VACON®
AC DRIVES

# DEVICENET OPTION BOARD OPTE7 USER MANUAL
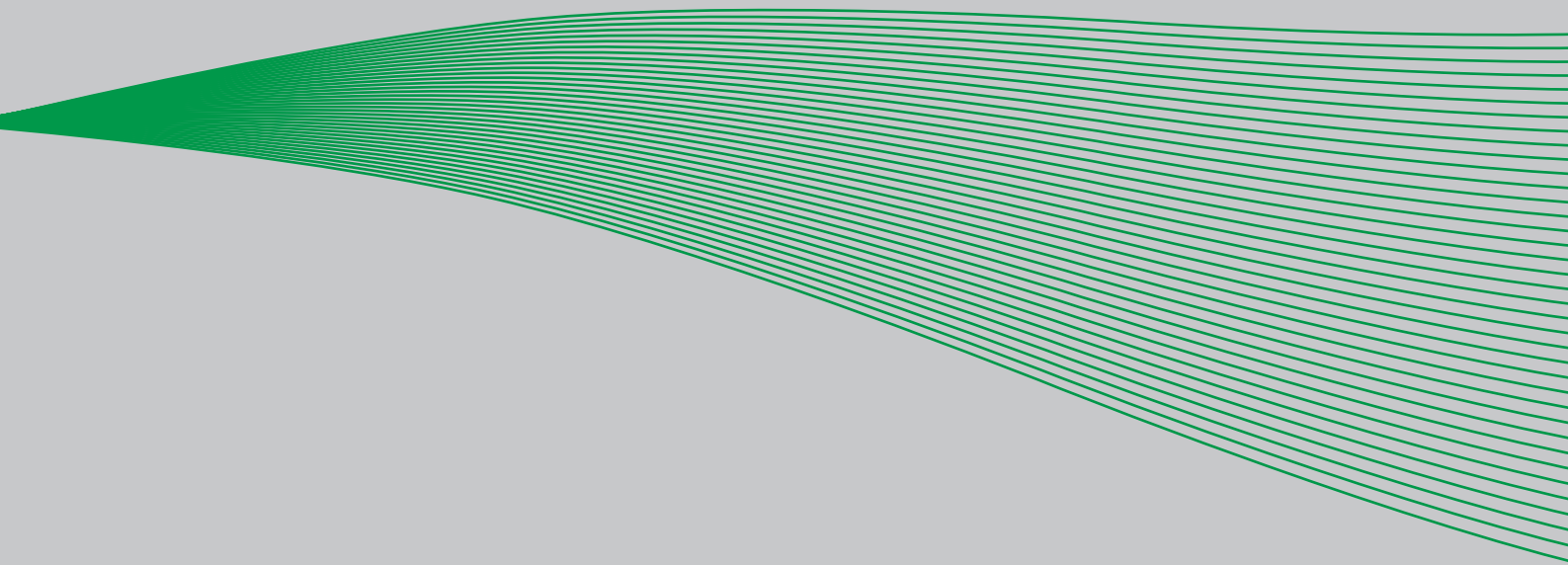
VACON®
DRIVEN BY DRIVES

# TABLE OF CONTENTS

# 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.

**Please 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 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 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 mm$^2$ Cu or 16 mm$^2$ Al, through its total run.

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

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

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

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

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

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

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

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**NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from  www.vacon.com/downloads.**

**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 www.vacon.com/downloads.**

# 2.    DeviceNet option board OPTE7 - General

## 2.1    Overview

OPTE7 is a DeviceNet option board for Vacon AC drives. It allows the AC drive to be controlled using the DeviceNet protocol. The option board implements the AC Drive device profile as defined by CIP.

The OPTE7 option board connects a drive into the DeviceNet network. There can be 64 nodes in one network. The baud rate is up to 500 kbit/s. The DeviceNet master can control and monitor the drives.
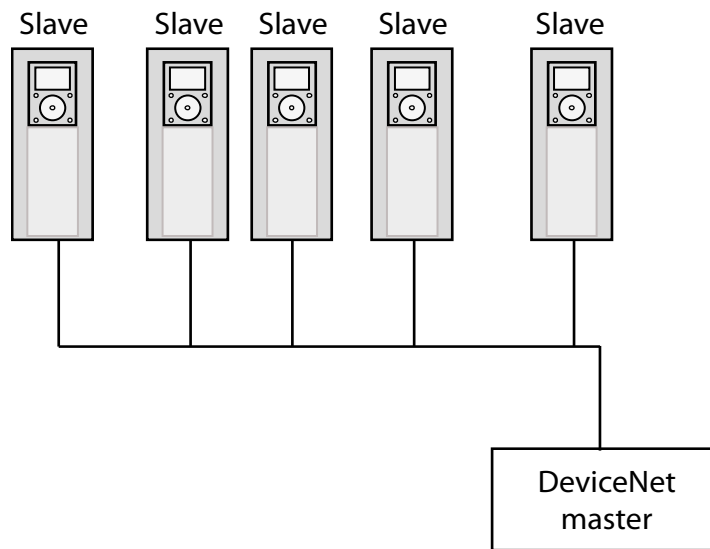


*9391.emf*

*Figure 1. Typical DeviceNet network structure*

### 2.1.1    DeviceNet physical layer and media

The basic trunkline-dropline topology provides separate twisted pair busses for both signal and power distribution. Thick or thin cable can be used for either trunklines or droplines. End-to-end network distance varies with data rate and cable size.

Devices can be powered directly from the bus and communicate with each other using the same cable. Nodes can be removed from or inserted to the network without powering down the network.

Power taps can be added at any point in the network which makes redundant power supplies possible. The trunkline current rating is 8 amperes. An opto-isolated design option allows externally powered devices (e.g. AC drive's starters and solenoid valves) to share the same bus cable. Other CAN-based networks allow only a single power supply (if at all) for the entire network.
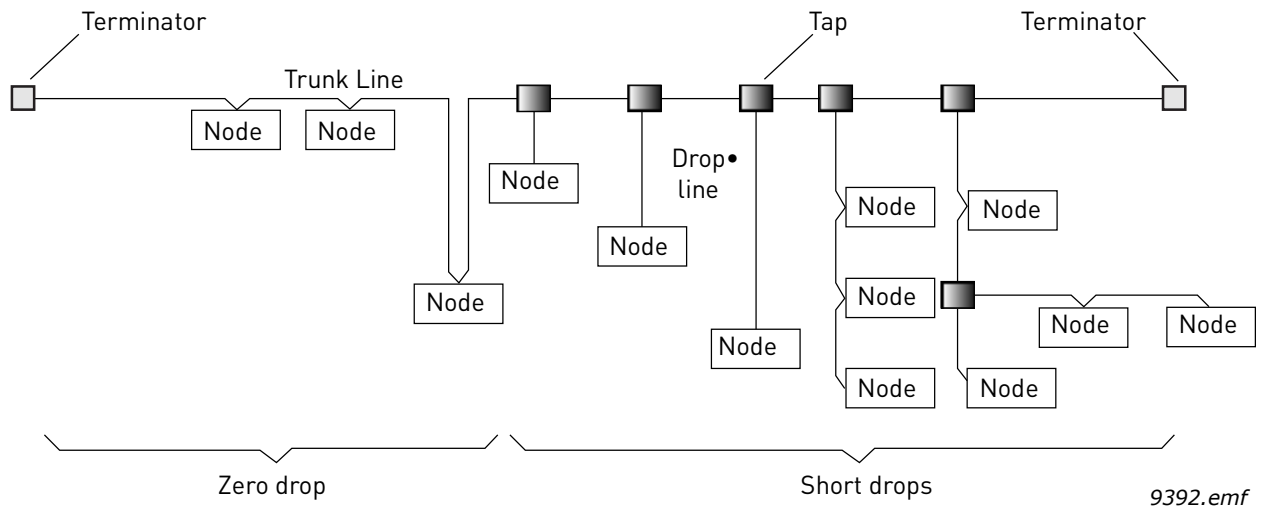
Figure 2. Thick or thin cable for either trunklines or droplines

## 2.2    DeviceNet protocol description

DeviceNet is a communication protocol that is managed by the ODVA (Open DeviceNet Vendors Association). It uses CAN (Controller Area Network) as the backbone technology and at the higher level it implements CIP (Common Industrial Protocol). CIP is used by the following protocols:

- DeviceNet
- EtherNet/IP
- ControlNet
- CompoNet

CIP ensures high integrity/interoperability between all of these, especially from the end user perspective. CIP is object-oriented. It defines objects with its attributes and supported services. The objects can have multiple instances. Instance zero indicates object's class itself. Depending on the implemented profile, some objects are mandatory and have to be implemented. Additionally, each vendor can implement vendor-specific objects.

The following objects are implemented by the OPTE7 option board:

*Table 2.*

|  | Class | Object |
|---|---|---|
| **Required by DeviceNet** | 0x01 | Identity |
|  | 0x02 | Message Router |
|  | 0x03 | DeviceNet |
|  | 0x04 | Assembly |
|  | 0x05 | DeviceNet Connection |
| **Required by Drive Profile** | 0x28 | Motor Data |
|  | 0x29 | Control Supervisor |
|  | 0x2A | AC/DC Drive |
| **Vendor-Specific** | 0xA0 | Vendor Parameter |

*Table 3.*

| | |
|---|---|
| **Physical / Data link layer** | CAN - Controller Area Network |
| **Application layer** | CIP - Common Industrial Protocol |
| **Profiles** | AC/DC Drives |
| **Configuration file** | EDS - Electronic Data Sheet |
| **Baud rates** | 125 kbit/s, 250 kbit/s, and 500 kbit/s |
| **Bus length** | Trunk length is inversely proportional to the speed, i.e. 500, 250 and 100 meters respectively |
| **Max nodes** | 64 |

### 2.2.1    EDS (Electronic Data Sheet) file

EDS is a configuration file that describes the capabilities of the DeviceNet node. It can be used by the configuration tool to simplify the process of commissioning. EDS is actually a simple text file that follows the rules specified by the ODVA in the DeviceNet specification. Therefore, it could be opened and viewed with a simple text editor e.g. Notepad.

The EDS file for the OPTE7 option board can be downloaded from www.vacon.com.

# 3.    DeviceNet option board OPTE7 - technical data

## 3.1    General

*Table 4. Technical data of OPTE7 option board*

| | | |
|---|---|---|
| **CAN bus electrical isolation** | 500 VDC | |
| **Ambient temperature** | As specified in drive specification (-10°C...40°C) | |
| **Storing temperature** | As specified in drive specification (-40°C...70°C) | |
| **Humidity** | 0-95%, non-condensing, corrosive | |
| **Vibration and electrical safety** | EN 61800-5-1 (2007)<br>5-15.8 Hz        1mm (peak)<br>15.8-150 Hz      1 G | |
| **Emission** | C2 level, EN 61800-3 (2004) | |
| **Immunity** | C2 level, EN 61800-3 (2004) | |
| **CAN Interface** | Isolation | 2500 V rms isolation with a less than 10-ns propagation delay |
| | Protection | ±8kV ESD IEC 61000-4-2 Contact Discharge<br>±80V Fault Protection<br>greater than ±12V common Mode Range |

## 3.2    CAN cable

The recommended cables for installation are 4-wire twisted and shielded cables with an impedance of 120 Ohm. The network topology is a 2-wire bus line that is terminated at both ends by resistors representing the characteristic impedance of the bus line. The typical CAN cable impedance is 120 Ohm, so you must use termination resistors of ~120 Ohm. For long networks, use a higher resistor value (150-300 Ohm).

*Table 5. Bus parameter relation to cable length*

| Cable length | Max bit rate [kbit/s] |
|---|---|
| 100 m | 500 |
| 250 m | 250 |
| 500 m | 120 |

### 3.2.1    Recommended cable

For all DeviceNet installations the use of 4-wire cable is recommended.

Vacon recommends the following cable:

- UNITRONIC® BUS CAN FD P, colour-coded in accordance with DIN 47100.



*Figure 3.  Recommended cable*

*Table 6. Cable thickness, length and baud rate relation*

| Bit rate | Min cable thickness [mm$^2$] | | |
|---|---|---|---|
| 500 kbit/s | 0.34 | | |
| 250 kbit/s | 0.34 | 0.6 | |
| 125 kbit/s | 0.34 | 0.6 | 0.6 |
| **Cable length [m]** | 100 | 250 | 500 |

# 4.    OPTE7 LAYOUT AND CONNECTIONS

## 4.1    Layout and connections

OPTE7 has two different hardware revisions with slightly different layouts. The layout is different in the LED arrangement and the termination resistor orientation.

The two hardware revisions are marked with different product codes, and this product code can be seen in the sticker on the top side of the option board (see the location in Figure 6).

The two hardware revisions are 70CVB01817 and 70CVB01555.
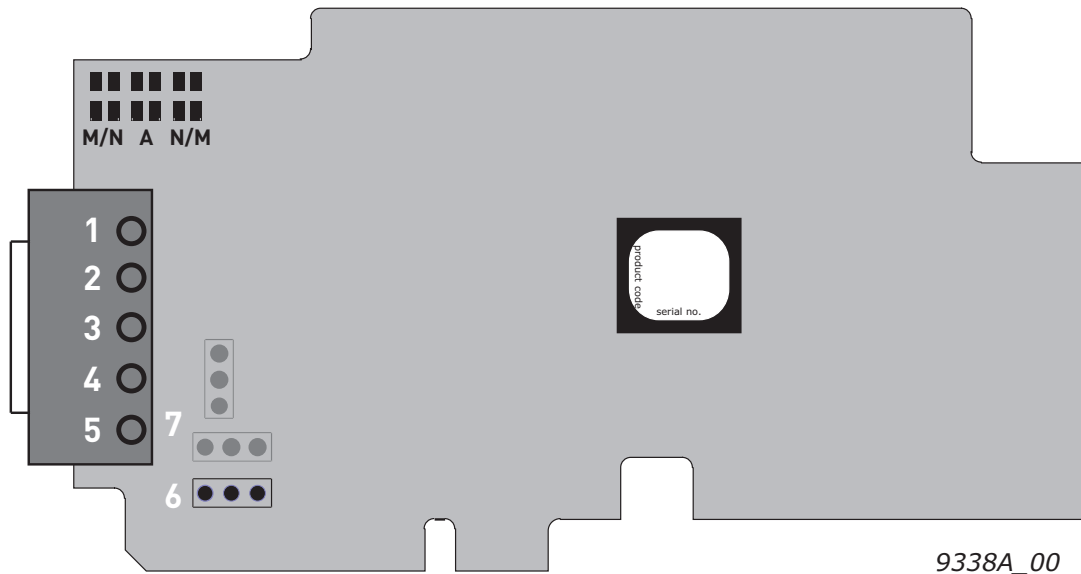


*Figure 4.  OPTE7 board layout*

1 = V- (GND)
2 = CAN L
3 = SHIELD (shield connector)
4 = CAN H
5 = V+ (24V)
6 = Cable shield grounding option
7 = CAN bus termination jumper



*Figure 5.  CAN connector*

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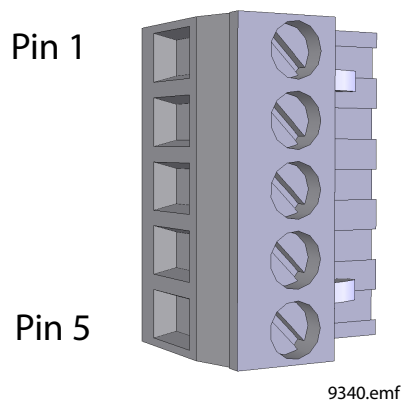
*Table 7. CAN connector pinout*

| Pin | Description |
|-----|-------------|
| 1 | V-, isolated digital ground |
| 2 | CAN LO |
| 3 | Shield connector |
| 4 | CAN HI |
| 5 | V+ (24V), communication power supply |

## 4.2    LED Indications

The DeviceNet option board includes two LED status indicators next to the connector: network status (N), and module status (M).
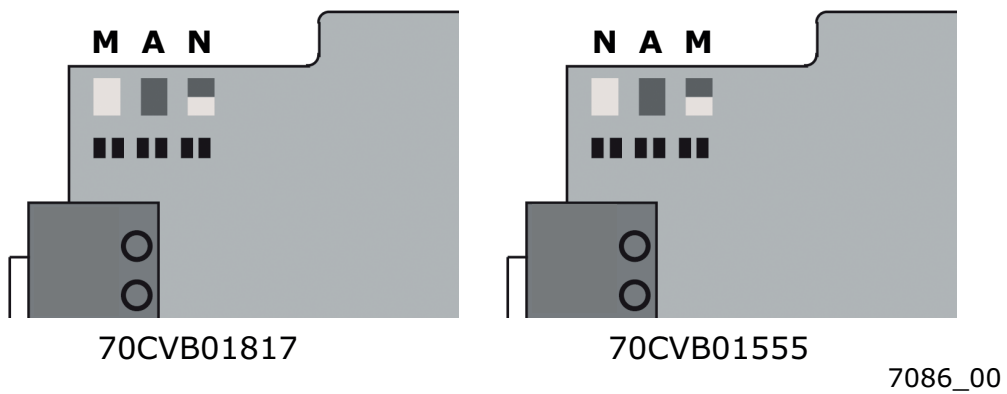


*Figure 6. OPTE7 LED indicators*

The network status provides information on the network connection status, and the module status provides information on the DeviceNet module.

*Table 8. Module status led*

| LED status | Description |
|---|---|
| OFF | No power is supplied to the drive. |
| Green | OPTE7 is operating normally. |
| Flashing green | OPTE7 is in the Standby state, or the device needs commissioning due to missing, incomplete or incorrect configuration. |
| Flashing red | The OPTE7 has detected a Recoverable Fault. |
| Red | The OPTE7 has detected an Unrecoverable Fault. |

*Table 9. Network status led*

| LED status | Description |
|---|---|
| OFF | OPTE7 is not online.<br><br>• The device has not completed the Dup_MAC_ID test yet.<br>• If the Module Status LED is off, the device is not powered. |
| Flashing green | The OPTE7 has passed the Dup_MAC_ID test, is online, but is not allocated to a master. |
| Green | The OPTE7 is online and allocated to a master. |
| Flashing red | One or more I/O connections are in the Timed–Out state. |
| Red | The OPTE7 cannot communicate on the network (Duplicate MAC ID, or Bus–off). |

### 4.3    Jumpers

The termination resistor jumper location differs on used hardware version. The jumper locations can be seen from figure below.
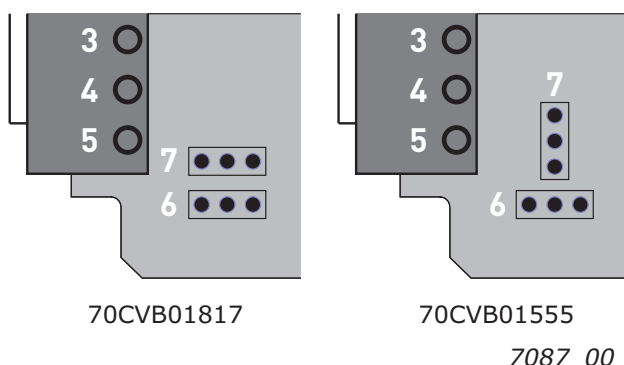


*Figure 7.  Jumper locations*

The jumper settings for the CAN bus termination resistor are shown in the figure below.
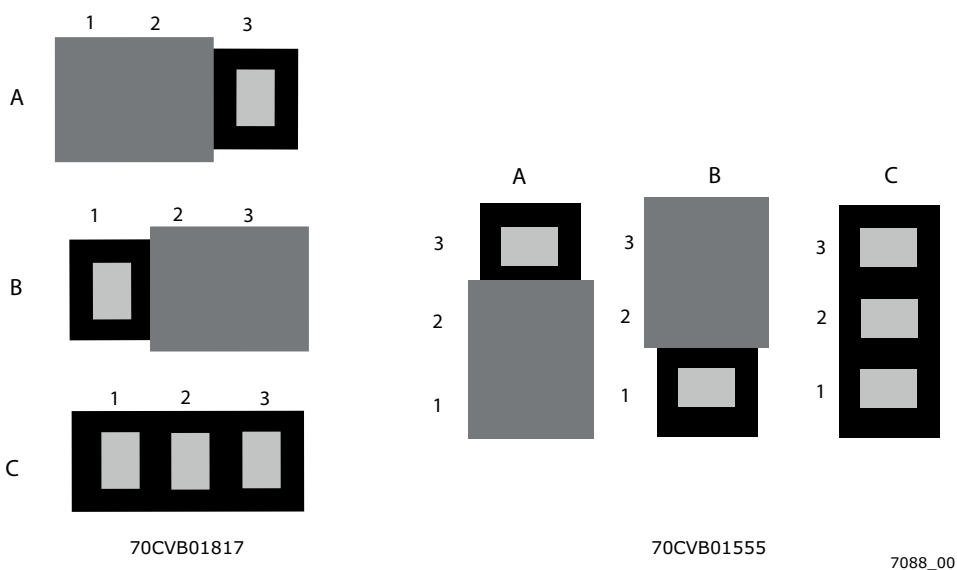


*Figure 8. Termination resistor settings*

A = Termination resistor 120 Ohm connected

B = Termination resistor is not connected to the CAN bus. (Factory default setting)

C = Termination resistor is not connected to the CAN bus

The jumper settings for the CAN cable shield grounding are shown in the following figure.
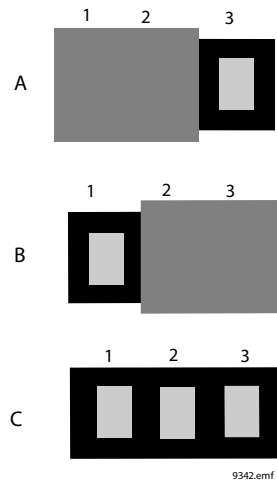
*Figure 9. Cable shield grounding option*

A = CAN connector pin 3 (shield) connected to the drive chassis with a high-impedance RC circuit. Recommended option when equipotential bonding is poor.

B = CAN connector pin 3 (shield) connected directly into the drive chassis. Recommended option when equipotential bonding is good. (Factory default setting).

C = CAN connector pin 3 is unconnected.

# 5. INSTALLATION

## 5.1 INSTALLATION IN VACON® 100
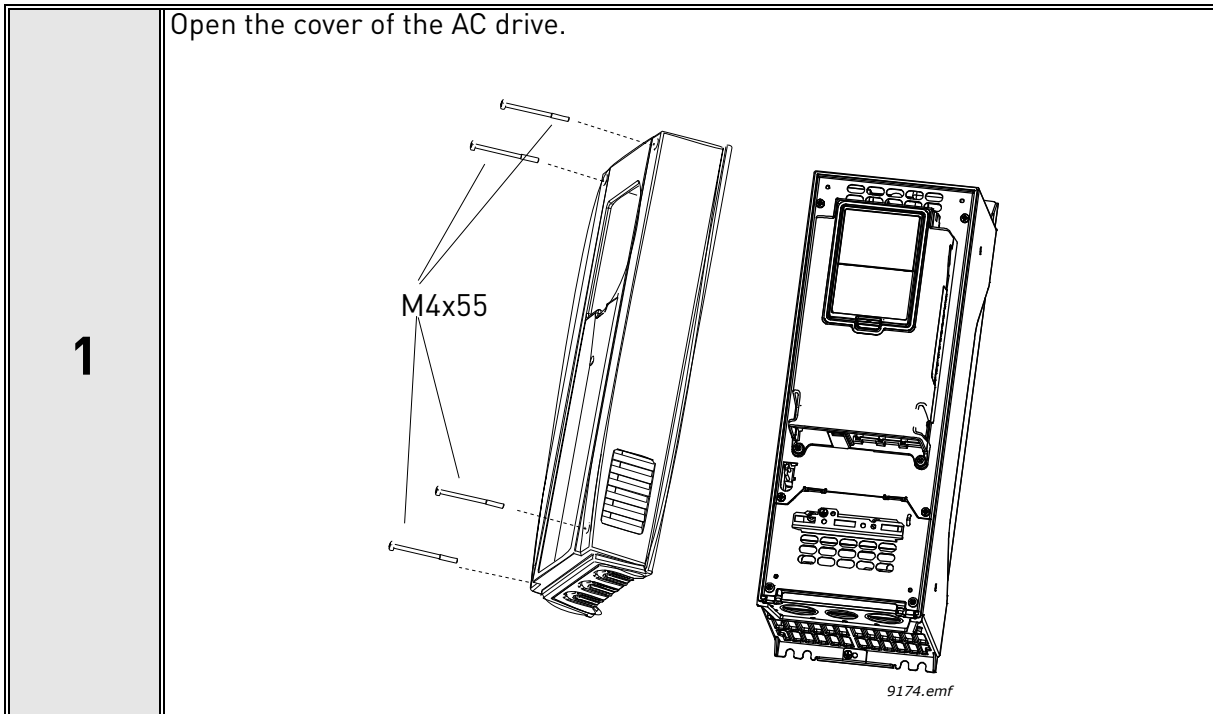
| | |
|---|---|
| **1** | Open the cover of the AC drive.<br><br>M4x55<br><br>*9174.emf* |

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

| | |
|---|---|
| **2** | Open the inner cover to reveal the option board slots **(C,D,E)**.<br><br><br>*3023.emf* |
| **3** | Install the fieldbus board into slot **D** or **E**.<br>**NOTE!** Incompatible boards cannot be installed on the drive. Compatible boards have a <u>slot coding</u> that enable the placing of the board.<br><br><br>*3024.emf* |
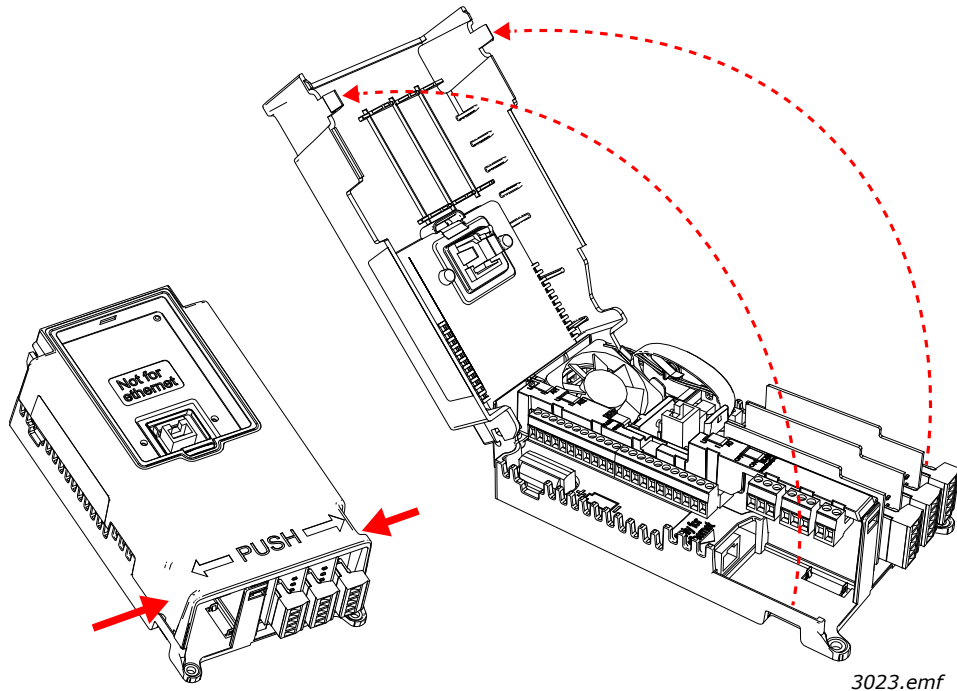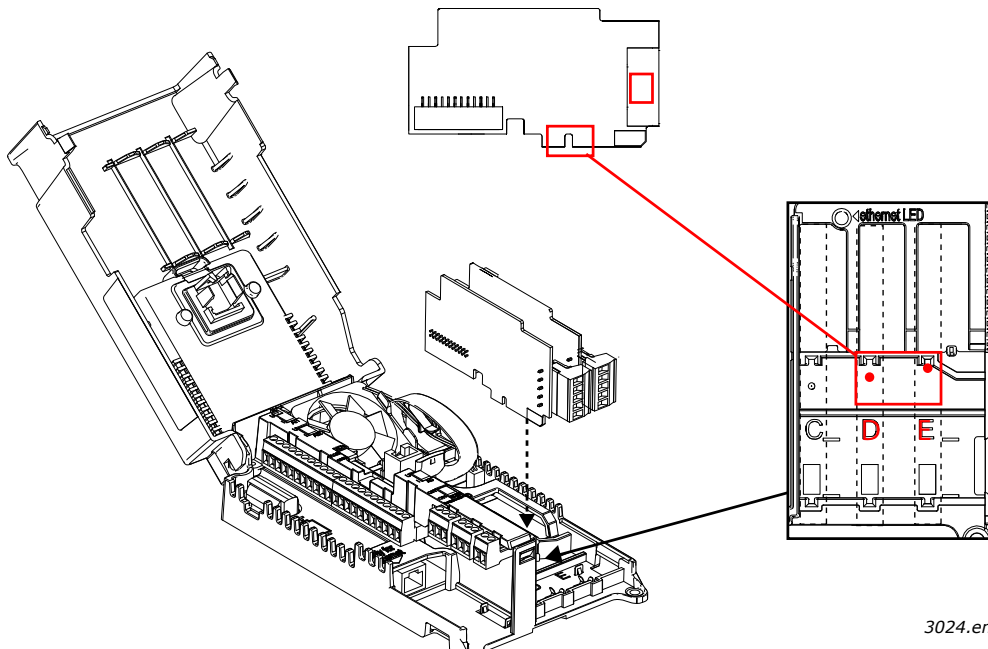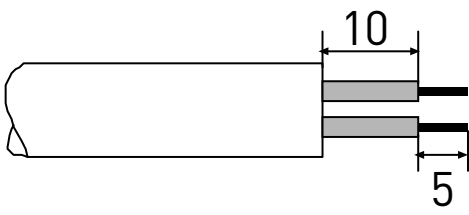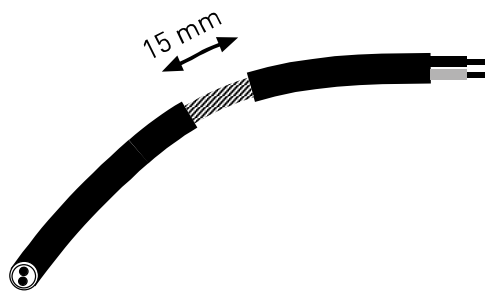
## 5.2 Prepare for use through fieldbus

| | |
|---|---|
| **4** | Strip about 15 mm of the fieldbus cable 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.<br><br>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!** |
| **5** | Then connect the cable to its appropriate terminals on the OPTE7 DeviceNet option board terminal  block. |

| | |
|---|---|
| **6** | Using the cable clamp included in the delivery of the drive, ground the shield of the CAN cable to the frame of the AC drive.<br>**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.<br><br>Cable clamp |
| **7** | **If the AC drive is  the last device on the bus**, the bus termination must be set with jumper X13. |
| **8** | Unless already done for the other control cables, cut free the opening on the AC drive cover for the fieldbus cable (protection class IP21).<br>**NOTE!** Cut the opening on the same side you have installed the board in!<br><br> |

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| | |
|---|---|
| **9** | Remount the AC drive cover and run the cable as shown in picture. <br> **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. <br><br> Fieldbus cables <br> *9202.emf* |
| **10** | The bus termination must be set for the first and the last device of the fieldbus line. See also step 7 on page 19. We recommend that the first device on the bus and, thus, terminated was the master device. <br><br> Vacon 100 Vacon 100 Vacon 100 Vacon 100       Vacon 100 <br><br> Termination **activated** <br> Fieldbus cable <br> ▨ = Bus termination <br> Termination **deactivated** <br> Termination **activated** with jumper <br> *3007.emf* |
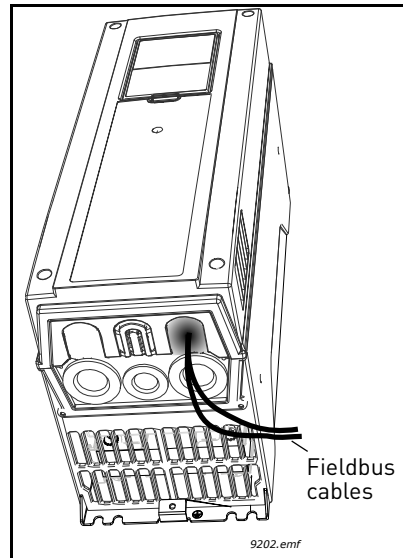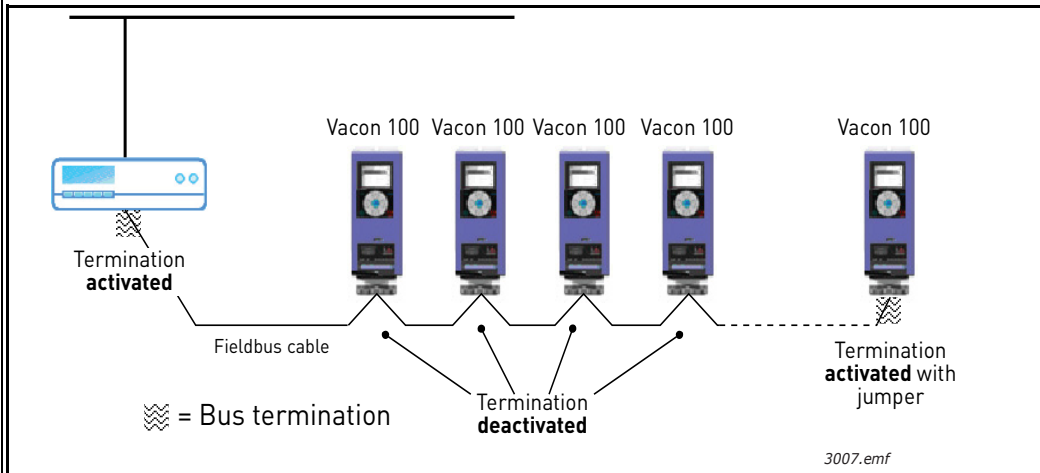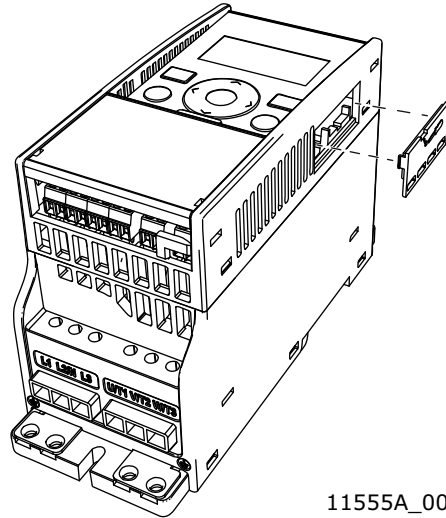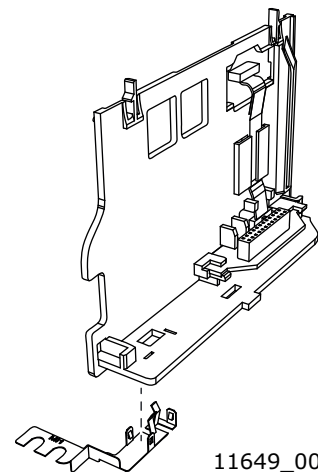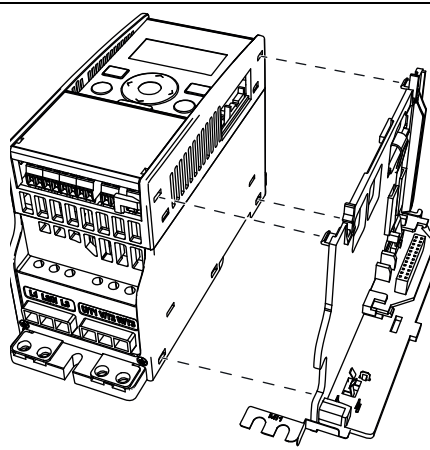
## 5.3    Installation in Vacon® 20

### 5.3.1    Frames MI1, MI2, MI3

| | |
|---|---|
| **1** | Remove the cable connector lid from the AC drive.<br><br>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 frame size.<br><br>11649_00 |
| **3** | Attach an option board mounting frame to the drive.<br><br>11556A_0( |

| 4 | Connect the flat cable from the option board mounting frame to the drive.<br><br><br><br>11557A_00 |
|---|---|
| 5 | If a cable strain relief is required, attach the parts as shown in the figure.<br><br><br><br>11558A_00 |

| 6 | Install the option board to the option board holder. Make sure that the option board is securely fastened. <br><br> 11550A_00 |
|---|---|
| 7 | Cut free a sufficiently wide opening for the option board connector. <br><br> 11650_00 |
| 8 | Attach the option board cover to the drive. Attach the strain relief cable clamp with screws if needed. <br><br> 11560A_00 |
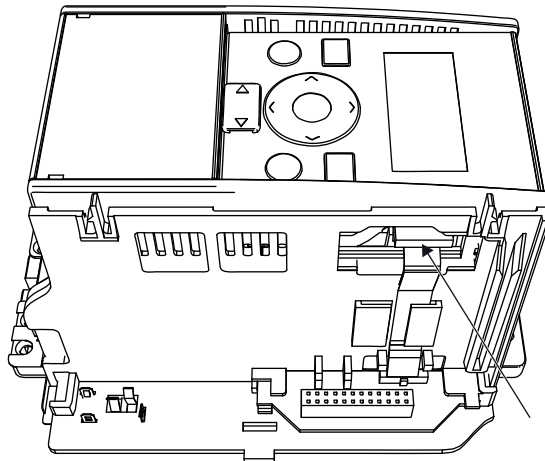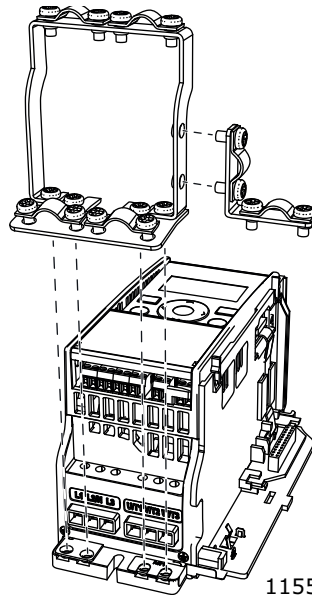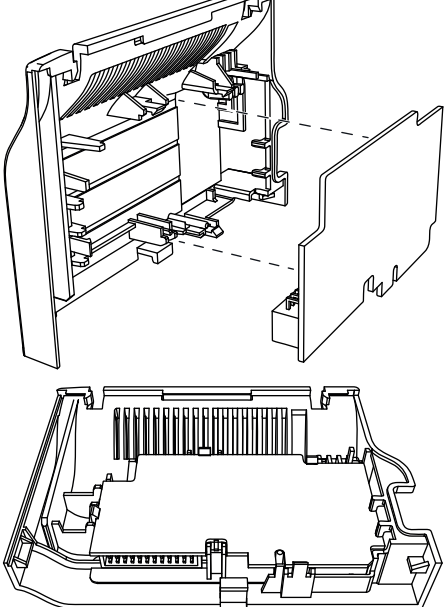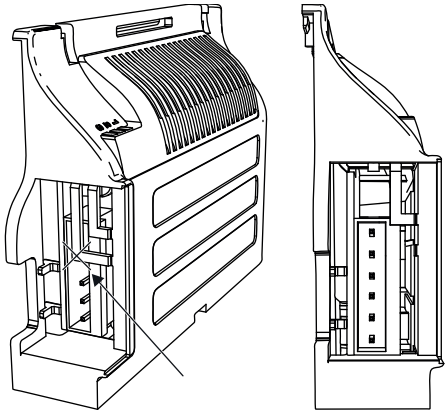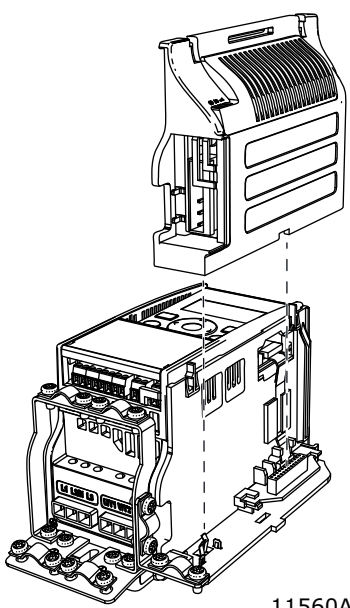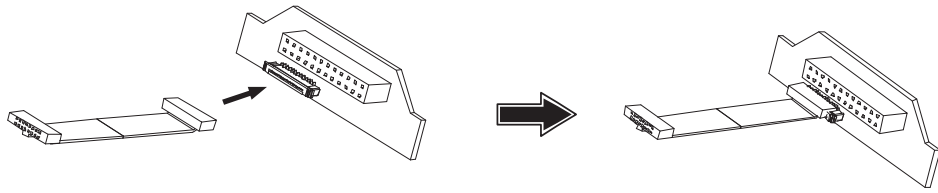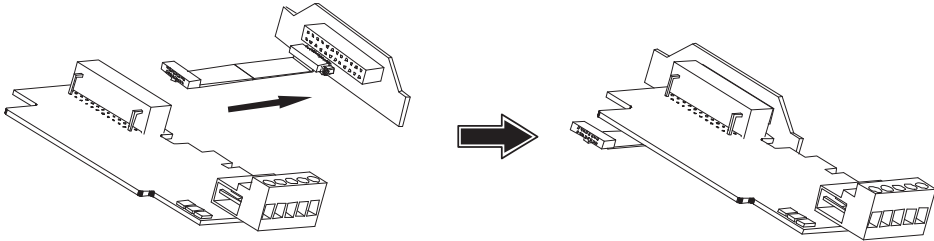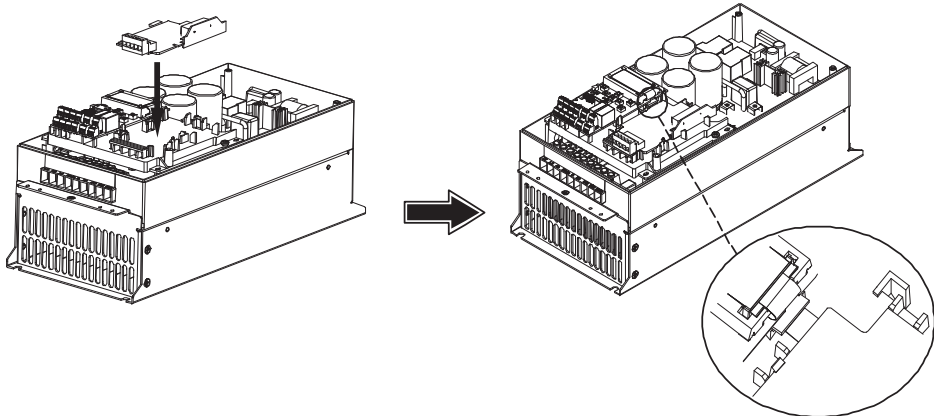
### 5.3.2    Frames MI4, MI5

| ⚠ | Make sure power is disconnected before opening the cover of the 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 drive and connect the flex cable.  *11566_00* |

| 6 | Attach a suitable grounding plate to the drive. The grounding plate is marked with supported frame size.<br><br>*11567_00* |
|---|---|
| 7 | Assemble a clamp on top of the grounding plate on both sides of the option board.<br><br>*11568_00* |

| 8 | 8a: For MI4: Close the cover.<br><br><br>*11569_00*<br><br>8b: For MI5: Remount the fan connector and close the cover.<br><br><br>*11570_00* |
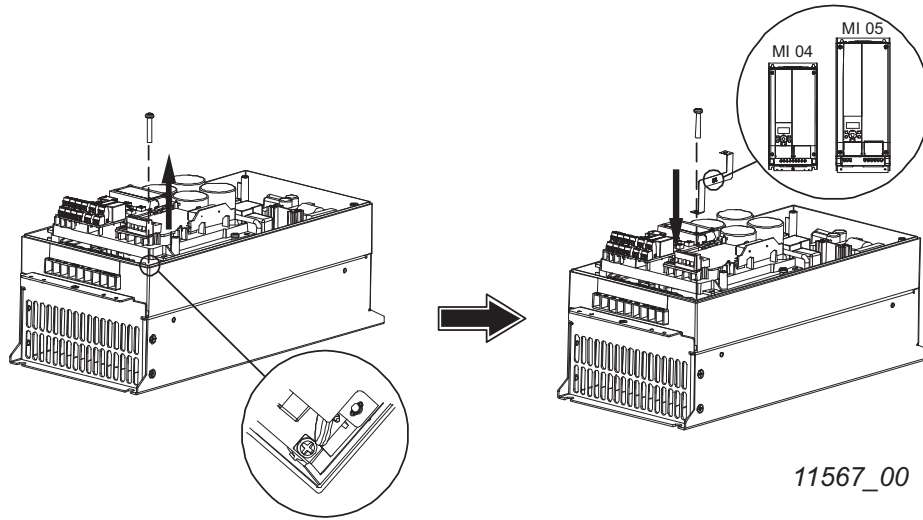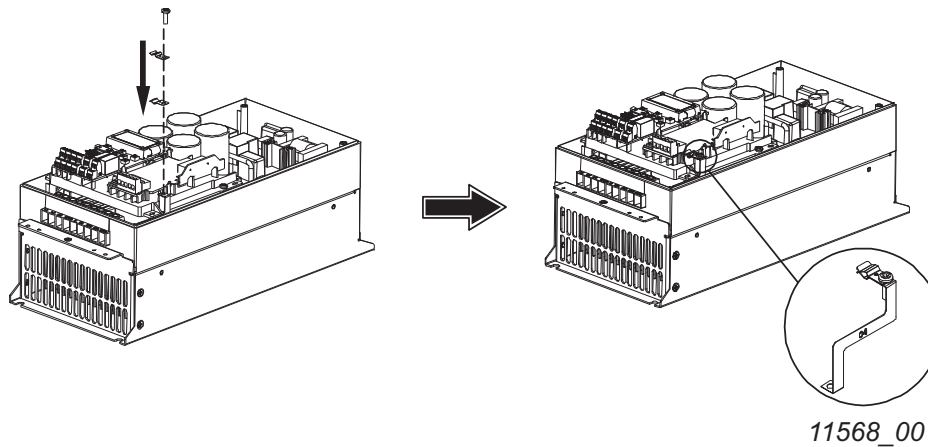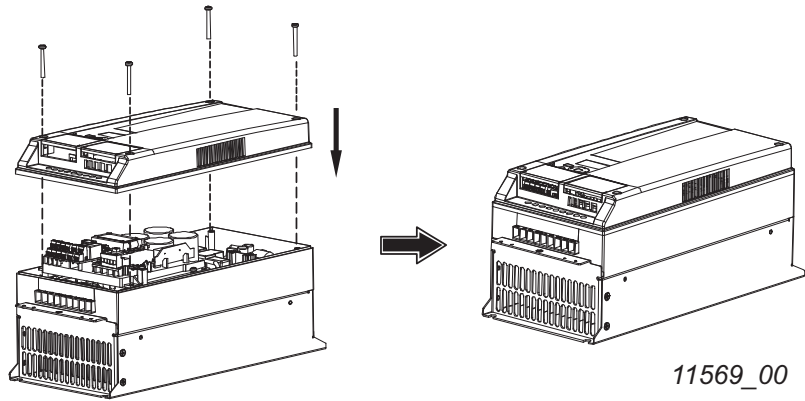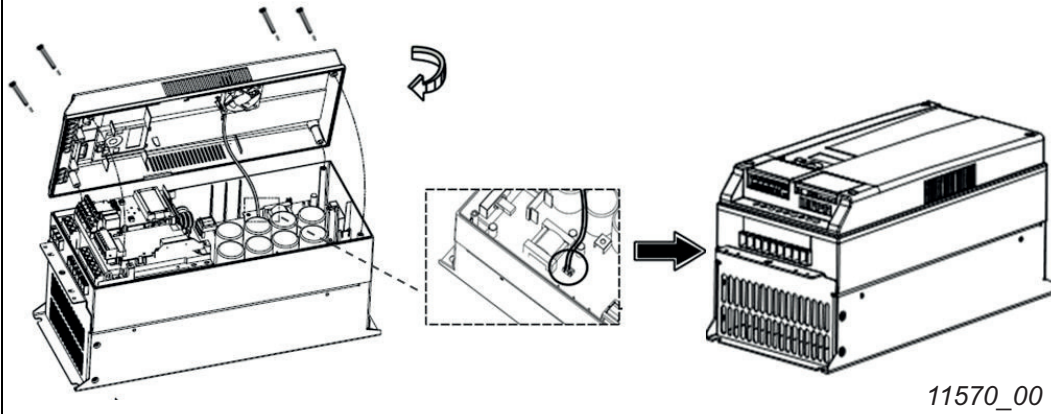
### 5.4    INSTALLATION IN VACON® 20 X AND 20 CP

> ⚠️ Do not add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.
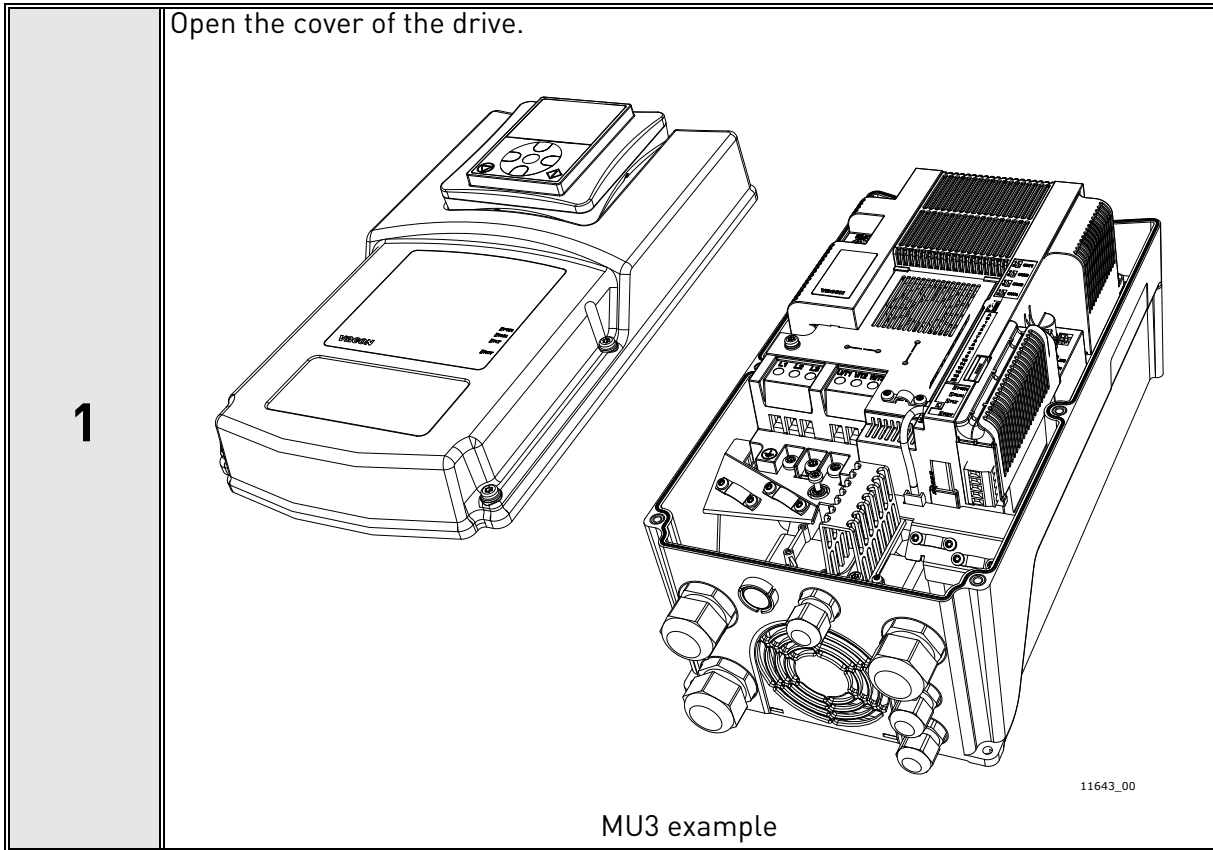
| | |
|---|---|
| **1** | Open the cover of the drive.<br><br>11643_00<br><br>MU3 example |

> ⚠️ 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*
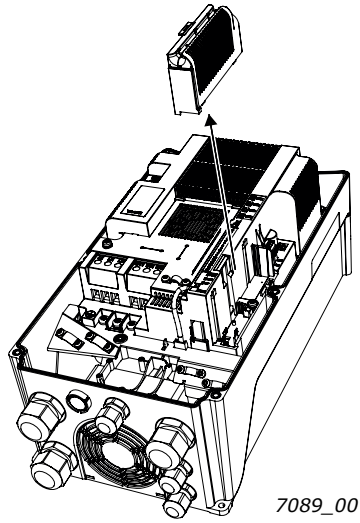
| 3 | Install the option board into the slot as shown in the figure. |
|---|---|

*7090_00*
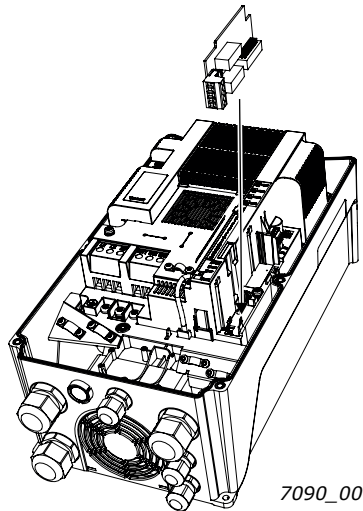
| 4 | Mount the option slot cover. Remove the plastic opening for the option board terminals.<br><br>7091_00 |
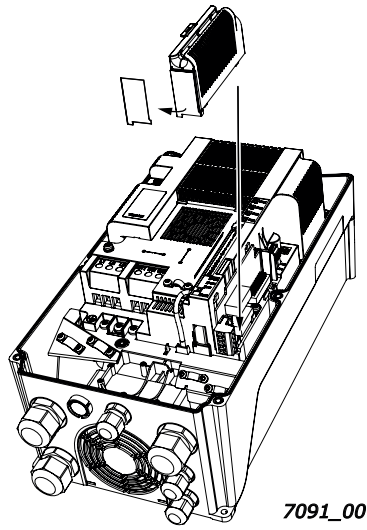
## 5.5    INSTALLATION IN VACON® 100 X (FRAMES MM4-MM6)
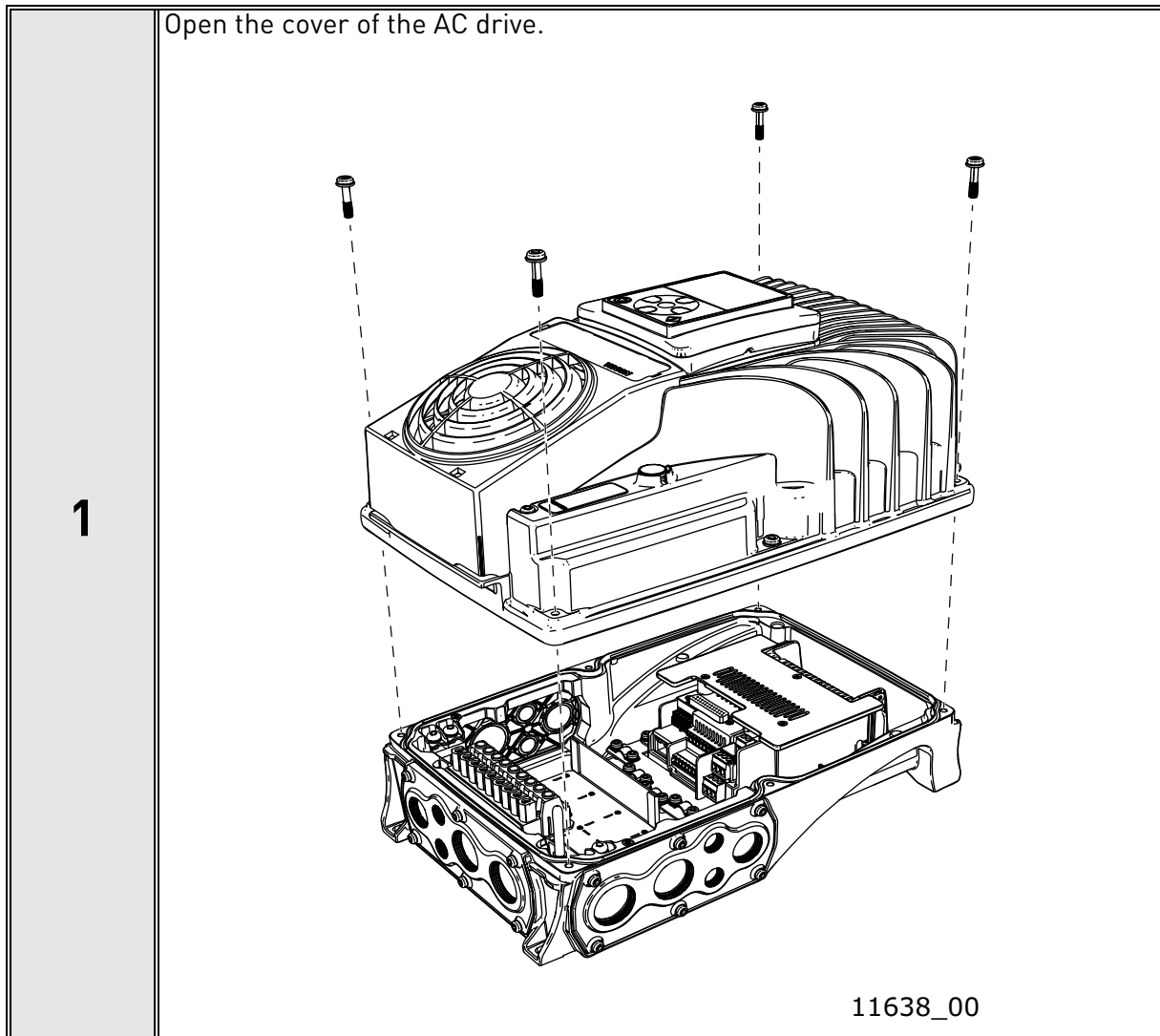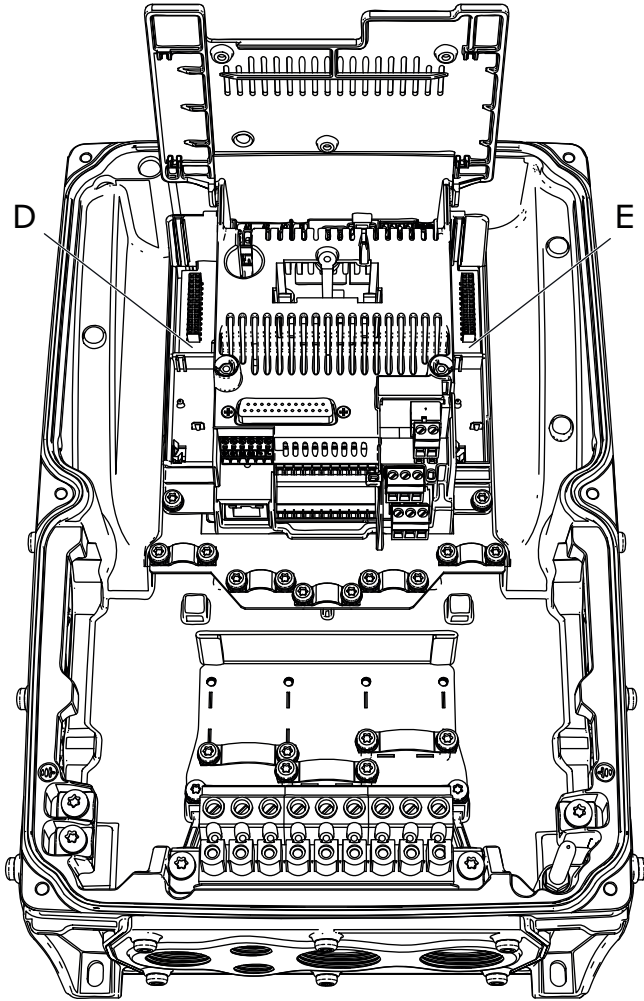
| | |
|---|---|
| **1** | Open the cover of the AC drive.<br><br><br><br>11638_00 |

| 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.<br><br><br><br>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.<br><br>**NOTE!** The cable entry plate at the bottom of the drive is used only for mains and motor cables.<br><br>11641_00 |
| **6** | Open the necessary holes in the cable entry plate. Do not open the other holes. See the Vacon® 100X 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.<br><br>**NOTE!** The fieldbus cable must go through the correct cable entry plate to avoid going near the motor cable.<br><br>11642_00 |
| **8** | Put the cable entry plate back. |
| **9** | Close the cover of the AC drive. |
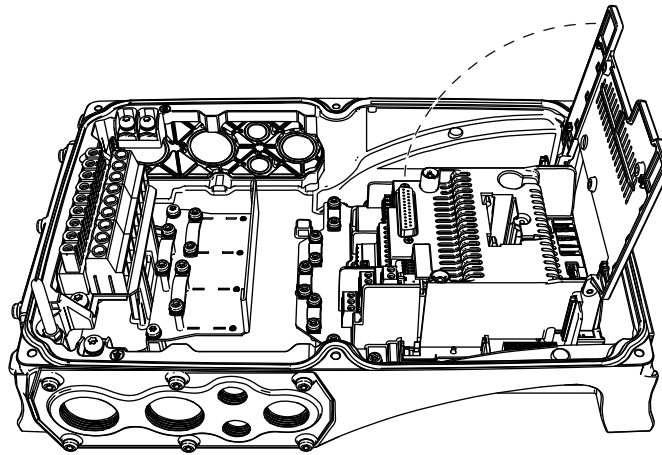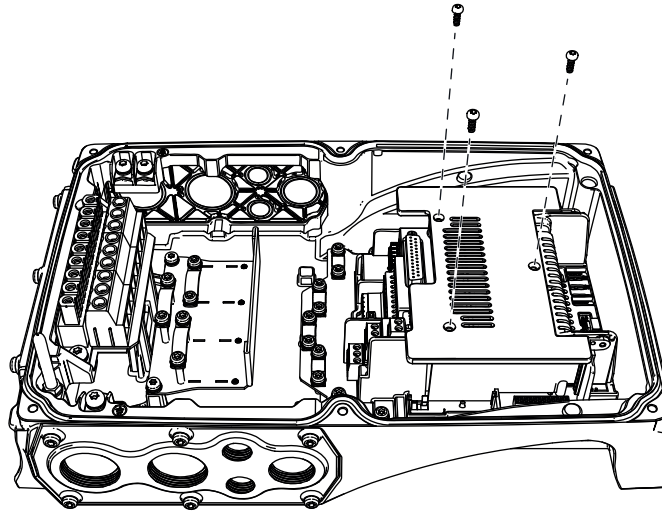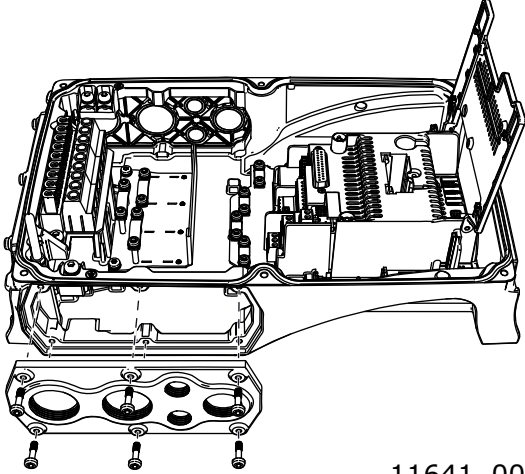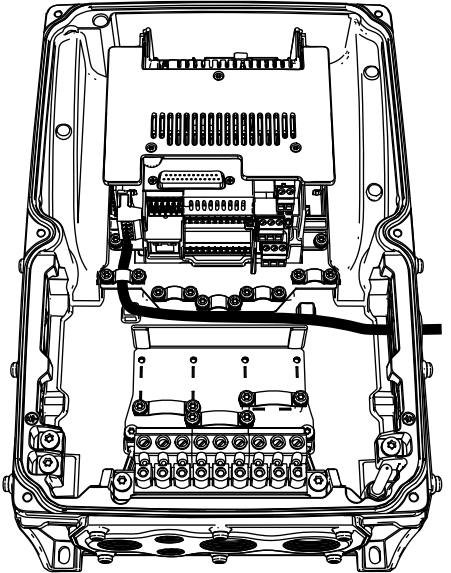
# 6.    Commissioning

## 6.1    Parameter view

*Table 10. Parameter view*

| Name | Default | Range | Description |
|---|---|---|---|
| MAC ID | 63 | 0...63 | Slave address. Valid device addresses are in the range of 0 to 63 decimal. |
| Baud rate | 125 kbit/s | 125 kbit/s 250 kbit/s 500 kbit/s | Communication speed |
| Output assembly | 21 | 20 21 23 25 101 111 | Output assembly used by the polled connection. Setting of this value via panel is not allowed when the I/O connection is established. If setting of this value fails, the value is not updated. |
| Input assembly | 71 | 70 71 73 75 107 117 | Input assembly used by the polled connection. Setting of this value via panel is not allowed when the I/O connection is established! If setting of this value fails, the value is not updated. |

## 6.2    Monitor view

*Table 11. Monitor view*

| Name | Range | Description |
|---|---|---|
| DeviceNet Status | Y.X | Y = Message counter X = DeviceNet status |

*Table 12. DeviceNet status*

| DeviceNet Status | Description |
|---|---|
| 0 | Non-existent |
| 1 | Configuring |
| 3 | Established |
| 4 | Timeout |

## 6.3    Software info view

*Table 13. Software info view*

| Number | Name | Range | Description |
|---|---|---|---|
| 1 | Version number | | Version number of the software in the option board |
| 2 | Board status | | Shows the status of the option board |

## 6.4    Fieldbus parametrisation

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

In order for the AC drive to accept commands from the fieldbus network, the control place of the AC drive has to be set to fieldbus. The default value of the parameter "Control Place" is usually I/O. Note that if the control unit firmware is updated, the default settings are restored. In addition, some applications may have the remote speed reference selection set by default to other than fieldbus. In these cases, the speed reference selection must be set to fieldbus, in order for the speed reference to be controlled via fieldbus.

In DeviceNet, the bits NetCtrl, NetRef and NetProc must be set in order for the option board to send commands / reference setpoint values to the AC drive. The bits Ctrl From Net and Ref From Net can be read to determine the actual control / reference place. Note that these bits are valid only if NetCtrl / NetRef bits are also set.

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

### 6.4.1    Fieldbus control and basic reference selection

The following tables list some of the parameters related to fieldbus control in case of three standard applications, the Vacon® 100, Vacon® 20 and Vacon® 20X, for use via fieldbus. See the application-specific manuals for more detailed information.

*Table 14. Parametrisation for Vacon® 100 (standard application)*

| Parameter name | ID | Value | Default | Panel Tree | Class, Instance, Attribute |
|---|---|---|---|---|---|
| Control mode | 600 | 0 = Frequency 1 = Speed 2 = Torque | 0 | P 3.1.2.1 | 0xA0, 0x03, 0x58 |
| Remote control place | 172 | 1 = Fieldbus CTRL | 0 | P 3.2.1 | 0xA0, 0x01, 0xAC |
| Local / remote | 211 | 0 = Remote | 0 | P 3.2.2 | 0xA0, 0x01, 0xD3 |
| Fieldbus ref. sel. | 122 | 3 = Fieldbus | 3 | P 3.3.1.10 | 0xA0, 0x01, 0x7A |

*Table 15. Parametrisation for Vacon® 20 (standard application)*

| Parameter name | ID | Value | Default | Panel Tree | Class, Instance, Attribute |
|---|---|---|---|---|---|
| Motor control mode | 600 | 0 = Frequency 1 = Speed | 0 | P 1.8 | 0xA0, 0x03, 0x58 |
| Rem. control place 1 sel. | 172 | 1 = Fieldbus CTRL | 0 | P 2.1 | 0xA0, 0x01, 0xAC |
| Local / remote | 211 | 0 = Remote | 0 | P 2.5 | 0xA0, 0x01, 0xD3 |
| Rem. control place 1 freq. ref. sel. | 117 | 3 = Fieldbus | 7 | P 3.3 | 0xA0, 0x01, 0x75 |

*Table 16. Parametrisation for Vacon® 20X (standard application)*

| Parameter name | ID | Value | Default | Panel Tree | Class, Instance, Attribute |
|---|---|---|---|---|---|
| Motor control mode | 600 | 0 = Frequency 1 = Speed | 0 | P 8.1 | 0xA0, 0x03, 0x58 |
| Control place selection | 125 | 2 = Fieldbus | 0 | P 1.11 | 0xA0, 0x01 0x7D |
| Local / remote | 211 | 0 = Remote | 0 | P 3.2.2 | 0xA0, 0x01, 0xD3 |
| Frequency ref. sel. | 1819 | 5 = Fieldbus | 5-7 | P 1.12 | 0xA0, 0x08, 0x1B |

### 6.4.2 Torque control parametrisation

Some extra parametrisation has to be made in order to control the frequency control with torque control. The following instructions are for the Vacon 100 application, see the application-specific manual for more detailed information.

- Motor control mode (ID 600) should be configured to "Torque control (Open Loop)" (2).

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

- PC-tool or panel (P 3.3.2.1) / ID 641
- Vendor Parameter Object TorqueRefSel (Class 0xA0, Instance 0x03, Attribute 0x81)

### 6.4.3 Process data mapping and default settings

In DeviceNet, output instances 107 and 117 (Chapter 7.1.2.5 and 7.1.2.6), can be used to send process data to network. This data is selectable in the application and the default settings vary between drives. Refer to the application manual for details. The following tables show the default values for Vacon 100, Vacon 20X and Vacon 20 applications.

*Table 17. Process data output mapping defaults for Vacon® 100 and Vacon® 20X (standard applications)*

| PD Out | AC Drive | Mapped Application Data | Unit | Scale |
|--------|----------|-------------------------|------|-------|
| 1 | Vacon 100 | Output Frequency | Hz | 0.01 Hz |
|   | Vacon 20X | Output Current | A | Varies |
| 2 | Vacon 100 & Vacon 20X | Motor Speed | rpm | 1 rpm |
| 3 | Vacon 100 & Vacon 20X | Motor Current | A | Varies |
| 4 | Vacon 100 & Vacon 20X | Motor Torque | % | 0.1% |
| 5 | Vacon 100 & Vacon 20X | Motor Power | % | 0.1% |
| 6 | Vacon 100 & Vacon 20X | Motor Voltage | V | 0.1 V |
| 7 | Vacon 100 & Vacon 20X | DC Link Voltage | V | 1 V |
| 8 | Vacon 100 & Vacon 20X | Last Active Fault Code | - | - |

*Table 18. Process data output mapping defaults for Vacon® 20 (standard application)*

| PD Out | AC Drive | Mapped Application Data | Unit | Scale |
|--------|----------|-------------------------|------|-------|
| 1 | Vacon 20 | Frequency Reference | Hz | 0.01 Hz |
| 2 | Vacon 20 | Output Reference | Hz | 0.01 Hz |
| 3 | Vacon 20 | Motor Speed | rpm | 1 rpm |
| 4 | Vacon 20 | Motor Voltage | V | 0.1 V |
| 5 | Vacon 20 | Motor Torque | % | 0.1% |
| 6 | Vacon 20 | Motor Current | A | Varies |
| 7 | Vacon 20 | Motor Power | % | 0.1% |
| 8 | Vacon 20 | DC Link Voltage | V | 1 V |

# 7.    DECIVENET INTERFACE

Vacon supports two types of DeviceNet messaging. They are I/O Messaging and Explicit Messaging.

## 7.1    I/O MESSAGING

I/O polling messages are for time-critical, control-oriented data. The messages are transferred between the devices all the time and they are used for continuous control of the AC drive. They provide a dedicated, special-purpose communication path between a producing application (master) and one or more consuming applications (slaves). They are exchanged across single or multi-cast connections, typically using high priority identifiers. I/O polling messages contain no protocol in the 8-byte data field. The meaning of the message is implied by the connection ID (CAN identifier). Before messages are sent using these IDs, both the device sending and receiving them must be configured. The configuration contains the source and destination object attribute addresses for the master and the slave.
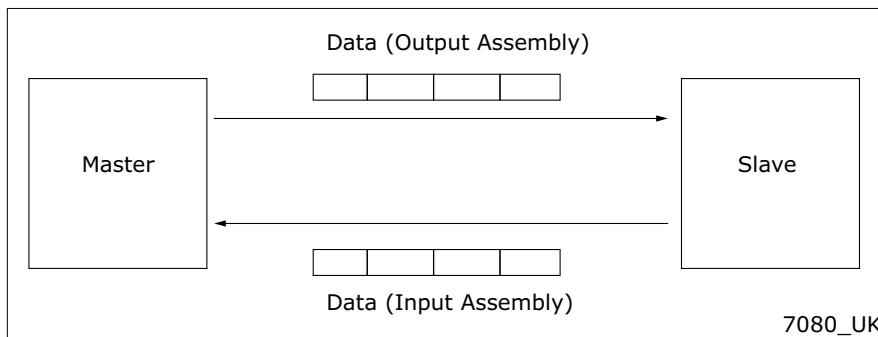


*Figure 10. DeviceNet I/O messaging*

The contents of the data message are chosen by input and output assemblies. These assemblies can be selected via panel or by setting Produced Connection Path (14) and Consumed Connection Path (16) attributes in DeviceNet connection object. Note that setting of instances is not allowed via panel, if I/O connection is open. See Chapter 10.2 for more details. Chapter 7.1.2 describes all supported input and output assemblies.

### 7.1.1    CONNECTION BEHAVIOUR

The following figure provides a general overview of the behaviour associated with an I/O connection object (instance type attribute = I/O).
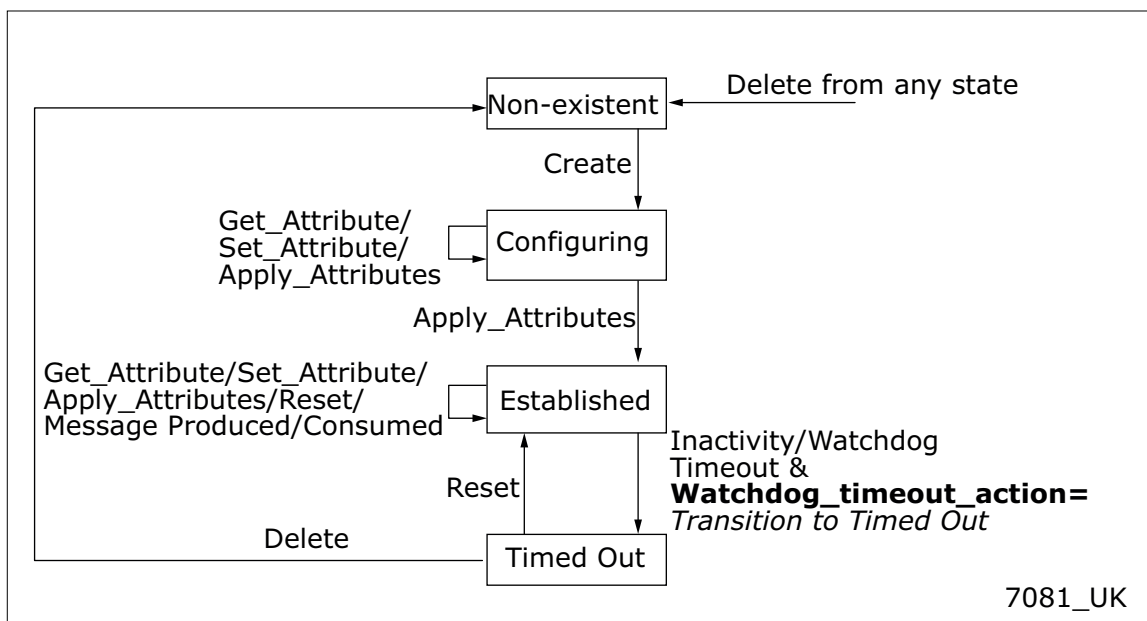
*Figure 11. I/O Connection Object State Transition Diagram*

By default, Expected Packet Rate (EPR) of I/O connection is set to zero, meaning that no transition to Timed Out state will occur. If EPR Timeout is set to other than zero, timeout will occur after four times Expected Packet Rate (4 * EPR). For example value 1000 (ms) will result in timeout after four seconds.

### 7.1.2 Input and Output Assemblies

The following chapters describe the used input/output assemblies.

*Table 19. Supported Input / Output Assemblies*

| Name | Profile | Number | Type |
|------|---------|--------|------|
| Basic Speed Control | CIP | 20 | Output |
|  |  | 70 | Input |
| Extended Speed Control (default) | CIP | 21 | Output |
|  |  | 71 | Input |
| Extended Speed and Torque Control | CIP | 23 | Output |
|  |  | 73 | Input |
| Process Control | CIP | 25 | Output |
|  |  | 75 | Input |
| Dynamic Process Control | Vacon | 101 | Output |
|  |  | 107 | Input |
| Bypass Control Output | Vacon | 111 | Output |
|  |  | 117 | Input |

### 7.1.2.1    20/70 Basic Speed Control

Basic speed control is the most basic control type, where the run direction is limited to only forward, and only Run and Fault reset commands are supported. Speed reference is given in revolutions per minute. The run/stop commands work as described in Table 39, with Run Rev always interpreted as zero. In this mode, the control supervisor attributes NetCtrl and NetRef bits are always set to one.

*Table 20. Basic Speed Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| **Basic Speed Control Output** | | | | | | | | | |
| 20 | 0 | | | | | | Fault Reset | | Run Fwd |
| | 1 | | | | | | | | |
| | 2 | Speed Reference (Low Byte) | | | | | | | |
| | 3 | Speed Reference (High Byte) | | | | | | | |
| **Basic Speed Control Input** | | | | | | | | | |
| 70 | 0 | | | | | | Running1 | | Faulted |
| | 1 | | | | | | | | |
| | 2 | Speed Actual (Low Byte) | | | | | | | |
| | 3 | Speed Actual (High Byte) | | | | | | | |

*Table 21. Basic Speed Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|-----------|------|-------|------|
| Speed Reference | rpm | 0-32767 | |
| Speed Actual | rpm | 0-32767 | |

### 7.1.2.2    21/71 Extended Speed Control (default)

Extended speed control provides more functionality over the basic speed control. NetRef and NetCtrl bits must be set to one, in order for the commands and reference values to be sent to the AC drive. When these bits are set, the actual control/reference place can be read from "Ctrl From Net" and "Ref From Net" bits. Run Forward and Run Reverse bits are used to control the direction of the motor. See Table 39 for complete description of the run commands.

*Table 22. Basic Speed Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| | | **Extended Speed Control Output** | | | | | | | |
| 21 | 0 | | NetRef | NetCtrl | | | Fault Reset | Run Rev | Run Fwd |
| | 1 | | | | | | | | |
| | 2 | Speed Reference (Low Byte) | | | | | | | |
| | 3 | Speed Reference (High Byte) | | | | | | | |
| | | **Extended Speed Control Input** | | | | | | | |
| 71 | 0 | At Ref- erence | Ref from Net | Ctrl from Net | Rea dy | Runnin g2 (Rev) | Running1 | Warning | Faulted |
| | 1 | Drive State | | | | | | | |
| | 2 | Speed Actual (Low Byte) | | | | | | | |
| | 3 | Speed Actual (High Byte) | | | | | | | |

*Table 23. Extended Speed Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|-----------|------|-------|------|
| Speed Reference | rpm | 0-32767 | |
| Speed Actual | rpm | 0-32767 | |
| Drive State | - | 0-7 | See Chapter 7.1.3 |

### 7.1.2.3     23/73 Extended Speed and Torque Control

Extended speed and torque assemblies can be used when torque reference is needed.

Torque Reference is converted from $T^{(Nm)}/2^n$ , where *n* is the torque scale value (AC/DC Drive object, instance 2, attribute 24), to a %-value for the AC drive. This value is sent in ProcessDataIn1 for the control unit when NetRef bit is set. Therefore, ProcessDataIn1 should be selected as torque reference selection. See the application manual or Chapter 6.4.2 for more details.

*Table 24. Extended Speed and Torque Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| | | **Extended Speed and Torque Control   Output** | | | | | | | |
| 23 | 0 | | NetRef | NetCtrl | | | Fault Reset | Run Rev | Run Fwd |
| | 1 | | | | | | | | |
| | 2 | Speed Reference (Low Byte) | | | | | | | |
| | 3 | Speed Reference (High Byte) | | | | | | | |
| | 4 | Torque Reference (Low Byte) | | | | | | | |
| | 5 | Torque Reference (High Byte) | | | | | | | |

*Table 24. Extended Speed and Torque Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| | | **Extended Speed and Torque Control Input** | | | | | | | |
| 73 | 0 | At Ref-erence | Ref from Net | Ctrl from Net | Ready | Running2 (Rev) | Running1 | Warning | Faulted |
| | 1 | Drive State | | | | | | | |
| | 2 | Speed Actual (Low Byte) | | | | | | | |
| | 3 | Speed Actual (High Byte) | | | | | | | |
| | 4 | Torque Actual (Low Byte) | | | | | | | |
| | 5 | Torque Actual (High Byte) | | | | | | | |

*Table 25. Extended Speed and Torque Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|-----------|------|-------|------|
| Speed Reference | rpm | 0-32767 | |
| Speed Actual | rpm | 0-32767 | |
| Torque Reference | $Nm/2^{Torque\ Scale}$ | -32768...32767 | |
| Torque Actual | $Nm/2^{Torque\ Scale}$ | -32768...32767 | |
| Drive State | - | 0-7 | See Chapter 7.1.3 |

7.1.2.4      25/75 Extended Process Control

Extended process control assemblies can be used to send process reference value directly to the application. The Process Reference value destination can be selected with Drive Mode byte according to Table 28. This should be configured in application as the receiving input. Process Actual value is always mapped to ProcessDataOut1. Note that process reference value is sent to drive only when NetProc bit is set.

*Table 26. Extended Process Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| | | **Extended Process Control Output** | | | | | | | |
| 25 | 0 | Net-Proc | NetRef | NetCtrl | | | Fault Reset | Run Rev | Run Fwd |
| | 1 | Drive Mode | | | | | | | |
| | 2 | Speed Reference (Low Byte) | | | | | | | |
| | 3 | Speed Reference (High Byte) | | | | | | | |
| | 4 | Process Reference (Low Byte) | | | | | | | |
| | 5 | Process Reference (High Byte) | | | | | | | |

*Table 26. Extended Process Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Extended Process Control Input** | | | | | | | |
| 75 | 0 | At Ref-erence | Ref from Net | Ctrl from Net | Rea dy | Runnin g2 (Rev) | Running1 | Warning | Faulted |
| | 1 | Drive State | | | | | | | |
| | 2 | Speed Actual (Low Byte) | | | | | | | |
| | 3 | Speed Actual (High Byte) | | | | | | | |
| | 4 | Process Actual (Low Byte) | | | | | | | |
| | 5 | Process Actual (High Byte) | | | | | | | |

*Table 27. Extended Process Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|---|---|---|---|
| Speed Reference | rpm | 0-32767 | |
| Speed Actual | rpm | 0-32767 | |
| Process Reference | - | - | See Table 28 |
| Process Actual | - | - | ProcessDataOut1 |
| Drive Mode | - | - | See Table 28 |
| Drive State | - | 0-7 | See Chapter 7.1.3 |

*Table 28. Drive Mode selection in Process Control*

| Drive Mode | Process Reference Mapping |
|---|---|
| 0 | ProcessDataIn1 |
| 4 | ProcessDataIn2 |
| Other | Not valid |

7.1.2.5    101/107 Vendor Dynamic Process Control

These assemblies can be used to send/receive process data directly to and from the application. The FB Speed Reference and the FB Speed Actual values are given as percentage of the minimum and maximum frequency. The control and status words are still given as CIP standard specific values.

*Table 29. Vendor Dynamic Process Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Dynamic Process Control Output** | | | | | | | |
| 101 | 0 | | NetRef | NetCtrl | | | Fault Reset | Run Rev | Run Fwd |
| | 1 | Process Data 1 Selector (bits 4-7) | | | | Process Data 2 Selector (bits 0-3) | | | |
| | 2 | FB Speed Reference (Low Byte) | | | | | | | |
| | 3 | FB Speed Reference (High Byte) | | | | | | | |
| | 4 | ProcessDataIn1 (Low Byte) | | | | | | | |
| | 5 | ProcessDataIn1 (High Byte) | | | | | | | |
| | 6 | ProcessDataIn2 (Low Byte) | | | | | | | |
| | 7 | ProcessDataIn2 (High Byte) | | | | | | | |
| | | **Dynamic Process Control Input** | | | | | | | |
| 107 | 0 | At Ref-erence | Ref from Net | Ctrl from Net | Ready | Running2 (Rev) | Running1 | Warning | Faulted |
| | 1 | Drive State | | | | | | | |
| | 2 | FB Speed Actual (Low Byte) | | | | | | | |
| | 3 | FB Speed Actual (High Byte) | | | | | | | |
| | 4 | ProcessDataOut1 (Low Byte) | | | | | | | |
| | 5 | ProcessDataOut1 (High Byte) | | | | | | | |
| | 6 | ProcessDataOut2 (Low Byte) | | | | | | | |
| | 7 | ProcessDataOut2 (High Byte) | | | | | | | |

*Table 30. Vendor Dynamic Process Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|---|---|---|---|
| FB Speed Reference | % | 0-10000 (100.00%) | |
| FB Speed Actual | % | 0-10000 (100.00%) | |
| ProcessDataIn1 | - | - | |
| ProcessDataIn2 | - | - | |
| ProcessDataOut1 | - | - | See Table 31 |
| ProcessDataOut2 | - | - | See Table 31 |
| Process Data Selector | - | - | See Table 31 |
| Drive State | - | 0-7 | See Chapter 7.1.3 |

Process data selector bits can be used to select what content is mapped to ProcessDataOut 1 & 2 (bytes 4-7). The following table describes what values in these fields correspond to which process data items.

*Table 31. Process Data Selector 1 & 2 description*

| Value | Bytes 4-5 of instance 107 | Bytes 6-7 of instance 107 |
|---|---|---|
| 0 * | Speed Actual [%] | Speed Actual [%] |
| 1 | ProcessDataOut1 | ProcessDataOut1 |
| 2 | ProcessDataOut2 | ProcessDataOut2 |
| 3 | ProcessDataOut3 | ProcessDataOut3 |
| 4 | ProcessDataOut4 | ProcessDataOut4 |
| 5 | ProcessDataOut5 | ProcessDataOut5 |
| 6 | ProcessDataOut6 | ProcessDataOut6 |
| 7 | ProcessDataOut7 | ProcessDataOut7 |
| 8 | ProcessDataOut8 | ProcessDataOut8 |
| Other | ProcessDataOut1 | ProcessDataOut2 |

* If both Process Data selectors are 0, bytes 4-5 are ProcessDataOut1 and bytes 6-7 are ProcessDataOut2.

7.1.2.6      111/117 Vendor Bypass Control

These assemblies can be used to bypass the CIP standard assemblies, and control the AC drive application directly. The FB Speed Reference and the FB Speed Actual values are given as percentage of the minimum and maximum frequency. The control and status words are application-specific values. Table 34 and Table 35 describe the control word, and Table 36 and Table 37 describe the fieldbus status words that are commonly used. Note that not all applications support all bits, and so application-specific manuals should be consulted.

*Table 32. Vendor Bypass Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Bypass Control Output** | | | | | | | |
| 111 | 0-1 | Control Word | | | | | | | |
| | 2-3 | FB Speed Reference | | | | | | | |
| | 4-5 | ProcessDataIn1 | | | | | | | |
| | 6-7 | ProcessDataIn2 | | | | | | | |
| | 8-9 | ProcessDataIn3 | | | | | | | |
| | 10-11 | ProcessDataIn4 | | | | | | | |
| | 12-13 | ProcessDataIn5 | | | | | | | |
| | 14-15 | ProcessDataIn6 | | | | | | | |
| | 16-17 | ProcessDataIn7 | | | | | | | |
| | 18-19 | ProcessDataIn8 | | | | | | | |

*Table 32. Vendor Bypass Control Instance descriptions*

| Instance | Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|----------|------|------|------|------|------|------|------|------|------|
| | | **Bypass Control Input** | | | | | | | |
| 117 | 0-1 | Status Word | | | | | | | |
| | 2-3 | FB Speed Actual [%] | | | | | | | |
| | 4-5 | FB Speed Actual [rpm] | | | | | | | |
| | 6-7 | Speed Actual With Slip | | | | | | | |
| | 8-17 | Reserved | | | | | | | |
| | 18-19 | ProcessDataOut1 | | | | | | | |
| | 20-21 | ProcessDataOut2 | | | | | | | |
| | 22-23 | ProcessDataOut3 | | | | | | | |
| | 24-25 | ProcessDataOut4 | | | | | | | |
| | 26-27 | ProcessDataOut5 | | | | | | | |
| | 28-29 | ProcessDataOut6 | | | | | | | |
| | 30-31 | ProcessDataOut7 | | | | | | | |
| | 32-33 | ProcessDataOut8 | | | | | | | |

*Table 33. Vendor Bypass Control Attribute descriptions*

| Attribute | Unit | Range | Note |
|-----------|------|-------|------|
| FB Speed Reference | % | 0-10000 (100.00%) | |
| FB Speed Actual | % | 0-10000 (100.00%) | |
| FB Speed Actual | rpm | -32768...32767 | Ramp output frequency converted to rpm. |
| Speed Actual With Slip | rpm | 0-32767 | Slip compensated RPM value. |

*Table 34. Fieldbus Control Word*

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| - | - | - | ESTP | JOG2 | JOG1 | BREF | BCTRL | ZREF | FRMP | QRMP | STPM2 | STPM1 | FRST | DIR | STRT |

*Table 35. Fieldbus Control Word description*

| Bit | | Name | Description | 0 | 1 |
|-----|---|------|-------------|---|---|
| 12 | ESTP | Emergency Stop | Request as fast stop as possible | - | Emergency Stop |
| 11 | JOG2 | Jogging Request | Select jogging with reference 2 | - | Select ref2 jogging |
| 10 | JOG1 | Jogging Request | Select jogging with reference 1 | - | Select ref1 jogging |

*Table 35. Fieldbus Control Word description*

|  | Bit | Name | Description | 0 | 1 |
|---|---|---|---|---|---|
| 9 | BREF | Bus Reference | Force reference to fieldbus | Selected reference place | Force fieldbus reference |
| 8 | BCTRL | Bus Control | Force fieldbus control active | Selected control place | Force fieldbus control |
| 7 | ZREF | Zero Ref | Force reference to zero | - | Force reference to zero |
| 6 | FRMP | Ramp Freeze | Freeze ramp generator | - | Freeze ramp generator |
| 5 | QRMP | Quick Ramp Time | Use quick ramp time | Normal ramp time | Quick Ramp Time |
| 4 | STPM2 | Stop Mode2 | Stop mode ramping | - | Stop By Ramp Mode |
| 3 | STPM1 | Stop Mode1 | Stop mode coasting | - | Coasting Stop Mode |
| 2 | FRST | Fault Reset | Request fault reset from drive | - | Request reset from drive |
| 1 | DIR | Direction | Rotation direction | Clockwise | Counterclockwise |
| 0 | STRT | Start / Stop | Start / Stop request | Stop | Run |

*Table 36. Fieldbus Status Word*

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - | FRDY | ZSPD | ATREF | ALARM | FLT | DIR | RUN | RDY |

*Table 37. Fieldbus Status Word description*

|  | Bit | Name | Description | 0 | 1 |
|---|---|---|---|---|---|
| 7 | FRDY | Flux Ready | Motor magnetisation is ready | - | Flux Ready |
| 6 | ZSPD | Zero Speed | Motor is running at zero speed | - | Zero speed condition |
| 5 | ATREF | At Reference | Reference frequency is reached | - | Reference reached |
| 4 | ALARM | Alarm | Alarm indication | - | Drive is in alarm |
| 3 | FLT | Faulted | Drive fault indication | - | Drive is faulted |
| 2 | DIR | Direction | Motor running direction | Clockwise | Counterclockwise |
| 1 | RUN | Run | Motor running information | Stopped | Running |
| 0 | RDY | Ready | Drive readiness information | - | Ready |

### 7.1.3    Control Supervisor Behaviour

The State Transition Diagram provides a graphical description of the states and the corresponding state transitions for the control supervisor.
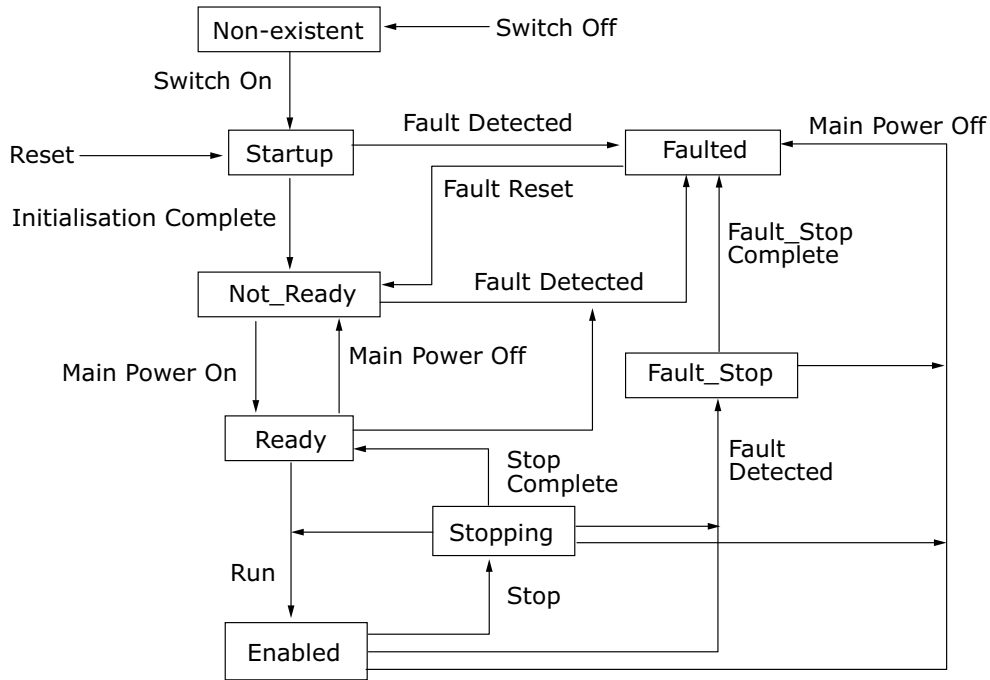


7082_UK

*Figure 12. Control Supervisor State Transition Diagram*

The current state of the Control Supervisor State can be read from Control Supervisor Object (Class 0x29), Instance 1, Attribute 6. The values correspond to the states according to the following table.

*Table 38. Control Supervisor State*

| Value | State |
|-------|-------|
| 0 | Non-existent |
| 1 | Startup |
| 2 | Not_Ready |
| 3 | Ready |
| 4 | Enabled |
| 5 | Stopping |
| 6 | Fault_Stop |
| 7 | Faulted |

The "Main Power On" and "Main Power Off" refer to the motor control status (READY / NOT READY). Stop command will result in stop by "Stop Function". The stop mode is selectable in application.

Run1 and Run2 bits trigger Stop and Run commands according to Table 39. Fault Reset will occur on a rising edge of the Reset command.

*Table 39. Run/Stop Event Matrix*

| Run1 | Run2 | Trigger Event | Run Type |
|------|------|---------------|----------|
| 0 | 0 | Stop | N/A |
| 0 -> 1 | 0 | Run | Run1 |
| 0 | 0 -> 1 | Run | Run2 |
| 0 -> 1 | 0 -> 1 | No Action | N/A |
| 1 | 1 | No Action | N/A |
| 1 -> 0 | 1 | Run | Run2 |
| 1 | 1 -> 0 | Run | Run1 |

## 7.2    Explicit messaging

Explicit Messaging is used in commissioning and parametrising of the DeviceNet option board. Explicit messages provide multipurpose, point-to-point communication paths between two devices. They provide the typical request/response-oriented network communication used to perform node configuration and problem diagnosis. Explicit messages typically use low priority identifiers and contain the specific meaning of the message right in the data field. This includes the service to be performed and the specific object attribute address.

### 7.2.1    Connection behaviour

Here you can see a general overview of the behaviour associated with an Explicit Messaging Connection Object (Instance type attribute = Explicit Messaging).
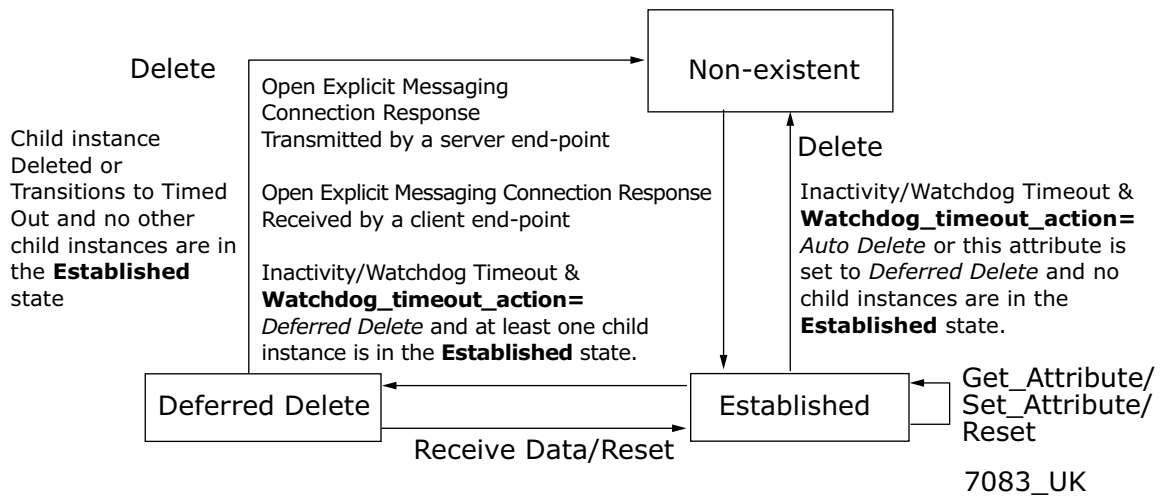


*Figure 13. Explicit Messaging Connection Object State Transition Diagram*

Explicit Connection Expected Packet Rate (EPR) is set by default to 2500, meaning that watchdog timeout action will occur after 10s.

# 8.    Fault handling

The following chapter describes different fault activation situations in OPTE7.

*Table 40. Fault Activation Sources*

| Name | Description | N LED |
|------|-------------|-------|
| BUS-OFF | CAN driver in in bus-off state | Red |
| DUP_MAC-ID | Duplicate MAC ID is found during startup/ MAC ID change | Red |
| PASSIVE | CAN driver is in passive state | - |
| EXT_PWR | External +24V is not detected | Off |
| PIO_TO | Polled I/O connection Expected Packet Rate watchdog timeout | Flashing red |

- Bus-off and passive states are cleared when CAN driver goes to active state.
- External power fault is cleared when +24V is connected to option board connector.
- Duplicate MAC check is made every time the MAC-ID is changed or the option board is powered up. The fault is cleared, when the duplicate MAC-ID check passes.
- Polled I/O connection timeout is cleared when the I/O connection is released or allocated

How the AC drive will react to these fault situations can be defined in application:

*Table 41. Fieldbus Fault Reaction in Vacon® 100 and Vacon® 20 (standard application)*

| Code | | Parameter | Min | Max | Default | ID | Description |
|------|------|-----------|-----|-----|---------|-----|-------------|
| Vacon 100 | Vacon 20 | | | | | | |
| P3.9.1.6 | P13.19 | Response to fieldbus fault | 0 | 4 | 3 | 733 | 0 = No response<br>1 = Alarm<br>2 = Fault, stop by stop function<br>3 = Fault, stop by coasting |

*Table 42. Fieldbus Fault Reaction in Vacon® 20X (standard application)*

| Code | Parameter | Min | Max | Default | ID | Description |
|------|-----------|-----|-----|---------|-----|-------------|
| P9.15 | Response to fieldbus fault | 0 | 2 | 2 | 733 | 0 = No action<br>1 = Warning<br>2 = Fault |

### 8.1    General and additional error codes

*Table 43. General Error Codes*

| Code | General Error | Description |
|------|---------------|-------------|
| 0x00 | Success | Service was successfully performed by the object specified. |
| 0x02 | Resource Unavailable | Resources needed for the object to perform the requested service were unavailable. |
| 0x08 | Service Not Supported | The requested service was not implemented or was not defined. |
| 0x09 | Invalid Attribute Value | Invalid attribute data detected. |
| 0x0B | Already In Requested State | Requested release connection does not exist. |
| 0x0C | Object State Conflict | The object cannot perform the requested service in its current mode/state. |
| | | Already allocated to another master. |
| 0x0E | Attribute Not Settable | A request to modify a non-modifiable attribute was received. |
| 0x10 | Device State Conflict | The current mode/state of the device prohibits the execution of the requested service. |
| 0x13 | Not Enough Data | Explicit request was too short. |
| 0x14 | Attribute Not Supported | The attribute specified in the request is not supported. |
| 0x15 | Too Much Data | The service supplied more data than was expected. |
| 0x16 | Object Does Not Exist | The object specified does not exist in the device. |
| 0x20 | Invalid Parameter | Message received on Group 2 unconnected requested port was not an allocate or release message. |
| | | A parameter associated with the request was invalid. |
| 0x28 | Invalid Member ID | The Member ID specified in the request does not exist. |

*Table 44. Additional Error Codes*

| Code | Description |
|------|-------------|
| 0x01 | Predefined Master/Slave Connection Set allocation conflict |
| 0x02 | Invalid Allocation/Release Choice parameter |
| 0x03 | Message received on Group 2 Only Unconnected Explicit Request message port that was not an Allocate or Release message |
| 0x04 | Resource required for use with the Predefined Master/Slave Connection Set is not available |

# 9.    Appendix A: Object dictionary

## 9.1    Implemented CIP objects

### 9.1.1    List of Object Classes

The Communication Interface supports the following object classes.

*Table 45. Implemented Object Classes*

| | Class | Object |
|---|---|---|
| **Required by DeviceNet** | 0x01 | Identity |
| | 0x02 | Message Router |
| | 0x03 | DeviceNet |
| | 0x04 | Assembly |
| | 0x05 | DeviceNet Connection |
| **Required by Drive Profile** | 0x28 | Motor Data |
| | 0x29 | Control Supervisor |
| | 0x2A | AC/DC Drive |
| **Vendor-Specific** | 0xA0 | Vendor Parameter |

### 9.1.2 LIST OF SERVICES

The following table shows the services supported by these object classes.

| Service Code (in hex) | Service Name | Identity | | Message Router | | DeviceNet | | Assembly | | Connection | | | Motor Data | | Control Supervisor | | AC/DC Drive | | Vendor Parameter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Class | Inst | Class | Inst | Class | Inst | Class | Inst | Class | Inst (Explicit) | Inst (Polled) | Class | Inst | Class | Inst | Class | Inst | Class | Inst |
| 0x05 | Reset | | Y* | | | | | | | | Y | Y | | | | | | | | |
| 0x09 | Delete | | | | | | | | | | Y | Y | | | | | | | | |
| 0x0E | Get_Attribute_Single | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 0x10 | Set_Attribute_Single | | Y | | Y | | Y | | Y | | Y | Y | | Y | | Y | | Y | | Y |
| 0x4B | Allocate_Master/Slave_Connection_Set | | | | | Y | | | | | | | | | | | | | | |
| 0x4C | Release_Master/Slave_Connection_Set | | | | | Y | | | | | | | | | | | | | | |

*) Supports reset type 0 and 1

### 9.1.3    Class Code 0x01 – Identity Object

*Table 46.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 |||||| 
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get |  | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get |  | STRUCT of: | List of optional services |
| | | | 2 | UINT | Number of services |
| | | | {5, 14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 10 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Identity" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 |||||| 
| 1 | Vendor ID | Get | 443 | UINT | Identification of each vendor by number. 443 = Vacon Plc |
| 2 | Device Type | Get | 2 | UINT | Indication of the general type of product. 2 = AC Drive |
| 3 | Product Code | Get | 2 | UINT | Identification of a particular product of an individual vendor. 2 = OPTE7 |
| 4 | Revision | Get | N/A | STRUCT of: | Revision of the item the Identity Object represents |
| | | | | USINT | Major revision |
| | | | | USINT | Minor revision |

*Table 46.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|----------------|----------|-------------------------|-----------|-------------|
| 5 | Status | Get | N/A 0 65535 | WORD | Summary status of the device. Defined in ODVA DeviceNet specification. Supported bits: Bit 0 = Owned Bit 7 = System fault Bit 8 = Minor Recoverable Fault Bit 9 = Minor Unrecoverable Fault Bit 10 = Major Recoverable Fault Bit 11 = Major Unrecoverable Fault |
| 6 | Serial Number | Get | N/A | UDINT | Serial number of the device. YYMMDDxxxx, where YY = year of manufacture MM = month of manufacture DD = day of manufacture xxxx = running number |
| 7 | Product Name | Get | "OPTE7" | SHORT_STRING | Human readable identification |
| 8 | State | Get | N/A 0 5 | USINT | Present state of the device as represented by the state transition diagram. 0 = Nonexistent 1 = Device Self-Testing 2 = Standby 3 = Operational 4 = Major Recoverable Fault 5 = Major Unrecoverable Fault |
| 9 | Configuration Consistency Value | Get | N/A 0 65535 | UINT | Contents identify configuration of the device |
| 10 | Heartbeat Interval | Get Set | 0 0 255 | USINT | Heartbeat message send interval in seconds. By default disabled. Zero disables the transmission. |

### 9.1.4    Class Code 0x02 - Message Router Object

*Table 47.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 |||||
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get | | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get | | STRUCT of: | List of optional services |
| | | | 1 | UINT | Number of services |
| | | | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 1 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Message Router" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 |||||
| 1 | Object List | Get | N/A | STRUCT of: | Structure with an array of object class codes supported by the device |
| | | | | UINT | Number of classes |
| | | | | ARRAY of UINT | Classes |

### 9.1.5    Class Code 0x03 - DeviceNet Object

*Table 48.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 |||||
| 1 | Revision | Get | 2 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |

*Table 48.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get | | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get | | STRUCT of: | List of optional services |
| | | | 1 | UINT | Number of services |
| | | | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 10 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Device-Net" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 | | | | | |
| 1 | MAC ID | Get Set | 63 0 63 | USINT | Node address |
| 2 | Baud Rate | Get Set | 0 0 2 | USINT | The baud rate of the device 0 = 125 kBaud 1 = 250 kBaud 2 = 500 kBaud If value is changed via network, it will be taken into use only after a reset / power cycle. If changed via panel, baud rate will be taken into use immediately. |
| 3 | BOI (Bus-off Interrupt) | Get Set | 1 0 1 | BOOL | 0 = Hold the CAN chip in bus-off state upon detection of a bus-off indication 1 = If possible, fully reset the CAN chip and continue communication upon detection of a bus-off indication |
| 4 | Bus-off counter | Get Set | 0 0 255 | USINT | Number of times CAN went to bus-off state. Received data is not used. Counter always reset to 0. |

*Table 48.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 5 | Allocation Information | Get | N/A | STRUCT of: | Allocation Choice Master's Mac ID |
| | | | | BYTE | Allocation Choice Byte Bit 0 = Explicit messaging Bit 1 = Polled I/O |
| | | | | USINT | Master's MAC ID 0-63 = valid 255 = unallocated |
| 100 | Bus-off Separation | Get | 128 | USINT | Messages that have to be received by the device to leave bus-off state. This value is set by the CAN controller. |

### 9.1.6    Class Code 0x04 - Assembly Object

*Table 49.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 |
| 1 | Revision | Get | 2 | UINT | Revision of this object |
| 2 | Max Instance | Get | 117 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 12 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get |  | STRUCT of: | List of optional instance attributes |
|  |  |  | 8 | UINT | Number of attributes |
|  |  |  | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get |  | STRUCT of: | List of optional services |
|  |  |  | 1 | UINT | Number of services |
|  |  |  | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 3 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Assembly" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 20 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.1. |
| Instance 21 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.2. |
| Instance 23 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.3. |
| Instance 25 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.4. |
| Instance 70 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.1. |
| Instance 71 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.2. |
| Instance 73 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.3. |
| Instance 75 |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.4. |
| Instance 101 |

**9**

*Table 49.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.5. |
| Instance 111 | | | | | |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.6. |
| Instance 107 | | | | | |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.5. |
| Instance 117 | | | | | |
| 3 | Data | Get | N/A | ARRAY | See Chapter 7.1.2.6. |

### 9.1.7      Class Code 0x05 - DeviceNet Connection Object

*Table 50.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 | | | | | |
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 2 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 2 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get |  | STRUCT of: | List of optional instance attributes |
|  |  |  | 8 | UINT | Number of attributes |
|  |  |  | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get |  | STRUCT of: | List of optional services |
|  |  |  | 1 | UINT | Number of services |
|  |  |  | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 17 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Device-Net Con-nection" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 - Explicit Connection | | | | | |

*Table 50.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 1 | State | Get | 0 0 5 | USINT | State of the object<br>0 = Non-existent<br>1 = Configuring<br>2 = Waiting<br>3 = Established<br>4 = Timeout<br>5 = Deferred Delete |
| 2 | Instance Type | Get | 0 | USINT | Indicates either I/O or Messaging Connection.<br>0 = Explicit Messaging<br>1 = I/O |
| 3 | Transport Class Trigger | Get | 0x83 | BYTE | Defines behavior of the connection. Defines behavior of the Connection. See CIP Vol.1 chapter 3.4.4.3 for more details. |
| 4 | Produced Connection ID | Get | 0x5FA 0x403 0x5FA | UINT | Placed in CAN Identifier Field when the Connection transmits on a DeviceNet subnet. See Table 55. |
| 5 | Consumed Connection ID | Get | N/A | UINT | CAN Identifier Field value that denotes message to be received on a DeviceNet subnet. See Table 55. |
| 6 | Initial Comm. Characteristics | Get | 0x21 | BYTE | Defines the Message Group(s) across which productions and consumptions associated with this connection occur. See CIP Vol.3 chapter 3-2.4 for more details. |
| 7 | Produced Connection Size | Get | 99 | UINT | Maximum number of bytes transmitted across this Connection |
| 8 | Consumed Connection Size | Get | 99 | UINT | Maximum number of bytes received across this Connection |
| 9 | Expected Packet Rate | Get Set | 2500 0 65535 | UINT | Defines timing associated with this connection |
| 12 | Watchdog Timeout Action | Get Set | 1 1 3 | USINT | Defines how to handle Inactivity/Watchdog timeouts.<br>1 = Auto Delete<br>2 = Invalid for Explicit Connection<br>3 = Deferred Delete |
| 13 | Produced Connection Length | Get | 0 | UINT | Not used in Explicit Connection |

*Table 50.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 14 | Produced Connection Path | Get | {0} | ARRAY of USINT | Not used in Explicit Connection |
| 15 | Consumed Connection Path Length | Get | 0 | UINT | Not used in Explicit Connection |
| 16 | Consumed Connection Path | Get | {0} | ARRAY of USINT | Not used in Explicit Connection |
| 17 | Production Inhibit Time | Get | 0 | UINT | Not used in Explicit Connection |
| Instance 2 - Polled I/O Connection | | | | | |
| 1 | State | Get | 0 0 4 | USINT | State of the object 0 = Non-existent 1 = Configuring 2 = Waiting 3 = Established 4 = Timeout |
| 2 | Instance Type | Get | 1 | USINT | Indicates either I/O or Messaging Connection. 0 = Explicit Messaging 1 = I/O |
| 3 | Transport Class Trigger | Get | 131 | BYTE | Defines behavior of the connection. See CIP Vol.1 chapter 3.4.4.3 for more details. |
| 4 | Produced Connection ID | Get | 0x3FF 0x3C1 0x3FF | UINT | Placed in CAN Identifier Field when the Connection transmits on a DeviceNet subnet. See Table 55. |
| 5 | Consumed Connection ID | Get | N/A | UINT | CAN Identifier Field value that denotes message to be received on a DeviceNet subnet. See Table 55. |
| 6 | Initial Comm. Characteristics | Get | 1 | BYTE | Defines the Message Group(s) across which productions and consumptions associated with this connection occur. See CIP Vol.3 chapter 3-2.4 for more details. |
| 7 | Produced Connection Size | Get | 99 | UINT | Maximum number of bytes transmitted across this Connection |
| 8 | Consumed Connection Size | Get | 99 | UINT | Maximum number of bytes received across this Connection |

*Table 50.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 9 | Expected Packet rate | Get Set | 0 0 65535 | UINT | Defines timing associated with this connection |
| 12 | Watchdog Timeout Action | Get Set | 0 0 0 | USINT | Defines how to handle Inactivity/Watchdog timeouts. 0 = Transition to Timed Out 1 = Invalid for I/O Connection |
| 13 | Produced Connection Length | Get | 6 | UINT | Number of bytes in the Produced Connection Path attribute |
| 14 | Produced Connection Path | Get Set | N/A | ARRAY of USINT | Application obj. producing data on this connection. See Chapter 10.2 for more details. |
| 15 | Consumed Connection Path Length | Get | 6 | UINT | Number of bytes in the Consumed Connection Path attribute |
| 16 | Consumed Connection Path | Get Set | N/A | ARRAY of USINT | Specifies the application object(s) that are to receive the data consumed by this connection. See Chapter 10.2 for more details. |
| 17 | Production Inhibit Time | Get | 0 | UINT | Not used in Polled I/O Connection |

### 9.1.8    CLASS CODE 0x28 – MOTOR DATA OBJECT

*Table 51.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| | | | Instance 0 | | |
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get | | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |

*Table 51.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 5 | Optional Service List | Get | | STRUCT of: | List of optional services |
| | | | 1 | UINT | Number of services |
| | | | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 15 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Motor Data" | SHORT_STRING | ASCII Name for the Object Class |
| | | | Instance 1 | | |
| 3 | Motor Type | Get Set | 7 3 7 | USINT | Motor types supported: 3 = PM Synchronous Motor 7 = Squirrel Cage Induction Motor |
| 6 | Rated Current | Get Set | N/A | UINT | Motor nominal current Unit: 100 mA |
| 7 | Rated Voltage | Get Set | N/A | UINT | Motor nominal voltage Unit: Volts |
| 9 | Rated Frequency | Get Set | N/A | UINT | Motor nominal frequency Unit: Hz |
| 12 | Pole Count | Get | N/A | UINT | Number of poles in the motor |
| 15 | Base Speed | Get Set | N/A | UINT | Nominal speed at rated frequency. Unit: RPM |

### 9.1.9    Class Code 0x29 – Control Supervisor Object

*Table 52.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 | | | | | |
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get | | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get | | STRUCT of: | List of optional services |
| | | | 1 | UINT | Number of services |
| | | | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 15 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "Control Supervisor" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 | | | | | |
| 3 | Run1 | Get Set | 0 0 1 | BOOL | See Table 39. |
| 4 | Run2 | Get Set | N/A | BOOL | See Table 39. |

*Table 52.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 5 | NetCtrl | Get Set | 0 0 1 | BOOL | Requests Run/Stop control to be local or from network. 0 = Local Control 1 = Network Control Note that this selection does not force control place to network if set. This bit only enables commands to be sent to the drive. Depending on how it is parametrised, this command might be ignored or used. See Chapter 6.4 for more details. Actual status of control is reflected in attribute 15. |
| 6 | State | Get | 0 0 7 | USINT | State of Control Supervisor Instance. See Chapter 7.1.3. 0 = Vendor-Specific 1 = Startup 2 = Not_Ready 3 = Ready 4 = Enabled 5 = Stopping 6 = Fault_Stop 7 = Faulted |
| 7 | Running1 | Get | N/A 0 1 | BOOL | Running forward status 0 = Other state 1 = Running forward |
| 8 | Running2 | Get | N/A 0 1 | BOOL | Running reverse status 0 = Other state 1 = Running reverse |
| 9 | Ready | Get | N/A 0 1 | BOOL | Ready to accept a run event 0 = Other state 1 = Ready to accept a run event |
| 10 | Faulted | Get | N/A 0 1 | BOOL | Fault occurred 0 = No faults present 1 = Fault occurred (latched) |
| 11 | Warning | Get | N/A 0 | BOOL | Warning present 0 = No warnings present 1 = Warning present (not latched) |
| 12 | FaultRst | Get Set | 0 0 1 | BOOL | Fault reset request 0 = No action 0 -> 1 = Fault reset request 1 = No action |

*Table 52.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 13 | FaultCode | Get | N/A | UINT | If in Faulted state, the Fault-Code indicates the fault that caused the transition to Faulted state. If not in Faulted state, the FaultCode indicates the fault that caused the last transition to the Faulted state. The supported fault codes are listed in Chapter 11. |
| 14 | WarnCode | Get | N/A | UINT | Indicates the lowest valued warning that caused the Warning bit to be TRUE. |
| 15 | CtrlFromNet | Get | N/A 0 1 | BOOL | Status of the Run/Stop control source 0 = Control is local (as parametrised) 1 = Control is from network |

### 9.1.10   Class Code 0x2A - AC/DC Drive Object

*Table 53.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| Instance 0 |
| 1 | Revision | Get | 1 | UINT | Revision of this object |
| 2 | Max Instance | Get | 1 | UINT | Maximum instance number |
| 3 | Number of Instances | Get | 1 | UINT | Number of object instances |
| 4 | Optional Attribute List | Get | | STRUCT of: | List of optional instance attributes |
| | | | 8 | UINT | Number of attributes |
| | | | {1, 2, 3, 4, 5, 6, 7, 176} | ARRAY of UINT | List of optional attribute numbers |
| 5 | Optional Service List | Get | | STRUCT of: | List of optional services |
| | | | 1 | UINT | Number of services |
| | | | {14} | ARRAY of UINT | List of optional service codes |
| 6 | Max Class Attribute ID | Get | 176 | UINT | The attribute ID number of the last class attribute |
| 7 | Max Instance Attribute ID | Get | 29 | UINT | The attribute ID number of the last instance attribute |
| 176 | Object Name | Get | "AC/DC Drive" | SHORT_STRING | ASCII Name for the Object Class |
| Instance 1 |
| 3 | At Reference | Get | N/A 0 1 | BOOL | 1 = Drive actual at reference (speed or torque reference) based on mode |

*Table 53.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 4 | Net Ref | Get Set | 0 0 1 | BOOL | Requests torque or speed reference to be local or from the network. 0 = Set Reference not DN Control 1 = Set Reference at DN Control This selection does not force the drive to use network reference. When set, the reference values are sent to the drive, but depending on how it is parametrised, it might ignore this reference value. See Chapter 6.4 for more details. Actual status of reference is reflected in attribute 29. |
| 5 | Net Proc | Get Set | 0 0 1 | BOOL | Requests process control reference to be active. See Chapter 7.1.2.4 for more details. |
| 6 | Drive Mode | Get Set | N/A 0 3 | USINT | 0 = Open loop frequency 1 = Open loop speed 2 = Closed loop speed 3 = Torque control |
| 7 | Speed Actual | Get | N/A 0 32767 | INT | Actual drive speed Unit: RPM |
| 8 | Speed Ref | Get Set | N/A 0 32767 | INT | Speed reference Unit: RPM |
| 9 | Current Actual | Get | N/A 0 32767 | INT | Actual motor phase current Unit: 100 mA |
| 10 | Current Limit | Get Set | N/A 0 32767 | INT | Motor phase current limit Unit: 100 mA |
| 11 | Torque Actual | Get | N/A -32768 32767 | INT | Actual torque Unit: $Nm / 2^{TorqueScale}$, where TorqueScale is attribute 24 |
| 12 | Torque Ref | Get Set | N/A -32768 32767 | INT | Torque reference Unit: $Nm / 2^{TorqueScale}$, where TorqueScale is attribute 24 |

*Table 53.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
| 13 | Process Actual | Get | N/A | INT | Actual process control value. Mapped to FB ProcessDataOut1. |
| 14 | Process Ref | Get Set | N/A | INT | Process control reference. See Chapter 7.1.2.4 for detailed information. |
| 15 | Power Actual | Get | N/A | INT | Actual output power Unit: Watts |
| 16 | Input Voltage | Get | N/A | INT | Input Voltage Unit: Volts |
| 17 | Output Voltage | Get | N/A | INT | Output Voltage Unit: Volts |
| 18 | Accel Time | Get Set | N/A | UINT | Acceleration time Unit: ms |
| 19 | Decel Time | Get Set | N/A | UINT | Deceleration time Unit: ms |
| 20 | Low Spd Limit | Get Set | N/A | UINT | Minimum speed limit Unit: RPM |
| 21 | High Spd Limit | Get Set | N/A | UINT | Maximum speed limit Unit: RPM |
| 24 | Torque Scale | Get Set | 0 -8 7 | SINT | Torque scaling factor. Scaling is accomplished as follows: ScaledTorque = Nm / $2^{TorqueScale}$ |
| 29 | Ref From Net | Get | N/A 0 1 | BOOL | Status of torque/speed reference. 0 = Local torque/speed reference 1 = Network torque/speed reference |

### 9.1.11    Class Code 0xA0 - Vendor Parameter Object

*Table 54.*

| # | Attribute Name | Services | Default Minimum Maximum | Data Type | Description |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| NOT SINGLE ATTRIBUTE PROVIDED | | | | | |

The Vendor Parameter Object is used to read and write parameters with an ID number directly from control unit. The desired Instance number and attribute number is constructed in the following way:

- Instance = Parameter ID (High Byte) + 1
- Attribute = Parameter ID (Low Byte)

Examples:

1) Energy Counter, ID = 2291 = 0x**08**F3
   a) Instance ID = **0x08** + 1 = 0x09
   b) Attribute ID = 0xF3
2) Maximum Frequency, ID = 102 = 0x**00**66
   a) Instance ID = **0x00** + 1 = 0x01
   b) Attribute ID = 0x66

**NOTE!** All the values (when applicable) are truncated to 16-bit values and the scale varies between different types of values.

# 10.    APPENDIX B: COMMUNICATION ATTRIBUTE DETAILS

This appendix can be used to determine how some of the DeviceNet communication class attributes are defined. For more details, refer to Vol.1 and Vol.3 of CIP.

## 10.1    DeviceNet's use of the CAN Identifier Field

The CAN Identifier bits that are available on DeviceNet are divided into message groups. The predefined Master/Slave connections that are relevant to DeviceNet can be seen in the table below. The full list of messages can be seen from CIP Vol.3 in Chapter 3-7.
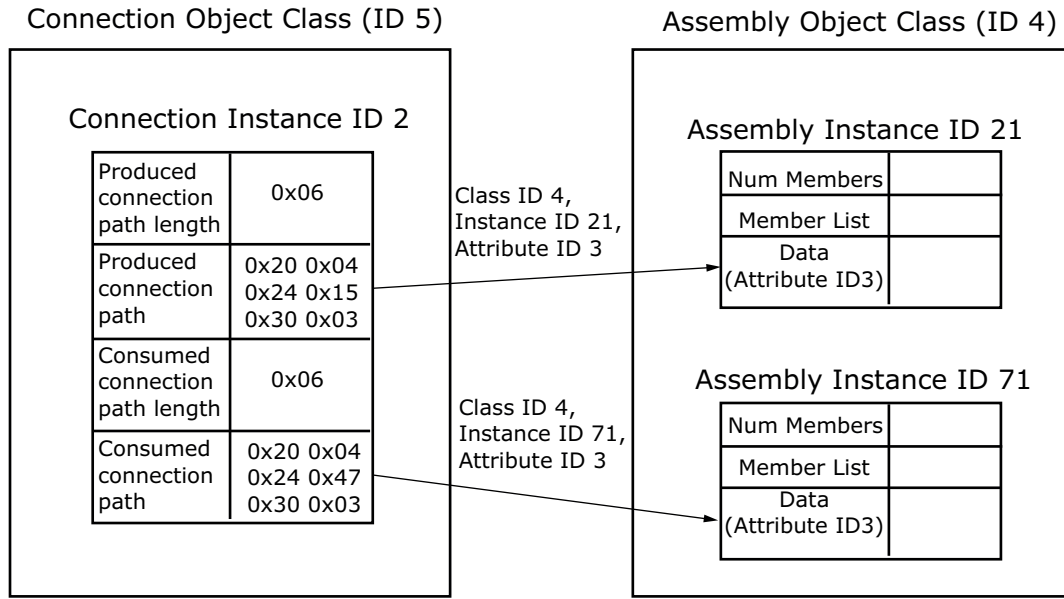
*Table 55. Predefined Master/Slave Connection Set Identifier Fields*

| Identifier Bits | | | | | | | | | | | Identity Usage | Hex Range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| 0 | Group 1 Message ID | | | | Source MAC ID | | | | | | Group 1 Messages | 000-3FF |
| 0 | 1 | 1 | 1 | 1 | Source MAC ID | | | | | | Slave's I/O Poll Response | |
| 1 | 0 | MAC ID | | | | | | Group 2 Message ID | | | Group 2 Messages | 400-5FF |
| 1 | 0 | Source MAC ID | | | | | | 0 | 1 | 1 | Slave's Explicit Response Message | |
| 1 | 0 | Destination MAC ID | | | | | | 1 | 0 | 0 | Master's Explicit Request Message | |
| 1 | 0 | Destination MAC ID | | | | | | 1 | 0 | 1 | Master's I/O Poll Command | |
| 1 | 0 | Destination MAC ID | | | | | | 1 | 1 | 1 | Duplicate MAC ID Check Message | |

## 10.2    CONNECTION OBJECT PATHS

This chapter describes how the connection object path is encoded to select different assembly instances in assembly object for I/O communication. For more detailed information, refer to Vol.1 of CIP Appendix C: C-1 Abstract Syntax Encoding Coding for Segment Types.

The following figures show how the Produced Connection Path (class code 5, instance 2, attribute 14) and the Consumed Connection Path (class code 5, instance 2, attribute 16) are used to map instances to assembly object class. For more information refer to Chapter 9.1.7.

Connection Object Class (ID 5)                    Assembly Object Class (ID 4)

Connection Instance ID 2                          Assembly Instance ID 21

| Produced connection path length | 0x06 |
|---|---|
| Produced connection path | 0x20 0x04 0x24 0x15 0x30 0x03 |
| Consumed connection path length | 0x06 |
| Consumed connection path | 0x20 0x04 0x24 0x47 0x30 0x03 |

Class ID 4, Instance ID 21, Attribute ID 3

| Num Members | |
|---|---|
| Member List | |
| Data (Attribute ID3) | |

Assembly Instance ID 71

Class ID 4, Instance ID 71, Attribute ID 3

| Num Members | |
|---|---|
| Member List | |
| Data (Attribute ID3) | |

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*Figure 14. Example Encoding for Connection Object Paths*

Segment Type = Logical Segment
Segment Format: Logical Type=Class
Format = 8 bits

Segment Type = Logical Segment
Segment Format: Logical Type=Instance
Logical Format = 8 bits

Segment Type = Logical Segment
Segment Format: Logical Type=Attribute ID
Logical Format = 8 bits

| 0x20 | 0x04 | 0x24 | 0x15 | 0x30 | 0x03 |
|---|---|---|---|---|---|

Class 4              Instance 21              Attribute ID 3
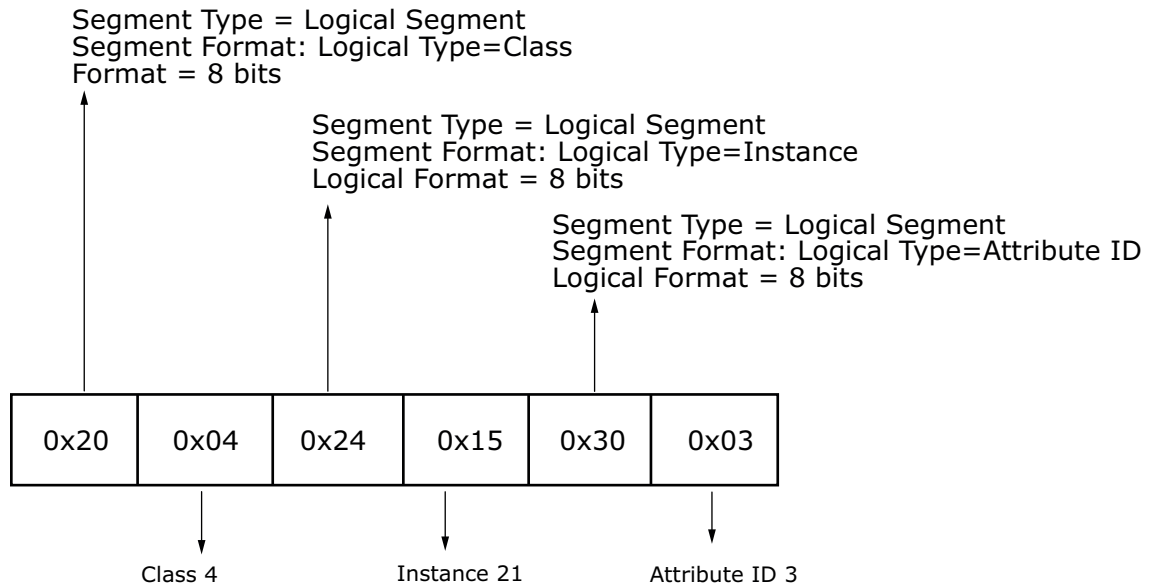
7085_UK

*Figure 15. Path with 8-bit class*

# 11.    Appendix C: Fault and warning codes

OPTE7 uses the implied fault/warning codes for the device profile. For AC drives, the implied fault/warning codes used are DRIVECOM Nutzergruppe e.V 16-bit codes. The supported fault codes are listed in the table below. The full list of error codes can be found in Vol. 1 of CIP, section 5-29.6.

*Table 56.*

| Code Value [Hex] | Meaning |
|---|---|
| 0000 | No fault |
| 1000 | General Fault |
| 2300 | Current, Device Output Side |
| 2330 | Short to Earth |
| 3130 | Phase Failure |
| 3210 | Overvoltage inside the device |
| 3220 | Undervoltage inside the device |
| 4210 | Excess Device Temperature |
| 4220 | Inadequate Device Temperature |
| 5120 | DC Link Power Supply |
| 5200 | Control |
| 5420 | Chopper |
| 6010 | Software Reset (Watchdog) |
| 6100 | Internal Software |
| 7111 | Brake Chopper Failure |
| 7120 | Motor |
| 7500 | Communication |
| 7600 | Data Memory |
| 9000 | External Malfunction |

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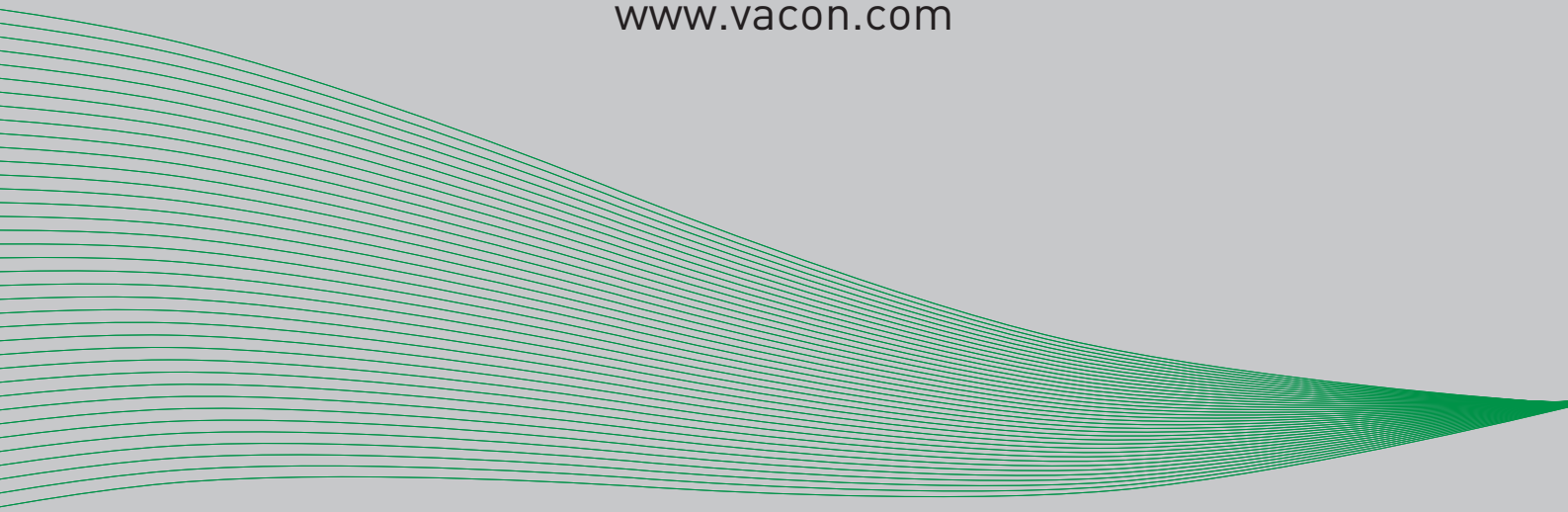
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