VACON®
AC DRIVES

OPTE2/E8

RS485 MULTIPROTOCOL OPTION BOARD

INSTALLATION MANUAL

VACON®

Table of Contents

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1. SAFETY

This manual contains clearly marked cautions and warnings that are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

Table 1. Warning signs

	**= DANGER! Dangerous voltage**
	**= WARNING or CAUTION**
	**= Caution! Hot surface**

1.1 DANGER

	The **components of the power unit are live** when the drive is connected to mains potential. Coming into contact with this voltage is **extremely dangerous** and may cause death or severe injury.
	The **motor terminals U, V, W and the brake resistor terminals are live** when the AC drive is connected to mains, even if the motor is not running.
	**After disconnecting** the AC drive from the mains, **wait** until the indicators on the keypad go out (if no keypad is attached, see the indicators on the cover). Wait 5 more minutes before doing any work on the connections of the drive. Do not open the cover before this time has expired. After expiration of this time, use a measuring equipment to absolutely ensure that no voltage is present. **Always ensure absence of voltage before starting any electrical work!**
	The control I/O-terminals are isolated from the mains potential. However, the **relay outputs and other I/O-terminals may have a dangerous control voltage** present even when the AC drive is disconnected from mains.
	**Before connecting** the AC drive to mains make sure that the front and cable covers of the drive are closed.
	During a ramp stop (see the Application Manual), the motor is still generating voltage to the drive. Therefore, do not touch the components of the AC drive before the motor has completely stopped. Wait until the indicators on the keypad go out (if no keypad is attached, see the indicators on the cover). Wait additional 5 minutes before starting any work on the drive.

1.2 WARNINGS

	The AC drive is meant for **fixed installations only**.
	**Do not perform any measurements** when the AC drive is connected to the mains.
	The **earth leakage current** of the AC drives exceeds 3.5mA AC. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See Chapter 1.3.
	If the AC drive is used as a part of a machine, the **machine manufacturer is responsible** for providing the machine with a **supply disconnecting device** (EN 60204-1).
	Only **spare parts** delivered by VACON® can be used.
	At power-up, power break or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Furthermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed. Disconnect, therefore, the motor if an unexpected start can cause danger.
	The **motor starts automatically** after automatic fault reset if the auto restart function is activated. See the Application Manual for more detailed information.
	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the AC drive.
	**Do not touch the components on the circuit boards**. Static voltage discharge may damage the components.
	Check that the **EMC level** of the AC drive corresponds to the requirements of your supply network.

1.3 GROUNDING AND EARTH FAULT PROTECTION

CAUTION!

The AC drive must always be earthed with an grounding conductor connected to the grounding terminal marked with ⏚.

The earth leakage current of the drive exceeds 3.5mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit must be satisfied:

a) The protective conductor must have a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al, through its total run.

b) Where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area must be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al.

c) Automatic disconnection of the supply in case of loss of continuity of the protective conductor.

The cross-sectional area of every protective grounding conductor which does not form part of the supply cable or cable enclosure must, in any case, be not less than:

- 2.5mm^2 if mechanical protection is provided or
- 4mm^2 if mechanical protection is not provided.

The earth fault protection inside the AC drive protects only the drive itself against earth faults in the motor or the motor cable. It is not intended for personal safety.

Due to the high capacitive currents present in the AC drive, fault current protective switches may not function properly.

Do not perform any voltage withstand tests on any part of the AC drive. There is a certain procedure according to which the tests must be performed. Ignoring this procedure can cause damage to the product.

NOTE! You can 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/.

2. GENERAL

OPTE2/E8 RS-485 multiple protocols field option board supports both Modbus RTU and Metasys N2 protocols. With these fieldbuses, the AC drives can then be controlled and monitored from the master.

OPTE2/E8 RS485 can be installed to the following VACON® AC drives:

- VACON® 20
- VACON® 20 X / CP
- VACON® 100 INDUSTRIAL
- VACON® FLOW
- VACON® HVAC
- VACON® 100 X
- VACON® NXP
- VACON® NXS

3. OPTION BOARD TECHNICAL DATA

3.1 GENERAL

Table 2. Technical data

Protocols	Modbus RTU / Metasys N2	
Communications	Interface	OPTE2: 5-pin pluggable connector OPTE8: 9-pin D-SUB connector (female)
	Data transfer method	RS-485, half-duplex
	Transfer cable	Shielded Twisted Pair
	Electrical isolation	500 VDC
Environment	Ambient operating temperature	-10°C–50°C
	Storing temperature	-40°C–70°C
	Humidity	<95%, no condensation allowed
	Altitude	Max. 1,000 m
	Vibration	0.5 G at 9–200 Hz
Safety	Fulfills EN50178 standard	

3.2 NEW FEATURES

Table 3. OPTE2/E8 RS485 firmware versions

New features	Firmware version
• Support for VACON® NXP and VACON® NXS AC drives. See control firmware requirements in Chapter 6 "Installation". • Support for 16 Modbus RTU process data items in VACON® NXP, VACON® 100 INDUSTRIAL and VACON® 100 FLOW AC drives. See details in Chapter 8.3 "Modbus data mapping" and Chapter 12 "Appendix C - Fieldbus option board communication". • Support for OPTC2/OPTC8 backward compatibility mode in VACON® NX and VACON® 100 family AC drives. See Chapter "OPTC2/OPTC8 RS485 compatibility mode".	V003
• Support for VACON® 100 INDUSTRIAL, VACON® 100 FLOW, VACON® 100 X, VACON® 100 HVAC and VACON® 20X/CP AC drives.	V002
• Initial version.	V001

4. LAYOUT AND CONNECTIONS

The difference between OPTE2 option board and OPTE8 option board is bus connector. OPTE2 option board has a 5-pin pluggable bus connector, and OPTE8 option board has a 9-pin female D-SUB connector. Except that, they have the same LED indications, jumpers and interface board connector.

4.1 OPTE2 (SCREW PLUG) OPTION BOARD LAYOUT

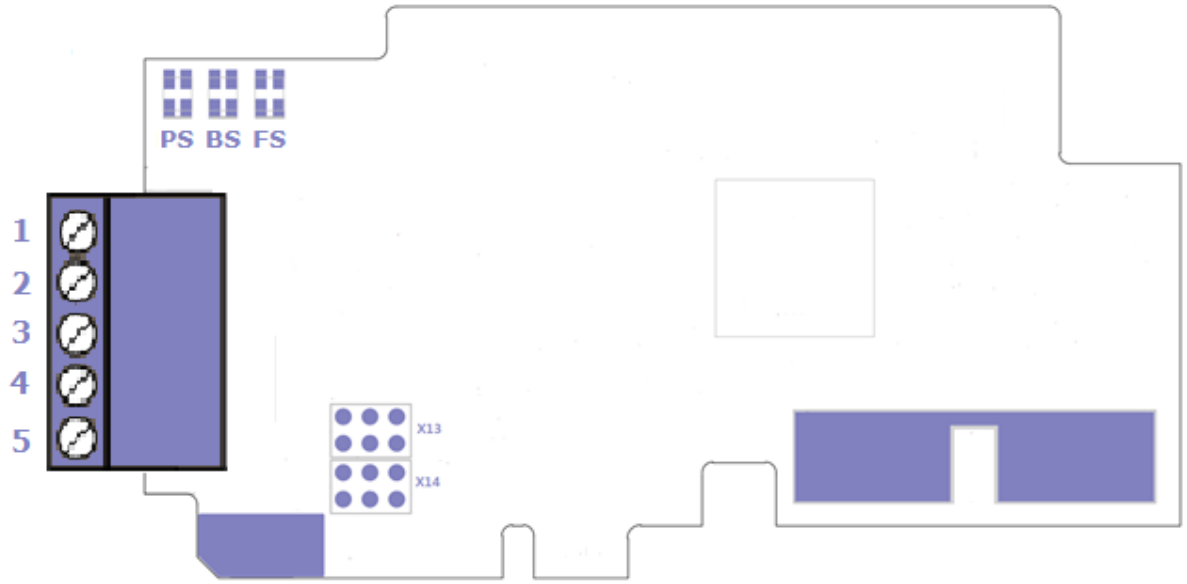


Figure 1. OPTE2 (screw plug) option board layout

Table 4. OPTE2 (screw plug) connector pinout

Signal	Pin	Description
Shield	1	Cable Shield
VP	2	Supply voltage - plus (5V)
RxD / TxD-P	3	Receive/Transmit data - plus(B)
RxD / TxD-N	4	Receive/Transmit data - minus(A)
DGND	5	Data ground (reference potential for VP)

NOTE! When replacing the OPTC2 option board with the OPTE2 option board, note that Receive/ Transmit data - plus (B) and Receive/Transmit data - minus (A) pins have switched places. In OPTC2, the pin 1 is not connected to the cable shield.

Table 5. OPTC2 (screw plug) connector pinout

Signal	Pin	Description
NC	1	No connection
VP	2	Supply voltage - plus (5V)
RxD / TxD-N	3	Receive/Transmit data - minus (A)
RxD / TxD-P	4	Receive/Transmit data - plus (B)
DGND	5	Data ground (reference potential for VP)

4.2 OPTE8 (SUB-D9) OPTION BOARD LAYOUT

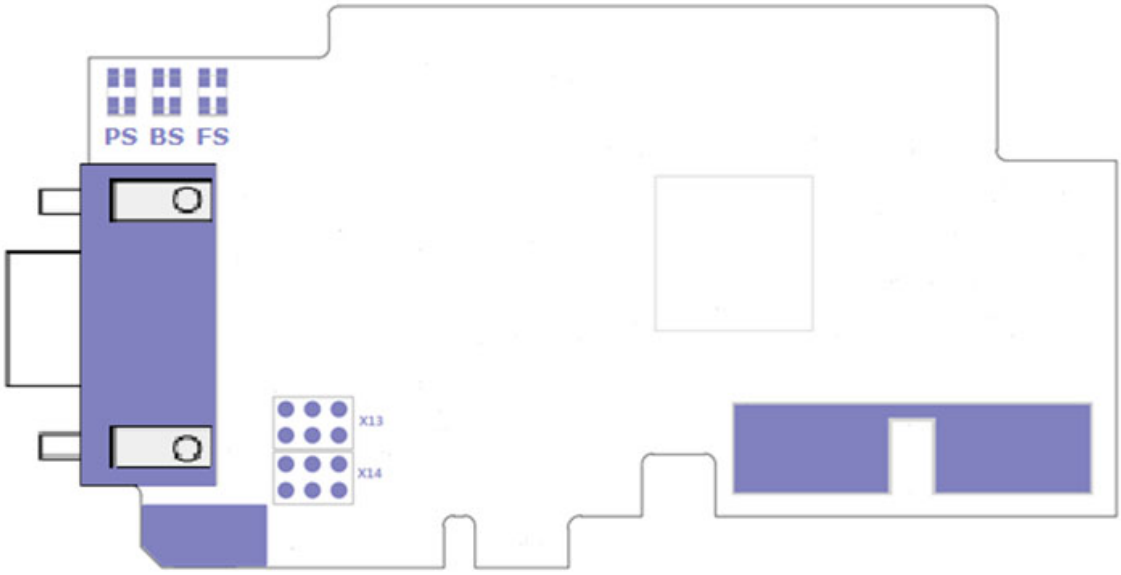


Figure 2. OPTE8 (Sub-D9) option board layout

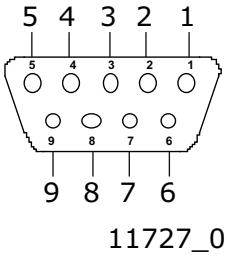


Figure 3. 9-pin female sub-D connector pinout

Table 6. OPTE8 (9-pin female sub-D) connector pinout

Signal	Pin	Description
Shield	1	Cable Shield
VP	6	Supply voltage - plus (5V)
RxD / TxD-P	3	Receive/Transmit data - plus (B)
RxD / TxD-N	8	Receive/Transmit data - minus (A)
DGND	5	Data ground (reference potential for VP)

NOTE! When replacing the OPTC8 option board with the OPTE8 option board, note that Receive/Transmit data - plus (B) and Receive/Transmit data - minus (A) pins have switched places.

Table 7. OPTC8 (9-pin female sub-D) connector pinout

Signal	Pin	Description
Shield	1	Cable Shield
VP	6	Supply voltage - plus (5V)
RxD / TxD-N	3	Receive/Transmit data - minus (A)
RxD / TxD-P	8	Receive/Transmit data - plus (B)
DGND	5	Data ground (reference potential for VP)

4.3 LED INDICATIONS

There are three LEDs on OPTE2/E8 option board to indicate board and communication status. This table describes their indications.

Table 8. LED indications

LEDs	Indication
PS	• Green ON when protocol is communicating • Yellow blinking (1s ON / 1s OFF) when protocol is ready for external communication • OFF when protocol is not ready for communications • Green blinking (fast) when firmware is corrupted or missing
BS	• Green ON when board is operational. • Red blinking (1s ON / 1s OFF) when protocol is in fault state
FS	• Green ON when protocol is communicating. • OFF when protocol is not communicating.

Figure below lists possible LED indication combinations.

Table 9. LED combinations

LED combinations			Description
PS	BS	FS	
Dim	Dim	Dim	No power. All LEDs are OFF
Green	Dim	Dim	Option board firmware is corrupted or missing. PS is blinking fast
Dim	Green	Dim	Option board is operational
Yellow	Green	Dim	Protocol is ready for communications. PS is blinking (1s ON / 1s OFF)
Green	Green	Green	Protocol is communicating. The option board is receiving requests from the PLC master and sending responses to the requests.
Yellow	Red	Dim	Protocol communication fault. BS is blinking to indicate a fault. PS is blinking to indicate that protocol is ready for communications.

4.4 JUMPERS

Setting of termination resistance and cable shield grounding options is described in Chapter 5.

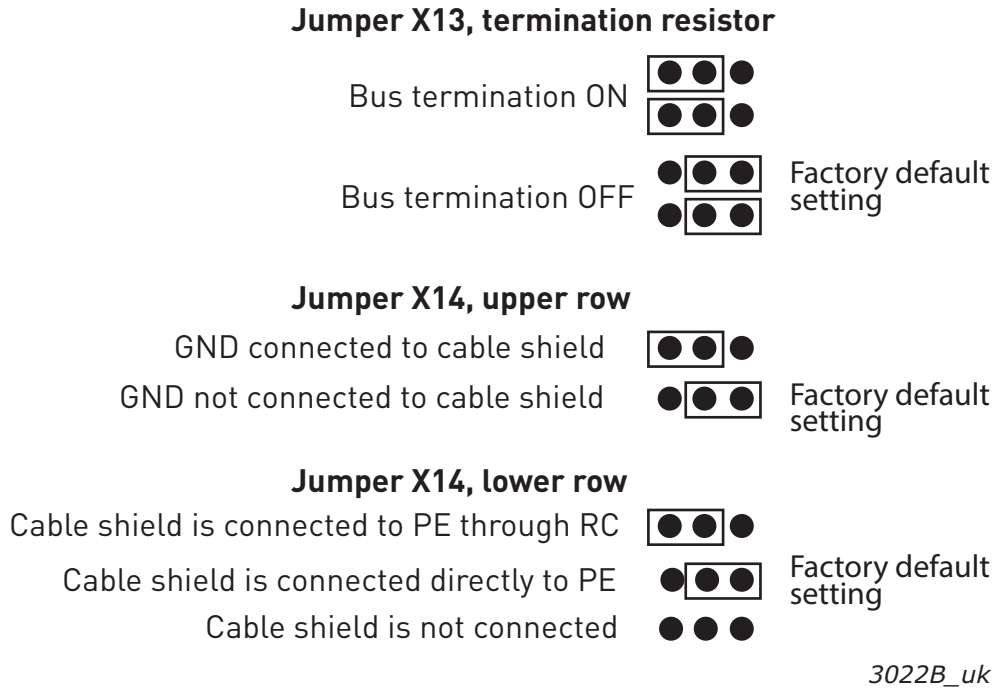


Figure 4. Position definition of jumpers

4.5 BUS TERMINAL AND BIAS RESISTORS

If VACON® AC drive is the last device of RS-485 line, the bus termination must be set. Use jumper X13 (ON position) or external termination resistors.

Bus biasing is required to ensure faultless communication between devices at RS-485 bus. Bus biasing makes sure that the bus state is at proper potential when no device is transmitting. Without biasing, faulty messages can be detected when the bus is in idle state. RS-485 bus state should be neither +0.200...+7 V or -0.200...-7 V. Illegal bus state is <200 mV...-200 mV.

The resistance of internal termination and biasing are 120 Ω and 560 Ω.

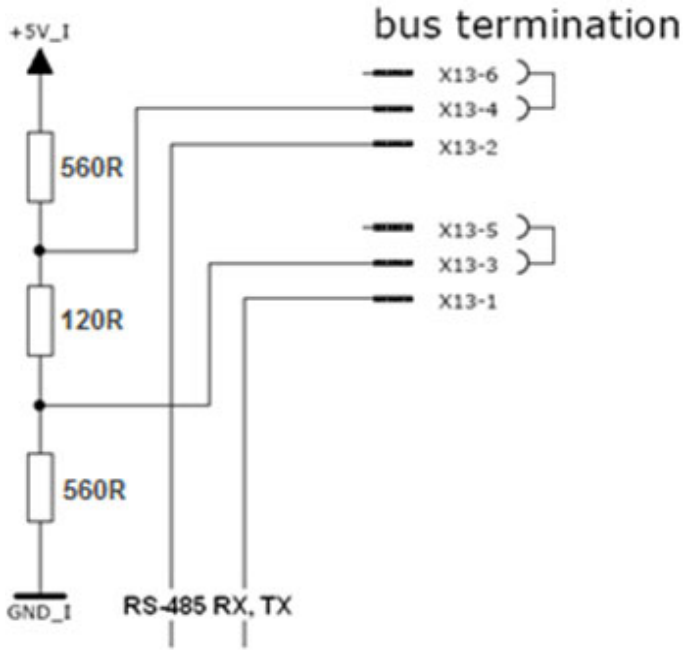


Figure 5. Bus termination

If necessary, external termination and biasing can be added depending on number of nodes and total length of cable.

Table 10. Bias resistance and termination resistance

Number of nodes	Bias resistance	Termination resistance
2-5	1.8 kΩ	120 Ω
5-10	2.7 kΩ	
11-20	12 kΩ	
21-30	18 kΩ	
31-40	27 kΩ	

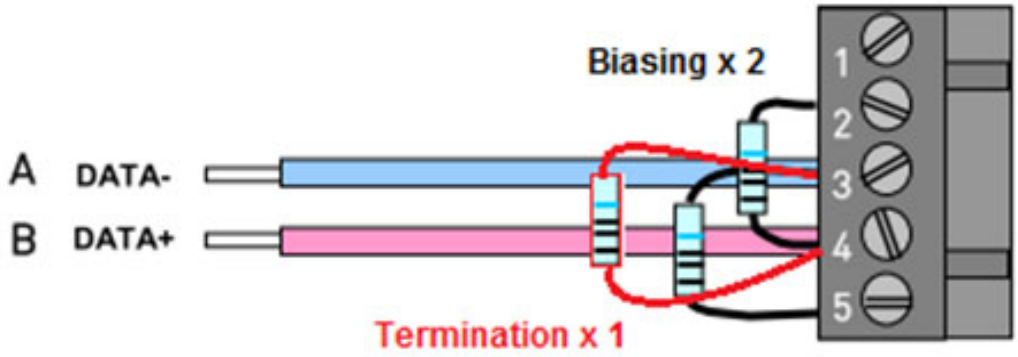


Figure 6.

5. CABLING INSTRUCTIONS

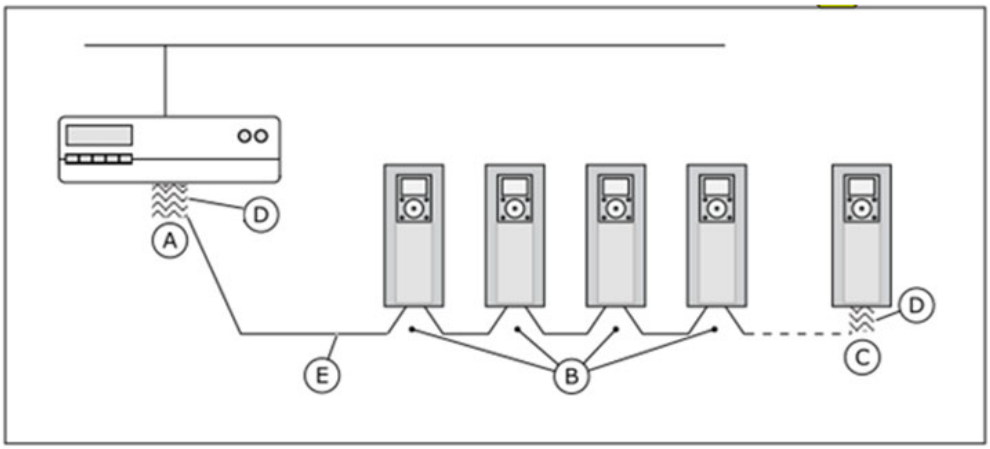
5.1 SELECTING CABLE

In EIA-485 systems, use only shielded cables with twisted-pair signal wires. With EIA-485 protocols, use for example:

- Lapp Kabel UNITRONICR BUS LD FD P A, part number 2170813 or 2170814

5.2 SETTING THE TERMINATION RESISTANCE

Install termination resistors at or near both ends of the EIA-485 segment. The typically termination resistor for EIA-485 is 120 Ω.



A. The termination is activated
B. The termination is deactivated
C. The termination is activated with a jumper
D. The bus termination
E. The fieldbus cable

Figure 7. Setting the termination resistance

5.3 SHIELD GROUNDING OPTIONS

The equipotential bonding system in an installation refers to metalwork that is used to bring earth potential everywhere in the installation to a common level, the system earth. The purpose is that the earth potential for all devices and equipment would be same, avoiding undesirable current flow through paths not normally designed to carry current, and to allow efficient shielding of cables.

5.3.1 SHIELD GROUNDING WHEN EQUIPOTENTIAL BONDING IS GOOD

When the equipotential bonding is good, the fieldbus cable shield can be grounded at each AC drive. The grounding can be done by connecting the shield to the drive frame directly, or it can be done through the fieldbus connector and the grounding tab in the option board.

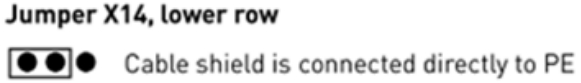


Figure 8. Jumper X14 setting (all points in system)

If the fieldbus cable is subjected to tensile load, it is recommended to do this grounding via the fieldbus board connector and grounding tab. The strain relief of the cable is then done without exposing the cable shield, which reduces the risk of mechanical wear on the cable.

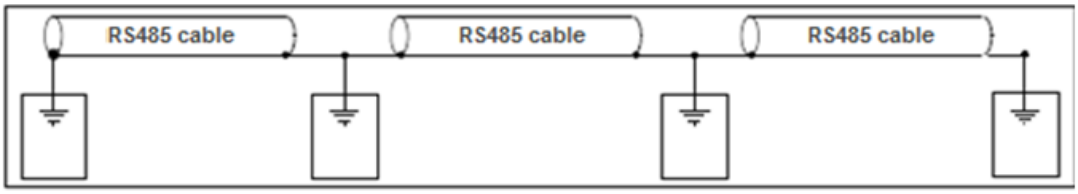


Figure 9. Grounding by clambing the cable to the AC drive frame

5.3.2 SHIELD GROUNDING WHEN EQUIPOTENTIAL BONDING IS POOR

In a situation where the equipotential bonding is poor, the fieldbus cable should be grounded directly only at one point in the system. This can be a VACON® AC drive but can also be some other point in the system. The fieldbus cable should not be directly grounded elsewhere in the system, because difference in electrical potential can cause equalization currents to appear in the shield, causing unnecessary disturbances.

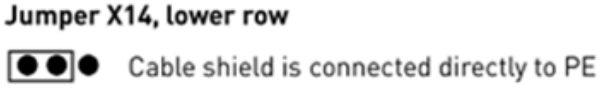


Figure 10. Jumper X14 setting (cable grounding to drive)

Figure 11. Jumper X14 setting (cable shield to RC filter)

In VACON® AC drives, the fieldbus cable can in these cases be connected to ground through an RC filter, which helps filter out disturbances in the shield without directly connecting it to the earth. In this case, the shield is connected to the option board connector and through an RC filter to the grounding tab in the option board. The strain relief is done without exposing the cable shield.

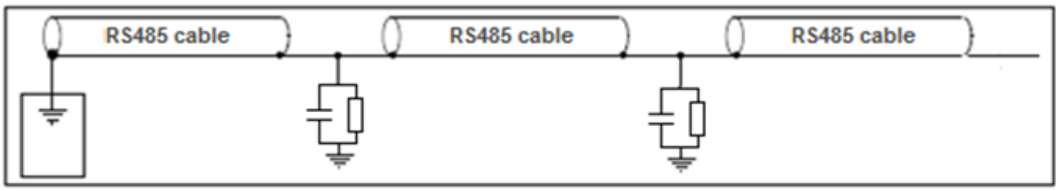


Figure 12. Grounding with RC filter

6. INSTALLATION

Following table shows which drives support OPTE2/E8 option board.

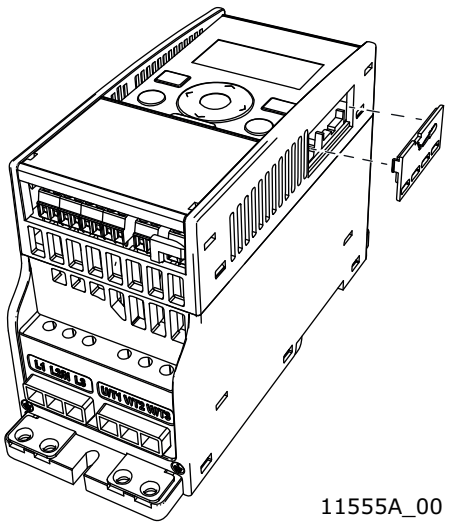
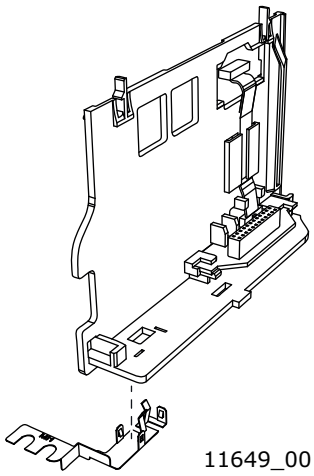
Table 11. OPTE2/E8 option board support

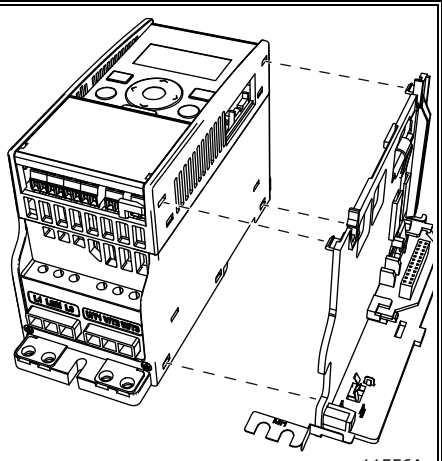
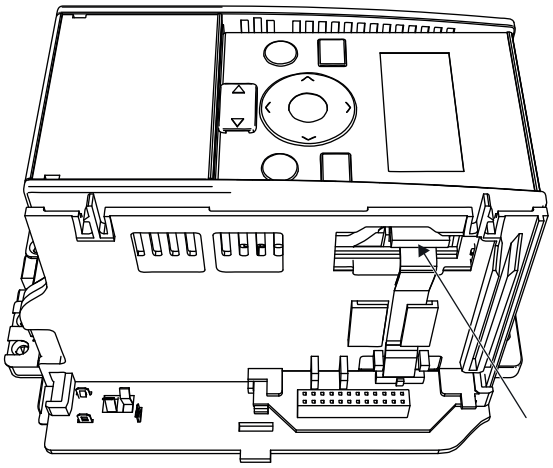
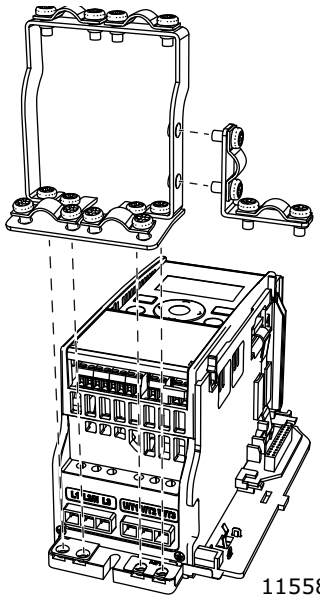
Drive	Slot	Since drive software version	Since OPTE2/E8 software version
VACON® 20	E	FW0107V013	FW0204V002
VACON® 20 X/CP	E	FW00117V012	FW0204V002
VACON® 100 INDUSTRIAL /100 X	D, E	FW0072V026	FW0204V002
VACON® 100 FLOW	D, E	FW0159V017	FW0204V002
VACON® 100 HVAC	D, E	FW0065V035	FW0204V002
VACON® NXP	D, E	NXP00002V197	FW0204V003
VACON® NXS	D, E	NXS00002V184	FW0204V003

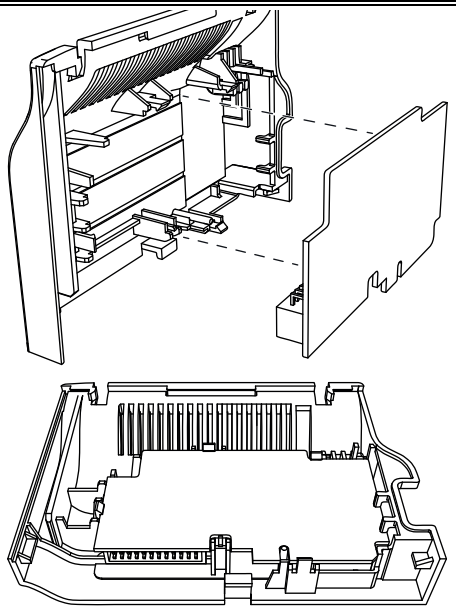
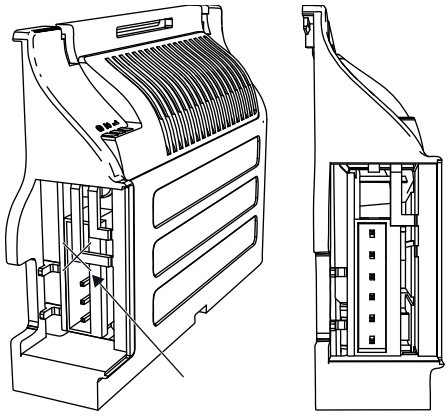
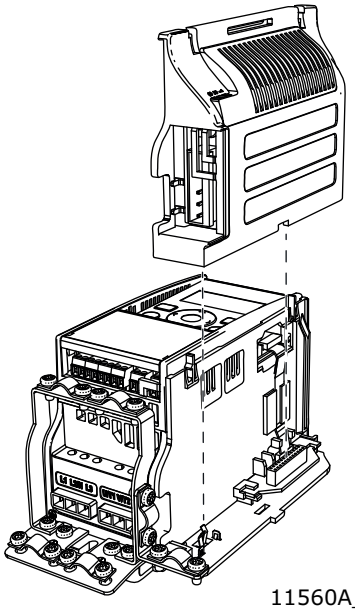
6.1 INSTALLATION IN VACON® 20

6.1.1 ENCLOSURES MI1, MI2, MI3

⚠ Make sure power is disconnected before installing the option board mounting kit.

1	Remove the cable connector lid from AC drive.	 11555A_00
2	Select a correct grounding plate and attach it to the option board mounting frame. The grounding plate is marked with the supported enclosure size.	 11649_00

3	Attach an option board mounting frame to the AC drive.  11556A_
4	Connect the flat cable from the option board mounting frame to the AC drive.  11557A_00
5	If a cable strain relief is required, attach the parts as shown in the figure.  11558A_00

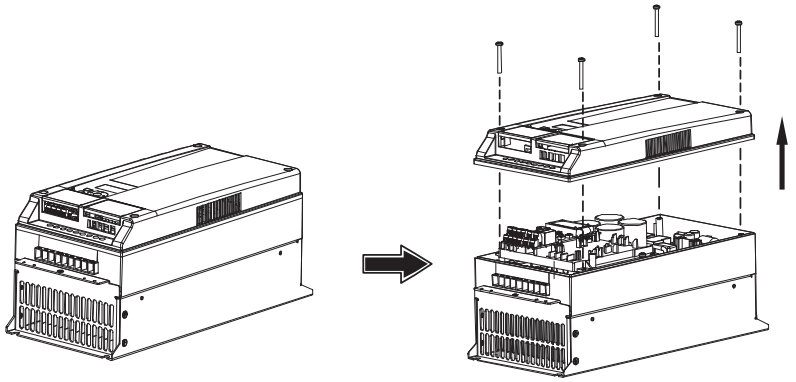
6	Install the option board to the option board holder. Make sure that the option board is securely fastened.  11559A_00
7	Cut free a sufficiently wide opening for the option board connector.  11650_00
8	Attach the option board cover to the AC drive. Attach the strain relief cable clamp with screws if needed.  11560A_00

6.1.2 ENCLOSURES MI4, MI5

⚠ Make sure power is disconnected before opening the cover of the AC drive.

1

1a: For MI4: Open the cover.



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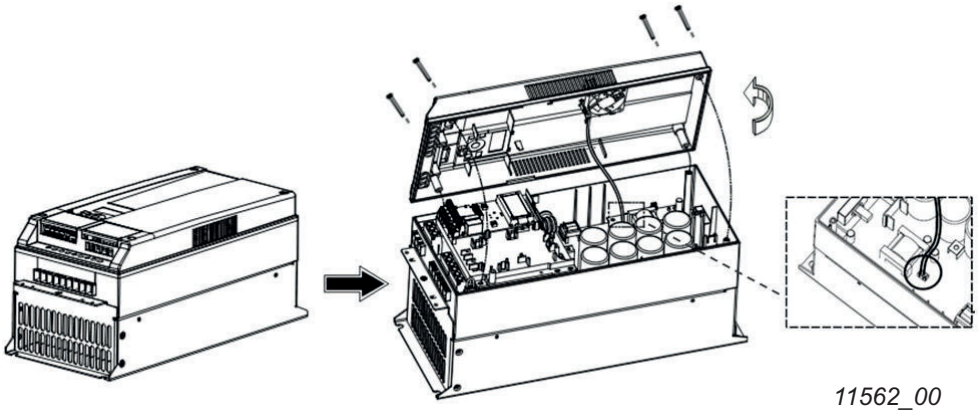
1b: For MI5: Open the cover and release the fan connector.



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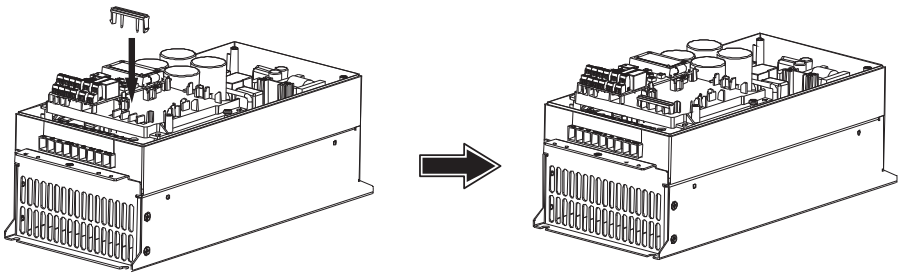
2

OPTE2: Attach the option board support.

OPTE8: Option board support is not used.



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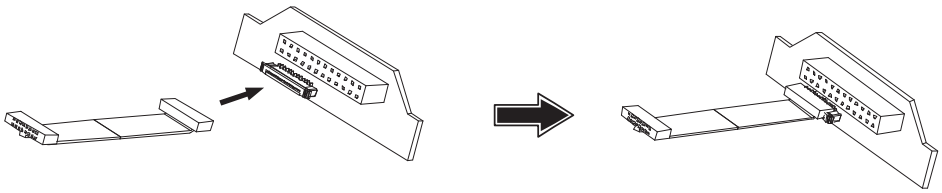
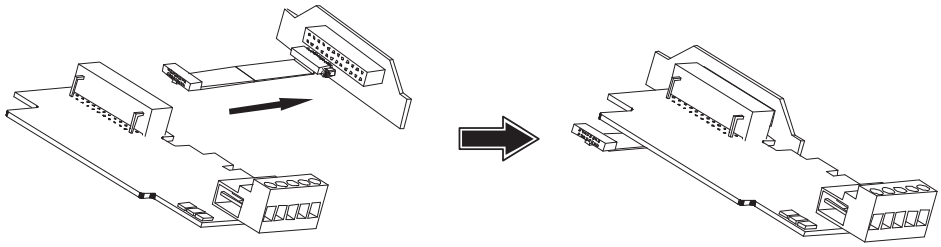
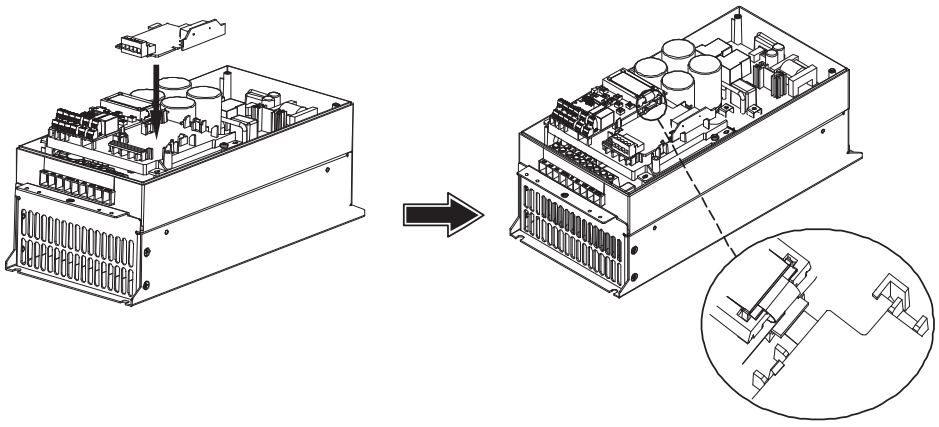
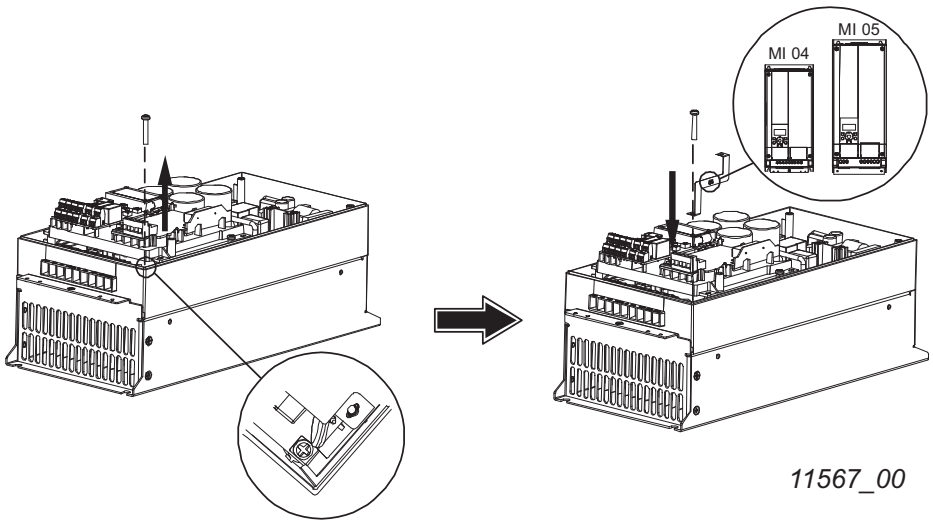
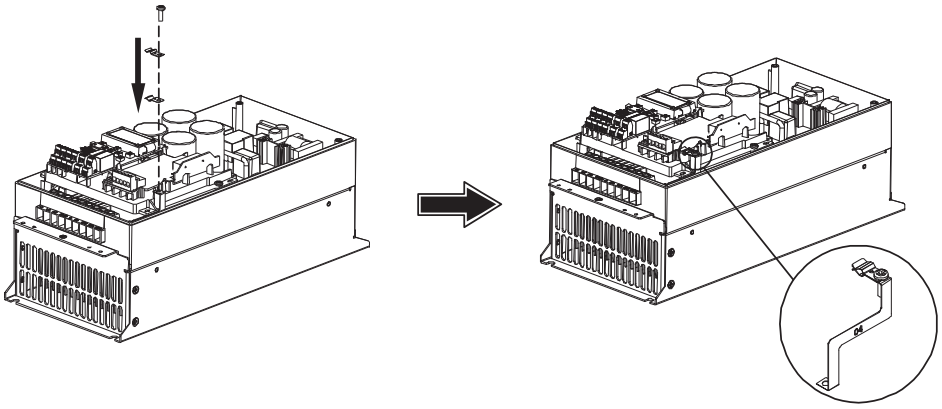
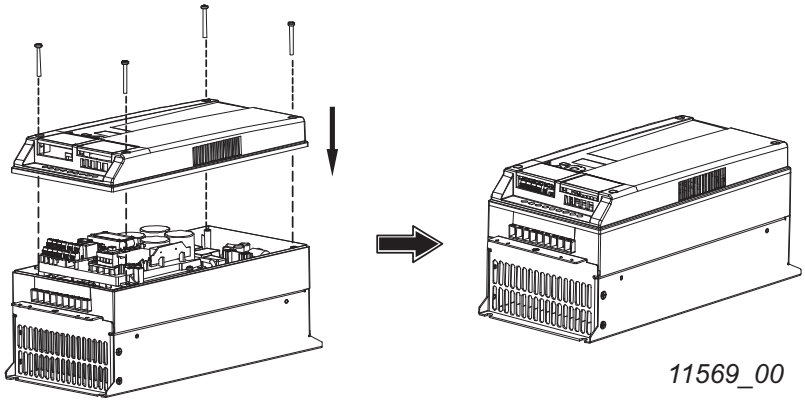
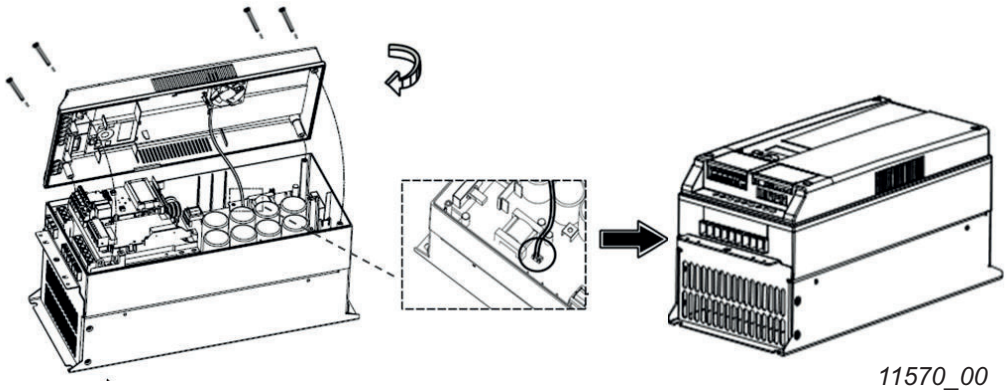
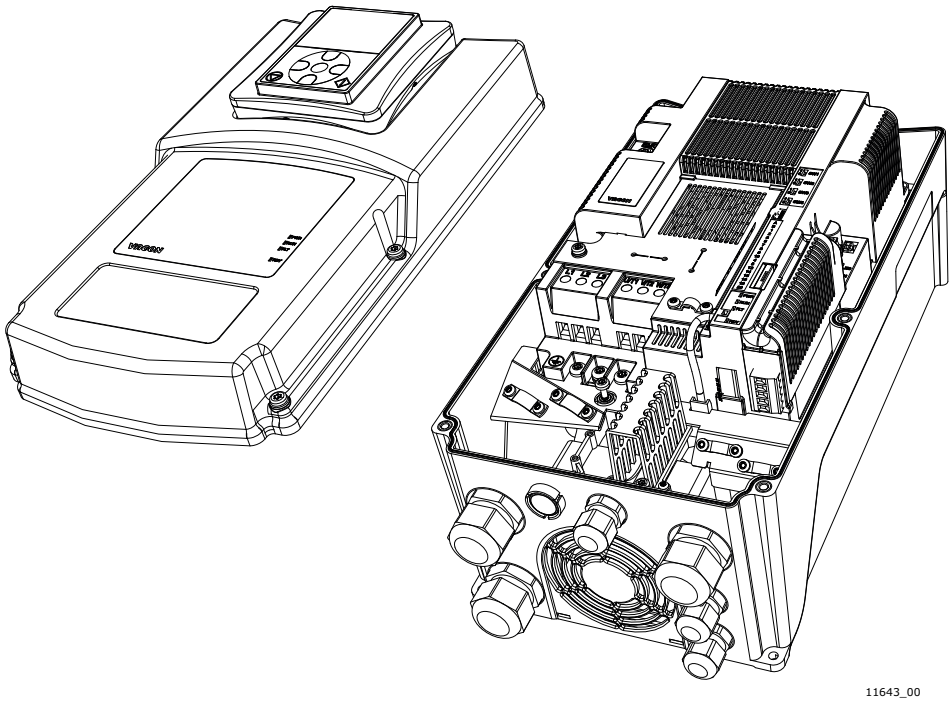
3	Connect the flex cable to option board connector PCB.  11564_00
4	Connect the option board to connector PCB.  11565_00
5	Attach the option board with connector PCB to the AC drive and connect the flex cable.  11566_00

6	Attach a suitable grounding plate to VACON® 20. The grounding plate is marked with supported enclosure size.  *11567_00*
7	Assemble a clamp on top of the grounding plate on both sides of the option board.  *11568_00*

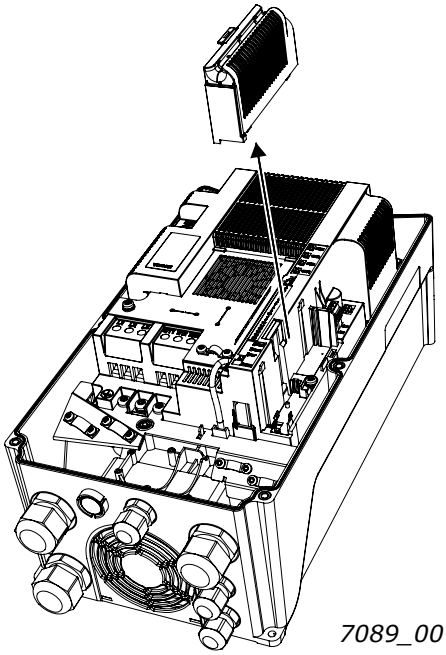
8	8a: For MI4: Close the cover.  *11569_00* 8b: For MI5: Remount the fan connector and close the cover.  *11570_00*

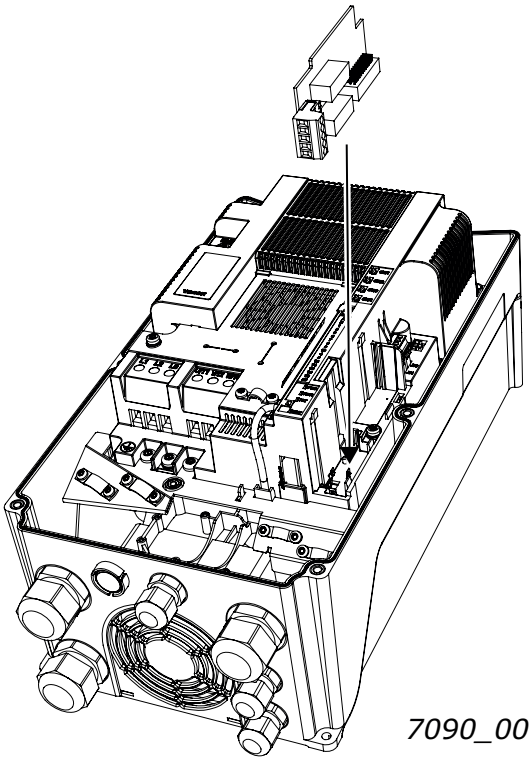
6.2 INSTALLATION IN VACON® 20 X AND 20 CP

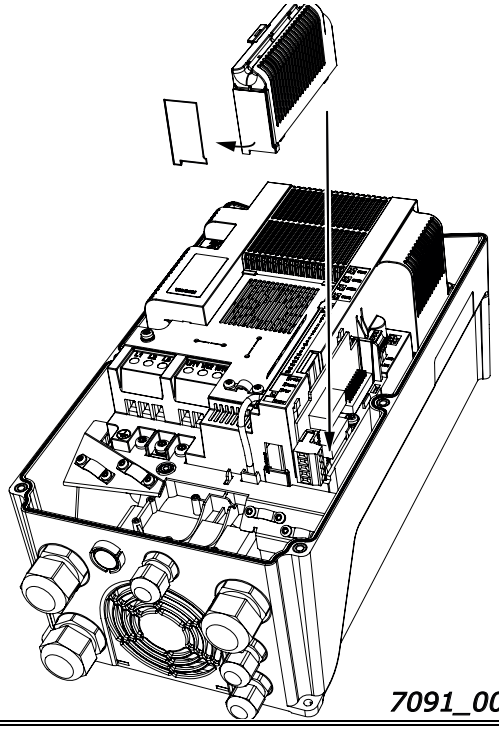
Do not add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.

1	Open the cover of the drive.  MU3 example

The relay outputs and other I/O-terminals may have a dangerous control voltage present even when the drive is disconnected from mains.

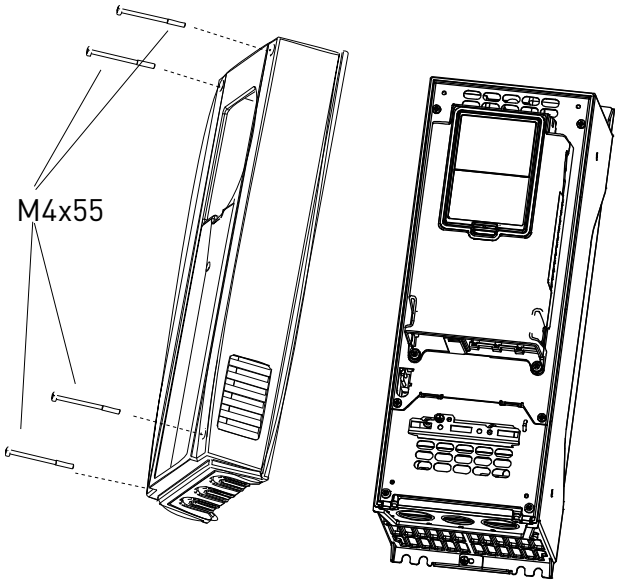
2	Remove the option slot cover.  *7089_00*

3	Install the option board into the slot as shown in the figure.  *7090_00*

4	Mount the option slot cover. Remove the plastic opening for the option board terminals.  *7091_00*

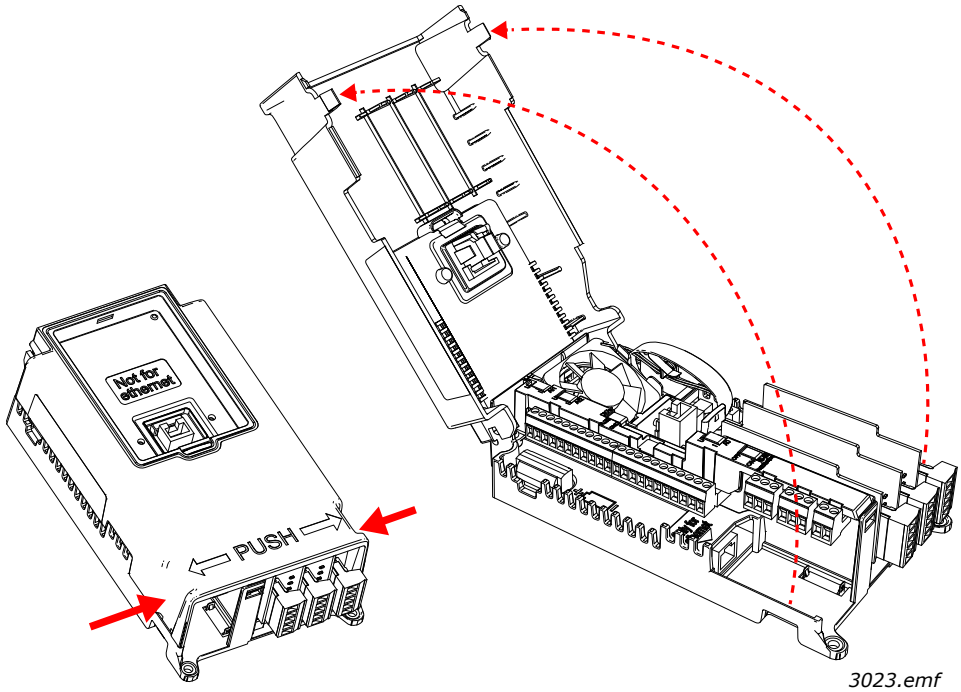
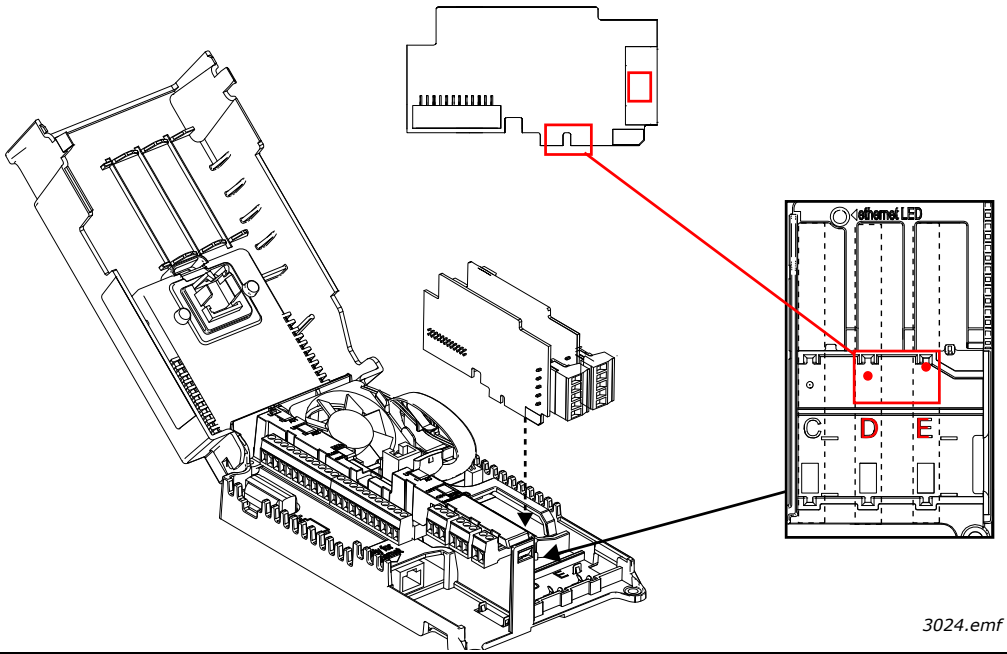
6.3 INSTALLATION IN VACON® 100 FAMILY

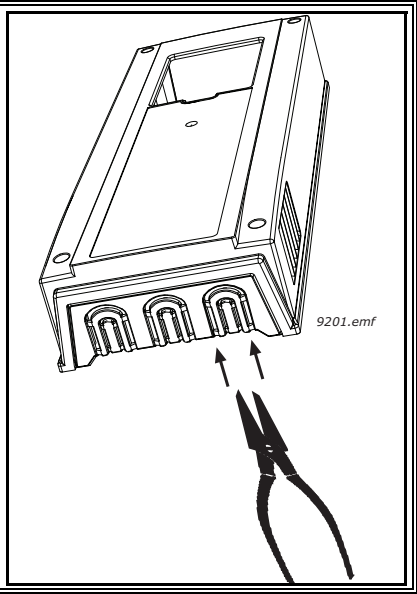
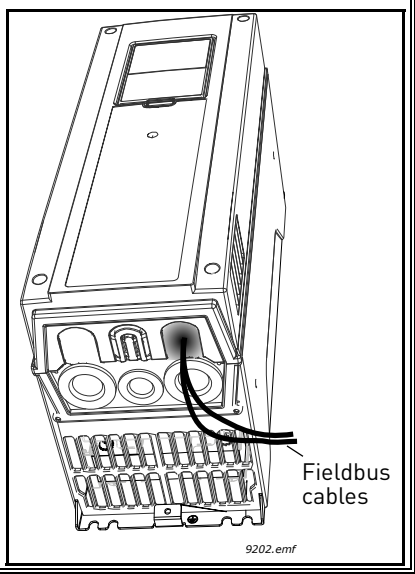
Do not add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.

1	Open the cover of the AC drive.  9174.emf

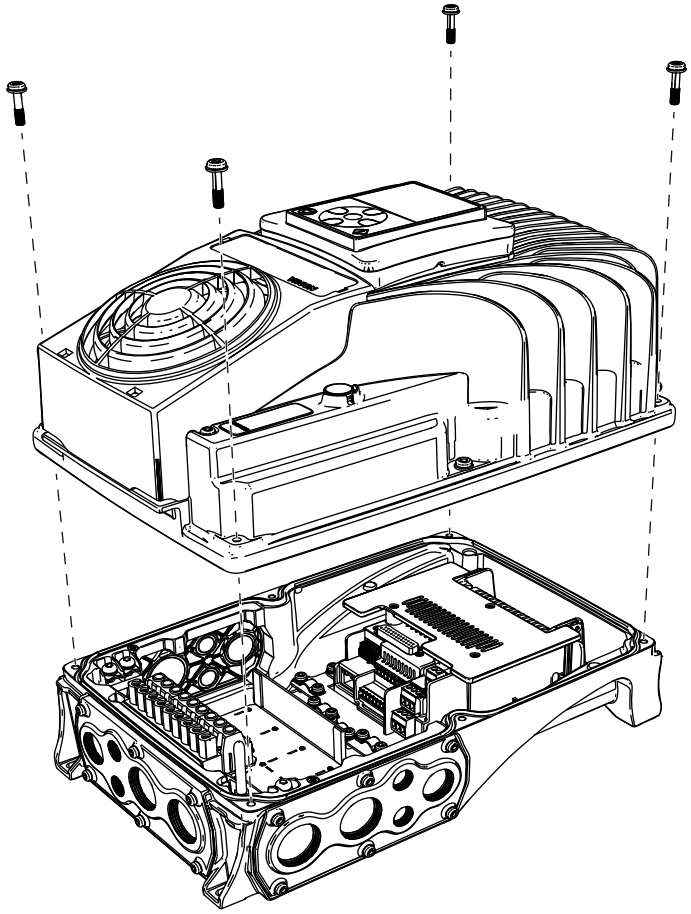
DANGER

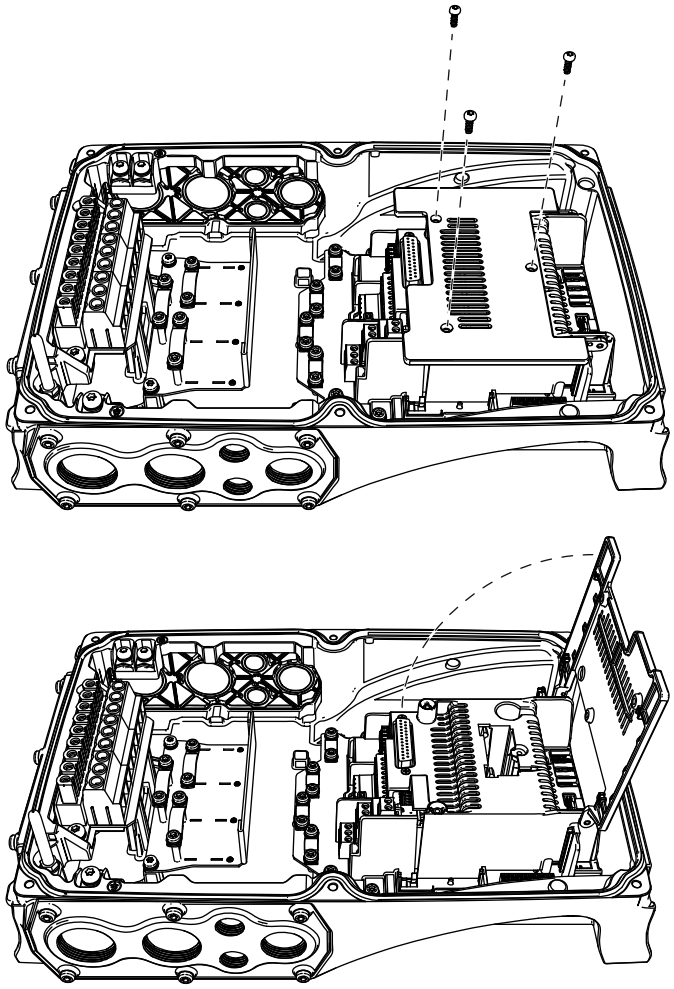
The relay outputs and other I/O-terminals may have a dangerous control voltage present even when VACON® 100 family AC drive is disconnected from mains.

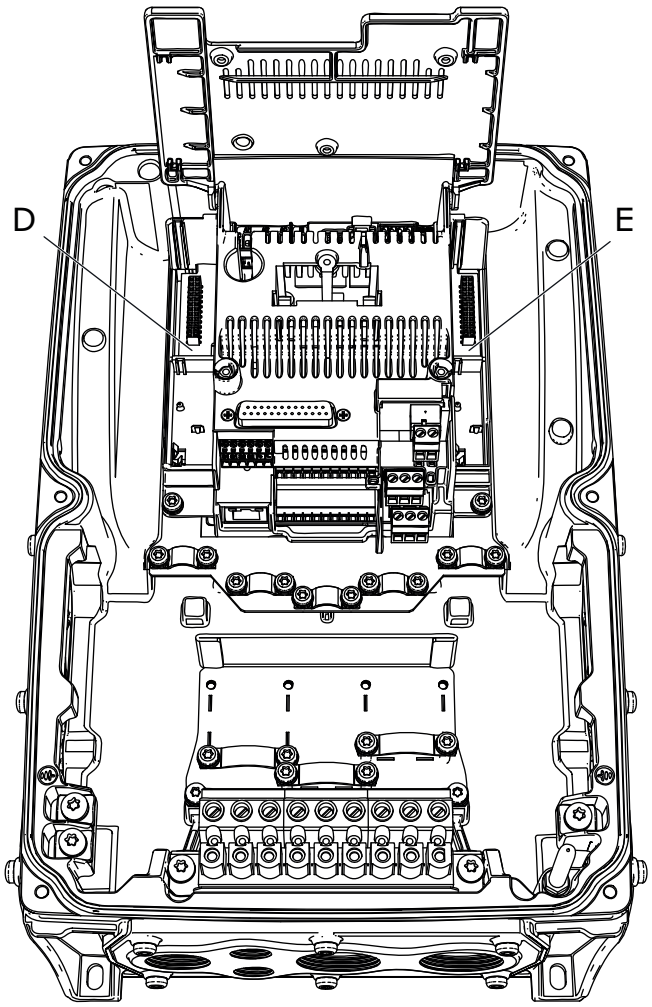
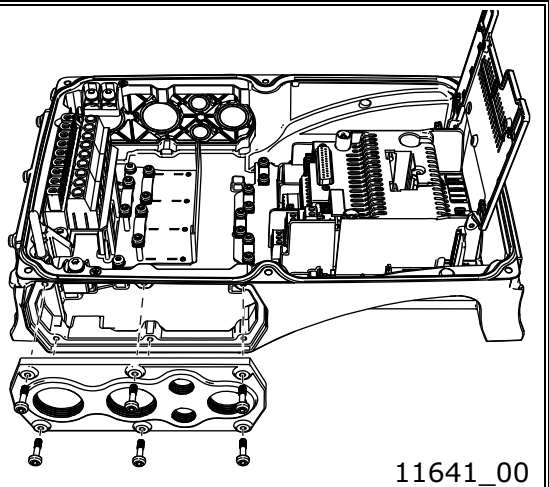
2	Open the inner cover to reveal the option board slots **(C,D,E)**. See the figure below.  *3023.emf*
3	Install the fieldbus board into slot **D** or **E**. See the figure below. **NOTE!** Incompatible boards cannot be installed on VACON® 100 family AC drive. Compatible boards have a slot coding that enable the placing of the board.  *3024.emf*

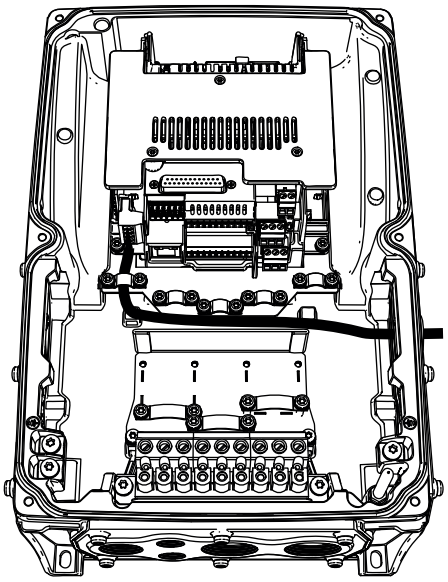
4	Unless already done for the other control cables, cut free the opening on the AC drive cover for the fieldbus cable (protection class IP21). **NOTE!** Cut the opening on the same side you have installed the board in	
5	Remount the AC drive cover and run the cable as shown in the figure. **NOTE!** When planning the cable runs, remember to keep the distance between the fieldbus cable and the motor cable at a **minimum of 30 cm**. It is recommended to route the option board cables away from the power cables as shown in the figure.	

6.4 INSTALLATION IN VACON® 100 X (ENCLOSURES MM4-MM6)

1	Open the cover of the AC drive.  11638_00

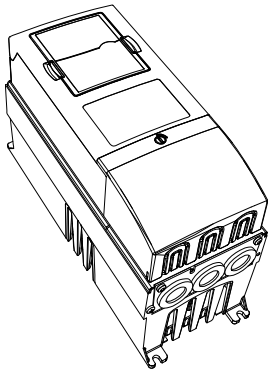
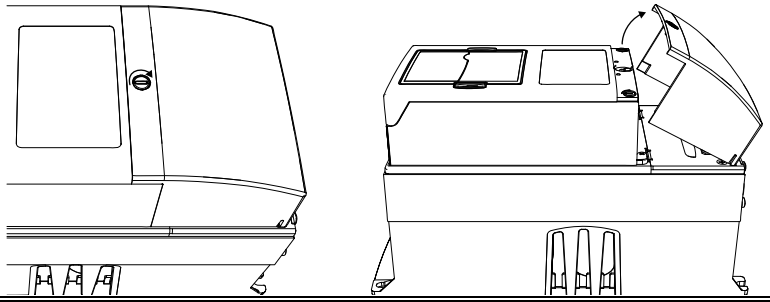
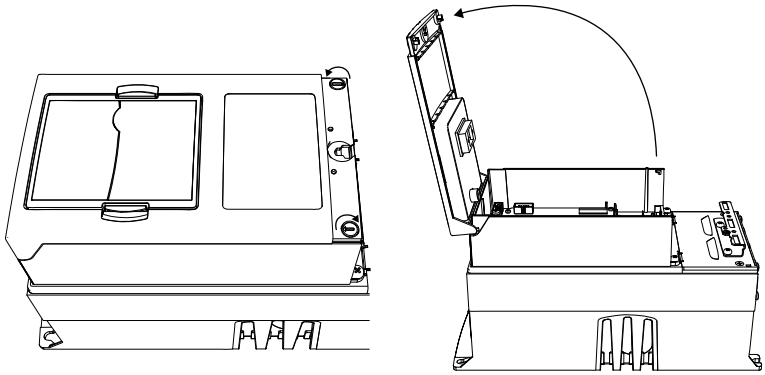
2	To get access to the option board slots, remove the screws and open the cover of the control unit.  11639_00

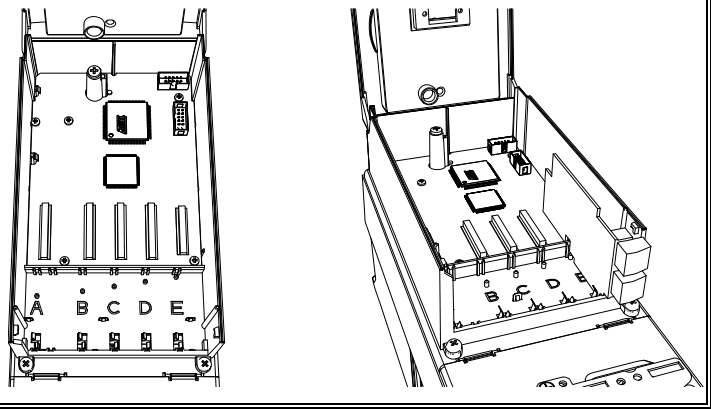
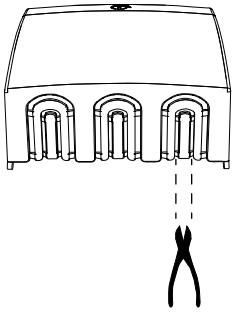
3	Install the option board into the correct slot, D or E.  11640_00
4	Close the option board cover.
5	Remove the cable entry plate. If you installed the option board in the slot D, use the cable entry plate on the right side. If you installed the option board in the slot E, use the cable entry plate on the left side. **NOTE!** The cable entry plate at the bottom of the drive is used only for mains and motor cables.  11641_00

6	Open the necessary holes in the cable entry plate. Do not open the other holes. See the VACON® 100 X Installation Manual for the dimensions of the holes.
7	Attach a cable gland on the hole in the cable entry plate. Pull the fieldbus cable through the hole. **NOTE!** The fieldbus cable must go through the correct cable entry plate to avoid going near the motor cable.  11642_00
8	Put the cable entry plate back.
9	Close the cover of the AC drive.

6.5 INSTALLATION IN VACON® NX

⚠ Make sure that the AC drive **is switched off** before an option or fieldbus board is changed or added!

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

4	Install the OPTE2/E8 RS485 option board in slot D or E on the control board of the AC drive. Make sure that the grounding plate fits tightly in the clamp. 
5	Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary. 
6	Close the cover of the control unit and the cable cover.

6.6 VACON® PC TOOLS

With VACON® PC tools it is possible to do following operations for OPTE2/E8 RS485:

- Update firmware into OPTE2/E8 RS485 option board
- Set parameters for OPTE2/E8 RS485
- Read monitor values of OPTE2/E8 RS485

6.6.1 PC TOOL SUPPORT

This table describes what PC tools are supported in each AC drive type. The connection type "serial" means a direct serial connection to the AC drive. The connection type "Ethernet" means that Ethernet connection is supported by using for example via VACON® 100 family built-in Ethernet interface or via OPTE9 Dual Port Ethernet option board.

Table 12. The supported PC tools with different AC drives

Tool	VACON® 100 family		VACON® NXS/NXP		VACON® 20 family	
	Serial	Ethernet	Serial	Ethernet	Serial	Ethernet
VACON® Loader	x		x		x	
VACON® Live	x	x			x	
NCIPConfig	Not used with OPTE2/E8 RS485					
NCDrive			x	x		
NCLoad	Not used with OPTE2/E8 RS485					

6.6.2 OPTE2/E8 OPTION BOARD FIRMWARE UPDATE WITH VACON® LOADER

You can update OPTE2/E8 RS485 firmware with VACON® Loader PC tool. You need to have:

- PC with VACON® Loader installed
- VACON® AC drive in which OPTE2/E8 RS485 option board is installed
- Serial cable:
- VACON® NXP/NXS is connected to PC with RS232 serial cable which is connected from PC to NXP/NXS control unit's 9-pin DSUB connector (female). If PC does not contain RS232 serial port, then USB - RS232 converter device is needed between PC and NXP/NXS control.
- VACON® 100 family and VACON® 20 are connected to PC with VACON® Serial Cable.

The VACON® Loader can be downloaded from https://www.danfoss.com/en/service-and-support/ → Downloads → Software → Select "Drives" as Business unit. It is bundled with the VACON® Live software package. After starting the installation program, follow the on-screen instructions.

The OPTE2/E8 RS485 firmware can be downloaded from https://www.danfoss.com/en/service-and-support/ → Downloads → Software → Select "Drives" as Business unit → Fieldbus firmware.

To update the option board firmware, follow the steps below.

NOTE! With VACON® 20, the baud rate 9600 must be used. 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® NX family AC drives VACON® Loader selects a correct baud rate automatically.

Step 1: Connect your PC to the controller by using the serial cable.

Then select the firmware file which you want to load to the option board and double click it. This will start the VACON® Loader software. You can also start the program from the Windows Start menu. In this case, select the firmware file using the "Browse" button.

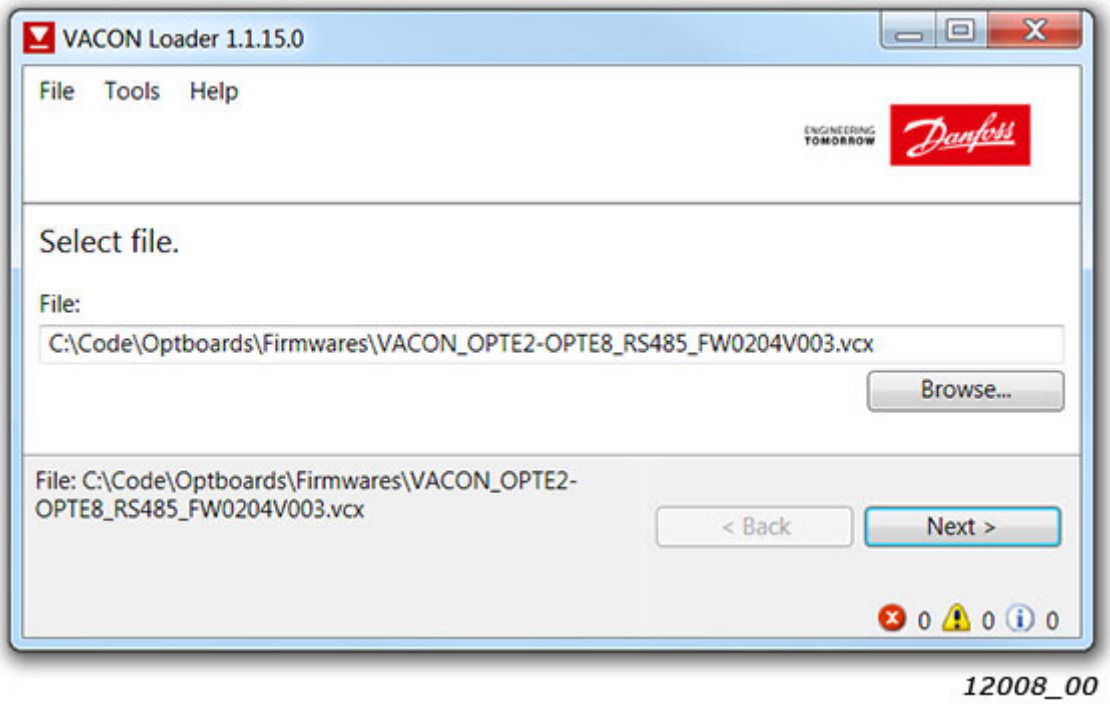


Figure 13. VACON® Loader: File selection

Step 2: Press 'next' and wait for the loader to find the network drives. Then select a drive from the list and press 'Connect to Selected'.

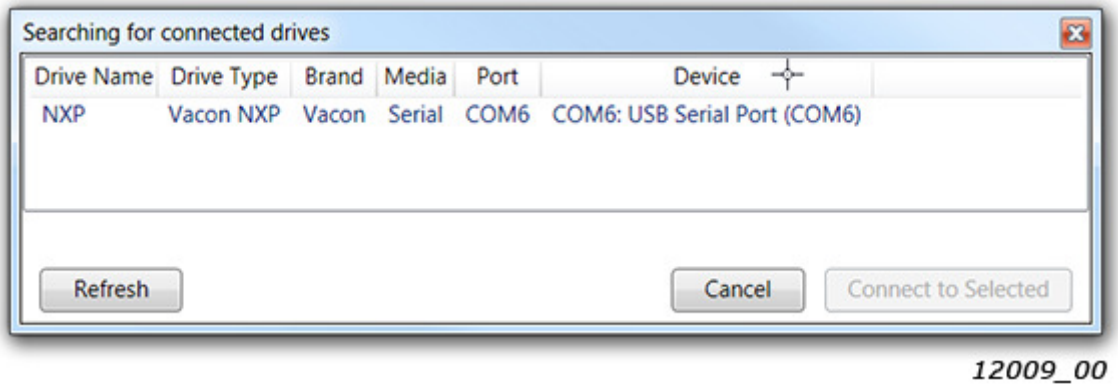


Figure 14. VACON® Loader: Connecting to drive

Step 3: Select the modules to be updated, press 'next' and wait until the operation is finished. See Figures below.

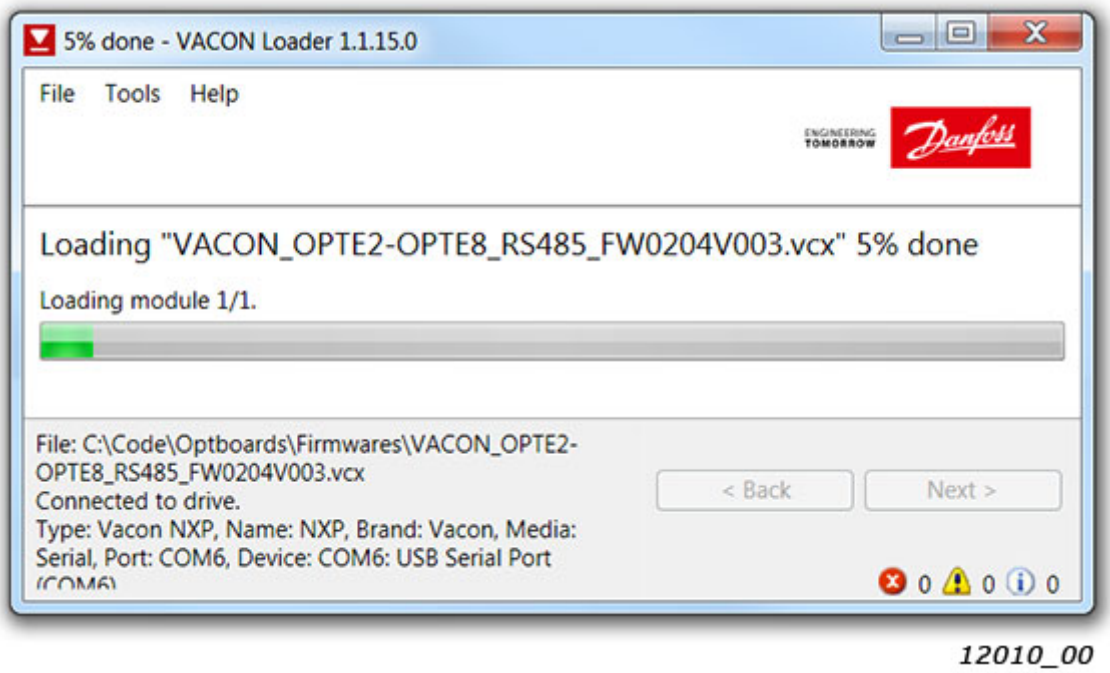


Figure 15. VACON® Loader: Firmware loading

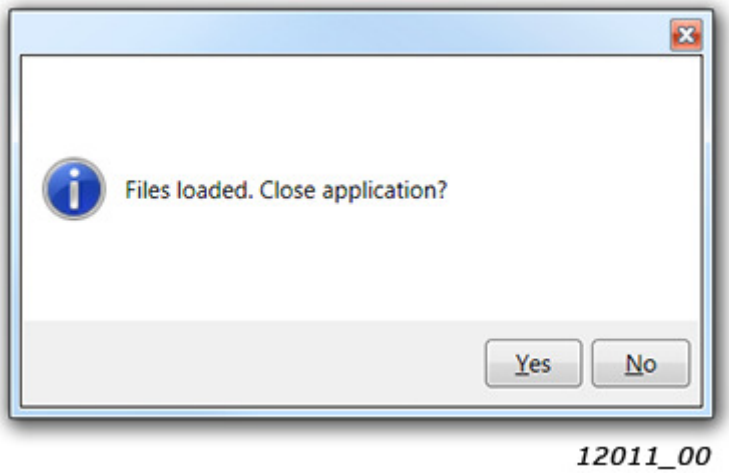


Figure 16. VACON® Loader: Loading is finished

6.6.3 PC TOOLS FOR VACON® NXP/NXS: NCDRIVE

You can configure the VACON® NXP/NXS AC drive and OPTE2/E8 RS485 parameters with the NCDrive PC tool. You need to have:

- PC with NCDrive installed
- VACON® NXP/NXS drive
- In case of Serial connection:
- If PC contains RS232 serial port, then connect the serial cable from PC to NXP/NXS control unit's 9-pin DSUB connector (female).
- If PC does not contain RS232 serial port, then USB - RS232 converter device is needed between PC and NXP/NXS control.
- In case of Ethernet connection:
- Ethernet cable which is connected to option board's Ethernet interface.
- VACON® NXP/NXS requires option board supporting Ethernet communication. For example, OPTE9 Dual Port Ethernet option board.

The NCDrive can be downloaded from https://www.danfoss.com/en/service-and-support/ → Downloads → Software → Select "Drives" as Business unit. After starting the installation program, follow the on-screen instructions.

Once the program is installed successfully, you can launch it by selecting it in the Windows Start menu. Select Help → Contents if you want more information about the software features.

6.6.3.1 NCDrive Serial communication settings

Connect your PC to the controller by using the USB/RS485 cable.

Select Tools → Options... → Communication tab. Then define settings for your USB - RS232 adapter and press OK.

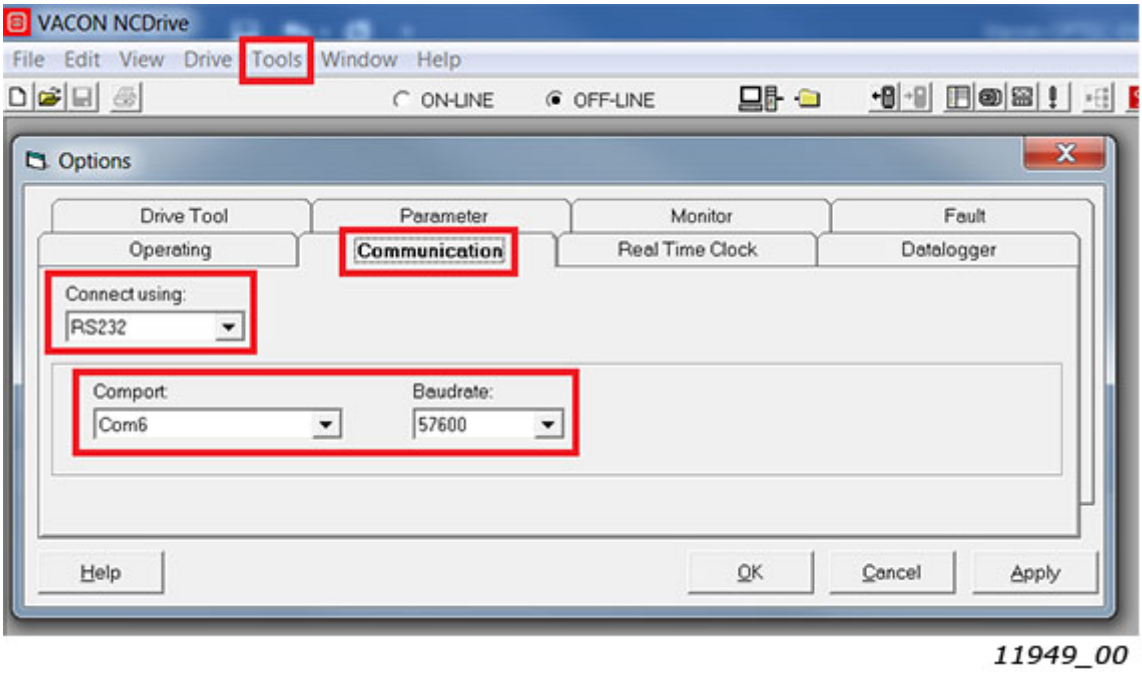


Figure 17. NCDrive: Serial communication settings

6.6.3.2 NCDrive Ethernet communication settings

For NCDrive Ethernet connection you need to have:

- Working Ethernet connection between PC and AC drive
- NCDrive is parametrized to use Ethernet connection

See instructions from Ethernet option board manual. Option board manuals can be downloaded from https://www.danfoss.com/en/service-and-support/ → Documentation → Select "Drives" as Business unit → Select "VACON® Option Boards" as Product Series.

6.6.3.3 Connecting to NCDrive

Press the "ON-LINE" button. The NCDrive will connect to the drive and start loading parameter information. See Figures below.

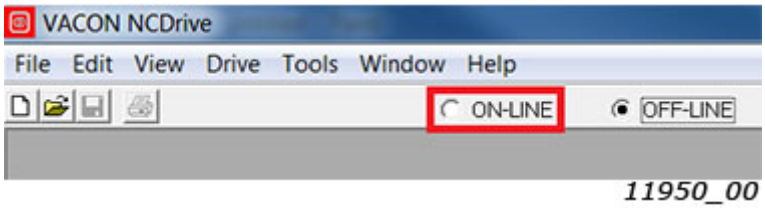


Figure 18. NCDrive: Going online

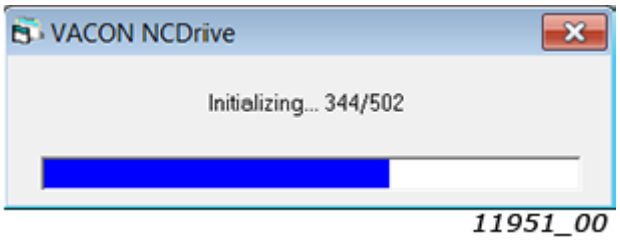


Figure 19. NCDrive: Loading information from the drive

To change the option board settings, navigate to the "M 7 Expander boards" menu and select the slot to which OPTE2/E8 RS485 is connected. It is possible to change parameters defined in chapter 7.1.2 Option board parameter menu.

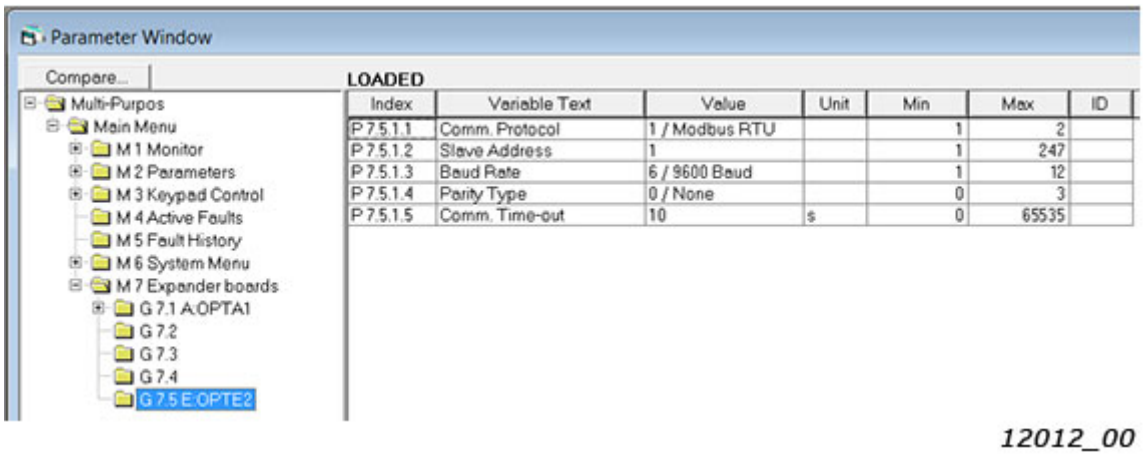


Figure 20. NC Drive: Parameter menu

6.6.4 PC TOOLS FOR VACON® 100 FAMILY AND VACON® 20: VACON® LIVE

You can configure the VACON® 100 family AC drives, VACON® 20 family AC drives and OPTE2/E8 RS485 parameters with VACON® Live PC tool. Also monitor values of these devices can be read with VACON® Live. You need to have:

- PC with VACON® Live installed
- VACON® 100 family or VACON® 20 family AC drive
- In case of Serial connection:
- VACON® Serial Cable (USB - Serial cable) which is connected from PC to AC drive control unit.
- In case of VACON® 20 also MCA (Micro Communications Adapter) is required. This adapter is not needed in case of VACON® 20 X / CP.
- In case of Ethernet connection:
- Ethernet cable which is connected to AC drive's Ethernet interface.
- In case of VACON® 100 family it is possible to use built-in Ethernet connection or Ethernet option board (for example OPTE9 Dual Port Ethernet).

NOTE! VACON® 20, VACON® 20 X and VACON® 20 Cold Plate do not support VACON® Live connection over Ethernet.

VACON® Live can be downloaded from https://www.danfoss.com/en/service-and-support/ → Downloads → Software → Select "Drives" as Business unit. After starting the installation program, follow the on-screen instructions.

Once the program is installed successfully, you can launch it by selecting it in the Windows Start menu. Select Help → Contents if you want more information about the software features.

6.6.4.1 VACON® Live Serial communication settings

Step 1: Connect your PC to VACON® AC drive with VACON® Serial Cable.

Step 2: Start VACON® Live. When the program starts, it asks "Select startup mode". Select "Online" startup mode. After this the program scans compatible drives.

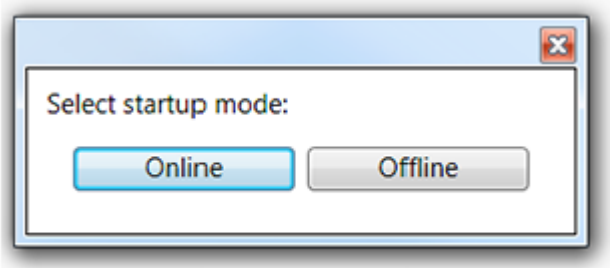


Figure 21. VACON® Live: To online mode

Step 2b: If VACON® Live cannot find your AC drive, then ensure that "Serial / Ethernet" or "Serial" is selected. After that press "Scan".

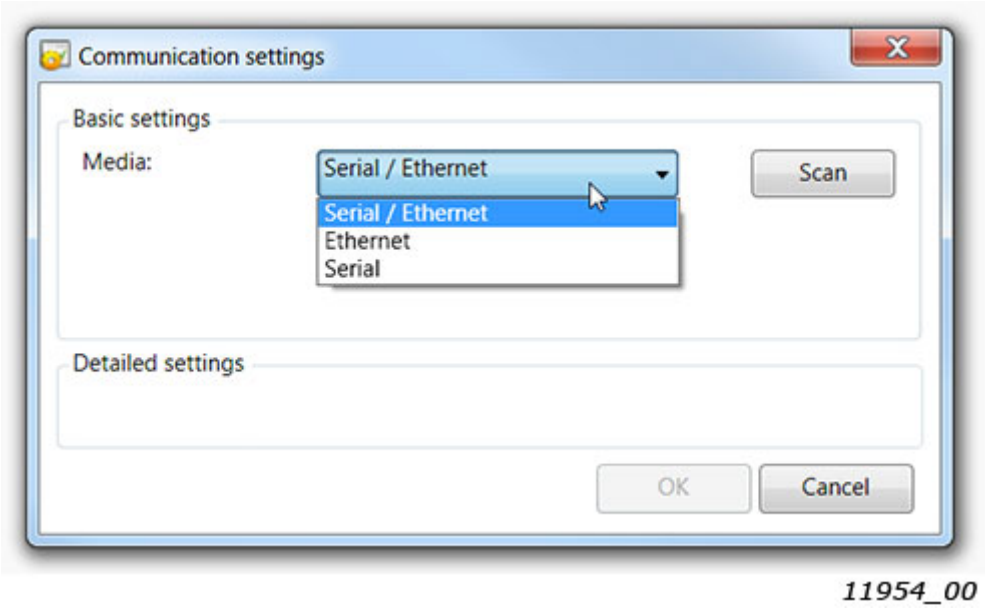


Figure 22. VACON® Live: Communication settings

Step 3: After successful scanning, VACON® Live shows the drive in connected drives window. Select the drive and press "Connected to Selected". After this VACON® Live reads parameter and monitor value tree from the drive.

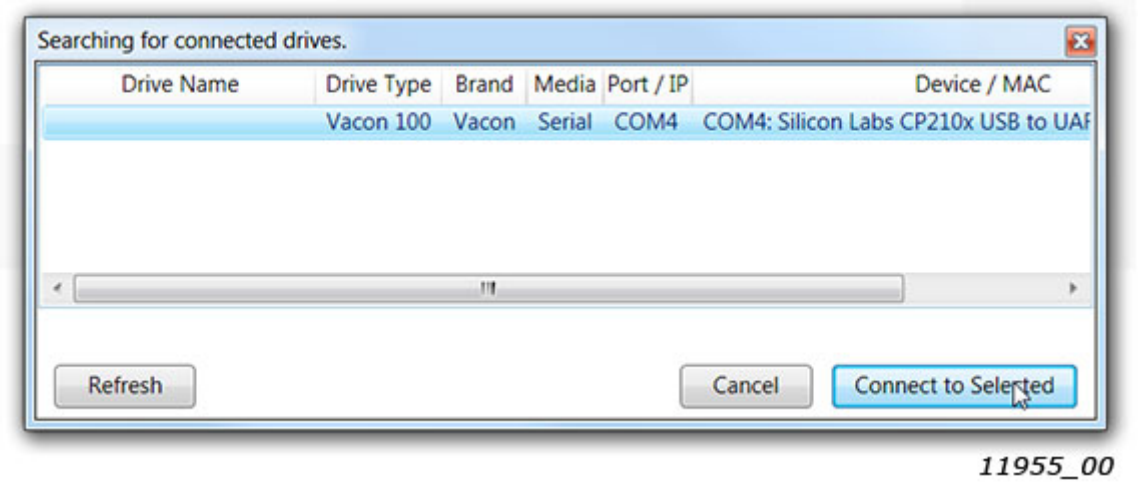


Figure 23. VACON® Live: Communication settings

6.6.4.2 VACON® Live Ethernet communication settings

For VACON® Live Ethernet connection you need to have:

- Working Ethernet connection between PC and AC drive
- VACON® Live is parametrized to use Ethernet connection

See instructions from Modbus, PROFINET IO, EtherNet/IP, BACnet/IP or OPTEA-OPTE9 Ethernet option board manuals for VACON® 100 family. Manuals can be downloaded from https://www.danfoss.com/en/service-and-support/ → Documentation → Select "Drives" as Business unit → Select "VACON® Option Boards" as Product Series.

6.6.4.3 OPTE2/E8 RS485 parameters in VACON® Live

OPTE2/E8 RS485 parameters and monitor values can be found from "5. I/O and Hardware" menu. With VACON® Live it is possible to modify OPTE2/E8 RS485 parameters and view monitor values.

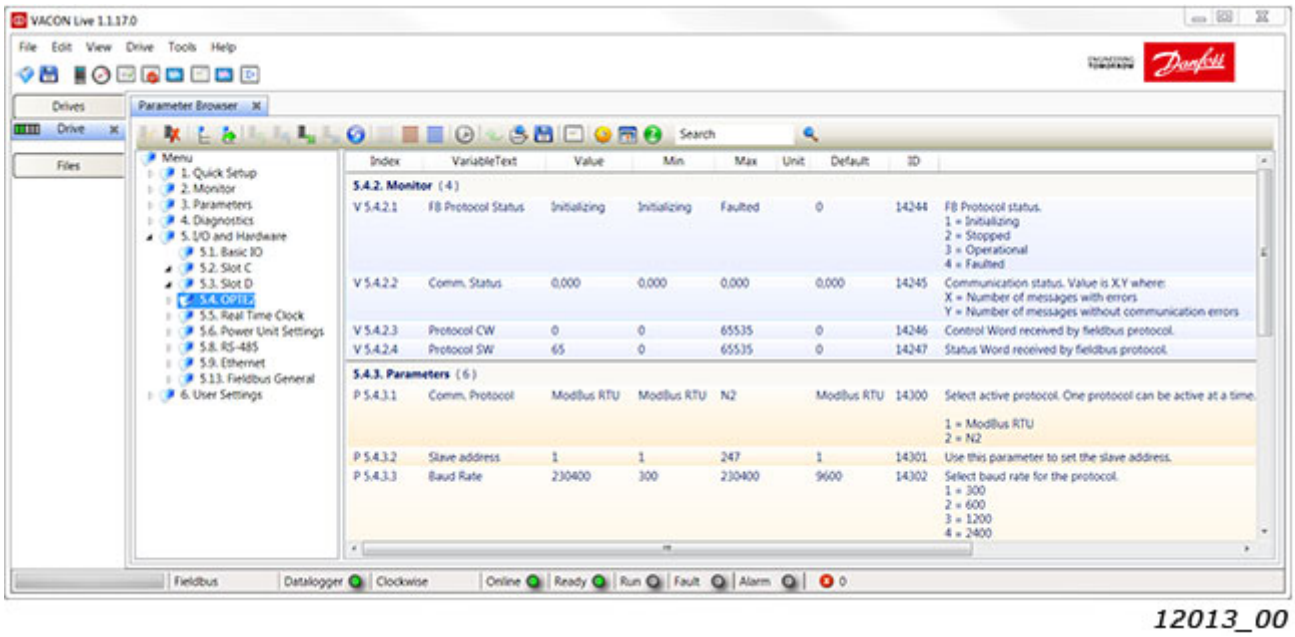


Figure 24. VACON® Live: OPTE2/E8 RS485 parameters

7. COMMISSIONING

OPTE2/E8 is commissioned with VACON® 20 keypad, VACON® 100 family panel or with VACON® NX family panel by setting appropriate parameters in the option board menu. Also PC tools can be used for OPTE2/E8 parametrization (see Chapter 6.6 "VACON® PC tools").

Keypad/Panel commissioning and location of parameters are different between these two types of drives.

Table 13. Parameter location for commissioning

Drive	Parameters location
VACON® 20	'System Menu' → P 2.x
VACON® 100 family	'I/O and Hardware (M7)' → Slot D' or 'Slot E'
VACON® NX family	Expander boards menu (M7) → Slot D' or 'Slot E'

NOTE! The AC drive application must be parametrized to enable motor controlling from the fieldbus. For application parametrization instructions, see Chapter 10 "Appendix A - Fieldbus parametrization".

7.1 OPTION BOARD MENU

The keypad/panel makes it possible for users to see which option board is connected to drive, and to reach and edit the parameters associated with option board.

7.1.1 OPTION BOARD MONITOR MENU

Table 14. Option board monitor menu

Monitor	Range	Description
Fieldbus protocol status	1 = Initializing, 3 = Operational, 4 = Faulted	
Communication Status	X.Y 0.0 ... 64.999	X = Number of messages with errors Y = Number of messages without communication errors
Protocol/fieldbus control word	-	Control word received from RS-485
Protocol/fieldbus status word	-	Status word in drive format

Communication status

The number of messages with errors counter is increased when OPTE2/E8 receives a corrupted frame from the bus. The content of the corrupted message cannot be parsed.

The number of messages without communication errors counter is increased when OPTE2/E8 receives a valid Modbus RTU or N2 frame from the bus. Also the frame that is addressed to some other slave device increases the counter.

7.1.2 OPTION BOARD PARAMETER MENU

Table 15. Option board parameter menu

Parameter	Range	Description
Communication protocol	1 = Modbus RTU 2 = N2	Current active fieldbus protocol. Default communication protocol is Modbus RTU
Slave address	1 ... 247	Slave address
Baud rate	1 = 300 bps 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600 7 = 19200 8 = 38400 9 = 57600 10 = 76800 11 = 115200 12 = 230400	Baud rate. Default baud rate is 9600 bps. When N2 protocol is used baud rate must be set to 9600.
Parity	0 = None 1 = Even 2 = Odd 3 = None Stopbits1	Modbus RTU: Parity None → 2 stop bit Parity Even → 1 stop bit Parity Odd → 1 stop bit Parity None Stopbits1 → 1 stop bit N2 always uses 1 stop bit.
Communication timeout	0 = Disable 1 ... 65535 s	Protocol communication timeout
Mode	1 = Normal 2 = NX mode	NX mode enables OPTC2/OPTC8 RS485 emulation. See Chapter "OPTC2/OPTC8 RS485 compatibility mode".

Communication timeout

The OPTE2/E8 RS485 option board reports communication timeout fault to the AC drive if the option board cannot receive Modbus RTU or Metasys N2 request during a communication timeout time. For more information on the fault, see Chapter 14.3 "Fieldbus timeout fault (F53)".

Only Modbus RTU or Metasys N2 requests that are pointed to the option board are taken into account in the communication timeout calculation. Requests that are pointed to other devices do not affect the timeout calculation.

Timeout monitoring starts after one valid request is received from the master.

The OPTE2/E8 RS485 does not create communication timeout fault to the drive when the timeout value is set to zero. This is useful for example when Modbus RTU or N2 is used only for monitoring the AC drive.

OPTC2/OPTC8 RS485 compatibility mode

OPTE2/OPTE8 firmware V003 and newer support the NX mode which enables emulation of the old OPTC2/OPTC8 RS485 option board.

- In case of VACON® NXP or VACON® NXS AC drive the emulation mode is enabled automatically.
- See also the related system parameter “Show to Application as” in Chapter 7.1.3 "System Parameter menu".

- In case of VACON® 100 family AC drives the emulation mode can be enabled by selecting "NX mode" with "Mode" parameter. See parameter in Chapter 7.1.2 "Option board parameter menu".

The OPTC2/OPTC8 compatibility mode causes the following functionality changes in OPTE2/OPTE8 RS485 option board:

- N2 Binary input (BI) mapping is different. See Chapter 9.3.2 "Binary Input (BI)".
- N2 Binary output (BO) mapping is different. See Chapter 9.3.4 "Binary Output (BO)".
- Modbus RTU reading/writing of multiple VACON® application ID's succeeds when reading/writing of at least one ID succeeds. Normally OPTE2/8 returns "Illegal Data Address" (2) Modbus error when access to one ID fails.
- Modbus RTU Holding/input register 98 reads the first active fault code.

7.1.3 System Parameter menu

Table 16. System Parameter menu

Parameter	Range	Description
Show to Application As*	0 = Default 17202 = OPTC2 17208 = OPTC8	Application sees the OPTE2/OPTE8 option board as OPTC2 or OPTC8 option board if "OPTC2" and "OPTC8" is selected.

*Available in VACON® NXP

Show to Application As

Some VACON® NXP applications assume that a certain fieldbus option board is used together with the application. In such cases, the application may refuse to go to the run state if a wrong type of fieldbus option is installed to the drive.

With the Show to Application As parameter it is possible to modify the option board type information that is fed to the application. For example, if an OPTC2 option board is replaced with an OPTE2 option board, with the Show to Application As parameter it is possible to lie to the application that an OPTC2 board is installed to the drive.

With the default setting the application normally sees the OPTE2/OPTE8 option board as OPTE2 or OPTE8 option board.

The Show to Application As parameter is available in VACON® NXP control firmware version NXP00002V198 and newer.

8. MODBUS RTU

8.1 OVERVIEW

The MODBUS protocol is an industrial communications and distributed control system to integrate PLCs, computers, terminals, and other monitoring, sensing, and control devices. MODBUS is a Master-Slave communications protocol. The Master controls all serial activity by selectively polling one or more slave devices. The protocol provides for one master device and up to 247 slave devices on a common line. Each device is assigned an address to distinguish it from all other connected devices.

The MODBUS protocol uses the master-slave technique, in which only one device (the master) can initiate a transaction. The other devices (the slaves) respond by supplying the request data to the master, or by taking the action requested in the query. The master can address individual slaves or initiate a broadcast message to all slaves. Slaves return a message ('response') to queries that are addressed to them individually. Responses are not returned to broadcast queries from the master.

8.2 MODBUS RTU COMMUNICATIONS

Features of the Modbus-VACON® interface:

- Acts as a Modbus slave
- Direct control of VACON® AC drive (e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to all VACON® parameters
- Monitor the status of the VACON® AC drive (e.g. Output frequency, Output current, Fault code)

8.2.1 DATA ADDRESSES IN MODBUS MESSAGE

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

- 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).

8.2.2 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 as well as the parameter ranges and steps can be found in the application manual in question. The parameter value is given without decimals. If several parameters/actual values are read with one message, the addresses of the parameters/actual values must be consecutive.

Table 17. Modbus memory map

Function code	Current terminology	Access type	Address range (hex
3 (0x03)	Read holding registers	16bit	40000-4FFFF
4 (0x04)	Read input registers	16bit	30000-3FFFF
6 (0x06)	Write single register	16bit	40000-4FFFF
16 (0x10)	Write multiple registers	16bit	40000-4FFFF
23 (0x17)	Read/Write multiple registers	16bit	40000-4FFFF

8.2.3 MODBUS EXCEPTION RESPONSES

Table 18. Modbus exception responses

Code	Function	Description
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the slave
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the slave
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for the slave
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred while slave was attempting to perform the requested action.
06	SLAVE DEVICE BUSY	The slave is engaged in processing a long-duration program command.
08	MEMORY PARITY ERROR	The slave attempted to read record file, but detected a parity error in memory.

8.3 MODBUS DATA MAPPING

8.3.1 HOLDING AND INPUT REGISTERS

Values can be read with function code 3 and code 4 (all registers are 3X and 4X reference). Modbus registers are mapped to the drive IDs as follows:

Table 19. Modbus register mapping to drive IDs

Address range	Purpose	Access type
0001 - 2000	VACON® Application IDs	16bit
98	If "NX mode" is enabled: Read active fault code	16bit
2001 - 2050	FBProcessDataIN	16bit
2051 - 2099	FBProcessDataIN	32bit
2101 - 2150	FBProcessDataOUT	16bit
2151 - 2199	FBProcessDataOUT	32bit
2200 - 10000	VACON® Application IDs	16bit
10501 - 10530	IDMap	16bit

Table 19. Modbus register mapping to drive IDs

Address range	Purpose	Access type
10601 - 10630	IDMap Read/Write	16bit
10701 - 10760	IDMap Read/Write	32bit
20001 - 40000	VACON® Application IDs	32bit
25101 - 25102	Drive system time	32bit
40001 - 40005	Operation day counter	16bit
40011 - 40012	Operation day counter	32bit
40201 - 40203	Energy counter	16bit
40211 - 40212	Energy counter	32bit
40301 - 40303	Resettable energy counter	16bit
40311 - 40312	Resettable energy counter	32bit
40401 - 40430	Fault history	16bit
40501	Communication timeout	16bit

8.3.1.1 VACON® application IDs

Application IDs are parameters that depend on the drive's application. These parameters can be read and written by pointing the corresponding memory range directly or by using the so-called ID map (more information below). It is easiest to use a straight address if you want to read a single parameter value or parameters with consecutive ID numbers. It is possible to read 12 consecutive ID addresses.

Table 20. VACON® application IDs

Address range	Purpose	ID
0001-2000	Application parameters (16bit)	1-2000
2200-10000	Application parameters (16bit)	2200-10000
20001 - 40000	Application parameters (32bit)	1-10000

Read register/registers can fail with Modbus error "ILLEGAL DATA ADDRESS" in the following cases:

- Reading of a single application ID fails if the ID does not exist.
- In case of VACON® 100 and VACON® 20 AC drives reading of multiple application IDs fails if reading of one ID fails.
- In "NX mode" OPTE2/E8 tries to read all registers. The read request succeeds if reading of one application ID succeeds. The failed application IDs are set to zero in the Modbus response data. If OPTE2/8 is used in VACON® NX AC drives, this mode is enabled automatically.
- In case of 32-bit address space the read operation fails if only half of the 32-bit value is read. The read request must read complete 32-bit values.

Write register/registers can fail with Modbus error "ILLEGAL DATA ADDRESS" in the following cases:

- Writing of a single application ID fails if the ID does not exist.
- In case of VACON® NXP/NXS AC drives writing of 32-bit value fails if the application ID is not 32-bit.
- In case of VACON® 100 family AC drives writing of register fails if the value written by Modbus is not inside the application ID value limits.
- In case of VACON® 100 family AC drives writing of register fails if the application ID is a monitor value.
- In case of VACON® 100 and VACON® 20 AC drives writing of multiple application IDs fails if writing of one ID fails.
- In "NX mode" OPTE2/8 tries to write all registers. The write request succeeds if writing of one application ID succeeds. If OPTE2/8 is used in VACON® NX drives, this mode is enabled automatically.
- In case of 32-bit address space the write operation fails if only half of the 32-bit value is written. The write request must write complete 32-bit values.

8.3.1.2 Drive System time

VACON® NX and VACON® 100 product families support reading and setting of drive system time via fieldbus. It is also possible to synchronize time by using SNTP protocol. For details of the functionality, see Ethernet fieldbus manuals.

With OPTE2/E8 Modbus RTU it is possible to read and write drive system time via ID 2551. The time is presented as unsigned 32-bit unix time. For example, unix time 1536315873 (0x5B9251E1) stands for 07-Sep-2018 10:24:33.

Example: Read or write drive system time by using 32-bit application parameter access. Modbus address 25102 (low data) becomes from calculation "32-bit area start address" + (application ID * 2) = 20000 + (2551 * 2).

Modbus index 25101 value: 23442 (0x5B92)

Modbus index 25102 value: 20961 (0x51E1)

NOTE! VACON® 100 family's default time zone is UTC. Local time can be configured by changing the time zone and setting the daylight saving mode. If the VACON® 100 family AC drive is equipped with a real-time clock battery, setting the time is not necessary after power cycle.

NOTE! VACON® NX family AC drives do not have time settings. Therefore the value written to this ID must be local time. VACON® NX system time is zero after the drive boots up. The system time is started after writing into ID 2551.

8.3.1.3 FB Process data IN

The process data in fields are used for fast controlling of the AC drive (e.g. Run, Stop, Reference and Fault Reset).

The 32-bit process data can be used with all VACON® AC drives, but only VACON® 100 family applications are able to process 32-bit data. In other AC drives the upper 16 bits are ignored.

Table 21. Process Data Master -> Slave (max 22 bytes)

Address		Name	Range/Type
16-bit*	32-bit		
2001	2051 = High data 2052 = Low data	FB Control Word	See Chapter 11.2 "Control Word bit support in VACON® AC drives".
2002	-	FB General Control Word	See Chapter 11.2 "Control Word bit support in VACON® AC drives".
2003	2053 = High data 2054 = Low data	FB Speed Reference	-10000...10000d See Chapter 11.6 "VACON® speed reference and actual speed - FBSpeedReference and FBActualSpeed".
2004	2055 = High data 2056 = Low data	FB Process Data In 1	See Chapter 11.7 "Process data".
2005	2057 = High data 2058 = Low data	FB Process Data In 2	See Chapter 11.7 "Process data".
2006	2059 = High data 2060 = Low data	FB Process Data In 3	See Chapter 11.7 "Process data".
2007	2061 = High data 2062 = Low data	FB Process Data In 4	See Chapter 11.7 "Process data".
2008	2063 = High data 2064 = Low data	FB Process Data In 5	See Chapter 11.7 "Process data".
2009	2065 = High data 2066 = Low data	FB Process Data In 6	See Chapter 11.7 "Process data".
2010	2067 = High data 2068 = Low data	FB Process Data In 7	See Chapter 11.7 "Process data".
2011	2069 = High data 2070 = Low data	FB Process Data In 8	See Chapter 11.7 "Process data".
2012**	2071 = High data 2072 = Low data	FB Process Data In 9	See Chapter 11.7 "Process data".
2013**	2073 = High data 2074 = Low data	FB Process Data In 10	See Chapter 11.7 "Process data".
2014**	2075 = High data 2076 = Low data	FB Process Data In 11	See Chapter 11.7 "Process data".
2015**	2077 = High data 2078 = Low data	FB Process Data In 12	See Chapter 11.7 "Process data".
2016**	2079 = High data 2080 = Low data	FB Process Data In 13	See Chapter 11.7 "Process data".
2017**	2081 = High data 2082 = Low data	FB Process Data In 14	See Chapter 11.7 "Process data".
2018**	2083 = High data 2084 = Low data	FB Process Data In 15	See Chapter 11.7 "Process data".
2019**	2085 = High data 2086 = Low data	FB Process Data In 16	See Chapter 11.7 "Process data".

*In VACON® 100 family, the Control Word and the Status Word are formed of 32 bits. Only the initial 16 bits can be read in the 16-bit area.

**See requirements for 9–16 process data items in Chapter 12 "Appendix C - Fieldbus option board communication".

Control word bits

See Control word bits definition in Chapter 11.8 "Fieldbus process data mapping and scaling".

8.3.1.4 FB Process data OUT

The process data out fields are used for fast monitoring of the AC drive (e.g. drive status and actual speed).

The 32-bit process data can be used with all VACON® AC drives, but only VACON® 100 family applications are able to transmit 32-bit data. In other drives the upper 16 bits are set to zero.

Table 22. FB Process data OUT

Address		Name	Range/Type
16-bit*	32-bit		
2101	2151 = High data 2152 = Low data	FB Status Word	See Chapter 11.3 "VACON® Status Word - FBFixedStatusWord".
2102	-	FB General Status Word	See Chapter 11.3 "VACON® Status Word - FBFixedStatusWord".
2103	2153 = High data 2154 = Low data	FB Actual Speed	-10000...10000d See Chapter 11.6 "VACON® speed reference and actual speed - FBSpeedReference and FBActualSpeed".
2104	2155 = High data 2156 = Low data	FB Process Data Out 1	See Chapter 11.7 "Process data".
2105	2157 = High data 2158 = Low data	FB Process Data Out 2	See Chapter 11.7 "Process data".
2106	2159 = High data 2160 = Low data	FB Process Data Out 3	See Chapter 11.7 "Process data".
2107	2161 = High data 2162 = Low data	FB Process Data Out 4	See Chapter 11.7 "Process data".
2108	2163 = High data 2164 = Low data	FB Process Data Out 5	See Chapter 11.7 "Process data".
2109	2165 = High data 2166 = Low data	FB Process Data Out 6	See Chapter 11.7 "Process data".
2110	2167 = High data 2168 = Low data	FB Process Data Out 7	See Chapter 11.7 "Process data".
2111	2169 = High data 2170 = Low data	FB Process Data Out 8	See Chapter 11.7 "Process data".
2112[2)]	2171 = High data 2172 = Low data	FB Process Data Out 9	See Chapter 11.7 "Process data".
2113**	2173 = High data 2174 = Low data	FB Process Data Out 10	See Chapter 11.7 "Process data".
2114**	2175 = High data 2176 = Low data	FB Process Data Out 11	See Chapter 11.7 "Process data".
2115**	2177 = High data 2178 = Low data	FB Process Data Out 12	See Chapter 11.7 "Process data".
2116**	2179 = High data 2180 = Low data	FB Process Data Out 13	See Chapter 11.7 "Process data".

Table 22. FB Process data OUT

Address		Name	Range/Type
16-bit*	32-bit		
2117**	2181 = High data 2182 = Low data	FB Process Data Out 14	See Chapter 11.7 "Process data".
2118**	2183 = High data 2184 = Low data	FB Process Data Out 15	See Chapter 11.7 "Process data".
2119**	2185 = High data 2186 = Low data	FB Process Data Out 16	See Chapter 11.7 "Process data".

*In VACON® 100 family, the Status Word is formed of 32 bits. Only the lower 16bits can be read in the 16-bit area.

**See requirements for 9–16 process data items in Chapter 12 "Appendix C - Fieldbus option board communication".

Status word bits

See Status word bits definition in Chapter 11.3 "VACON® Status Word - FBFixedStatusWord".

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...PD8 the device can be given other reference values (e.g. Torque reference).

With the Status Word (SW) read by the Master, the status of the device can be seen. Actual Value (ACT) and PD1...PD8 show the other actual values.

8.3.1.5 ID map

Using the ID map, you can read consecutive memory blocks that contain parameters whose ID's are not in a consecutive order. The address range 10501 - 10530 is called 'IDMap', and it includes an address map in which you can write your parameter IDs in any order. The address range 10601 to 10630 is called 'IDMap Read/Write,' and it includes values for parameters written in the IDMap. As soon as 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 - 10730 contains the ID Map for 32bit values.

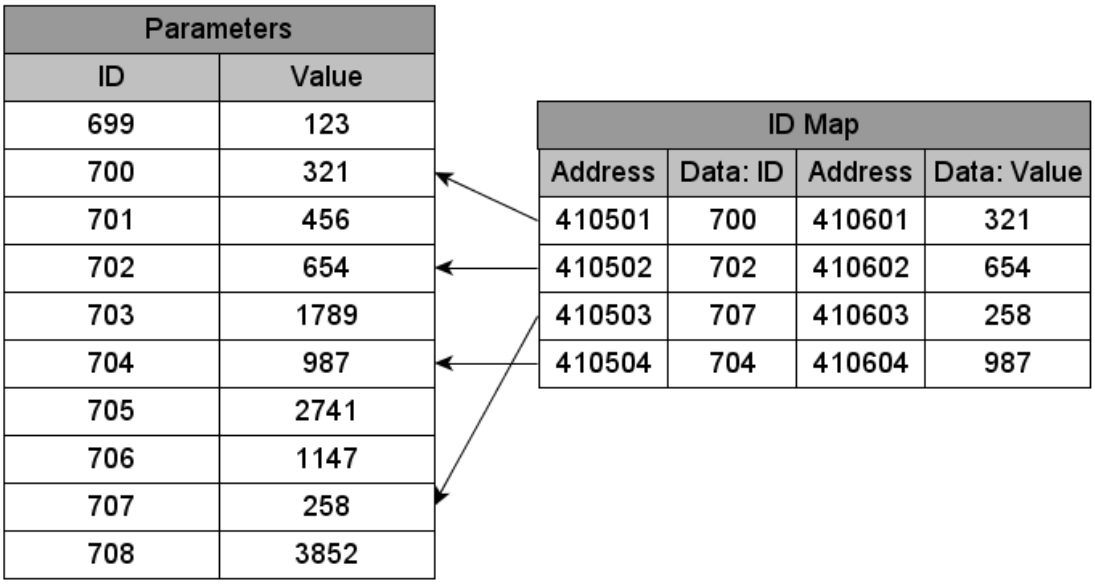


Figure 25.

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

Table 23.

Address	Data
410601	Data included in parameter ID700
410602	Data included in parameter ID702
410603	Data included in parameter ID707
410604	Data included in parameter ID704

If the IDMap table has not been initialized, all 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 24. Example of 32bit IDMap

Address	Data
410701	Data High, parameter ID700
410702	Data Low, parameter ID700
410703	Data High, parameter ID702
410704	Data Low, parameter ID702

8.3.1.6 Operation day counter

Control unit operating time counter (total value). This counter cannot be reset.

Operation day counter as seconds

This counter in registers 40011d to 40012d holds the value of operation days as seconds in a 32-bit unsigned integer.

Table 25. Operation day counter as seconds

Address	Register	Description
40011 High data	440011	Holds the counter value as seconds.
40012 Low data	440012	

Operation day counter

This counter in registers 40001d to 40005d holds the value of operation days counter.

For compatibility with V100 internal and OPT-CI option board, this counter is found from two different register areas: holding registers 40001d to 40005d and input registers 1d to 5d.

Table 26. 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

8.3.1.7 Resettable operation day counter

This register holds the value for resettable control unit operating time counter (trip value).

NOTE! VACON® 20 does not support resettable operation day counter.

Resettable operation day counter as seconds

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

Table 27. Resettable operation day counter as seconds

Address	Register	Description
40111 High data	440111	Holds the counter value as seconds.
40112 Low data	440112	

Resettable operation day counter

This counter in registers 40101d to 40105d holds the value of operation days counter.

For compatibility, this counter is found from two different register areas: holding registers 40101d to 40105d and input registers 30101d to 30105d.

Table 28. 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

8.3.1.8 Energy counter

This counter holds the value of total amount of energy taken from supply network. This counter cannot be reset.

Energy counter as kWh

This counter is in registers 40211d to 40212d and is a 32-bit floating point (IEEE 754) value containing the number of kilowatt-hours (kWh) that is in the drive's energy counter. This value is read-only.

Table 29. Energy counter as kWh

Address	Register	Description
40211 High data	440201	Holds the value of energy counter in kWh. Datatype is 32 bit float IEEE 754
40212 Low data	440202	

Energy counter

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, 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 30. Energy counter

Holding register address	Input register address	Purpose	Description
40201	201	Energy	Amount of energy taken from 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.

8.3.1.9 Resettable energy counter

This counter holds the value of total amount of energy taken from supply network since the counter was last reset.

Resettable energy counter as kWh

This counter is in registers 40311d to 40312d and is a 32-bit floating point (IEEE 754) value containing the number of kilowatt-hours (kWh) that is in the drive's resettable energy counter.

Table 31. Resettable energy counter as kWh

Address	Register	Description
40311 High data	440311	Holds the value of energy counter in kWh since last counter reset. Datatype is 32 bit float IEEE 754
40312 Low data	440312	

Resettable energy counter

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, 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 32. Resettable energy counter

Holding register address	Input register address	Purpose	Description
40301	301	Energy	Amount of energy taken from 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 4 = TWh	Unit of the value.

8.3.1.10 Fault history

The fault history can be viewed by reading 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 maximum 29 faults at the same time (Note: VACON® 20 fault history contains only maximum 9 faults). For compatibility, this counter is also found from input register area: 401d to 403d.

The fault history contents are represented as follows.

Table 33. Fault history

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

8.3.1.11 Fault history with 16-bit error codes

The fault history can be viewed by reading from address 40511 onward. The faults are listed in chronological order so that the latest fault is mentioned first and the oldest last. These addresses contain fault code and the subcode for the fault. Reading can be started from any address.

Table 34. Fault history with 16-bit error codes

Holding register address	Input register address	Purpose
40511	Fault code 1	16-bit fault code in index 1.
40512	Sub code 1	16-bit sub code for fault in index 1.
40513	Fault code 2	16-bit fault code in index 2.
40514	Sub code 2	16-bit sub code for fault in index 2.
...		
40569	Fault code 30	
40570	Sub code 30	

8.4 QUICK SETUP

Following these instructions, you can easily and fast set up your Modbus for use:

First parametrize AC drive for field bus. See instructions in Chapter 10 "Appendix A - Fieldbus parametrization".

In the Master software:

1. Make these settings in the master software
2. Set Control Word to **'0'** (2001)
3. Set Control Word to **'1'** (2001)
4. Drive's status is RUN
5. Set Reference value to **'5000'** (50.00%) (2003).
6. Actual speed is 5000 (25.00 Hz if MinFreq is 0.00 Hz and MaxFreq is 50.00 Hz)
7. Set Control Word to **'0'** (2001)
8. Drive's status is STOP.

8.5 EXAMPLE MESSAGES

8.5.1 EXAMPLE 1: WRITE PROCESS DATA

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

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	
	No. of registers HI	00 hex	Number of registers 0003 hex (= 3)
	No. 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	Data 3 = 1388 hex (= 5000), Speed Reference to 50.00%
	Data LO	88 hex	
ERROR CHECK	Data HI	C8 hex	CRC field C8CB hex (= 51403)
	Data LO	CB hex	

Message frame:

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

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

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	
	No. of registers HI	00 hex	Number of registers 0003 hex (= 3)
	No. of registers LO	03 hex	
ERROR CHECK	CRC HI	80 hex	CRC 8085 hex (= 32901)
	CRC LO	85 hex	

Reply frame:

01	10	07	D0	00	03	80	85

8.5.2 EXAMPLE 2: READ PROCESS DATA

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

Command Master - Slave:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Starting address HI	08 hex	Starting address 0836 hex (= 2102)
	Starting address LO	36 hex	
	No. of registers HI	00 hex	Number of registers 0002 hex (= 2)
	No. of registers LO	02 hex	
ERROR CHECK	CRC HI	93 hex	CRC 93A5 hex (= 37797)
	CRC LO	A5 hex	

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.

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

Reply frame:

01	04	04	13	88	09	C4	78	E9

8.5.3 EXAMPLE 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.

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	
	No. of registers HI	00 hex	Invalid number of registers 0005 hex (= 5)
	No. of registers LO	05 hex	
ERROR CHECK	CRC HI	34 hex	CRC 3466 hex (= 13414)
	CRC LO	66 hex	

Message frame:

01	04	17	70	00	05	34	55

Exception response.

Answer Slave - Master:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		84 hex	Most significant bit set to 1
DATA	Starting address HI	04 hex	Error code 04 => Slave device failure
ERROR CHECK	CRC HI	42 hex	CRC 3466 hex (= 13414)
	CRC LO	C3 hex	

Reply frame:

01	84	04	42	C3

9. METASYS N2

9.1 OVERVIEW

The N2 communications protocol is used by Johnson Controls and others to connect terminal unit controllers to supervisory controllers. It is open to any manufacturer and based upon simple ASCII protocol widely used in the process control industry.

The physical characteristics of the N2 bus are two wires RS-485 with a maximum of 100 devices over a 4000 foot distance running at 9600 bps by default. Logically, the N2 is a master-slave protocol, the supervisory controller normally being the master.

9.2 METASYS N2 COMMUNICATION

Features of the N2 interface:

- Direct control of drive (e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to necessary parameters
- Monitor drive status (e.g. Output frequency, Output current, Fault code)
- In standalone operation, or should the polling stop, the overridden values are released after a specified period.

9.2.1 ANALOGUE INPUT (AI)

All Analogue Input (AI) points have the following features:

- Support Change of State (COS) reporting based on high and low warning limits.
- Support Change of State (COS) reporting based on high and low alarm limits.
- Support Change of State (COS) reporting based on override status.
- Always considered reliable and never out of range.
- Writing of alarm and warning limit values beyond the range that can be held by the drive's internal variable will result in having that limit replaced by the "Invalid Float" value even though the message is acknowledged. The net result will be the inactivation of the alarm or warning (the same as if the original out of range value was used).
- Overriding is supported from the standpoint that the "Override Active" bit will be set and the value reported to the N2 network will be the overridden value. However, the value in the drive remains unchanged. Therefore, the N2 system should be set up to disallow overriding AI points or have an alarm condition activated when an AI point is overridden.
- Overriding an AI point with a value beyond the limit allowed by the drive's internal variable will result in an "Invalid Data" error response and the override status and value will remain unchanged.

9.2.2 BINARY INPUT (BI)

All Binary Input (BI) points have the following features:

- Support Change of State (COS) reporting based on current state.
- Support Change of State (COS) reporting based on alarm condition.
- Support Change of State (COS) reporting based on override status.
- Always considered reliable.

Overriding is supported from the standpoint that the "Override Active" bit will be set and the value reported to the N2 network will be the overridden value. However, the value in the drive remains unchanged. Therefore, the N2 system should be set up to disallow overriding BI points or have an alarm condition activated when a BI point is overridden.

9.2.3 Analogue Output (AO)

All Analogue Output (AO) points have the following features:

- Support Change of State (COS) reporting based on override status.
- Always considered reliable.
- Overriding of the AO points is the method used to change a value. Overriding an AO point with a value beyond the limit allowed by the drive's internal variable will result in an "Invalid Data" error response and the override status and value will remain unchanged. If the overridden value is beyond the drive's parameter limit but within the range that will fit in the variable, an acknowledge response is given and the value will be internally clamped to its limit.
- An AO point override copies the override value to the corresponding drive parameter. This is the same as changing the value on the keypad. The value is non-volatile and will remain in effect when the drive is turned off and back on. It also remains at this value when the N2 network "releases" the point. The N2 system always reads the current parameter value.

NOTE! On some N2 systems, the system will not poll the AO point when it is being overridden. In this case, the N2 system will not notice a change in value if the change is made with the keypad. To avoid this, set the point up as a "local control" type and release it once it has been overridden. In this way, the N2 system will monitor the value when not being overridden.

9.2.4 Binary Output (BO)

All Binary Output (BO) points have the following features:

- Support Change of State (COS) reporting based on override status.
- Always considered reliable.
- Overriding BO points control the drive. These points are input commands to the drive. When released, the drive's internal value remains at its last overridden value.

9.2.5 Internal Integer (ADI)

All Internal Integer (ADI) points have the following features:

- Do not support Change of State (COS) reporting.
- Can be overridden and the "Override Active" bit will be set. However, the Internal value is unchanged (Read only).

9.3 METASYS N2 POINT MAP

9.3.1 ANALOGUE INPUT (AI)

Table 35. Analogue Input (AI)

NPT	NPA	Description	Units	Note
AI	1	Speed setpoint	Hz	2 decimals
AI	2	Output frequency	Hz	2 decimals
AI	3	Motor speed	Rpm	0 decimal
AI	4	Load (power)	%	1 decimal
AI	5	Megawatt hours	MWh	Total counter
AI	6	Motor current	A	2 decimals
AI	7	Bus voltage	V	0 decimal
AI	8	Motor volts	V	1 decimal
AI	9	Heatsink temperature	°C	0 decimal
AI	10	Motor torque	%	1 decimal
AI	11	Operating days (trip)	Day	0 decimal
AI	12	Operating hours (trip)	Hour	0 decimal
AI	13	Kilowatt hours (trip)	kWh	Trip counter
AI	14	Torque reference	%	1 decimal
AI	15	Motor temperature rise*	%	1 decimal
AI	16	FBProcessDataOut1	-32768 to +32767	0 decimal
AI	17	FBProcessDataOut2	-32768 to +32767	0 decimal
AI	18	FBProcessDataOut3	-32768 to +32767	0 decimal
AI	19	FBProcessDataOut4	-32768 to +32767	0 decimal
AI	20	FBProcessDataOut5	-32768 to +32767	0 decimal
AI	21	FBProcessDataOut6	-32768 to +32767	0 decimal
AI	22	FBProcessDataOut7	-32768 to +32767	0 decimal
AI	23	FBProcessDataOut8	-32768 to +32767	0 decimal

*This is not supported by VACON® 20.

9.3.2 BINARY INPUT (BI)

Binary Input (BI) functionality depends on the compatibility mode. See Chapter "OPTC2/OPTC8 RS485 compatibility mode".

- In "Normal" mode the functionality is the same as in VACON® 100 family onboard N2 protocol.
- In "NX mode" mode OPTE2/E8 emulates the functionality of the OPTC2/C8 RS485 option board. The binary Inputs 8–15 are mapped to application specific FB General Status Word bits.

Table 36. Binary Input (BI) in Normal mode

NPT	NPA	Description	0 =	1 =
BI	1	Ready	Not ready	Ready
BI	2	Run	Stop	Run
BI	3	Direction	Clockwise	Counterclockwise
BI	4	Faulted	Not faulted	Faulted
BI	5	Alarm	Not alarm	Alarm
BI	6	Reference frequency reached	False	True
BI	7	Motor running zero speed	False	True
BI	8	Flux ready	Not ready	Ready

Table 37. Binary input (BI) in NX mode

NPT	NPA	Description	0 =	1 =
BI	1	Ready	Not ready	Ready
BI	2	Run	Stop	Run
BI	3	Direction	Clockwise	Counterclockwise
BI	4	Faulted	Not faulted	Faulted
BI	5	Alarm	Not alarm	Alarm
BI	6	Reference frequency reached	False	True
BI	7	Motor running zero speed	False	True
BI	8	FB General Status Word bit 0	0	1
BI	9	FB General Status Word bit 1	0	1
BI	10	FB General Status Word bit 2	0	1
BI	11	FB General Status Word bit 3	0	1
BI	12	FB General Status Word bit 4	0	1
BI	13	FB General Status Word bit 5	0	1
BI	14	FB General Status Word bit 6	0	1
BI	15	FB General Status Word bit 7	0	1

9.3.3 ANALOGUE OUTPUT (AO)

Table 38. Analogue Output (AO)

NPT	NPA	Description	Units	Note
AO	1	Common speed	-100.00%–100.00%	2 decimals
AO	2	Current limit	A	2 decimals
AO	3	Minimum speed	Hz	2 decimals
AO	4	Maximum speed	Hz	2 decimals
AO	5	Acceleration time	s	1 decimal
AO	6	Deceleration time	s	1 decimal
AO	7	FBProcessDataIN1	-32768 to +32767	0 decimal
AO	8	FBProcessDataIN2	-32768 to +32767	0 decimal
AO	9	FBProcessDataIN3	-32768 to +32767	0 decimal
AO	10	FBProcessDataIN4	-32768 to +32767	0 decimal
AO	11	FBProcessDataIN5	-32768 to +32767	0 decimal
AO	12	FBProcessDataIN6	-32768 to +32767	0 decimal
AO	13	FBProcessDataIN7	-32768 to +32767	0 decimal
AO	14	FBProcessDataIN8	-32768 to +32767	0 decimal
AO	15	Any parameter read/write	-	Depends on parameter

9.3.4 BINARY OUTPUT (BO)

Binary Out (BO) functionality depends on the compatibility mode. See Chapter "OPTC2/OPTC8 RS485 compatibility mode".

- In "Normal" mode the functionality is the same as in VACON® 100 family onboard N2 protocol.
- In "NX mode" mode OPTE2/E8 emulates the functionality of the OPTC2/C8 RS485 option board. The binary Outputs 4–16 are mapped to Fixed control word bits.

Table 39. Binary Output (BO) in Normal mode

NPT	NPA	Description	0=	1=
BO	1	Comms start/stop	Stop	Start
BO	2	Comms forward/reverse	Forward	Reverse
BO	3	Reset fault	N/A	Reset
BO	4	Stop mode information 1	-	-
BO	5	Stop mode information 2	-	-
BO	6	Force ramp to zero	-	-
BO	7	Freeze ramp	-	-
BO	8	Reference to zero	-	-
BO	9	BusCtrl	-	-
BO	10	BusRef	-	-
BO	11	Operation time trip reset	-	Reset AI11 & AI12
BO	12	Energy trip counter reset	-	Reset AI13

Table 40. Binary Output (BO) in NX mode

NPT	NPA	Description	0=	1=
BO	1	Comms start/stop	Stop	Start
BO	2	Comms forward/reverse	Forward	Reverse
BO	3	Reset fault	N/A	Reset
BO	4	FB Control Word bit 3	-	-
BO	5	FB Control Word bit 4	-	-
BO	6	FB Control Word bit 5	-	-
BO	7	FB Control Word bit 6	-	-
BO	8	FB Control Word bit 7	-	-
BO	9	FB Control Word bit 8	-	-
BO	10	FB Control Word bit 9	-	-
BO	11	FB Control Word bit 10	-	-
BO	12	FB Control Word bit 11	-	-
BO	13	FB Control Word bit 12	-	-
BO	14	FB Control Word bit 13	-	-
BO	15	FB Control Word bit 14	-	-
BO	16	FB Control Word bit 15	-	-

9.3.5 Internal Integer (ADI)

Table 41. Internal Integer (ADI)

NPT	NPA	Description	Units
ADI	1	Active fault code	-
ADI	2	Control word	-
ADI	3	Status word	-
ADI	4	Any parameter ID	-

N2 Any parameter service

With the Any parameter functionality it is possible to read and write ID's from/to the AC drive. Take into account the application specific limitations and value scaling. For more information, see application manual.

Read ID 102 (Maximum Frequency Reference) parameter value:

7. Write '102' to ADI4: Any parameter ID.
8. Read AO15: Any parameter read/write.

Write value '15' to ID 103 (Acceleration Time 1) parameter:

1. Write '103' to ADI4: Any parameter ID.
2. Write value '15' to AO15: Any parameter read/write.

9.4 QUICK SETUP

Following these instructions, you can easily and fast set up your N2 for use.

First parametrize AC drive for field bus. See instructions in Chapter 10 "Appendix A - Fieldbus parametrization".

Make these settings in the N2 master software:

1. Set Control Word to '0' (ADI2).
2. Set Control Word to '1' (ADI2).
3. AC drive status is RUN.
4. Set Reference value to '50.00%' (AO1).
5. Output Frequency (AI2) is 25.00Hz if MinFreq is 0.00 Hz and MaxFreq is 50.00 Hz.
6. Set Control Word to '0' (ADI2).
7. AC drive status is STOP.

10. APPENDIX A - FIELDBUS PARAMETRIZATION

The following chapter describes briefly how to parametrize the AC drive in order for the motor to be controllable via fieldbus. These instructions are written for some basic applications. For more information, see the application specific manual.

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. Note that if the control unit firmware is updated, the default settings are restored. In addition, some applications may have the remote speed reference selection set by default to other than fieldbus. In these cases, the speed reference selection must be set to fieldbus, in order for the speed reference to be controlled via fieldbus.

NOTE! The motor control mode should be selected to support the used process and profile.

10.1 FIELDBUS CONTROL AND BASIC REFERENCE SELECTION

The following tables list some of the parameters related to fieldbus control in case of standard applications for the VACON® 100 family, VACON® NX family and VACON® 20 family AC drives. See the application specific manuals for more detailed information and latest updates.

The parameters can be read and written by using the drive panel, PC tools or fieldbus protocol. The following table contains links to chapters where the ID value reading is described.

Table 42. Parametrization for VACON® 100 family (standard application)

Parameter name	ID	Value	Default	Panel Tree
Control mode	600	0 = Frequency 1 = Speed 2 = Torque	0	P3.1.2.1
Remote control place	172	1 = Fieldbus CTRL	0	P3.2.1
Local / remote	211	0 = Remote	0	P3.2.2
Fieldbus ref. sel.	122	3 = Fieldbus	3	P3.3.1.10
Controlling fieldbus	2539	See description in a following Chapter “10.2 Controlling fieldbus parameter”	1	P5.13.1

Table 43. Parametrization for VACON® 20 (standard application)

Parameter name	ID	Value	Default	Panel Tree
Disable showing of Quick menu	-	0 = Advanced menu 1 = Quick setup parameters	1	P17.2
Motor control mode	600	0 = Frequency 1 = Speed	0	P1.8
Rem. Control place 1 sel.	172	1 = Fieldbus CTRL	0	P2.1
Local / remote	211	0 = Remote	0	P2.5
Rem. Control place 1 freq. ref. sel.	117	3 = Fieldbus	7	P3.3

Table 44. Parametrization for VACON® 20 X (standard application)

Parameter name	ID	Value	Default	Panel Tree
Motor control mode	600	0 = Frequency 1 = Speed	0	P8.1
Control place selection	125	2 = Fieldbus	0	P1.11
Local / remote	211	0 = Remote	0	P3.2.2
Frequency ref. sel.	1819	5 = Fieldbus	5–7	P1.12

Table 45. Parametrization for VACON® NX (multipurpose application)

Parameter name	ID	Value	Default	Panel Tree
Motor control mode	600	0 = Frequency 1 = Speed 2 = Torque 3 = Closed loop speed control* 4 = Closed loop torque control*	0	P2.6.1
Control place selection	125	3 = Fieldbus	1	P3.1
Fieldbus Ctrl ref.	122	9 = Fieldbus	3	P2.1.13

* Available in VACON® NXP

10.2 CONTROLLING FIELDBUS PARAMETER

VACON® 100 family AC drives have parameter called “P5.13.1 Controlling Fieldbus”. It is used to select the instance from which the process data is sent to the drive application. By default, the setting is in "Automatic" and the functionality (when receiving process data from multiple sources) is application dependent.

The parameters only show options that are possible with the used software and hardware configuration. For example, slot E is shown only if the option board slot E contains a fieldbus option board. The use of VACON® 100 family built-in PROFINET IO and EtherNet/IP requires a license.

For example, if the option board has been installed to slot E and it is used with PROFINET to control the drive, the user can select "Slot E" as value for this parameter. Now only the process data from the option board in slot E is forwarded to the application. All other fieldbuses still receive process data out. With this setting it is possible to prevent that the monitoring fieldbuses accidentally write process data in.

Table 46. VACON® 100 family controlling fieldbus options

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 forwarded to application. Value is visible only, if option board is installed to slot D.
Slot E	3	Only process data from slot E is forwarded to application. Value is visible only, if option board is installed to slot E.
RS485	4	Only process data from VACON® 100 family internal RS 485 protocol is forwarded to application
PROFINET IO	5	Only process data from VACON® 100 family internal PROFINET IO 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

10.3 TORQUE CONTROL PARAMETRIZATION

Some extra parametrization must be made in order to control the frequency control with torque control. The following instructions are for the VACON® 100 family and VACON® NXP/NXS application. For more information, see the application specific manual.

- Motor control mode (ID 600) must be configured to “Torque control” (2).

To configure the AC drive to use correct torque reference, select the parameter "Torque Reference Selection" to ProcessDataIn1 (9). This can be done with:

- PC tool or panel (VACON® 100 family: P3.3.2.1, VACON® NXP/NXS: P2.10.4) / ID 641
- Vendor Parameter Object

10.4 RESPONSE TO FIELDBUS FAULT

In case of a fieldbus fault (for example, loss of connection), a fieldbus fault is triggered. This fault can be parametrized in application to result in a desired response. Always check the application specific manual for details as responses vary between used applications. For common fault responses used commonly in standard applications, see the table below.

Table 47. Response to fieldbus fault in VACON® AC drives

ID	AC drive	Value	Default	Panel tree
733	VACON® 100 family	0 = No action 1 = Alarm 2 = Alarm + preset frequency 3 = Fault: Stop function 4 = Fault: Coast	3	P3.9.1.6
	VACON® 20			P13.19
	VACON® 20 X	0 = No action 1 = Warning 2 = Fault	2	P9.15
	VACON® NX family	0 = No action 1 = Warning 2 = Fault: Stop function 3 = Fault: Coast	2	P2.7.22

11. APPENDIX B - VACON® IO DATA DESCRIPTION

The PLC master typically commands VACON® AC drive by transmitting Control Word, Speed Reference and Process Data In variables to the AC drive application. The AC drive status is typically monitored by receiving Status Word, Actual Speed and Process Data Out variables from the AC drive application.

Control Word, Speed Reference, Status Word and Actual Speed formats depend on the fieldbus and application. This appendix describes the VACON® specific profile. For description of PROFIdrive, CiA-402 CANopen and CIP AC/DC drive profile, see related fieldbus manual.

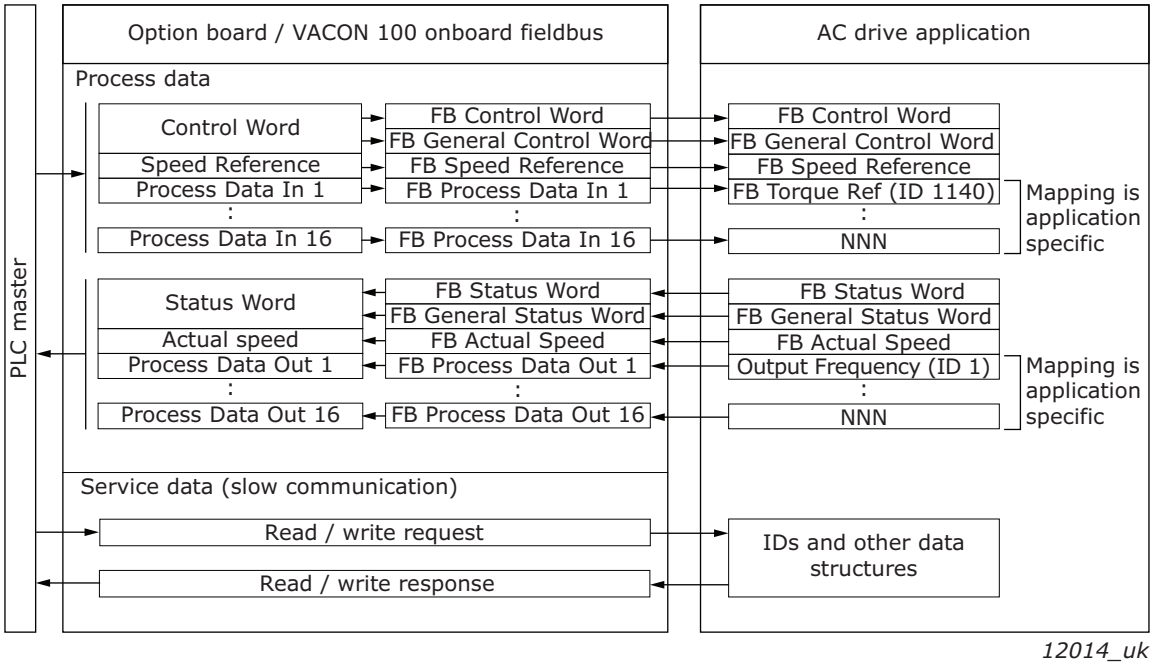


Figure 26. Communication between PLC master and AC drive application

11.1 VACON® PROFILE

The VACON® specific control profile is described in the following chapters.

11.1.1 VACON® CONTROL WORD - FBFIXEDCONTROLWORD

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 the functionality of FBFixedControlWord is fixed in VACON® standard applications, the functionality of FBGeneralControlWord is completely application specific and can vary even in VACON® standard applications.

The FBFixedControlWord bit definitions are described in the following table. Note that there are some control word bit modifications in the VACON® NXP and NXS AC drives. These modifications are described in Table 49. Unused bits must be set to zero.

Table 48. FBFixedControlWord bits

Bit	Function		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	No action when 1 → 1. Rising edge (0 → 1) = Active faults, alarms and infos are reset.
3	Stop mode 1	0	Stop mode is unmodified.
		1	Stop mode is overridden to "Coasting".
4	Stop mode 2	0	Stop mode is unmodified.
		1	Stop mode is overridden to "Ramping".
5	Quick ramp time	0	Normal deceleration ramp time.
		1	Deceleration ramp time is switched to shorter than normal.
6	Freeze setpoint	0	Changes in the setpoint value from fieldbus (FBSpeed-Reference) are taken into use by the application.
		1	Changes in the setpoint value from fieldbus (FBSpeed-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 parametrized in the drive (unchanged).
		1	Control Place is overridden to Fieldbus Control.
9	Request Fieldbus Reference	0	Source of the setpoint value is as parametrized 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.
13	Reserved	0	-
		1	-
14	Reserved	0	-
		1	-

Bit	Function		Description
15	Master connected*	0	Only in certain VACON® NX applications. Fieldbus sets this bit to zero when it detects that there is no connection to the master.
		1	Only in certain VACON® NX applications. Fieldbus sets this bit to one when it detects valid connection from the master.

*This functionality can be enabled/disabled by application from drive parameters.

Table 49. FBFixedControlWord modifications in VACON® NX family

Bit	Function		Description
3	Fieldbus DIN1	0	Fieldbus DIN1 off
		1	Fieldbus DIN1 on
4	Fieldbus DIN2	0	Fieldbus DIN2 off
		1	Fieldbus DIN2 on
5	Fieldbus DIN3	0	Fieldbus DIN3 off
		1	Fieldbus DIN3 on
6	Fieldbus DIN4	0	Fieldbus DIN4 off
		1	Fieldbus DIN4 on
7	Fieldbus DIN5	0	Fieldbus DIN5 off
		1	Fieldbus DIN5 on

11.2 CONTROL WORD BIT SUPPORT IN VACON® AC DRIVES

The following table describes the control word bit support in different AC drives. Notice that the table is valid only for VACON® standard applications. Always check the application specific manual.

Table 50. FBFixedControlWord bit support in different VACON® AC drives

Bit	Function	VACON® 100 family	VACON® NX family	VACON® 20	VACON® 20 X/CP
0	Start/Stop	x	x	x	x
1	Direction	x	x	x	x
2	Fault reset	x	x	x	x
3	Stop mode 1	x	o		x
4	Stop mode 2	x	o		x
5	Quick ramp time	x	o	x	x
6	Freeze setpoint	x	o		x
7	Setpoint to zero	x	o		x
8	Request Fieldbus Control	x	x		x

Bit	Function	VACON® 100 family	VACON® NX family	VACON® 20	VACON® 20 X/CP
9	Request Fieldbus Reference	x	x		x
10	Jogging 1	x			
11	Jogging 2	x			
12	Quick stop	x			x
13–14	Reserved				
15	Master connected		x		

x) Supports standard function
o) FBDIN function instead of standard function

11.3 VACON® STATUS WORD - FBFIXEDSTATUSWORD

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 the functionality of FBFixedStatusWord is fixed in VACON® standard applications, the functionality of the FBGeneralStatusWord is totally application specific and can vary even in VACON® standard applications.

The FBFixedStatusWord bit definitions are described in the following table. Unused bits are set to zero. In VACON® NX series AC drives FBFixedStatusWord comes from firmware variable "MCStatus".

Table 51. FBFixedStatusWord bits

Bit	Function		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*	0	No fault active.
		1	Drive has an active fault.
4	Alarm*	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	Info*	0	No info active.
		1	Drive has an active info.

Bit	Function		Description
9–15	Reserved	0	-
		1	-

*Drive faults have three levels: Fault, Alarm and info. Bits 3, 4 and 8 are set to 1 if the given fault type is activated.

11.4 STATUS WORD BIT SUPPORT IN VACON® AC DRIVES

Table 52. FBFixedStatusWord bit support in different VACON® AC drives

Bit	Function	VACON® 100 family	VACON® NX family	VACON® 20	VACON® 20 X/CP
0	Ready	x	x	x	x
1	Run	x	x	x	x
2	Direction	x	x	x	x
3	Fault	x	x	x	x
4	Alarm	x	x	x	x
5	At reference	x	x	x	x
6	Zero speed	x	x		x
7	Flux ready	x	x		
8	Info	x			
9–15	Reserved				

11.5 MONITORING OF CONTROL AND STATUS WORDS IN VACON® AC DRIVES

The following table describes from where the control/status words can be read in different AC drives via panel or PC tool.

Table 53. Panel tree for control and status words

Signal	VACON® 100 family	VACON® NX family	VACON® 20	VACON® 20 X/CP
FBFixedControlWord	V2.12.1 (Low Word)	V1.24.3*	-	-
FBGeneralControl-Word	V2.12.1 (High Word)	-	-	-
FBFixedStatusWord	V2.12.11 (Low Word)	V1.24.16*	V3.1	-
FBGeneralStatusWord	V2.12.11 (Low Word)	V1.24.3*	V3.2	-

* Advanced application only

For VACON® 100 family, VACON® 20 and VACON® 20 X/CP, VACON® Live PC tool is used for accessing the drive parameters. VACON® NCDrive PC tool is used with VACON® NX family.

NCDrive:

- View → Monitoring
- Type: Firmware

Table 54. Signal name in PC tools

Signal	VACON® NCDrive	VACON® Live		
	VACON® NXP/ NXS	VACON® 100 family	VACON® 20	VACON® 20 X/CP
FBFixedControlWord	FBFixedControl-Word	FB Control Word (Low Word)	-	-
FBGeneralControl-Word	FBGeneralCon-trolWord	FB Control Word (High Word)	-	-
FBFixedStatusWord	MCStatus	FB Status Word (Low Word)	Drive status word	-
FBGeneralStatusWord	FBGeneralSta-tusWord	FB Status Word (High Word)	Application status word	-

11.6 VACON® SPEED REFERENCE AND ACTUAL SPEED - FBSPEEDREFERENCE AND FBACTUALSPEED

The FBSpeedReference value is signed in the range of -10000...10000d (d8f0...2710h). The given reference is scaled in percentage between the 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 the direction bit in control word is set (means direction should be counterclockwise) and the reference is negative, motor runs clockwise despite the direction bit.

The FBActualSpeed value is signed in the range -10000...10000d (d8f0...2710h). Actual speed is scaled in percentage between the 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%.

Some VACON® applications support speed values over 100%. In these cases, the range is wider than -10000...10000d (d8f0...2710h). When using control modes that are fieldbus protocol specific, for example PROFIdrive, exceeding the speed value range is not possible.

NOTE! Some VACON® applications do not support negative speed reference. In this case the direction must be controlled with control word's direction bit. Some VACON® applications support negative reference but the actual speed is always positive. In this case the direction status must be read from status word's direction bit.

11.7 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 the drive. Some drives and firmware versions can support up to sixteen process data items. If the drive does not support 9–16 process data items, then the incoming 9–16 process data items are ignored and outgoing 9–16 process data items are set to zero. For more information, see chapter "12. Appendix C - Fieldbus option board communication" and chapter "13. Appendix D - Parameters for application developers".

Values sent from the drive to the PLC are called ProcessDataOut variables, whereas the values sent from the PLC to the drive are called ProcessDataIn variables. The contents of the ProcessDataOut variables can be parametrized in the AC drive using a feature known as Fieldbus process data mapping. For more information, see the following chapter.

11.8 FIELDBUS PROCESS DATA MAPPING AND SCALING

This chapter describes how standard applications map process data items by default. For more information, especially when not using a standard application, see the application manual for the AC drive in use.

Table 55. Process data output mapping defaults for VACON® 100 INDUSTRIAL and VACON® 100 FLOW

PD out	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*
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	-	-

*Scaling is based on drive nominal power. Scaling can be seen from Table 59.

Table 56. Process data output mapping defaults for VACON® NX family (standard applications) and VACON 100® HVAC

PD out	Mapped application data	ID	Unit	Scale
1	Output frequency	1	Hz	0.01 Hz
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 57. Process data output mapping defaults for VACON® 20 X/CP (standard applications)

PD out	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*
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	-	-

*Scaling is based on drive nominal power. Scaling can be seen from Table 59.

Table 58. Process data output mapping defaults for VACON® 20 (standard application)

PD out	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*
7	Motor power	5	%	0.1%
8	DC link voltage	7	V	1 V

*Scaling is based on drive nominal power. Scaling can be seen from Table 59.

Table 59. Current scaling based on nominal power

Nominal power	Current scale
< 5 kW	0.01 A
5–100 kW	0.1 A
> 100 kW	1 A

Default process data out mapping can be changed in standard applications.

Table 60. FB process data out mapping

Parameter name	VACON® 100 family		VACON® NX**		VACON® 20		VACON® 20 X/ CP	
	Path	ID	Path	ID	Path	ID	Path	ID
FB DataOut 1 Selection	P3.6.1	852	P2.9.3	852	P10.1	852	P11.1	852
FB DataOut 2 Selection	P3.6.2	853	P2.9.4	853	P10.2	853	P11.2	853
...	...	...	...	...	...	...	...	...
FB DataOut 8 Selection	P3.6.8	859	P2.9.10	859	P10.8	859	P11.8	859
FB DataOut 9 Selection	P3.6.9*	890	P2.9.12*	558	-	-	-	-
FB DataOut 10 Selection	P3.6.10*	891	P2.9.13*	559	-	-	-	-
...	...	...	...	...	...	...	...	...
FB DataOut 16 Selection	P3.6.16*	897	P2.9.18*	565	-	-	-	-

*See firmware requirements for 9–16 process data items in chapter "12. Appendix C - Fieldbus option board communication".
**Multipurpose application.

Process data in can also be mapped in VACON® NXP AC drives.

Table 61. FB process data in mapping

Parameter name	VACON® NXP**	
	Path	ID
FB DataIn 1 Selection	P2.9.19	876
FB DataIn 2 Selection	P2.9.20	878
...	...	...
FB DataIn 8 Selection	P2.9.26	883
FB DataIn 9 Selection	P2.9.27*	550
FB DataIn 10 Selection	P2.9.28*	551
...	...	...
FB DataIn 16 Selection	P2.9.34*	557

*See firmware requirements for 9–16 process data items in chapter "12. Appendix C - Fieldbus option board communication".
**Multipurpose application.

11.8.1 MONITORING OF PROCESS DATA IN VACON® AC DRIVES

This chapter describes how incoming and outgoing process data can be monitored with the standard applications. For more information, especially when not using a standard application, see the application manual for the AC drive in use.

Table 62. FB Process data monitoring in VACON® 100 family and VACON® 20 AC drives

Parameter name	VACON® 100 family		VACON® 20		VACON® 20 X/ CP	
	Path	ID	Path	ID	Path	ID
FB DataIn 1	V2.12.5.1	876	-	-	-	-
..	...	...	-	-	-	-
FB DataIn 8	V2.12.5.8	883	-	-	-	-
FB DataIn 9	V2.12.5.9*	229	-	-	-	-
...	...	...	-	-	-	-
FB DataIn 16	V2.12.5.16*	236	-	-	-	-
FB DataOut 1	V2.12.6.1	866	-	-	-	-
..	...	...	-	-	-	-
FB DataOut 8	V2.12.6.8	873	-	-	-	-
FB DataOut 9	V2.12.6.9*	245	-	-	-	-
...	..	...	-	-	-	-
FB DataOut 16	V2.12.6.16*	252	-	-	-	-

*See firmware requirements for 9–16 process data items in chapter "12. Appendix C - Fieldbus option board communication".

Table 63. FB Process data monitoring in VACON® NX drives

Monitor value	VACON® NXP*		VACON® NXS	
	Path	ID	Path	ID
FB DataIn 1	P1.22.16.1*	221		
...	...	...		
FB DataIn 8	P1.22.16.8	228		
FB DataIn 9	P1.22.16.9**	229		
...	...	...		
FB DataIn 16	P1.22.16.16**	236		
FB DataOut 1	P1.22.16.17	237		
...	...	...		
FB DataOut 8	P1.22.16.24	244		
FB DataOut 9	P1.22.16.25**	245		
...	...	...		
FB DataOut 16	P1.22.16.32**	252		

*Multipurpose application

**See firmware requirements for 9–16 process data items in chapter "12. Appendix C - Fieldbus option board communication".

12. APPENDIX C - FIELDBUS OPTION BOARD COMMUNICATION

Traditionally all VACON® AC drives and fieldbuses support transferring of Control Word/Status Word, speed information and 8 process data values between PLC master and the AC drive application. Typically in this so-called "Normal communication mode" the process data is updated to/from the AC drive application with 10-ms interval.

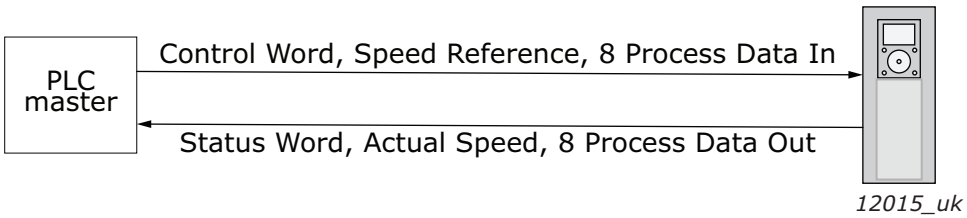


Figure 27. Normal fieldbus communication

With advanced communication modes it is possible to get more process data items, faster update cycle and safety data channel. The functionalities and requirements of the communication modes are described in the following chapters.

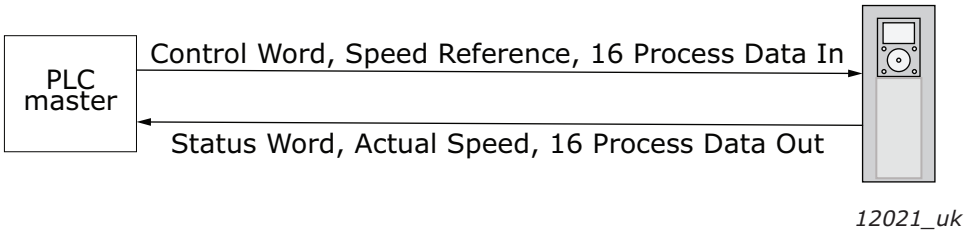


Figure 28. Advanced fieldbus communication

Table 64. Communication modes overview

Communication mode	Process Data In	Process Data Out	Update cycle
Normal mode	CW + Speed Reference + 8 Process data	SW + Actual Speed + 8 Process data	~10 ms*
Normal extended mode	CW + Speed Reference + 16 Process data	SW + Actual Speed + 16 Process data	~10 ms*
Fast mode	CW + Speed Reference + 16 Process data	SW + Actual Speed + 16 Process data	1 ms
Fast safety mode	CW + Speed Reference + 16 Process data + Safety data	SW + Actual Speed + 16 Process data + Safety data	1 ms
Fast PROFIBUS mode	CW + Speed Reference + 8 Process data	SW + Speed ref + 8 Process data	1 ms

*Depends on the AC drive application.

Table 65. Communication mode support in the AC drives

Communication mode	VACON® NXP	VACON® 100 INDUSTRIAL VACON® 100 FLOW	VACON® 100 HVAC VACON® 20 VACON® 20 X/CP VACON® NX
Normal mode	x	x	x
Normal extended mode*	x	x	
Fast mode*	x		
Fast safety mode*	x		
Fast safety mode*	x		
Fast PROFIBUS mode*	x		

*For description and requirements, see the following chapters.

12.1 NORMAL FIELDBUS COMMUNICATION

The normal fieldbus communication can be used for most commonly used setups.

- Transfers Control/Status Word, speed information and 8 process data values between PLC master and the AC drive application.
- 10 ms update cycle
- Supported in all VACON® AC drives and fieldbuses.
- Can be used simultaneously in option board slots D and E. The AC drive application can select from which slot it receives the process data.
- Normal mode is enabled by default if other communication modes are not possible or available.

The normal fieldbus communication between option board and AC drive application is visible in Figure 29. Maximum data transfer delay for the process data can be calculated by adding all delays together:

$$t = t_{IOdatacycle} + t_{updateinterval} + 2 \cdot t_{communicationdelay} + t_{applicationcycle}$$

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

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

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.

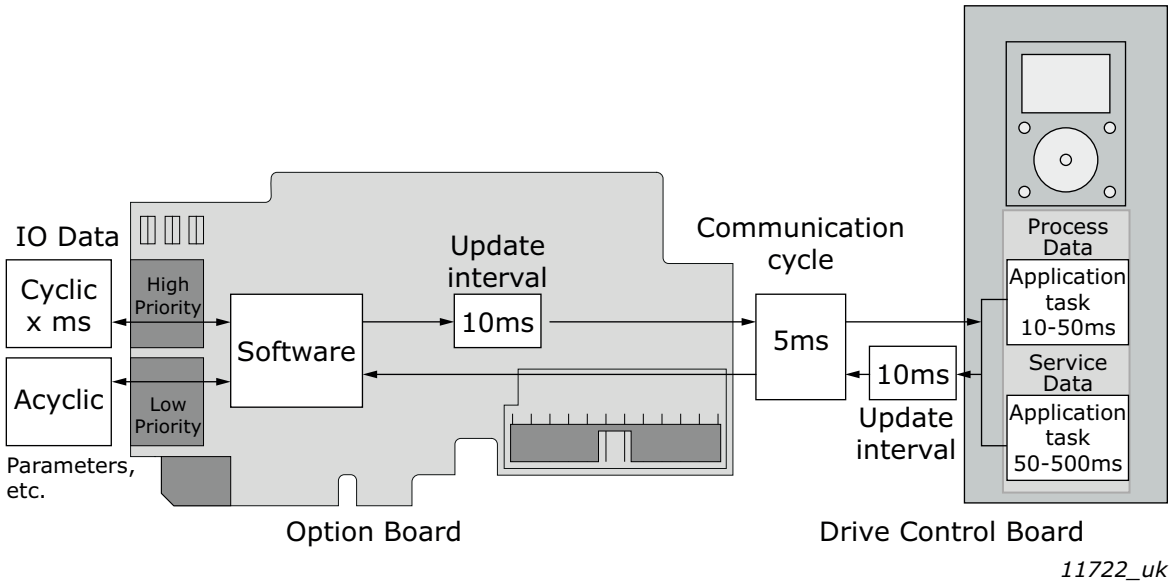


Figure 29. Normal fieldbus communication

12.2 NORMAL EXTENDED MODE

The normal extended mode like "Normal mode" bit it transfers 16 process data items into both directions.

- Transfers Control/Status Word, speed information and 16 process data values between PLC master and the AC drive application.
- In case of VACON® 100 family AC drives the process data is 32-bit which means that process data can contain 32 bit values.
- In case of other AC drives the process data is 16-bit.
- 10 ms update cycle.
- Can be used simultaneously in option board slots D and E. The AC drive application can select from which slot it receives the process data.
- Supported in VACON® NXP, VACON® 100 INDUSTRIAL and VACON® FLOW AC drives. For requirements, see the following tables.

NOTE! VACON® application might enable this mode automatically if the fieldbus supports the normal extended mode.

Table 66. VACON® NXP requirements for Normal Extended Mode

Board	Since software version
VACON® NXP	NXP00002V196
Application	Multipurpose V236
OPTE2/OPTE8 RS485 Modbus RTU	V003
OPTE3/OPTE5 PROFIBUS DP	V006
OPTE6 CANopen	V010
OPTE7 DeviceNet	V006
OPTE9 Dual Port Ethernet	V007
OPTEA Advanced Dual Port Ethernet	V001
OPTEC EtherCAT	V003

Table 67. VACON® 100 family requirements for Normal Extended Mode

Board	Since software version
VACON® 100 INDUSTRIAL	FW0072V030
VACON® 100 FLOW	FW0159V021
OPTE2/OPTE8 RS485 Modbus RTU	V003
OPTE3/OPTE5 PROFIBUS DP	To be defined
OPTE6 CANopen	To be defined
OPTE7 DeviceNet	To be defined
OPTE9 Dual Port Ethernet	To be defined
OPTEA Advanced Dual Port Ethernet	V003
OPTEC EtherCAT	To be defined

NOTE! Some VACON® 100 family built-in fieldbuses also support a similar functionality starting from firmware releases VACON® 100 INDUSTRIAL FW0072V029 and VACON® 100 FLOW FW0159V020. See respective VACON® 100 fieldbus manuals.

12.3 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.

- Transfers Control/Status Word, speed information and 16 process data values between PLC master and the AC drive application.
- 1 ms update cycle
- Application can be synchronized to run with the communication cycle.
- Can be used simultaneously in option board slots D and E. The AC drive application can select from which slot it receives the process data.
- Supported in VACON® NXP AC drives. For requirements, see the following table.

Table 68. VACON® NXP requirements for Fast Mode

Board	Since software version
VACON® NXP	NXP00002V196
Application	Multipurpose V236*
OPTE2/OPTE8 RS485 Modbus RTU	V003
OPTE3/OPTE5 PROFIBUS DP	V006
OPTE6 CANopen	V010
OPTE7 DeviceNet	V006
OPTE9 Dual Port Ethernet	V007
OPTEA Advanced Dual Port Ethernet	V001
OPTEC EtherCAT	V003

*In addition to Multipurpose application delivered with NXP firmware as part of the All-in-one application suite, some other applications may include support for use of Fast Mode. See respective application manual.

The fast fieldbus communication between option board and the AC drive application is presented in Figure 30. The maximum communication delay for process data in fast communication mode is (when application task is synchronized with communication):

$$t = t_{IOdata\ cycle} + t_{update\ interval} + t_{application\ cycle}$$

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

$$t = 1\ ms + 1\ ms + 1\ ms = 3\ ms$$

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.

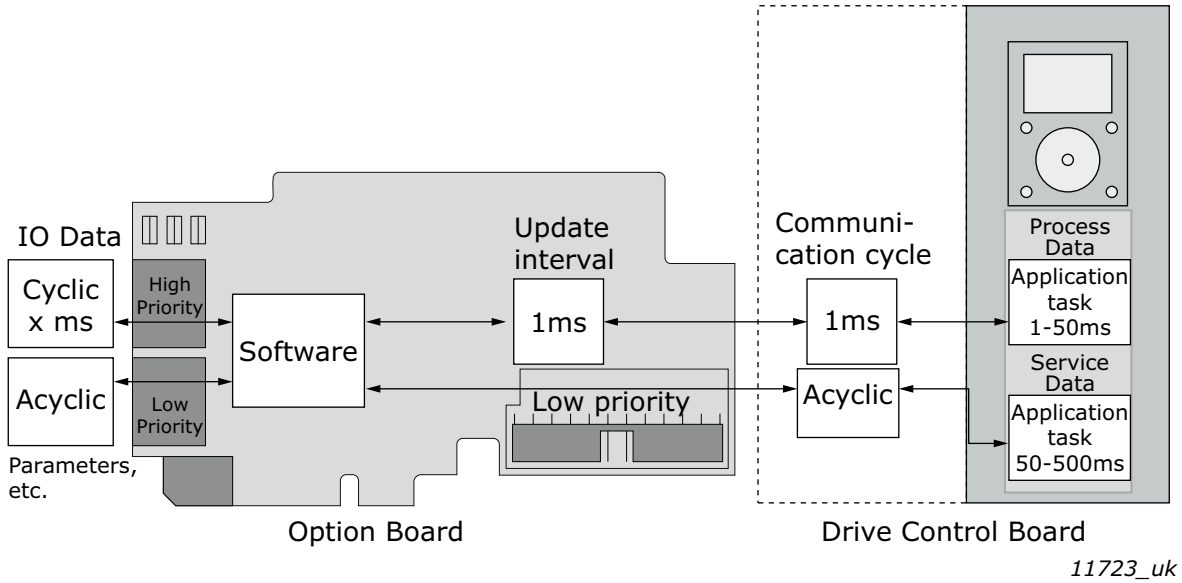


Figure 30. Fast fieldbus communication

12.4 FAST SAFETY FIELDBUS COMMUNICATION

Fast safety mode is the same as fast mode but it additionally transfers safety data between PLC master and OPTBL/OPTBM/OPTBN Advanced Safety Option.

- Transfers Control/Status Word, speed information and 16 process data values between PLC master and the AC drive application.
- Transfers safety data over "black channel" between PLC master and OPTBL/OPTBM/OPTBN Advanced Safety Option
- 1 ms update cycle.
- Application can be synchronized to run with the communication cycle.
- Can be used in option board slot E.
- Supported in VACON® NXP AC drives. For requirements, see the following table.

NOTE! This mode is automatically enabled by the system if OPTBL/OPTBM/OPTBN Advanced Safety Option is connected to the option board slot D and the safety fieldbus is activated. In this situation the mode cannot be changed by the user or application. This mode is also automatically turned off when the safety option board is removed or if safety fieldbus is not used.

Table 69. VACON® NXP requirements for Fast Safety Mode

Board	Since software version
VACON® NXP	NXP00002V196
Application	No application requirements
OPTBL/OPTBM/OPTBN Advanced Safety Option	V001
OPTE3/OPTE5 PROFIBUS DP	V006
OPTEA Advanced Dual Port Ethernet	V001

12.5 FAST PROFIBUS FIELDBUS COMMUNICATION

NOTE! This mode is not recommended for new installations.

Fast PROFIBUS mode was originally developed for the OPTC3/C5 PROFIBUS option board. This mode can achieve the same latencies for process data as Fast Mode. However, this mode has significant limitations, and it is not recommended for new installations.

- Transfers Control/Status Word, speed information and 8 process data values between PLC master and the AC drive application.
- 1 ms update cycle.
- No service data is available. Mode transfers only process data.
- Option board panel parameters and monitor values cannot be accessed after the mode is enabled.
- Supported in VACON® NXP AC drives. For requirements, see the following table.

Table 70. VACON® NXP requirements for Fast PROFIBUS Mode

Board	Since software version	Other info
VACON® NXP (Control board SN 761)	NXP00002V179	Only option board slot E
VACON® NXP (Control board SN 561)	NXP00002V171	Option board slots D and E
Application	System Interface V110 Advanced V085 Marine V107	
OPTC3 PROFIBUS DP (VB00257) OPTC5 PROFIBUS DP (VB00279)	OPTC3_10502V014.vcn	
OPTC3 PROFIBUS DP (70CVB01987) OPTC5 PROFIBUS DP (70CVB01985)	OPTC3-5_FW0232V001.vcx	
OPTEC EtherCAT	V001	

The fast PROFIBUS communication between option board and the AC drive application is visible in Figure 31. The communication delay for process data is the same as in Fast Mode.

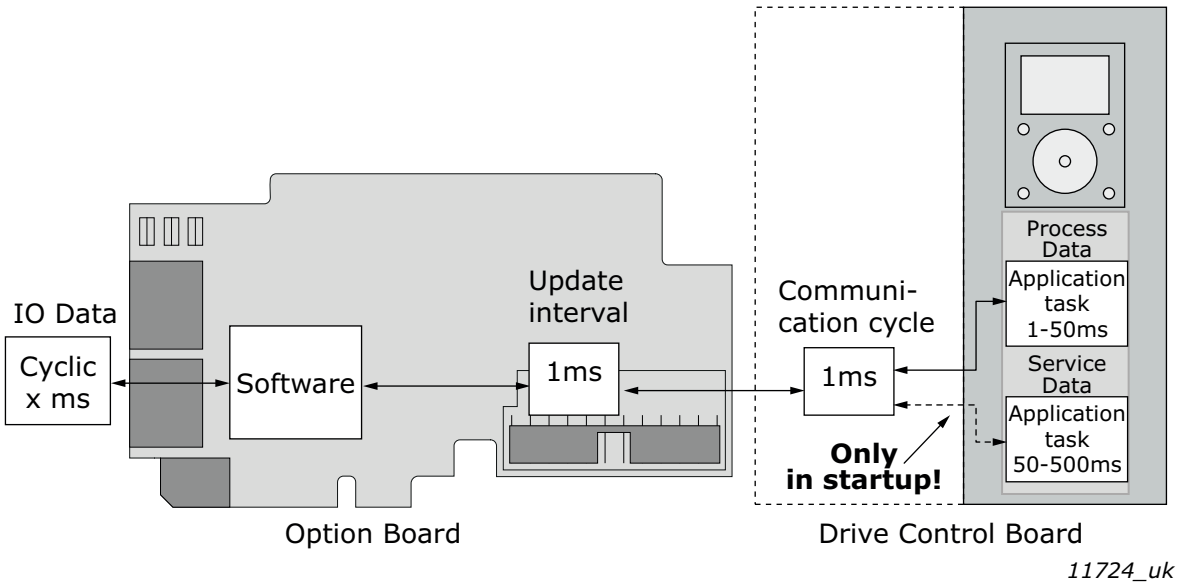


Figure 31. Fast PROFIBUS communication

13. APPENDIX D - PARAMETERS FOR APPLICATION DEVELOPERS

This appendix gives information for the application developers and system integrators on the VACON® NXP system software variables used to activate and control different fieldbus communication modes and features.

For more information on supported modes and required firmware version on given option board and control unit, see Appendix C - Fieldbus option board communication.

NOTE! Changing the mode while the motor is running is not supported because of security reasons.

Table 71. System software variables for selecting communication modes

Parameter	Value	Default
FBModeSlotD_fwu8	0 = Normal mode 1 = Fast safety mode* 2 = Fast mode 3 = Fast PROFIBUS mode 4 = Normal extended mode	0
FBModeSlotE_fwu8		0

* Fast safety mode is automatically enabled/disabled by system software. Cannot be set by user.

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.

Table 72. System software variables for monitoring supported communication modes

Parameter	Value	Default
FBModeSlotDSupModes_fwu16	0x00 = Not yet updated. Read again later. 0x01 = Fieldbus communication not supported 0x02 = Normal mode supported 0x04 = Fast safety mode supported 0x08 = Fast mode supported 0x10 = Fast PROFIBUS mode supported 0x20 = Normal extended mode supported	0
FBModeSlotESupModes_fwu16		0

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. The value should be asked again. Any option board not supporting fieldbus communication returns value '1'.

Example 1: OPTE9_FW0196V007 Dual Port Ethernet 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 can be set.

Table 73. System software variables for selecting the input process data slot

Parameter	Value	Default
FBControlSlotSelector_fwu8	0 = All slots 4 = Slot D only 5 = Slot E only 6 = Fast PROFIBUS D slot 7 = Fast PROFIBUS E slot	0

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 two fieldbus option boards are installed to VACON® NXP option board slots D and E. 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.

14. APPENDIX E - FAULT TRACING

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 and a short fault description. You can reset the fault with the Reset button on the control keypad, via the I/O terminal or via the used fieldbus protocol. The faults are stored in the Fault history menu, which can be browsed. The fault table presents only the fault conditions related to the fieldbus in use.

NOTE! When you contact a distributor or a factory because of a fault condition, always write down all texts and codes on the keypad display. Then send the problem description together with the Drive Info File to the local distributor. If possible, also send a fieldbus communication log from the situation if applicable.

Service Info can be read from the drive with PC tool.

- In case of VACON® Live connect to the drive and select from VACON® Live menu bar: Drive → Service information...
- In case of NCDrive connect to the drive and select from NCDrive menu bar: File → Service Info...

See basic usage of VACON® PC tools in Chapter 6.6 VACON® PC tools.

See local contacts in Danfoss website: https://www.danfoss.com/en/contact-us/contacts-list/. Select "Drives" as business unit.

Table 74. Fieldbus communication log tools

Recommended tool	For	Boards
Wireshark	Ethernet based fieldbuses	OPTE9 Dual Port Ethernet OPTEA Advanced Dual Port Ethernet OPTEC EtherCAT
ProfiTrace	PROFIBUS	OPTE3/E5 PROFIBUS DP
CANalyzer	CAN based boards	OPTE6 CANopen OPTE7 DeviceNet
RealTerm	Simple RS485 protocols	OPTE2/E8 RS485

14.1 DIAGNOSTIC INFORMATION

OPTE2/8 RS485 offers the following diagnostic information for problem solving:

- Monitor values. See Chapter 7.1.1 Option board monitor menu.
- Option board LEDs. See Chapter 4.3 LED indications.
- Fieldbus fault diagnostic. See Chapter 14.3.2 Fieldbus timeout fault (F53) diagnostic info.

14.2 TYPICAL FAULT CONDITIONS

14.2.1 PLC MASTER CANNOT GET RESPONSE FROM OPTE2/E8 RS485

Modbus RTU master or N2 master cannot get response from OPTE2/E8 RS485.

1. Check OPTE2/E8 RS485 board's LED status that is described in Chapter 4.3 LED indications.
   - If all three LED's are green, then OPTE2/E8 receives requests from the PLC master with a correct slave address. → Check PLC master status again.
   - If the PS led is flashing yellow and the BS led is flashing red, then OPTE2/E8 RS485 has activated Fieldbus timeout fault (F53). This means that OPTE2/E8 received requests from the PLC master with a correct slave address but that connection to PLC master was lost.
   - In other cases OPTE2/E8 RS485 has not communicated with the PLC master.
2. Check "Communication Status" monitor value that is described in Chapter 7.1.1 Option board monitor menu.
   - If the number of messages without errors increases, then OPTE2/E8 RS485 is successfully receiving frames from the PLC master but probably with a different slave address. → See step 3. Check that the slave address is correct
   - If the number of messages with errors increases, then OPTE2/E8 RS485 is receiving corrupted frames from the bus. → See step 4. Check baud rate and parity settings. → Check cabling and connectivity described in steps 5–11.
   - If "Communication Status" monitor value counters are not increasing, then OPTE2/E8 RS485 is not receiving any data from the bus. → Check cabling and connectivity described in steps 5–11.
3. Check that the slave address is correct.
   - Check that the PLC master sends the frames with the same slave address as configured with Slave Address panel parameter which is described in Chapter 7.1.2 Option board parameter menu.
   - Check that the RS485 bus does not have two slave devices with the same slave address.
4. Check baud rate and parity settings.
   - Check that OPTE2/E8 RS485 uses the same baud rate and parity as used by the PLC master. Baud rate and parity parameters are described in Chapter 7.1.2 Option board parameter menu.
5. Check that the RS485 bus is terminated properly from both ends.
   - RS485 communication might work without termination with slow baud rates in a short distance. Despite of this bus termination is always required.
   - If OPTE2/E8 is the last device of a RS485 bus, termination must be set in OPTE2/E8. For instructions, Chapter 4.4 Jumpers.
6. Check that the RS485 bus is biased properly. Biasing ensures that the bus state is at a proper potential when no device is transmitting.
   - Typically bias voltage is generated from one device in the RS485 bus.
   - Bias voltage can be generated from OPTE2/E8 according instructions in Chapter 4.5 Bus terminal and bias resistors.
7. Check that the RS485 cable is connected correctly to the OPTE2/E8 option board's connector. For pin layout, see Chapter 4. Layout and connections.
8. Check that the RS485 cable is not short-circuited.

9. Check that the supply or motor cable is not located too close to the RS485 cable.
   - The supply or motor cable can cross the RS485 cable in a 90-degree angle. However, it is problematic if the supply or motor cable is placed into the same cable duct with the RS485 cable.
   - If it is possible that the supply or motor cable causes communication problems, the impact of the supply or motor cable can be tested with the following procedure:

   1. Disconnect the main supply from the automation devices.

   2. Power on the control unit of VACON® AC drive with +24 V. For instructions on powering the control unit, see AC drive manual.

   3. Test the communication with the PLC master.

10. Check grounding of the cable shield and the related OPTE2/E8 option board jumper settings.
    - The OPTE2/E8 option board supports different shield grounding options. For for information, see Chapter 5.3 Shield grounding options.
11. Check that the RS485 cable is not too long.
    - If it is possible that RS485 cable it too long, then try to use lower baud rate in communication.

14.2.2 Data corruption in communication

Communication works at some level but the PLC master or OPTE2/E8 option board reports data corruption on bus. The OPTE2/E8 option board's "Communication Status" monitor tells if the option board receives corrupted data from the bus. For information on monitor value, see Chapter 7.1.1 Option board monitor menu.

→Check steps 5–11 in Chapter 14.2.1 PLC master cannot get response from OPTE2/E8 RS485.

14.2.3 AC drive does not start to run

The PLC master gives a run command to the AC drive via Modbus RTU or N2 but the motor is not started.

1. Check that the AC drive is configured to fieldbus control. See Chapter 10. Appendix A - Fieldbus parametrization.
2. Check that fault is not active in the AC drive. For fault behavior in used AC drive, see AC drive specific manual.
3. Check that the AC drive is in "Ready" state.
   - VACON® NX and VACON® 100 family AC drives show this information in the keypad panel.
   - For VACON® 20 and VACON® 20 X/CP AC drives, see AC drive specific manual.
4. Check that OPTE2/E8 is in “Operational” state:

"Fieldbus protocol status" monitor value tells the state of the OPTE2/E8 option board. For more information, see Chapter 7.1.1 Option board monitor menu.

- If the status is "Initializing", then OPTE2/E8 is waiting for communication from the PLC master. Follow instructions in Chapter 14.2.1 PLC master cannot get response from OPTE2/E8 RS485.
- If the status is "Faulted", then communication has been active between the PLC master and OPTE2/E8 but connection to PLC master was lost. Connection should be re-established again, and the possible Field bus timeout fault (F53) should be cleared in the AC drive. For fault behavior, see AC drive specific manual.
- If the status is "Operational", then OPTE2/E8 RS485 is receiving requests from the PLC master with a correct slave address, but probably the format of the commands is incorrect.

5. Check that OPTE2/E8 really receives run command from the PLC master. Control words and status words handled by OPTE2/E8 can be seen from the monitor values. See the following monitor values in Chapter 7.1.1 Option board monitor menu.
   - Protocol/Fieldbus control word
   - Protocol/Fieldbus status word
6. Check that the AC drive application understands the control word given by the PLC master.
   - In most cases VACON® standard applications can be commanded with a VACON® control word format described in Chapter 11. Appendix B - VACON® IO data description. However, some applications support special command modes. For example, VACON® NXP Advanced application (APFIFF08) supports PROFIdrive mode where the control word must be given in PROFIdrive format. → For control word format, see application manual.
7. Check special requirements of the AC drive application.
   - Some applications have special requirements for motor controlling. For example, VACON® NXP SIAII application (APFIFF40) requires by default that digital inputs DIN4 (Run enable), DIN5 (Switch is closed) and DIN6 (Quick stop active) are connected before running the motor is possible. → For applications specific requirements, see application manual

14.2.4 DRIVE RUNS WITH WRONG SPEED

See Chapter 10. Appendix A - Fieldbus parametrization.

14.2.5 AC DRIVE REPORTS FIELDBUS TIMEOUT FAULT (F53)

See Chapter 14.3 Fieldbus timeout fault (F53).

14.2.6 FIELDBUS TIMEOUT FAULT (F53) CANNOT BE RESET

See Chapter 14.3 Fieldbus timeout fault (F53).

14.3 FIELDBUS TIMEOUT FAULT (F53)

VACON® fieldbuses create a fieldbus timeout fault (F53) when a fault occurs in the fieldbus protocol and the AC drive is set to fieldbus control.

NOTE! If the control place is set to e.g. I/O, no fieldbus fault is triggered even if a fault condition is detected. The fault response can also be modified in the AC drive application. For more information, see Chapter 10. Appendix A - Fieldbus parametrization.

NOTE! Some drive applications require that the fieldbus writes non-zero process data before fieldbus fault activation is possible.

14.3.1 OPTE2/E8 RS485 FAULT CONDITIONS

OPTE2/E8 creates a Fieldbus fault F53 in the conditions described in the following table.

NOTE! Connection to the PLC master must be re-established before resetting the F53 Fieldbus fault is possible.

Table 75. OPTE2/E8 RS485 Fieldbus fault trigger conditions

Fault	Description
Too many bad messages (10)	• OPTE2/E8 cannot receive a valid request from the PLC master within time defined by the Communication timeout parameter (Chapter 7.1.2 Option board parameter menu). Corrupted data frames are received during the timeout time.
IO watchdog (1)	• OPTE2/E8 cannot receive a valid request from the PLC master within time defined by the Communication timeout parameter (Chapter 7.1.2 Option board parameter menu). • It is possible that OPTE2/E8 receives requests addressed to some other slave.

14.3.2 FIELDBUS TIMEOUT FAULT (F53) DIAGNOSTIC INFO

In VACON® 100 family a detailed fault code for fieldbuses is "Source3" in the fault history. This feature is available from VACON® 100 firmware version V026 (INDUSTRIAL) and V018 (FLOW).

This information can be read with:

- Panel (4.1.x.26): Diagnostics → "Active Faults" → "FB Timeout" → Details.
- Panel (4.3.x.26): Diagnostics → "Fault History" → "FB Timeout" → Details.
- VACON® Live: View → "Fault Diagnostics" → Icon "Load active faults".
- VACON® Live: View → "Fault Diagnostics" → Icon "Load fault history".

Table 76. Description of the fault fields

Fault field	Description
Source 1	Activation source. Always “Control”.
Source 2	Slot to which the option board is installed (slot D or E)
Source 3	Additional fault code

The following table contains "source 3" additional fault codes. Note that not all subcodes listed here are applicable for all fieldbuses / option boards.

Table 77. Additional fault codes

Fault code	Fault name	Description
1	IO watchdog	IO connection timeout noticed by watchdog
2	IO master closed connection	IO 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 communication had been started
6	Cable not disconnected	Fieldbus cable was not connected after device start-up

Fault code	Fault name	Description
7	IOPS changed to BAD	PROFINET IO master data status changed from GOOD to BAD
8	Idle state activated	EtherNet/IP IO connection status changed to IDLE when motor is been 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	Nodeguard timeout	Nodeguard 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	RHD timeout	PROFINET Redundant Data Hold Time elapsed

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