte)							
2	% Speed Actual (Low Byte) *							
3	% Speed Actual (High Byte) *							
4	RPM Speed Actual (Low Byte) **							
5	RPM Speed Actual (High Byte) **							
6	RPM with Slip Speed Actual (Low Byte)***							
7	RPM with Slip Speed Actual (High Byte) ***							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							
16	Reserved							
17	Reserved							
18	ProcessDataOut1 (LowByte)							
19	ProcessDataOut1 (HighByte)							
20	ProcessDataOut2 (LowByte)							
21	ProcessDataOut2 (HighByte)							
22	ProcessDataOut3 (LowByte)							
23	ProcessDataOut3 (HighByte)							
24	ProcessDataOut4 (LowByte)							
25	ProcessDataOut4 (HighByte)							
26	ProcessDataOut5 (LowByte)							
27	ProcessDataOut5 (HighByte)							
28	ProcessDataOut6 (LowByte)							
29	ProcessDataOut6 (HighByte)							
30	ProcessDataOut7 (LowByte)							
31	ProcessDataOut7 (HighByte)							
32	ProcessDataOut8 (LowByte)							
33	ProcessDataOut8 (HighByte)							

* The actual value from the AC drive. The value is between 0...10000. In the application, the value is scaled in percentage of frequency area between set minimum and maximum frequency.
0 = 0.00 %, 10000 = 100.00 %
** The actual speed of the motor. The unit is RPM.
*** The actual speed of the motor with slip speed. The unit is RPM.

7.2.8 Assembly instance 127

Table 32.

Instance 127 Length = 20 Bytes								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
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)							

8. DATA MAPPING

8.1 Control word

Table 33.

Bit		0	1
0		STOP	RUN
1		Clockwise	Counterclockwise
2		Rising edge of this bit will reset active fault	
3-15		Not in use	

8.2 Status word

Table 34.

Bit		0	1
0	Ready status	Drive is not ready for operation	Drive is ready for operation
1	Run/Stop status	Drive is stopped	Drive is running
2	Direction status	Drive is running clockwise	Drive is running counterclockwise
3	Fault status	No fault is active	Drive is in fault state
4	Alarm status	No alarm is active	An alarm is active
5	Reference reached	Reference is not reached	Reference is reached
6	Zero speed	Motor is not running at zero speed	Motor is running at zero speed
7	Motor magnetisation	Motor is not magnetised	Motor is magnetised
8-15	Not in use		

8.3 Process Data OUT (Slave → Master)

The fieldbus master can read the actual values of the AC drive by using process data variables. The applications *Basic, Standard, Local/Remote, Multi-Step, PID control and Pump and fan control* use process data as follows:

Table 35.

Data	Value	Unit	Scale
Process data OUT 1	Output Frequency	Hz	0.01 Hz
Process data OUT 2	Motor Speed	rpm	1 rpm
Process data OUT 3	Motor Current	A	0.1 A
Process data OUT 4	Motor Torque	%	0.1%
Process data OUT 5	Motor Power	%	0.1%
Process data OUT 6	Motor Voltage	V	0.1 V
Process data OUT 7	DC link voltage	V	1 V
Process data OUT 8	Active Fault Code	-	-

The *Multipurpose* application has a selector parameter for every Process Data. The monitoring values and drive parameters are selected using the ID number (see VACON® NX All in One Application Manual, Tables for monitoring values and parameters). Default selections are as in the table above.

8.4 Process Data IN (Master → Slave)

ControlWord, Reference and Process Data are used with All-in One applications as explained in the three following tables.

Table 36. Basic, Standard, Local/Remote, Multi-Step applications

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
PD1 – PD8	Not used	-	-

Table 37. Multipurpose control application

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
Process Data IN1	Torque Reference	%	0.1%
Process Data IN2	Free Analogue INPUT	%	0.01%
Process Data IN3	Adjust Input	%	0.01%
PD3 – PD8	Not Used	-	-

Table 38. PID control and Pump and fan control applications

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
Process Data IN1	Reference for PID controller	%	0.01%
Process Data IN2	Actual Value 1 to PID controller	%	0.01%
Process Data IN3	Actual Value 2 to PID controller	%	0.01%
PD4–PD8	Not Used	-	-

8.5 Additional information

8.5.1 Handling of the NetCtrl bit (Network Control)

If NetCtrl bit is set, Output Instance's Control Word is sent to the drive. Additionally, BusCtrl bit of the FBFixedControlWord is set.

8.5.2 Handling of the NetRef bit (Network Reference)

If NetRef bit is set, Torque Reference and Speed Reference are sent to the drive. Additionally, BusRef bit of the FBFixedControlWord is set.

8.5.3 Handling of the NetProc bit in assembly instance 25 (Net Process)

If NetProc bit is set, Process Reference is sent to the drive.

8.5.4 Handling of RefFromNet and CtrlFromNet bits

RefFromNet and CtrlFromNet bits are set if value of REMOTEIndication is more than 0, and NetRef and NetCtrl bits are set. See Chapters 6.2.3 and 6.2.4.

NOTE! When you contact a distributor or a factory because of a fault condition, always write down all the texts and codes on the keypad display. Then send the problem description together with the Drive Info File to the local distributor. See local contacts: http://drives.danfoss.com/danfoss-drives/local-contacts/ . If possible, also send a "Wireshark" log from the situation if applicable.

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