

OPTE2/E8 RS485 MULTIPROTOCOL OPTION BOARD INSTALLATION MANUAL



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Document: DPD01780C Release date : 7/1/19

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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 (\downarrow).

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 mm² Cu or 16 mm² Al, through its total run.
- b) Where the protective conductor has a cross-sectional area of less than 10 mm² Cu or 16 mm² 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 mm² Cu or 16 mm² 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:

- 2.5mm² if mechanical protection is provided or
- 4mm² 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 | | |
| | Interface | OPTE2: 5-pin pluggable connector OPTE8: 9-pin D-SUB connector (female) | |
| Communications | Data transfer method | RS-485, half-duplex | |
| | Transfer cable | Shielded Twisted Pair | |
| | Electrical isolation | 500 VDC | |
| | Ambient operating temperature | -10°C-50°C | |
| F | Storing temperature | -40°C-70°C | |
| Environment | 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

| 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) |

| Table 4. OPTE2 (screw plug |) connector pinout |
|----------------------------|--------------------|
|----------------------------|--------------------|

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.

| 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) |

OPTE8 (SUB-D9) OPTION BOARD LAYOUT 4.2



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



Figure 3. 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) |

| Table & OPTE8 | (9-nin female sub-D | l connector ninout |
|---------------|---|---------------------|
| | $(7 - \mu m n c m a c - \mu m c - \mu)$ | ι τοιπιστιοι μπισαι |

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.

| 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.

| 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.

| LED combinations | | ations | Description | |
|------------------|-------|--------|---|--|
| PS | BS | FS | Description | |
| 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. | |

Table 9. LED combinations

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 $\Omega.$



Figure 5. Bus termination

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

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

Table 10. Bias resistance and termination resistance



Figure 6.

CABLING INSTRUCTIONS 5.

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 120Ω .



A. The termination is activated

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

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.

Jumper X14, lower row



Cable shield is connected directly to PE

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.

Jumper X14, lower row

Cable shield is connected directly to PE

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

Cable shield is connected to PE through RC

```
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.

| 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 |

Table 11. OPTE2/E8 option board support

<u>1</u>\

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.











11560A_00

6.1.2 ENCLOSURES MI4, MI5

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















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.





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







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.





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.





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







| 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. |
| 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!




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.

| Tool | VACON® | 100 family | VACON® | NXS/NXP | VACON® | ⁾ 20 family |
|---------------------------|--------|------------|-------------|-------------|--------|------------------------|
| 1000 | Serial | Ethernet | Serial | Ethernet | Serial | Ethernet |
| VACON [®] Loader | х | | х | | х | |
| VACON [®] Live | х | х | | | х | |
| NCIPConfig | | Not | used with O | PTE2/E8 RS4 | 485 | |
| NCDrive | | | х | х | | |
| NCLoad | | Not | used with O | PTE2/E8 RS4 | 485 | |

Table 12. The supported PC tools with different AC drives

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/ \rightarrow Downloads \rightarrow Software \rightarrow 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/ \rightarrow Downloads \rightarrow Software \rightarrow Select "Drives" as Business unit \rightarrow 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.

| VACON Loader 1.1.15.0 | |
|--|----------------------|
| File Tools Help | ENGINEERING Danfoss |
| Select file. File: | R5485 FW0204V003.vcx |
| | Browse |
| File: C:\Code\Optboards\Firmwares\VACON_OPTE2- OPTE8_RS485_FW0204V003.vcx | < Back Next > |
| | |

12008_00

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'.

| Drive Name | Drive Type | Brand | Media | Port | Device | |
|------------|------------|-------|--------|------|------------------------------|------------|
| NXP | Vacon NXP | Vacon | Serial | COM6 | COM6: USB Serial Port (COM6) | |
| | | | | | | Coloritord |

12009_00

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.

| ile Tools Help | |
|---|---------------------|
| | TOMORROW Danfots |
| Loading "VACON_OPTE2-OPTE8_RS485_FW020 | 04V003.vcx" 5% done |
| | |
| File: C:\Code\Optboards\Firmwares\VACON_OPTE2- OPTE8_RS485_FW0204V003.vcx Connected to drive. | < Back Next > |

12010_00

Figure 15. VACON[®] Loader: Firmware loading



12011_00

Figure 16. VACON[®] Loader: Loading is finished

6.6.3 PC TOOLS FOR VACON[®] NXP/NXS: NCDRIVE

You can configure the VACON $^{(\!R\!)}$ 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/ \rightarrow Downloads \rightarrow Software \rightarrow 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 \rightarrow 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 \rightarrow Options... \rightarrow Communication tab. Then define settings for your USB - RS232 adapter and press OK.

| tions | | | |
|-----------------|---------------|-----------------|------------|
| Drive Tool | Parameter | Monitor | Fault |
| Operating | Communication | Real Time Clock | Datalogger |
| Comport Com6 | Baudrate: | 1 | |
| 1 | | <u> </u> | |
| | | | |

11949_00

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 \rightarrow 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.

| 0 | ACON | NCDriv | /e | - | - | | |
|------|------|--------|-------|-------|--------|---------|----------|
| File | Edit | View | Drive | Tools | Window | Help | |
| | | 65 | | | C | ON-LINE | OFF-LINE |
| | | | | | | | |
| | | | | | | | 11950_00 |

Figure 18. NCDrive: Going online

| B VACON NCDrive | — × |
|----------------------|------------|
| Initializing 344/502 | |
| | |
| | 11951_00 |

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.

| Compare | LOADED | | | | | | |
|--|-----------|----------------|----------------|------|-----|-------|----|
| Multi-Purpos | Index | Variable Text | Value | Unit | Min | Mex | ID |
| 🖻 😂 Main Menu | P 7.5.1.1 | Comm. Protocol | 1 / Modbus RTU | | 1 | 2 | |
| 🖲 🧰 M 1 Monitor | P 7.5.1.2 | Slave Address | 1 | | 1 | 247 | |
| B B M 2 Parameters | P 7.5.1.3 | Baud Rate | 6 / 9600 Baud | | 1 | 12 | |
| 🖲 🧰 M 3 Keypad Control | P 7.5.1.4 | Parity Type | 0 / None | | 0 | 3 | |
| - Call M 4 Active Faults | P 7.5.1.5 | Comm. Time-out | 10 | \$ | 0 | 65535 | |
| M 6 System Menu M 7 Expander boards G 7.1 A:OPTA1 G 7.2 | | | | | | | |

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/ \rightarrow Downloads \rightarrow Software \rightarrow 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 \rightarrow 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.



11953_00

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".

| asic settings | | |
|-------------------|--------------------|------|
| Media: | Serial / Ethernet | Scan |
| | Serial / Ethernet | |
| | Ethernet Serial | |
| | | |
| Detailed settings | | |
| | | |



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.

| Drive Name | Drive Ty | pe Bra | nd Me | dia Po | ort / IP | | | | Devid | e/M | AC |
|------------|----------|---------|-------|--------|----------|-------|---------|------|-------|-------|-------|
| | Vacon 1 | LOO Vac | on Se | rial C | OM4 | COM4: | Silicon | Labs | CP210 | x USB | to UA |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

11955_00

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/ \rightarrow Documentation \rightarrow Select "Drives" as Business unit \rightarrow 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.



12013_00

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.

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

| 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 |

Table 14. Option board monitor menu

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

| 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". |

Table 15. Option board parameter menu

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 (B0) mapping is different. See Chapter 9.3.4 "Binary Output (B0)".
- 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 $^{\textcircled{R}}$ 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.

| 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 |

Table 17. Modbus memory map

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:

| 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 |

Table 19. Modbus register mapping to drive IDs

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.

| Address | | Nomo | Dengo (Tyre | |
|---------------------|-------------------------------------|-------------------------|---|--|
| 16-bit [*] | 32-bit | Name | Kange/Type | |
| 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 | -1000010000d 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". | |

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

*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.

| Address | | Namo | Pange/Type | |
|---------------------|-------------------------------------|------------------------|---|--|
| 16-bit [*] | 32-bit | Name | Kalige/Type | |
| 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 | -1000010000d 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

| Table ZZ. FB Process data UUT |
|-------------------------------|
|-------------------------------|

| Address | | Name | Pango/Typo | |
|---------------------|-------------------------------------|------------------------|----------------------------------|--|
| 16-bit [*] | 32-bit | | Nalige/Type | |
| 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.

<u>8.3.1.5</u> <u>ID map</u>

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.

| Parameters | | | | | | |
|------------|-------|------------|---------|----------|---------|-------------|
| ID | Value | | | | | |
| 699 | 123 | | | ID | Мар | |
| 700 | 321 | ▼ | Address | Data: ID | Address | Data: Value |
| 701 | 456 | | 410501 | 700 | 410601 | 321 |
| 702 | 654 | ≺ | 410502 | 702 | 410602 | 654 |
| 703 | 1789 | 1 / | 410503 | 707 | 410603 | 258 |
| 704 | 987 | └── | 410504 | 704 | 410604 | 987 |
| 705 | 2741 | 1 / | | • | • | • |
| 706 | 1147 | 1/ | | | | |
| 707 | 258 | Y | | | | |
| 708 | 3852 |] | | | | |

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.

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

Table 24. Example of 32bit IDMap

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 second | |
| 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.

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

| Table 26. | Operation | day counter |
|-----------|-----------|-------------|
| | | |

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 |
| 40112 Low data | 440112 | value as seconds. |

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.

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

Table 28. Resettable operation day counter

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.

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

Table 29. Energy counter as kWh

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.

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

| Table 31. Resettable energy | gy counter as kWh |
|-----------------------------|-------------------|
|-----------------------------|-------------------|

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.

| 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. |

Table 32. Resettable energy counter

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.

| 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 | |

| Table 34. Fault history with | 16-bit error codes |
|------------------------------|--------------------|
|------------------------------|--------------------|

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) |
| | Starting address HI | 07 hex | |
| | Starting address LO | D0 hex | Starting address 07D0 hex (= 2000) |
| | No. of registers HI | 00 hex | Number of registers (1003 bey (- 3) |
| DATA | 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 |
| | Data LO | 01 hex | bit to 1. |
| | Data HI | 00 hex | $D_{2} = 0.000 \text{ bey} (-0)$ |
| | Data LO | 00 hex | |
| | Data HI | 13 hex | Data 3 = 1388 hex (= 5000), Speed Reference to |
| | Data LO | 88 hex | 50.00% |
| ERROR CHECK | Data HI | C8 hex | CRC field $C8CB$ bey (= 51/03) |
| | Data LO | CB hex | |

Message frame:

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) | |
| | Starting address HI | 07 hex | Starting address 0700 box (- 2000) | |
| DATA | Starting address LO | D0 hex | | |
| | No. of registers HI | 00 hex | Number of registers 0003 box (- 2 | |
| | No. of registers LO | 03 hex | | |
| ERROR CHECK | CRC HI | 80 hex | CRC 8085 box (= 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) | |
| | Starting address HI | 08 hex | Starting addross (1836 box (- 2102) | |
| DATA | Starting address LO | 36 hex | | |
| | No. of registers HI | 00 hex | Number of registers 0002 bey (-2) | |
| | No. of registers LO | 02 hex | | |
| ERROR CHECK | CRC HI | 93 hex | CRC 9345 box (- 37797) | |
| | RC 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) |
| Byte coun | | 04 hex | Byte count 4 hex (= 4) |
| DATA | Data HI | 13 hex | Speed reference = 1388 hex (=5000 => |
| | Data LO | 88 hex | 50.00%) |
| | Data HI | 09 hex | Output Frequency = 09C4 hex (=2500 |
| | Data LO | C4 hex | =>25.00Hz) |
| ERROR CHECK | CRC HI | 78 hex | CRC 78E9 her (- 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) |
| | Starting address HI | 17 hex | Starting addross 1770 box (- 6000) |
| DATA | Starting address LO | 70 hex | |
| | No. of registers HI | 00 hex | Invalid number of registers 0005 box (- 5) |
| | No. of registers LO | 05 hex | |
| ERROR CHECK | CRC HI | 34 hex | CRC 3/66 her (-13/1/) |
| | CRC LO | 66 hex | -CICC 3400 Hex (= 13414) |

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 | CRC HI | 42 hex | CPC 2/44 hav (-12/1/) |
| CHECK | CRC LO | C3 hex | CRC 5400 Hex (= 13414) |

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 (A0)

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)

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

Table 35. Analogue Input (AI)

*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.

| 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 36. Binary Input (BI) in Normal mode

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 |
| A0 | 3 | Minimum speed | Hz | 2 decimals |
| AO | 4 | Maximum speed | Hz | 2 decimals |
| A0 | 5 | Acceleration time | S | 1 decimal |
| A0 | 6 | Deceleration time | S | 1 decimal |
| AO | 7 | FBProcessDataIN1 | -32768 to +32767 | 0 decimal |
| A0 | 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 |
| A0 | 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.

| NPT | NPA | Description | 0= | 1= |
|-----|-----|---------------------------|---------|-------------------|
| BO | 1 | Comms start/stop | Stop | Start |
| B0 | 2 | Comms forward/reverse | Forward | Reverse |
| B0 | 3 | Reset fault | N/A | Reset |
| B0 | 4 | Stop mode information 1 | - | - |
| B0 | 5 | Stop mode information 2 | - | - |
| B0 | 6 | Force ramp to zero | - | - |
| B0 | 7 | Freeze ramp | - | - |
| B0 | 8 | Reference to zero | - | - |
| B0 | 9 | BusCtrl | - | - |
| B0 | 10 | BusRef | - | - |
| B0 | 11 | Operation time trip reset | - | Reset AI11 & AI12 |
| B0 | 12 | Energy trip counter reset | - | Reset AI13 |

Table 39. Binary Output (BO) in Normal mode

| NPT | NPA | Description | 0= | 1= |
|-----|-----|------------------------|---------|---------|
| B0 | 1 | Comms start/stop | Stop | Start |
| B0 | 2 | Comms forward/reverse | Forward | Reverse |
| B0 | 3 | Reset fault | N/A | Reset |
| B0 | 4 | FB Control Word bit 3 | - | - |
| B0 | 5 | FB Control Word bit 4 | - | - |
| BO | 6 | FB Control Word bit 5 | - | - |
| B0 | 7 | FB Control Word bit 6 | - | - |
| B0 | 8 | FB Control Word bit 7 | - | - |
| BO | 9 | FB Control Word bit 8 | - | - |
| B0 | 10 | FB Control Word bit 9 | - | - |
| B0 | 11 | FB Control Word bit 10 | - | - |
| BO | 12 | FB Control Word bit 11 | - | - |
| B0 | 13 | FB Control Word bit 12 | - | - |
| B0 | 14 | FB Control Word bit 13 | - | - |
| B0 | 15 | FB Control Word bit 14 | - | - |
| B0 | 16 | FB Control Word bit 15 | - | - |

Table 40. Binary Output (BO) in NX mode

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 A015: 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 A015: 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%' (A01).
- 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.

| 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 42. Parametrization for VACON[®] 100 family (standard application)

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 param- eters | 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 |

| 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 44. Parametrization for VACON[®] 20 X (standard application)

| Table 45. | Parametrization | for VACON [®] | NX (multipurpose | application) |
|-----------|---------------------|------------------------|------------------|--------------|
| | i ulullicti izution | | in accipation | appacation |

| 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.

| 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 $^{\ensuremath{\mathbb{R}}}$ 100 family internal RS 485 protocol is forwarded to application |
| PROFINET IO | 5 | Only process data from VACON $^{\rm (IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII$ |
| EtherNet/IP | 6 | Only process data from VACON [®] 100 family internal EtherNet/IP pro- tocol is forwarded to application |
| Modbus TCP/ UDP | 7 | Only process data from VACON $^{\ensuremath{\mathbb{R}}}$ 100 family internal Modbus TCP/UDP protocol is forwarded to application |
| BACnet/IP | 8 | Only process data from VACON $^{\mbox{\scriptsize B}}$ 100 family internal BACnet/IP protocol is forwarded to application |

Table 46. VACON[®] 100 family controlling fieldbus options

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.
| ID | AC drive | Value | Default | Panel tree |
|-----|----------------------------------|--|---------|------------|
| 733 | VACON [®] 100 family | 0 = No action 1 = Alarm | S | P3.9.1.6 |
| | VACON [®] 20 | 3 = Fault: Stop function 4 = Fault: Coast | 5 | 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 |

| Table 47 R | esnonse to | fieldhus fault in | VACON® | AC drives |
|--------------|------------|-------------------|--------|-----------|
| Table 47. IN | esponse io | netubus tautt in | VACON | AC UNVES |

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.

| Bit | Function | | Description |
|-----|-----------------------|---|---|
| 0 | Start/Stop | 0 | Stop request from fieldbus. |
| 0 | Start/Stop | 1 | Run request from fieldbus. |
| 1 | Direction | 0 | Requested direction is "FORWARD". |
| 1 | Direction | 1 | Requested direction is "REVERSE". |
| | | 0 | No action. |
| 2 | Fault reset | 1 | No action when $1 \rightarrow 1$. Rising edge $(0 \rightarrow 1)$ = Active faults, alarms and infos are reset. |
| з | Stop mode 1 | 0 | Stop mode is unmodified. |
| 5 | | 1 | Stop mode is overridden to "Coasting". |
| 4 | Stop mode 2 | 0 | Stop mode is unmodified. |
| 4 | | 1 | Stop mode is overridden to "Ramping". |
| | | 0 | Normal deceleration ramp time. |
| 5 | Quick ramp time | 1 | Deceleration ramp time is switched to shorter than nor- mal. |
| 6 | Freeze setpoint | 0 | Changes in the setpoint value from fieldbus (FBSpeed- Reference) are taken into use by the application. |
| 0 | | 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 | 0 | Control Place is as parametrized in the drive (unchanged). |
| | Control | 1 | Control Place is overridden to Fieldbus Control. |
| 9 | Request Fieldbus Ref- | 0 | Source of the setpoint value is as parametrized in the drive (unchanged). |
| | | 1 | Source of the setpoint value is overridden to Fieldbus. |
| 10 | logging 1 | 0 | No action. |
| 10 | sogging i | 1 | Jogging request with jogging reference 1. |
| 11 | logging 2 | 0 | No action. |
| | 50991192 | 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 |
| 5 | | 1 | Fieldbus DIN1 on |
| 4 | Fieldbus DIN2 | 0 | Fieldbus DIN2 off |
| 4 | | 1 | Fieldbus DIN2 on |
| 5 | Fieldbus DIN3 | 0 | Fieldbus DIN3 off |
| | | 1 | Fieldbus DIN3 on |
| 6 | Fieldbus DIN4 | 0 | Fieldbus DIN4 off |
| 0 | | 1 | Fieldbus DIN4 on |
| 7 | Fieldhus 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 | х | x | х | х |
| 1 | Direction | х | x | x | x |
| 2 | Fault reset | Х | x | х | х |
| 3 | Stop mode 1 | Х | 0 | | х |
| 4 | Stop mode 2 | х | 0 | | х |
| 5 | Quick ramp time | Х | 0 | х | х |
| 6 | Freeze setpoint | Х | 0 | | х |
| 7 | Setpoint to zero | х | 0 | | х |
| 8 | Request Fieldbus Control | х | х | | х |

| Bit | Function | VACON [®] 100 family | VACON [®] NX family | VACON [®] 20 | VACON [®] 20 X/CP |
|-------|---------------------------------|----------------------------------|---------------------------------|-----------------------|-------------------------------|
| 9 | Request Fieldbus Ref- erence | х | х | | х |
| 10 | Jogging 1 | x | | | |
| 11 | Jogging 2 | Х | | | |
| 12 | Quick stop | х | | | х |
| 13–14 | Reserved | | | | |
| 15 | Master connected | | х | | |

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".

| Bit | Function | | Description |
|-----|--------------------|---|--|
| Ο | Ready | 0 | Drive is not ready. |
| 0 | liteduy | 1 | Drive is ready to run. |
| 1 | Run | 0 | Motor is not running. |
| • | | 1 | Motor is running. |
| 2 | Direction | 0 | Motor is running clockwise. |
| Z | Direction | 1 | Motor is running counterclockwise. |
| 3 | Fault [*] | 0 | No fault active. |
| | | 1 | Drive has an active fault. |
| 4 | Alarm [*] | 0 | No alarm active. |
| 4 | | 1 | Drive has an active alarm. |
| 5 | At reference | 0 | Motor is not running at reference speed. |
| 5 | | 1 | Motor is running at reference speed. |
| 6 | Zero speed | 0 | Motor is not at zero speed. |
| 0 | | 1 | Motor is running at zero speed. |
| 7 | Flux ready | 0 | Motor is not magnetized. |
| , | i lux reauy | 1 | Motor is magnetized. |
| 8 | lofo* | 0 | No info active. |
| 0 | Inio | 1 | Drive has an active info. |

Table 51. FBFixedStatusWord bits

| Bit | Function | | Description |
|------|------------|---|-------------|
| 9–15 | Reserved 0 | 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 | х | х | х | х |
| 1 | Run | х | х | х | х |
| 2 | Direction | х | x | х | х |
| 3 | Fault | х | х | х | х |
| 4 | Alarm | х | x | х | х |
| 5 | At reference | х | x | х | х |
| 6 | Zero speed | х | х | | х |
| 7 | Flux ready | х | х | | |
| 8 | Info | х | | | |
| 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.

| 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 | - |

Table 53. Panel tree for control and status words

* 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

| | - / | <u>~</u> , | | | | |
|-------|-----|------------|------|----|----|-------|
| lable | 54. | Signal | name | ın | PC | tools |

| | VACON [®] NCDrive | VACON [®] Live | | | |
|---------------------------|--------------------------------|-----------------------------------|----------------------------|-------------------------------|--|
| Signal | 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.

| 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 | А | 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 | - | - |

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

*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 | А | 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 | - | - |

| 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 | А | 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 | - | - |

Table 57. Process data output mapping defaults for VACON[®] 20 X/CP (standard applications)

*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 | А | 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.

| Parameter name | rameter name VACON [®] 100 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 | - | - | - | I |
| | | | | | | | | |
| FB DataOut 16 Selection | P3.6.16* | 897 | P2.9.18 [*] | 565 | - | - | - | - |

Table 60. FB process data out mapping

*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 proce | ess 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 $^{\textcircled{R}}$ 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.

| Parameter name | VACON [®] 10 | VACON [®] 100 family | | VACON [®] 20 | | VACON [®] 20 X/ CP | |
|----------------|-------------------------|-------------------------------|------|-----------------------|------|--------------------------------|--|
| | Path | ID | Path | ID | Path | ID | |
| FB DataIn 1 | V2.12.5.1 | 876 | - | - | - | - | |
| | | | - | - | - | - | |
| FB Dataln 8 | V2.12.5.8 | 883 | - | - | - | - | |
| FB Dataln 9 | V2.12.5.9 [*] | 229 | - | - | - | - | |
| | | | - | - | - | - | |
| FB Dataln 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 | - | - | - | - | |

Table 62. FB Process data monitoring in VACON $^{ extsf{8}}$ 100 family and VACON $^{ extsf{8}}$ 20 AC drives

*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 [®] N | IXP [*] | VACON [®] NXS | | | | |
| | Path | ID | Path | ID | | | |
| FB DataIn 1 | P1.22.16.1* | 221 | | | | | |
| | | | | | | | |
| FB Dataln 8 | P1.22.16.8 | 228 | | | | | |
| FB DataIn 9 | P1.22.16.9 ^{**} | 229 | | | | | |
| | | | | | | | |
| FB Dataln 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.



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Figure 28. Advanced fieldbus communication

| 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 |

Table 64. Communication modes overview

*Depends on the AC drive application.

| Communication mode | VACON [®] NXP | VACON [®] 100 INDUSTRIAL VACON [®] 100 FLOW | VACON [®] 100 HVAC VACON [®] 20 VACON [®] 20 X/CP VACON [®] NX |
|--------------------------|------------------------|--|---|
| Normal mode | х | Х | Х |
| Normal extended mode* | х | x | |
| Fast mode* | х | | |
| Fast safety mode* | х | | |
| Fast safety mode* | х | | |
| Fast PROFIBUS mode* | Х | | |

Table 65. Communication mode support in the AC drives

*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.

| 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 66. VACON[®] NXP 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 |

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

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:

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

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



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.

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

Table 69. VACON[®] NXP requirements for Fast Safety Mode

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.

| 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 | |

Table 70. VACON[®] NXP requirements for Fast PROFIBUS Mode

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.

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

Table 71. System software variables for selecting communication modes

* 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 | su | oported | communication | n modes |
|-------|-----|--------|----------|-----------|-----|------------|----|---------|---------------|---------|
| | | | | | | J | | 1 | | |

| Parameter | Value | Default |
|---------------------------|--|---------|
| FBModeSlotDSupModes_fwu16 | 0x00 = Not yet updated. Read again later. | 0 |
| FBModeSlotESupModes_fwu16 | UXU1 = 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 |

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.

| 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 |

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

FBControlSlotSelector_fwu8 variable is used to select the controlling fieldbus option board slot. When selected (other than '0'), process data is accepted only from the selected slot and all other process data is discarded. Process data out is still updated normally to all slots.

This selector can be used to support redundant fieldbus connection. In fieldbus redundancy mode 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.

| 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 |

Table 74. Fieldbus communication log tools

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.

 \rightarrow 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.

| 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. |

Table 75. OPTE2/E8 RS485 Fieldbus fault trigger conditions

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 \rightarrow "Active Faults" \rightarrow "FB Timeout" \rightarrow Details.
- Panel (4.3.x.26): Diagnostics \rightarrow "Fault History" \rightarrow "FB Timeout" \rightarrow Details.
- VACON[®] Live: View \rightarrow "Fault Diagnostics" \rightarrow Icon "Load active faults".
- VACON[®] Live: View \rightarrow "Fault Diagnostics" \rightarrow 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 connec- tion | IO connection was closed (gracefully) by master |
| 3 | EM watchdog | Explicit messaging connection timeout noticed by watchdog |
| 4 | EM master closed connec- tion | 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 | PD0 timeout | PD0 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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Document ID:

DPD01780C

Rev. C

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Sales code: DOC-OPTE2/E8+DLUK