VACON®
AC DRIVES

PROFIBUS DP OPTION BOARD OPTE3/E5

USER MANUAL

VACON®

Table of Contents

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1. SAFETY

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

Read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

Table 1. Warning signs

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

1.1 DANGER

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

1.2 WARNINGS

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

1.3 EARTHING AND EARTH FAULT PROTECTION

CAUTION!

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

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

a) The protective conductor must have a cross-sectional area of at least 10 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 earthing 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 http://drives.danfoss.com/knowledge-center/technical-documentation/.

REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site http://drives.danfoss.com/knowledge-center/technical-documentation/.

2. PROFIBUS DP - GENERAL

VACON® AC drives can be connected to the PROFIBUS DP network using a fieldbus board. The drive can then be controlled, monitored and programmed from the Host system.

The PROFIBUS DP uses Master-Slave type communication. The master devices control the communication. The master can send data without a separate command if a token is given to the Master. The slave devices are peripheral devices. Typical slave devices include input/output devices, valves, drives and measuring transmitters. They do not have bus access rights and they can only acknowledge received messages or send messages to the master when requested to do so.

OPTE5/E3 option board also supports connection from DP Master (class 2) if DP-V1 is enabled. In this case, the Master class 2 can initiate a connection, read and write parameters using the PROFIdrive Parameter Access service, and close the connection.

List of abbreviations used in this manual:

Table 2. List of abbreviations used in this document

Abbreviation	Explanation
FB	Fieldbus
DP	Decentralized Periphery
PPO	Parameter Process Data Object
CW	Control Word
SW	Status Word
PLC	Programmable Logic Controller
GSD	Generic Station Description

3. PROFIBUS DP TECHNICAL DATA

3.1 GENERAL

Table 3. PROFIBUS DP Option board technical data

Connections	Interface	OPTE3: Pluggable connector (5.08mm) OPTE5: 9-pin DSUB connector (female)
	Data transfer method	RS-485, half-duplex
	Transfer cable	Shielded Twisted Pair
	Electrical isolation	500 VDC
Communications	Drive profile	PROFIdrive
	Standard Telegrams	1, 20
	Vendor Telegrams	100, 101, 138, 139
	Standard (Safety) Telegrams	30, 31*
	Vendor (Safety) Telegrams	58000*
	PPO types	1, 2, 3, 4, 5, 6
	Baud rate	9.6 kbaud to 12 Mbaud. Autobaud detect is always on.
	Addresses	2 to 126
Environment	Ambient operating temperature	-10°C...50°C (See the drive installation manual for further information)
	Storing temperature	-40°C...60°C
	Humidity	<95%, no condensation, or frost allowed, non-corrosive
	Altitude	Max. 1000 m
	Vibration	0.5 G at 9...200 Hz
Safety	Fulfils EN50178 standard	

* Select only when Advanced safety option board with PROFIsafe is connected.

4. LAYOUT, CABLING AND INSTALLATION

The PROFIBUS DP fieldbus is connected to the OPTE3 board using a 5-pin pluggable bus connector, or to the OPTE5 board using a 9-pin female sub-D-connector. The only difference between OPTE3 and OPTE5 boards is the fieldbus connector.

4.1 PROFIBUS OPTE3/E5 OPTION BOARD LAYOUT

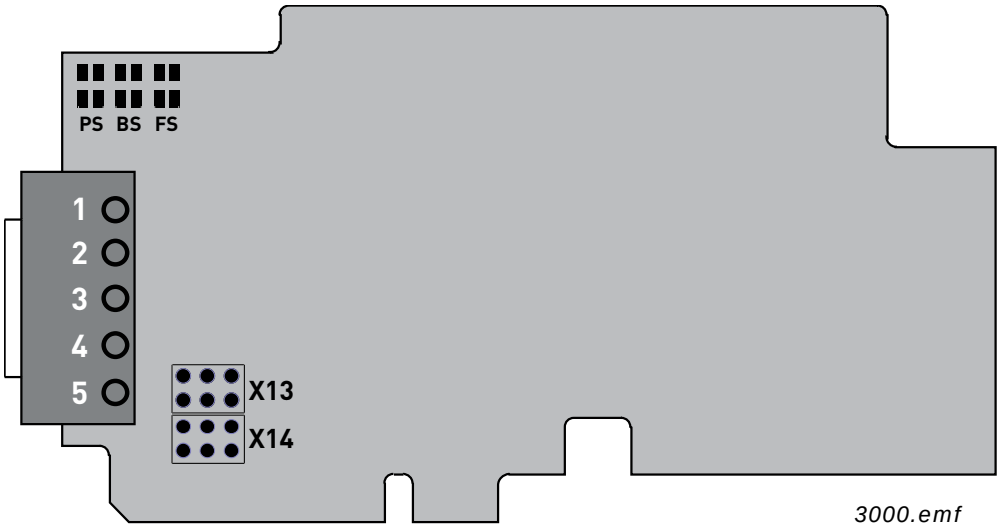


Figure 1. OPTE3/E5 board layout

4.2 CONNECTIONS

Table 4. OPTE3 board connections

Signal	Connector		Description
	OPTE3	OPTE5	
Shield	1	1	Cable shield
VP	2	6	Supply voltage - plus (5V)
RxD/TxD -P	3	3	Receive/Transmit data - plus (B)
RxD/TxD -N	4	8	Receive/Transmit data - minus (A)
DGND	5	5	Data ground (reference potential for VP)

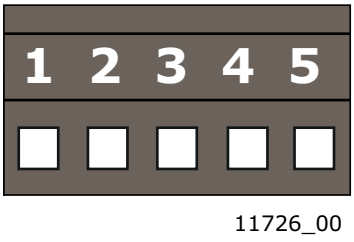


Figure 2. OPTE3 5-pin bus connector

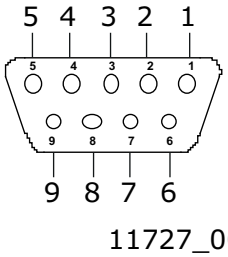


Figure 3. OPTE5 9-pin female sub-D connector pinout

4.3 LED INDICATIONS

The LED indications are the same on both OPTE3 and OPTE5 option boards.

PS = PROFIBUS status, RED

Table 5.

LED is	Meaning:
OFF	PROFIBUS DP communicates normally
ON	PROFIBUS DP communication is broken or not started • Bus cable broken or incorrectly connected • Wrong configuration or parameterization data of Master • Master is offline or shut down
Blinking yellow	The software is restarting

BS = PROFIBUS board status, YELLOW

Table 6.

LED is	Meaning:
OFF	Option board not activated
ON	Option board in initialisation state waiting for activation command from the AC drive
Blinking fast (once/1 s)	Option board is activated and in RUN state • Option board is ready for external communication
Blinking slow (once/5 s)	Option board is activated and in FAULT state • Internal fault on option board

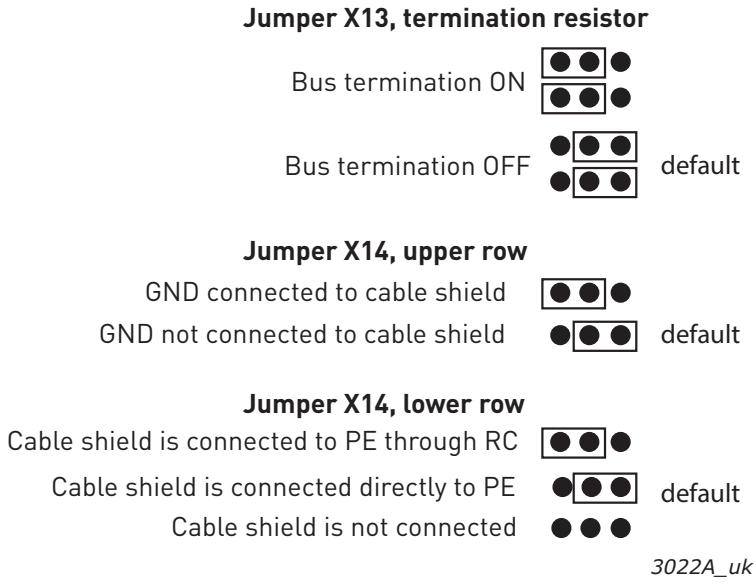
FS = Fieldbus status, GREEN

Table 7.

LED is	Meaning:
OFF	Fieldbus module is waiting for parameters from the AC drive • No external communication
ON	Fieldbus module is activated • Parameters received and module activated • Module is waiting for messages from the bus
Blinking fast (once/1 s)	Module is activated and receiving messages from the bus
Blinking slow (once/5 s)	Module is in FAULT state • No messages from Net within the watchdog time • Bus broken, cable loose or Master offline

4.4 JUMPERS

The jumper settings of OPTE3/E5 are shown below. See the jumper locations on the board in Figure 1.



4.5 CABLING AND GROUNDING

4.5.1 PROFIBUS DP CABLE

The PROFIBUS devices are connected in a bus structure. Up to 32 stations (master or slaves) can be connected in one segment. The bus is terminated at the beginning and end of each segment (see Figure 4). Both bus terminations must always be powered. When more than 32 stations are used, repeaters (line amplifiers) must be used to connect the individual bus segments.

The maximum cable length depends on the transmission speed and cable type (see Table 8). The specified cable length can be increased using the repeaters. The use of more than 3 repeaters in series is not recommended.

Table 8. Cable lengths

Baud rate (kbit/s)	9.6	19.2	93.75	187.5	500	1500	3000 - 12000
Length line A (m)	1200	1200	1200	1000	400	200	100
Length line B (m)	1200	1200	1200	600	200	-	-

The following connectors can be used (180° cable outlet):

- Phoenix SUBCON-PLUS-PROFIB/AX/SC 27 44 38 0
- Siemens Profibus connector 6GK1 500-0EA02

The following cables can be used, for example:

- Belden PROFIBUS Data Cable 3079A
- Olflex PROFIBUS Cable 21702xx
- Siemens SINEC L2 LAN cable for PROFIBUS, 6XV1 830-0AH10

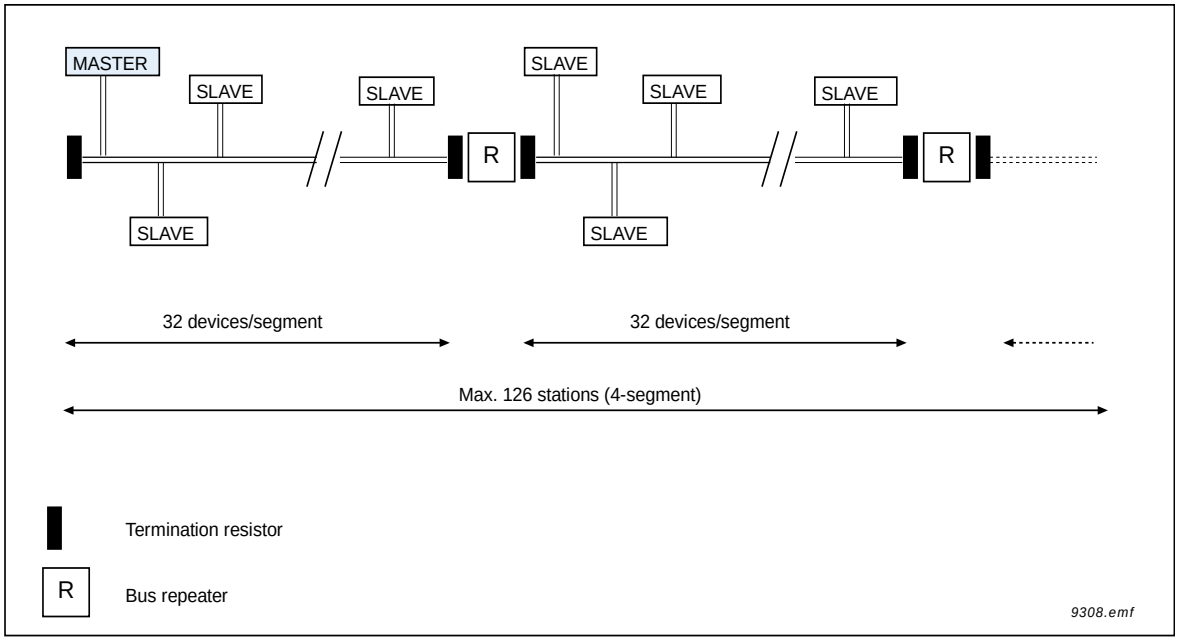


Figure 4. Cabling and bus termination

4.5.2 GROUNDING OF CABLE SHIELD

When installing a fieldbus cable, ensure that the equipotential bonding is good. If the equipotential bonding is good, the fieldbus cable shield can be grounded at both ends. However, if the equipotential bonding system is poor, the shield of the fieldbus cable should be grounded only at one point in the system, in order to avoid current flow in the cable shield from equalizing the potential difference.

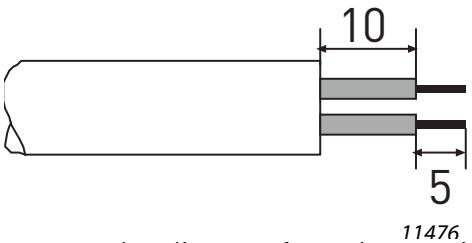
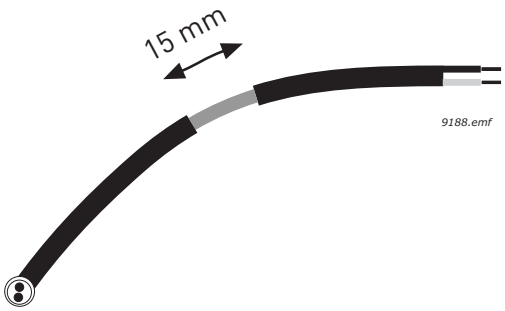
The bus cable shield can be grounded in three different ways:

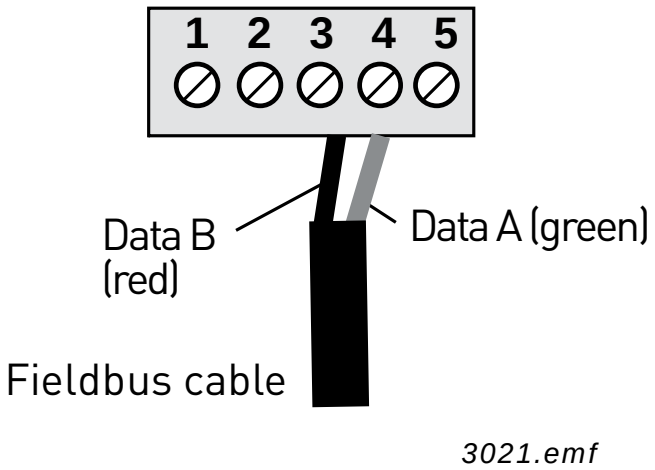
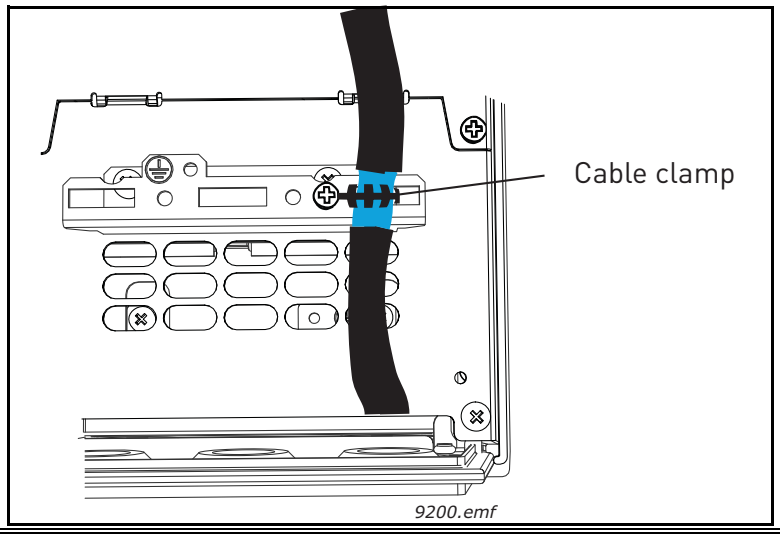
a) Clamping the cable to the AC drive enclosure (recommended when equipotential bonding is good)
   - Jumper settings of X13 and X14 is of no importance in this case

b) Directly to the AC drive enclosure
   - Set Jumper X13 to connect GND with cable shield
   - Set Jumper X14 to connect cable shield directly to PE

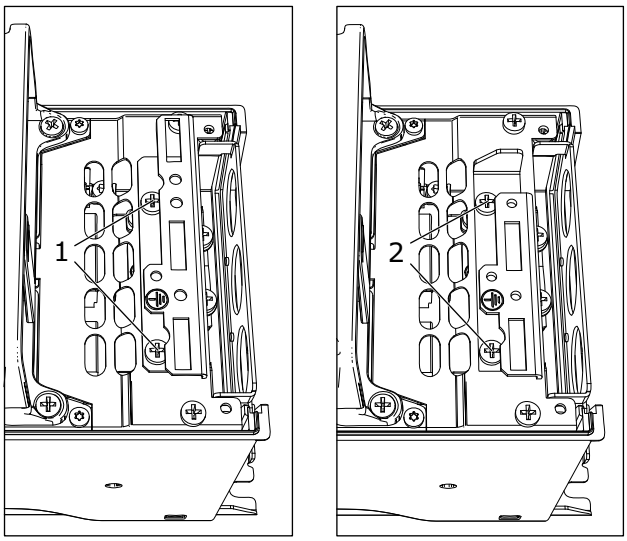
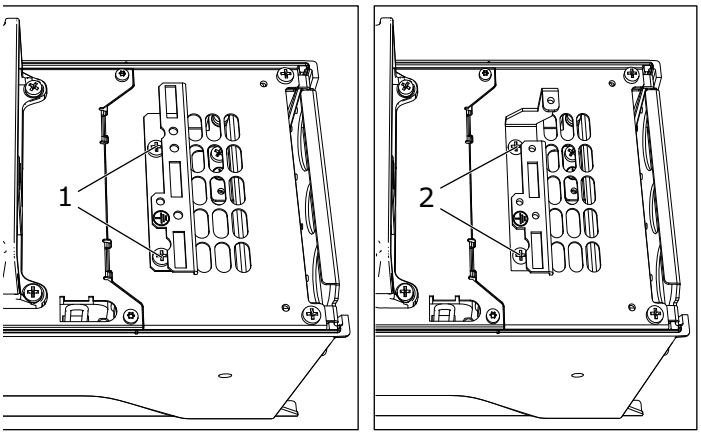
c) To the enclosure of the AC drive through a RC filter (recommended when equipotential bonding is poor)
   - Set Jumper X13 to connect GND with cable shield
   - Set Jumper X14 to connect cable shield to PE through RC

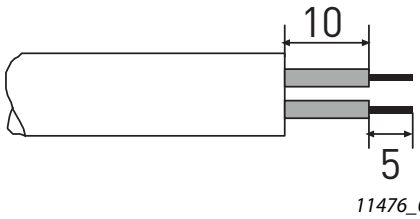
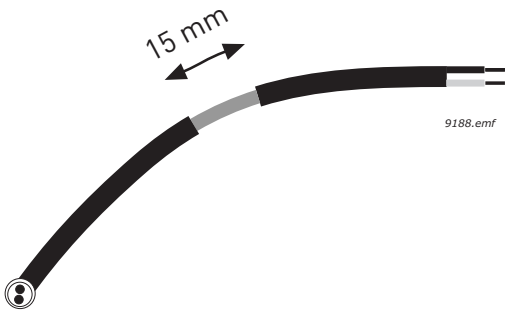
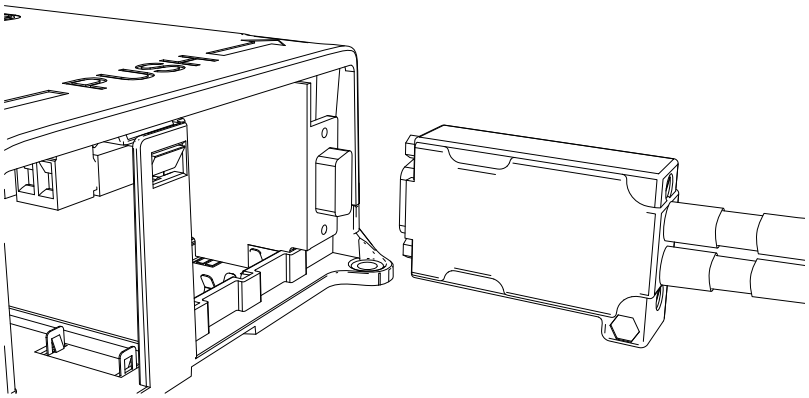
4.5.3 OPTE3 CABLING

1	Strip about 15 mm of the fieldbus cable (see specification in ch.) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). Leave no more than 10 mm of the cable outside the terminal block and strip the cables at about 5 mm to fit in the terminals. See the figure below.  Also strip the cable now at such a distance from the terminal that you can fix it to the enclosure with the grounding clamp. Strip the cable at a maximum length of 15 mm. **Do not strip the aluminum cable shield!** 

2	Connect the cable to its appropriate terminals on PROFIBUS Option Board terminal block. 
3	Using the cable clamp included in the delivery of the drive, ground the shield of the PROFIBUS cable to the enclosure of the AC drive. **NOTE!** This can be done in all drives if there is no difference in PE potential between the drives. However, if there is PE potential difference then the shield should be connected to PE only at one point in the system. The shields of the cables must be joint but not connected to several PE points with different potential. 

4.5.4 OPTE5 CABLING

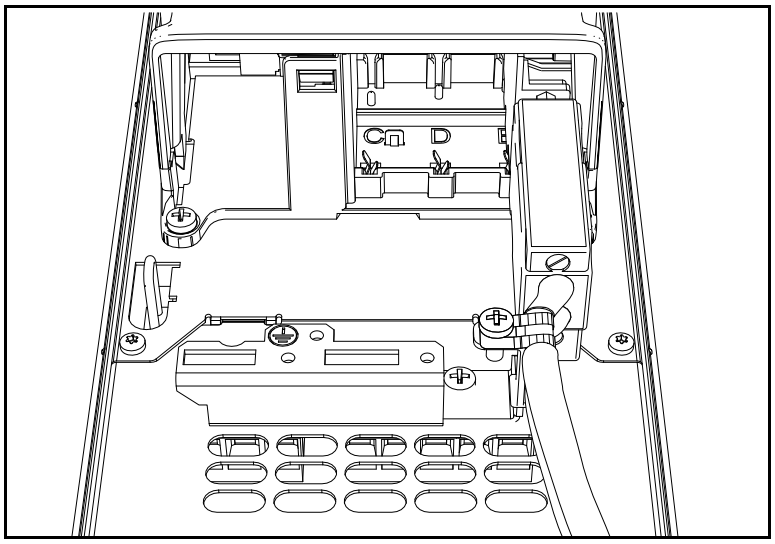
1	This step only applies if the OPTE5 option was purchased separately. 1. Remove the factory installed grounding bracket. It is mounted with two screws. 2. Install the PROFIBUS grounding bracket. Use the screws you just removed. **MR4:**  **MR5-9:** 

2	Strip about 15 mm of the fieldbus cable (see specification in ch.) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). Leave no more than 10 mm of the cable outside the terminal block and strip the cables at about 5 mm to fit in the terminals. See the figure below.  11476_00 Also strip the cable now at such a distance from the terminal that you can fix it to the enclosure with the grounding clamp. Strip the cable at a maximum length of 15 mm. **Do not strip the aluminum cable shield!**  9188.emf
3	Connect the cable to its terminal on PROFIBUS Option Board terminal. 

4

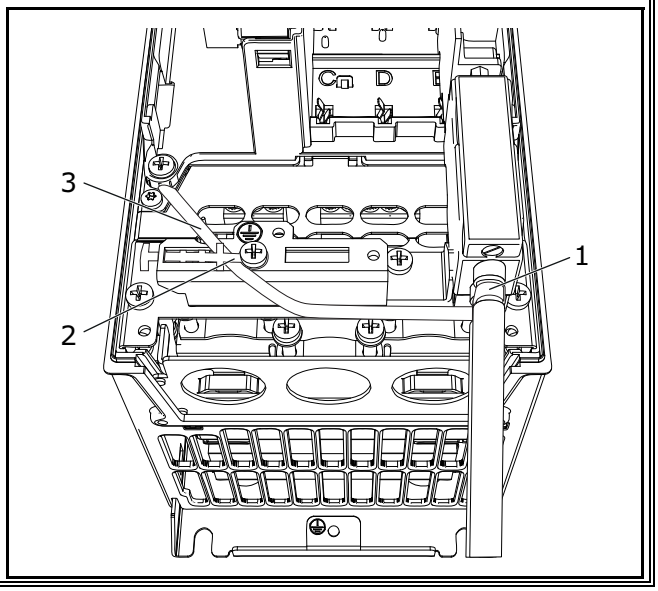
Using the cable clamp included in the delivery of the drive, ground the shield of the PROFIBUS cable to the enclosure of the AC drive.

NOTE! This can be done in all drives if there is no difference in PE potential between the drives. However, if there is PE potential difference then the shield should be connected to PE only at one point in the system. The shields of the cables must be joint but not connected to several PE points with different potential.



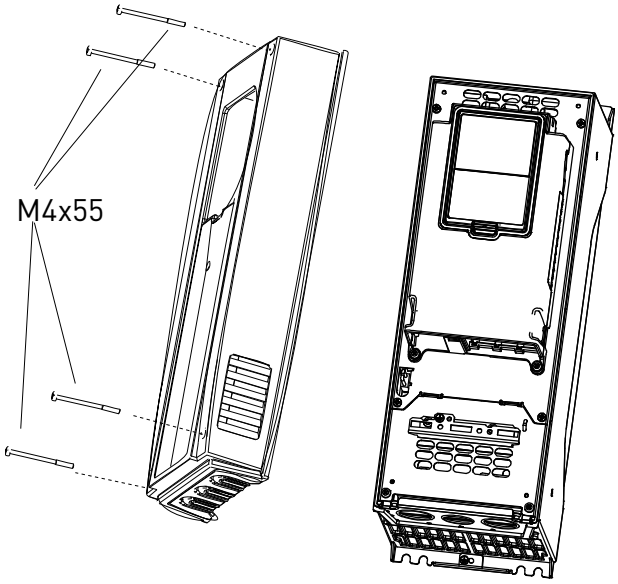
For MR4:

1. Tighten the grounding cable tie around the stripped part of the cables.
2. Place the end of the grounding cable tie under an earthing lamella (supplied with the drive) and fix it tightly with a screw on the PROFIBUS grounding bracket.
3. Cut off the end of the cable tie.



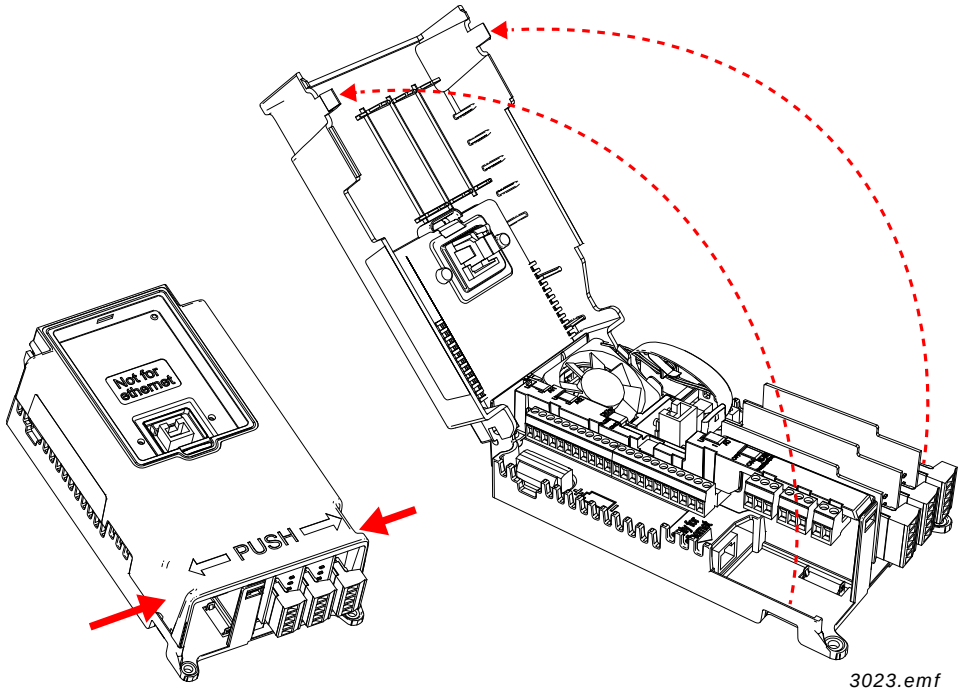
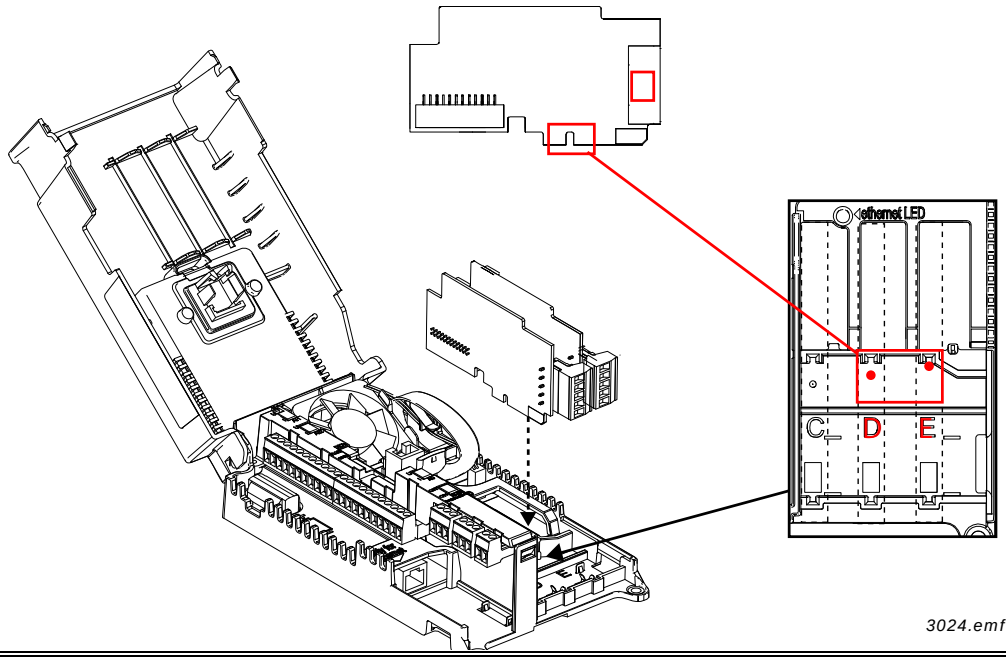
4.6 INSTALLATION IN VACON® 100 FAMILY

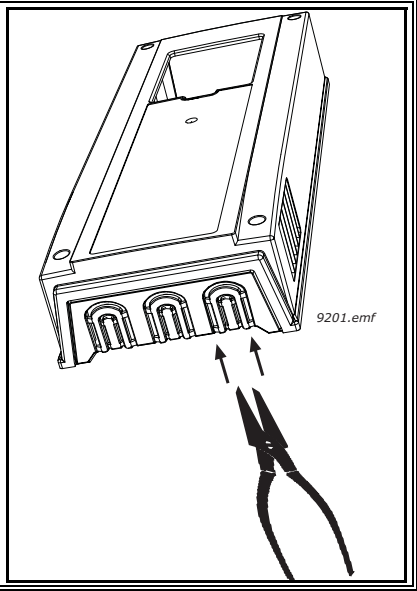
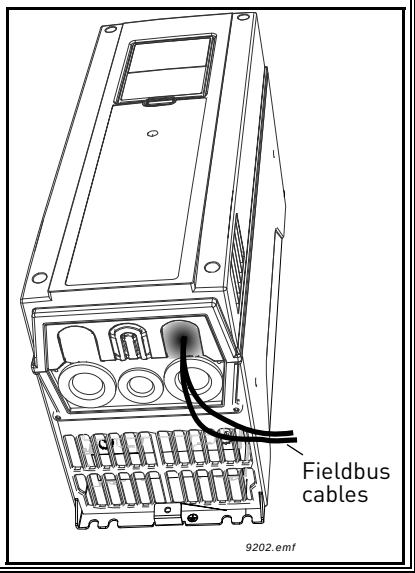
Do not add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.

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

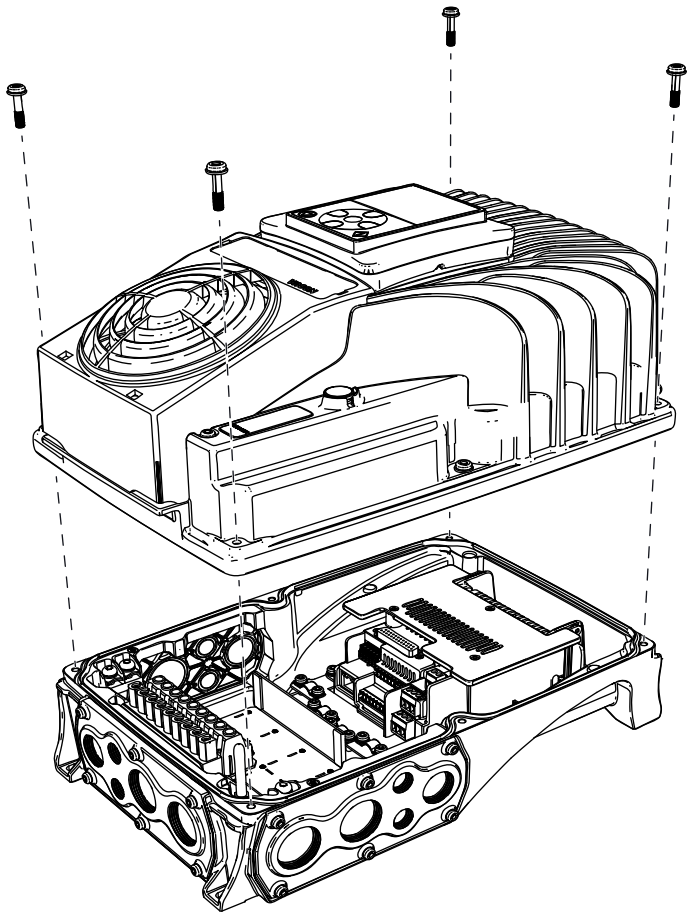
DANGER

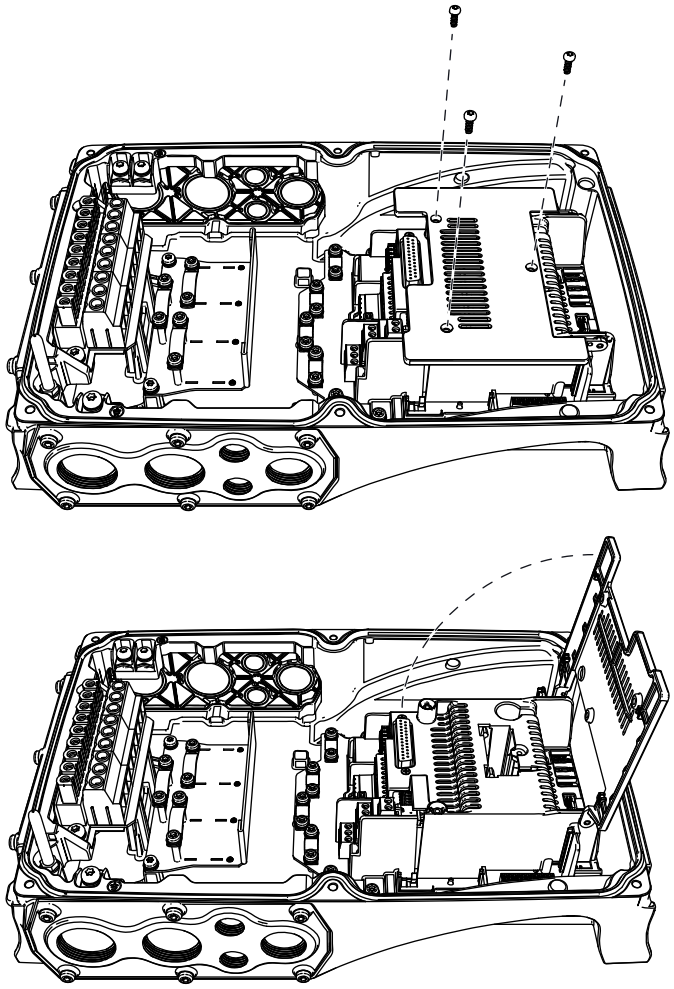
The relay outputs and other I/O-terminals may have a dangerous control voltage present even when VACON® 100 family AC drive is disconnected from mains.

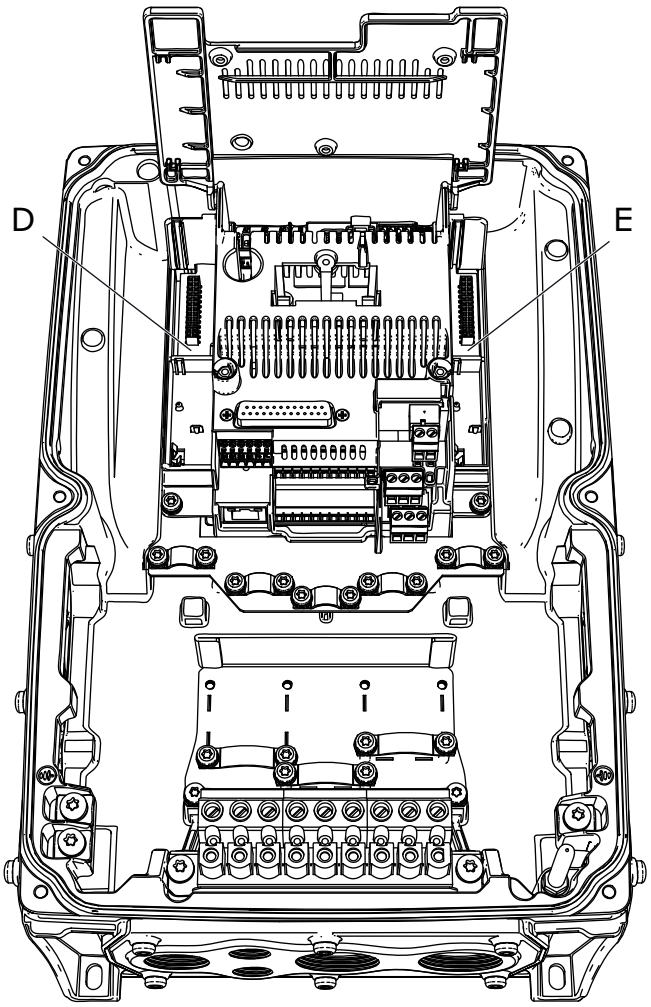
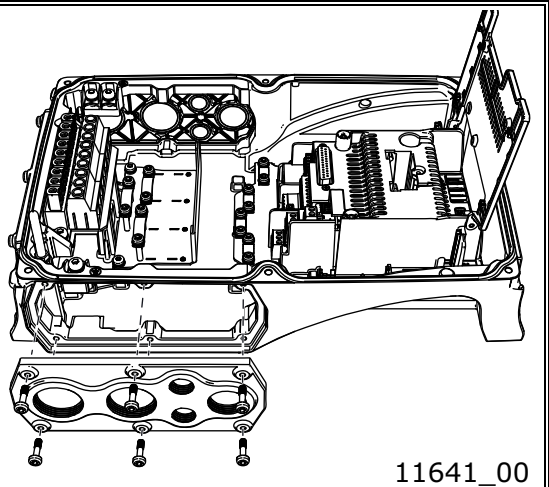
2	Open the inner cover to reveal the option board slots **(C,D,E)**. See the figure below.  3023.emf
3	Install the fieldbus board into slot **D** or **E**. See the figure below. **NOTE! OPTE3** can be installed to either slot **D** or **E** but **OPTE5** board can only be used in slot **E.** **NOTE!** Incompatible boards cannot be installed on VACON® 100 family AC drive. Compatible boards have a slot coding that enable the placing of the board.  3024.emf

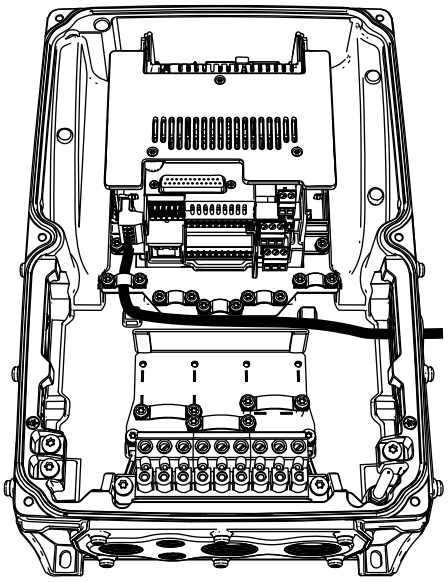
4	**If VACON® 100 family AC drive is the last device on the bus**, the bus termination must be set with jumper X13 (see Chapter 4.4.)
5	Unless already done for the other control cables, cut free the opening on the AC drive cover for the fieldbus cable (protection class IP21). **NOTE!** Cut the opening on the same side you have installed the board in 
6	Remount the AC drive cover and run the cable as shown in the figure. **NOTE!** When planning the cable runs, remember to keep the distance between the fieldbus cable and the motor cable at a **minimum of 30 cm**. It is recommended to route the option board cables away from the power cables as shown in the figure. 

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

1	Open the cover of the AC drive.  11638_00

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

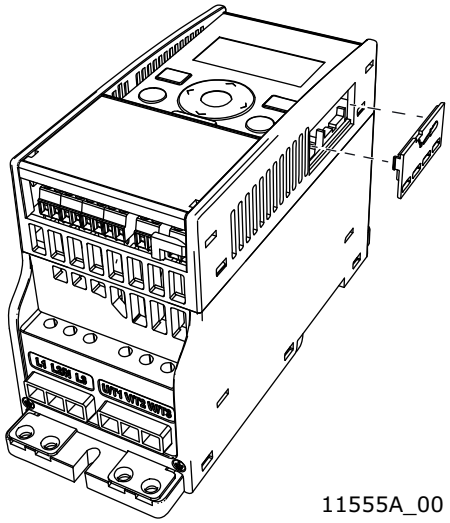
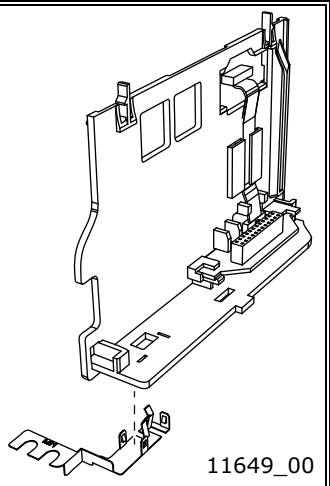
3	Install the option board into the correct slot, D or E.  11640_00
4	Close the option board cover.
5	Remove the cable entry plate. If you installed the option board in the slot D, use the cable entry plate on the right side. If you installed the option board in the slot E, use the cable entry plate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

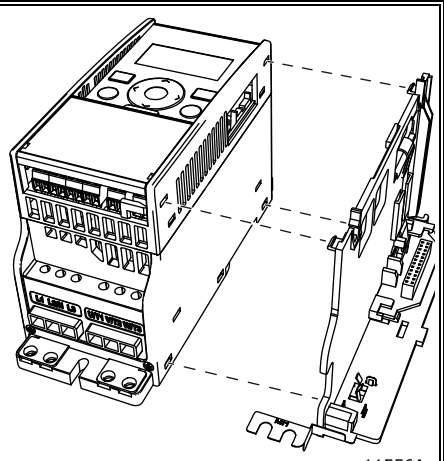
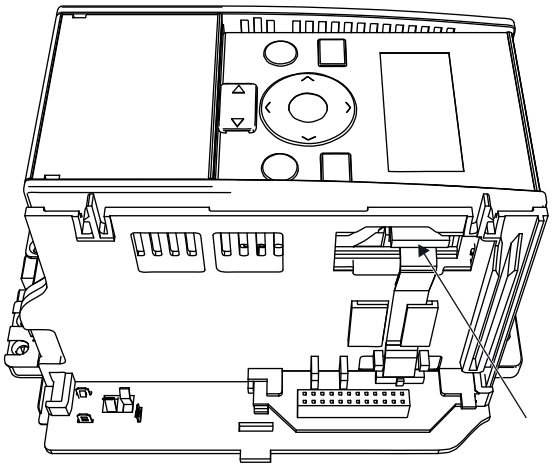
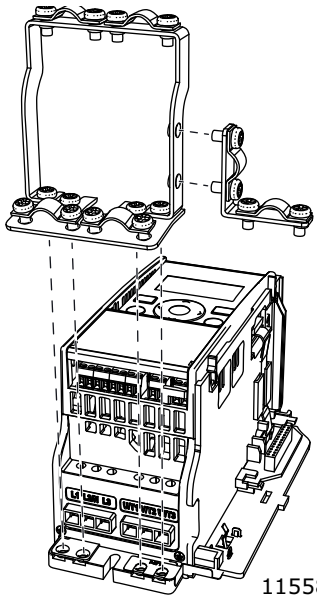
6	Open the necessary holes in the cable entry plate. Do not open the other holes. See the VACON® 100 X Installation Manual for the dimensions of the holes.
7	Attach a cable gland on the hole in the cable entry plate. Pull the fieldbus cable through the hole. **NOTE!** The fieldbus cable must go through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

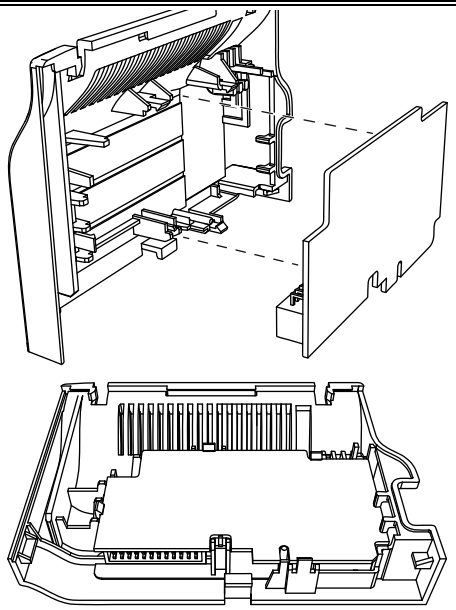
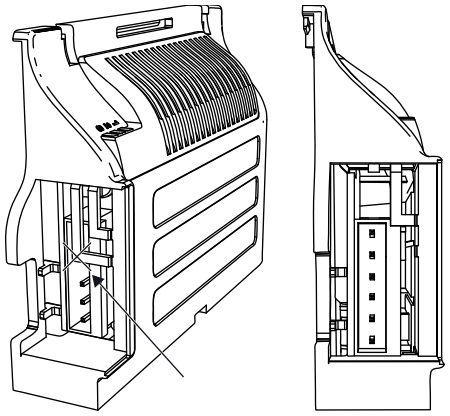
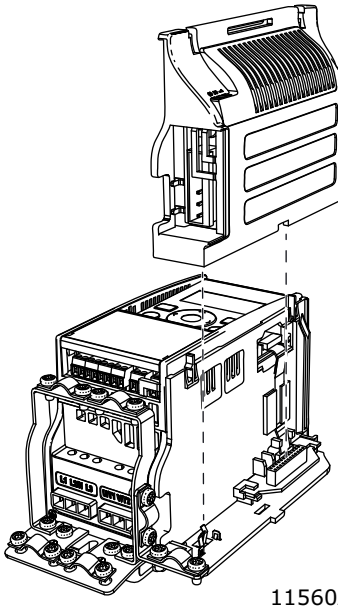
4.8 INSTALLATION IN VACON® 20

4.8.1 ENCLOSURES MI1, MI2, MI3

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

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

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

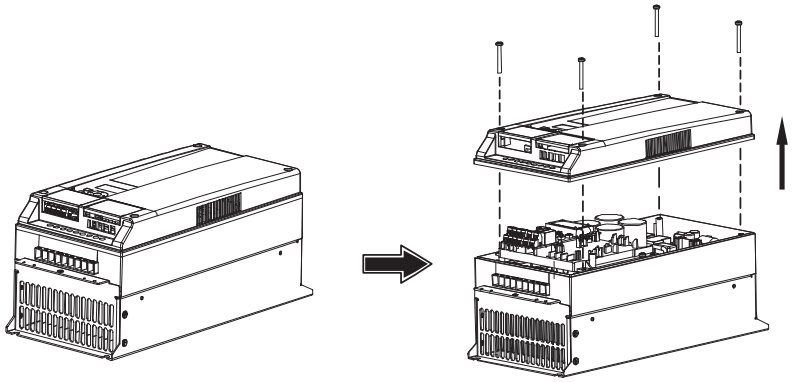
6	Install the option board to the option board holder. Make sure that the option board is securely fastened.  11559A_00
7	Cut free a sufficiently wide opening for the option board connector.  11650_00
8	Attach the option board cover to the AC drive. Attach the strain relief cable clamp with screws if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

4.8.2 ENCLOSURES MI4, MI5

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

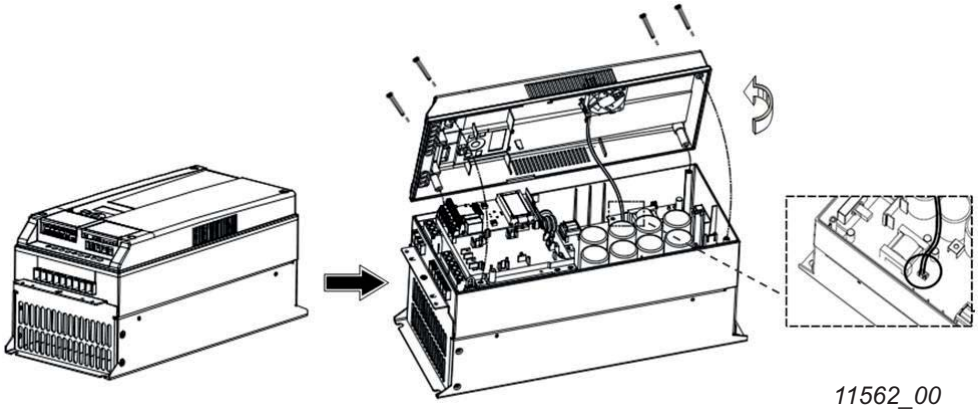
1

1a: For MI4: Open the cover.



11561_00

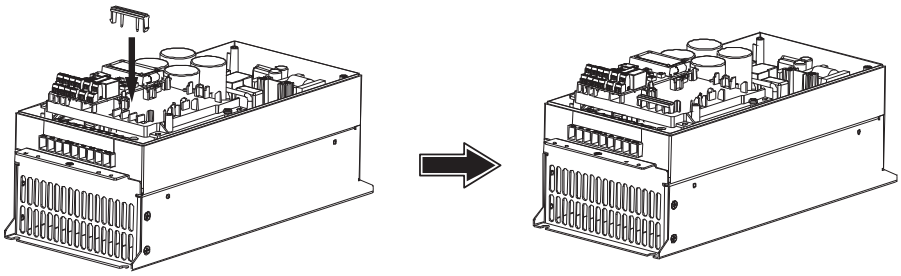
1b: For MI5: Open the cover and release the fan connector.



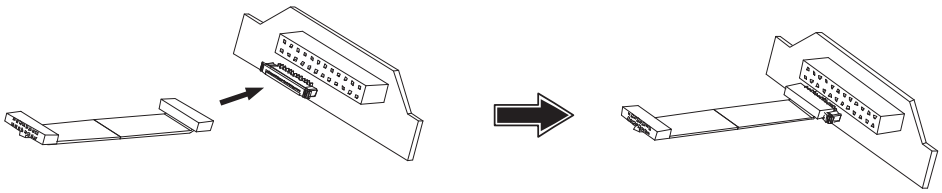
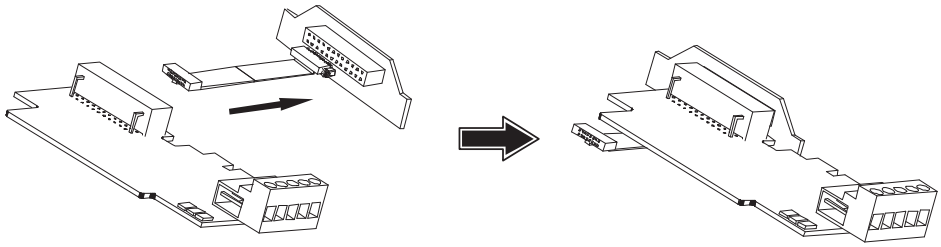
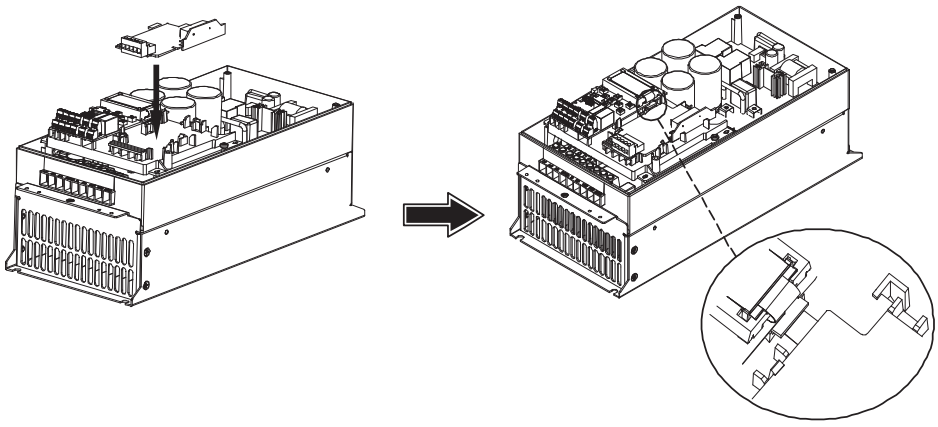
11562_00

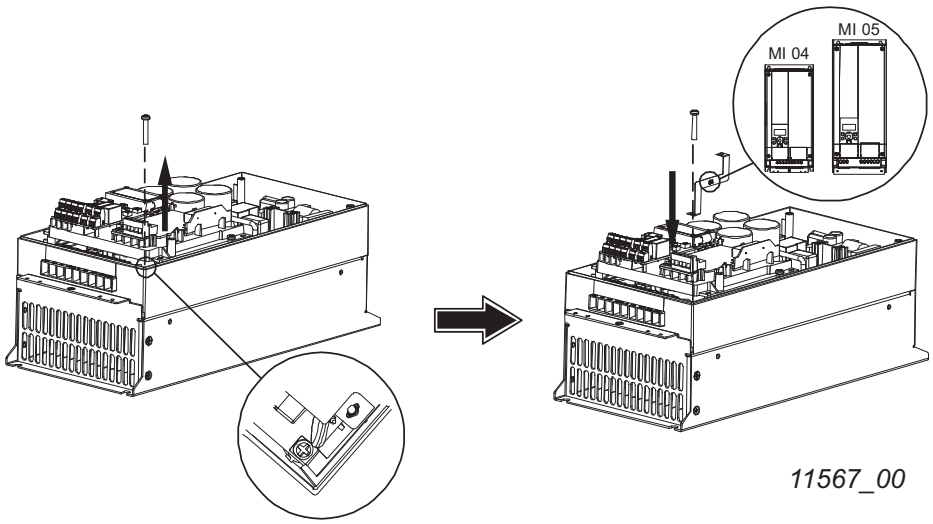
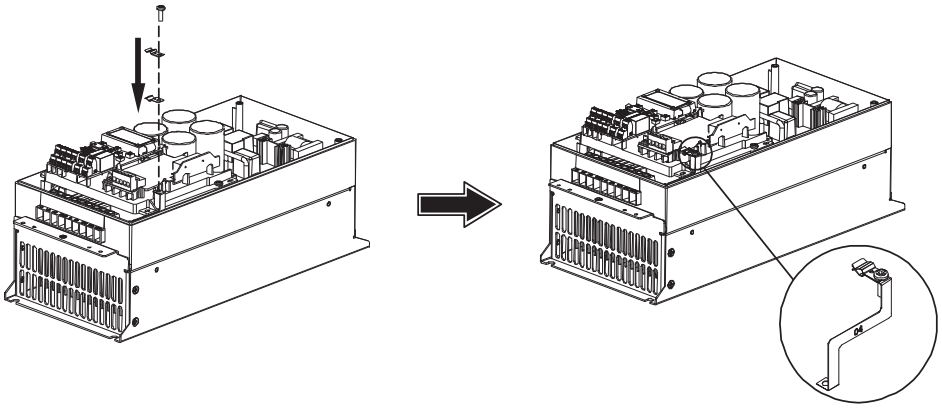
2

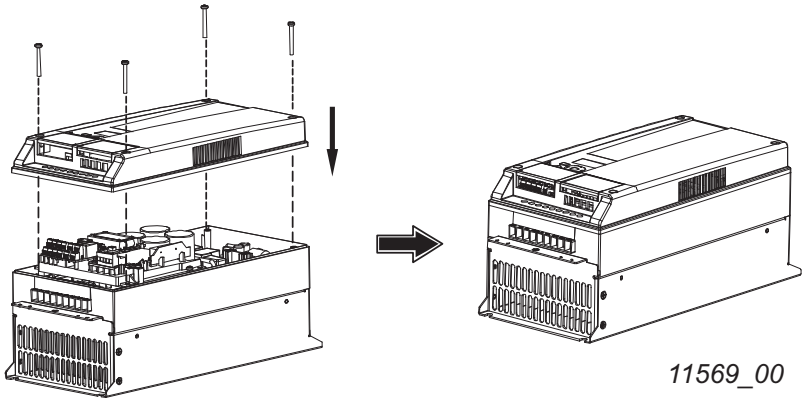
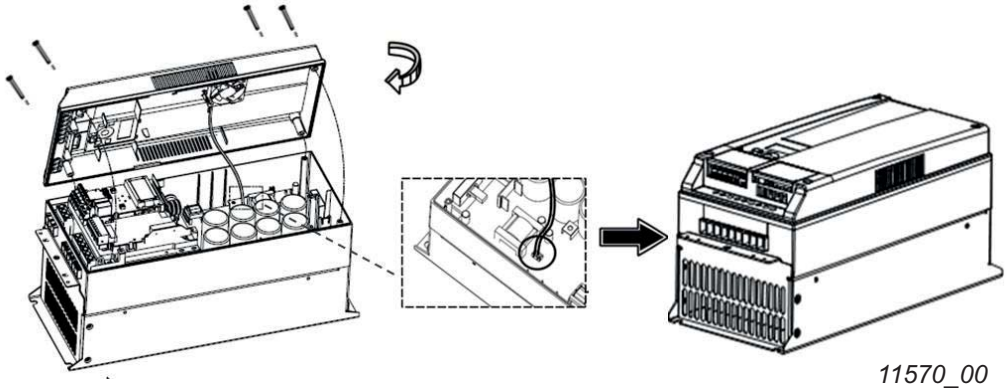
Attach the option board support.



11563_00

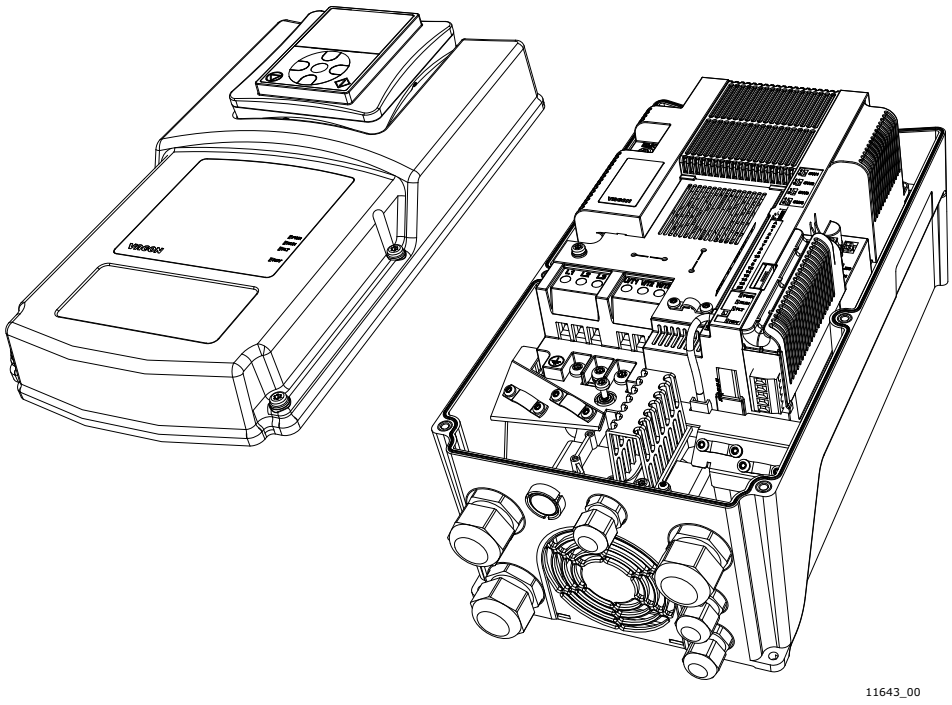
3	Connect the flex cable to option board connector PCB.  11564_00
4	Connect the option board to connector PCB.  11565_00
5	Attach the option board with connector PCB to the AC drive and connect the flex cable.  11566_00

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

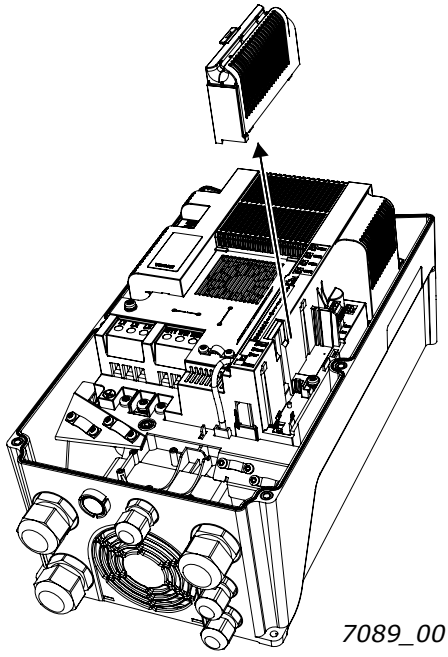
8	8a: For MI4: Close the cover.  11569_00 8b: For MI5: Remount the fan connector and close the cover.  11570_00

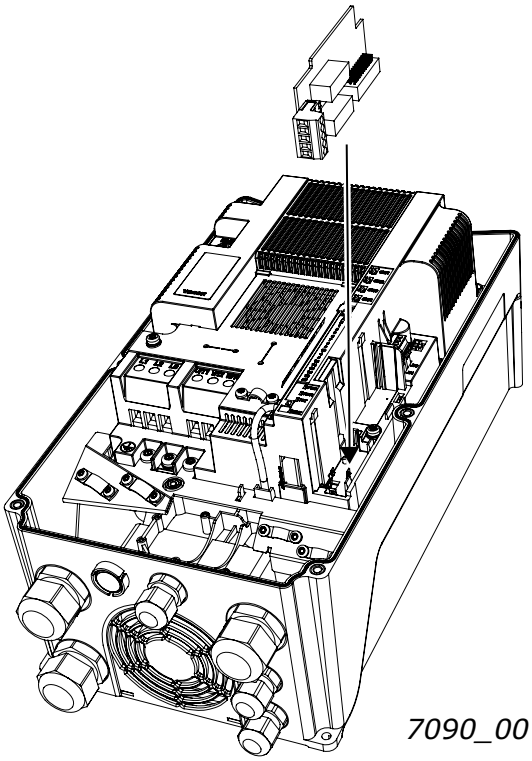
4.9 INSTALLATION IN VACON® 20 X AND 20 CP

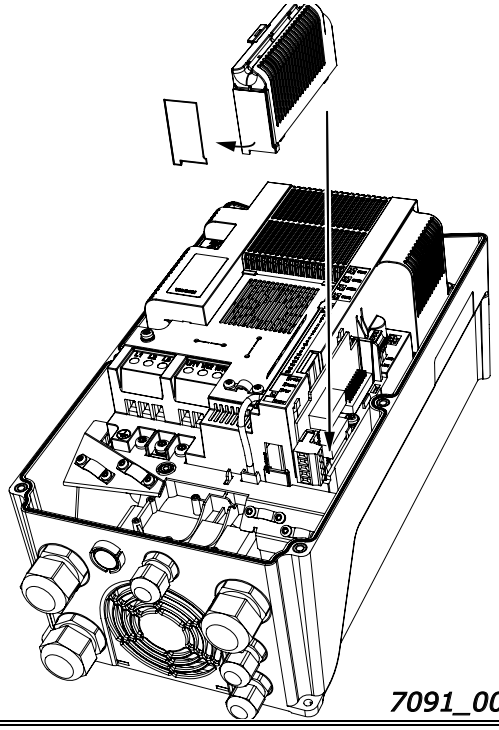
Do not add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.

1	Open the cover of the drive.  MU3 example

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

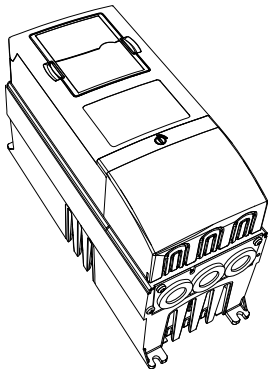
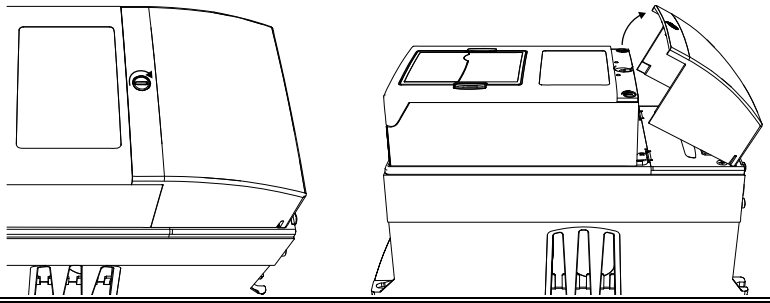
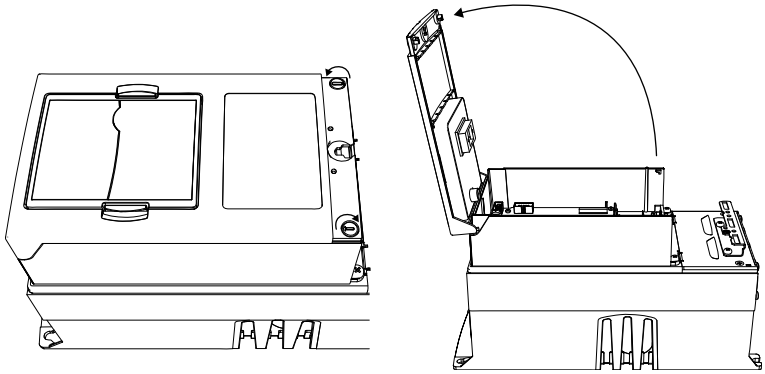
2	Remove the option slot cover.  *7089_00*

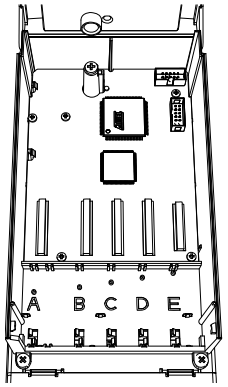
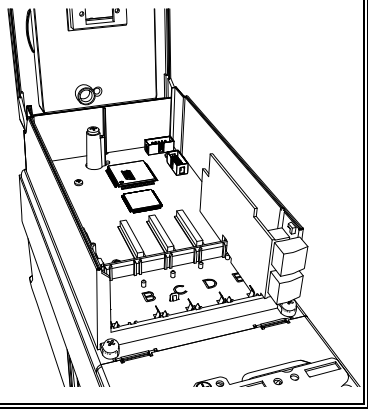
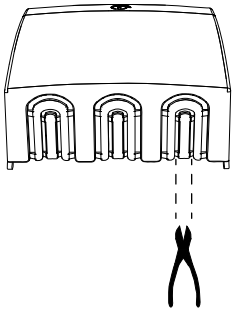
3	Install the option board into the slot as shown in the figure.  *7090_00*

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

4.10 INSTALLATION IN VACON® NX

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

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

4	Install the OPTE3/E5 Option Board in slot D or E on the control board of the AC drive. Make sure that the grounding plate fits tightly in the clamp.  
5	Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary. 
6	Close the cover of the control unit and the cable cover.

5. COMMISSIONING

5.1 PROFIBUS DP BOARD PARAMETERS

Table 9. OPTE3/E5 parameters

Panel Code				Parameter	Min	Max	Default	Description
VACON® 100 family	VACON® NXP	VACON® 20	VACON® 20 X					
P5.x.3.1	P7.x.1.1	P2.6	P2.6	Slave address	2	126	126	Address of the slave
P5.x.3.2	P7.x.1.2	P2.7	P2.7	Operate mode	1	3	1	1 = PROFIdrive 2 = Bypass 3 = Echo
P5.x.3.3	P7.x.1.3	P2.8	P2.8	Compatib. mode	1	2	1	1 = Normal 2 = NX Mode / C3/C5 Mode

Slave address: Valid PROFIBUS device addresses are in the range of 0 to 127 (decimal). The address 0 is reserved for Service-, diagnosis- and programming tools. Address 1 is reserved for the fieldbus master. Address 127 is a broadcast address. Address 126 is only for commissioning. Do not use it permanently. Thus, values in the range from 2 to 125 can be assigned to individual slave devices.

Operate mode: 3 different operate modes are available in OPTE3/E5 (see the figures below). The PROFIdrive mode uses telegrams specified in the profile specification. The bypass mode uses manufacturer-specific control and status word. The echo mode echoes the data back to the fieldbus master.

NOTE! When using ST1 and ST20 telegrams in PROFIdrive-Operate Mode, the PROFIdrive 4.1 State machine, together with PROFIdrive 4.1 Control and Status Words, is used. When using PPO types, the PROFIdrive 2.0 State machine, together with PROFIdrive 2.0 Control and Status Words, is used.

NOTE! When using an application supporting PROFIdrive, set the application fieldbus state machine to "PROFIdrive" and the PROFIBUS option board to bypass mode.

Compatib. Mode: This setting can be used to set a compatibility mode. If set to "NX Mode" in VACON® 100 family and VACON® 20, or to "C3 C5 Mode" in VACON® NXP, the OPTE3/E5 will identify as NX OPTC3/C5 option board. See Chapter 5.6 for more details.

5.1.1 PROFIDRIVE OPERATING MODE

The PROFIdrive operating mode can be used to enable the profile driver in the OPTE3/E5 option board for PROFIdrive support.

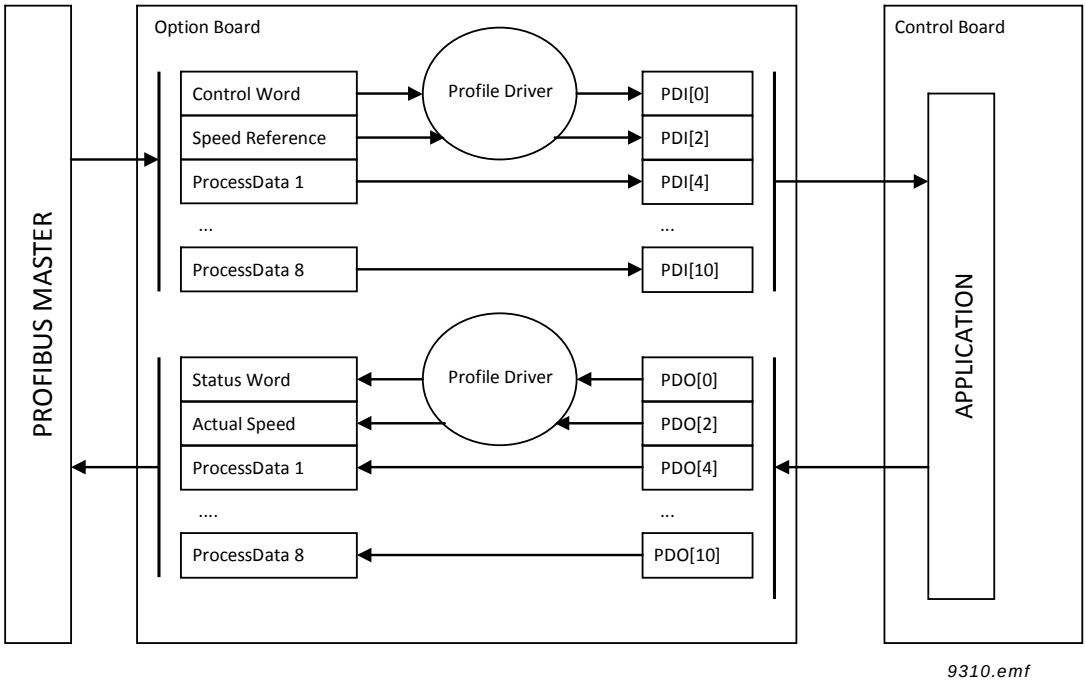


Figure 5. PROFIdrive operating mode

5.1.2 BYPASS OPERATING MODE

The information of the process data field is transferred to the application without handling.

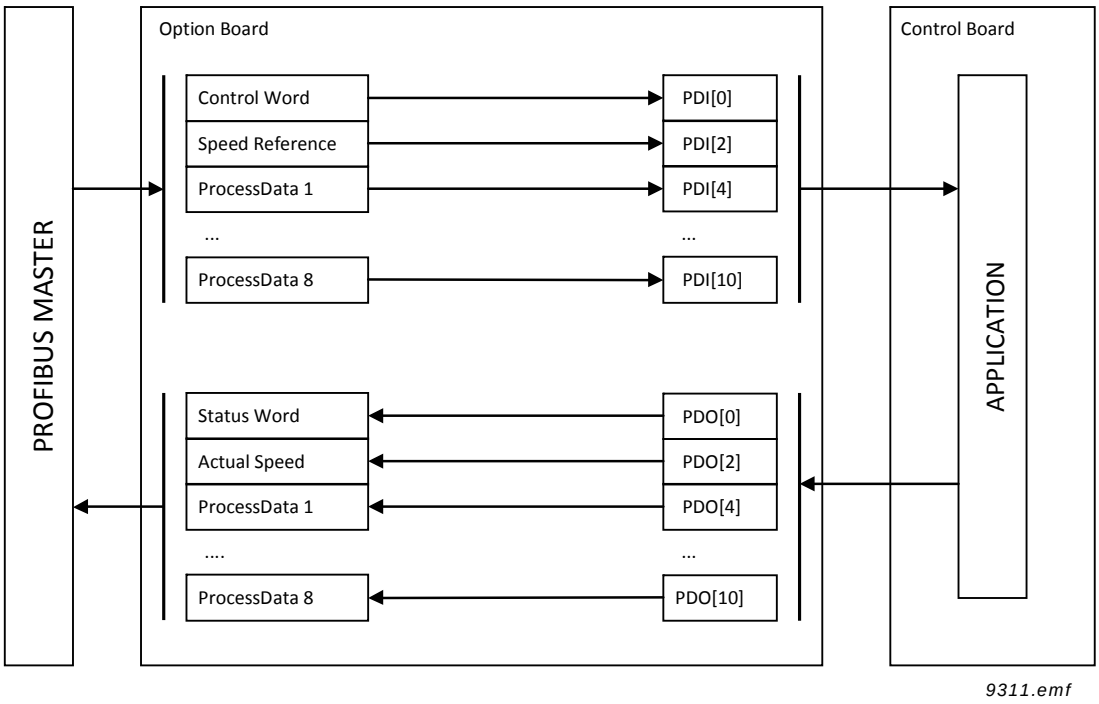


Figure 6. Bypass operating mode

NOTE! The Status Word content is different between VACON® AC drives, when using bypass mode.

- VACON® 100 and VACON® 20 family AC drives return PDO [0] (Fixed Status Word)
- VACON® NX series drives return PDI [1] (General Status Word)

5.1.3 ECHO OPERATING MODE

The received information is echoed back to Master (Output -> Input), without accessing the application.

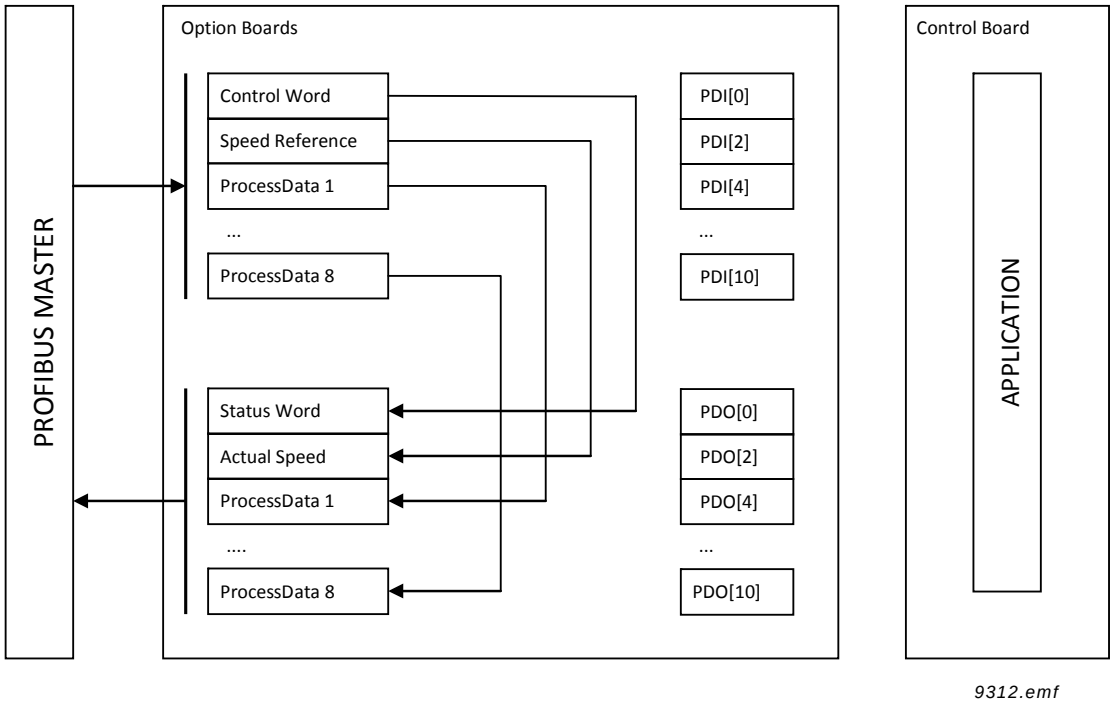


Figure 7. Echo operating mode

5.1.4 LOCAL VERSUS REMOTE MODE

In the GSD for OPTE3/E5, it is possible to select the operating mode for the slave. Possible options are:

- Local mode
- Remote PROFIdrive mode
- Remote Bypass mode
- Remote Echo mode

In the Remote modes, the fieldbus master can force the slave into a specific operating mode. This allows the operating mode of the slave to be changed in the master configuration, without a need to use the keypad.

In the Local mode, the operating mode of the slave can be parameterized in the drive (e.g. manually through the keypad). When the drive powers up, the operating mode of the PROFIBUS DP slave is determined by the last value configured in the drive.

NOTE! When the operating mode of the OPTE3/E5 board is remotely selected, its mode cannot be changed from the drive keypad

5.1.5 BYPASS AND ECHO OPERATING MODE LIMITATIONS

It is not possible to use the Bypass or Echo modes when the Standard Telegram 20 is used. In this case, only PROFIdrive mode is allowed.

5.2 PROFIBUS DP BOARD MONITOR VALUES

Table 10. OPTE3/E5 monitor values

Panel Code				Parameter	Min	Max	Unit	Description
VACON® 100 family	VACON® NXP	VACON® 20	VACON® 20 X					
V5.x.2.1	V7.x.2.1	V2.1	V2.1	Profibus Status	0.0	5000.2	xxxx.y	xxxx = Message counter y = Status of communication, y(0) = Wait_Prm y(1) = Wait_Cfg y(2) = Data_Exchange
V5.x.2.2	V7.x.2.2	V2.2	V2.2	FB Protocol Status	1	4		1 = Initializing 2 = Stopped 3 = Operational 4 = Faulted
V5.x.2.3	V7.x.2.3	V2.3	V2.3	Protocol	0	1		0 = DP-V0 1 = DP-V1
V5.x.2.4	V7.x.2.4	V2.4	V2.4	Baud Rate	1	10		1 = 9.6 kBaud 2 = 19.2 kBaud 3 = 93.75 kBaud 4 = 187.6 kBaud 5 = 500 kBaud 6 = 1500 kBaud 7 = 3 MBaud 8 = 6 MBaud 9 = 12 MBaud 10 = Auto
V5.x.2.5	V7.x.2.5	V2.6	V2.6	PPO Type	0	6		0 = Not Used 1 = PPO1 2 = PPO2 3 = PPO3 4 = PPO4 5 = PPO5 6 = PPO6
M5.x.2.6	V7.x.2.6	V2.5	V2.5	Telegram Type	0	4		0 = Not Used 1 = ST1 2 = ST1 + 4PD 3 = ST1 + 8PD 4 = ST20
-	V7.x.2.7	-	-	Safety Telegram	0	3		0 = Not Used 1 = ST30 2 = ST31 3 = ST58000
M5.x.2.8	V7.x.2.8	V2.9	V2.9	Profile CW	0	65535		Control Word from PLC
M5.x.2.9	V7.x.2.9	V2.10	V2.10	Profile SW	0	65535		Status Word from AC drive

x = Depends on used option board slot

Profibus status: This field has two values. The first part is an incrementing message counter. It increases every time a message is received and holds a maximum value of 5000 (after which it starts from 0). The second part is the Profibus communication status. In Wait_prm the board is expecting a parameter assignment message. In Wait_Cfg the board is waiting for a configuration message. After a successful configuration, the device goes into Data_Exchange, where an exchange of user data with master is initialized.

FB Protocol Status: Fieldbus protocol status.

Protocol: Used Profibus DP protocol. DP-V0 (cyclic data exchange) and DP-V1 (acyclic and cyclic data exchange) are supported.

Baud Rate: Actual communication baud rate. Value stays at 10, "Auto" (Auto baud), as long as a valid baud rate is found.

PPO Type: Used PPO type. If Standard Telegram is used, this field shows as "Not Used".

Telegram Type: Used Standard Telegram type. If PPO1-6 is used this shows as "Not Used".

Safety Telegram: Used Standard Safety Telegram. Only valid when using VACON® Advanced safety options. This value shows the value configured by master (PLC).

Profile CW: Control Word sent from master (PLC).

Profile SW: Status Word sent to master (PLC).

5.3 PROFIBUS DP MODULES

The OPTE3/E5 option board implements the following PROFIBUS modules:

Table 11. OPTE3/E5 modules

Module name	Number	Abbreviation	Type	Description
Standard Telegram 1	7	ST1	Drive	See chapter 6.3.2.1
Vacon Telegram 100	8	ST1+4PD		See chapter 6.3.2.3
Vacon Telegram 101	9	ST1+8PD		
Vacon Telegram 138	11	ST1+12PD		
Vacon Telegram 139	12	ST1+16PD		
Standard Telegram 20	10	ST20		See chapter 6.3.2.2
Parameter-Process Data Type 1...6	1...6	PPO1...PPO6		See chapter 6.5.4
Standard Telegram 30	13	ST30	Safety	See chapter 7.2
Standard Telegram 31	14	ST31		
Vacon Telegram 58000	15	ST58000		

NOTE! PPO types imply the use of PROFIdrive 2.0, and is not recommended for new installations.

Drive module rules:

- Only one drive module is allowed.
- One drive module must always be configured.

Safety module rules:

- If a safety module is configured, it must always be in slot 1.
- Only one safety module is allowed.
- ST20 and PPO1...6 is not allowed with safety modules.
- The same safety module must be selected as configured in Advanced Safety option board.

The supported module combinations are described in Table 12.

Table 12. Supported module combinations

Slot 2 / Slot 1	Empty	ST1(+PD)	ST20	ST30, 31	ST58000	PPO1...6
Empty		X	X			X
ST1(+PD)	X					
ST20	X					
ST30, 31		X				
ST58000		X				
PPO1...6	X					

X = allowed

An invalid module configuration causes a diagnostic configuration fault. As a result, the device returns to parameterization state and does not start the data exchange with PROFIBUS master.

In case of a safety module fault, a channel related diagnosis (refer to Chapter 8.2) is activated to notify the master of a problem with the safety module. The data exchange is started with PROFIBUS master.

5.4 PROFIBUS DP PARAMETERS

In the GSD for OPTE3/E5, it is possible to further select operating modes for the slave.

Table 13. Modifiable parameters in GSD file

Parameter	Value	Range	Default
Operate mode	0 = Local 1 = Remote, PROFIdrive 2 = Remote, Bypass 3 = Remote, Echo	0-3	0
DP mode	0 =DP-V0 1 = DP-V0 + DP-v1	0-1	1

Operate mode:

In the Remote modes, the fieldbus master can force the slave into a specific operating mode. This allows the operating mode of the slave to be changed in the master configuration, without a need to use the keypad. When these modes are used, the drive keypad cannot be used to change the operating mode.

In the Local mode, the operating mode of the slave can be parameterized in the drive (e.g. manually through the keypad). When the drive powers up, the operating mode of the PROFIBUS DP slave is determined by the last value configured in the drive.

DP mode:

The fieldbus master selects the PROFIBUS communication method.

DP-V0: Cyclic data exchange and diagnosis

DP-V1: Acyclic data exchange and alarm handling

For more details, see chapter 6.1.

5.4.1 SAFETY PARAMETERS

When a PROFIsafe connection is used, extra safety parameters (F-Parameters) must be provided for the safety module to verify the safety connection settings. All F-Parameters must match the parameterization of the safety system. If any of the parameters are incorrectly parameterized a system fault and a channel related diagnosis is triggered.

NOTE! In addition, the configured Safety Telegram number must match the configuration with the Advanced Safety option board. The Safety PLC is not allowed to choose the used Safety Telegram. If the safety telegram does not match, an error and channel related diagnosis is triggered.

For more details on PROFIsafe parameterization and commissioning, refer to VACON® NXP Advanced Safety Options Operating Guide.

5.5 PROFIBUS DP BOARD COMMUNICATION MODE

The OPTE3/E5 option board supports the following fieldbus board communication modes:

- Normal mode, for most commonly used setups
- Fast mode, with low latency process data
- Fast safety mode with safety "black channel"

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

For more details about fieldbus option board communication modes, see Chapter 12.

5.6 REPLACING VACON® NXS/NXL WITH VACON® 100 FAMILY AC DRIVE

The VACON® NXS/NXL series AC drives using the OPTC3/C5 option board can be replaced with VACON® 100 family AC drives using OPTE3/E5 option board. In this case, consider the following issues.

5.6.1 FIELDBUS CONFIGURATION (GSD) FILE

By default, the OPTE3/E5 uses a different GSD file containing more modules than OPTC3/C5. Take the newer GSD file into use in the PLC. The PPO types supported in OPTC3/C5 (1-5) are still supported and are compatible with OPTE3/E5.

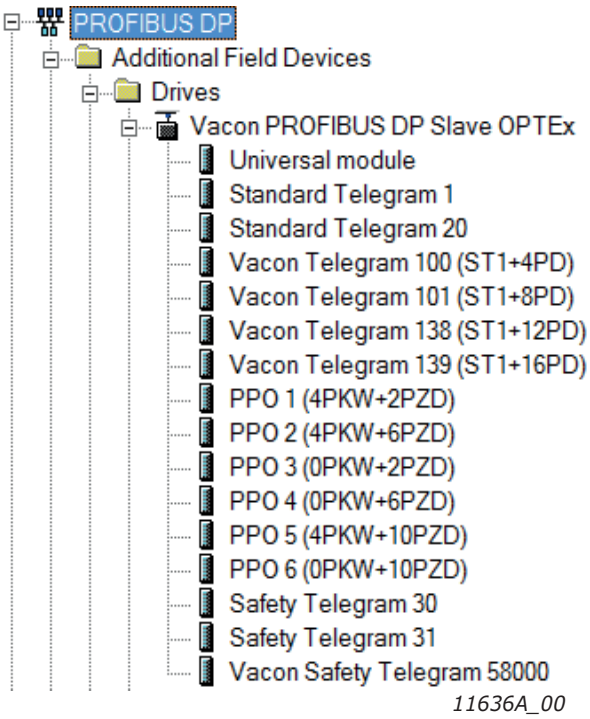


Figure 8. Module selection with new configuration

NOTE! If the "Mode" parameter is set to "NX mode" or "C3/C5 mode" (refer to 5.1), the GSD file for OPTC3/C5 must be used. This option can be used to support old installations.

GSD files can be downloaded from http://drives.danfoss.com.

5.6.2 PARAMETERIZATION

In OPTC3/C5, the PPO type and operate mode was selected using panel parameters. Now it is possible to do this with the PLC. However, with "local" selection it is possible to select operate mode with panel parameter. See chapter 5.1.4 for more information. Remember also that in OPTE3/E5 the baud rate is always automatically selected.

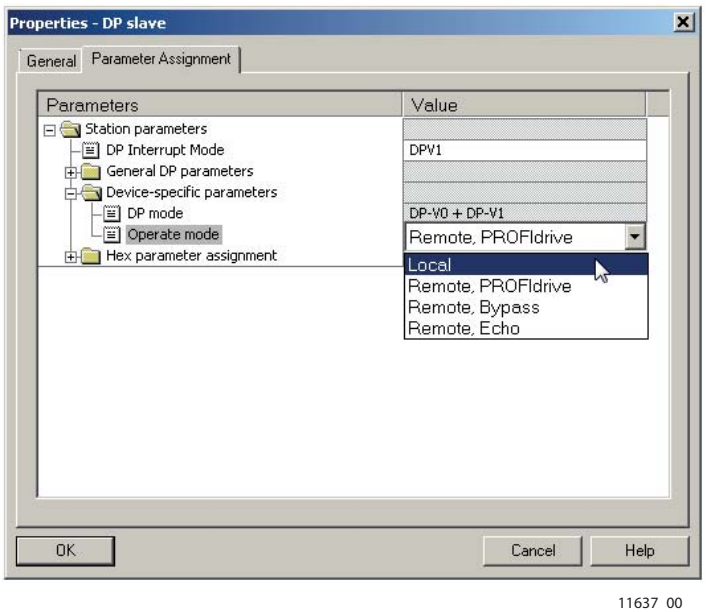


Figure 9. Operate mode selection

5.6.3 OTHER ISSUES TO CONSIDER

FBDIN bits used in PROFIdrive 2.0 are not supported by VACON® 100 family AC drive.

NX Fast Profibus mode is not supported by VACON® 100 family AC drive and OPTE3/E5.

OPTE3/E5 and VACON® 100 family AC drive uses VACON® Live and VACON® Loader instead of VACON® NCDrive and VACON® NCLoad. Use these new tools to upload firmware and to connect to the PC tool.

6. PROFIBUS DP INTERFACE

Features of the PROFIBUS-VACON® interface:

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

6.1 GENERAL

The data transfer between the PROFIBUS DP master and the slave takes place via the input/output data field. The Master writes to Slave's output data and the Slave answers by sending the contents of its input data to the Master. The contents of the input/output data is defined in the device profile. The device profile for AC drives is PROFIdrive.

When fieldbus has been selected as the AC drive's active control place, the AC drive's operation can be controlled from the PROFIBUS DP Master. Whether or not the active control place is fieldbus, the AC drive can be monitored and its parameters set by the PROFIBUS DP Master.

The communication between the PROFIBUS board and the AC drive can be split into two types, Process Data and Service Data.

Process Data In (PDI): For controlling AC drive, max 10 words

Process Data Out (PDO): Is used for fast monitoring of the AC drive, max 10 words

Service Data: Used for Write/Read parameters and variables. Available only when the device is configured to use PPO1, PPO2 or PPO5. In this case, the profile state machine is not compliant with the PROFIdrive 4.1 specification.

NOTE! If Standard Telegrams are used in data exchange, Service Data is communicated using the acyclic data exchange as specified in DP-V1 and the PROFIdrive 4.1 specification. (See Figure 10).

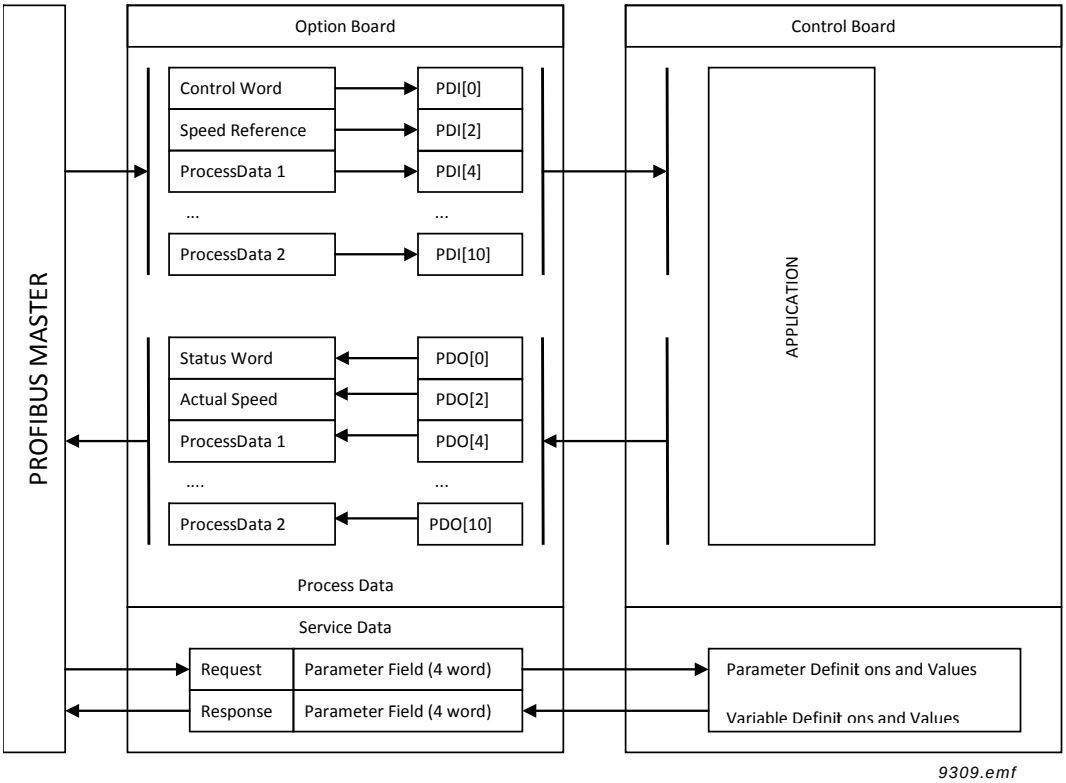


Figure 10. Data transfer between PROFIBUS master and VACON® AC drive

6.2 PROFIBUS DP CYCLE TIME

In some cases, it is useful to determine the PROFIBUS cycle time. For example, when using PROFIsafe over PROFIBUS, the safety watchdog time must take into consideration the cycle time of PROFIBUS.

The PROFIBUS cycle time depends on the following factors:

- Number of slaves
- Transmission rate
- Data volume (input and output data)

The PROFIBUS master calculates the cycle time based on these variables. This value must be checked from the used PLC program. Below are two examples using the same setup: PLC with 4 VACON® AC drives configured with 16 bytes of Process Data on a transmission rate of 1.5Mbps.

Siemens TIA Portal V13:

Network view --> Click the PROFIBUS network --> General --> PROFIBUS --> Bus parameters --> Ttr typical (3.3 ms)

Beckhoff TwinCAT System Manager V2

I/O - Configuration --> Click the PROFIBUS master --> EL6731 (in this example) --> Estimated DP-Cycle (3.1 ms)

NOTE! These cycle time do not take into account acyclic data exchange, alarms or retransmissions.

6.3 DATA MAPPING FOR PROFIDRIVE 4.1

This section describes the messages used for controlling the drive through the OPTE5/OPTE3 PROFIBUS DP option board.

NOTE! The PPO types cannot be used with PROFIdrive 4.1. The PROFIdrive version 2.0 is used, if PROFIdrive is selected and the PPO types are used.

6.3.1 PROFIDRIVE 4.1 STATE MACHINE

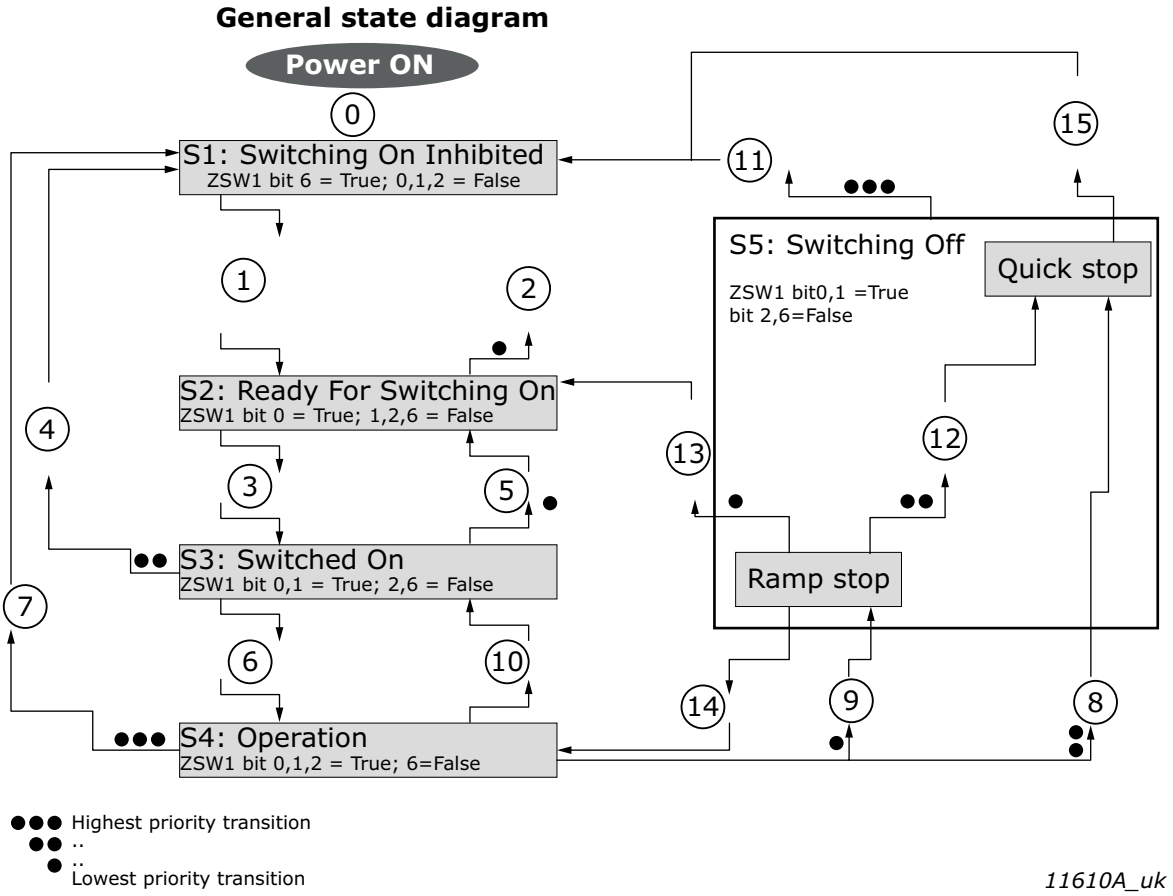


Figure 11. General state diagram

NOTE! When using VACON® NX series AC drives and OPTE3/E5 in "PROFIdrive" mode, the stop command always follows configured stop mode and not the stop command given from fieldbus.

NOTE! Quick stop only occurs if the application supports it. If the application does not support Quick stop, a normal ramp stop is executed.

Table 14. PROFIdrive state machine commands

#	Bits of control word	Value (hex)	Action(s)		
			VACON® 100 family & VACON® 20X/CP	VACON® 20	VACON® NXP
0	-	-	Self-initiation is performed		
1	OFF AND No Coast Stop AND No Quick Stop STW1 bit 0 = False; 1, 2 = True	0x47E	None, requires that Drive is READY (ZSW1 status word bit 13)		
2	Coast Stop OR Quick Stop STW1 bit 1 = False OR bit 2 = False		None		
3	ON STW1 bit 0 = True	0x477	None		
4	Coast Stop OR Quick Stop		None		
5	STW1 bit 1 = False OR bit 2 = False		None		

Table 14. PROFIdrive state machine commands

#	Bits of control word	Value (hex)	Action(s)		
			VACON® 100 family & VACON® 20X/CP	VACON® 20	VACON® NXP
6	Enable operation STW1 bit 3 = True	0x47F	Drive function is enabled, requires that Drive is in fieldbus control (ZSW1 status word bit 9		
7	Coast stop STW1 bit 1 = False	0x47D	Stop by coast	Stop by coast	Stop function
8, 12	Quick stop STW1 bit 2 = False	0x47B	Quick stop	Stop by ramp	Stop function
9	Ramp stop STW1 bit 0 = False	0x47E	Stop by ramp	Stop by ramp	Stop function
10	Disable operation STW1 bit 3 = False	0x477	Drive function is disabled, stop by stop function		
11	Coast stop STW1 bit 1 = False	0x47D	Stop by coast	Stop by coast	Stop function
13, 15	Standstill detected OR Disable operation STW1 bit 3 = False	0x477	Drive function is disabled, stop by stop function		
14	ON (Re-enable operation)	0x47F	Drive function is re-enabled		

6.3.2 STANDARD TELEGRAMS

The PROFIdrive 4.1 profile specifies two telegrams used for communication. The OPTE3/E5 supports two standard telegrams used for AC drive control: Standard Telegram 1 and Standard Telegram 20 and four vendor specific telegrams with added process data items.

The safety telegrams are not defined in this chapter. See the VACON® NXP Advanced Safety Options Operating Guide about details on Safety Telegram definitions.

Table 15. Supported telegrams

Telegram no.	Telegram
1	Standard Telegram 1
20	Standard Telegram 20
100	Standard Telegram 1 + PD[1..4]
101	Standard Telegram 1 + PD[1..8]
138	Standard Telegram 1 + PD[1..12]
139	Standard Telegram 1 + PD[1..16]

6.3.2.1 Standard Telegram 1

The Standard Telegram 1 comprises a control word and a setpoint value which is sent to the slave. The slave returns a status word and an actual speed value to the PROFIBUS DP master.

In its basic form, the Standard Telegram 1 consists of four bytes. The first two bytes contain the control/status word and the next two bytes the speed reference/actual value.

Table 16. Definition of standard telegram 1

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	1...3	NSOLL_A	NIST_A

6.3.2.2 Standard Telegram 20

The Standard Telegram 20 contains essentially the same control/status word and setpoint/actual speed value fields as the Standard Telegram 1. The data sent by the slave to the master contains additional fields regarding the controlled process. In Standard Telegram 20 the output signals are filtered. Filtered signals include the suffix _GLATT.

Table 17. Definition of standard telegram 20

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	3...4	NSOLL_A	NIST_A_GLATT
3	5...6		IAIST_GLATT
4	7...8		ITIST_GLATT
5	9...10		PIST_GLATT
6	11...12		MELD_NAMUR

Standard Telegram 20 has some modifications to both control word and status word. These can be seen from Table 18 and Table 19.

Table 18. Control word (STW1) modifications in ST20

Bits	Description	
	Value = 1	Value = 0
11	Setpoint inversion	No setpoint inversion
12-14	Reserved	Reserved
15	Parameter Set 2*	Parameter Set 1

* This feature is not supported in OPTE3/E5

Table 19. Status word (ZSW1) modifications in ST20

Bits	Description	
	Value = 1	Value = 0
4	Coast Stop not activated or Inevitable Line Interruption not activated	Coast Stop activated or Inevitable Line Interruption activated
5	Quick Stop not activated or External Interlock not activated	Quick Stop activated or External Interlock activated
11	Adjustable Current Limit or Torque Limit not reached	Adjustable Current Limit or Torque Limit reached*
12	Reserved	Reserved
13	Motor Overload not activated	Motor Overload activated*

Table 19. Status word (ZSW1) modifications in ST20

Bits	Description	
	Value = 1	Value = 0
14	Positive Speed direction	No Positive Speed direction
15	Parameter Set 2 active*	Parameter Set 1 active

* This feature is not supported in OPTE3/E5

The value in the IAIST_GLATT and ITIST_GLATT fields is the filtered motor current, which is reported in percentages of the value of PNU10116. The value in the "Active Power" field is the filtered motor power, which is reported in percentages of the value of PNU10117.

Table 20. Description of signals IAIST_GLATT, ITIST_GLATT and PIST_GLATT

Signal	Description	Unit	Reference
IAIST_GLATT	Filtered motor output current	4000h = 100.00%	100% = PNU10116
ITIST_GLATT	Filtered motor active current	4000h = 100.00%	100% = PNU10116
PIST_GLATT	Filtered motor active power	4000h = 100.00%	100% = PNU10116

The MELD_NAMUR field is an extra drive/fault word transferred in process data. The definition of this fault word can be seen in Table 21.

Table 21. Definition of Drive status/fault word (MELD_NAMUR)

Bits	Description	
	Value = 1	Value = 0
0	Fault Control Electronics/Software	No Fault Control Electronics/Software
1	Fault Supply Net	No Fault Supply Net
2	DC Link Overvoltage	No DC Link Overvoltage
3	Fault Power Section	No Fault Power Section
4	Overtemperature Converter	No Overtemperature Converter
5	Earth Fault	No Earth Fault
6	Overload Motor	No Overload Motor
7	Error Communication Bus	No Error Communication Bus
8	External Safety Trip	No External Safety Trip
9	Fault Speed Sensor	No Fault Speed Sensor
10	Fault Internal Communication	No Fault Internal Communication
11	Fault Infeed System (DC Link)	No Fault Infeed System (DC Link)
12	Reserved	Reserved
13	Reserved	Reserved
14	Reserved	Reserved
15	Miscellaneous Faults	No Miscellaneous Faults

NOTE! In OPTE5/E3, a fault in the drive is indicated by setting bit 15. No other bits are currently controlled.

6.3.2.3 Vendor specific telegrams

Vacon Telegram 100: The vendor specific telegram 100 is the Standard Telegram 1 appended with 4 drive specific Process Data items. This telegram is named "ST1+4PD".

Table 22. Definition of Vacon Telegram 100

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	3...4	NSOLL_A	NIST_A
3	5...6	PDI1	PDO1
4	7...8	PDI2	PDO2
5	9...10	PDI3	PDO3
6	11...12	PDI4	PDO4

Vacon Telegram 101: The vendor specific telegram 101 is the Standard Telegram 1 appended with 8 drive specific Process Data items. This telegram is named "ST1+8PD".

Table 23. Definition of Vacon Telegram 101

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	3...4	NSOLL_A	NIST_A
3	5...6	PDI1	PDO1
4	7...8	PDI2	PDO2
5	9...10	PDI3	PDO3
6	11...12	PDI4	PDO4
7	13...14	PDI5	PDO5
8	15...16	PDI6	PDO6
9	17...18	PDI7	PDO7
10	19...20	PDI8	PDO8

Vacon Telegram 138: The vendor specific telegram 138 is the Standard Telegram 1 appended with 12 drive specific Process Data items. This telegram is named "ST1+12PD".

Table 24. Definition of Vacon Telegram 138

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	3...4	NSOLL_A	NIST_A
3	5...6	PDI1	PDO1
4	7...8	PDI2	PDO2
5	9...10	PDI3	PDO3
6	11...12	PDI4	PDO4
7	13...14	PDI5	PDO5

Table 24. Definition of Vacon Telegram 138

IO Data number	Bytes	Setpoint	Actual value
8	15...16	PDI6	PDO6
9	17...18	PDI7	PDO7
10	19...20	PDI8	PDO8
11	21...22	PDI9	PDO9
12	23...24	PDI10	PDO10
13	25...26	PDI11	PDO11
14	27...28	PDI12	PDO12

Vacon Telegram 139: The vendor specific telegram 139 is the Standard Telegram 1 appended with 16 drive specific Process Data items. This telegram is named "ST1+16PD".

Table 25. Definition of Vacon Telegram 139

IO Data number	Bytes	Setpoint	Actual value
1	1...2	STW1	ZSW1
2	3...4	NSOLL_A	NIST_A
3	5...6	PDI1	PDO1
4	7...8	PDI2	PDO2
5	9...10	PDI3	PDO3
6	11...12	PDI4	PDO4
7	13...14	PDI5	PDO5
8	15...16	PDI6	PDO6
9	17...18	PDI7	PDO7
10	19...20	PDI8	PDO8
11	21...22	PDI9	PDO9
12	23...24	PDI10	PDO10
13	25...26	PDI11	PDO11
14	27...28	PDI12	PDO12
15	29...30	PDI13	PDO13
16	31...32	PDI14	PDO14
17	33...34	PDI15	PDO15
18	35...36	PDI16	PDO16

6.3.3 PROFIDRIVE 4.1 CONTROL WORD (STW1)

Table 26.

Bits	Description	
	Value = 1	Value = 0
0	Switch ON	Switch OFF
1	No coast stop	Perform coast stop
2	No quick stop	Perform quick stop
3	Enable operation	Disable operation
4	Enable ramp generator	Reset ramp generator
5	Unfreeze setpoint value	Freeze setpoint value
6	Enable setpoint value	Disable setpoint value
7	Acknowledge fault (0 -> 1)	
8	Not used	
9	Not used	
10	Control by PLC	No Control by PLC
11-15	Not used	

Bit 0: Switching ON / OFF
This bit is used in combination with other bits to enable operation of the drive. When this bit is set to 0 during operation, the drive performs a ramp stop.

Bit 1: Coast stop command
This bit is used to request a coast stop to be executed. When it is set to 0 during operation, the drive performs a coast stop.

Bit 2: Quick stop command
This bit is used to request a quick stop to be executed. When it is set to 0 during operation, the drive quickly ramps down to zero speed and stops.

Bit 3: Enabling of operation
This bit is used in combination with other bits to enable operation of the drive. When it is set to 0 during operation, the drive performs a coast stop.

Bit 4: Enabling of ramp generator
This bit is used in combination with other bits to enable operation of the drive. When it is set to 0 during operation, the drive quickly decelerates to zero speed.

Bit 5: Freezing of setpoint value
This bit can be used to freeze the setpoint value used by the drive. The value is frozen if this bit is set to 0. If the bit is 1, the setpoint value provided by the PROFIBUS master is continuously updated.

Bit 6: Enabling of setpoint value
This bit can be used to disable the fieldbus setpoint value. If this bit is set to 0, the PROFIBUS DP option board ignores the setpoint value by the master and instead uses a setpoint value of 0. During operation, if this bit is set to 0, the drive decelerates to a standstill.

Bit 7: Fault acknowledge
This bit is used to acknowledge faults in the drive. When a rising edge (0 -> 1) is seen in this bit by the PROFIBUS DP option board, it requests the drive to acknowledge present faults. The functionality of this bit is rising-edge sensitive only.

Bit 10: Control by PLC
This bit is used by the PROFIBUS DP master to indicate that it is in control of the slave and that the commands sent via fieldbus are valid.

During operation, this bit must be 1. If the drive is not operating and this bit is 0, the drive cannot be started. If the drive is operating, and this bit becomes 0, the option board freezes the process data provided to the drive, and sets its state to FAULT. The drive reaction to this fieldbus fault depends on the drive parameterization.

6.3.4 PROFIDRIVE 4.1 STATUS WORD (ZSW1)

Table 27.

Bits	Description	
	Value = 1	Value = 0
0	Ready to switch on	Not ready to switch on
1	Ready to operate	Not ready to operate
2	Operation enabled (drive follows setpoint)	Operation disabled
3	Fault present	No Fault
4	Coast stop not activated	Coast stop activated
5	Quick stop not activated	Quick stop activated
6	Switching on inhibited	Switching on not inhibited
7	Warning present	No warning present
8	Speed error within tolerance range	Speed error out of tolerance range
9	Control by PLC requested	Control by PLC not requested
10	f or n reached or exceeded	f or n not reached
11	Not used	
12	Drive is running	Drive is stopped
13	Drive is ready for operation	Drive is not ready for operation
14-15	Not used	

Bit 0: Readiness to switch on
This bit indicates whether the drive is ready to switch on the power electronics. When the bit has the value 0, the drive is not ready to switch on the power electronics. When the bit has the value 1, the drive is ready to switch on the power electronics.

Bit 1: Readiness to operate
This bit indicates whether the drive is ready to begin operation. When the bit has the value 0, the power electronics is switched off and the drive is unable to begin operation. When the bit has the value 1, the power electronics is switched on and the drive can begin operation if requested by the master.

Bit 2: State of operation
This bit indicates whether the drive is operating or not. When the bit has the value 0, the drive is not operating. When the bit has the value 1, the drive is operating.

Bit 3: Presence of fault
This bit indicates the presence of unacknowledged faults in the drive. When the bit has the value 0, no unacknowledged faults are present in the drive. When the bit has the value 1, at least one unacknowledged fault is present in the drive.

Bit 4: Coast stop activated
This bit indicates whether a coast stop command is active or not. When the bit has the value 0, a coast stop command is active. When the bit has the value 1, no coast stop command is active.

Bit 5: Quick stop activated
This bit indicates whether a quick stop command is active or not. When the bit has the value 0, a quick stop command is active. When the bit has the value 1, no quick stop command is active.

Bit 6: Switching on inhibition
This bit indicates whether the power electronics may be switched on or not. When the bit has the value 0, the power electronics may be switched on. When the bit has the value 1, the power electronics are prevented from switching on.

Bit 7: Presence of warning
This bit indicates the presence of warning/alarm information in the drive. When the bit has the value 0, no warning is present. When the bit has the value 1, a warning is present.

Bit 8: Running at setpoint
This bit indicates whether the drive is operating and the actual speed value matches the setpoint value. When the bit has the value 0, the actual speed value does not match the setpoint value. When the bit has the value 1, the actual speed value matches the setpoint value.

Bit 9: Request control by master
This bit indicates whether the field bus master should take control of the drive. When this bit has the value 0, the master need not take control of the drive. When this bit has the value 1, the master is requested take control of the drive.

In OPTE3/E5, this bit depends on the configuration for the drive control place. If the control place is assigned to field bus, the bit has the value 1. If the control place is elsewhere, the bit has the value 0.

Bit 10: Setpoint reached or exceeded
This bit indicates whether the setpoint value has been reached or exceeded. When this bit has the value 0, the setpoint value has not been reached or exceeded. When this bit has the value 1, the setpoint value has been reached or exceeded.

Bit 12: Running indication
This bit indicates whether the drive is in the RUN state or not. When this bit has the value 0, the drive is not running. When this bit has the value 1, the drive is in the RUN state.

Bit 13: Readiness to operate
This bit indicates whether the drive is in the READY state or not. When this bit has the value 0, the drive is not ready to operate. When this bit has the value 1, the drive is in the READY state.

6.3.5 SETPOINT VALUE

The setpoint value used for controlling the drive is a signed 16-bit integer. The sign of the setpoint indicates the desired direction of rotation. The correspondence to RPM is described in chapter 6.3.7.

When using Standard Telegrams 1 or 20, the setpoint signal is called for control and the operate mode is "PROFIdrive profile", and the speed setpoint value (NSOLL_A) used is normalized according to the following table:

Table 28.

Setpoint value	Speed	Direction of rotation	Description of command
0xC000 (-16384d)	-100.00 %	REVERSE	Full speed in REVERSE direction
0x0000 (0d)	0,00 %	N/A	Minimum speed
0x4000 (16384d)	+100.00 %	FORWARD	Full speed in FORWARD direction

If the operate mode is "Bypass", the value is in the range of 0d to +10000d. The scale of the setpoint value is 0.01%. In this case the value 0% corresponds to the parameterized Minimum Frequency in the drive, while 100% corresponds to Maximum Frequency.

The direction of rotation is determined from the Bypass-mode control word bit 1.

Table 29.

Setpoint value	Speed	Direction of rotation	Description of command
0x0000 (0d)	0,00 %	N/A	Minimum Frequency
0x2710 (+10000d)	+100.00 %	Control word dep.	Full speed

In "Echo" mode, there is no limit to this value.

When using PPO types 1-6, the value is identical to that of the operate mode "Bypass". Refer to VACON® NX OPTC3-C5 Profibus User Manual for more details.

6.3.6 Actual speed value

The actual speed value used to indicate the drive operation is a signed 16-bit integer. The sign of the setpoint indicates the current direction of rotation. The correspondence to RPM is described in chapter 6.3.7.

When using Standard Telegrams 1 or 20 for control and the operate mode is "PROFIdrive profile", the speed actual value (NIST_A) used is normalized according to the following table:

Table 30.

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

If the operate mode is "Bypass" or "Echo", the value is in the range of 0d to +10000d. The scale of the actual value is 0.01%. In this case the value 0% corresponds to the parameterized Minimum Frequency in the drive, while 100% corresponds to Maximum Frequency.

The direction of rotation is indicated in the Bypass-mode status word bit 2.

Table 31.

Actual value	Speed	Direction of rotation	Description of value
0x0000 (0d)	0.00 %	N/A	At Minimum Frequency
0x2710 (+10000d)	+100.00 %	FORWARD	Full speed

In Echo mode, the value is the same as commanded by the master.

When using PPO types 1-6, the speed actual value corresponds to that of the operate mode "Bypass". Refer to VACON® NX OPTC3-C5 Profibus User Manual for more details.

6.3.7 Normalization reference parameter

Since the speed setpoint and actual values are provided in normalized fashion as a ratio, with 0x4000 corresponding to 100.00%, a manufacturer-specific parameter with PNU 10111 is available. The value contained in this parameter indicates the number of RPM that corresponds to 100%.

See chapter 6.4 for details on how to read parameter values.

Example:

The parameter PNU10111 contains the value 1500, which corresponds to 1500 RPM. This means that if the setpoint value provided by the field bus master is 0x4000 (100.00%), then this corresponds to a 1500 RPM setpoint. A setpoint of 0x2000 (50.00%) thus corresponds to a 750 RPM setpoint. The same calculation method applies in the actual value direction.

6.3.8 SHORTLIST OF COMMANDS TO START THE DRIVE

The following sequence of commands may be used to operate the drive:

1. Beginning the operation:

The following commands must be used to begin the operation:

Table 32.

Control word value (hexadecimal)	Description of command
0000h	Power-up default command
047Eh	Ready the drive for beginning the operation
047Fh	Begin operation

2. Executing a ramp stop

The following commands may be used to execute a ramp stop:

Table 33.

Control word value (hexadecimal)	Description of command
047Fh	Operating
047Eh	Execute ramp stop
047Fh	Cancel ramp stop*

* It is possible to interrupt a ramp stop and return to the operating mode, by setting the bit 0 in the control word before standstill is reached

3. Executing a coast stop

The following commands may be used to execute a coast stop:

Table 34.

Control word value (hexadecimal)	Description of command
047Fh	Operating
047Dh	Execute coast stop

4. Executing a quick stop

The following commands may be used to execute a quick stop:

Table 35.

Control word value (hexadecimal)	Description of command
047Fh	Operating
047Bh	Execute quick stop

6.3.9 CODING OF DATA SIGNALS

The following number coding is used for signals communicated in cyclic data exchange. The signals numbers are categorized according to Table 36 and detailed description of signals can be found in Table 37.

Table 36. PROFIdrive signal categories

Signal number	Signal description
0...89	PROFIdrive specific
90...99	PROFIdrive specific safety
100...60099	Vendor specific
61000...61999	Vendor specific safety

Table 37. Data signal description

Signal number	Signal description	Abbreviation	Length (Bits)	Description
1	Profile control word STW1	STW1	16	See chapter 6.3.3
2	Profile status word ZSW1	ZSW1	16	See chapter 6.3.4
5	Speed setpoint value	NSOLL_A	16	See chapter 6.3.5
6	Speed actual value	NIST_A	16	See chapter 6.3.6
51	Filtered output current	IAIST_GLATT	16	See chapter 6.3.2.2
52	Filtered active current	ITIST_GLATT	16	
54	Filtered active power	PIST_GLATT	16	
57	Filtered speed actual value	NIST_A_GLATT	16	
58	Drive status/fault word	MELD_NAMUR	16	
90	Safety control word 1	S_STW1	16	See chapter 7.2
91	Safety status word 1	S_ZSW1	16	
93	Safety control word 2	S_STW2	32	
94	Safety status word 2	S_ZSW2	32	
100	Process data out word 1	PDO1	16	See chapter 6.9
...	...	...		
107	Process data out word 8	PDO8		
110	Process data in word 1	PDI1		
...	...	...		
117	Process data in word 8	PDI8		
118	Non-profile control word	-	16	See chapter 6.7
119	Non-profile status word	-	16	
120	Non-profile speed setpoint value	-	16	See chapter 6.7.1
121	Non-profile speed actual value	-	16	
140	Process data out word 9	PDO9	16	See chapter 6.9
...	...	...		
147	Process data out word 16	PDO16		
148	Process data in word 9	PDI9		
...	...	...		
155	Process data in word 16	PDI16		
61000	Vacon safety control word	VS_CW	48	See chapter 7.2
61010	Vacon safety status word	VS_SW	48	

6.4 PARAMETER ACCESS IN PROFIDRIVE 4.1

6.4.1 PARAMETER ACCESS SEQUENCE

Parameter access over DP-V1 takes place by using the parameter channel. A parameter request is written to the drive, revealing the desired operation and target parameter information. The master then polls the slave using read requests and receives a positive response once the parameter processing is finished. If a problem occurs then a negative response is provided by the slave.

The Parameter Channel can be used to access both the drive's and the PROFIdrive's parameters.

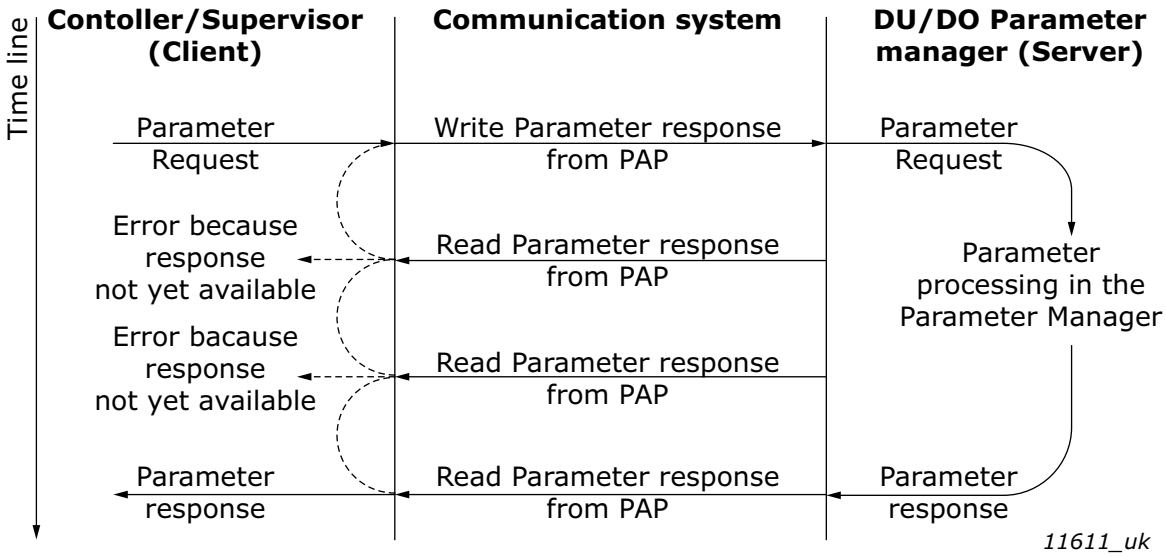


Figure 12. Data flow for Base Mode Parameter Access

The parameter response can only be read once per successful request. After this, the Parameter manager in the PROFIdrive profile returns to its idle state and begins waiting for a new parameter request. Attempts to read the parameter response to the previous request will return an error.

6.4.2 PARAMETER REQUESTS

There are two types of parameter requests in PROFIdrive:

- Read requests for reading parameters from the device
- Change requests for writing parameters to the device

Each parameter request over PROFIBUS DP-V1 consists of four elements:

- PROFIBUS DP-V1 header
- Request header
- Parameter address
- Parameter value (only in Change requests)

Table 38.

DP-V1 header	Request header	Parameter address(es)	Parameter value(s)

OPTE5/E3 supports a maximum of 240 octets of data, which includes the request header, parameter address(es) and parameter value(s).

6.4.2.1 DP-V1 header

The DP-V1 header consists of 4 fields, each one octet in size.

Table 39.

Octet number	Field name	Description	Allowed values
1	Function Number	PROFIBUS DP-specific operation number.	Use 0x5E for read requests. Use 0x5F for write requests. The slave returns 0xDE to indicate error in read request. The slave returns 0xDF to indicate error in write request. Other values are not allowed in the Parameter Access.
2	Slot Number	PROFIBUS DP-specific reference to internal device module.	Use 0 for OPTE5/E3. Other values should not be used.
3	Index	PROFIBUS DP-specific index used to address different properties.	Use 47 (decimal) for Parameter Access in OPTE5/E3. Other values should not be used for Parameter Access.
4	Data Length	Number of data octets in the parameter request frame. This count excludes the DP-V1 header.	Number of octets in request header, parameter address(es) and parameter value(s) fields.

6.4.2.2 Request header

The request header consists of 4 fields, each one octet in size.

Table 40.

Octet number	Field name	Description	Allowed values
1	Request Reference	Unique number for each request/response pair. This value is changed by the master for each new request. It is mirrored by the slave in the response.	Values 1 to 255 are allowed. Value 0 restricted by PROFIdrive 4.1 -> only 1...255 allowed.
2	Request ID	Defines the type of request.	Use 0x01 for Read requests. Use 0x02 for Change requests. Other values are not allowed.
3	Axis Number	Not used, should be set to 1 in OPTE5/E3.	Use 1 for OPTE5/E3. Other values should not be used.
4	Requested number of parameters	The number of parameters affected by the request.	Values 1 to 39 are allowed. The value 0 is not allowed. Values 40 to 255 are not allowed.

6.4.2.3 Parameter address

The parameter address consists of 4 fields, totaling six octets in size.

Table 41.

Octet number	Field name	Description	Allowed values
1	Attribute	Describes which part of a parameter should be accessed.	Use 0x10 for reading/writing the value of a parameter. Use 0x20 for reading the description of a parameter. Use 0x30 for reading the text of a parameter (not supported). Other values should not be used in OPTE5/ OPTE3.
2	Number of elements	Specifies the number of elements which are addressed in an array.	Values 0 and 1 are allowed for non-array parameters. Values 1 to 234 are allowed for array parameters. Other values should not be used.
3...4	Parameter number	The number of the parameter to be addressed.	Allowed values are those of supported parameters, see chapter 6.4.4
5...6	Subindex	Defines the first array element of the parameter to be accessed.	Values 0 to 65535 are allowed. Other values are not allowed.

The "Parameter number" and "Subindex" fields are two-octet fields, while the "Attribute" and "No. of elements" fields are one-octet fields.

6.4.2.4 Parameter value

The parameter value field is included only in Change requests (not in Read requests). The parameter value field consists of a two-octet parameter value header followed by a list of values. Depending on the format of the parameter, the octet size of a single value is one, two or four octets. The total size of the parameter value field thus depends on the format and number of values in the message.

Table 42.

Octet number	Field name	Description	Allowed values
1	Format	Describes the data type of the parameter.	Use 0x41 for Byte. Use 0x42 for Word. Use 0x43 for Double Word. Value 0x44 is used for Error. Other values should not be used.
2	Number of values	Defines the number of values in the parameter value field.	Values 0 to 234 are possible. Subject to limitations as described below.
3...	Value	The value of the parameter.	Values 0 to 65535 are allowed. Other values are not allowed.

Because of the limitation in the maximum length of the Parameter Access messages (PROFIBUS DP: 240 bytes), the number of values which can be transmitted in one frame is limited by the parameter format.

6.4.3 Parameter responses

There are two types of parameter responses in PROFIdrive:

- Write response (response to a Write request)
- Read response (response to a Read request)

A read response over PROFIBUS DP-V1 consists of three elements:

- PROFIBUS DP-V1 header
- Response header
- Parameter value(s) (depending on the request type)

A write response over PROFIBUS DP-V1 contains only the PROFIBUS DP-V1 header.

Table 43.

DP-V1 header	Response header	Parameter value(s)

6.4.3.1 DP-V1 header

The DP-V1 response header consists of 4 fields, each one octet in size.

Table 44.

Octet number	Field name	Description	Allowed values
1	Function Number	PROFIBUS DP-specific operation number.	Use 0x5E for read requests. Use 0x5F for write requests. Other values are not used in the Parameter Access.
2	Slot Number	PROFIBUS DP-specific reference to internal device module.	This value is mirrored from the associated request.
3	Index	PROFIBUS DP-specific index used to address different properties.	Use 47 for Parameter Access in OPTE5/E3. Other values should not be used for Parameter Access.
4	Data Length	Number of data octets in the parameter request frame. This count excludes the DP-V1 header.	Number of octets in response header, parameter address(es) and parameter value(s) fields.

6.4.3.2 Error response

If an error occurred in the Parameter Access, the response provided by the slave is an error response. Its PROFIBUS DP-V1 header contents differ from a normal read/write response. An error response contains 4 octets as described below.

Table 45.

Octet number	Field name	Description	Allowed values
1	Function Number	PROFIBUS DP-specific operation number.	The slave returns 0xDE to indicate an error read response. The slave returns 0xDF to indicate an error write response. Other values are not used in the Parameter Access.
2	Error Decode	Defines how the error information in the following two fields should be decoded.	Always 128 in PROFIdrive. Other values are not used in the Parameter Access.
3	Error Code 1	High 4 bits indicate error class, 4 lower bits indicate error code.	See chapter 6.4.3.3.
4	Error Code 2	Application-specific.	Always 0 in PROFIdrive.

6.4.3.3 PROFIdrive 4.1 error classes and codes

Table 46.

Error class	Error codes	PROFIdrive meaning
0x0...0x9 = reserved (not used)		
0xA = application	0x0 = read error 0x1 = write error 0x2 = module failure 0x3...0x7 = reserved (not used) 0x8 = version conflict 0x9 = feature not supported 0xA...0xF = user-specific (not used)	
0xB = access	0x0 = invalid index	0xB0 = parameter requests are not supported
	0x1 = write length error 0x2 = invalid slot 0x3 = type conflict 0x4 = invalid area	
	0x5 = state conflict	0xB5 = parameter access is temporarily not possible due to internal processing status
	0x6 = access denied	
	0x7 = invalid range	0xB7 = Write request with error in the parameter request header
	0x8 = invalid parameter 0x9 = invalid type 0xA...0xF = user-specific (not used)	
0xC = resource	0x0 = read constraint conflict 0x1 = write constraint conflict	
	0x2 = resource busy	
	0x3 = resource unavailable	
	0x4...0x7 = reserved (not used) 0x8...0xF = user-specific (not used)	
0xD...0xF = user-specific (not used)		

6.4.3.4 PROFIdrive Parameter Access errors

In addition to the error indications in the PROFIBUS DP-V1 header, details about the error are provided in the parameter value field. The third octet in the parameter value is set to 0x00 and the fourth octet is assigned the error number, as described in the table below (continued on next page).

Table 47.

Error number	Meaning	When used
0x00	Impermissible parameter number	Access to unavailable parameter
0x01	Parameter value cannot be changed	Change request to a read-only parameter
0x02	Low or high limit exceeded	Change request which exceeds parameter value range
0x03	Invalid subindex	Access to an unavailable subindex of an array parameter

Table 47.

Error number	Meaning	When used
0x04	Non-array parameter	Attempt to access subindex of a non-array parameter
0x05	Incorrect data type	Change request containing invalid data type for the accessed parameter
0x06	Setting not permitted (may only be reset)	Change request to non-zero value, where this is not allowed
0x07	Description element cannot be changed	Change request to a read-only parameter description element
0x08	Reserved (not used)	
0x09	No description data available	Access to unavailable parameter description
0x0A	Reserved (not used)	
0x0B	No operation priority	Change request without access rights to perform the change
0x0C...0x0E	Reserved (not used)	
0x0F	No text array available	Access to unavailable parameter text array
0x10	Reserved (not used)	
0x11	Request cannot be executed	Access is temporarily not possible due to unspecified reasons
0x12...0x13	Reserved (not used)	
0x14	Value impermissible	Change request with a value within the allowed range, but is otherwise not permissible.
0x15	Response too long	The length of the response exceeds the maximum transmittable length
0x16	Impermissible parameter address	Error in the parameter address field
0x17	Illegal format	Illegal format was provided in write request
0x18	Number of values are not consistent	Number of values in the write request does not match the number of values in the parameter
0x19	Axis non-existent	Access to non-existent axis number
0x20	Parameter text cannot be changed	Change request to unavailable parameter text
0x21	Invalid request ID	If a parameter request does not have the request ID 01h or 02h, this error code is returned.
0x22...0x64	Reserved (not used)	
0x65	Invalid request reference	Unallowed value for request reference
0x66	Invalid request ID	Unallowed value in request ID (not Request Parameter nor Change Parameter)
0x67	Reserved (not used)	
0x68	Invalid number of parameters	Invalid number of parameters in request (0 or greater than 39)
0x69	Invalid attribute	Invalid attribute specified in request
0x6A	Reserved (not used)	
0x6B	Request is too short	Not enough parameter value data was transmitted in a Change request. Alternatively, the request did not contain a complete parameter address.

Table 47.

Error number	Meaning	When used
0x6C	Drive parameter was not found	An access to a drive parameter through PNU10001 could not be completed, because a drive parameter with the matching ID could not be found.
0x6D	An invalid change request was provided	The length and contents of the parameter change request could not be verified.
0x6E...0xFF	Reserved (not used)	

6.4.3.5 Response header

The response header consists of 4 fields, each one octet in size.

Table 48.

Octet number	Field name	Description	Allowed values
1	Request Reference	Unique number for each request/response pair.	Mirrored by the slave.
2	Response ID	Defines the type of response. An error in the execution of a request is indicated by setting bit 7 in this field.	Uses 0x01 for successful request parameter operation. Uses 0x02 for successful change parameter operation. Uses 0x80 to indicate that an invalid request ID was received. Uses 0x81 for unsuccessful request parameter operation. Uses 0x82 for unsuccessful change parameter operation. Other values are not used.
3	Axis Number	Not used, should be set to 1 in OPTE5/E3.	Mirrored by the slave.
4	Requested number of parameters	The number of parameters affected by the request.	Number of parameters in the response. Mirrored from the request.

6.4.3.6 Parameter values

Parameter values are included in the response only if the request was of "Request parameter" type. For details on the contents of this field, see Parameter value on page 61.

6.4.3.7 Parameter description elements

For each implemented parameter, there exists a corresponding parameter description element which can be read from the device. A complete parameter description element consists of 46 octets which are structured as follows:

Table 49.

Sub-index	Field name	Data type	Description
1	Identifier (ID)	Unsigned16	Bitmask with information about the parameter characteristics.
2	Number of array elements	Unsigned16	For array parameters, the number of elements in the array.
3	Standardisation factor	FloatingPoint	If the information represented by the parameter can be converted into some standardized form, this field contains factor for this conversion.
4	Variable attribute	Array of two Unsigned8	Contains two index numbers for describing the parameter information.
5	Reserved	Array of four Unsigned8	Reserved, always 0.
6	Name	ASCII string, 16 characters	Symbolic name of the parameter.
7	Low limit	Array of four Unsigned8	Limit for valid values of the parameter.
8	High limit	Array of four Unsigned8	Limit for valid values of the parameter.
9	Reserved	Array of two Unsigned8	Reserved, always 0.
10	ID extension	Unsigned16	Not used, always 0.
11	Normalization reference parameter	Unsigned16	Parameter number, the value of which is used as normalization reference for the parameter whose description this is.
12	Normalization field	Unsigned16	Contains information about normalization of this parameter.

The subindex 0 for the parameter description element corresponds to the complete description element. Thus, if a parameter access targets this subindex of a parameter description, all the above 12 fields are returned for a total of 46 octets.

6.4.3.8 Identifier field

The identifier field consists of the following parts:

Table 50.

Bits	Name	Description
0-7	Data type	Specifies the data type of the parameter value. Value 3 corresponds to Integer16. Value 6 corresponds to Unsigned16. Value 10 corresponds to array of Unsigned8.
8	Standardization factor and variable attribute not relevant	If this bit is set, then physical values cannot be calculated for the parameter. Values in standardization factor and variable attribute fields are not relevant. If this bit is cleared, then the standardization factor and variable attribute are valid.
9	Parameter is read-only	If this bit is set, then the value of the parameter cannot be changed.
10	Additional text array available	Not supported, is always 0.

Table 50.

Bits	Name	Description
11	Reserved	Always 0.
12	Parameter was changed with respect to the factory setting	If this bit is set, the parameter value is unequal to the factory setting. **NOTE!** In OPTE3/E5, this bit is always set because it is not possible to detect in detail which parameters have changed. The bit is always set so that a master is encouraged to read the up-to-date value from the slave.
13	Parameter value may be reset only	If this bit is set, then the parameter value can only be set to "0", i.e. reset. If this bit is cleared, then the parameter value can be changed to any value, providing that the parameter is writeable.
14	Parameter is array	If this bit is set, then the parameter is an array of the specified data type.
15	Reserved	Always 0.

6.4.3.9 Number of array elements field

In the case of an array type parameter, this field contains the number of elements which the array consists of.

6.4.3.10 Standardisation factor field

This field contains a factor which helps to convert the device internal value into an external, standardized variable. See examples in chapter 6.4.3.11 for more information.

6.4.3.11 Variable attribute field

This field consists of two Unsigned8 values. The most significant octet is referred to as variable index and describes the physical quantity which is represented by the parameter value. The variable index also includes information about the base unit of the quantity.

The least significant octet is referred to as conversion index. Using the conversion index, it is possible to convert a parameter value into the base quantity as specified by the variable index. Each conversion index corresponds to a factor A and an offset B.

Table 51.

Variable index	Physical quantity	Base unit	Allowed units	Conversion indexes
0	No dimension	N/A	N/A	0
9	Power	Watt	Watt Kilowatt	0 3
11	Speed	1/second	1/second 1/minute 1/hour	0 67 72
22	Electrical current	1 Ampere	1A 0.1A	0 -1
24	Ratio	Percent	%	0

The following conversion indexes are used:

Table 52.

Conversion index	Factor A	Factor B
0	N/A	0
-1	1,0 E-1	0
67	1/60=1,667 E-2	0
72	1/3600=2,778 E-4	0

The following two equations are used to calculate the value of the parameter:

- Physical value in the specified unit: (transmitted value × standardization factor)
- Physical value in the base unit: (transmitted value ×standardization factor × A + B)

EXAMPLE 1:

A parameter has variable index 11, i.e. "Speed" and base unit is 1/second. The conversion index is 67, i.e. the value transmitted from drive has the unit 1/minute.

- Transmitted value: 1200
- Standardization factor: 1.0
- Variable index: 11 "Speed", base unit is "1/second"
- Conversion index: 67 The transmitted value has the unit "1/minute"

Physical value in the specified unit "1/min": 1200 × 1.0 1/minute= 12001/minute

Physical value in the base unit "1/sec": 1200 ×1.0 × (1/60) + 0= 201/second

EXAMPLE 2:

A parameter has variable index 22, i.e. "Electrical current" and base unit is 1 Ampere. The conversion index is -1, i.e. the value transmitted from drive has the unit 0.1 A.

- Transmitted value: 35
- Standardization factor: 1.0
- Variable index: 22 "Electrical current", base unit is "1 Ampere"
- Conversion index: -1 The transmitted value has the unit "0.1 Ampere"

Physical value in the **specified** unit "0.1 Ampere": 35 × 1.0 = 35(0.1 Ampere)

Physical value in the **base** unit "1 Ampere": 35 ×1.0 × 0.1 + 0 = 3.5 Ampere.

6.4.3.12 Name field

This field contains 16 ASCII characters which form the symbolic name for the parameter.

6.4.3.13 Low/High limit fields

These fields contain the possible low and high limits of the parameter. If the parameter is a string, the limits are irrelevant.

6.4.3.14 ID extension field

This field is not used in the PROFIdrive 4.1 specification, and is always 0.

6.4.3.15 Normalization reference parameter field

For parameters with the physical quantity "Ratio", it may be possible to convert the value into another physical unit by use of a reference parameter. If this is the case, this field contains the parameter number (PNU) of the reference parameter for this value.

E.g. the speed setpoint and actual values are in PROFIdrive 4.1 mode normalized as 0x4000 corresponding to 100.00%. The parameter description contains the number of the reference parameter which describes what the physical reference value is. This is announced in conjunction with the normalization field contents (see example in chapter 6.4.3.16).

The description of the reference parameter contains the variable index and conversion index of the physical reference value, e.g. "Speed" and "1/minute".

If no physical reference parameter is available, the contents of this field are 0.

6.4.3.16 Normalization field

The normalization field contains the following information:

Table 53.

Bits	Name	Description
0-5	Identifier (ID)	Specifies which bit is the normalization bit, which corresponds to the physical reference value. Values 0-31 are allowed. Values 32-63 are reserved and thus not allowed.
6-14	Reserved	Always 0.
15	Normalization valid.	This bit is set if the parameter is normalized.

EXAMPLE:

In PROFIdrive 4.1 mode, the speed setpoint value is normalized such that 0x4000 corresponds to 100.00% of a reference value.

The normalization reference parameter field contains the parameter number of the reference parameter.

In the normalization field, bit 15 is set and the bits 0-5 contain the value 14. This means that bit 14 (0x4000) corresponds to the value which is specified in the physical reference parameter.

6.4.4 EXAMPLE REQUESTS AND RESPONSES

6.4.4.1 Request parameter PNU918 value

The following information is used for this request:

Table 54.

Field	Contents
Request reference	0x01
Request ID	0x01 = Request parameter
Axis Number	0x01
No. of Parameters	0x01
Attribute	0x10 = Value
No. of elements	0x01
Parameter Number	0x0396 (918d)
Subindex	0x0000 (0d)

The final request is thus:

Table 55.

DP-V1 header	Request header	Parameter address
0x5F 0x00 0x2F 0x0A	0x01 0x01 0x01 0x01	0x10 0x01 0x03 0x96 0x00 0x00

The slave responds to the write request as follows:

Table 56.

DP-V1 header
0x5F 0x00 0x2F 0x0A

6.4.4.2 Read response to request parameter PNU918

First the request in 6.4.4.1 is sent, then the read request is sent to the slave. The write request as provided as example in 6.3.4.1 must be written first to the drive.

Table 57.

DP-V1 header
0x5E 0x00 0x2F 0xF0

The response received from the device is:

Table 58.

DP-V1 header	Response header	Parameter value
0x5E 0x00 0x2F 0x08	0x01 0x01 0x01 0x01	0x42 0x01 0x00 0x03

This can be expanded into:

Table 59.

Field	Contents
Response reference	0x01
Response ID	0x01 = Request parameter (successful)
Axis Number	0x01

Table 59.

Field	Contents
No. of Parameters	0x01
Format	0x42 = Word
No. of values	0x01
Value	0x0003

The node address used in the example was 3.

6.4.4.3 Request all elements of parameter PNU964

The following information is used for this request.

Table 60.

Field	Contents
Request reference	0x02
Request ID	0x01 = Request parameter
Axis Number	0x01
No. of Parameters	0x01
Attribute	0x10 = Value
No. of elements	0x06
Parameter Number	0x03C4 (964d)
Subindex	0x0000 (0d)

The final request is thus:

Table 61.

DP-V1 header	Request header	Parameter address
0x5F 0x00 0x2F 0x0A	0x02 0x01 0x01 0x01	0x10 0x06 0x03 0xC4 0x00 0x00

The slave responds to the write request as follows:

Table 62.

DP-V1 header
0x5F 0x00 0x2F 0x0A

6.4.4.4 Read response to request parameter PNU964

A read request is sent to the slave as follows:

Table 63.

DP-V1 header
0x5E 0x00 0x2F 0xF0

The response received from the device is:

Table 64.

DP-V1 header	Response header	Parameter value
0x5E 0x00 0x2F 0x12	0x02 0x01 0x01 0x01	0x42 0x06 0x01 0xBA 0x00 0x02 0x00 0x6B 0x07 0xDA 0x0A 0x2D 0x00 0x01

This can be expanded into:

Table 65.

Field	Contents
Response reference	0x01
Response ID	0x01 = Request parameter (successful)
Axis Number	0x01
No. of Parameters	0x01
Format	0x42 = Word
No. of values	0x06
Values	0x01BA 0x0002 0x006B 0x07DA 0x0A2D 0x0001

Thus the following information can be determined about the device:

- Manufacturer code is 0x01BA
- Drive Unit type is 0x0002 (VACON® 100 Family)
- Software version is 1.7 (0x006B = 107d)
- Firmware date (year) is 2010 (0x07DA)
- Firmware date (day/month) is 26/05 (0x0A2D = 2605d)
- The device contains one axis

6.4.4.5 Requesting the value of an unsupported parameter PNU 900

The following information is used for this request:

Table 66.

Field	Contents
Request reference	0x03
Request ID	0x01 = Request parameter
Axis Number	0x01
No. of Parameters	0x01
Attribute	0x10 = Value
No. of elements	0x01
Parameter Number	0x0384 (900d)
Subindex	0x0000 (0d)

The final request is thus:

Table 67.

DP-V1 header	Request header	Parameter address
0x5F 0x00 0x2F 0x0A	0x03 0x01 0x01 0x01	0x10 0x01 0x03 0x84 0x00 0x00

The slave responds to the write request as follows:

Table 68.

DP-V1 header
0x5F 0x00 0x2F 0x0A

6.4.4.6 Read response to request of unsupported parameter PNU900

A read request is sent to the slave as follows:

Table 69.

DP-V1 header
0x5E 0x00 0x2F 0xF0

The response received from the device is:

Table 70.

DP-V1 header	Response header	Parameter value
0x5E 0x00 0x2F 0x08	0x03 0x81 0x01 0x01	0x44 0x01 0x00 0x00

The error which occurred is indicated in several parts of the message:

- The second octet in the response header contains 0x80 (negative result).
- The first octet in the parameter value is 0x44 (Error).
- The third octet in the parameter value is indicates the error code (0 = impermissible PNU).
- If reading from an array, the fourth octet indicates the first element where the error occurs.

6.4.4.7 Requesting the value of drive parameter ID 103

Master write request:

Table 71.

DP-V1 header	Request header	Parameter address
0x5F 0x00 0x2F 0x0A	0x04 0x01 0x01 0x01	0x10 0x01 0x27 0x11 0x00 0x67

Slave acknowledge:

Table 72.

DP-V1 header
0x5F 0x00 0x2F 0x0A

Master read request:

Table 73.

DP-V1 header
0x5E 0x00 0x2F 0xF0

Slave response:

Table 74.

DP-V1 header	Response header	Parameter value
0x5E 0x00 0x2F 0x08	0x04 0x01 0x01 0x01	0x42 0x01 0x00 0x1E

6.4.4.8 Changing the value of drive parameter ID 103 (successful)

Master write request to change ID 103 value to 40d:

Table 75.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x05 0x02 0x01 0x01	0x10 0x01 0x27 0x11 0x00 0x67	0x42 0x01 0x00 0x28

Slave acknowledge:

Table 76.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 77.

DP-V1 header
0x5E 0x00 0x2F 0xF0

Slave response:

Table 78.

DP-V1 header	Response header
0x5E 0x00 0x2F 0x04	0x05 0x02 0x01 0x01

6.4.4.9 Changing the value of drive parameter ID 103 (unsuccessful)

Master write request to change ID 103 value to 0d (Acceleration Time = 0.0s, not allowed):

Table 79.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x06 0x02 0x01 0x01	0x10 0x01 0x27 0x11 0x00 0x67	0x42 0x01 0x00 0x00

Slave acknowledge:

Table 80.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 81.

DP-V1 header
0x5E 0x00 0x2F 0xF0

Slave response:

Table 82.

DP-V1 header	Response header	Parameter value
0x5E 0x00 0x2F 0x08	0x06 0x82 0x01 0x01	0x44 0x01 0x00 0x02

The error code 0x02 indicates that the low or high limit of the parameter was exceeded.

6.4.4.10 Changing the values of multiple drive parameters (successful)

There are two methods of writing multiple drive parameters: writing multiple parameters or writing multiple elements. When writing multiple elements, the format (data type) of the parameters must be identical.

For both examples, the master writes a request to change ID 101 (Minimum frequency reference) to value 1000d (10.00Hz) and ID 102 (Maximum frequency reference) to value to 4000d (40.00Hz).

Method 1: Writing multiple drive parameters

Table 83. Method 1: Writing multiple drive parameters

Field	Contents
Request reference	0x06
Request ID	0x02 = Change parameter
Axis number	0x01
No. of parameters	0x02
Attribute	0x10 = Value
No. of elements	0x01
Parameter numbers	0x2711 (10001d)
Subindex 1	0x0065 (101d)
Subindex 2	0x0066 (102d)
Parameter formats	0x42
No. of values	0x01
Parameter 1 value	0x03E8 (1000d)
Parameter 2 value	0x0FA0 (4000d)

The final master write request is thus:

Table 84.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x06 0x02 0x01 0x02	0x10 0x01 0x27 0x11 0x00 0x65 0x10 0x01 0x27 0x11 0x00 0x66	0x42 0x01 0x03 0xE8 0x42 0x01 0x0F 0xA0

Slave acknowledge:

Table 85.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 86.

DP-V1 header
0x5F 0x00 0x2F 0xF0

Slave response:

Table 87.

DP-V1 header	Reques header
0x5E 0x00 0x2F 0x0E	0x06 0x02 0x01 0x02

This can be expanded to:

Table 88.

Field	Contents
Response reference	0x06
Request ID	0x02 = Change parameter (successful)
Axis number	0x01
No. of parameters	0x02

Method 2: Writing multiple drive parameter elements

Table 89. Method 2: Writing multiple drive parameter elements

Field	Contents
Request reference	0x06
Request ID	0x02 = Change parameter
Axis number	0x01
No. of parameters	0x01
Attribute	0x10 = Value
No. of elements	0x02
Parameter numbers	0x2711 (10001d)
Subindex	0x0065 (101d)
Parameter format	0x42
No. of values	0x02
Parameter 1 value	0x03E8 (1000d)
Parameter 2 value	0x0FA0 (4000d)

The final master write request is thus:

Table 90.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x06 0x02 0x01 0x01	0x10 0x02 0x27 0x11 0x00 0x65	0x42 0x02 0x03 0xE8 0x0F 0xA0

Slave response:

Table 91.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 92.

DP-V1 header
0x5F 0x00 0x2F 0xF0

Slave response:

Table 93.

DP-V1 header	Request header
0x5E 0x00 0x2F 0x0E	0x06 0x02 0x01 0x01

This can be expanded to:

Table 94.

Field	Contents
Response reference	0x06
Request ID	0x02 = Change parameter (successful)
Axis number	0x01
No. of parameters	0x01

6.4.4.11 Changing the values of multiple drive parameters (unsuccessful)

Writing maximum frequency (ID 102) value lower than minimum frequency (ID 101) is not allowed.
The following information is used for this request:

Method 1: Writing multiple drive parameters

Table 95. Method 1: Writing multiple drive parameters

Field	Contents
Request reference	0x07
Request ID	0x02 = Change parameter
Axis number	0x01
No. of parameters	0x02
Attribute	0x10 = Value
No. of elements	0x01
Parameter numbers	0x2711 (10001d)
Subindex 1	0x0065 (101d)
Subindex 2	0x0066 (102d)
Parameter formats	0x42
No. of values	0x01
Parameter 1 value	0x03E8 (1000d)
Parameter 2 value	0x01F4 (500d)

The final master write request is thus:

Table 96.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x07 0x02 0x01 0x02	0x10 0x01 0x27 0x11 0x00 0x65 0x10 0x01 0x27 0x11 0x00 0x66	0x42 0x01 0x03 0xE8 0x42 0x01 0x0F 0xF4

Slave response:

Table 97.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 98.

DP-V1 header
0x5F 0x00 0x2F 0xF0

Slave response:

Table 99.

DP-V1 header	Response header	Response value
0x5E 0x00 0x2F 0x0E	0x07 0x82 0x01 0x02	0x40 0x00 0x44 0x01 0x00 0x02

This can be expanded to:

Table 100.

Field	Contents
Response reference	0x07
Request ID	0x82 = Change parameter (unsuccessful)
Axis number	0x01
No. of parameters	0x02
Format 1	0x40 = Zero (indicates successful write)
No. of values	0x00
Format 2	0x44 = Error
No. of values	0x01
Error value	0x00 0x02 = Low or high limit exceeded

Method 2: Writing multiple drive parameter elements

NOTE! When you use this method, the remaining operations are skipped, if the writing of an element fails.

Table 101. Method 2: Writing multiple drive parameter elements

Field	Contents
Request reference	0x07
Request ID	0x02 = Change parameter
Axis number	0x01
No. of parameters	0x01
Attribute	0x10 = Value
No. of elements	0x02
Parameter numbers	0x2711 (10001d)
Subindex	0x0065 (101d)
Parameter format	0x42

Table 101. Method 2: Writing multiple drive parameter elements

Field	Contents
No. of values	0x02
Parameter 1 value	0x03E8 (1000d)
Parameter 2 value	0x01F4 (500d)

The final master write request is thus:

Table 102.

DP-V1 header	Request header	Parameter address	Parameter value
0x5F 0x00 0x2F 0x0E	0x07 0x02 0x01 0x01	0x10 0x02 0x27 0x11 0x00 0x65	0x42 0x02 0x03 0xE8 0x01 0xF4

Slave response:

Table 103.

DP-V1 header
0x5F 0x00 0x2F 0x0E

Master read request:

Table 104.

DP-V1 header
0x5F 0x00 0x2F 0xF0

Slave response:

Table 105.

DP-V1 header	Response header	Response value
0x5E 0x00 0x2F 0x0E	0x07 0x82 0x01 0x01	0x01 0x44 0x01 0x00 0x02

This can be expanded to:

Table 106.

Field	Contents
Response reference	0x07
Request ID	0x82 = Change parameter (unsuccessful)
Axis number	0x01
No. of parameters	0x01
Format	0x44 = Error
No. of values	0x01
Error value	0x00 0x02 = Low or high limit exceeded

6.4.5 SUPPORTED PARAMETERS

The OPTE3/E5 supports a number of PNUs (Parameter Number) for acyclic data access. This chapter describes the list and content of the supported PNUs.

Table 107. PNU data type description

Data type	Description
UINT	Unsigned 16-bit integer
UINT[x]	Array of unsigned integers, x elements
INT	Signed 16-bit integer
INT[x]	Array of signed integers, x elements
BYTE[x]	Array of 8-bit unsigned integers, x elements
LONG	Unsigned 32-bit integer
FLOAT	32-bit floating point

List of all supported PNUs can be seen from Table 108.

Table 108. Supported PNUs

PNU	Significance	Data type	Description
915	Selection switch for DO IO Data in setpoint telegram	UINT[18]	IO setpoint data description. Read only.
916	Selection switch for DO IO Data in actual value telegram	UINT[18]	IO actual data description. Read only.
918	PROFIBUS DP node address	UINT	See chapter 5.1.
922	Telegram selection	UINT	Used telegram. See Table 15.
923	List of all parameters for signals	UINT[x]	See chapter 6.3.9.
930	Operating mode	UINT	1 = Speed control mode
944	Fault message counter	UINT	See chapter 6.4.6.
947	Fault number	UINT[32]	
950	Scaling of the fault buffer	UINT[2]	
963	PROFIBUS DP actual baud rate	UINT	See Table 109.
964	Drive Unit identification	UINT[6]	See Table 110.
965	Profile identification number	BYTE[2]	Byte 1 = 3 (PROFIdrive), Byte 2 = 41 (Version 4.1)
975	Drive Object identification	UINT[7]	See Table 111.
980	Number list of defined parameters	UINT[46]	List of defined parameters in array
981...999	Number list of defined parameters	UINT	Not used.
9900	Dummy writeable single parameter	UINT	Test parameter
9901	Dummy writeable array parameter	UINT[8]	Test array parameter
10001	Parameter in drive	UINT	Parameter channel. See chapter 6.4.4.7 for example.
10100	Profile control word (STW1)	UINT	See chapter 6.3.3.
10101	Speed setpoint (NSOLL_A)	INT	See chapter 6.3.5.
10102	Profile status word (ZSW1)	UINT	See chapter 6.3.4.
10103	Speed actual value (NIST_A)	INT	See chapter 6.3.6.
10104	Filtered output current (IAIST_GLATT)	INT	See Table 20.
10105	Filtered active current (ITIST_GLATT)	INT	
10106	Filtered active power (PIST_GLATT)	INT	
10107	Filtered speed actual value (NIST_A_GLATT)	INT	See chapter 6.3.2.2.

Table 108. Supported PNUs

PNU	Significance	Data type	Description
10108	Drive status/fault word (MELD_NAMUR)	UINT	See Table 21.
10109	Process Data In word	UINT[16]	See chapter 6.9.
10110	Process Data Out word	UINT[16]	
10111	Speed physical reference value	UINT	Motor nominal speed
10112	Non-profile control word	UINT	See chapter 6.7.
10113	Non-profile status word	UINT	
10114	Non-profile speed setpoint value	UINT	See chapter 6.7.1.
10115	Non-profile speed actual value	UINT	
10116	Motor current physical reference value	UINT	Motor nominal current in 0.1 A
10117	Power physical reference value	UINT	Motor nominal power in W.
10118	Clear fault history	UINT	Writing to this PNU will clear fault history from AC drive.
10119	Read fault history	BYTE[40]	Read fault history as 8-bit error codes
10124	Operation time	LONG	Operation time in seconds
10125	Trip operation time	LONG	Trip operation time in seconds. Write 0 value to clear trip time.
10126	Energy counter	FLOAT	Energy counter in kWh
10127	Trip energy counter	FLOAT	Trip energy counter in kWh. Write 0 value to clear trip counter.
10200	Safety control word 1 (S_STW1)	BYTE[2]	See VACON® NXP Advanced Safety Options Operating Guide.
10201	Safety status word 1 (S_ZSW1)	BYTE[2]	
10202	Safety control word 2 (S_STW2)	BYTE[4]	
10203	Safety status word 2 (S_ZSW2)	BYTE[4]	
10204	Vacon safety control word (VS_CW)	BYTE[6]	
10205	Vacon safety status word (VS_SW)	BYTE[6]	
60022	Safety telegram number	UINT	Parameterized safety telegram number. 0 = Not used
60044	Safety fault message counter	UINT	See chapter 6.4.6.
60047	Safety fault number	UINT[64]	
60050	Scaling of the safety fault buffer	UINT[2]	

Table 109. Coding of PNU 963 (PROFIBUS DP actual baud rate)

Value	Signifance
0	9.6 kbit/s
1	19.2 kbit/s
2	93.75 kbit/s
3	187.5 kbit/s
4	500 kbit/s
5	Not defined
6	1500 kbit/s
7	3000 kbit/s
8	6000 kbit/s

Table 109. Coding of PNU 963 (PROFIBUS DP actual baud rate)

Value	Signifance
9	12000 kbit/s
10	31.25 kbit/s
11	45.45 kbit/s

Table 110. Structure of PNU 964 (Drive Unit identification)

Subindex	Content	Value
0	Manufacturer	0x01BA = VACON®
1	Drive Unit type	0x0001 = VACON® NX family AC drive 0x0002 = VACON® 100 family AC drive 0x0003 = VACON® 20 family AC drive
2	Version (Software)	Varies: e.g 600(d) = 6.0
3	Firmware date (year)	yyyy (decimal)
4	Firmware date (day/month)	ddmm (decimal)
5	Number of Drive Objects (DO)	0x0001

Table 111. Structure of PNU 975 (DO identification)

Subindex	Content	Value
0	Manufacturer	0x01BA = Vacon
1	DO type	0x0003
2	Version (Software)	Varies: e.g 0x0600 = 6.0
3	Firmware date (year)	yyyy (decimal)
4	Firmware date (day/month)	ddmm (decimal)
5	PROFIdrive DO type class	0x0001 = Axis
6	PROFIdrive DO sub class 1	0x0001

6.4.6 PROFIdrive Fault Buffer

The PROFIdrive fault buffer can be used to read drive faults via PROFIBUS. The PROFIdrive fault buffer consists of several PNUs, which implement the PROFIdrive fault system. Overview of the PROFIdrive fault buffer can be seen in Figure 13.

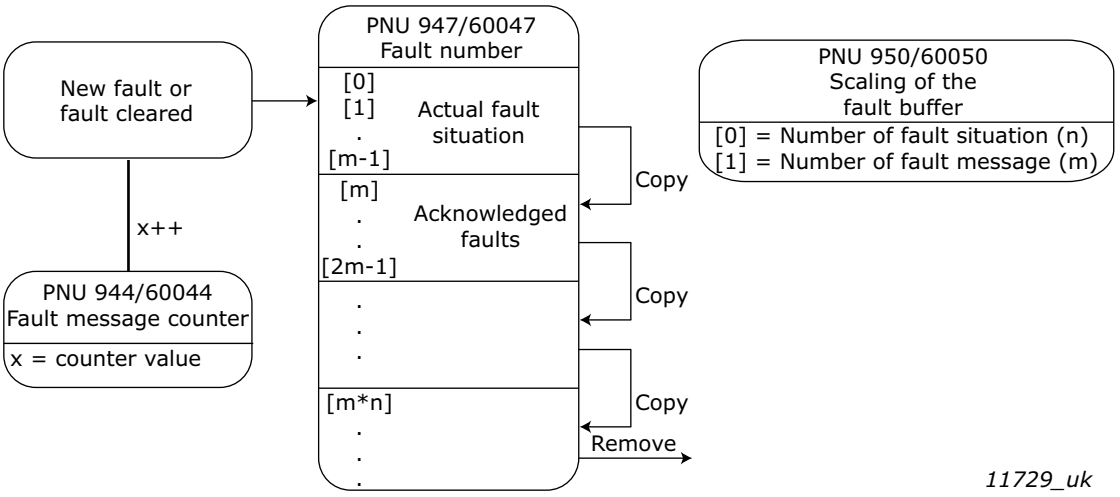


Figure 13. PROFIdrive Fault Buffer

The OPTE3/E5 supports two PROFIdrive fault buffers, one for AC drive errors, and the other for safety related errors. All safety related errors will appear in the safety fault buffer and all error codes in normal fault buffer. PNUs 944, 947 and 950 are used for AC drive fault buffer and PNUs 60044, 60047 and 60050 for safety fault buffer. All used PNUs are listed in Table 112.

Table 112. PROFIdrive fault buffer parameters

PNU	Designation	Explanation	Data type	Value
944	Fault message counter	Incremented each time that the fault buffer changes	UINT16	-
947	Fault number	Contains the internal fault number for each fault message	UINT16[32]	-
950	Scaling of the fault buffer	Index 0: The number of fault situations of the fault buffer	UINT16[2]	4
		Index 1: The number of fault messages per fault situation		8
60044	Safety fault message counter	Incremented each time that the safety fault buffer changes	UINT16	-
60047	Safety fault number	32-bit safety fault codes (2 messages per active fault)	UINT16[64]	-
60050	Scaling of the safety fault buffer	Index 0: The number of fault situations of the fault buffer	UINT16[2]	8
		Index 1: The number of fault messages per fault situation		8

The PNU 947 fault number error codes are linked directly from the AC drive fault system (16-bit). The definition of these fault codes can be found in application specific manuals. 4 active faults can be shown at once, and the fault history is 8 faults long.

The PNU 60047 safety fault number error codes are 32-bit long, each fault taking two messages from the fault buffer. Therefore the number of active fault situations is 8 / 2 = 4. The safe fault history holds 8 fault situations.

The fault code is defined as follows:

0xAABBCCDD, where

AA = Error class

BB = Source

CC = Fault number

DD = Additional Info

The definition of these fault codes can be found in the VACON® NXP Advanced Safety Options Operating Guide.

NOTE! If no fault is active, the active fault situation (first fault situation) is zero.

6.5 DATA MAPPING IN PROFIDRIVE 2.0

The OPTE5 / OPTE3 option board uses the PROFIdrive 2.0 profile if it is configured by the master to use PPO types for communication. The implementation is not completely compliant with the PROFIdrive 2.0 specification.

The PROFIdrive 2.0 is supported by OPTE5 / OPTE3 for backward compatibility reasons. The implementation is similar to that of OPTC5 / OPTC3.

NOTE! The Standard telegrams cannot be used with PROFIdrive 2.0. The PROFIdrive version 4.1 is used if PROFIdrive is selected and Standard telegrams are used.

6.5.1 PROFIDRIVE 2.0 CONTROL WORD

Table 113.

CW		REF		PD1		PD2		PD3		PD4		PD5		PD6		PD7		PD8	

The Control command for the state machine (see Figure 14) The state machine describes the device status and the possible control sequence of the AC drive.

NOTE! VACON® 100 family does not support the FBDIN control word bits.

The control word is composed of 16 bits that have the following meanings:

Table 114. Control word bit descriptions

Bits	Description	
	Value = 0	Value = 1
0	STOP 1 (by ramp)	ON 1
1	STOP 2 (by coast)	ON 2
2	STOP 3 (by ramp)	ON 3
3	RUN DISABLE	ENABLE
4	No Action	START
5	No Action	START
6	No Action	START
7	No Action	FAULT RESET (0 -> 1)
8	No Action	No Action
9	No Action	No Action

Table 114. Control word bit descriptions

Bits	Description	
	Value = 0	Value = 1
10	Disable Profibus control	Enable Profibus control
11	Fieldbus DIN1=OFF	Fieldbus DIN1=ON
12	Fieldbus DIN2=OFF	Fieldbus DIN2=ON
13	Fieldbus DIN3=OFF	Fieldbus DIN3=ON
14	Fieldbus DIN4=OFF	Fieldbus DIN4=ON
15	Fieldbus DIN5=OFF	Fieldbus DIN5=ON

With the help of the control word, the start and stop commands can be given to the device. Also a fault can be acknowledged.

Table 115. Commands with control word

Command	ControlWord	Description
RUN	047Fhex	Start motor if "Fieldbus" is active control source
STOP 1	047Ehex	Stop by Ramp
STOP 2	047Dhex	Stop by Coast
STOP 3	047Bhex	Stop by Ramp
RUN DISABLE	0477hex	Stop by Coast
FAULT RESET (step 1) FAULT RESET (step 2)	bit 7 = 0 bit 7 = 1	Rising edge to bit 7

As shown above, there are several stop modes. It depends on the operating situation, which mode is selected.

NOTE! In VACON® NX AC drive, the commands STOP1 and STOP3 are identical. Also, the commands STOP2 and RUN DISABLE are identical.

The commands STOP1 and STOP3 can be used only with either one of the motor control modes (P2.6.1) Frequency control or Speed control selected **and** the fieldbus selected as the control place.

6.5.2 PROFIDRIVE 2.0 STATUS WORD

Table 116.

SW		ACT		PD1		PD2		PD3		PD4		PD5		PD6		PD7		PD8	

Information about the status of the device and messages is indicated in the Status word. The Status word is composed of 16 bits that have the following meanings:

Table 117. Status word bit descriptions

Bits	Description	
	Value = 0	Value = 1
0	Not Ready (initial)	READY 1 **
1	Not Ready	READY 2 **
2	DISABLE	ENABLE **
3	NO FAULT	FAULT ACTIVE *
4	STOP 2	NO STOP 2 **
5	STOP 3	NO STOP 3 **
6	START ENABLE	START DISABLE **
7	No Warning	Warning *
8	Reference ≠ Actual value	Reference = Actual value *
9	Fieldbus control OFF	Fieldbus control ON *
10	Not used	Not used
11	Not used	Not used
12	FC stopped	Running *
13	FC not ready	FC ready *
14	Not used	Not used
15	Not used	Not used

* Comes straight from the AC drive
** Bits of the State Machine

6.5.3 STATE MACHINE FOR PROFIDRIVE 2.0

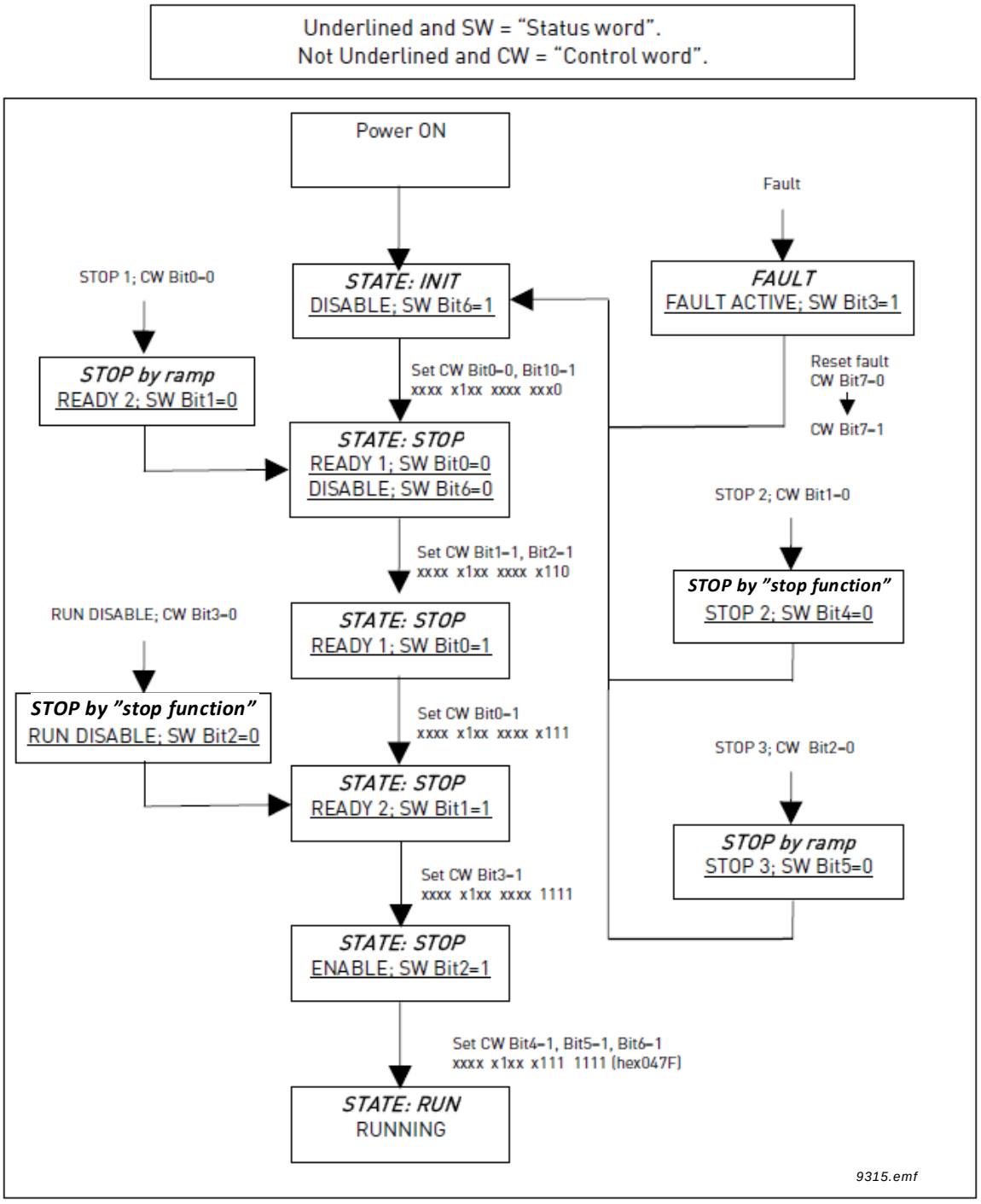


Figure 14. PROFIdrive 2.0 state machine

NOTE! When using a VACON® NX series AC drives and OPTE3/E5 in "PROFIdrive" mode, the stop command always follows the configured stop mode and not the stop command given from the fieldbus.

6.5.4 PPO TYPES

PPO1 contains a parameter field (PKW) for performing parameter access, as well as control/status word and setpoint/actual value fields.

PPO2 contains a parameter field (PKW) for performing parameter access, as well as control/status word and setpoint/actual value fields. Additionally, four Process Data words are included in this type.

PPO3 contains control/status word and setpoint/actual value fields.

PPO4 contains control/status word and setpoint/actual value fields, as well as four Process Data words.

PPO5 contains a parameter field (PKW) for performing parameter access, as well as control/status word and setpoint/actual value fields. Additionally, eight Process Data words are included in this type.

PPO6 contains control/status word and setpoint/actual value fields, as well as eight Process Data words.

The diagram below shows a comparison between different PPO types:

Table 118.

Parameter field								**Process data field**															
ID		IND		VALUE				CW SW		REF ACT		PD1 PD1		PD2 PD2		PD3 PD3		PD4 PD4		PD5 PD5		PD6 PD6		PD7 PD7		PD8 PD8	
												NOT USED													
																				NOT USED					
NOT USED												NOT USED													
NOT USED																				NOT USED					
NOT USED																									

Descriptions:

= Byte

ID = Parameter type and number

IND = Parameter subindex

VALUE = Parameter value

CW = Control Word

SW = Status Word

REF = Reference Value 1

ACT = Actual Value 1

PD = Process Data

6.6 PARAMETER ACCESS IN PROFIDRIVE 2.0

6.6.1 DP-V1 WITH PROFIDRIVE 2.0

In the PROFIdrive 2.0 mode, only the following parameters are supported through DP-V1:

- 918 (node address),
- 963 (current baud rate),
- 980 (number list of defined parameters)
- 10001 (read parameter from drive)

In this case the parameter 980 contains four elements; 918, 963, 10001 and 0.

For information on using DP-V1 with PROFIdrive 2.0 configuration, see chapter 6.4.

When using PPO1, PPO2 or PPO5, the PKW field is used to access parameters from the drive only. The parameter number which is provided in the PKW field is interpreted as an application ID and is read from/written to the drive.

6.6.2 PARAMETER FIELD (PKW) IN PPO TYPES

The parameter request field is structured into three subfields:

- ID field (2 octets)
- Index field (2 octets)
- Value field (4 octets)

Table 119.

ID field	Index field	Value field

The master formulates a task for parameter processing by issuing a request in the PKW field. The master repeats this request until it receives a response from the slave. The slave repeats its response until it receives a new request from the master.

6.6.2.1 ID Subfield

The ID subfield consists of three subsections:

Table 120.

ID field octet 1								ID field octet 2							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Request/response type				Not used	Parameter Number (= Drive Application ID number)										

The possible request/response types are:

Table 121.

Value	Meaning if request	Meaning if response
0	No request	No response
1	Read parameter value (word)	Parameter value ready (word)
2	Write parameter value (word)	Reserved
3...6	Reserved	Reserved
7	Reserved	Request rejected (+ fault code)

If a request is rejected, a fault code from the table below is provided:

Table 122.

Fault Code	Description
0	Illegal parameter
1	Parameter is read-only (e.g. actual value)
2	Parameter value is out of limits
17	Request is temporarily rejected (e.g. can be changed only when drive is in STOP state)
18	Unspecified fault
101	Unknown request type

6.6.2.2 Index subfield

This field is not used in the PKW processing. Its contents should be set to 0.

6.6.2.3 Value subfield

The Value subfield consists of two words i.e. four octets:

Table 123.

Data word 1 (HIGH)		Data word 2 (LOW)	
Octet 0	Octet 1	Octet 2	Octet 3

When writing a parameter to the drive, the data to be written should be placed in the "Data word 2 (LOW)" field by the master.

When reading a parameter from the drive, the response is placed in the "Data word 2 (LOW)" field by the slave.

The "Data word 1 (HIGH)" field is zero.

6.6.3 EXAMPLES

6.6.3.1 Reading maximum frequency (ID=102)

The master sends the following PKW request:

Table 124.

Octet 1	Octet 2	Octet 3	Octet 4	Octet 5	Octet 6	Octet 7	Octet 8
0x10	0x66	0x00	0x00	0x00	0x00	0x00	0x00

This translates to:

Table 125.

Field	Contents	Meaning
ID	0x1066	1 = Read parameter value 0x066 = 102d (Maximum Frequency ID)
Index	0x0000	No meaning
Value	0x00000000	No meaning

Assuming that the drive is parameterized with Maximum Frequency = 50.00 Hz, its response will be:

Table 126.

Octet 1	Octet 2	Octet 3	Octet 4	Octet 5	Octet 6	Octet 7	Octet 8
0x10	0x66	0x00	0x00	0x00	0x00	0x13	0x88

This translates to:

Table 127.

Field	Contents	Meaning
ID	0x1066	1 = Parameter value ready (word) 0x066 = 102d (Maximum Frequency ID)
Index	0x0000	No meaning
Value	0x00001388	0x1388 = 5000d (Maximum Frequency is 50.00 Hz)

6.6.3.2 Writing control place (ID=125)

The master sends the following PKW request:

Table 128.

Octet 1	Octet 2	Octet 3	Octet 4	Octet 5	Octet 6	Octet 7	Octet 8
0x20	0x7D	0x00	0x00	0x00	0x00	0x00	0x02

This translates to:

Table 129.

Field	Contents	Meaning
ID	0x207D	2 = Write parameter value 0x07D = 125d (Control Place ID)
Index	0x0000	No meaning
Value	0x00000002	Value to be written is 2

If the write is successful, the slave will respond:

Table 130.

Octet 1	Octet 2	Octet 3	Octet 4	Octet 5	Octet 6	Octet 7	Octet 8
0x10	0x7D	0x00	0x00	0x00	0x00	0x00	0x00

This translates to:

Table 131.

Field	Contents	Meaning
ID	0x1066	1 = Parameter value ready (word) 0x07D = 125d (Control Place ID)
Index	0x0000	No meaning
Value	0x00000000	No meaning

6.7 Data Mapping in Bypass operate mode

In the Bypass operate mode, the control word and status word fields in Process Data do not use the PROFIdrive bit definitions. Instead, the internal control and status word bit definitions are used. These definitions may differ depending on the used application.

For the control and status word definitions in the standard applications, see chapter 11. For latest information and special applications, see the application specific manual.

6.7.1 Bypass setpoint and actual value

In the Bypass operate mode, the valid ranges for setpoint and actual values is 0...10000, which corresponds to 0.00% to 100.00%.

The desired direction of rotation is announced using bit 1 in the control word, and the actual direction is indicated by bit 2 in the status word.

6.8 Data Mapping in Echo operating mode

In the Echo operating mode, the data exchange messages sent from the fieldbus master is echoed back by the slave. No processing of the information is performed in the slave or the drive.

Table 132.

Master-to-slave		Slave to master field
PKW request*	-->	PKW response*
Control word	-->	Status word
Setpoint value	-->	Actual speed value
Process Data 1...16*	-->	Process Data 1...16*

* If present in the selected I/O configuration.

6.9 Process data mapping

The process data items are directly sent unmodified from fieldbus to the application. Therefore the process data mapping and usage must be configured in application.

For the process data mapping parameters and default values, see chapter 10. For the latest information, see the application specific manual.

7. PROFIsafe

The OPTE3/E5 supports a black channel PROFIsafe interface via PROFIBUS to Advanced safety option board to support safety functions. This chapter briefly introduces PROFIsafe, for more detailed information, see VACON® NXP Advanced Safety Options Operating Guide.

NOTE: This functionality is available in OPTE3/E5 version 006 or later. Also use .GSD file with Revision "2" or later.

7.1 Overview

See the figure below for the PROFIsafe system overview, when using PROFIsafe over PROFIBUS.

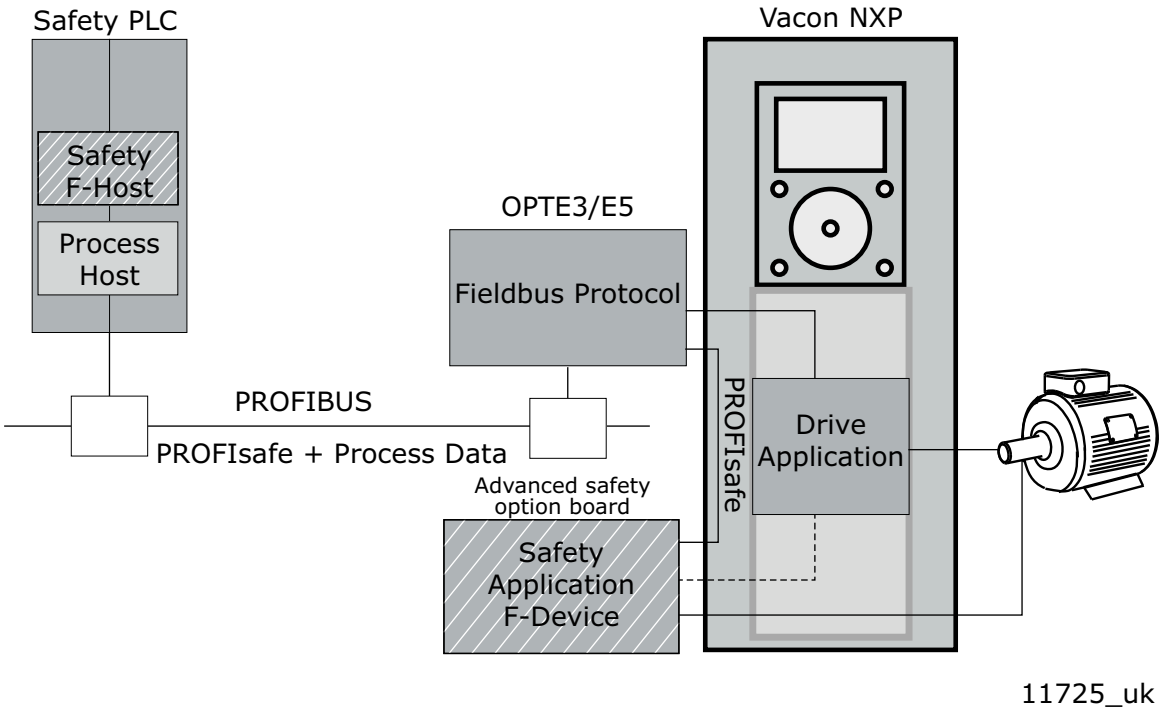


Figure 15. PROFIsafe system overview

The PROFIBUS option board (OPTE3/E5) communicates with the safety PLC via PROFIBUS. The exchanged data includes PROFIsafe data and non-safe process data. The PROFIBUS option board extracts the process data and the safety frame from the received message and forwards them. The process data is sent to the drive application, and the safety frame is sent to the Advanced safety option board.

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

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

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

7.2 PROFIdrive on PROFIsafe

The VACON® Advanced Safety Options support three safety telegrams consisting of both standard PROFIdrive on PROFIsafe functionality as well as vendor specific functionality. These telegrams are Standard Telegram 30, Standard Telegram 31 and Vacon specific Telegram 58000. The content (signals) of these telegrams are described in Table 133.

Table 133. Supported Safety Telegrams

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

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

8. PROFIBUS DP DIAGNOSIS

The PROFIBUS DP defines several different ways to report status and diagnosis information. An overview of the defined and OPTE3/E5 supported diagnosis methods is shown in the figure below.

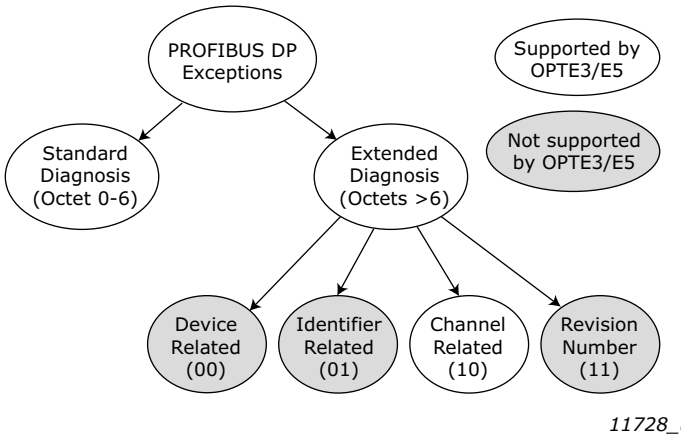


Figure 16. Overview of PROFIBUS DP diagnosis

8.1 STANDARD DIAGNOSIS

The standard diagnosis consists of the first 6 octets of any diagnosis message within PROFIBUS DP. The diagnosis information is related to communication, device identification, readiness, watchdogs and parameterization/ configuration faults. Detailed information of the bit fields are described in the table below.

Table 134. Description of Standard Diagnosis message

Octet	Bit	Name	Description
1	0	Diag.Station_Non_Existent	1 = Slave does not exist
	1	Diag.Station_Not_Ready	1 = Slave not ready for data exchange
	2	Diag.Cfg_Fault	1 = Slave has mismatching configuration data
	3	Diag.Ext_Diag	0 = Slave sends standard diagnosis data only (6 bytes) 1 = Slave indicates serious faults, usually with extended diagnosis data
	4	Diag.Not_Supported	Slave does not support the required function
	5	Diag.Invalid_Slave_Response	0 = Set by slave 1 = Set by master in case of fault
	6	Diag.Prm_Fault	Slave got wrong parameterization
	7	Diag.Master_Lock	Slave has been parameterized by another master

Table 134. Description of Standard Diagnosis message

Octet	Bit	Name	Description
2	0	Diag.Prm_Req	1 = Slave requests parameterization
	1	Diag.Stat_Diag	1 = Slave not able to provide valid diagnosis data Master repeats diagnosis requests while in Data Exchange mode until this bit is set (0) Only valid within the start-up phase of a slave
	2	DP	Always set to 1
	3	Diag.WD_On	1 = Slave reports exceeded watchdog time
	4	Diag.Freeze_Mode	1 = Slave is in FREEZE mode
	5	Diag.Sync_Mode	1 = Slave is in SYNC mode
	6	Reserved	
	7	Diag.Deactivated	1 = Diagnosis deactivated
3	0...6	Reserved	
	7	Diag.Ext_Diag_Overflow	1 = Slave has more diagnosis data than fit into the buffer
4	0...7	Diag_Master_Add	0-125: Address of the master that has parameterized the slave 126-254: Not allowed 255: Not parameterized
5	0...7	Ident_Number (High)	High byte of the slave's ident number
6	0...7	Ident_Number (Low)	Low byte of the slave's ident number

8.2 Channel related diagnosis

The channel related diagnosis is used in OPTE3/E5 for informing errors and failures of PROFISafe.

Table 135. Description of Extended Diagnosis message

Octet	Bit	Name	Description
1	0...5	Identifier_Number	Slot of diagnosis (1)
	6...7	Selection	2 = Channel related diagnosis
2	0...5	Channel_Number	Channel of diagnosis (0)
	6...7	Input_Output_Selection	3 = Input and output
3	0...4	Error_Type	16...31 manufacturer specific
	5...7	Channel_Type	0 = unspecific, may be used for any type

The OPTE3/E5 has 1 channel per module, so the error is always given to channel 0. As safety modules must always be inserted in the first slot (see chapter 5.3), the slot of these safety related diagnosis errors is always 1.

The diagnosis errors from 0 to 15 are predefined or reserved by PROFIBUS, and 16 to 31 are manufacturer specific. These error codes are defined via .GSD entries. These entries are described in the table below.

Table 136. Manufacturer specific channel diagnosis error codes

Error type	Channel diagnosis	Description
16	PROFIsafe not responding	Cannot verify used safety configuration
17	Safety module mismatch	Different or no safety telegram is used
18	PROFIsafe configuration mismatch	F-Parameters do not match

PROFIsafe not responding: Connection between PROFIBUS option board and advanced safety option board cannot be established. Check the option board connections and firmware revisions.

Safety module mismatch: Safety telegram configured in use by PROFIBUS master is different than the one that is configured in advanced safety option board. These settings must match.

PROFIsafe configuration mismatch: F-Parameters between PROFIBUS master and advanced safety option board do not match. Compare all F-Parameters and the F-Par CRC value from the advanced safety option board configuration and from PROFIBUS master.

9. APPENDIX 1 - 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 software 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.

9.1 FIELDBUS CONTROL AND 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® NXP, VACON® 20 and VACON® 20X 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. For instructions on fieldbus writing, see the fieldbus specific manual.

Table 137. Fieldbus parameterization for VACON® 100 family (standard application)

Parameter name	ID	Value	Default	Panel Tree
Control mode	600	0 = Frequency 1 = Speed 2 = Torque	0	P3.1.2.1
Remote control place	172	1 = Fieldbus CTRL	0	P3.2.1
Local / remote	211	0 = Remote	0	P3.2.2
Fieldbus ref. sel.	122	3 = Fieldbus	3	P3.3.1.10
Controlling fieldbus	2539	1 = Automatic 2 = Slot D 3 = Slot E	1	P5.13.1

Table 138. Fieldbus parametrization for VACON® 20 (standard application)

Parameter name	ID	Value	Default	Panel Tree
Motor control mode	600	0 = Frequency 1 = Speed 2 = Torque	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.	122	3 = Fieldbus	7	P3.3

Table 139. Fieldbus parametrization for VACON® 20X (multipurpose application)

Parameter name	ID	Value	Default	Panel Tree
Motor control mode	600	0 = Frequency 1 = Speed	0	P8.1
Control place selection	125	2 = Fieldbus	0	P1.11
Frequency ref. sel.	1819	5 = Fieldbus	0	P1.12

Table 140. Fieldbus parametrization for VACON® NXP (multipurpose application)

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

9.2 RESPONSE TO FIELDBUS FAULT

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

Table 141. Response to fieldbus fault in VACON® AC drives

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

10. Appendix 2 - Fieldbus Process Data mapping and scaling

Table 142. Fieldbus Process Data Selection Panel Tree for VACON® AC drives

Parameter name	ID	Panel Tree			
		VACON® 100 family	VACON® NXP **	VACON® 20	VACON® 20 X/CP
FB DataOut 1 Selection	852	P3.6.1	P2.13.3	P10.1	P11.1
FB DataOut 2 Selection	853	P3.6.2	P2.13.4	P10.2	P11.2
...	...	...	...	...	...
FB DataOut 8 Selection	859	P3.6.8	P2.13.10	P10.8	P11.8
FB DataOut 9 Selection*	*	-	*	-	-
FB DataOut 10 Selection*	*	-		-	-
...	...	-	...	-	-
FB DataOut 16 Selection*	*	-		-	-

* Only in applications supporting fast communication
** Multipurpose application

Table 143. Default process data mapping for VACON® 100 family and VACON® NXP

VACON® 100 family					VACON® NXP				
PD	Mapped Application Data	ID	Unit	Scale	PD	Mapped Application Data	ID	Unit	Scale
1	Output Frequency	1	Hz	0.01 Hz	1	Output Frequency	1	Hz	0.01 Hz
2	Motor Speed	2	rpm	1 rpm	2	Motor Speed	2	rpm	1 rpm
3	Motor Current	3	A	Varies*	3	Motor Current	45	A	0.1 A
4	Motor Torque	4	%	0.1 %	4	Motor Torque	4	%	0.1 %
5	Motor Power	5	%	0.1 %	5	Motor Power	5	%	0.1 %
6	Motor Voltage	6	V	0.1 V	6	Motor Voltage	6	V	0.1 V
7	DC Link Voltage	7	V	1 V	7	DC Link Voltage	7	V	1 V
8	Last Active Fault Code	37	-	-	8	Last Active Fault Code	37	-	-

*Scaling is based on drive nominal power. Scaling can be seen from Table 41.

Table 144. Default process data mapping for VACON® 20 X/CP and VACON® 20

VACON® 20 X/CP					VACON® 20				
PD	Mapped Application Data	ID	Unit	Scale	PD	Mapped Application Data	ID	Unit	Scale
1	Output Frequency	1	Hz	0.01 Hz	1	Frequency Reference	25	Hz	0.01 Hz
2	Motor Speed	2	rpm	1 rpm	2	Output Reference	1	Hz	0.01 Hz
3	Motor Current	3	A	Varies*	3	Motor Speed	2	rpm	1 rpm
4	Motor Torque	4	%	0.1 %	4	Motor Voltage	6	V	0.1 V
5	Motor Power	5	%	0.1 %	5	Motor Torque	4	%	0.1 %
6	Motor Voltage	6	V	0.1 V	6	Motor Current	3	A	Varies*
7	DC Link Voltage	7	V	1 V	7	Motor Power	5	%	0.1 %
8	Last Active Fault Code	37	-	-	8	DC Link Voltage	7	V	1 V

* Scaling is based on drive nominal power. Scaling can be seen from Table 145.

Table 145. 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

11. APPENDIX 3 - VACON CONTROL / STATUS WORD DEFINITION

11.1 CONTROL WORD DESCRIPTION

The Vacon Control Word is composed of 32 bits. This control data is split into two words: FBFixedControlWord consist of the first 16 bits and FBGeneralControlWord consist of the remaining 16 bits.

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

FBFixedControlWord bit definitions are described in Table 146. Note that there are some control word bit modifications in VACON® NXP AC drive. These modifications are described in Table 147. Unused bits have to be set to zero.

Table 146. Definition of FBFixedControlWord

Bit	Function	Value	Description
0	Start/Stop	0	Stop request from fieldbus
		1	Run request from fieldbus
1	Direction	0	Requested direction is "FORWARD"
		1	Requested direction is "REVERSE"
2	Fault reset	0	No action
		1	Rising edge (0-->1) resets active faults, alarms and info
3	Stop mode 1	0	Stop mode is unmodified
		1	Stop mode is overridden to "Ramping"
4	Stop mode 2	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
5	Quick ramp time	0	Normal deceleration ramp time
		1	Deceleration ramp is switched to shorter than normal
6	Freeze setpoint	0	Changes in the setpoint value from fieldbus (FB Speed Reference) are taken into use by the application
		1	Changes in the setpoint value from fieldbus (FB Speed Reference) are not taken into use by the application
7	Setpoint to Zero	0	The setpoint value from fieldbus is taken from FB Speed Reference
		1	The setpoint value from fieldbus is changed to 0
8	Request Fieldbus Control	0	Control Place is as parameterized in the drive (unchanged)
		1	Control Place is overridden to Fieldbus Control
9	Request Fieldbus Reference	0	Source of the setpoint value is as parameterized in the drive (unchanged)
		1	Source of the setpoint value is overridden to Fieldbus
10	Jogging 1	0	No action
		1	Jogging request with jogging reference 1
11	Jogging 2	0	No action
		1	Jogging request with jogging reference 2

Table 146. Definition of FBFixedControlWord

Bit	Function	Value	Description
12	Quick stop	0	No action
		1	Drive executes quick stop / emergency stop
13-15	Reserved		

Table 147. FBFixedContro Word modifications in VACON® NXP

Bit	Function	Value	Description
3	Fieldbus DIN 1	0	Fieldbus DIN 1 off
		1	Fieldbus DIN 1 on
4	Fieldbus DIN 2	0	Fieldbus DIN 2 off
		1	Fieldbus DIN 2 on
5	Fieldbus DIN 3	0	Fieldbus DIN 3 off
		1	Fieldbus DIN 3 on
6	Fieldbus DIN 4	0	Fieldbus DIN 4 off
		1	Fieldbus DIN 4 on
7	Fieldbus DIN 5	0	Fieldbus DIN 5 off
		1	Fieldbus DIN 5 on

11.2 CONTROL WORD BIT SUPPORT IN VACON® AC DRIVES

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

Table 148. FBFixedControlWord bit support in different VACON® AC drives

Bit	Function (x)	Function (o)	VACON® 100 family	VACON® NXP	VACON® 20	VACON® 20 X/CP
0	Start/stop		x	x	x	x
1	Direction		x	x	x	x
2	Fault reset		x	x	x	x
3	Stop mode 1	FBDIN 1	x	o		x
4	Stop mode 2	FBDIN 2	x	o		x
5	Quick ramp time	FBDIN 3	x	o	x	x
6	Freeze setpoint	FBDIN 4	x	o		x
7	Setpoint to zero	FBDIN 5	x	o		x

Table 148. FBFixedControlWord bit support in different VACON® AC drives

Bit	Function (x)	Function (o)	VACON® 100 family	VACON® NXP	VACON® 20	VACON® 20 X/CP
8	Request fieldbus control		x	x		x
9	Request fieldbus reference		x	x		x
10	Jogging 1		x			
11	Jogging 2		x			
12	Quick stop		x			x
13-15	Reserved					

x = Functionality based on Table 146
o = Functionality based on Table 147

11.3 STATUS WORD DESCRIPTION

The Vacon Status Word is composed of 32 bits. This status data is split into two words: FBFixedStatusWord consist of the first 16 bits and FBGeneralStatusWord consist of the remaining 16 bits.

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

FBFixedStatusWord bit definitions are described in table below. Unused bits are set to zero.

Table 149. Definition of FBFixedStatusWord

Bit	Function	Value	Description
0	Ready	0	Drive is not ready
		1	Drive is ready to run
1	Run	0	Motor is not running
		1	Motor is running
2	Direction	0	Motor is running clockwise
		1	Motor is running counter clockwise
3	Fault	0	No fault active
		1	Drive has an active fault
4	Alarm	0	No alarm active
		1	Drive has an active alarm
5	At reference	0	Motor is not running at reference speed
		1	Motor is running at reference speed
6	Zero speed	0	Motor is not at zero speed
		1	Motor is running at zero speed
7	Flux ready	0	Motor is not magnetized
		1	Motor is magnetized
8	Info	0	No info active
		1	Drive has an active info

Table 149. Definition of FBFixedStatusWord

Bit	Function	Value	Description
9-15	Reserved		

11.4 STATUS WORD BIT SUPPORT IN VACON® AC DRIVES

The table below describes the status word bit support in different drives. Notice that this table is valid only for VACON® standard applications. Always check the application-specific manual.

Table 150. FBFixedStatusWord bit support in different VACON® AC drives

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

x = Functionality based on Table 149

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

The tables below describe how the control / status words can be read from different drives via panel or PC-tool.

Table 151. Panel Tree for Control and Status Words

Signal	VACON® 100 family	VACON® NXP	VACON®20	VACON® 20 X/CP
FBFixedControlWord	V2.12.1 (Low Word)	V1.24.1*	-	-
FBGeneralControlWord	V2.12.1 (High Word)	-	-	-
FBFixedStatusWord	V2.12.11 (Low Word)	V1.24.16*	V3.1	-
FBGeneralStatusWord	V2.12.11 (Low Word)	V1.24.3*	V3.2	-

* Advanced Application only

NCDrive

- View --> Monitoring
- Type: Firmware

Table 152. PC-tool monitoring values for Control and Status Words

Signal	VACON® NCDrive	VACON® Live		
	VACON® NXP	VACON® 100 family	VACON® 20	VACON® 20 X/CP
FBFixedControlWord	FBFixedControlWord	FB Control Word (Low Word)	-	-
FBGeneralControlWord	FBGeneralControlWord	FB Control Word (High Word)	-	-
FBFixedStatusWord	MCStatus	FB Status Word (Low Word)	Drive status word	-
FBGeneralStatusWord	FBGeneralStatusWord	FB Status Word (High Word)	Application status word	-

12. APPENDIX 4 - FIELDBUS OPTION BOARD COMMUNICATION

The different communication modes can be enabled for fieldbus option board for different features. There are different modes available for different setups:

- Normal mode, for most commonly used setups. 8 process data items.
- Normal extended mode, for setups that requires 16 process data items.
- Fast mode, with low latency process data. 16 process data items.
- Fast safety mode, with safety "black channel" and low latency process data. 16 process data items.
- Fast PROFIBUS mode, for backward compatibility. 8 process data items.

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

Note that the old fast PROFIBUS mode is still supported but that mode has limitations and is not recommended for new installations.

12.1 REQUIREMENTS FOR COMMUNICATION MODES

The following table describes the required components for different communication modes:

Table 153. Requirements for different fieldbus communication modes

	Fast / Normal Extended	**Fast safe**	**Fast PROFIBUS**
Control Board	NXP (serial no. 761 or later)	NXP (serial no. 761 or later)	NXP (serial no. 561 or later)
System Software	NXP00003V194.VCN or later	NXP00003V194.VCN or later	NXP00002V171.VCN or later
			NXP00003V179.VCN or later
Applica-tions	Multipurpose V236 or later (Normal Extended Mode)	Any*	System Interface V110 or later
			Advanced V085 or later
			Marine V107 or later
Fieldbus option slot	OPTE3-E5_FW0083V006.vcx or later	OPTE3-E5_FW0083V006.vcx or later	OPTC3_10502V014.vcn or later
	OPTE9_FW0196V007.vcx or later	-	OPTC3-5_FW0232V001.vcx or later
	OPTEA in future	OPTEA in future	-
	OPTEC in future	-	OPTEC_FW0128V001.vcx or later
Advanced safety option	-	OPTBL_FW0227V001 or later	-

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

Refer to application specific manuals for latest information about application support for fieldbus communication modes.

12.2 FIELDBUS COMMUNICATION MODE FEATURES AND LIMITATIONS

Fast mode:

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

Fast safe mode:

- 1 ms process data interval
- Includes safety "black channel"
- Activated/deactivated automatically, cannot be set by user or application
- Fast safe mode is available only in slot E
- Advanced safety option board must be installed into slot D
- Safety fieldbus must be activated in safety configuration

16 process data items:

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

12.3 NORMAL FIELDBUS COMMUNICATION

The normal fieldbus communication between option board and the AC drive application is visible in Figure 17. In normal communication both process data and service data are transferred in succession at 5 ms interval.

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

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

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.

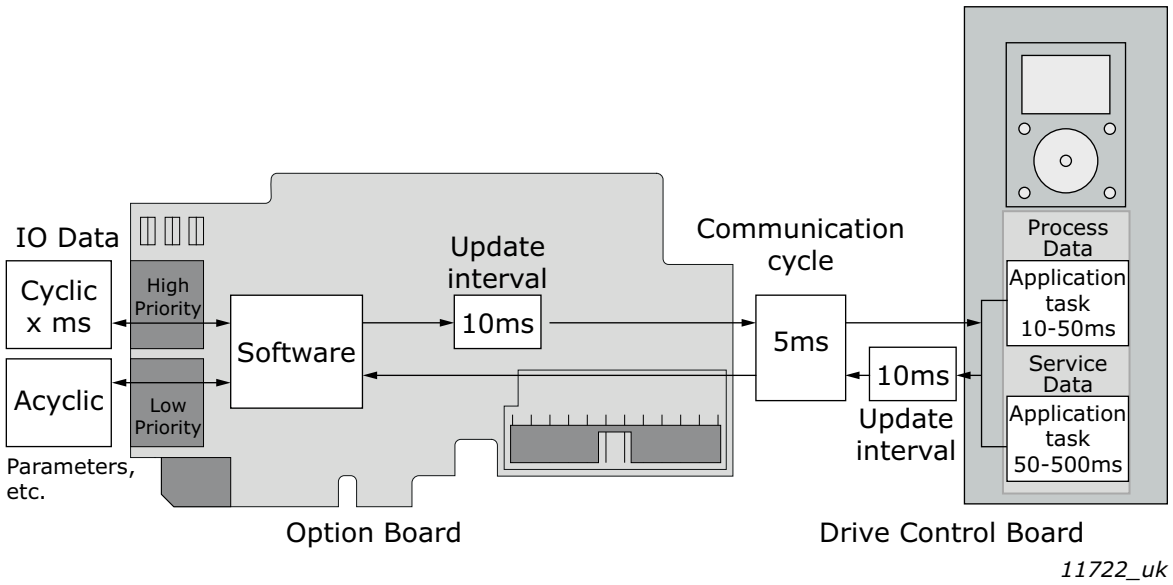


Figure 17. Normal fieldbus communication

12.4 FAST FIELDBUS COMMUNICATION

The fast mode decreases the communication delay between the PLC and the AC drive application significantly by using two communication channels separately for process and service data. The process data interval is set to 1 ms, while other data is sent acyclically. When the fast mode is activated, the application can be synchronized to run with the communication cycle. The Fast communication mode is visible in Figure 18. This mode also includes the ability to transfer 16 process data items.

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

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

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

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

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

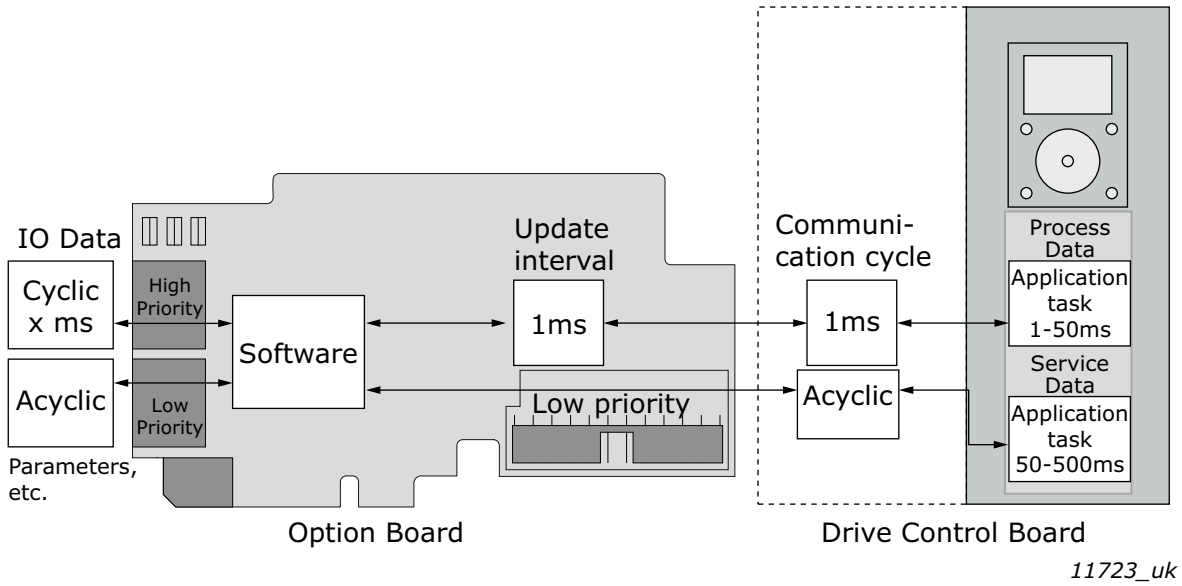


Figure 18. Fast fieldbus communication

12.5 FAST SAFETY FIELDBUS COMMUNICATION

The fast safety mode uses the same communication methods as in "Fast mode" (Figure 18), but also transfers safety "black channel" data used to the advanced safety option board.

NOTE: This mode is automatically enabled, if an advanced safety option board is connected to slot D and the safety fieldbus is activated and cannot be set by the user or application. This mode is also automatically turned off when the advanced safety option board is removed.

12.6 NORMAL EXTENDED MODE

The normal extended mode uses the same communication method as in "Fast mode", but reduces the communication cycle to 10ms.

This can be used in applications where 16 process data items are required but lowest possible communication delay is not needed or the increased CPU load of Fast mode to VACON® NXP drives is undesirable.

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

12.7 FAST PROFIBUS FIELDBUS COMMUNICATION

NOTE: This mode is not recommended for new installations.

There is also a second type of fast communication mode, the Fast PROFIBUS mode originally meant for the OPTC3/C5 PROFIBUS board. This mode can be seen in Figure 19.

This mode can achieve same latencies for process data as the fast mode introduced chapter 12.4, however, this mode imposes several limitations:

- No service data is available
- Option board can be run only in Bypass mode

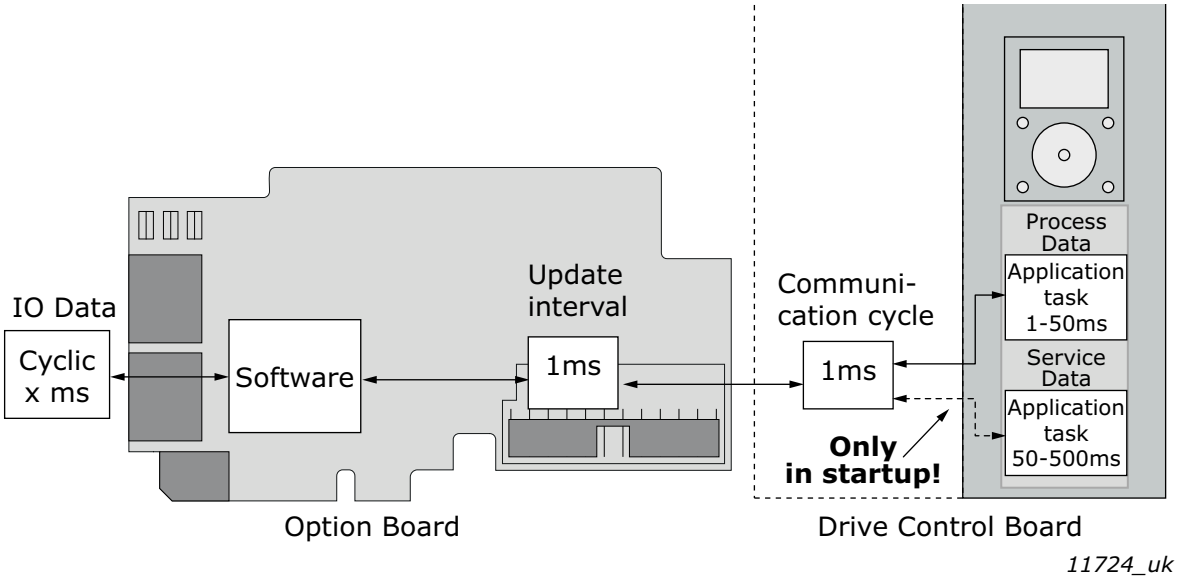


Figure 19. Fast PROFIBUS communication

13. APPENDIX 5 - 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.

Table 154. System software variables for selecting communication modes

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

*Automatically enabled/disabled by system software. Cannot be set by user.
** Fast PROFIBUS mode is not supported in OPTE3/5 PROFIBUS.

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 155. System software variables for monitoring supported communication modes

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

* Only set when installed into slot E and PROFIsafe is configured to be used in advanced safety option board

FBModeSlotXSupModes_fwu16 variables can be used to determine the different supported modes of the fieldbus option boards. All features are set as bit fields as multiple modes can be supported.

Value '0' is returned while the feature set of the option board is not yet retrieved. Value should be asked again. Any option board not supporting fieldbus communication returns value '1'.

Example 1: OPTE3-E5_FW0083V006 PROFIBUS board returns value: 0x2A, indicating support for Normal, Fast and Fast safety modes.

Example 2 (PROFIsafe is used): OPTE3-E5_FW0083V006 board returns value: 0x04, indicating that only Fast safe mode is allowed to be set.

Table 156. System software variables for selecting the input process data slot

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

*For backward compatibility only. Same as FBModeSlotX_fwu8 variable setting '3'. Fast PROFIBUS is not supported in OPTE3/5 PROFIBUS.

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.

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