VACON®
AC DRIVES

CANOPEN OPTION BOARD OPTE6
USER MANUAL

VACON®

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1. SAFETY

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

Please read the information included in cautions and warnings carefully.

The cautions and warnings are marked as follows:

	**= 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 the manufacturer can be used.
	At power-up, power break or fault reset **the motor will start immediately** if the start signal is active, unless the pulse control for Start/Stop logic has been selected. Furthermore, the I/O functionalities (including start inputs) may change if parameters, applications or software are changed. Disconnect, therefore, the motor if an unexpected start can cause danger.
	The **motor starts automatically** after automatic fault reset if the auto restart function is activated. See the Application Manual for more detailed information.
	**Prior to measurements on the motor or the motor cable**, disconnect the motor cable from the AC drive.
	**Do not touch the components on the circuit boards**. Static voltage discharge may damage the components.
	Check that the **EMC level** of the AC drive corresponds to the requirements of your supply network.
	Wear protective gloves when you do mounting, cabling or maintenance operations. There can be sharp edges in the AC drive that can cause cuts.

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

0) 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.

a) 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.

b) 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:

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

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

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

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

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from www.danfoss.com/en/service-and-support/.

REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site www.danfoss.com/en/service-and-support/.

2. CANopen option board OPTE6 - General

The VACON® OPTE6 CANopen option board can be used with the following VACON® AC drives.

Table 1. OPTE6 usage in different VACON® AC drives

AC drive	Slots	From AC drive SW version	From OPTE6 SW version
VACON® NXP	D, E	NXP00002V196	V010
VACON® 100 INDUSTRIAL and 100 X	D, E	FW0072V015	V007
VACON® 100 FLOW	D, E	FW0159V011	V007
VACON® 20	-	FW0107V011	V007
VACON® 20 X and CP	-	FW0117V007	V007

2.1 Overview

OPTE6 is a CANopen adapter board for VACON® AC drives. The board allows the AC drive to be controlled by using the CANopen protocol. The board implements the AC drive profile with the velocity mode.

The option board firmware implements the following protocol specifications:

- **CiA-301** CANopen communication specification version 4.2
- **CiA-402** CANopen Profile for Drives and Motion Controller version 3.2

  Device: AC drive

  Operation mode: velocity mode
- **CiA-303-3** CANopen indicator specification, implemented by using 2 CANopen status led indicators

2.2 Software

2.2.1 CAN

The CAN data link layer protocol is standardised in ISO 11898. The standard describes mainly the data link layer composed of the logical link control (LLC) sub layer and the media access control (MAC) sub layer, and some aspects of the physical layer of the OSI reference model.

2.2.2 CANopen

CANopen is an application layer protocol on top of the CAN bus.

The protocol specification describes:

- Set of bit rates to support
- Network Management (NMT)
- Service data transmission (SDO)
- Process data transmission (PDO)
- Error message transmission (EMCY)
- Node status monitoring (heartbeat and node guarding)
- Identity information
- Parameter saving and restoring

3. CANOPEN PROTOCOL DESCRIPTION

3.1 NMT

NMT network management manages CANopen, and is a mandatory, common feature for all devices. The protocol describes several node control services and the state machine.

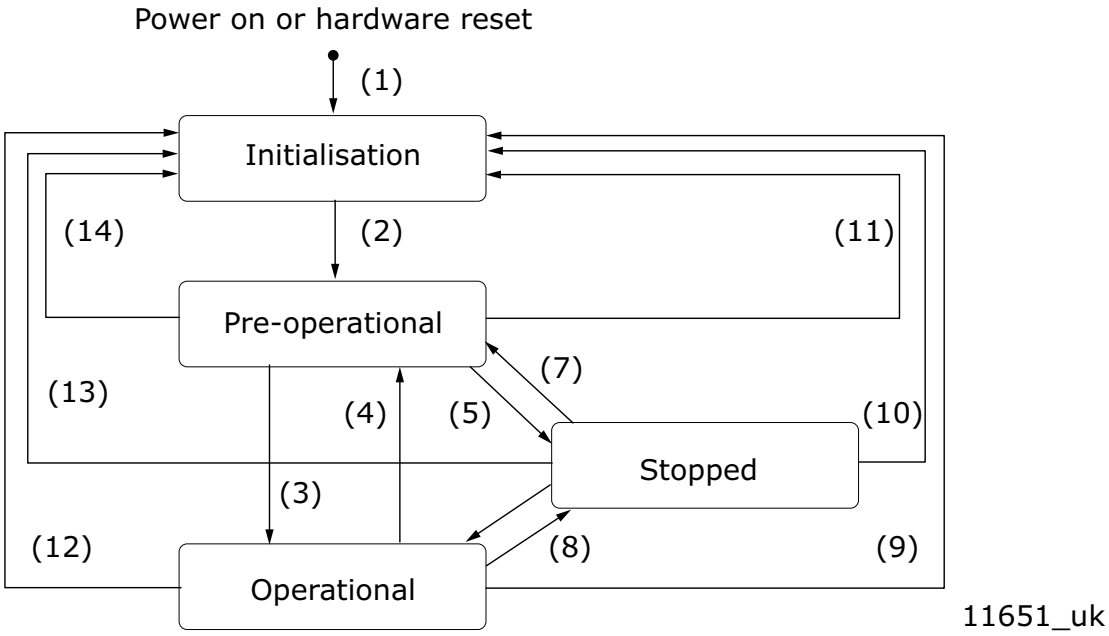

Figure 1. NMT state machine

1 = When the power is on, the NMT state is entered autonomously

2= The NMT state initialization is finished, the NMT pre-operational state is entered automatically

3 = NMT service starts with remote node indication or by local control

4 and 7 = NMT service enters pre-operational indication

5 and 8 = NMT service stops remote node indication

6 = NMT service starts remote node indication

9, 10 and 11 = NMT resets node indication

12, 13 and 14 = Indication of NMT service reset communication

Boot-up protocol

After a node starts, it will enter automatically into the pre-operational state. Always when this transition occurs, a boot-up message is sent into the bus.

Table 2: Boot-up message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x700 + Node ID	1	0							

3.2 Node control protocols

Protocol start remote node

The start remote node message sets the node(s) into operational state. See Figure 1. NMT state machine. If the node ID in the message is set to '0', the message affects all nodes (broadcast).

Table 3: Start remote node message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0	0x2	0x1	NODE ID						

Protocol stop remote node

The stop remote node message sets the node(s) into stopped state. See Figure 1 NMT state machine. If the node ID in the message is set to '0', the message affects all nodes (broadcast). When the node is in stopped state, it will not answer to SDO or PDO messages.

Table 4: Stop remote node message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0	0x2	0x2	NODE ID						

Protocol enter pre-operational

The enter pre-operational message sets the node(s) into pre-operational state. See Figure 1. NMT state machine. If the node ID in the message is set to '0', the message affects all nodes (broadcast). When the node is in pre-operational state, it will not answer to PDO messages.

Table 5: Enter pre-operational message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0	0x2	0x80	NODE ID						

Protocol reset node

The reset node message makes the node(s) apply application reset. See Figure 1. NMT state machine. Application reset sets the whole object dictionary back to the default or previously saved values. If the node ID in the message is set to '0', the message affects all nodes (broadcast). After the node has made the application reset, it will enter the pre-operational state automatically from the initializing state. This also creates a boot-up event and the boot-up message is sent after the reset.

Table 6: Reset node message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0	0x2	0x81	NODE ID						

Protocol reset communication

The reset communication message makes the node(s) apply communication reset. See Figure 1. NMT state machine. Communication reset does not affect the object dictionary values. If the node ID in the message is set to '0', the message affects all nodes (broadcast). After the node has made the communication reset, it will enter the pre-operational state automatically from the initializing state. This also creates a boot-up event and the boot-up message is sent after the reset.

Table 7: Reset communication message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0	0x2	0x82	NODE ID						

3.3 ERROR CONTROL PROTOCOLS

It is not allowed to use guarding protocol and heartbeat protocol on one NMT slave at the same time. If the heartbeat producer time is unequal 0, the heartbeat protocol is used.

3.3.1 HEARTBEAT PROTOCOL

Heartbeat protocol defines the producer and consumer. The producer node sends its NMT status that is then available for any consumer node. The consumer node is the receiver of heartbeat messages. The producer node has a timing parameter that indicates how often the heartbeat message should be sent. The consumer node has a relative parameter that indicates how often the heartbeat message should be received. If the consumer does not receive the heartbeat message within the time defined in the heartbeat object entry, an error event occurs.

Table 8: Node status description

Value	Description
0x0	Boot-up
0x4	Stopped
0x5	Operational
0x7F	Pre-operational

Table 9: Heartbeat message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x700 + Node ID	0x1	Status							

Table 10: Heartbeat-related objects in OD

Index	Description
0x1016	Consumer heartbeat time
0x1017	Producer heartbeat time
0x1029	Error behavior

3.3.2 Node guarding protocol

Node guarding protocol is a NMT master driver protocol, where the master sends a remote transmission request, which is answered by the slave. The slave response includes one data byte that consists of a NMT slave state, and a toggle bit that toggles every response.

NOTE! The CiA application note 802 recommends that the node guarding protocol should not be used, because of different handling of RTR frames in CAN controllers.

OPTE6 option board does not have a hardware-triggered automatic response to the RTR frame. RTR information is handled by software, and the response data always consists of updated information.

Table 11: Node guarding RTR frame (remote request)

CAN ID	LENGTH	RTR	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x700 + Node ID	0x0	1								

Table 12: Node guarding response

CAN ID	LENGTH	DATA0		DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x700 + Node ID	0x1	t	Status							

Table 13: Node guarding slave status

Status	
Value	**Description**
0x4	Stopped
0x5	Operational
0x7F	Pre-operational

Table 14: Node guarding related objects in OD

Index	**Description**
0x100C	Guard time
0x100D	Life time factor

3.3.3 EMCY object

Option board works as an EMCY producer. The EMCY object is transmitted when a fault occurs in the drive or option board. To switch off the EMCY producer, disable the EMCY COB-id by writing MSB to 1 (object 0x1014).

When an error occurs, the EMCY message is transmitted with the current value of the error register and the error code is inserted into the predefined error field list. The newest error code is always the first sub-index on the error field list. When all active errors are cleared, an empty EMCY object is transmitted.

If a drive-internal fault occurs, the MSEF field contains the drive fault code. See the application and user manual for possible fault codes. The ER field holds a bit coded value of the error type. See object 0x1001 for more details.

Table 15: EMCY message

CAN ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x80 + Node ID	0x8	EEC		ER	MSEF				

Table 16: EMCY message data fields

EEC	Emergency error code
ER	Error register value
MSEF	Manufacturer-specific error code

Table 17: Used EMCY error codes and description MSEF fields

DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x0000		ER	3: Number of remaining error sources				
0x1000			Drive fault codes				
0x8110			-				
0x8120			-				
0x8130			3: Heartbeat consumer subindex 4: Heartbeat consumer node-ID				
0x8140			-				
0x8210			-				
0x8220			-				
0x8240			-				
0x8250			-				

Table 18: Description and behavior of different error situations

EEC	Description	Error behavior	Err LED
0x0000	Error Reset or No Error	If MSEF field is empty all error sources are cleared and drive fault is cleared.	-
0x1000	Generic Error	Drive fault codes have changed.	-
0x8120	CAN in Error Passive Mode	EMCY is sent after CAN driver goes back to active state. This also clears the fault.	Single flash
0x8130	Life Guard Error	Error is reset when a RTR is received or either of the life guard objects (0x100C, 0x100D) is written to zero.	Double flash
	Heartbeat Error	Error is reset when a HB message is received by the HB consumer, or the consumer entry is changed (either Node-ID or Heartbeat Time).	
0x8140	Recovered from Bus-Off	EMCY is sent after CAN driver goes back to active state. This also clears the fault.	On
0x8250	PDO timer expired	Error is cleared when a PDO is received (in expired PDO).	Quadruple flash

All communication errors are reset if a reset command is given. This does not however reset drive faults if there are active error sources.

EMCYs are also created in some cases, even though a fault is not created. These are for notification only.

Table 19: Notification EMCY objects

EEC	Description
0x8110	CAN overrun (objects lost)
0x8210	PDO not processed due to length error
0x8220	PDO length exceeded
0x8240	Unexpected SYNC data length

Table 20: EMCY-relate objects in OD

Index	Description
0x1001	Error register
0x1003	Pre-defined error field list
0x1014	EMCY object COB-ID

3.4 SDO protocol

The Option board contains one SDO server. The SDO protocol provides a direct access to the object entries of the object dictionary of the CANopen device. Each message is acknowledged by the server. The protocol is mostly used to set and read parameters from the object dictionary at the pre-operational state. Some objects have limitations for SDO usage at the operational state.

Up to four bytes can be transferred by using the expedited transfer, where the data fits into one CAN message. For bigger than 4-byte object sizes, segmented transfer must be used. Optionally, block transfer is also possible with bigger data types. Block transfer is most efficient with big data sizes.

Table 21: SDO-related objects in OD

Index	Description
0x1200	SDO server parameter object

Some objects have limitations for SDO usage at the operational state. The following SDO abort codes can be returned by the OPTE6 option board.

Table 22: SDO abort codes

Abort code	Description
0504 0001h	Client/server command specifier not valid or unknown
0504 0005h	Out of memory
0601 0000h	Unsupported access to an object
0601 0002h	Attempt to write a read only object
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0606 0000h	Access failed due to a hardware error
0607 0010h	Data type does not match, length of service parameter does not match
0609 0011h	Sub-index does not exist
0609 0030h	Invalid value for parameter (download only)
0609 0031h	Value of parameter written too high (download only)
0609 0032h	Value of parameter written too low (download only)
0800 0020h	Data cannot be transferred or stored to the application
0800 0022h	Data cannot be transferred or stored to the application because of the present device state
0800 0024h	No data available

3.5 PDO protocol

Process data objects PDOs are used to transmit real-time data with no protocol overhead. Each PDO has its mapping and communication parameter record.

There are two different types of PDOs. Transmit PDOs for producing data into network and Receive PDOs for consuming data from network. OPTE6 board supports 5 receive and 5 transmit PDOs.

Each of rxPDO and txPDO mapping parameter record contains four (4) process data items. For example, 0x01600 Receive PDO Mapping Parameter 1 contains following process data items:

- Mapping entry 1
- Mapping entry 2
- Mapping entry 3
- Mapping entry 4

All VACON® AC drives supports transferring of eight (8) process data items between master device and AC drive. Using of 9-16 process data items requires Normal Extended Communication or Fast Communication support from VACON® AC drive. See details of communication modes in following chapters:

- Appendix E - Fieldbus option board communication
- Appendix F - Parameters for application developers

If master device assigns 16 process data items and VACON® AC drive supports only 8 process data items, then content of process data items 9-16 is ignored in VACON® AC drive.

Table 23: PDO-related objects in OD

Index	Description
0x1400	1st rxPDO communication parameter record
0x1401	2nd rxPDO communication parameter record
0x1402	3rd rxPDO communication parameter record
0x1403	4th rxPDO communication parameter record
0x1404	5th rxPDO communication parameter record
0x1600	1st rxPDO mapping parameter record
0x1601	2nd rxPDO mapping parameter record
0x1602	3rd rxPDO mapping parameter record
0x1603	4th rxPDO mapping parameter record
0x1604	5th rxPDO mapping parameter record
0x1800	1st txPDO communication parameter record
0x1801	2nd txPDO communication parameter record
0x1802	3rd txPDO communication parameter record
0x1803	4th txPDO communication parameter record
0x1804	5th txPDO communication parameter record
0x1A00	1st txPDO mapping parameter record
0x1A01	2nd txPDO mapping parameter record
0x1A02	3rd txPDO mapping parameter record
0x1A03	4th txPDO mapping parameter record
0x1A04	5th txPDO mapping parameter record

3.5.1 PDO communication parameter record

PDO communication parameter record defines the COB-id, transmission type and how often the PDO is transmitted. The fields can be modified during the pre-operational state.

Table 24: PDO communication parameter record

Indexes	Sub-index	Name	Data type	RX PDO	TX PDO
0x1400 0x1401 0x1402 0x1403 0x1404 0x1800 0x1801 0x1802 0x1803 0x1804	0	Highest sub-index supported	UNSIGNED8	ro	ro
	1	COB ID	UNSIGNED32	r/w	r/w
	2	Transmission type	UNSIGNED8	r/w	r/w
	3	Inhibit time	UNSIGNED16	ro	r/w
	4	Reserved	UNSIGNED8	ro	ro
	5	Event timer	UNSIGNED16	r/w	r/w
	6	SYNC start value	UNSIGNED8	Not available	r/w

3.5.2 COB ID

COB ID determines whether the PDO is valid (active) and using 11-bit or 29-bit frames.

Table 25: COB ID

31	30	29	28 11	10 0
Valid	Reserved	Frame	0x00000	11-bit CAN-ID
			29-bit CAN-ID	

Table 26: COB ID data fields

Bit(s)	Value	Description
Valid	0	PDO exists / enabled
	1	PDO does not exist / disabled
Reserved	x	Not applicable
Frame	0	11-bit CAN-ID valid
	1	20-bit CAN-ID valid
29-bit CAN-ID	x	29-bit CAN-ID of the CAN extended frame
11-bit CAN-ID	x	11-bit CAN-ID of the CAN base frame

3.5.3 Transmission type

Table 27: PDO transmission types

Value	Description	Receive PDO	Transmit PDO
0x00	Synchronous (acyclic)	X	X
0x01	Synchronous (cyclic every sync)	X[1]	X
0x02	Synchronous (cyclic every 2nd sync)	X[1]	X
0x03	Synchronous (cyclic every 3rd sync)	X[1]	X
0x04	Synchronous (cyclic every 4th sync)	X[1]	X
...	...	X[1]	X
0xF0	Synchronous (cyclic every 240th sync)	X[1]	X
0xF1	Reserved	-	-
...	...	-	-
0xFB	Reserved	-	-
0xFC	RTR-only (synchronous)	-	X
0xFD	RTR-only (Event-driven)	-	X
0xFE	Event-driven (manufacturer-specific)	X	X
0xFF	Event-driven (device and application profile)	X	X

[1] For receive PDO, each sync transmission mode equals the same. Each sync always activates the latest received PDO value.

Synchronous means that the PDO is transmitted after the SYNC. The CANopen device starts sampling the data with the reception of the SYNC. If the transmission mode of the PDO is acyclic, the CANopen device gives an internal event, the sampling starts with the next SYNC and the PDO is transmitted afterwards. If the transmission mode is cyclic, the sampling starts with the reception of every SYNC, every second SYNC, every third SYNC etc. depending on the given value, and the PDO is transmitted afterwards.

RTR-only means that the PDO is requested via RTR. If the transmission mode of the PDO is synchronous, the CANopen device starts sampling with the reception of every SYNC and will buffer the PDO. If the mode is event-driven, the CANopen device starts the sampling with the reception of the RTR and transmits the PDO immediately.

Event-driven means that the PDO can be transmitted at any time based on the occurrence of the internal event of the CANopen device. An event that triggers the OPTE6 transmission occurs when the data mapped into the PDO is changed. Also, an event timer can be used to create transmit events.

Inhibit time

For transmit PDOs, the inhibit time defines the minimum transmission interval, when 0xFE or 0xFF transmission types are selected. For receive PDOs, the inhibit time is disabled. The inhibit time is 16bit unsigned value that is given as multiple of 100µs. Zero value means that the inhibit time is disabled.

Event timer

For a transmit PDO event, the timer defines the maximum interval between the transmissions, if the transmission type is set to 0xFE or 0xFF.

For a receive PDO event, the timer activates the deadline monitoring. The deadline monitoring is activated at the first received PDO. If the time between the after the last PDO received is longer than defined in the event timer, a fault will occur.

Event timer is 16bit unsigned value that is given as multiple of 1ms. Zero value means that the event timer is disabled.

NOTE: It is recommended to define non-zero Event timer value when using Event-driven transmission type. By default Event timer value is zero, which together with Event-driven transmission type means that OPTE6 CANopen transmits TPDO only when its data content changes. In certain situations TPDO data content rarely or never changes. For example, when running zero speed, TPDO1 data content (status word and actual speed) does not change after zero speed has been reached.

Sync start value

Sync start value gives the possibility to compensate network peak traffic in case of sync transmission mode. If the sync start value is zero, the normal sync behavior for the PDO is used. If the sync start value is greater than zero, the PDO waits for the SYNC message that contains the counter value. When the counter value of a SYNC message equals the SYNC start value, the first SYNC message is regarded as received. The sync start value must not be changed while the PDO exists. See the SYNC message format in Table 31.

3.5.4 PDO parameter mapping record

Each PDO consists of a maximum of 8 bytes of mapped data. To data map the PDO, use a corresponding mapping record that consists of index, sub-index and the length of the mapped object.

NOTE! All VACON® AC drives supports transferring of eight (8) process data items between master device and AC drive. Read about usage of 9-16 process data items in Chapter 3.5.

Table 28: PDO mapping structure

31 16	15 8	7 0
Index	Sub-index	Length

Table 29: PDO mapping parameter record

Indexes	Sub-index	Name	Data type	Access
0x1600 0x1601 0x1602 0x1603 0x1604 0x1A00 0x1A01 0x1A02 0x1A03 0x1A04	0	Number of mapped objects in PDO	UNSIGNED8	r/w
	1	1st object to be mapped	UNSIGNED32	r/w
	2	2nd object to be mapped	UNSIGNED32	r/w
	3	3rd object to be mapped	UNSIGNED32	r/w
	4	4th object to be mapped	UNSIGNED32	r/w

To data map the PDOs, first disable the related PDO COB ID in the pre-operational state. In the mapping structure, write the sub-index 0 to zero (number of mapped objects). Then write the mapping structures on the mapping parameter record, starting from the sub-index 1. When you have written all the necessary structures, write the sub-index 0 to correspond to the mapped objects.

Example on how to write a dummy object to RPDO1 4th entry (when using Bypass mode) is explained below:

Table 30: RPDO mapping example

Transfer data (hex)	Interpretation
23 00 14 01 **01 02 00 80**	Write RPDO1 COB-ID (1400:01) to invalid (**0x8000 0201**)
2F 00 16 00 **00** 00 00 00	Write RPDO1 mapping number of entries (1600:00) to **0**
23 00 16 04 **10 00 06 00**	Write RPDO1 4th entry (1600:04) to Dummy object (**00060010**)
2F 00 16 00 **04** 00 00 00	Write RPDO1 mapping number of entries (1600:00) to **4**
23 00 14 01 **01 02 00 00**	Write RPDO1 COB-ID (1400:01) as valid (**0x201**)

3.6 SYNC protocol

Sync protocol is used by PDOs when the transmission is synchronous. The sync object that is defined by COB ID in the object 0x1005 triggers the transmission of the txPDOs, or activates the previously received data of the rxPDO. At the default sync message the CAN-ID is 0x80. The sync message is a zero-length message but optionally it can consist of an 8bit counter.

Table 31: SYNC message

CAN ID	LENGTH
0x80	0x0

Table 32: SYNC message with counter

CAN ID	LENGTH	DATA0
0x80	0x1	Counter

3.6.1 SYNC with counter

When a counter is used in a sync message, the PDOs that have a defined sync start value compare the value against the sync message counter. The sync producer counter will overflow after it reaches the value defined in its 'synchronous counter overflow value' at the object 0x1019. Also, the sync consumer has the object 0x1019 even when the value itself is ignored. When the value of the sync consumer is greater than zero, the sync counter handling and expecting of the sync messages with counter are activated.

When the sync start value and the sync counter value match, the first sync message is regarded as received.

The following figure shows an example of SYNC messaging, when the slave is configured with:

- 0x1019 - Synchronous counter 128
- 0x1800,2 - Transmission type = 2 (Cyclic, No. of SYNCs = 2)
- 0x1800,6 - Sync start value = 4

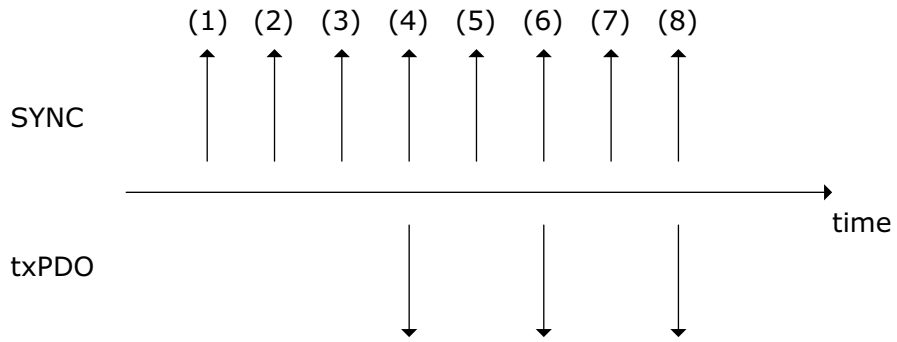

Figure 2. txPDO responses to SYNC messages

Table 33: Sync-related object in OD

Index	Description
0x1005	COB ID SYNC
0x1019	Synchronous counter
0x1014	EMCY object COB ID
0x1400	1st rxPDO communication parameter record
0x1401	2nd rxPDO communication parameter record
0x1402	3rd rxPDO communication parameter record
0x1403	4th rxPDO communication parameter record
0x1404	5th rxPDO communication parameter record
0x1800	1st txPDO communication parameter record
0x1801	2nd txPDO communication parameter record
0x1802	3rd txPDO communication parameter record
0x1803	4th txPDO communication parameter record
0x1804	5th txPDO communication parameter record

3.7 Communication objects

3.7.1 0x1000 - Device Type

The device type object indicates basic information about the device, including the supported device profile and the profile settings.

Table 34: 0x1000 Device type

Index	Sub-index	Value	Name	Data type	Access
0x1000	-	0x00010192	Device type	UNSIGNED32	const

Value description:

0x0192 = 402 (Drive profile)

0x0001 = AC drive with PDO set for a generic drive device

3.7.2 0x1001 - Error Register

Error register indicates the active error code.

Table 35: 0x1001 Error register

Index	Sub-index	Value	Name	Data type	Access
0x1001	-	0x0	Error register	UNSIGNED8	ro

Table 36: Error register bit descriptions

Bit	Meaning
0	Generic error
1	Current
2	Voltage
3	Temperature
4	Communication error (overrun, error state)
5	Device profile-specific*
6	Reserved*
7	Manufacturer-specific*

* Not used/supported

3.7.3 0x1003 - Pre-defined Error Field

Predefined error field is a list of errors signaled with an EMCY object, listing the error history of up to 9 error entries. Sub-index 1 contains the latest error.

Table 37: 0x1003 Predefined error field

Index	Sub-index	Value	Name	Data type	Access
0x1003	0	0x0	Number of errors	UNSIGNED8	ro
	1	0x0	Standard error field	UNSIGNED32	ro
	..	..	..	..	..
	9	0x0	Standard error field	UNSIGNED32	ro

3.7.4 0x1005 - COB ID SYNC

Defines the synchronization message COB ID. Receiving the sync message causes actions in the PDOs that have a synchronous transmission mode.

Table 38: 0x1005 COB ID sync

Index	Sub-index	Value	Name	Data type	Access
0x1005	-	0x00000080	COB ID sync	UNSIGNED32	r/w

3.7.5 0x100C - Guard Time

The object contains the guard time in milliseconds. As a default, guarding is disabled.

Table 39: 0x100C Guard time

Index	Sub-index	Value	Name	Data type	Access
0x100C	-	0x0000	Guard time	UNSIGNED16	r/w

3.7.6 0x100D - Life Time Factor

Life time factor is used together with guard time, which is multiplied with the life time factor.

Table 40: 0x100D Guard time

Index	Sub-index	Value	Name	Data type	Access
0x100D	-	0x00	Guard time	UNSIGNED8	r/w

Node life time = life time factor x guard time. If node life time is zero, guarding is disabled.

3.7.7 0x1014 - COB ID EMCY

The object defines the emergency message COB ID.

Table 41: 0x1014 COB ID EMCY

Index	Sub-index	Value	Name	Data type	Access
0x1014	-	0x00000080+ node id	COB ID EMCY	UNSIGNED32	r/w

Setting MSB (bit 31) to 1 will disable sending of EMCY messages.

3.7.8 0x1016 - Heartbeat Consumer Entries

The device can act as the heartbeat consumer. Up to 8 devices can be monitored, as defined in the table below. If the heartbeat transmission delay of a defined node ID exceeds the heartbeat time, the error behavior is activated according to the error behavior object.

Table 42: 0x1016 Heartbeat consumer entries

Index	Sub-index	Value	Name	Data type	Access
0x1016	0	0x08	Number of entries	UNSIGNED8	ro
	1	0x0000 0000	Consumer heart beat time 1	UNSIGNED32	r/w
	2	0x0000 0000	Consumer heart beat time 2	UNSIGNED32	r/w
	3	0x0000 0000	Consumer heart beat time 3	UNSIGNED32	r/w
	4	0x0000 0000	Consumer heart beat time 4	UNSIGNED32	r/w
	5	0x0000 0000	Consumer heart beat time 5	UNSIGNED32	r/w
	6	0x0000 0000	Consumer heart beat time 6	UNSIGNED32	r/w
	7	0x0000 0000	Consumer heart beat time 7	UNSIGNED32	r/w
	8	0x0000 0000	Consumer heart beat time 8	UNSIGNED32	r/w

Table 43: Consumer heartbeat time entry

31 24	23 16	15 0
Not used, must be zeroes.	Node ID	Heartbeat time

3.7.9 0x1017 - Producer Heartbeat Time

Heartbeat producer object consists of the time in milliseconds (ms) that it takes to transmit the heartbeat message into the network. If the value is zero, the heartbeat is not used.

Table 44: 0x1017 Producer heartbeat time

Index	Sub-index	Value	Name	Data type	Access
0x1017	-	0x0000	Producer heartbeat time	UNSIGNED16	r/w

Table 45: Heartbeat message

CAN ID	LENGTH	DATA0
0x700 + node	0x1	Node state

3.7.10 0X1018 - IDENTIFY OBJECT

The object gives information about the option board

Table 46: 0x1018 Identify object

Index	Sub-index	Value	Name	Data type	Access
0x1018	0	0x04	Number of entries	UNSIGNED8	ro
	1	0x90	Vendor ID	UNSIGNED32	ro
	2	-	Product code	UNSIGNED32	ro
	3	-	Revision number	UNSIGNED32	ro
	4	-	Serial number	UNSIGNED32	ro

3.7.11 0X1019 - SYNCHRONOUS COUNTER OVERFLOW VALUE

The synchronous counter overflow value defines whether a counter is mapped into the SYNC message, as well as the highest value the counter can reach. 0 disables the sync counter.

Table 47: 0x1019 Synchronous counter

Index	Sub-index	Value	Name	Data type	Access
0x1019	-	0x00	Synchronous counter	UNSIGNED8	r/w

3.7.12 0X1029 - ERROR BEHAVIOR

Error behavior allows a change in the default error behavior if there is a communication error.

Table 48: 0x1029 Error behavior

Index	Sub-index	Value	Name	Data type	Access	Min	Max
0x1029	0	0x01	Number of entries	UNSIGNED8	ro	2	2
	1	0x00	Communication error	UNSIGNED8	r/w	0	2
	2	0x01	Internal error	UNSIGNED8	r/w	1	1

Table 49: Error behavior

Value	Description
0	Pre-operational
1	No change in state
2	Stopped
3..127	Reserved

3.8 Saving and restoring the object dictionary

CANopen defines a way of restoring the values in an object dictionary to the defaults and saving the values if the modified values must be valid after the power cycle. The manufacturer-specific bypass configuration can be restored to the object dictionary.

3.8.1 0x1010 Store parameter field

To save the object dictionary, use the object 0x1010 'Store Parameter Field'.

The option board only saves the parameters in the object dictionary with a command. Autonomous saving is not supported. To save the parameters in the object dictionary, write the value 0x65766173 (ASCII "save") into the sub-index by using the SDO protocol.

Table 50: 0x1010 Store parameter field

Index	Sub-index	Name	Data type	Access
0x1010	0	Highest sub-index supported	UNSIGNED8	ro
	1	Save all parameters	UNSIGNED32	r/w

3.8.2 0x1011 Restore default parameters

The object values of the object dictionary are restored to defaults by using the object 0x1011. Option board supports restoring All parameters (sub index 1) and manufacturer-specific Bypass mode defaults (sub index 4).

To restore parameters, write 0x64616F6C (ASCII "load") into the sub-index by using the SDO protocol. Default object values are selected after reset. Restore all default parameter restores CiA-402 default parameters (refer to Chapter 7.2.2.2). Bypass parameter set is described in Chapter 7.3.

Table 51: 0x1011 Restore default parameters

Index	Sub-index	Name	Data type	Access
0x1011	0	Highest sub-index supported	UNSIGNED8	ro
	1	Restore all default parameters	UNSIGNED32	r/w
	4	Restore bypass parameter set*	UNSIGNED32	r/w
	5	Restore Puller parameter set	UNSIGNED32	r/w
	6	Restore Co-Extruder parameter set	UNSIGNED32	r/w

* The bypassed set disables the CIA- 402 drive profile and resets the PDO mapping to the vendor specific configuration. See Chapter 7.2 and Chapter 7.3 for more information.

4. CANopen option board OPTE6 - technical data

4.1 General

Table 52. Technical data of CANopen option board

CAN bus electrical isolation	500 V DC	
Ambient temperature	Same as for the used AC drive. Refer to the drive manual.	
Storing temperature	Same as for the used AC drive. Refer to the drive manual.	
Humidity	0-95%, non-condensing, corrosive	
Vibration and electrical safety	EN 61800-5-1 (2007) 5... 15.8 Hz 1 mm (peak) 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	±8 kV ESD IEC 61000-4-2 Contact Discharge ±80 V Fault Protection greater than ±12 V common Mode Range

4.2 New features

The following table shows new major features that are added in the OPTE6 CANOpen option board's firmware versions.

Table 53. OPTE6 CANopen firmware versions

New features	Firmware version
• Support for VACON® NXP drive. • Support for Fast Communication and 16 process data when installed to NXP drive. See details in Chapter 13. Appendix E - Fieldbus option board communication.	V010
• Support for modifiable CANopen parameters and monitor values via keypad in VACON® 100 product family. CANopen parameters can also be stored and restored to/from keypad or PC tool. Functionality requires the following or newer AC drive control firmware version: - VACON® 100 INDUSTRIAL and 100 X: FW0072V029 - VACON® 100 FLOW: FW0159V018 • Support for CiA-420 EUROMAP extruder and puller. Note that this requires special AC drive application.	V009
• Support for new 70CVB01605 hardware. Firmware can be used also with older 70CVB01124 hardware.	V008
• Miscellaneous improvements	V007
• Miscellaneous improvements	V006
• Support for VACON® 100 INDUSTRIAL, VACON® 100 FLOW, VACON® 100 X, VACON® 20 X/CP and VACON® 20 drives.	V005

4.3 CAN cable

The recommended cables for installations are 4 wires twisted and a shielded cable with an impedance of 120 Ω. 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 Ω, and so for the termination resistors of ~120 Ω must be used. For long networks a higher resistor value must be used (150-300 Ω).

Table 54. Bus parameter relation to cable length

Cable length	Max bit rate [kbit/s]	Max cable resistance [mΩ/m]
0-40 m	1000	Max 70
100 m	500	<60
500 m	100	<40
1 km	50	<26

4.3.1 Isolated ground connection

The OPTE6 option board is galvanically isolated. In CANopen networks that are completely galvanically isolated the CAN ground signal is carried in the cable line. It is connected at only one point into common ground potential. If one CAN device with not galvanically isolated interface is connected to the network, the potential for isolated CAN ground is given. Therefore only one device with not galvanically isolated interface may be connected to the network.

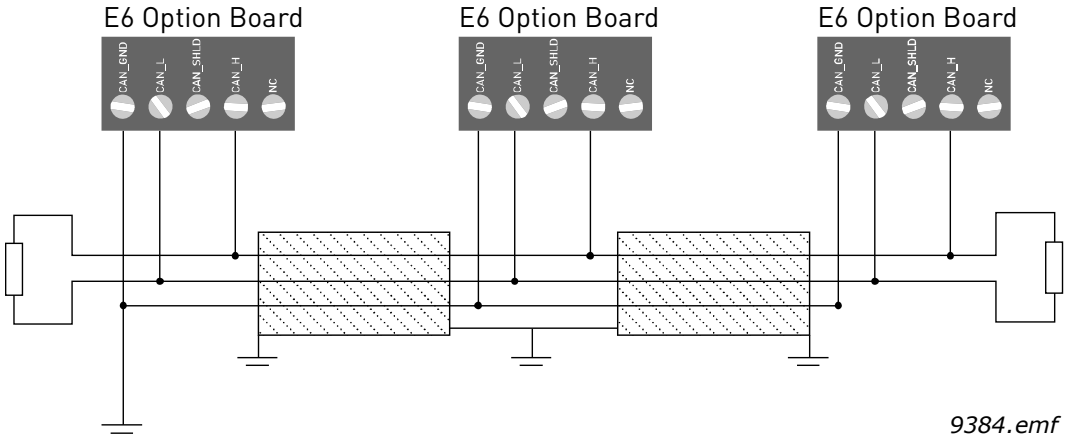

Figure 3. Completely isolated nodes

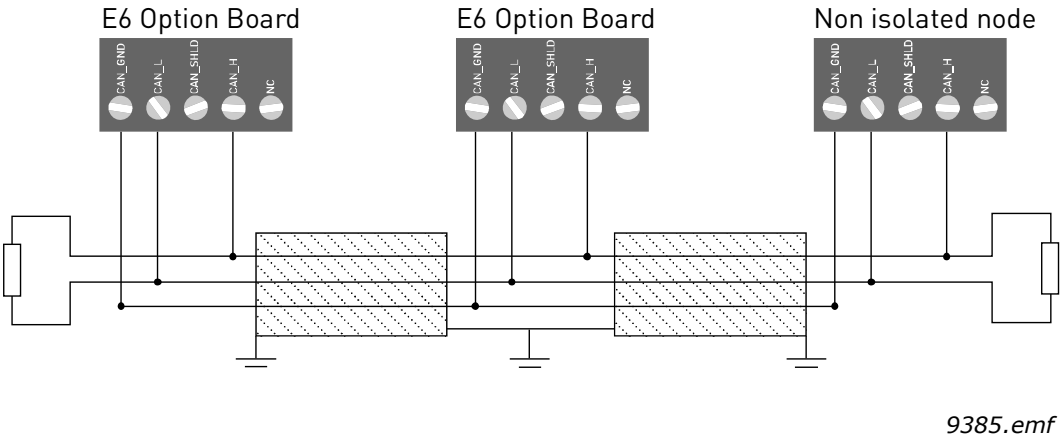

Figure 4. CAN network with one non-isolated node

4.3.2 Recommended cable

For all OPTE6 installations the use of 4-wire cable is recommended. 4 wires enable the connection of isolated digital grounds with nodes.

VACON® recommends the following cable:

UNITRONIC® BUS CAN FD P

Color-coded in accordance with DIN 47100

Figure 5. Recommended cable

Table 55. Cable thickness, length and baud rate relation

Bit rate	Min cable thickness			
1 Mbit/s	0.25			
500 kbit/s	0.25	0.34		
250 kbit/s	0.25	0.34	0.6	
125 kbit/s	0.25	0.34	0.6	
100 kbit/s	0.25	0.34	0.6	0.6
50 kbit/s	0.25	0.34	0.6	0.6
Cable length	25	100	250	500

5. OPTE6 LAYOUT AND CONNECTIONS

5.1 LAYOUT AND CONNECTIONS

OPTE6 has two different hardware revisions with slightly different layout. Layout is different in LED arrangement and termination resistor orientation.

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

The two hardware revisions are named 70CVB01605 and 70CVB01124.

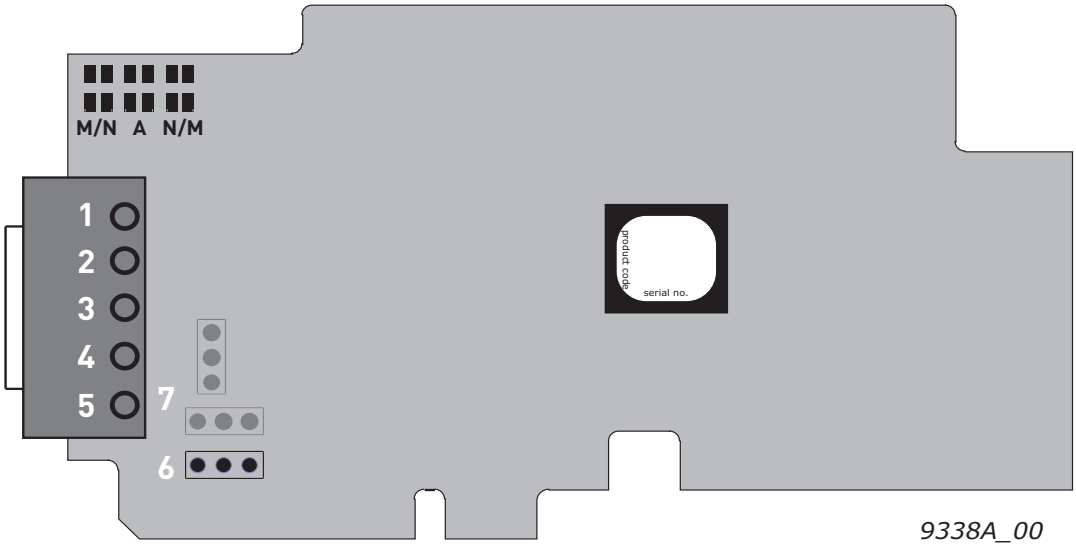

Figure 6. OPTE6 board layout

1 = CAN GND (isolated digital ground reference)
2 = CAN L
3 = SHIELD (shield connector)
4 = CAN H
5 = NC (No connection)
6 = Grounding option jumper
7= Bus termination resistor

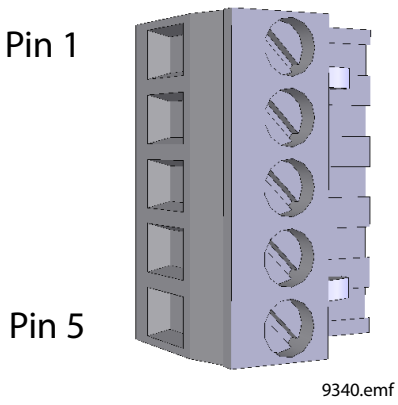

Figure 7. CAN connector

CAN connector pinout

Pin out	
1	CAN GND, isolated digital ground reference
2	CAN LO
3	Shield connector
4	CAN HI
5	No connection

5.2 LED Indications

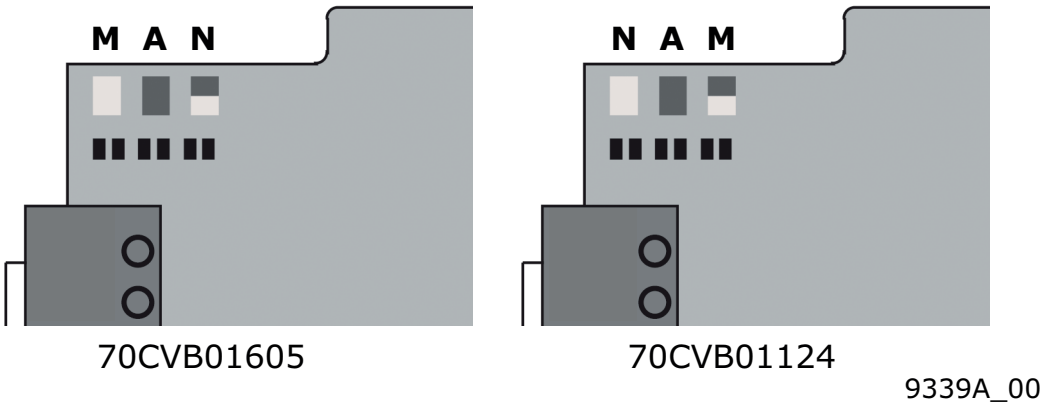

Figure 8. LED indicators

M = CANopen run led

A = CANopen err led

N = Board status

CANopen run led (green)

LED is	Description
Blinking	The CANopen device is in the pre-operational state.
Single flash	The CANopen device is in the stopped state.
ON	The CANopen device is in the operational state.

CANopen err led (red)

LED is	Description
OFF	No error
Blinking	Invalid configuration
Single flash	At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many error frames).
Double flash	A guard event (NMT slave or NMT master) or a heartbeat event (heartbeat consumer) has occurred.
Quadruple flash	An expected PDO was not received before the event timer elapsed.
ON	The CAN controller is bus-off.

Board status led (green)

LED is	Description
OFF	Option board is not activated.
ON	Option board is in initialization state, waiting activation command from the AC drive.
Blinking (once/1s)	Option board is activated and in RUN state. Option board is ready for external communication.

5.3 JUMPER SETTINGS

For the termination resistor jumper settings, see the *VACON® RS485 and CAN Bus Option Boards Installation Guide*.

6. COMMISSIONING

This chapter describes how to commission the OPTE6 board for use. For instructions on how to set-up the AC drive to be controlled over fieldbus, refer to Chapter 10 Appendix B - Fieldbus parametrization.

6.1 OPTE6 PANEL PARAMETERS

Different number of panel parameters are visible depending on the used AC drive and version.

VACON® NX family option board parameters are found under "Expander boards". Path depends on used slot where OPTE6 is installed (7.4.1 or 7.5.1).

VACON® 100 family option board parameters are found under "I/O and Hardware". Path depends on used slot where OPTE6 is installed (5.3.1 or 5.4.1).

VACON® 20 family option board parameters are under SYS menu.

Table 56. OPTE6 board basic parameters

#	Parameter	Min	Max	Default	Description
1	Node ID	1	127	1	Network-wide unique identifier for each CANopen device
2	Baud Rate	3	8	5	Data signalling rate. Should be the same on each node in the same bus. See Table 57
3	Operate Mode	1	4	1	Selection between OPTE6 operate modes. See Table 58
4*	Comm. Timeout	0	65535	1	Timeout in seconds for CAN communication faults (PASSIVE, BUS-OFF)
5*	Restore from Set	0	1	0	0 -> 1 All CANopen parameters are reset to default values based on Operate Mode.
6*	Mode	0	1	0	Set OPTE6 mode. See Table 59

* From version V26 (VACON® 100 INDUSTRIAL) and V18 (VACON® 100 FLOW) and V196 (VACON® NXP).

Table 57. OPTE6 Baud Rate settings

Value	Bit rate
1	10 kbps (not supported)
2	20 kbps (not supported)
3	50 kbps
4	100 kbps
5	125 kbps
6	250 kbps
7	500 kbps
8	1000 kbps

Table 58. OPTE6 Operate Mode settings

Value	Name	Description
1	Drive Profile	CiA-402 drive profile, velocity mode active
2	Bypass	VACON® specific bypass mode active
3	Puller*	CiA-420 EUROMAP profile, puller mode active
4	Co-Extruder*	CiA-420 EUROMAP profile, co-extruder mode active

*Restricted availability, requires use of special application

Baud Rate: used in CANopen communication. Regardless of the selected bitrate, the bit sample timing is set as close as possible to 87.5 % according to the CANopen specification.

Operate Mode: is used to change the modes of operation between standardized profile modes and VACON® specific Bypass mode.

Different operate modes activate different device profile segment objects. Accessing e.g. CiA-402 velocity profile objects in Bypass mode is not possible. See Chapter 7.2 Velocity mode and Chapter 7.3 Bypass mode.

Comm. Timeout: Fieldbus communication timeout is time in seconds after a fault is created from CAN bus communication errors (PASSIVE, BUS-OFF). Setting this value to 0 disables CAN bus errors from triggering a fault in AC drive. This does not affect other CANopen faults, e.g. heartbeat consumer times. This value is the same as object 0x2004 - Communication timeout. See conditions when fieldbus communication timeout is activated in Chapter 8.2 Fieldbus timeout fault (F53).

Table 59. OPTE6 Mode settings

Value	Description	Details
1	Normal	
2	Pre V008	Anyparameter service behaves same as version 7 and earlier in VACON® 100 family devices. See Chapter 7.5 for more details.

Mode: compatibility mode(s) can be activated using this parameter. This parameter is the same as object 0x2005 - Mode.

6.1.1 OPTE6 ADDITIONAL PANEL PARAMETERS

From VACON® 100 (INDUSTRIAL V027 and FLOW V018) and OPTE6 V009 firmware version forwards, CANopen bus communication parameters are stored and can also be modified directly from panel parameters. The stored parameters are modifiable and stored under the "Parameters" menu and these parameters are restored after power cycle. The active settings are visible under the "Monitor" menu.

These parameters are separated into sub-folders for easier modification. It is recommended to use VACON® Live PC-tool to modify the parameters.

Table 60. OPTE6 board CANopen object parameters under General folder

Parameter	Default	Reference
Sub menu: General		
COB-ID SYNC	0x80	3.7.4
Guard Time	0	3.7.5
Life Time Factor	0	3.7.6

Table 60. OPTE6 board CANopen object parameters under General folder

Parameter	Default	Reference
COB-ID EMCY	0x80 + Node ID	3.7.7
Sync Counter Ovf.	0	3.7.11
Error Behavior	0	3.7.12
Sub menu: Heartbeat		
Producer Time	0	3.7.9
Consumer Time 1	0	3.7.8
Consumer Time 2	0	
Consumer Time 3	0	
Consumer Time 4	0	
Consumer Time 5	0	
Consumer Time 6	0	
Consumer Time 7	0	
Consumer Time 8	0	
Sub menu: RPDO1 Communication		
COB-ID	0x200 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	0	
Event Timer	0	
Sub menu: RPDO2 Communication		
COB-ID	0x80000300 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	0	
Event Timer	0	
Sub menu:RPDO3 Communication		
COB-ID	0x80000400 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	0	
Event Timer	0	
Sub menu: RPDO1 Mapping		
Number of Entries	2	3.5.4
1st Application Obj.	0x60400010	
2nd Application Obj.	0x60420010	
3rd Application Obj.	0	
4th Application Obj.	0	
Sub menu: RPDO2 Mapping		

Table 60. OPTE6 board CANopen object parameters under General folder

Parameter	Default	Reference
Number of Entries	4	3.5.4
1st Application Obj.	0x20000410	
2nd Application Obj.	0x20000510	
3rd Application Obj.	0x20000610	
4th Application Obj.	0x20000710	
Sub menu: RPDO3 Mapping		
Number of Entries	4	3.5.4
1st Application Obj.	0x20000810	
2nd Application Obj.	0x20000910	
3rd Application Obj.	0x20000A10	
4th Application Obj.	0x20000B10	
Sub menu: TPDO1 Communication		
COB-ID	0x180 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	100	
Event Timer	0	
Sync Start Value	0	
Sub menu: TPDO2 Communication		
COB-ID	0x80000280 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	1000	
Event Timer	0	
Sync Start Value	0	
Sub menu: TPDO3 Communication		
COB-ID	0x80000380 + Node ID	3.5.2
Transmission Type	0xFE	3.5.3
Inhibit Time	1000	
Event Timer	0	
Sync Start Value	0	
Sub menu: TPDO1 Mapping		
Number of Entries	2	3.5.4
1st Application Obj.	0x60410010	
2nd Application Obj.	0x60440010	
3rd Application Obj.	0	
4th Application Obj.	0	
Sub menu: TPDO2 Mapping		

Table 60. OPTE6 board CANopen object parameters under General folder

Parameter	Default	Reference
Number of Entries	4	3.5.4
1st Application Obj.	0x20010410	
2nd Application Obj.	0x20010510	
3rd Application Obj.	0x20010610	
4th Application Obj.	0x20010710	
Sub menu: TPDO3 Mapping		
Number of Entries	4	3.5.4
1st Application Obj.	0x20010810	
2nd Application Obj.	0x20010910	
3rd Application Obj.	0x20010A10	
4th Application Obj.	0x20010B10	

Considerations when modifying the CANopen object related parameters:

- All settings written to the CANopen related panel parameters are taken into use immediately if the value is valid
- No error is given if parameter value is invalid, instead the parameter value is restored back to previous value when read back
- Writing of an invalid value (for example 0) to a PDO mapping application object is not allowed. If a mapping must be invalidated, use the number of entries parameter to set the number of used objects
- All settings written via CANopen objects (bus parameters) are not automatically stored and visible in the panel parameters. Only after giving the "Save all parameters" command (object 0x1010,1), the parameters written from bus are stored to parameters
- Parameter Error Behavior is linked to the Communication error (object 0x1029:01)

6.1.2 PANEL PARAMETER CHANGE REACTION

Changing of a parameter can change CANopen parameterization depending on what parameter is changed and what has been previously parameterized. This chapter clarifies the changes that occur in OPTE6 while parameters are changed from panel parameters or from CANopen objects that are linked to these parameters. Note that there are some differences between OPTE6 versions.

Changing of Node ID:
V008 and earlier: No difference to any stored parameter (listed in Table 60). This means that if the COB-IDs of e.g. PDO communication parameters need to be recalculated using the new Node ID one of the following actions must be performed:

- Change operate mode parameter (or toggle back and forth)
- Restore default parameter set from bus using the 0x1011 object and sending a reset node message

V009 forwards: COB-IDs are recalculated using the new Node ID and validity of COB-ID. Therefore, the following objects are changed:

Object	Name	New value if enabled	New value if disabled
0x1014	COB-ID EMCY	0x80 + Node ID	0x80000080 + Node ID
0x1400:01	(RPDO1) COB-ID	0x200 + Node ID	0x80000200 + Node ID
0x1401:01	(RPDO2) COB-ID	0x300 + Node ID	0x80000300 + Node ID
0x1402:01	(RPDO3) COB-ID	0x400 + Node ID	0x80000400 + Node ID
0x1403:01	(RPDO4) COB-ID	0x500 + Node ID	0x80000500 + Node ID
0x1404:01	(RPDO5) COB-ID	Not changed	
0x1800:01	(TPDO1) COB-ID	0x180 + Node ID	0x80000180 + Node ID
0x1801:01	(TPDO2) COB-ID	0x280 + Node ID	0x80000280 + Node ID
0x1802:01	(TPDO3) COB-ID	0x380 + Node ID	0x80000380 + Node ID
0x1803:01	(TPDO4) COB-ID	0x480 + Node ID	0x80000480 + Node ID
0x1804:01	(TPDO5) COB-ID	Not changed	

The 5th PDOs are not automatically calculated, as the CANopen standard Predefined Connection set supports 4 transmit and receive PDOs. If 4 PDOs per device is not sufficient, you must define custom COB-IDs for PDOs.

Any heartbeat consumer entry using the new Node ID is reset to default value. No other parameters are affected.

If special PDO communication settings are used, these settings are overwritten and must be restored. They can be restored from bus, panel or PC-tool. It is recommended to create a user set (with PC-tool) before changing the Node ID setting and restoring it after changing Node ID (and Operate Mode).

Changing of Operate Mode:
V008 and earlier: All CANopen communication parameters are restored to use operate mode specific default values.

V009 forwards: Only PDO communication and mapping parameters are restored to use mode specific default values. CANopen communication objects such as Heartbeat and Node guarding are not modified.

Using "Restore from Set" parameter:
When writing any value (other than zero) to this parameter, all CANopen communication parameters are restored to default parameters and PDO communication and mapping parameters are restored to default parameters of the currently active operate mode.

Node ID, operate mode, baud rate, communication timeout and mode parameters are not affected.

After the restore the parameter value is set back to zero automatically.

6.1.3 REPLACING OPTION BOARD AND PARAMETER RESTORE

CANopen parameters must be defined for OPTE6 CANopen board in case the board is replaced in the field. Table 56 defines OPTE6 basic parameters and Table 60 defines CANopen communication parameters.

From the following AC drive models it is possible to take a complete CANopen parameter backup with Keypad or VACON® Live PC tool. The CANopen parameter backup can be restored to another OPTE6 board. This functionality requires that OPTE6 CANopen board contains V009 firmware or newer.

- VACON® 100 INDUSTRIAL (control firmware FW0072V029 or newer)
- VACON® 100 X (control firmware FW0072V029 or newer)
- VACON® 100 FLOW (control firmware FW0159V018 or newer)

From the following AC drive models it is possible to take parameter backup of the OPTE6 board's basic parameters that are defined in Table 56. The backup can be taken and restored from/to the board with Keypad or VACON® Live PC tool. CANopen communication parameters must be defined by writing them via CAN bus.

- VACON® NXP
- VACON® 20
- VACON® 20 X
- VACON® 20 Cold Plate

In all cases CANopen communication parameters (Table 60) can be defined for OPTE6 CANopen board by writing them via CAN bus. CANopen objects used for CANopen parametrization are defined in Chapter 9 Appendix A: Object dictionary.

OPTE6 parameters can be restored into default settings by using "Restore from set" parameter with Keypad or VACON® Live PC tool. See Chapter 6.1 OPTE6 panel parameters.

NOTE: OPTE6 board's parameters are stored into the board's flash memory. If OPTE6 board is parametrized, for example, in VACON® 100 FLOW drive and then moved into VACON® NXP drive which does not contain CANopen communication parameters, OPTE6 board uses CANopen communication parameters from its internal memory.

6.2 OPTE6 PANEL MONITOR VALUES

Different number of panel monitoring values are visible depending on the used AC drive and version.

VACON® NX family option board parameters are found under "Expander boards". Path depends on used slot where OPTE6 is installed (7.4.2 or 7.5.2).

VACON® 100 family option board parameters are found under "I/O and Hardware". Path depends on used slot where OPTE6 is installed (5.3.2 or 5.4.2).

VACON® 20 family option board monitoring values are under SYS menu.

Table 61. OPTE6 Monitoring Values

#	Parameter	Format	Description
1*	CANopen Status	NNNN.Y	NNNN = A running counter for incoming messages Y = Node CANopen status, see Table 62
2*	Drive CW	-	Control word sent to AC drive from OPTE6
3*	Drive SW	-	Status word received from AC drive
4*	Protocol CW	-	Control word received from CANopen protocol
5*	Protocol SW	-	Status word sent to CANopen protocol

* From version V26 (VACON® 100 INDUSTRIAL) and V18 (VACON® 100 FLOW) and V196 (VACON® NXP).

Table 62. Node CANopen status

Value	Description
0	Initialising
4	Stopped
5	Operational
6	Pre-operational
7	Reset application
8	Reset communication

From VACON® 100 (INDUSTRIAL V027 and FLOW V018) and OPTE6 V009 firmware version forwards, the active CANopen object values are visible as monitoring values. These values are the currently active settings and are equal to values read via CANopen objects. These objects might have different values than the stored parameters, depending if parameters written via bus are stored or not. The values are divided into subfolders same way as the corresponding parameters.

6.3 VACON PC-TOOLS

With VACON PC-tools it is possible to do following operations for OPTE6 CANopen:

- Update firmware into OPTE6 CANopen option board
- Set parameters for OPTE6 CANopen
- Read monitor values of OPTE6 CANopen

6.3.1 PC TOOL SUPPORT

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

Table 63. The supported PC tools with different AC drives

	VACON® 100 family		VACON® NXS/NXP		VACON® 20 family	
Tool	**Serial**	**Ethernet**	**Serial**	**Ethernet**	**Serial**	**Ethernet**
VACON® Loader	x		x		x	
VACON® Live	x	x			x	
NCIPConfig	Not used with OPTE6 CANopen					
NCDrive			x	x		
NCLoad	Not used with OPTE6 CANopen					

6.3.2 OPTE6 OPTION BOARD FIRMWARE UPDATE WITH VACON® LOADER

You can update OPTE6 CANopen firmware with VACON® Loader PC-tool. You need to have:

- PC with VACON® Loader installed
- VACON® AC drive in which OPTE6 CANopen option board is installed
- Serial cable:
  - VACON® NXP is connected to PC with RS232 serial cable which is connected from PC to NXP control unit's 9-pin DSUB connector (female). If PC does not contain RS232 serial port, then USB - RS232 converter device is needed between PC and NXP control.
  - VACON® 100 and VACON® 20 are connected to PC with VACON® Serial Cable.

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

The OPTE6 CANopen firmware can be downloaded from www.danfoss.com/en/service-and-support/ -> Software -> select "Drives" as Business unit -> Fieldbus firmware.

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

NOTE! With VACON® 20, the baud rate 9600 must be used. With VACON® 20 X and VACON® 20 CP, the following baud rates are supported: 9600, 19200, 38400 or 57600. With VACON® 100 and VACON® NXP drives VACON® Loader selects a correct baud rate automatically.

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

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

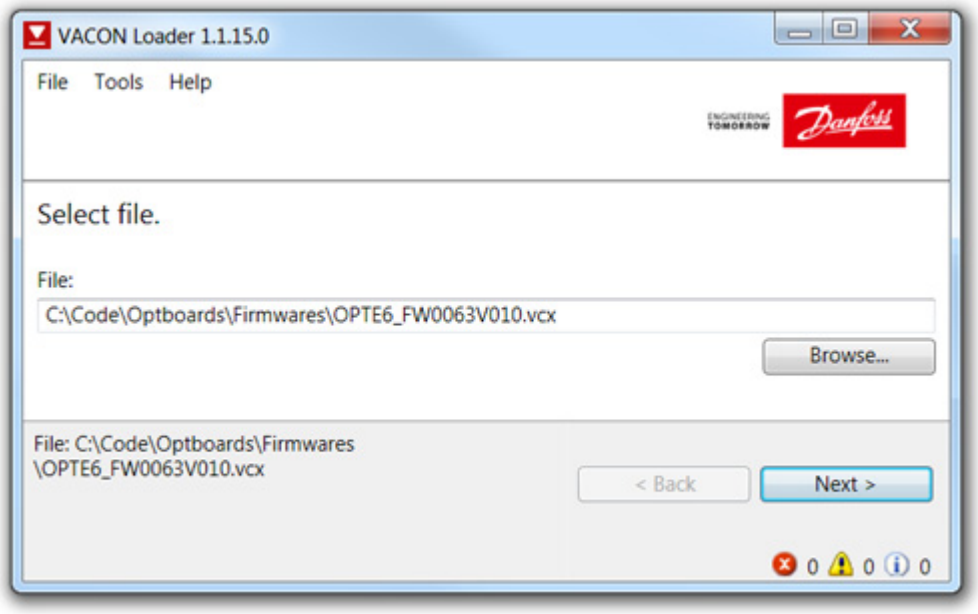

Figure 9. VACON® Loader: File selection

Step 2. Press 'next' and wait for the loader to find the network drives.

Then select a drive from the list and press 'Connect to Selected'.

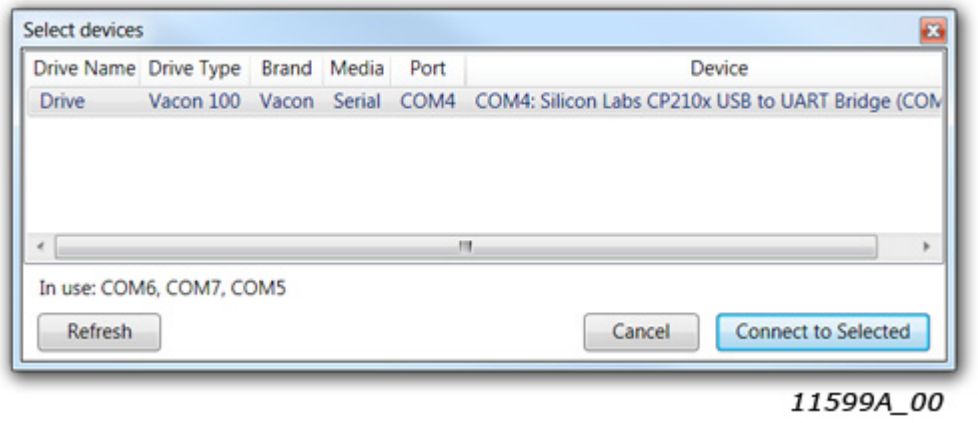

Figure 10. VACON® Loader: Connecting to drive

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

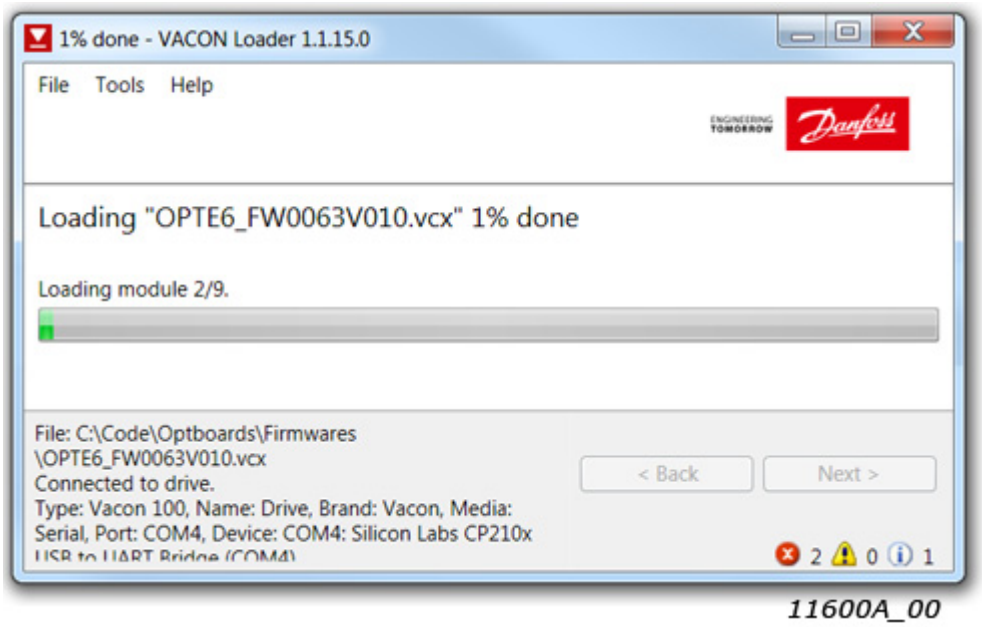

Figure 11. Option board module selection

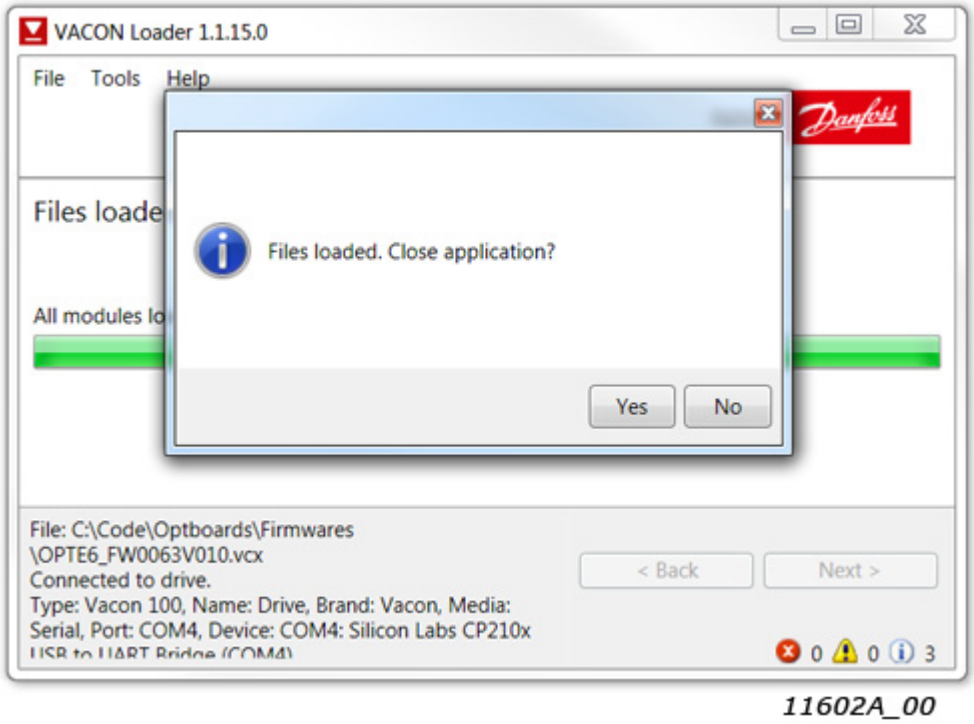

Figure 12.VACON® Loader: Loading is finished

6.3.3 PC TOOLS FOR VACON® NXP: NCDRIVE

You can configure the VACON® NXP AC drive and OPTE6 CANopen parameters with the NCDrive PC-tool. You need to have:

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

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

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

6.3.3.1 NCDrive Serial communication settings

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

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

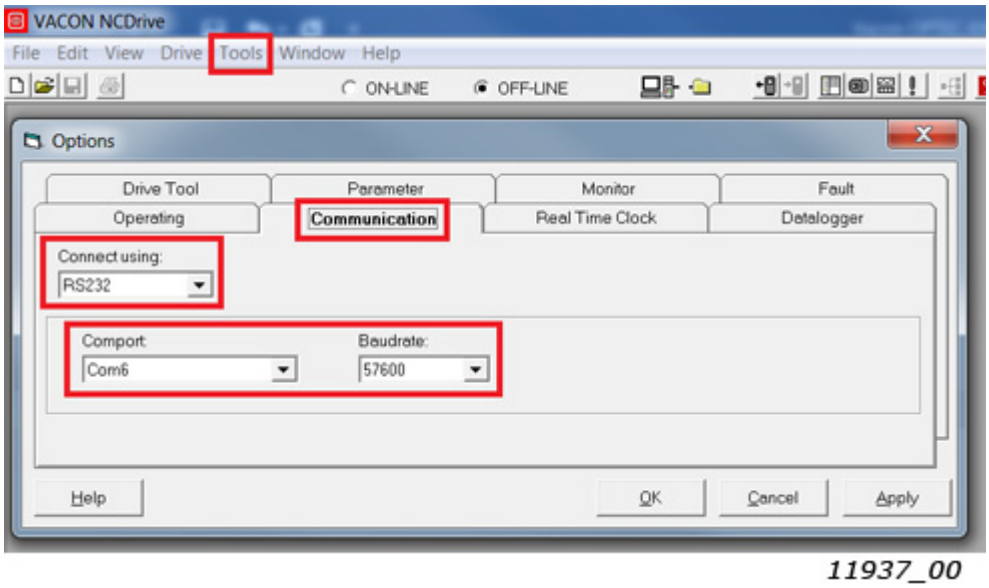

Figure 13. NCDrive: Serial communication settings

6.3.3.2 NCDrive Ethernet communication settings

For NCDrive Ethernet connection you need to have:

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

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

6.3.3.3 Connecting to NCDrive

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

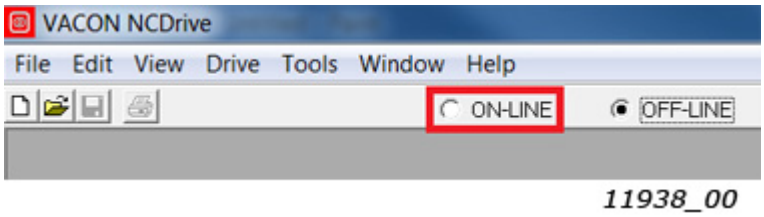

Figure 14. NCDrive: Going online

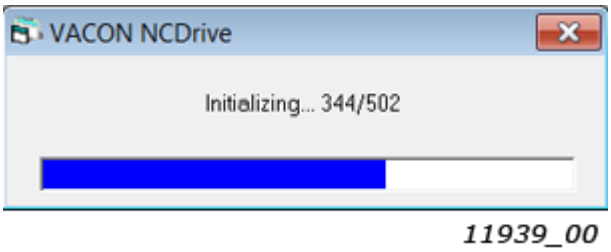

Figure 15. NCDrive: Loading information from the drive

To change the option board settings, navigate to the "M 7 Expander boards" menu and select the slot in which OPTE6 CANopen is connected to. It is possible to change parameters defined in Chapter 6.1 OPTE6 panel parameters.

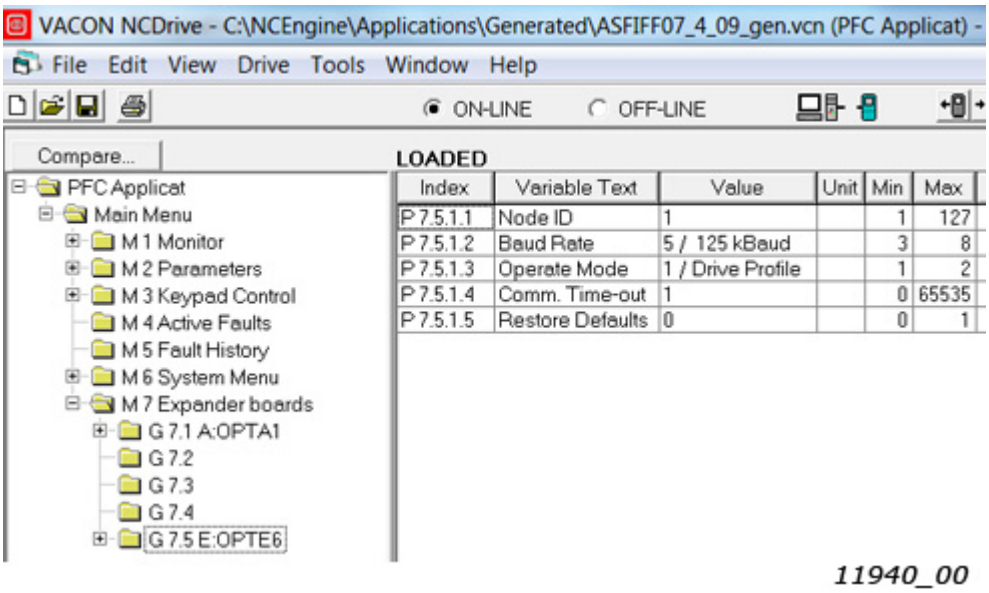

Figure 16. NC Drive: Parameter menu

6.3.4 PC TOOLS FOR VACON® 100 AND VACON® 20: VACON LIVE

You can configure the VACON® 100 AC drives, VACON® 20 AC drives and OPTE6 CANopen parameters with the VACON® Live PC-tool. Also monitor values of these devices can be read with VACON® Live. You need to have:

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

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

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

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

6.3.4.1 VACON Live Serial communication settings

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

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

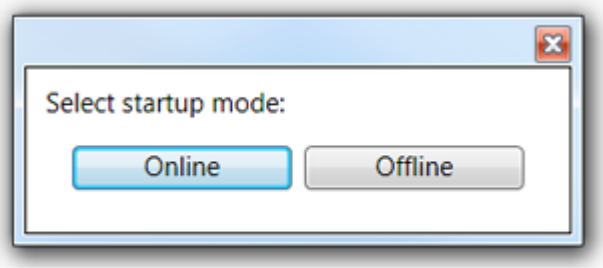

Figure 17. VACON® Live: To online mode

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

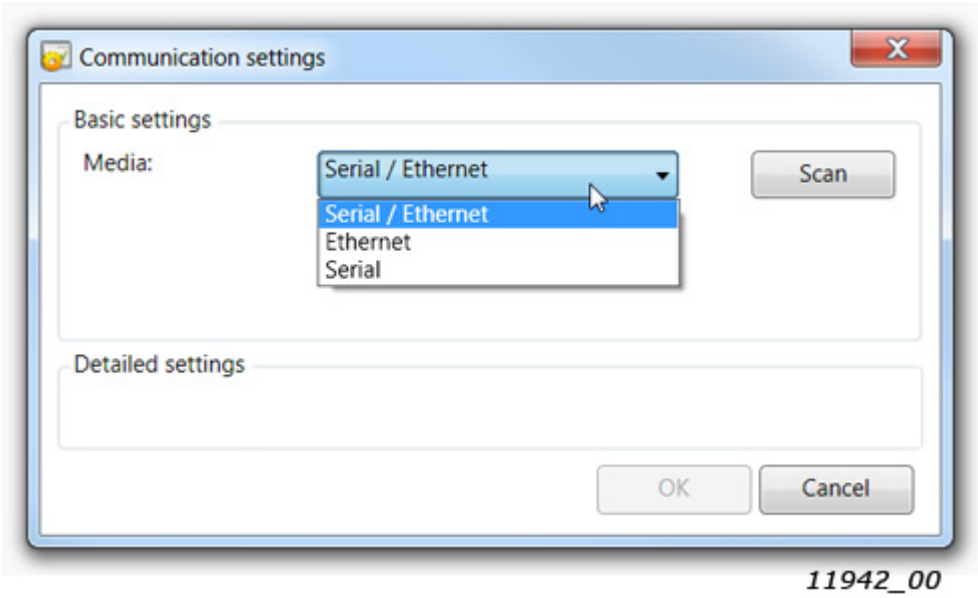

Figure 18. VACON® Live: Communication settings

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

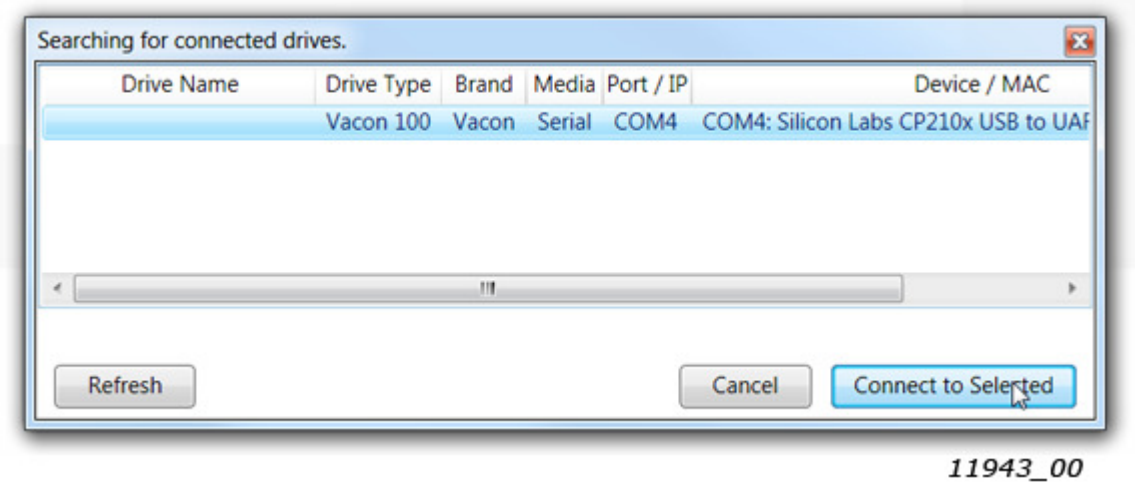

Figure 19.VACON® Live: Communication settings

6.3.4.2 VACON Live Ethernet communication settings

For VACON® Live Ethernet connection you need to have:

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

See instructions from VACON® 100 Modbus, PROFINET IO, Ethernet/IP, BACnet or OPTE9 Dual Port Ethernet option board manual. Manuals can be downloaded from www.danfoss.com/en/service-and-support/ -> Documentation -> Select "Drives" as Business unit -> Select "VACON Option Boards" as Product Series.

6.3.4.3 OPTE6 CANopen parameters in VACON® Live

OPTE6 CANopen parameters and monitor values can be found from "5. I/O and Hardware" menu. With VACON® Live it is possible to modify OPTE6 CANopen parameters and view monitor values.

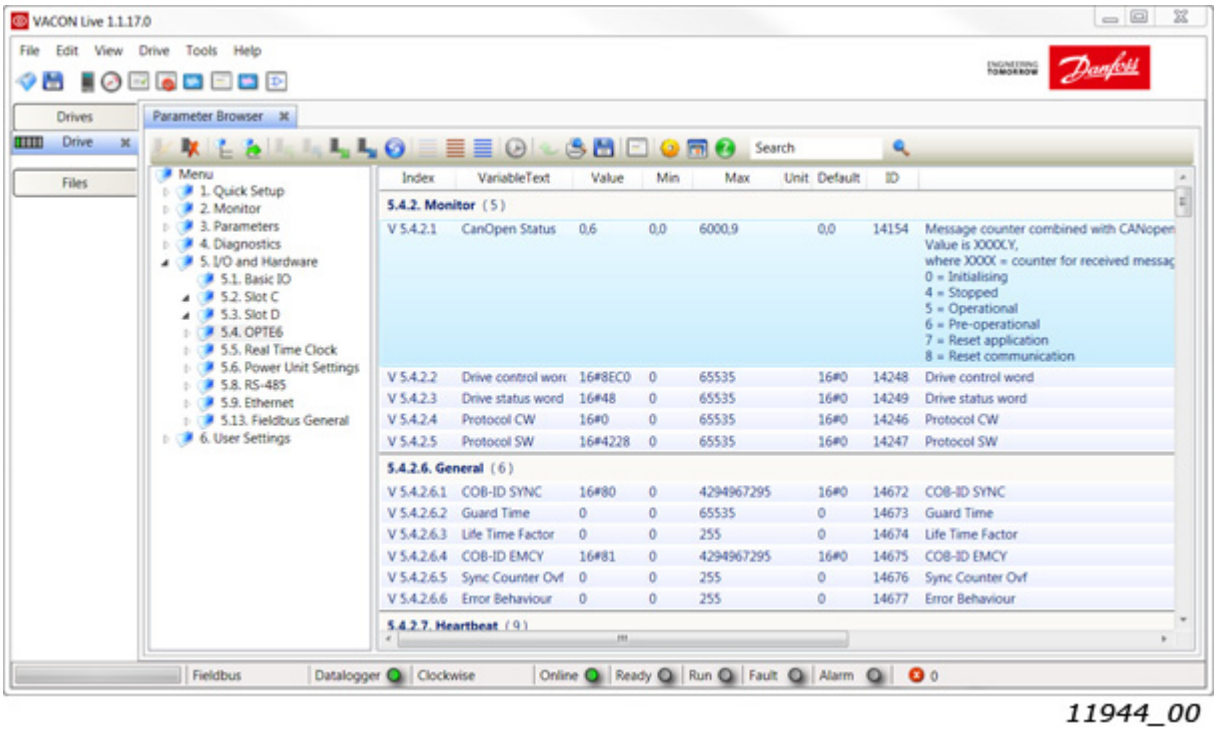

Figure 20. VACON® Live: OPTE6 CANopen parameters.

6.4 QUICK INSTRUCTIONS FOR CONTROLLING THE MOTOR

This chapter gives quick instructions on how to get the motor running using either CiA-402 velocity or Bypass mode using SDO protocol.

1. Set the OPTE6 jumpers, refer to the *VACON® RS485 and CAN Bus Option Boards Installation Guide*.
2. Install OPTE6 option board in VACON® AC drive and connect the CAN cable, refer to the *VACON® RS485 and CAN Bus Option Boards Installation Guide*.
3. Set the option board parameters to establish CANopen communication. Refer to chapter 6.1.
4. Set the AC drive parameters so that it is controlled over fieldbus. Refer to Chapter 10 Appendix B - Fieldbus parametrization

Drive profile:
Motor control mode should be set to Speed control. If it is not, Statusword has bit 0x4000 set.

If Statusword bit 0x200 is not set, the AC drive is not in fieldbus control mode and cannot be started via CANopen.

5. Set Controlword (0x6040) to 0x00
   - Statusword (0x6041) is 0x270
6. Set Controlword to 0x06
   - Statusword is 0x4231
7. Set Controlword to 0x0F
   - AC drive starts, Statusword is 0x637
8. Set vl target velocity (0x6042) to 500 (rpm)
   - Motor starts to run at 500 rpm (0x6044 vl velocity actual value)
   - If actual velocity does not change, check that AC drive reference is set to fieldbus

Bypass:
Motor control mode must be set to Frequency (if reference is given as percentage of maximum frequency).

5. Set FB Control Word (0x2000:01) to 0x00
   - FB Status Word (0x2001:01) is 0x41
6. Set FB Control Word to 0x01
   - AC drive starts, FB Status Word is 0x23
   - If AC drive does not start, check that AC drive is in fieldbus control mode
7. Set FB Speed Reference (0x2000:03) to 2500 = 25.00% of maximum frequency. Usually default value for maximum frequency is 50.00 Hz, so in this case the reference is 12.50 Hz.
   - FB Actual Speed (0x2001:03) is 2500 = 25.00% output frequency of maximum frequency
   - If actual speed does not change, check that AC drive reference is set to fieldbus

If motor control mode is set to Speed, the reference is given as a percentage of maximum frequency converted to rpm. In this case the FB Actual Speed should not be read as this holds the percentage related to output frequency. Therefore, the actual speed should be from process data out 2 (by default set to speed in rpm).

7. CANopen option board interface

By default, the CANopen option board is configured to operate in Drive Profile mode. The drive profile implementation is 'Velocity Mode' which is defined in CiA 402 specification with PDO set for the AC drive. The board can also be configured into Manufacturer specific mode.

7.1 Supported drive modes

Drive modes can be selected by writing the desired mode in Modes of Operation (0x6060) object or by selecting the mode from panel. The active mode of operation can be read from object Modes of Operation Display (0x6061).

The supported drive modes object will return value 0x80000002, which is described in table below.

Table 64. Supported drive modes

Bit(s)	Description
31	Manufacturer specific Bypass mode
30-2	Not supported
1	Velocity mode
0	Not supported

Table 65. Drive modes

Value	Mode name	Description
2	Velocity mode	The CiA 402 Drive Profile mode where the control of the drive is done using a control word and speed reference value as specified in the drive profile specification.
-1	Bypass mode	In this mode, the Drive control can be done using raw process data which is exchanged with drive application. The drive profile state machine and the related objects become invalid.
-3	Puller mode	CiA 420 EUROMAP profiles. Restricted availability, requires use of special application.
-4	Co-Extruder mode	

Table 66. Operating mode related objects

Index	Description
0x6060	Modes of Operation
0x6061	Modes of Operation Display
0x6502	Supported Drive Modes

7.2 Velocity mode

The velocity mode is one of the specific modes that CIA-402 Drive Profile defines. Common behavior in all modes are PDS state machine, some control and status bits and certain objects.

7.2.1 PDS State machine

The PDS state machine describes the generic start and stop sequence of the drive and the error behavior. The state machine is controlled by the Control word object and internal events.The following objects are usable in velocity mode:

Table 67. Velocity mode related objects in OD

Index	Description
0x6040	Controlword
0x6041	Statusword
0x6042	Vl Target Velocity
0x6043	Vl Velocity Demand
0x6044	Vl Velocity Actual Value
0x6046	Vl Velocity Min Max Amount
0x6048	Vl Velocity Acceleration
0x6049	Vl Velocity Deceleration

The possible state machine transitions can be seen from Figure 22. The state of the AC drive can be changed by writing the corresponding bits to Control word data object. The needed bit values for each command can be seen from Figure 21.

Command	Bits of the *controlword*					Transitions
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	X	1	1	0	2.6.8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3 + 4 (NOTE)
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset		X	X	X	X	15
NOTE Automatic transition to Enable operation state after executing SWITCHED ON state funtionality. *9422A_uk*						

Figure 21. Control word commands

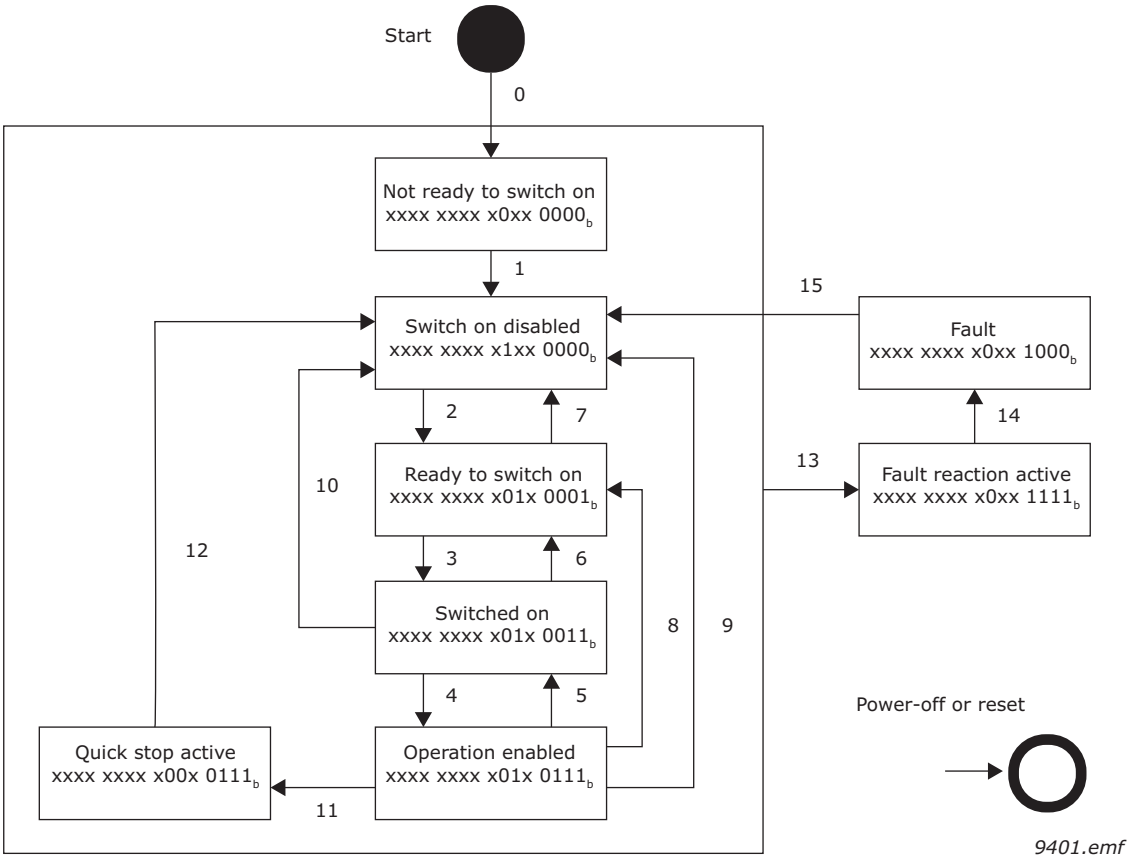

Figure 22. Power Drive System state machine

The table below explains the actions taken in different state transitions and which event triggers which state transition. If the used drive/application does not support different stop bits in Fixed Control Word, the stop method will always be according to set stop function.

Table 68. State transition events and actions

Transition	Event(s)	Action(s)
0	Automatic transition after power-on or reset	Self-initialization is performed
1	Automatic transition after drive status is 'ready'	None
2, 6	Shutdown command	None
3	Switch on command	None
4	Enable operation command	Drive function is enabled
5	Disable operation command	Drive function is disabled
7	Disable voltage or quick stop command	None
8	Shutdown command	Stop by ramp /stop function
9	Disable voltage command	Stop by coast / stop function
10, 12	Disable voltage command	None
11	Quick stop command	Quick stop / stop function
13	Fault signal	Go to fault state and stop by stop function
14	Automatic transition	None
15	Fault reset command	Reset fault if no fault currently exists on drive

Current state can be determined by reading the value of Statusword data object and comparing the value of bits to the table below.

Table 69. Statusword bits

Bits of the statusword									PDS state
15-8	7	6	5	4	3	2	1	0	
x	x	0	x	x	0	0	0	0	Not ready to switch on
x	x	1	x	x	0	0	0	0	Switch on disabled
x	x	0	1	x	0	0	0	1	Ready to switch on
x	x	0	1	x	0	0	1	1	Switched on
x	x	0	1	x	0	1	1	1	Operation enabled
x	x	0	0	x	0	1	1	1	Quick stop active
x	x	0	x	x	1	1	1	1	Fault reaction active
x	x	0	x	x	1	0	0	0	Fault
x = Do not care									

7.2.2 CiA-402 objects

7.2.2.1 0X6040 - Controlword

Controlword is used to control the drive operation according to the PDS state machine. By default, Controlword is mapped into the first two bytes of rxPDO1.

Table 70. 0x6040:Controlword

Bit		Name	Description
12-15	na	Not used	Bits 12 through 15 are not in use.
11	ar	Alarm reset	Rising edge resets alarm
10	r	Reserved	Bit 10 is not in use
9	oms	Operation mode specific	Bit 9 is not in use
8	h	Halt	Bit 8 is not in use
7	fr	Fault reset	Rising edge resets fault
4-6	na	Not Used	Bits 4 through 6 are not in use.
3	eo	Enable operation	Start drive
2	$\overline{qs}$	Quick stop	Stops the drive using the drive/application specific stop function used as quick stop
1	ev	Enable voltage	Enables/disables output voltage
0	so	Switch on	Enables possibility to start drive together with ev

7.2.2.2 0X6041 - Statusword

Statusword indicates whether the drive is in remote control and if the target velocity is reached. By default, Statusword is mapped into the first two bytes of txPDO1.

Table 71. 0x6041:Statusword

Bit		Name	Description
15	na	Not in use	Bit 15 is not in use
14	idm	Incorrect drive mode	Indicates that the drive is in incorrect “Control mode” for the used CiA-402 profile
12-13	oms	Operation mode specific	Bits 12 through 13 are not in use
10	tr	Target reached	Target velocity reached
9	rm	Remote	Indicates if the drive is controllable by Fieldbus
8	na	Not in use	Bit 8 not in use.
7	w	Warning	The AC drive has an active Alarm.
6	sod	Switch on disabled	PDS switch on disable
5	$\overline{qs}$	Quick stop	PDS quick stop active
4	ve	Voltage enabled	Voltage is enabled
3	f	Fault	PDS Fault (indicates fault condition)
2	oe	Operation enabled	PDS operation enabled (drive is running)
1	so	Switched on	PDS switched on
0	rtso	Ready to switch on	PDS ready to switch on

7.2.2.3 0X6042 - vl Target Velocity

The signed value of motor rpm speed request to drive. A negative value means that the motor is running clockwise. By default, the object is mapped into the last two bytes of rxPDO1.

Range: -32768...32767

0x6042:vl Target Velocity	
15	**0**
Rpm request to drive	

7.2.2.4 0X6043 - vl Velocity Demand

The signed read-only value of the ramp generator output scaled into rpm. A negative value means that the motor is running clockwise. By default, the object is not mapped into any PDO.

Range: -32768...32767

0x6043:vl Velocity Demand	
15	**0**
Drive ramp generator output scaled into rpm	

7.2.2.5 0X6044 - vl Velocity Actual Value

The signed value of the motor actual rpm speed. A negative value means that the motor is running clockwise. By default, the object is mapped into the last two bytes of txPDO1.

Range: -32678...32767

0x6044:vl Velocity Actual Value	
15	**0**
Motor actual rpm speed	

7.2.2.6 0X6046 - vl Velocity Min Max Amount

The minimum and maximum rpm speed of the AC drive's motor. The motor runs on minimum speed defined here when the vl Target Velocity is set to 0.

0x6046.01: vl Velocity Min Amount	
31	**0**
Motor minimum rpm speed	

0x6046.02: vl Velocity Max Amount	
31	**0**
Motor maximum rpm speed	

Range: 0... 4294967296

7.2.2.7 0X6048 - vl Velocity Acceleration

This object indicates the configured delta speed and delta time of the slope of the acceleration ramp.

0x6048.01: Delta speed	
31	**0**
Maximum change of rpm the motor will accelerate during the time specified in Delta Time.	

Range: 0... 4294967296

0x6048.02: Delta time	
16	**0**
Time (in seconds) in which the rpm of the motor will accelerate the amount specified in Delta Speed.	

Range: 0... 65536

7.2.2.8 0X6049 - vl Velocity Deceleration

This object indicates the configured delta speed and delta time of the slope of the deceleration ramp.

0x6049.01: Delta speed	
31	**0**
Maximum change of rpm the motor will accelerate during the time specified in Delta Time.	

Range: 0... 4294967296

0x6049.02: Delta time	
16	**0**
Time (in seconds) in which the rpm of the motor will accelerate the amount specified in Delta Speed.	

Range: 0... 65536

7.2.3 PDO configuration

This chapter describes the default PDO mapping configuration when using CiA-402 velocity mode. By default, RPDO/TPDO 2 - 5 are disabled. These settings are restored when:

- changing the operate mode to "Velocity" from either panel or object 0x6060
- using the "Restore from Set" panel parameter when Velocity operate mode is selected, or
- loading a default parameter set with object 0x1011, 1 "Restore all Default parameters"

When the parameter set is restored, the COB-IDs are calculated according to used Node ID.

Table 72. Overview of Receive PDO configuration in CiA-402 vl mode

Object	COB-ID	Size	DATA0 DATA1	DATA2 DATA3	DATA4 DATA5	DATA6 DATA7
RPDO1	0x200 + Node ID	4	0x6040, Controlword	0x6042, vl Target Velocity	Not used	
RPDO2*	0x80000300 + Node ID	8	0x2000,4 FB PD in 1	0x2000,5 FB PD in 2	0x2000,6 FB PD in 3	0x2000,7 FB PD in 4
RPDO3*	0x80000400 + Node ID	8	0x2000,8 FB PD in 5	0x2000,9 FB PD in 6	0x2000,A FB PD in 7	0x2000,B FB PD in 8
RPDO4*	0x80000500 + Node ID	8	0x2000,C FB PD in 9	0x2000,D FB PD in 10	0x2000,E FB PD in 11	0x2000,F FB PD in 12
RPDO5*	0x80000000 + Node ID	8	0x2000,10 FB PD in 13	0x2000,11 FB PD in 14	0x2000,12 FB PD in 15	0x2000,13 FB PD in 16

* Disabled by default

Table 73. Overview of Transmit PDO configuration in CiA-402 vl mode

Object	COB-ID	Size	DATA0 DATA1	DATA2 DATA3	DATA4 DATA5	DATA6 DATA7
TPDO1	0x180 + Node ID	4	0x6041, Statusword	0x6044, vl Velocity Actual	Not used	
TPDO2*	0x80000280 + Node ID	8	0x2001,4 FB PD out 1	0x2001,5 FB PD out 2	0x2001,6 FB PD out 3	0x2001,7 FB PD out 4
TPDO3*	0x80000380 + Node ID	8	0x2001,8 FB PD out 5	0x2001,9 FB PD out 6	0x2001,A FB PD out 7	0x2001,B FB PD out 8
TPDO4*	0x80000480 + Node ID	8	0x2001,C FB PD out 9	0x2001,D FB PD out 10	0x2001,E FB PD out 11	0x2001,F FB PD out 12
TPDO5*	0x80000000 + Node ID	8	0x2001,10 FB PD out 13	0x2001,11 FB PD out 14	0x2001,12 FB PD out 15	0x2001,13 FB PD out 16

* Disabled by default

7.3 Bypass mode

In bypass mode, some data defined in the profile is invalid, and the drive control is done using raw process data. The raw process data arrays are located in the manufacturer specific objects 0x2000 and 0x2001. There are two arrays: one for incoming data and one for outgoing data.

The drive application defines what data is mapped into the outgoing process data and how the incoming process data is handled. See 11. Appendix C - Fieldbus process data mapping and scaling for more details.

7.3.1 PDO configuration

This chapter describes the default PDO mapping configuration when using Bypass mode. By default, RPDO/TPDO 4 & 5 are disabled. These settings are restored when:

- changing the operate mode to "Bypass" from either panel or object 0x6060
- using the "Restore from Set" panel parameter when Bypass operate mode is selected, or
- loading a default parameter set with object 0x1011,4 "Restore Bypass parameter set" and sending a NMT reset message

When the parameter set is restored, the COB-IDs are calculated according to used Node ID.

Table 74. Overview of Receive PDO configuration in Bypass mode

Object	COB-ID	Size	DATA0 DATA1	DATA2 DATA3	DATA4 DATA5	DATA6 DATA7
RPDO1	0x200 + Node ID	6	0x2000,1, Controlword	0x2000,2 FB General Control Word	0x2000,3 FB Speed Reference	Not used
RPDO2	0x300 + Node ID	8	0x2000,4 FB PD in 1	0x2000,5 FB PD in 2	0x2000,6 FB PD in 3	0x2000,7 FB PD in 4
RPDO3	0x400 + Node ID	8	0x2000,8 FB PD in 5	0x2000,9 FB PD in 6	0x2000,A FB PD in 7	0x2000,B FB PD in 8
RPDO4*	0x80000500 + Node ID	8	0x2000,C FB PD in 9	0x2000,D FB PD in 10	0x2000,E FB PD in 11	0x2000,F FB PD in 12
RPDO5*	0x80000000 + Node ID	8	0x2000,10 FB PD in 13	0x2000,11 FB PD in 14	0x2000,12 FB PD in 15	0x2000,13 FB PD in 16

* Disabled by default

Table 75. Overview of Transmit PDO configuration in Bypass mode

Object	COB-ID	Size	DATA0 DATA1	DATA2 DATA3	DATA4 DATA5	DATA6 DATA7
TPDO1	0x180 + Node ID	6	0x2001,1 FB Status Word	0x2001,2 FB General Status Word	0x2001,3 FB Actual Speed	Not used
TPDO2	0x280 + Node ID	8	0x2001,4 FB PD out 1	0x2001,5 FB PD out 2	0x2001,6 FB PD out 3	0x2001,7 FB PD out 4
TPDO3	0x380 + Node ID	8	0x2001,8 FB PD out 5	0x2001,9 FB PD out 6	0x2001,A FB PD out 7	0x2001,B FB PD out 8
TPDO4*	0x80000480 + Node ID	8	0x2000,C FB PD out 9	0x2000,D FB PD out 10	0x2000,E FB PD out 11	0x2000,F FB PD out 12
TPDO5*	0x80000000 + Node ID	8	0x2000,10 FB PD out 13	0x2000,11 FB PD out 14	0x2000,12 FB PD out 15	0x2000,13 FB PD out 16

* Disabled by default

7.4 Default process data application mapping

This chapter describes the default mapping of the OPTE6 process data variables to the application data in the drive. It also provides a description of the application data in the drive. Supported control/status word bits might differ depending on used application. See AC drive specific bit definition in 12. Appendix D - Control and status word.

7.4.1 FB Control Word

Table 76. FB 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	ZRMP	STPM2	STPM1	FRST	DIR	STRT

Table 77. FB 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
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	Counter clockwise
0	STRT	Start / Stop	Start / Stop request	Stop	Run

7.4.2 FB Control Word Extension (general control word)

Table 78. FB Control Word Extension

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BSTAT2	BSTAT1	BFLT	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 79. FB Control Word extension description

Bit		Name	Description	0	1
15	BSTAT2	Bus status	Informs bus status into application	Status of option board	
14	BSTAT1	Bus status	Informs bus status into application		
13	BFLT	Bus fault	Request fieldbus fault	-	Generate field bus fault

7.4.3 FB Speed Reference

Table 80. FB Speed Reference

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FB Speed Reference															

Table 81. FB Speed reference description

Name	Description	Min	Max
FB Speed Reference	Frequency reference at percentage between minimum and maximum frequency. Control word DIR bit is used to select rotation direction.	0 (0%)	10000 (100.00%)

7.4.4 FB Process data Input 1...16

Table 82. FB Process Data Input 1...16

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FB Process data in															

7.4.5 FB Processdata Input mapping in application

In addition to sending control commands and speed reference values to the application, 16 process data items can be sent directly to the application to control other features via fieldbus. These can be, for example, activating preset frequencies, activating or deactivating faults, selecting different ramp times, controlling I/O's, and so on. Different applications support different features. For more information, see the application manual. Also, always check the value of the sent data in the application manual to see in which format they are given (for example, % values, bit coded values, and so on).

7.4.6 FB Status Word

Table 83. FB 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 84. FB Status word description

Bit		Name	Description	0	1
7	FRDY	Flux ready	Motor magnetization is ready	-	Flux ready
6	ZSPD	Zero speed	Motor is running on 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 indicatioin	-	Drive is Faulted
2	DIR	Direction	Motor running direction	Clockwise	Counter clockwise
1	RUN	Run	Motor running information	Stopped	Running
0	RDY	Ready	Drive readiness information	-	Ready

7.4.7 FB Status Word Extension (general status word)

Table 85. FB Status word extension

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CP3	CP2	CP1	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 86. FB Status word extension description

Bit		Name	Description	0	1
15	CP3	Control Place	Drive Control place information	0,0,1-(1) Fieldbus 0,1,0- (2) Panel 0,1,1 - (3) Tool 1,0,0 - (4) I/O	
14	CP2				
13	CP1				

7.4.8 FB Actual Speed

Table 87. FB Actual Speed

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FB Actual Speed															

Table 88. FB Actual Speed description

Name	Description	Min	Max
FB Actual Speed	Actual output frequency at percentage between minimum and maximum frequency. Status word bit DIR is used to indicate actual direction.	0 (0%)	10000 (100.00%)

7.4.9 FB Processdata Output 1...16

Table 89. FB Process data output 1...16

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FB Process data Out															

7.4.10 FB Processdata Output mapping in application

Process data output mappings are selectable and also the default settings vary between drives. Refer to application manual for details. See Chapter 11. Appendix C - Fieldbus process data mapping and scaling for default values for commonly used applications.

7.5 VACON anyparameter service

For access to AC drive parameters and monitoring values, the OPTE6 maps the CANopen manufacturer segment 0x2100 - 0x5FFF into the application IDs of the drive based on the IEC61131 standard. Both read and write access is supported.

The application ID 1 maps to CANopen object 0x2101 and so on, making it possible to read/write any application ID between 1 and 16127 (0x3EFF). To access the application IDs in the drive, make the following calculation:

Index = ID number + 0x2100

NOTE! The response data is in raw format. See application manual for available IDs, decimal count and the unit used for the parameters.

IDs can be read/written as VACON® NX scaled values in all AC drives, or in VACON® 100 family AC drives also as actual raw value. Units such as Hz, rpm, A, V, etc. are given with 4 decimal point precision. See examples for more details.

The used scale in VACON® 100 family depends on the "Mode" parameter setting. This can be written from panel parameter of by using CANopen object 0x2005.

VACON® provides .EDS files which contains the correct data types and IDs for multiple VACON® AC drive applications.

These files can be downloaded from www.danfoss.com/en/service-and-support/ -> Software -> Select “Drives” as Business unit -> Fieldbus configuration files.

7.5.1 Error responses

In case an error occurs during reading or writing a parameter via the anyparameter service, the following SDO abort error codes are returned:

Table 90. SDO abort codes returned by anyparameter service

Abort code	Description	Error
0x0602 0000	Object does not exist in the object dictionary	ID is not found in used application
0x0601 0002	Attempt to write a read only object	ID is a monitoring value
0x0607 0010	Data type does not match, length of service parameter does not match	Data length does not match ID data type
0x0609 0030	Invalid value for parameter (download only).	Data value is invalid
0x0800 0000	General error	Other error
0x0800 0024	No data available	Parameter access timeout

7.5.2 Examples

In the examples below, the following ID values are used:

- 102 = Maximum frequency (Hz)
- 600 = Motor control mode

Table 91. Example 1: Reading values from different AC drives

AC drive	Mode	Read command		Response			
		ID	Index	Length	Hex (LSB)	Dec (MSB)	Actual value
VACON® 20 family VACON® 100 family	Any Pre V008	102	0x2166	2	88 13	5000	50.00 Hz
		600	0x2358	2	01 00	1	1 = OL Speed
VACON® 100 family	Normal	102	0x2166	4	20 A1 07 00	500000	50.0000 Hz
		600	0x2358	4	01 00 00 00	1	1 = OL Speed

AC drive	Mode	Write command				Actual value
		ID	Index	Length	Value (Hex)	
VACON® 20 family VACON® 100 family	Any Pre V008	102	0x2166	2	94 11	45.00 Hz
		600	0x2358	2	00 00	0 = OL Frequency
VACON® 100 family	Normal	102	0x2166	4	D0 DD 06 00	45.0000 Hz
		600	0x2358	4	00 00 00 00	0 = OL Frequency

8. FAULT TRACING

When the option board or the AC drive control diagnostics detect an unusual operating condition, the drive opens a notification, for example, on the keypad. The keypad shows the ordinal number of the fault, the fault code and a short fault description.

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

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

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

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

See basic usage of VACON® PC-tools in 6.3 VACON PC-tools.

See local contacts in Danfoss web pages:

www.danfoss.com/en/contact-us/contacts-list/ -> select "Drives" as Business unit.

8.1 TYPICAL FAULT CONDITIONS

Table 92. Typical fieldbus fault conditions

Fault condition		Possible cause	Remedy
No communication	Cabling	Supply or motor cables are located too close to the fieldbus cable	Refer to the installation guide.
		Wrong type of fieldbus cable, e.g. insufficient shielding	Refer to Chapter 4.3
		Too long cabling	
		Invalid termination	Refer to Chapter 4.3.1 and the installation guide.
	Grounding	Inadequate or invalid grounding	Refer to Chapter 4.3.1 and the installation guide.
	Connections	Excessive stripping of cables	Refer to the installation guide.
		Conductors in wrong terminals	Refer to Chapter 5.1
		Too loose connections of conductors	
Faulty communication	Parametrization	Overlapping Node ID	Refer to Chapter 6.1
		Wrong baud rate	
Drive does not start		PDO mapping is invalid	Refer to Chapter 6.1 and Chapter 3.5
		Wrong control place selected	Refer to Chapter 10.
Drive runs at wrong speed		Wrong motor control mode selected	
Fieldbus fault (F53)	Fieldbus	See chapter Chapter 8.2	

8.2 FIELDBUS TIMEOUT FAULT (F53)

VACON® fieldbuses create a fieldbus timeout fault (F53) when a fault has occurred in the fieldbus protocol and the AC drive is set to fieldbus control. If the control place is set to e.g. I/O, no fieldbus fault is triggered even if a fault condition is met. The fault response can also be modified in the AC drive application, see chapter Chapter 10.2 for more details.

OPTE6 creates a fieldbus fault in the following conditions:

Table 93. OPTE6 Fieldbus fault trigger conditions

Fault	Description	Remedy
CAN Passive	• "Communication timeout" parameter is other than zero • Either Transmit Error Counter or Receive Error Counter raises above 127, causing the CAN driver to go into passive state	• Check cabling and baud rates of all nodes in network • Disable communication timeout or increase the time.
CAN BUS-OFF	• "Communication timeout" parameter is other than zero • Transmit Error Counter raises above 255, causing the CAN driver to go into bus-off state	
Heartbeat Consumer	• Heartbeat consumer is set • At least one valid heartbeat message has been received • The heartbeat time has elapsed	• Check Heartbeat Consumer time • Check heartbeat producer time of the producer CANopen node • Increase Heartbeat Time • Check cabling
Node Guard	• Guard Time and Life Time Factor are set, • At least one valid node guard message has been received • Node Life Time has elapsed	• Check Node Life Time (Life Time Factor Guard Time) • Check Node Guard producer CANopen node • Increase Node Life Time • Check cabling
PDO Timer	• RPDO Timer is set • At least one valid PDO message has been received • RPDO Timer has elapsed	• Check RPDO Timer time • Check PDO producer CANopen node • Increase PDO Timer time • Check cabling

If any of the Table 93 fault situations occur (even if no fault is triggered in AC drive), the CANopen NMT state machine state can be affected. This is managed by object 0x1029:01 Communication Error. By default, the error response has value 0 = Change to NMT state Pre-operational.

Any other fault (e.g. overtemperature), does not affect the NMT state machine. The object 0x1029:02 Internal Error is fixed to value 1 = No change to NMT state.

8.3 DETAILED FAULT CODE

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

This information can be read with:

- Panel (4.1.x.26): Diagnostics ' Active Faults ' "FB Timeout" ' Details ' Source 3
- Panel (4.3.x.26): Diagnostics ' Fault History ' "FB Timeout" ' Details ' Source 3
- VACON® Live: View ' Fault Diagnostics ' Icon "Load active faults" ' Source3
- VACON® Live: View ' Fault Diagnostics ' Icon "Load fault history" ' Source3

Source3 fault codes are defined as follows:

Table 94. VACON® 100 family fieldbus fault Source3 codes

Code	Name	Description
1*	IO Watchdog	IO connection closed after timeout occurred
2*	IO Connection Closed	IO connection closed by fieldbus master
3*	Explicit Messaging Watchdog	Explicit messaging connection (other than cyclic IO data) closed after timeout occurred
4*	Explicit Messaging Connection Closed	Explicit messaging connection closed by fieldbus master
5*	Cable Disconnected	Fieldbus cable disconnected after device startup
6*	Cable Not Connected	Fieldbus cable was not connected after device startup
7*	Bad Data	Master IO data has changed from GOOD to BAD
8*	Idle State	Connection status changed to IDLE when motor is controlled
9*	Internal System Fault	Internal fieldbus fault, contact technical support
10*	Too Many Bad Messages	Protocol has received too many bad messages in a row and closed the connection
11	CAN BUS-OFF	CAN driver is in BUS-OFF state
12	CAN Passive	CAN driver is in passive state
13*	No External Power	No external power detected
14	Heartbeat Consumer	Heartbeat consumer timeout occurred
15	Node Guard	Node guarding timeout occurred
16	PDO Timer	PDO timer event timeout occurred

* Not relevant to OPTE6 CANopen option board

In case multiple error situations occur at once, the fault that has happened first has its code shown as the Source3 fault code.

9. APPENDIX A: OBJECT DICTIONARY

9.1 COMMUNICATION SEGMENT

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
Object 1000h: Device Type								
1000	0	Device type	Variable	UNSIGNED32	CONST	No	0x00010192	
Object 1001h: Error Register								
1001	0	Error Register	Variable	UNSIGNED8	RO	No	0x00	
Object 1003h: Pre-defined Error Field								
1003		Pre-defined Error Field	Array	UNSIGNED32				
	000	Number of Errors		UNSIGNED8	RW	No	0x00000000	
	001	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	002	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	003	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	004	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	005	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	006	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	007	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	008	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
	009	Standard Error Field		UNSIGNED32	RO	No	0x0000000	
Object 1005h: COB-ID SYNC								
1005	0	COB-ID SYNC	Variable	UNSIGNED32	RW	No	0x00000080	
Object 100Ch: Guard Time								
100C	0	Guard Time	Variable	UNSIGNED16	RW	No	0x00000000	ms
Object 100Dh: Life Time Factor								
100D	0	Life Time Factor	Variable	UNSIGNED8	RW	No	0x00000000	
Object 1010h: Store Parameter Field								
1010		Store Parameter Field	Array	UNSIGNED32				
	000	Number of Entries		UNSIGNED8	RO	No	0x2	
	001	Save all Parameters		UNSIGNED32	RW	No	-	
Object 1011h: Restore Default Parameters								
1011		Restore Default Parameters	Array	UNSIGNED32				
	000	Number of Entries		UNSIGNED8	RO	No	0x4	
	001	Restore all Default Parameters		UNSIGNED32	RW	No	-	
	004	Restore Bypass parameter set		UNSIGNED32	RW	No	-	
Object 1014h: COB-ID EMCY								
1014	0	COB-ID EMCY	Variable	UNSIGNED32	RW	No	0x80	
Object 1016h: Heartbeat Consumer Entries								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
1016		Heartbeat Consumer Entries	Array	UNSIGNED32				
	000	Number of Entries		UNSIGNED8	RO	No	0x08	
	001	Consumer Heartbeat Time 1		UNSIGNED32	RW	No	0x0000000	
	002	Consumer Heartbeat Time 2		UNSIGNED32	RW	No	0x0000000	
	003	Consumer Heartbeat Time 3		UNSIGNED32	RW	No	0x0000000	
	004	Consumer Heartbeat Time 4		UNSIGNED32	RW	No	0x0000000	
	005	Consumer Heartbeat Time 5		UNSIGNED32	RW	No	0x0000000	
	006	Consumer Heartbeat Time 6		UNSIGNED32	RW	No	0x0000000	
	007	Consumer Heartbeat Time 7		UNSIGNED32	RW	No	0x0000000	
	008	Consumer Heartbeat Time 8		UNSIGNED32	RW	No	0x0000000	
Object 1017h: Producer Heartbeat Time								
1017	0	Producer Heartbeat Time	Variable	UNSIGNED16	RW	No	0x00000000	
Object 1018h: Identity Object								
1018		Identity Object	Record	IDENTITY				
	000	Number of Entries		UNSIGNED8	RO	No	0x4	
	001	Vendor Id		UNSIGNED32	RO	No	0x90	
	002	Product Code		UNSIGNED32	RO	No	-	
	003	Revision number		UNSIGNED32	RO	No	-	
	004	Serial number		UNSIGNED32	RO	No	-	
Object 1019h: Synchronous counter								
1019	0	Synchronous counter	Variable	UNSIGNED8	RW	No	0x00000000	
Object 1029h: Error Behavior								
1029		Error Behavior	Array	UNSIGNED8				
	000	Number of Entries		UNSIGNED8	RO	No	0x1	
	001	Communication Error		UNSIGNED8	RW	No	0x0	
	002	Internal Error		UNSIGNED8	RW	No	0x1	
Object 1400h: Receive PDO Communication Parameter 1								
1400		Receive PDO Communiction Parameter 1	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x05	
	001	COB-ID		UNSIGNED32	RW	No	0x200	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x0	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
Object 1401h: Receive PDO Communication Parameter 2								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
1401		Receive PDO Communiction Parameter 2	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x05	
	001	COB-ID		UNSIGNED32	RW	No	0x80000300	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x0	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
Object 1402h: Receive PDO Communication Parameter 3								
1402		Receive PDO Communiction Parameter 3	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x05	
	001	COB-ID		UNSIGNED32	RW	No	0x80000400	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x0	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
Object 1403h: Receive PDO Communication Parameter 4								
1403		Receive PDO Communication Parameter 4	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x05	
	001	COB-ID		UNSIGNED32	RW	No	0x80000500	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x0	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
Object 1404h: Receive PDO Communication Parameter 5								
1404		Receive PDO Communication Parameter 5	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x05	
	001	COB-ID		UNSIGNED32	RW	No	0x80000000	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x0	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
Object 1600h: Receive PDO Mapping Parameter 1								
1600		Receive PDO Mapping Parameter 1	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x02	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x60400010	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x60420010	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x00000000	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x00000000	
Object 1601h: Receive PDO Mapping Parameter 2								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
1601		Receive PDO Mapping Parameter 2	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20000410	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20000510	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20000610	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20000710	
Object 1602h: Receive PDO Mapping Parameter 3								
1602		Receive PDO Mapping Parameter 3	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20000810	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20000910	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20000A10	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20000B10	
Object 1603h: Receive PDO Mapping Parameter 4								
1603		Receive PDO Mapping Parameter 4	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20000C10	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20000D10	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20000E10	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20000F10	
Object 1604h: Receive PDO Mapping Parameter 5								
1604		Receive PDO Mapping Parameter 5	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20001010	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20001110	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20001210	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20001310	
Object 1800h: Transmit PDO Communication Parameter 1								
1800		Transmit PDO Communiction Parameter 1	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x06	
	001	COB-ID		UNSIGNED32	RW	No	0x180	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x64	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
	006	Sync start value		UNSIGNED8	RW	No	0x0	
Object 1801h: Transmit PDO Communication Parameter 2								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
1801		Transmit PDO Communiction Parameter 2	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x06	
	001	COB-ID		UNSIGNED32	RW	No	0x80000280	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x3E8	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
	006	Sync start value		UNSIGNED8	RW	No	0x0	
Object 1802h: Transmit PDO Communication Parameter 3								
1802		Transmit PDO Communiction Parameter 3	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x06	
	001	COB-ID		UNSIGNED32	RW	No	0x80000380	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x3E8	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
	006	Sync start value		UNSIGNED8	RW	No	0x0	
Object 1803h: Transmit PDO Communication Parameter 4								
1803		Transmit PDO Communiction Parameter 4	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x06	
	001	COB-ID		UNSIGNED32	RW	No	0x80000480	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x3E8	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
	006	Sync start value		UNSIGNED8	RW	No	0x0	
Object 1804h: Transmit PDO Communication Parameter 5								
1804		Transmit PDO Communiction Parameter 5	Record	PDO_COMM_PAR				
	000	Number of Entries		UNSIGNED8	RO	No	0x06	
	001	COB-ID		UNSIGNED32	RW	No	0x80000000	
	002	Transmission Type		UNSIGNED8	RW	No	0xFE	
	003	Inhibit Time		UNSIGNED16	RW	No	0x3E8	100 µs
	005	Event Timer		UNSIGNED16	RW	No	0x0	ms
	006	Sync start value		UNSIGNED8	RW	No	0x0	
Object 1A00h: Transmit PDO Mapping Parameter 1								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
1A00		Transmit PDO Mapping Parameter 1	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x02	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x60410010	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x60440010	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x00000000	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x00000000	
Object 1A01h: Transmit PDO Mapping Parameter 2								
1A01		Transmit PDO Mapping Parameter 2	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20010410	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20010510	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20010610	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20010710	
Object 1A02h: Transmit PDO Mapping Parameter 3								
1A02		Transmit PDO Mapping Parameter 3	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20010810	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20010910	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20010A10	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20010B10	
Object 1A03h: Transmit PDO Mapping Parameter 4								
1A03		Transmit PDO Mapping Parameter 4	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20010C10	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20010D10	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20010E10	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20010F10	
Object 1A04h: Transmit PDO Mapping Parameter 5								
1A04		Transmit PDO Mapping Parameter 5	Record	PDO_MAPPING				
	000	Number of Entries		UNSIGNED8	RW	No	0x04	
	001	Mapping Entry 1		UNSIGNED32	RW	No	0x20011010	
	002	Mapping Entry 2		UNSIGNED32	RW	No	0x20011110	
	003	Mapping Entry 3		UNSIGNED32	RW	No	0x20011210	
	004	Mapping Entry 4		UNSIGNED32	RW	No	0x20011310	

9.2 MANUFACTURER SEGMENT

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
Object 2000h: FB Processdata In								
2000		FB Processdata In	Array	UNSIGNED16				
	000	Number of Entries		UNSIGNED8	CONST	No	0xB	
	001	FB Control Word		UNSIGNED16	RWW	Yes	0x0	
	002	FB Control Word Extension		UNSIGNED16	RWW	Yes	0x0	
	003	FB Speed Reference		UNSIGNED16	RWW	Yes	0x0	
	004	FB Process Data In 1		UNSIGNED16	RWW	Yes	0x0	
	005	FB Process Data In 2		UNSIGNED16	RWW	Yes	0x0	
	006	FB Process Data In 3		UNSIGNED16	RWW	Yes	0x0	
	007	FB Process Data In 4		UNSIGNED16	RWW	Yes	0x0	
	008	FB Process Data In 5		UNSIGNED16	RWW	Yes	0x0	
	009	FB Process Data In 6		UNSIGNED16	RWW	Yes	0x0	
	010	FB Process Data In 7		UNSIGNED16	RWW	Yes	0x0	
	011	FB Process Data In 8		UNSIGNED16	RWW	Yes	0x0	
	012	FB Process Data In 9 *		UNSIGNED16	RWW	Yes	0x0	
	013	FB Process Data In 10 *		UNSIGNED16	RWW	Yes	0x0	
	014	FB Process Data In 11 *		UNSIGNED16	RWW	Yes	0x0	
	015	FB Process Data In 12 *		UNSIGNED16	RWW	Yes	0x0	
	016	FB Process Data In 13 *		UNSIGNED16	RWW	Yes	0x0	
	017	FB Process Data In 14 *		UNSIGNED16	RWW	Yes	0x0	
	018	FB Process Data In 15 *		UNSIGNED16	RWW	Yes	0x0	
	019	FB Process Data In 16 *		UNSIGNED16	RWW	Yes	0x0	
Object 2001h: FB Processdata Out								

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default value	Unit
2001		FB Processdata Out	Array	UNSIGNED16				
	000	Number of Entries		UNSIGNED8	CONST	No	0xB	
	001	FB Status Word		UNSIGNED16	RO	Yes	0x0	
	002	FB Status Word Extension		UNSIGNED16	RO	Yes	0x0	
	003	FB Actual Speed		UNSIGNED16	RO	Yes	0x0	
	004	FB Process Data Out 1		UNSIGNED16	RO	Yes	0x0	
	005	FB Process Data Out 2		UNSIGNED16	RO	Yes	0x0	
	006	FB Process Data Out 3		UNSIGNED16	RO	Yes	0x0	
	007	FB Process Data Out 4		UNSIGNED16	RO	Yes	0x0	
	008	FB Process Data Out 5		UNSIGNED16	RO	Yes	0x0	
	009	FB Process Data Out 6		UNSIGNED16	RO	Yes	0x0	
	010	FB Process Data Out 7		UNSIGNED16	RO	Yes	0x0	
	011	FB Process Data Out 8		UNSIGNED16	RO	Yes	0x0	
	012	FB Process Data Out 9 *		UNSIGNED16	RO	Yes	0x0	
	013	FB Process Data Out 10 *		UNSIGNED16	RO	Yes	0x0	
	014	FB Process Data Out 11 *		UNSIGNED16	RO	Yes	0x0	
	015	FB Process Data Out 12 *		UNSIGNED16	RO	Yes	0x0	
	016	FB Process Data Out 13 *		UNSIGNED16	RO	Yes	0x0	
	017	FB Process Data Out 14 *		UNSIGNED16	RO	Yes	0x0	
	018	FB Process Data Out 15 *		UNSIGNED16	RO	Yes	0x0	
	019	FB Process Data Out 16 *		UNSIGNED16	RO	Yes	0x0	
Object 2002h: FB Dummy In								
2002		FB Dummy In	Array	UNSIGNED16				
	000	Number of Entries		UNSIGNED8	CONST	No	0xB	
	001	FB Dummy In Offset 0		UNSIGNED16	RW	Yes	0x0	
	...	...	...	...	...	...	...	...
	011	FB Dummy In Offset 10		UNSIGNED16	RW	Yes	0x0	
Object 2003h: FB Dummy Out								
2003			Array					
	000	Number of Entries		UNSIGNED8	CONST	No	0xB	
	001	FB Dummy Out Offset 0		UNSIGNED16	RO	Yes	0x0	
	...	...	...	...	...	...	...	...
	011	FB Dummy Out Offset 10		UNSIGNED16	RO	Yes	0x0	
Object 2004h: Communication Timeout								
2004	0	Communication Timeout	Variable	UNSIGNED16	RW	No	0x01	s
Object 2005h: Mode								
2005	0	Mode	Variable	UNSIGNED16	RW	No	0x0	

* Supported in VACON® NXP when Fast mode or Normal extended mode is enabled. See details in Chapters 13. Appendix E - Fieldbus option board communication and 14. Appendix F - Parameters for application developers.

The objects from 0x2100 to 0x5FFF contain the device-specific parameters and monitor values defined in separate .EDS files. These files can be downloaded from www.danfoss.com/en/service-and-support/ -> Software -> select "Drives" as Business unit -> Fieldbus configuration files.

For more information refer to chapter 7.5.

9.3 DEVICE PROFILE SEGMENT

Index	Sub-index	Description	Object Code	Data Type	Access	PDO Mapping	Default Value
Object 6040h: Controword							
6040	0	Controlword	Variable	UNSIGNED16	RWW	Yes	-
Object 6041h: Statusword							
6041	0	Statusword	Variable	UNSIGNED16	RO	Yes	-
Object 6042h: vl Target Velocity							
6042	0	vl Target Velocity	Variable	INTEGER16	RWW	Yes	0x0000
Object 6043h: vl Velocity Demand							
6043	0	vl Velocity Demand	Variable	INTEGER16	RO	Yes	-
Object 6044h: vl Velocity Actual Value							
6044	0	vl Velocity Actual Value	Variable	INTEGER16	RO	Yes	-
Object 6046h: vl Velocity Min Max Amount							
6046		vl Velocity Min Max Amount	Array	UNSIGNED32			
	000	Number of Entries		CONST		No	0x00000002
	001	vl_Velocity_Min_Amount		UNSIGNED32	RW	No	0x2
	002	vl_Velocity_Max_Amount		UNSIGNED32	RW	No	-
Object 6048h: vl Velocity Acceleration							
6048		vl Velocity Acceleration	Record	P402_VL_VEL_ACC_T			
	000	NumOfEntries		CONST		No	0x2
	001	DeltaSpeed		UNSIGNED32	RW	No	0x0
	002	DeltaTime		UNSIGNED16	RW	No	0x0
Object 6049h:vl Velocity Decelaration							
6049		vl Velocity Deceleration	Record	P402_VL_VEL_ACC_T			
	000	NumOfEntries		CONST		No	0x2
	001	DeltaSpeed		UNSIGNED32	RW	No	0x0
	002	DeltaTime		UNSIGNED16	RW	No	0x0
Object 6060h: Modes of Operation							
6060	0	Modes of Operation	Variable	INTEGER8	RW	No	-
Object 6061h: Modes of Operation Display							
6061	0	Modes of Operation Display	Variable	INTEGER8	RO	No	-
Object 6502h: Supported Drive Modes							
6502	0	Supported Drive Modes	Variable	UNSIGNED32	RO	No	-

10. APPENDIX B - FIELDBUS PARAMETRIZATION

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

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

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

10.1 FIELDBUS CONTROL AND REFERENCE SELECTION

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

The parameters can be read and written by using the drive panel, PC Tools or fieldbus protocol. For instructions on fieldbus writing, see the fieldbus specific manual.

Table 95. Fieldbus parameterization for VACON® 100 family (standard application)

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

Table 96. Fieldbus parametrization for VACON® 20 (standard application)

Parameter name	ID	Value	Default	Panel Tree
Disable showing of Quick menu	-	0 = Advanced menu 1 = Quick setup parameters	1	P 17.2
Motor control mode	600	0 = Frequency 1 = Speed 2 = Torque	0	P1.8
Rem. Control place 1 sel.	172	1 = Fieldbus CTRL	0	P2.1
Local / remote	211	0 = Remote	0	P2.5
Rem. Control place 1 freq. ref. sel.	122	3 = Fieldbus	7	P3.3

Table 97. Fieldbus parametrization for VACON® 20X (multipurpose application)

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

Table 98. Fieldbus parametrization for VACON® NXP (multipurpose application)

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

10.1.1 CONTROLLING FIELDBUS PARAMETER

In VACON® 100 family products, if multiple fieldbus options or protocols are active at once, use the "Controlling Fieldbus"-parameter to select the instance from which the process data is sent to the drive application. This parameter is located under I/O and Hardware / Fieldbus General (5.13.1).

By default, the setting is in "Automatic" and the functionality (when receiving process data from multiple sources) is application dependent.

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

Table 99. Controlling Fieldbus Parameter

Value name	Value	Description
Automatic	1	Process data from all sources is forwarwed to application
Slot D	2	Only process data from slot D is forward to application. Value is visible only, if option board is installed to slot D.
Slot E	3	Only process data from slot E is forward to application. Value is visible only, if option board is installed to slot E.
RS485	4	Only process data from VACON® 100 family internal RS 485 protocol is forwarded to application
PROFINET IO	5	Only process data from VACON® 100 family internal PROFINET IO protocol is forwarded to application
EtherNet/IP	6	Only process data from VACON® 100 family internal EtherNet/IP protocol is forwarded to application

Table 99. Controlling Fieldbus Parameter

Value name	Value	Description
Modbus TCP/ UDP	7	Only process data from VACON® 100 family internal Modbus TCP/ UDP protocol is forwarded to application
Bacnet IP	8	Only process data from VACON® 100 family internal Bacnet IP protocol is forwarded to application

10.2 RESPONSE TO FIELDBUS FAULT

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

Table 100. Response to fieldbus fault in VACON® AC drives

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

11. APPENDIX C - FIELDBUS PROCESS DATA MAPPING AND SCALING

Fieldbus process data items can be used to write and read variables quickly and periodically to/from VACON® AC drives. Incoming process data can be used for multiple different purposes (e.g. torque reference), and outgoing process data can be used for information about the state of the AC drive.

For fast access to any VACON® AC drive application ID over any fieldbus, generic Process Data Out parameters are defined. The content of the process data items are selected with the FB DataOut Sel parameters. Writing any application ID number to these parameters will then map the data value of that application ID to be sent in the corresponding Process Data Out variable.

Figure 23 illustrates how the fieldbus data mapping (FB DataOut x Sel) affects the data of the corresponding Process Data Out variable. By writing ID value 1 to FB DataOut1 Sel (ID 852), the value of ID 1 (Output Frequency) is sent in Process Data Out 1. The value is always raw value in process data out, so e.g. 16.43 Hz has value 1643. The scaling of the parameters can be checked from application manuals.

The status word and actual speed values cannot be changed, however the values sent by the fieldbus protocol might differ if a profile is used. In Bypass mode, these values are given as is.

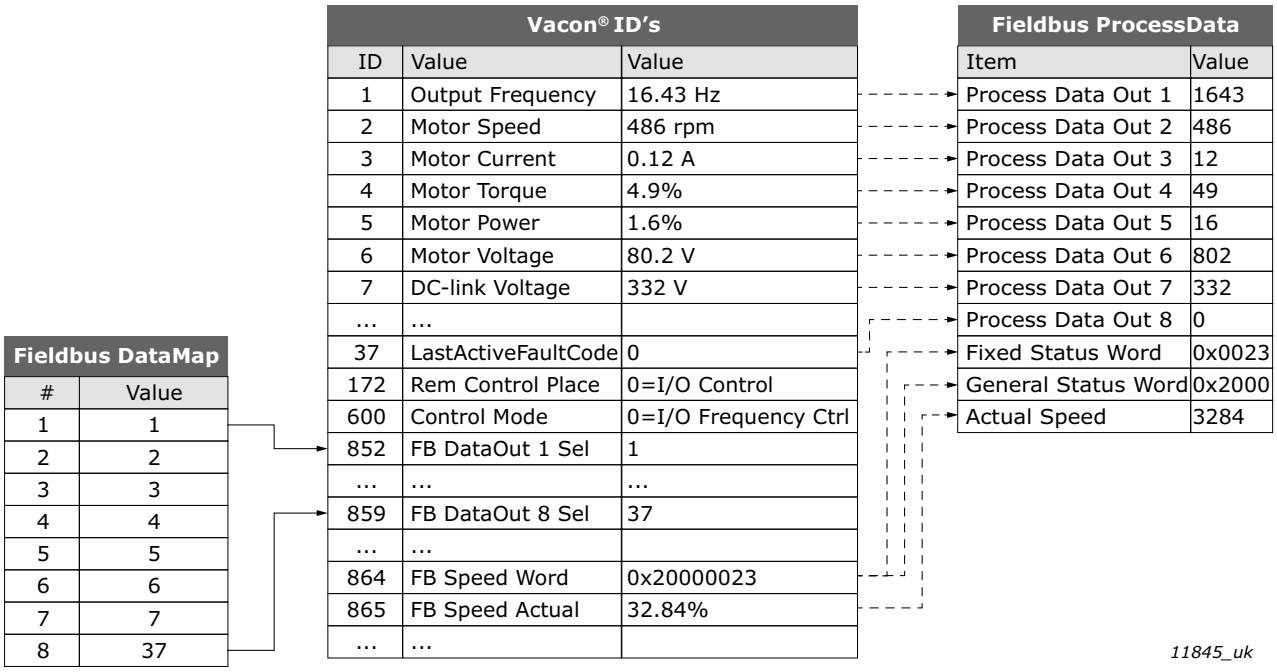

Figure 23. Fieldbus Datamapping

Table 101. Fieldbus Process Data Selection Panel Tree for VACON® AC drives

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

Table 101. Fieldbus Process Data Selection Panel Tree for VACON® AC drives

Parameter name	ID	Panel Tree			
		VACON® 100 family	VACON® NXP **	VACON® 20	VACON® 20 X/CP
FB DataOut 10 Selection*	*	-		-	-
...	...	-	...	-	-
FB DataOut 16 Selection*	*	-		-	-

* Supported in VACON® NXP when Fast mode or Normal extended mode is enabled. See details in Chapters Appendix E - Fieldbus option board communication and Appendix F - Parameters for application developers.
** Multipurpose application

Table 102. Default process data mapping for VACON® 100 family and VACON® NXP

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

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

Table 103. Default process data mapping for VACON® 20 X/CP and VACON® 20

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

* Scaling is based on drive nominal power. Scaling can be seen from Table 104.

Table 104. Current scaling based on nominal power

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

12. APPENDIX D - CONTROL AND STATUS WORD

12.1 CONTROL WORD BIT DESCRIPTION

The Control word is composed of 32 bits. FBFixedControlWord consist of the first 16 bits. FBGeneralControlWord consist of the remaining 16 bits. While the functionality of FBFixedControlWord is fixed in the VACON® standard applications, the functionality of FBGeneralControlWord is totally application specific and can vary even in the VACON® standard applications.

The meanings of FBFixedControlWord bits are described below. Unused bits have to be set to zero.

NOTE! This table is valid for VACON® standard applications.

NOTE! There are some control word bit modifications in VACON® NXP AC drive. These modifications are described in Table 106. Unused bits have to be set to zero.

Table 105. FBFixedControlWord bits

Bit	Function		Description
B0	Start/Stop	0	Stop request from fieldbus.
		1	Run request from fieldbus.
B1	Direction	0	Requested direction is "FORWARD".
		1	Requested direction is "REVERSE".
B2	Fault reset	0	No action.
		1	No action. Rising edge (0->1) = Active faults, alarms and infos are reset.
B3	Stop mode 1	0	Stop mode is unmodified.
		1	Stop mode is overridden to "Coasting".
B4	Stop mode 2	0	Stop mode is unmodified.
		1	Stop mode is overridden to "Ramping".
B5	Quick ramp time	0	Normal deceleration ramp time.
		1	Deceleration ramp time is switched to shorter than normal.
B6	Freeze Setpoint	0	Changes in the setpoint value from fieldbus (FB Speed Reference) are taken into use by the application.
		1	Changes in the setpoint value from fieldbus (FB Speed Reference) are not taken into use by the application.
B7	Setpoint to Zero	0	The setpoint value from fieldbus is taken from FB Speed Reference.
		1	The setpoint value from fieldbus is changed to 0.
B8	Request Fieldbus Control	0	Control Place is as parameterized in the drive (unchanged).
		1	Control Place is overridden to Fieldbus Control.
B9	Request Fieldbus Reference	0	Source of the setpoint value is as parameterized in the drive (unchanged).
		1	Source of the setpoint value is overridden to Fieldbus.
B10	Jogging 1	0	No action.
		1	Jogging request with ref1.
B11	Jogging 2	0	No action.
		1	Jogging request with ref2.

Table 105. FBFixedControlWord bits

Bit	Function		Description
B12	Quick stop	0	Drive operates as normal.
		1	Drive executes quick stop / emergency stop.
B13	Reserved	0	-
		1	-
B14	Reserved	0	-
		1	-
B15	Reserved	0	-
		1	-

Table 106. FBFixedControWord modifications in VACON® NXP

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

12.2 STATUS WORD DESCRIPTIONS

The Status word is composed of 32 bits. FBFixedStatusWord consist of the first 16 bits. FBGeneralStatusWord consist of the remaining 16 bits. While the functionality of FBFixedStatusWord is fixed in the VACON® standard applications, the functionality of FBGeneralStatusWord is totally application specific and can vary even in the VACON® standard applications.

The meanings of FBFixedStatusWord bits are described below. Unused bits have to be set to zero.

In VACON® NX series AC drives the FBFixedStatusWord comes from firmware variable "MCStatus".

Table 107. FBFixedStatusWord bits

Bit	Function		Description
B0	Ready	0	Drive is not ready.
		1	Drive is ready to run.
B1	Run	0	Motor is not running.
		1	Motor is running.
B2	Direction	0	Motor is running clockwise.
		1	Motor is running counterclockwise.
B3	Fault	0	No fault active.
		1	Drive has an active fault.
B4	Alarm	0	No alarm active.
		1	Drive has active alarm.
B5	At reference	0	Motor is not running at reference speed.
		1	Motor is running at reference speed.
B6	Zero speed	0	Motor is not at zero speed.
		1	Motor is running at zero speed.
B7	Flux ready	0	Motor is not magnetized.
		1	Motor is magnetized.
B8-B12	Reserved		

12.3 CONTROL WORD BIT SUPPORT IN DRIVES

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

Table 108. Control word

Bit	Function	VACON® 100 family	VACON® NXS/NXP	VACON® 20	VACON® 20 X
B0	Start/Stop	x	x	x	x
B1	Direction	x	x	x	x
B2	Fault reset	x	x	x	x
B3	Stop mode 1	x			x
B4	Stop mode 2	x			x
B5	Quick ramp time	x		x	x
B6	Freeze setpoint	x			x
B7	Setpoint to zero	x			x
B8	Request fieldbus control	x	x		x
B9	Request fieldbus reference	x	x		x
B10	Jogging 1	x			
B11	Jogging 2	x			
B12	Quick stop	x			x
B13	Reserved				
B14	Reserved				
B15	Reserved				

12.4 Status word bit support in drives

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

Table 109. Status word

Bit	Function	VACON® 100 family	VACON® NXS/NXP	VACON® 20	VACON® 20 X
B0	Ready	x	x	x	x
B1	Run	x	x	x	x
B2	Direction	x	x	x	x
B3	Fault	x	x	x	x
B4	Alarm	x	x	x	x
B5	At reference	x	x	x	x
B6	Zero speed	x	x		x
B7	Flux ready	x	x		
B8	Reserved				
B9	Reserved				
B10	Reserved				
B11	Reserved				
B12	Reserved				
B13	Reserved				
B14	Reserved				
B15	Reserved				

13. APPENDIX E - FIELDBUS OPTION BOARD COMMUNICATION

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

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

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

NOTE! OPTE6 CANopen does not support Fast safety mode and Fast PROFIBUS mode.

13.1 REQUIREMENTS FOR COMMUNICATION MODES

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

Table 110. Requirements for different fieldbus communication modes

<table>
<tr><th></th><th>Fast / Normal Extended</th><th>Fast safe</th><th>Fast PROFIBUS</th></tr>
<tr><td>Control Board</td><td>NXP (serial no. 761 or later)</td><td>NXP (serial no. 761 or later)</td><td>NXP (serial no. 561 or later)</td></tr>
<tr><td rowspan="2">System Software</td><td rowspan="2">NXP00003V196.VCN or later</td><td rowspan="2">NXP00003V194.VCN or later</td><td>NXP00002V171.VCN or later</td></tr>
<tr><td>NXP00003V179.VCN or later</td></tr>
<tr><td rowspan="3">Applica-tions</td><td rowspan="3">Multipurpose V236 or later (Normal Extended Mode)</td><td rowspan="3">Any*</td><td>System Interface V110 or later</td></tr>
<tr><td>Advanced V085 or later</td></tr>
<tr><td>Marine V107 or later</td></tr>
<tr><td rowspan="5">Fieldbus option slot</td><td>OPTE3-E5, V006 or later</td><td>OPTE3-E5, V006 or later</td><td>OPTC3_10502V014.vcn</td></tr>
<tr><td>OPTE9, V007 or later</td><td>-</td><td>OPTC3-5_FW0232V001.vcx or later</td></tr>
<tr><td>OPTEA, V001 or later</td><td>OPTEA, V001 or later</td><td></td></tr>
<tr><td>OPTEC, V003 or later</td><td>-</td><td>OPTEC, V001 or later</td></tr>
<tr><td>OPTE6, V010 or later</td><td>-</td><td>-</td></tr>
<tr><td>Advanced safety option</td><td>-</td><td>OPTBL_FW0227V001 or later</td><td>-</td></tr>
</table>

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

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

13.2 FIELDBUS COMMUNICATION MODE FEATURES AND LIMITATIONS

Fast mode:

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

Fast safe mode:

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

16 process data items:

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

13.3 NORMAL FIELDBUS COMMUNICATION

The normal fieldbus communication between option board and the AC drive application is visible in Figure 24. In normal communication both process data and service data are transferred in succession at 5 ms interval.

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

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

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

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

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

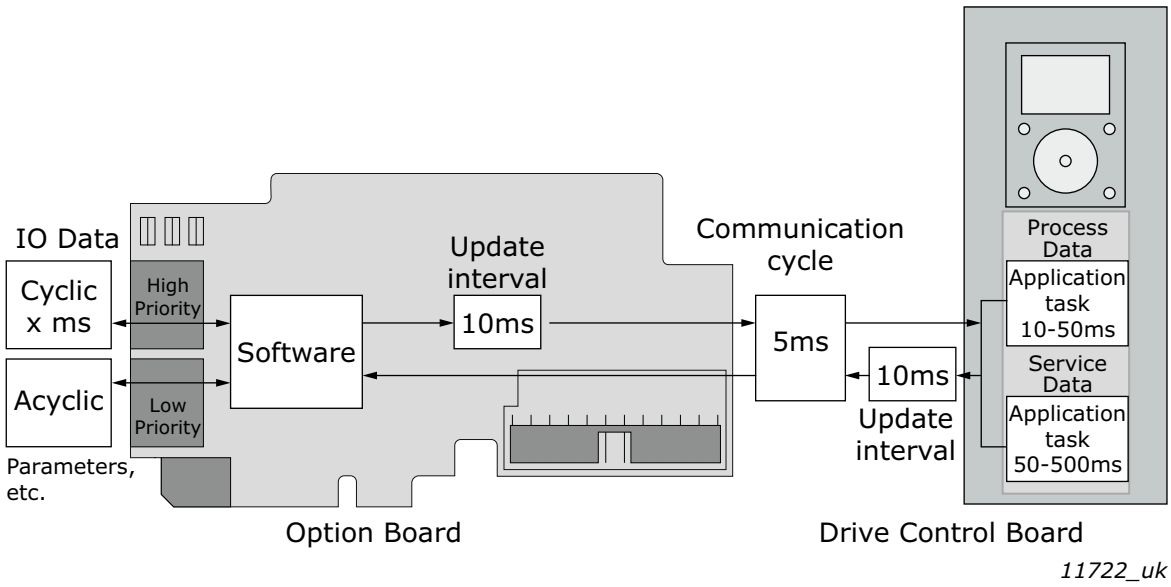

Figure 24. Normal fieldbus communication

13.4 FAST FIELDBUS COMMUNICATION

The fast mode decreases the communication delay between the PLC and the AC drive application significantly by using two communication channels separately for process and service data. The process data interval is set to 1 ms, while other data is sent acyclically. When the fast mode is activated, the application can be synchronized to run with the communication cycle. The Fast communication mode is visible in Figure 25. This mode also includes the ability to transfer 16 process data items.

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

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

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

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

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

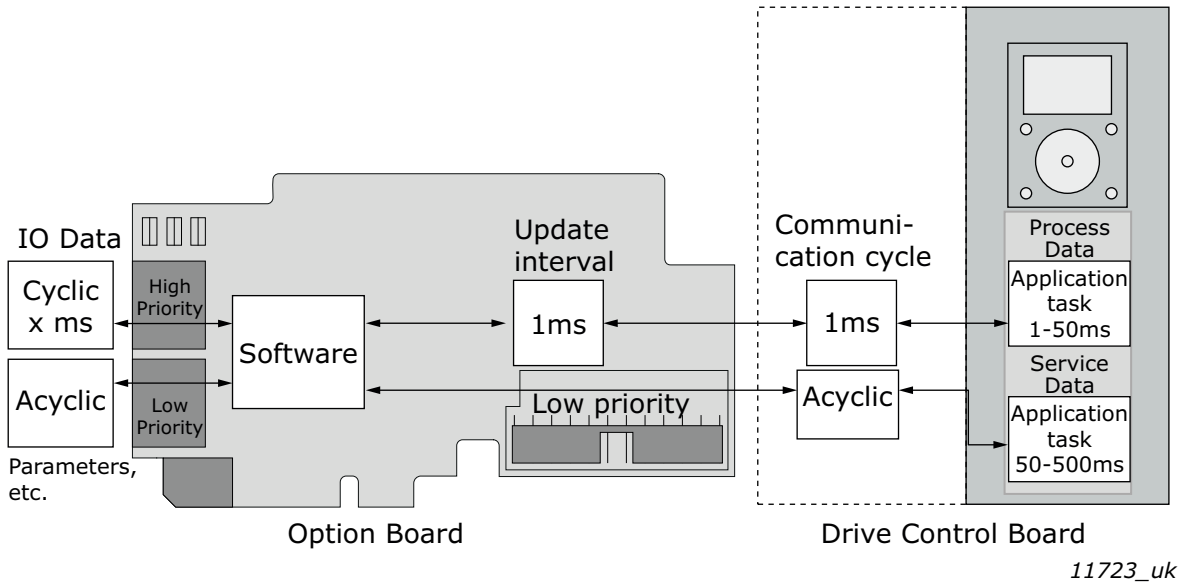

Figure 25. Fast fieldbus communication

13.5 NORMAL EXTENDED MODE

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

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

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

14. APPENDIX F - PARAMETERS FOR APPLICATION DEVELOPERS

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

Table 111. System software variables for selecting communication modes

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

* Fast safety mode is automatically enabled/disabled by system software. Cannot be set by user. This mode is not supported in OPTE6 CANopen.
** Fast PROFIBUS mode is not supported in OPTE6 CANopen.

FBModeSlotX_fwu8 variables are used to select the active fieldbus option board communication mode. If no fieldbus option board is connected to the related slot, the selection of the FBModeSlot parameter is set to 0 = Normal mode.

Table 112. System software variables for monitoring supported communication modes

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

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

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

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

Example 2: OPTE9_FW0196V006 Dual Port Ethernet board returns value: 0x0A, indicating support for Normal and Fast modes.

Table 113. System software variables for selecting the input process data slot

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

*For backward compatibility only. Same as FBModeSlotX_fwu8 variable setting '3'. Fast PROFIBUS is not supported in OPTE6 CANopen.

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

This selector can be used to support redundant fieldbus connection. In fieldbus redundancy mode two fieldbus option boards are installed to VACON® NXP option board slots D and E. Application selects with FBControlSlotSelector_fwu8 variable which fieldbus option board can deliver process data from fieldbus master to the application.

Default value for FBControlSlotSelector_fwu8 is '0' which means that process data is accepted from both fieldbus option boards.

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Danfoss Drives Oy
Runsorintie 7
65380 Vaasa
Finland