

VACON 100
AC DRIVES

**PROFIBUS DP OPTION BOARD OPTE3/E5
USER MANUAL**

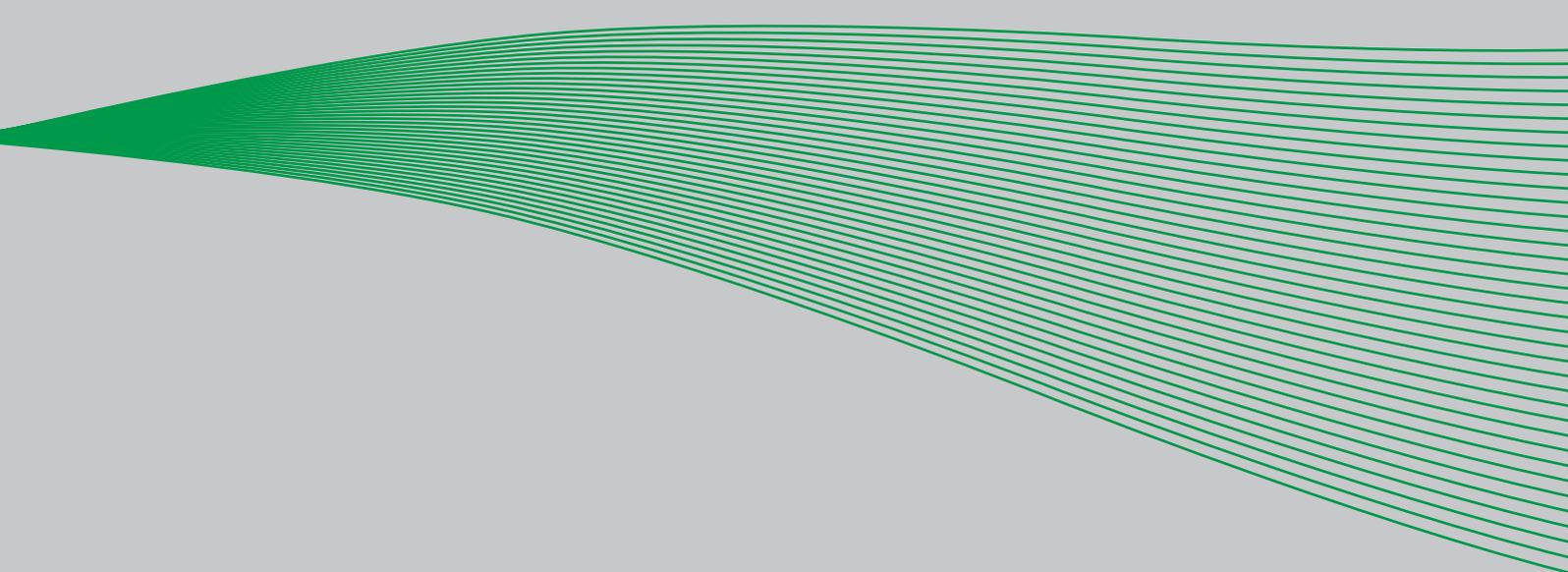


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1. SAFETY

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

Please read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

	= DANGEROUS VOLTAGE!
	= WARNING or CAUTION

Table 1. Warning signs

1.1 DANGER



The **components of the power unit of Vacon 100 are live** when the AC 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 Vacon 100 is connected to mains, even if the motor is not running.



After disconnecting the AC drive from the mains, **wait** 5 minutes before doing any work on the connections of Vacon100. 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 Vacon 100 is disconnected from mains.



Before connecting the AC drive to mains make sure that the front and cable covers of Vacon 100 are closed.



During a coast stop (see 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 5 minutes before starting any work on the drive.

1.2 WARNINGS



Vacon 100 AC drive is meant for **fixed installations only**.



Do not perform any measurements when the AC drive is connected to the mains.



The **touch current** of Vacon 100 AC drives exceeds 3.5mA AC. According to standard EN61800-5-1, a **reinforced protective ground connection** must be ensured. See installation manual.



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 brake 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 autoreset 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. See installation manual.

1.3 EARTHING AND EARTH FAULT PROTECTION



CAUTION!

The Vacon 100 AC drive must always be earthed with an earthing conductor connected to the earthing terminal marked with

The earth leakage current of Vacon 100 exceeds 3.5mA AC. According to EN61800-5-1, one or more of the following conditions for the associated protective circuit shall be satisfied:

- a) The protective conductor shall 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 shall 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 shall, 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 Vacon 100. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

2. PROFIBUS DP - GENERAL

Vacon 100 frequency converters can be connected to the PROFIBUS DP network using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system.

PROFIBUS DP uses Master-Slave type communication. Master devices control the communication. The master can send data without a separate command if a token is given to the Master. 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:

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

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
	PPO types	1, 2, 3, 4, 5, 6
	Baud rate	9.6 kbaud to 12 Mbaud
	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	

Table 2. PROFIBUS DP Option board technical data

3.2 PROFIBUS DP CABLE

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 1). 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 3). The specified cable length can be increased using the repeaters. The use of more than 3 repeaters in series is not recommended.

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	-	-

Table 3. Cable lengths

E.g. following cables can be used:

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

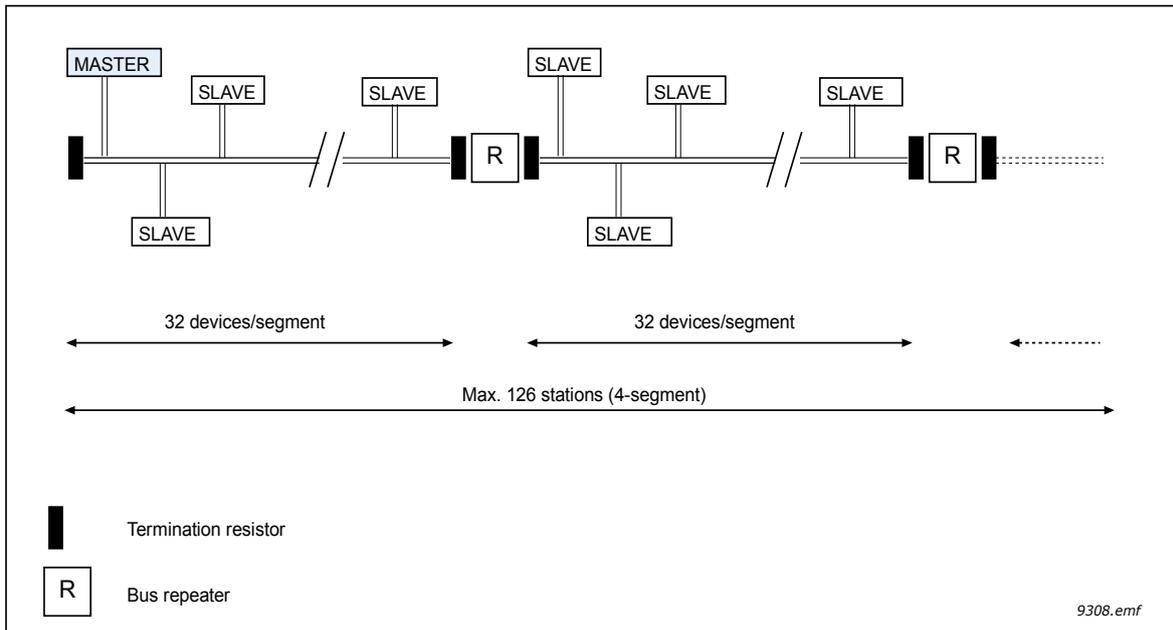


Figure 1. Cabling and bus termination

4. LAYOUT, CONNECTIONS 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

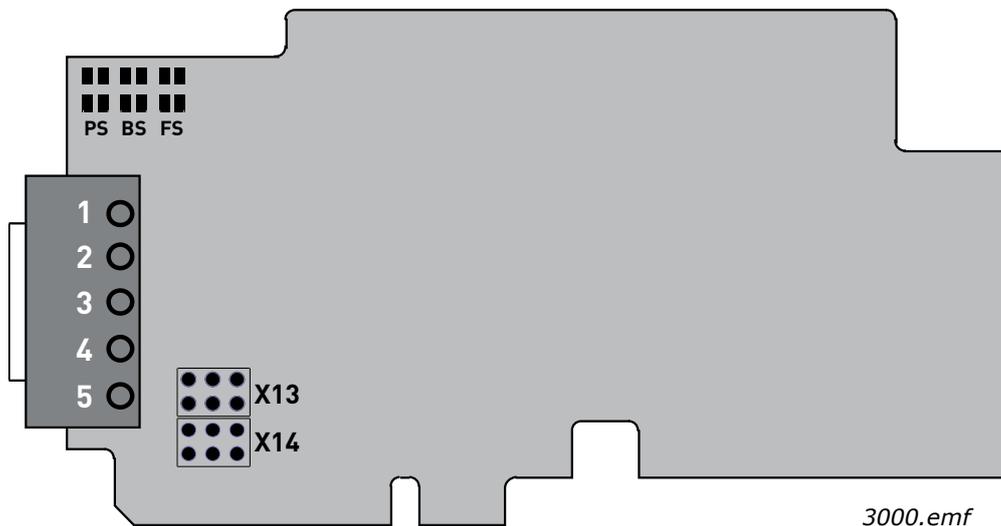


Figure 2. OPTE3/E5 board layout

4.2 CONNECTIONS

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

Table 4. OPTE3 board connections

4.3 LED INDICATIONS

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

PS = PROFIBUS status, RED

LED is	Meaning:
OFF	PROFIBUS DP communicates normally
ON	PROFIBUS DP communication is broken or not started <ul style="list-style-type: none"> • Bus cable broken or incorrectly connected • Wrong configuration or parameterization data of Master • Master is offline or shut down

The PS LED blinks in yellow, when the software is restarting

BS = PROFIBUS board status, YELLOW

LED is	Meaning:
OFF	Option board not activated
ON	Option board in initialisation state waiting for activation command from the frequency converter
Blinking fast (once/1 s)	Option board is activated and in RUN state <ul style="list-style-type: none"> • Option board is ready for external communication
Blinking slow (once/5 s)	Option board is activated and in FAULT state <ul style="list-style-type: none"> • Internal fault on option board

FS = Fieldbus status, GREEN

LED is	Meaning:
OFF	Fieldbus module is waiting for parameters from the frequency converter <ul style="list-style-type: none"> • No external communication
ON	Fieldbus module is activated <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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 2.

Jumper X13, termination resistor

Bus termination ON 

Bus termination OFF 

Jumper X14, upper row

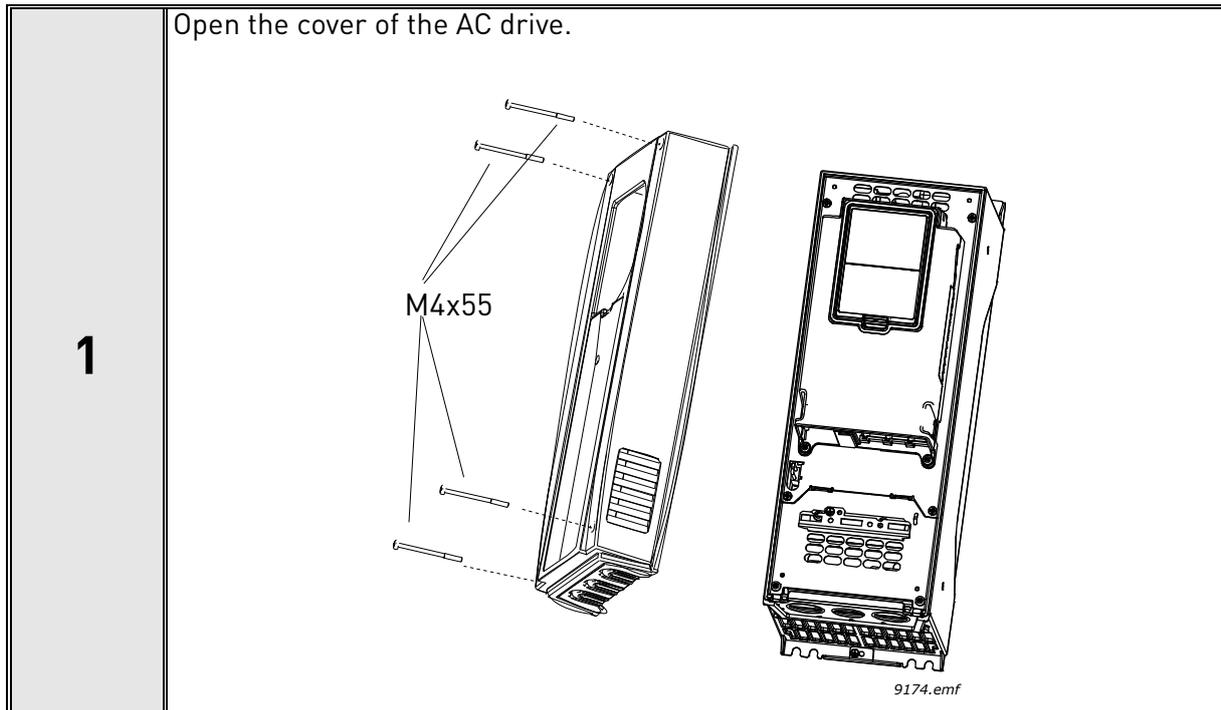
GND connected to cable shield 
 GND not connected to cable shield 

Jumper X14, lower row

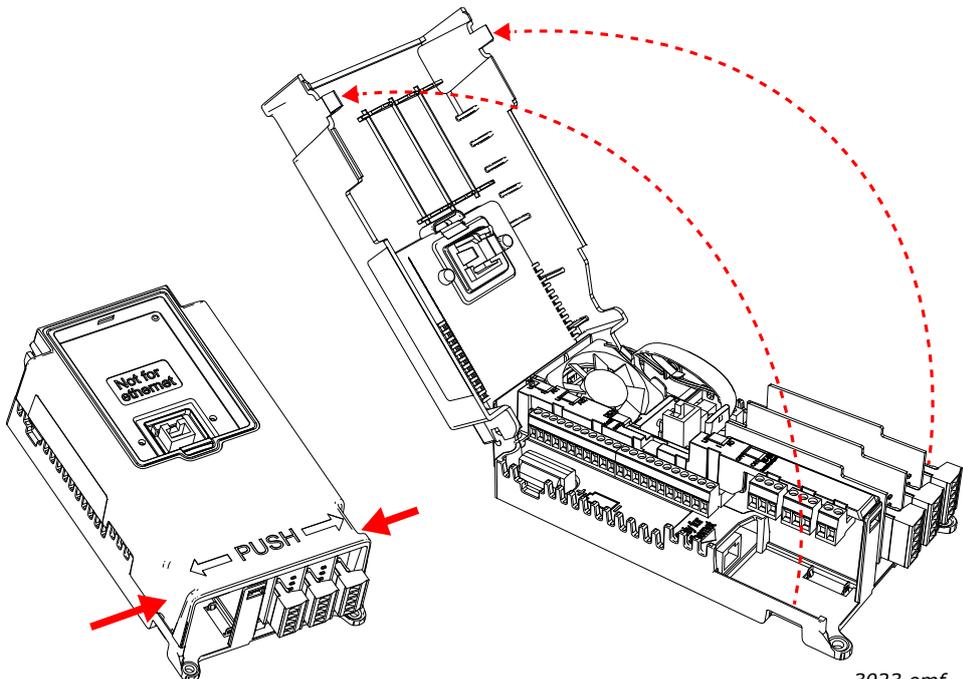
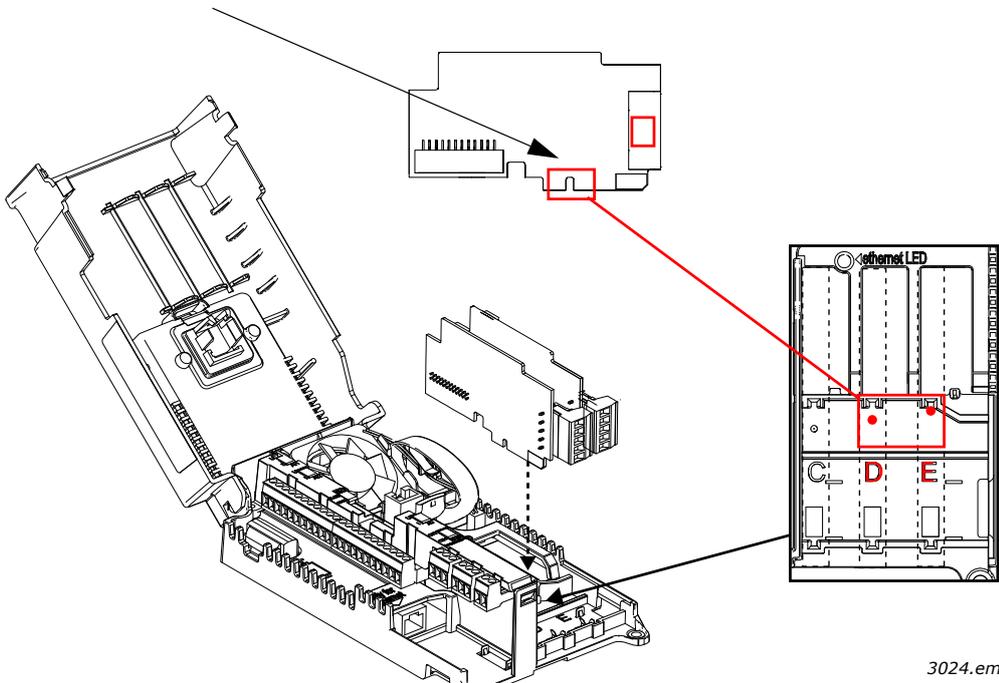
Cable shield is connected to PE through RC 
 Cable shield is connected directly to PE 
 Cable shield is not connected 

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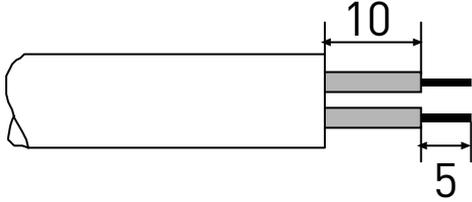
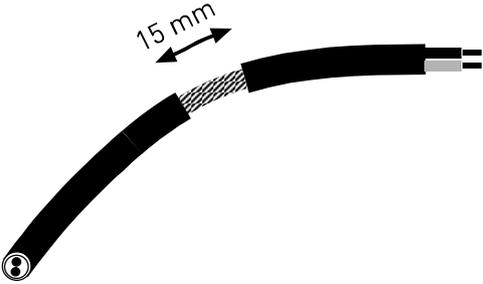
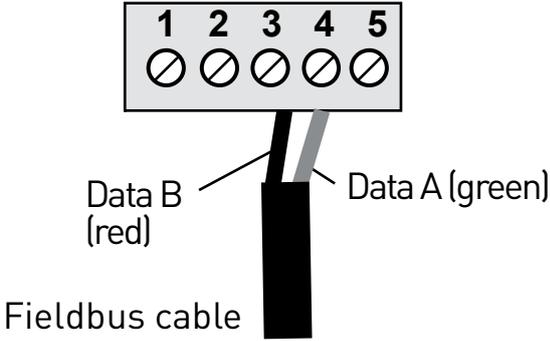
4.5 INSTALLATION IN VACON 100



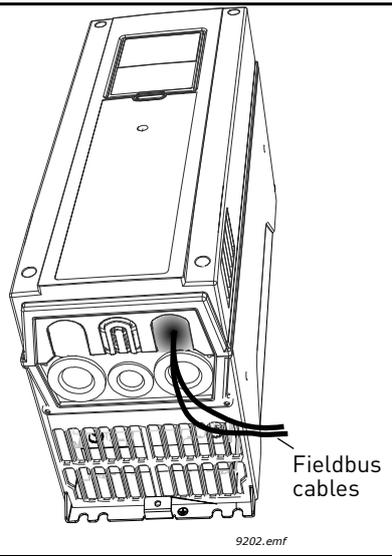
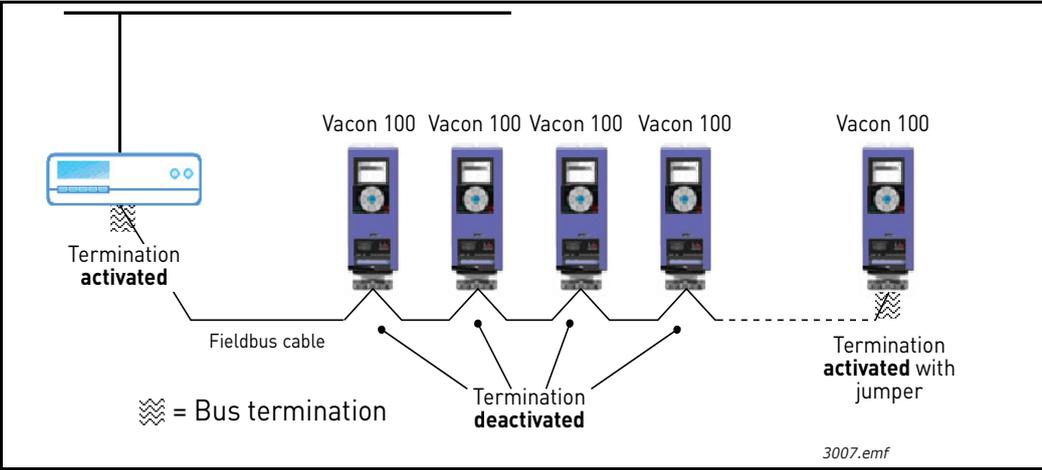
The relay outputs and other I/O-terminals may have a dangerous control voltage present even when Vacon 100 is disconnected from mains.

2	<p>Open the inner cover to reveal the option board slots (C,D,E). See Figure below.</p>  <p style="text-align: right;">3023.emf</p>
3	<p>Install the fieldbus board into slot D or E. See figure below.</p> <p>NOTE: OPTE3 can be installed to either slot D or E but OPTE5 board can only be used in slot E.</p> <p>NOTE: Incompatible boards cannot be installed on Vacon 100. Compatible boards have a <u>slot coding</u> that enable the placing of the board.</p>  <p style="text-align: right;">3024.emf</p>

4.6 PREPARE FOR USE THROUGH FIELDBUS

<p style="text-align: center; font-size: 2em; font-weight: bold;">4</p>	<p>Strip about 15 mm of the fieldbus cable (see specification in ch. 3.2) and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device).</p> <p>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 picture below.</p> <div style="text-align: center;">  </div> <p>Also strip the cable now at such a distance from the terminal that you can fix it to the frame with the grounding clamp. Strip the cable at a maximum length of 15 mm. Do not strip the aluminum cable shield!</p> <div style="text-align: center;">  </div>
<p style="text-align: center; font-size: 2em; font-weight: bold;">5</p>	<p>Then connect the cable to its appropriate terminals on PROFIBUS Option Board terminal block.</p> <div style="text-align: center;">  </div> <p style="text-align: right;"><i>3021.emf</i></p>

<h1>6</h1>	<p>Using the cable clamp included in the delivery of the drive, ground the shield of the PROFIBUS cable to the frame of the AC drive.</p> <p>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 shall be joint but not connected to several PE points with different potential.</p> <div data-bbox="491 472 1259 987" style="text-align: center;"> </div>
<h1>7</h1>	<p>If Vacon 100 is the last device on the bus, the bus termination must be set with jumper X13 (see ch. 4.4.)</p>
<h1>8</h1>	<p>Unless already done for the other control cables, cut free the opening on the AC drive cover for the fieldbus cable (protection class IP21).</p> <p>NOTE: Cut the opening on the same side you have installed the board in!</p> <div data-bbox="995 1111 1399 1684" style="text-align: center;"> </div>

<h1>9</h1>	<p>Remount the AC drive cover and run the cable as shown in picture.</p> <p>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 picture.</p>	
<h1>10</h1>	<p>The bus termination must be set for the first and the last device of the fieldbus line. See picture below. See also step 7 on page 15. We recommend that the first device on the bus and, thus, terminated was the Master device.</p> 	

5. COMMISSIONING

5.1 PROFIBUS DP BOARD PARAMETERS

Code	Parameter	Min	Max	Unit	Default	ID	Description
M5.x.3.1	Slave address	2	126		126		Address of the slave
M5.x.3.2	Operate mode	1	3		1		1 = Profidrive 2 = Bypass 3 = Echo

5.1.1 PARAMETER DESCRIPTIONS

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 and should not be used 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 OPTE5/3 (see figures below). The PROFIdrive mode uses telegrams specified in the profile specification. Bypass mode uses manufacturer-specific CW, SW & PD1-PD8. Echo mode echoes the data back to the fieldbus master.

PROFIdrive operating mode:

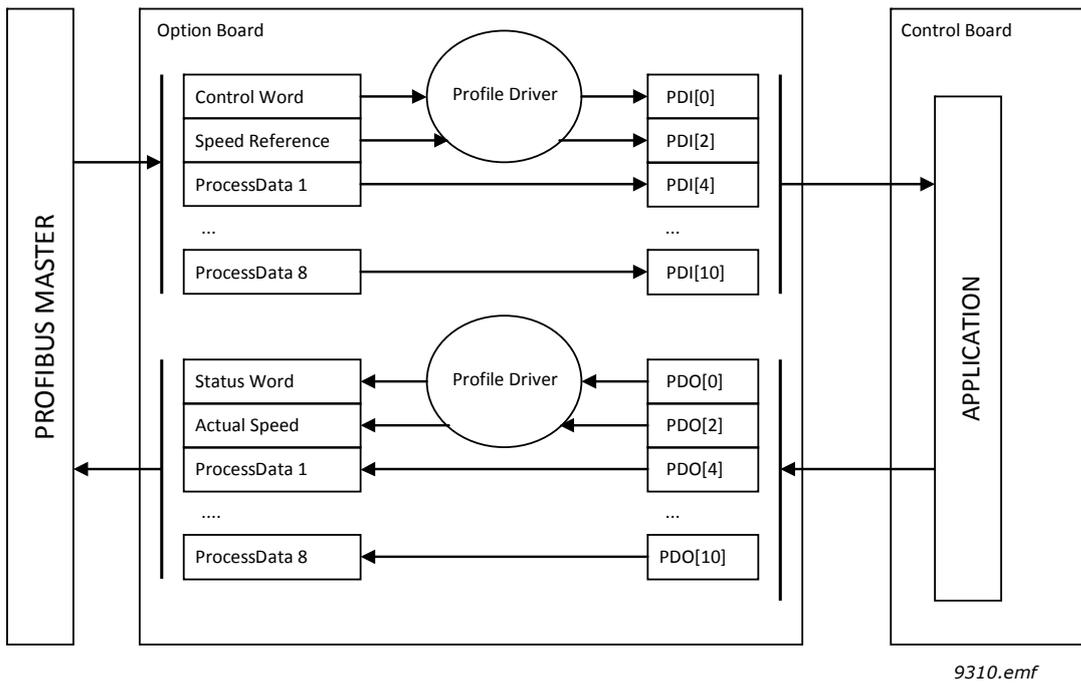


Figure 3. PROFIdrive operating mode. Data transfer follows the PROFIdrive profile

Bypass operating mode. The information of the process data field is transferred to the application without handling:

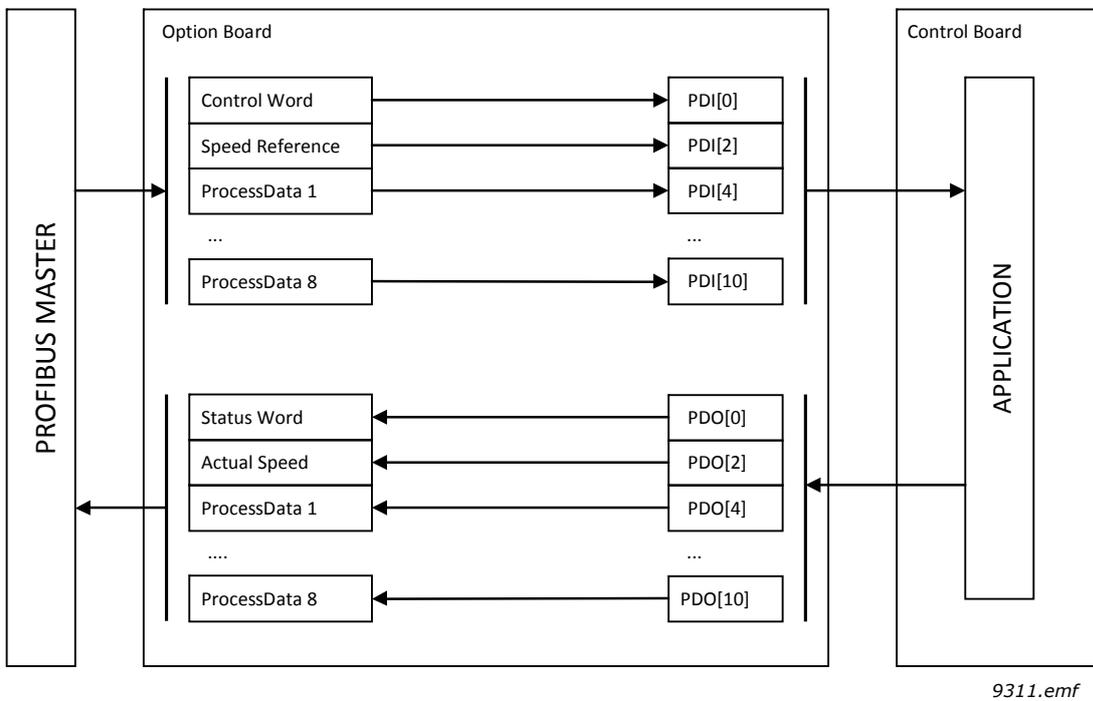
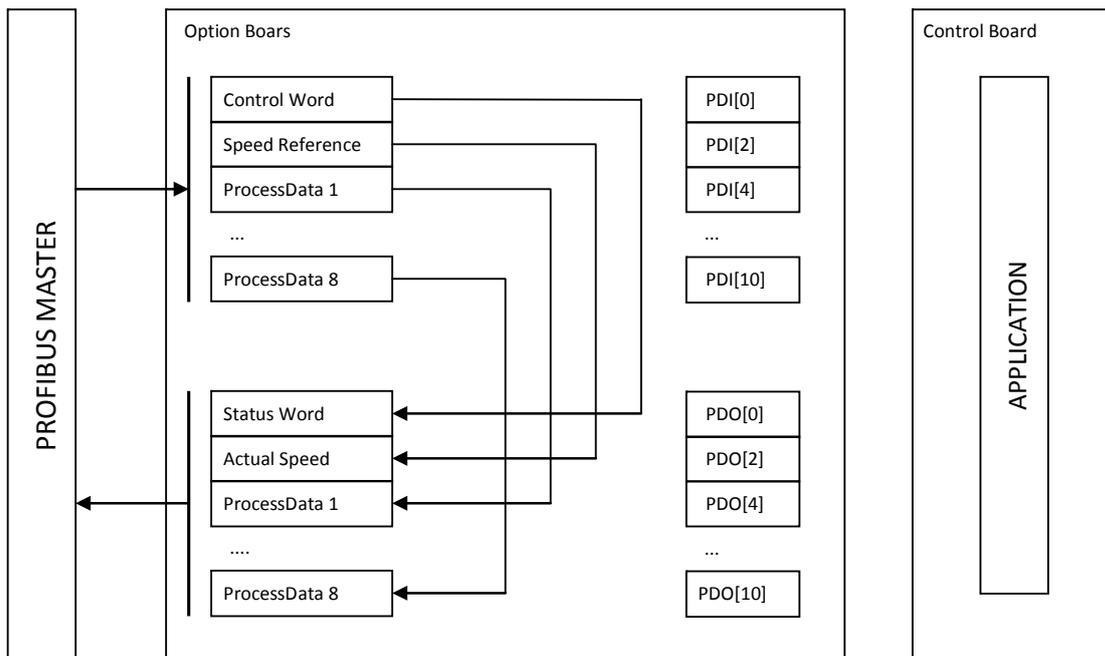


Figure 4. Bypass operating mode. This mode cannot be selected with the I/O configuration "Standard Telegram 20"

Echo operating mode. Received information is echoed back to Master (Output -> Input):



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Figure 5. Echo operating mode. This mode cannot be selected with the I/O configuration "Standard Telegram 20"

5.1.1.1 Local versus remote mode

In the GSD for OPTE3/5, 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 be in the physical vicinity of the drive to change using 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 OPTE3/5 board is remotely selected, its mode cannot be changed from the drive keypad

5.1.1.2 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.

6. PROFIBUS DP INTERFACE

Features of the PROFIBUS-Vacon interface:

- Direct control of Vacon 100 (e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to all Vacon 100 parameters
- Monitor Vacon 100 status (e.g. Output frequency, Output current, Fault code)

6.1 GENERAL

Data transfer between PROFIBUS DP master and 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 frequency converters is PROFIDRIVE.

The Vacon 100 frequency converter can be controlled by PROFIBUS DP Master using the PPO-types defined in Profidrive (see Chapter 6.3). When fieldbus has been selected as the frequency converter's active control place, the frequency converter's operation can be controlled from the PROFIBUS DP Master. Whether or not the active control place is fieldbus, the frequency converter can be monitored and its parameters set by the PROFIBUS DP Master.

Communication between PROFIBUS board and frequency converter can be split into two types, Process Data and Service Data.

Process Data In (PDI):

- For controlling frequency converter, max 10 words

Process Data Out (PDO):

- Is used for fast monitoring of the frequency converter, 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 below)

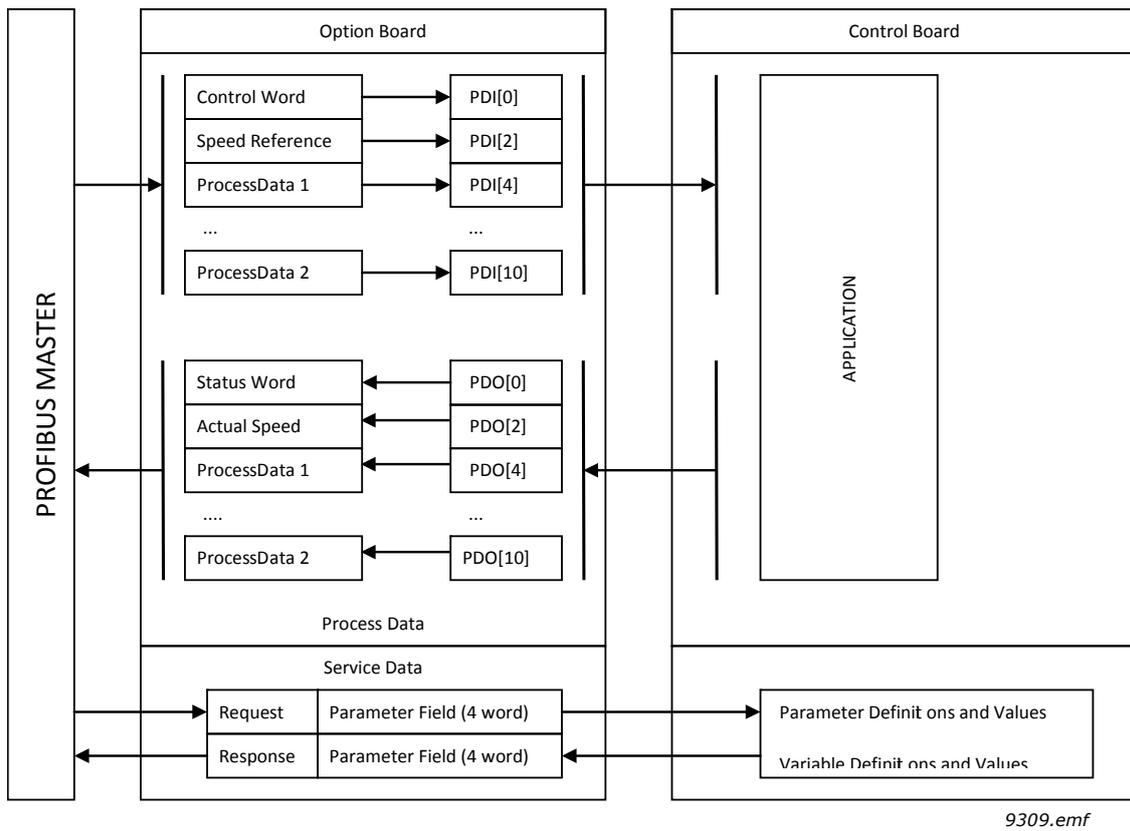


Figure 6. Data transfer between PROFIBUS master and Vacon 100

6.2 DATA MAPPING FOR PROFIDRIVE 4.1

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

6.2.1 PROFIDRIVE 4.1 STATE MACHINE

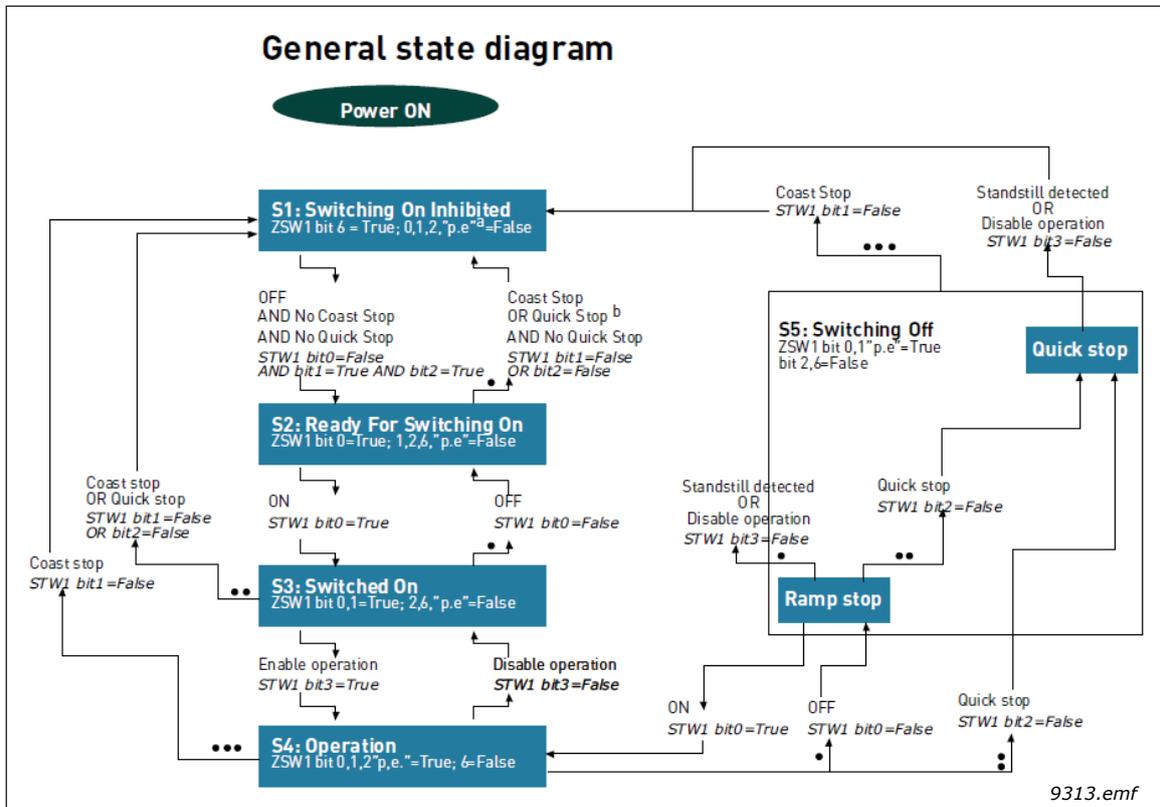


Figure 7. General state diagram

6.2.2 STANDARD TELEGRAMS

The PROFIDrive 4.1 profile specifies two telegrams used for communication; the Standard Telegram 1 and Standard Telegram 20.

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.

ST1	Bytes 1-2	Bytes 3-4
Master to slave	Control word (STW1)	Setpoint value
Slave to master	Status word (ZSW1)	Actual speed value

The OPTE5/OPTE3 option board supports three I/O data configurations using the Standard Telegram 1:

- Standard Telegram 1 only
- Standard Telegram 1 with four additional Process Data 16-bit words
- Standard Telegram 1 with eight additional Process Data 16-bit words

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.

ST20	Bytes 1-2	Bytes 3-4
Master to slave	Control word (STW1)	Setpoint value

Control word (STW1) modification in ST20.

The additional bits in the control word are presented in the table below.

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 OPTE3/5

ST20	Bytes 1-2	Bytes 3-4	Bytes 5-6	Bytes 7-8	Bytes 9-10	Bytes 11-12
Slave to master	Status word (ZSW1)	Actual speed value	Output current	Active current	Active power	Drive status/fault word

The value in the "Output Current" and "Active Current" fields is the filtered motor current, which is reported in percents of the value of PNU10116. The value in the "Active Power" field is the filtered motor power, which is reported in percents of the value of PNU10117. Please see the table below:

Field	Description	Unit	Reference
Output current	Filtered motor current	4000h = 100.00%	100%=PNU10116
Active current	Filtered motor current	4000h = 100.00%	100%=PNU10116
Active power	Filtered motor power	4000h = 100.00%	100%=PNU10117

Status word (ZSW1) modification in ST20.

The additional bits in the status word are presented in the table below:

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*
14	Positive Speed Direction	No Positive Speed Direction
15	Parameter Set 2 active*	Parameter Set 1 active

* This feature is not supported in OPTE3/5

Drive status/fault word in ST20.

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 OPTE5/3, a fault in the drive is indicated by setting bit 15. No other bits are currently controlled.

6.2.3 PROFIDRIVE CONTROL WORD (STW1)

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.

6.2.4 PROFIDRIVE STATUS WORD (ZSW₁)

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 OPTE3/5, 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.

6.2.5 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 6.2.7.

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

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	Standstill
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.

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.

6.2.6 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 6.2.7.

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

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.

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.

6.2.7 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 6.3 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.

6.2.8 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:

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:

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:

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:

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

6.2.9 CODING OF DATA SIGNALS

The following number coding is used for signals communicated in cyclic data exchange. Signal numbers 0-99 are specified in PROFIdrive 4.1, while numbers greater than or equal to 100 are device-specific:

Signal number	Signal description
0	Unassigned / no signal
1	Profile control word STW1
2	Profile status word ZSW1
3...4	Not used
5	Speed setpoint value
6	Speed actual value
7...50	Not used
51	Filtered output current
52	Filtered active current
53	Not used
54	Filtered active power
55...56	Not used
57	Filtered speed actual value
58	Drive status/fault word
59...99	Not used
100	Process Data Out word 1
101	Process Data Out word 2
...	...
107	Process Data Out word 8
110	Process Data In word 1
111	Process Data In word 2
...	...
117	Process Data In word 8
118	Non-profile control word
119	Non-profile status word
120	Non-profile speed setpoint value
121	Non-profile speed actual value

6.3 PARAMETER ACCESS IN PROFIDRIVE 4.1

6.3.1 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 the drive's parameters and the PROFdrive's parameters.

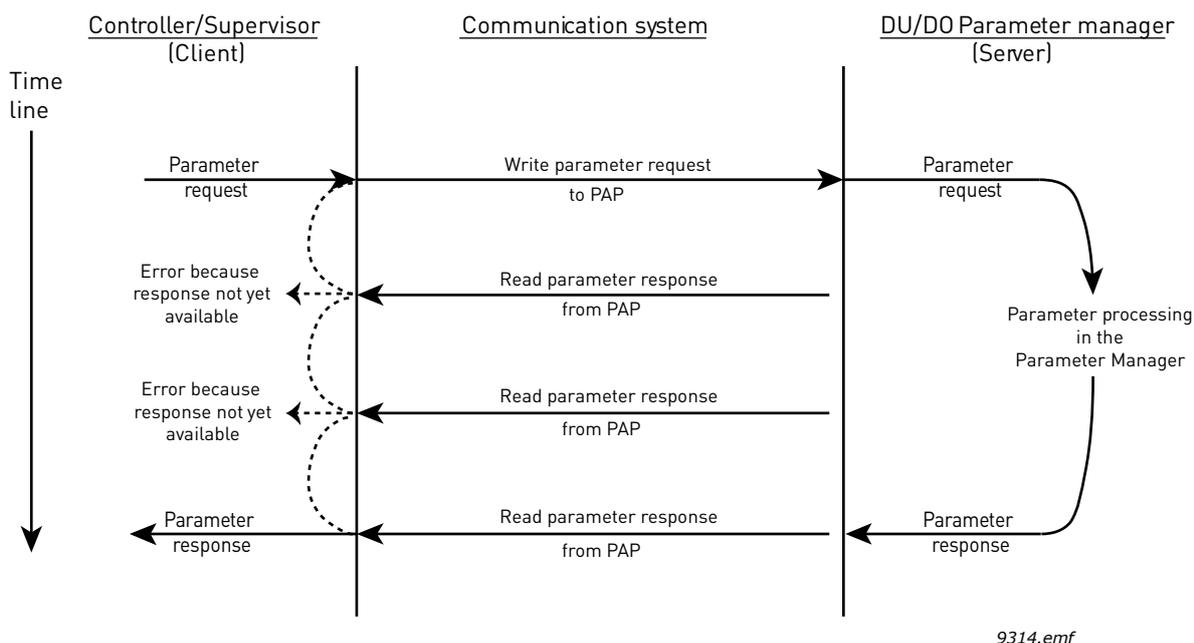


Figure 8. Data flow for Base Mode Parameter Access

The parameter response can only be read once per successful request. After this, the Parameter manager in the PROFdrive 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.

6.3.2 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)

DP-V1 header	Request header	Parameter address(es)	Parameter value(s)
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OPTE5/E3 supports a maximum of 240 octets of data, which includes the request header, parameter address(es) and parameter value(s).

6.3.2.1 DP-V1 header

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

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.

6.3.2.2 Request header

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

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.

6.3.2.3 Parameter address

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

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 6.3.4
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.

6.3.2.4 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.

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.

6.3.3 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.

DP-V1 header	Response header	Parameter value(s)
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6.3.3.1 DP-V1 header

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

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 OPT5/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.

6.3.3.2 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.

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 6.3.3.3.
4	Error Code 2	Application-specific.	Always 0 in PROFIdrive.

6.3.3.3 PROFIdrive 4.1 error classes and codes

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)		

6.3.3.4 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).

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
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

Error number	Meaning	When used
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.
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)	

6.3.3.5 Response header

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

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.	<p>Uses 0x01 for successful request parameter operation.</p> <p>Uses 0x02 for successful change parameter operation.</p> <p>Uses 0x80 to indicate that an invalid request ID was received.</p> <p>Uses 0x81 for unsuccessful request parameter operation.</p> <p>Uses 0x82 for unsuccessful change parameter operation.</p> <p>Other values are not used.</p>
3	Axis Number	Not used, should be set to 1 in OPT5/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.

6.3.3.6 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 35.

6.3.3.7 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:

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.

6.3.3.8 Identifier field

The identifier field consists of the following parts:

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.
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 OPTE3/5, 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.

6.3.3.9 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.

6.3.3.10 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 6.3.3.11 for more information.

6.3.3.11 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.

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:

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": $1200 \times 1,0 \text{ 1/minute} = 1200 \text{ 1/minute}$

Physical value in the base unit "1/sec": $1200 \times 1,0 \times (1/60) + 0 = 20 \text{ 1/second}$

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": $35 \times 1,0 = 35 \text{ (0.1 Ampere)}$

Physical value in the **base** unit "1 Ampere": $35 \times 1,0 \times 0,1 + 0 = 3,5 \text{ Ampere}$.

6.3.3.12 Name field

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

6.3.3.13 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.

6.3.3.14 ID extension field

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

6.3.3.15 Normalization reference parameter field

For parameters of 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 6.3.3.16).

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.

6.3.3.16 Normalization field

The normalization field contains the following information:

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.

6.3.4 EXAMPLE REQUESTS AND RESPONSES

6.3.4.1 Request parameter PNU918 value

The following information is used for this request:

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:

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:

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

6.3.4.2 Read response to request parameter PNU918

First the request in 6.3.4.1 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.

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

The response received from the device is:

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

This can be expanded into:

Field	Contents
Response reference	0x01
Response ID	0x01 = Request parameter (successful)
Axis Number	0x01
No. of Parameters	0x01
Format	0x42 = Word
No. of values	0x01
Value	0x0003

The node address used in the example was 3.

6.3.4.3 Request all elements of parameter PNU964

The following information is used for this request.

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:

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:

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

6.3.4.4 Read response to request parameter PNU964

A read request is sent to the slave as follows:

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

The response received from the device is:

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:

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
- 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

6.3.4.5 Requesting the value of an unsupported parameter PNU 900

The following information is used for this request:

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:

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:

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

6.3.4.6 Read response to request of unsupported parameter PNU900

A read request is sent to the slave as follows:

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

The response received from the device is:

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.

6.3.4.7 Requesting the value of drive parameter ID 103

Master write request:

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

Slave acknowledge:

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

Master read request:

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

Slave response:

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

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

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

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:

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

Master read request:

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

Slave response:

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

6.3.4.9 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):

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:

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

Master read request:

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

Slave response:

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.

6.3.5 SUPPORTED PARAMETERS

The following PROFIdrive parameters are supported by the OPTE5 / OPTE3 option board:

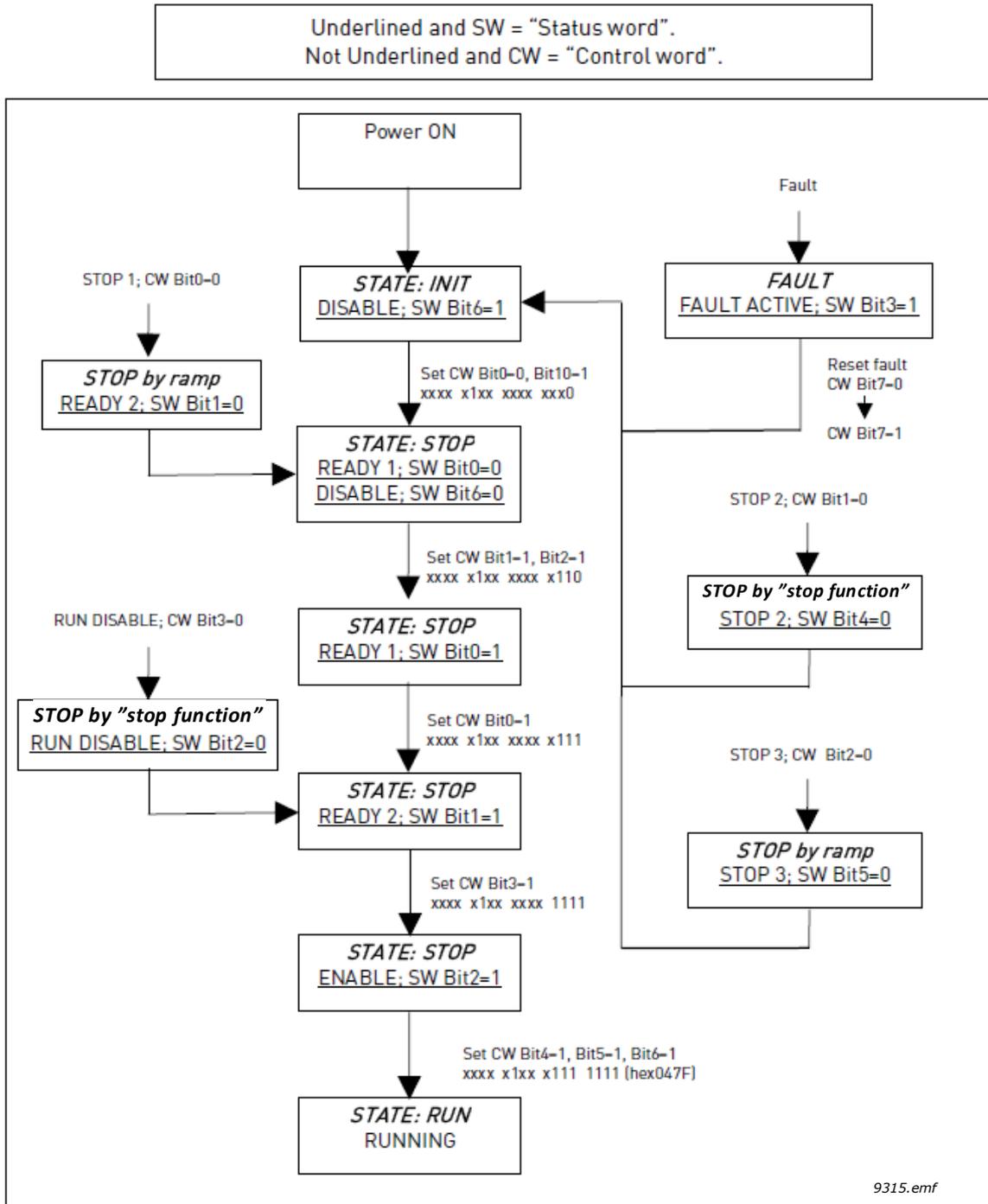
Par. number	Description	Data type
915	Selection for data in setpoint telegram	Array of unsigned 16-bit integers, 10 elements
916	Selection for data in actual value telegram	Array of unsigned 16-bit integers, 10 elements
918	PROFIBUS DP node address	Unsigned 16-bit integer
922	Telegram selection	Unsigned 16-bit integer
923	List of all parameters for signals	Array of unsigned 16-bit integers, 122 elements
930	Operating mode	Unsigned 16-bit integer
944	Fault message counter	Unsigned 16-bit integer
947	Fault number	Array of unsigned 16-bit integers, 8 elements
950	Scaling of the fault buffer	Array of unsigned 16-bit integers, 2 elements
963	PROFIBUS DP actual baud rate	Unsigned 16-bit integer
964	Drive Unit identification	Array of unsigned 16-bit integers, 6 elements
965	Profile identification number	Unsigned 16-bit integer
975	Drive Object identification	Array of unsigned 16-bit integers, 7 elements
980	Number list of defined parameters	Array of unsigned 16-bit integers, 38 elements
981...999	Number list of defined parameters	Arrays of unsigned 16-bit integers, 1 element in each
9900	Dummy writeable single parameter	Unsigned 16-bit integer
9901	Dummy writeable array parameter	Array of unsigned 16-bit integers, 8 elements
10001	Parameter in drive	Unsigned 16-bit integer
10100	Profile control word STW1	Unsigned 16-bit integer
10101	Speed setpoint	Signed 16-bit integer
10102	Profile status word ZSW1	Unsigned 16-bit integer
10103	Speed actual value	Signed 16-bit integer
10104	Filtered output current	Signed 16-bit integer
10105	Filtered active current	Signed 16-bit integer
10106	Filtered active power	Signed 16-bit integer
10107	Filtered speed actual value	Signed 16-bit integer
10108	Drive status/fault word	Unsigned 16-bit integer
10109	Process Data In words	Array of unsigned 16-bit integers, 8 elements
10110	Process Data Out words	Array of unsigned 16-bit integers, 8 elements
10111	Speed physical reference value	Unsigned 16-bit integer
10112	Non-profile control word	Unsigned 16-bit integer
10113	Non-profile status word	Unsigned 16-bit integer
10114	Non-profile speed setpoint value	Unsigned 16-bit integer
10115	Non-profile speed actual value	Unsigned 16-bit integer
10116	Current physical reference value	Unsigned 16-bit integer
10117	Power physical reference value	Unsigned 16-bit integer
10118	Clear fault history	Unsigned 16-bit integer

6.4 DATA MAPPING FOR 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 profile uses control and status words which are very similar to those in PROFIdrive 4.1 (see chapter 6.2).

6.4.1 STATE MACHINE FOR PROFIDRIVE 2.0



6.4.2 PPO TYPES

PP01 contains a parameter field (PKW) for performing parameter access, as well as control/status word and setpoint/actual value fields.

PP02 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.

PP03 contains control/status word and setpoint/actual value fields.

PP04 contains control/status word and setpoint/actual value fields, as well as four Process Data words.

PP05 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.

PP06 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:

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

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

6.5 PARAMETER ACCESS IN PROFIDRIVE 2.0

6.5.1 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 using DP-V1 with PROFIdrive 2.0 configuration please see chapter 6.3.

When using PP01, PP02 or PP05, 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.

6.5.2 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)

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 shall repeat its response until it receives a new request from the master.

6.5.2.1 ID Subfield

The ID subfield consists of three subsections:

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:

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:

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

6.5.2.2 Index subfield

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

6.5.2.3 Value subfield

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

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.

6.5.3 EXAMPLES

6.5.3.1 Reading maximum frequency (ID=102)

The master sends the following PKW request:

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:

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:

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:

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)

6.5.3.2 Writing control place (ID=125)

The master sends the following PKW request:

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:

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:

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:

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

6.6 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 below definitions are used.

6.6.1 BYPASS CONTROL WORD

Bits	Description	
	Value = 1	Value = 0
0	Run request	Stop request
1	Reverse direction	Forward direction
2	Acknowledge fault (0 -> 1)	No action
3	Stop by coasting*	Use stop function parameter
4	Stop by ramping*	Use stop function parameter
5	Short ramp time	Normal ramp time
6	Freeze setpoint	Unfreeze setpoint
7	Force setpoint to zero	
8	Force fieldbus control	Do not force fieldbus control
9	Force fieldbus reference	Do not force fieldbus reference
10-11	Not used	
12	Perform quick stop	No action
13-15	Not used	

* Effective only when a stop request is active, i.e. bit 0 = 0.

6.6.2 BYPASS STATUS WORD

Bits	Description	
	Value = 1	Value = 0
0	Drive is ready	Drive is not ready
1	Drive is running	Drive is not running
2	Counterclockwise rotation	Clockwise rotation
3	Fault present	No faults present
4	Not used	
5	Running at reference	Not running at reference
6	Zero speed	Non-zero speed
7*	Motor is magnetized	Motor not magnetized
8-15	Not used or application-specific	

*Not available in MMX.

6.6.3 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.

6.7 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.

Master-to-slave		Slave to master field
PKW request*	-->	PKW response*
Control word	-->	Status word
Setpoint value	-->	Actual speed value
Process Data 1...8*	-->	Process Data 1...8*

* If present in the selected I/O configuration.

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