

Altivar 32

Variable speed drives
for synchronous and asynchronous motors

CANopen[®] Communication Manual

09/2012



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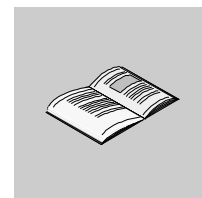
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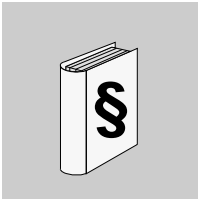
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Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety message that follow this symbol to avoid possible injury or death.

⚠ DANGER
DANGER indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.

⚠ WARNING
WARNING indicates a potentially hazardous situation, which, if not avoided, can result in death, serious injury or equipment damage.

⚠ CAUTION
CAUTION indicates a potentially hazardous situation, which, if not avoided, can result in injury or equipment damage.

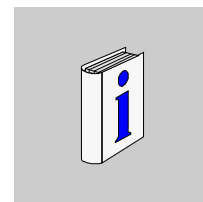
CAUTION
CAUTION , used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, can result in equipment damage.

PLEASE NOTE

The word “drive” as used in this manual refers to the controller portion of the adjustable speed drive as defined by NEC.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

About the Book



At a Glance

Document Scope

The purpose of this document is to:

- show you how to install the CANopen fieldbus on your Altivar 32,
- show you how to configure the Altivar 32 to use CANopen for monitoring and control,
- provide examples of setup using SoMachine and Unity.

NOTE: Read and understand this document and all related documents (see below) before installing, operating, or maintaining your ATV32.

Validity Note

This documentation is valid for the Altivar 32 CANopen fieldbus.

Related Documents

Title of Documentation	Reference Number
ATV32 Quick Start	S1A41715
ATV32 Installation manual	S1A28686
ATV32 Programming manual	S1A28692
ATV32 Modbus manual	S1A28698
ATV32 Communication Parameters	S1A44568
ATV32 Atex manual	S1A45605
ATV32 Safety manual	S1A45606
ATV32 certificates and other option manuals: see www.schneider-electric.com	

You can download the latest versions of these technical publications and other technical information from our website at www.schneider-electric.com.

Product Related Information

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

- Read and understand this manual before installing or operating the Altivar 32 drive.
- Any changes made to the parameter settings must be performed by qualified personnel.

Failure to follow these instructions will result in death or serious injury.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Read and understand this manual before installing or operating the Altivar 32 drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- DO NOT touch unshielded components or terminal strip screw connections with voltage present.
- DO NOT short across terminals PA/+ and PC/- or across the DC bus capacitors.
- Before servicing the drive:
 - Disconnect all power, including external control power that may be present.
 - Place a "DO NOT TURN ON" label on all power disconnects.
 - Lock all power disconnects in the open position.
 - WAIT 15 MINUTES to allow the DC bus capacitors to discharge.
 - Measure the voltage of the DC bus between the PA/+ and PC/- terminals to ensure that the voltage is less than 42 Vdc.
 - If the DC bus capacitors do not discharge completely, contact your local Schneider Electric representative. Do not repair or operate the drive
- Install and close all covers before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

DAMAGE DRIVE EQUIPMENT

Do not operate or install any drive or drive accessory that appears damaged.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.(1)

Failure to follow these instructions can result in death, serious injury, or equipment damage.

(1) For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems."

ATV32 CANopen Features Overview

1

What's in this Chapter?

This chapter contains the following topics:

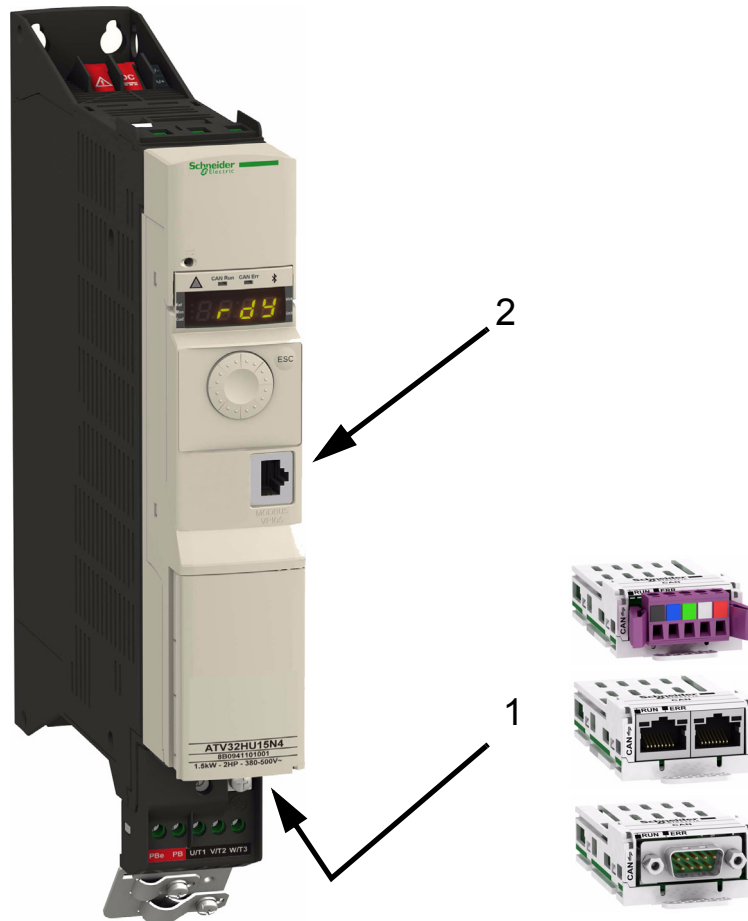
Topic	Page
Hardware Presentation	9
CANopen Profile	9
Communication and Services	10

Hardware Presentation

The ATV32 can be connected to a CANopen network by several ways:

- The first solution is to use a CANopen communication adapter (VW3 A3 608, VW3 A3 618, VW3 A3 628) that can be locked in the option slot of the drive (see 1 below).
- The second solution is to use the communication base port in the front of the drive (see 2 below).

NOTE: The CANopen base port will become inactive when an option card is inserted.



CANopen Profile

The ATV32 supports CiA[®]301 and CiA[®]402 V3 drive profile.

Communication and Services

Cyclical Communication

- PDO1 is dedicated to the control of the drive, according to CiA402.
- PDO2 extends the communication capabilities.
- PDO3 is intended for use with the Communication scanner.

PDO1 and PDO3 provides scan cycle optimization (synchronized with drive task) which allows short reaction time application (<10ms). See "Optimizing the Response Time" on page 57.

The configuration means are:

- CANopen configuration tool, then the configuration is downloaded by the master,
- SoMove, DTM ATV32.

Acyclic Services

The ATV32 manages a SDO server, characterized by two identifiers:

- One for requests
- One for responses

Segmented transfer is supported.

Other CANopen Supported Services

Assignment by default of address-based identifiers.

- NMT commands
- Boot up
- Heartbeat producer and consumer
- Node Guarding
- Emergency (EMCY)
- SYNC, for all PDOs on the Altivar
- General broadcast support on identifier 0

EDS File

The EDS file for the ATV32 can be downloaded on www.schneider-electric.com

Profiles

2

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Definition of a Profile	12
Functional Profiles Supported by the Altivar 32	13

Definition of a Profile

There are three types of profile:

- Communication profiles
- Functional profiles
- Application profiles

Communication Profiles

A communication profile describes the characteristics of the bus or network:

- Cables
- Connectors
- Electrical characteristics
- Access protocol
- Addressing system
- Periodic exchange service
- Messaging service
- ...

A communication profile is unique to a type of network (Modbus CIP, Profibus DP, etc.) and is used by various different types of device.

Functional Profiles

A functional profile describes the behavior of a type of device. It defines:

- Functions
- Parameters (name, format, unit, type, etc.)
- Periodic I/O variables
- State chart(s)
- ...

A functional profile is common to all members of a device family (variable speed drives, encoders, I/O modules, displays, etc.).

They can feature common or similar parts. The standardized (IEC 61800-7) functional profiles of variable speed drives are:

- CiA402
- PROFIDRIVE
- CIP

DRIVECOM has been available since 1991.

CiA402 "Device profile for drives and motion control" represents the next stage of this standard's development and is now part of the IEC 61800-7 standard.

Some protocols also support the ODVA (Open DeviceNet Vendor Association) profile.

Application Profiles

Application profiles define in their entirety the services to be provided by the devices on a machine. For example, "CiA DSP 417-2 V 1.01 part 2: CANopen application profile for lift control systems - virtual device definitions".

Interchangeability

The aim of communication and functional profiles is to achieve interchangeability of the devices connected via the network.

Functional Profiles Supported by the Altivar 32

I/O Profile

Using the I/O profile simplifies PLC programming.

The I/O profile mirrors the use of the terminal strip for control by utilizing 1 bit to control a function.

With an Altivar 32, the I/O profile can also be used when controlling via a network.

The drive starts up as soon as the run command is sent.

15 bits of the control word (bits 1 to 15) can be assigned to a specific function.

This profile can be developed for simultaneous control of the drive via:

- The terminals
- The Modbus control word
- The CANopen control word
- The network module control word

The I/O profile is supported by the drive itself and therefore in turn by all the communication ports (integrated Modbus, CANopen, Ethernet, Profibus DP, DeviceNet communication modules).

CiA402 Profile

The drive only starts up following a command sequence.

The control word is standardized.

5 bits of the control word (bits 11 to 15) can be assigned to a function.

The CiA402 profile is supported by the drive itself and therefore in turn by all the communication ports (integrated Modbus, CANopen, Ethernet, Profibus DP, DeviceNet communication modules).

The Altivar 32 supports the CiA402 profile's "Velocity mode".

In the CiA402 profile, there are two modes that are specific to the Altivar 32 and characterize command and reference management:

- Separate mode **[Separate]** (*S E P*)
- Not separate mode **[Not separ.]** (*S I N*)

See "CiA[®] 402 - IEC61800-7 Functional Profile" on page 37.

PDOs Set Overview

See "PDO Default Configuration" on page 56.

Hardware Setup

3

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
CANopen Base Port	15
CANopen Communication Modules	16
Electrical Installation	21

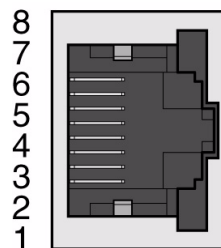
CANopen Base Port

NOTE: This CANopen connection shares the same connector with Modbus base serial port.

Base Port RJ45 Pin Out

The following table describes the pin out of the RJ45 connector:

Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_GND
4	D1 - RS485 (Modbus)
5	D0 - RS485 (Modbus)
6	Not connected
7	VP - Reserved for RS232/RS485 converter
8	Common



NOTE: The CANopen signals on the base port are deactivated if an option card is plugged in the drive.

NOTE: The Common I/O terminal is the same as the one of the embedded communication port.

CANopen Communication Modules

Introduction

3 CANopen opto-isolated modules exist for the ATV32, they offer convenient and optimized wiring solution for CANopen networks:

- VW3 A3 608: Dual RJ45 module.
- VW3 A3 618: Legacy CANopen connection with SubD9.
- VW3 A3 628: Open style 5 poles connector.

CANopen Daisy Chain Module (VW3 A3 608)

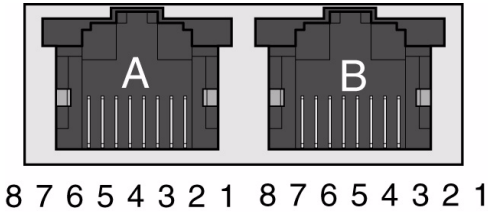
The following figure shows the dual RJ45 connector:



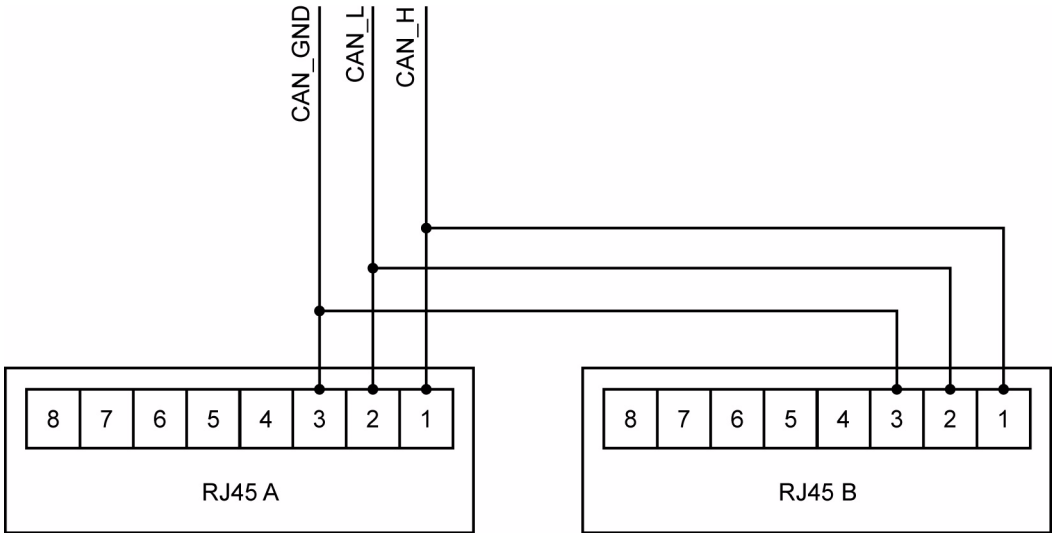
NOTE: Maximum bus length are divided by 2 with the CANopen Daisy chain VW3 A3 608. See “Maximum Length Bus with SubD9 CANopen Connectors” on page 21.

The following table describes the pin out of each RJ45:

Pin	RJ45 Signal
1	CAN_H
2	CAN_L
3	CAN_GND
4	Not connected
5	Not connected
6	Not connected
7	Not connected
8	Not connected



NOTE: Both RJ45 are interconnected internally as on the diagram below:



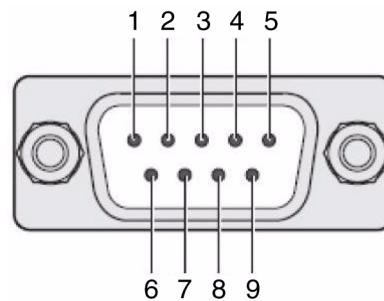
SubD9 CANopen Communication Module (VW3 A3 618)

The following figure shows the SubD9 connector:



The following table describes the pin out of the SubD9 connector (male):

Pin	SubD Signal
1	Reserved
2	CAN_L
3	CAN_GND
4	Reserved
5	CAN_SHLD
6	GND
7	CAN_H
8	Reserved
9	Reserved



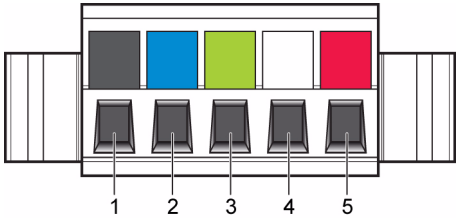
Open Style CANopen Communication Module (VW3 A3 628)

The following figure shows the open style connector:



The following table describes the pin out of the open style connector:

Pin	Signal
1	CAN_GND
2	CAN L bus line
3	CAN shield
4	CAN H bus line
5	Reserved



CANopen Modules Mounting

- Check that the card catalog number marked on the label is the same as that on the delivery note corresponding to the purchase order.
- Remove the communication module from its packaging and check that it has not been damaged in transit.

CAUTION

RISK OF DAMAGE TO THE DRIVE

Install only communication modules designed for ATV32. See references in the catalog.

Failure to follow these instructions can result in equipment damage.

⚠ ⚠ DANGER

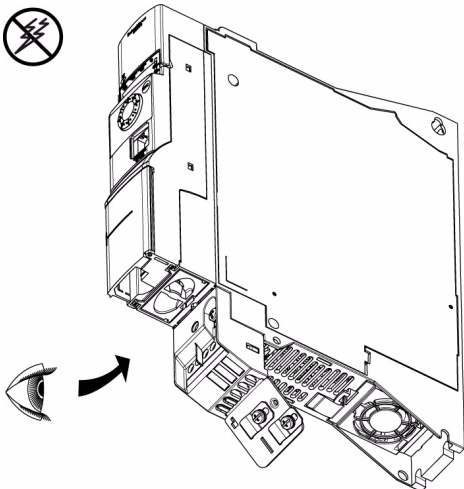
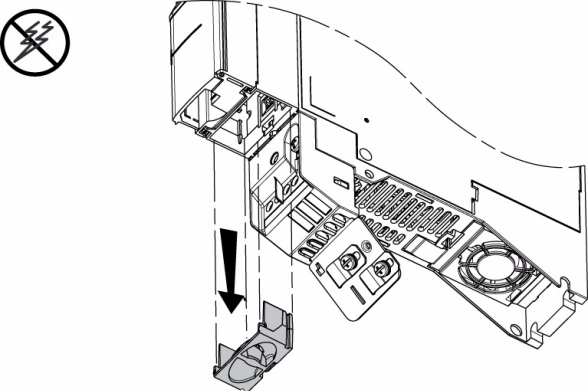
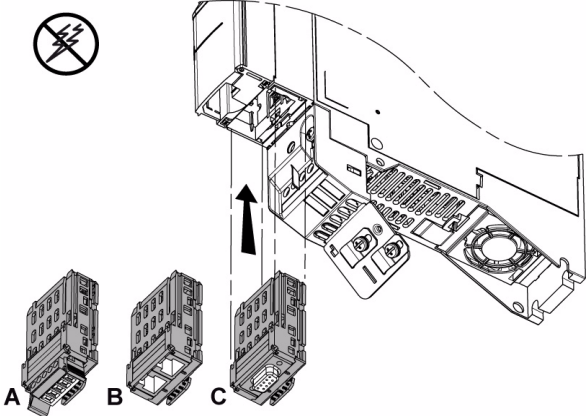
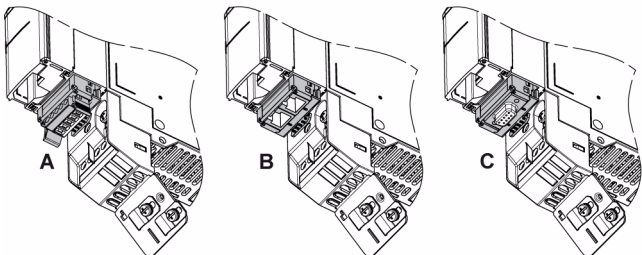
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Read and understand the precautions in “About the Book” on page 6 before performing the procedure in this section.


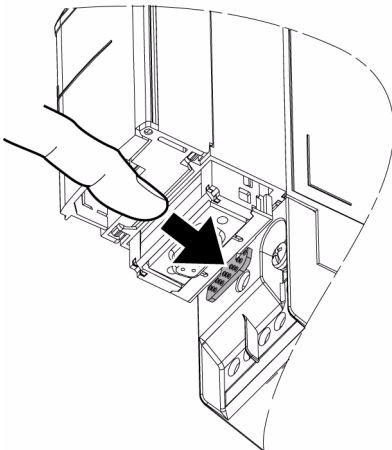

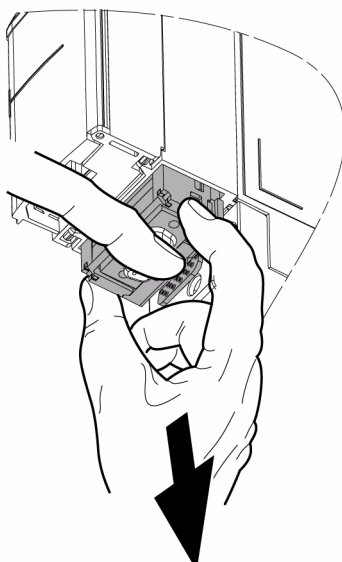
Failure to follow these instructions will result in death or serious injury.

NOTE: The CANopen signals on the base port are deactivated if an option card is plugged in the drive.

Install the communication module in ATV32 as follows:

Step	Action	Comment
1	Ensure that the power is off. Locate the option card port on the bottom of the ATV32.	
2	Extract the cover.	
3	Insert the module A, B or C A: open style module VW3 A3 628. B: daisy chain module VW3 A3 608. C: SubD9 module VW3 A3 618.	
4	Check that the module is correctly inserted and locked mechanically in the drive.	

Extract the communication module as follows:

Step	Action	Comment
1	Ensure that the power is off. Press the strip.	 
2	Extract the module while maintaining the strip pressed,	 

Electrical Installation

The maximum bus length depends on the selected baud rate. The table below shows the maximum recommended overall length of the CAN bus in the case of cables with SubD9 connectors.

Maximum Length Bus with SubD9 CANopen Connectors

The following table describes the Maximum length:

Baud rate KBit/s	Maximum bus length m (ft)
50	1000 (3280)
125	500 (1640)
250	250 (820)
500	100 (328)
1000	20 (65)

The reference potential CAN_0V and the shield connection (connector housing) are galvanically isolated.

- Keep the galvanic isolation in order to avoid ground loops via the CAN bus.
- Use equipotential bonding conductors.
- Use pre-assembled cables to reduce wiring errors.
- Verify that wiring, cables and connected interfaces meet the PELV requirements.

Terminating Resistors

Both ends of a CAN bus line must be terminated. A 120 Ohm terminating resistor between CAN_L and CAN_H is used for this purpose. According to the CANopen several solutions are available.

The following table describes the CANopen accessories for the different bus termination:

Bus termination	Accessories	
CANopen RJ45 module VW3 A3 608	CANopen terminating resistor, 120 Ohm, integrated in RJ45 connector	TCSCAR013M120
CANopen Open style module VW3 A3 628	CANopen terminating resistor, 120 Ohm, for terminal screw terminal	TCSCAR01NM120
CANopen SubD9 module VW3 A3 618	CANopen connector, SubD9 (female), with switchable terminating resistor, straight	TSXCANKCDF180T
	CANopen cable, 1 m, SubD9 (female) with integrated terminating resistor to RJ45	VW3M3805R01
	CANopen cable, 3 m, SubD9 (female) with integrated terminating resistor to RJ45	VW3M3805R030

Configuration

4

What's in this Chapter?

This chapter contains the following topics:

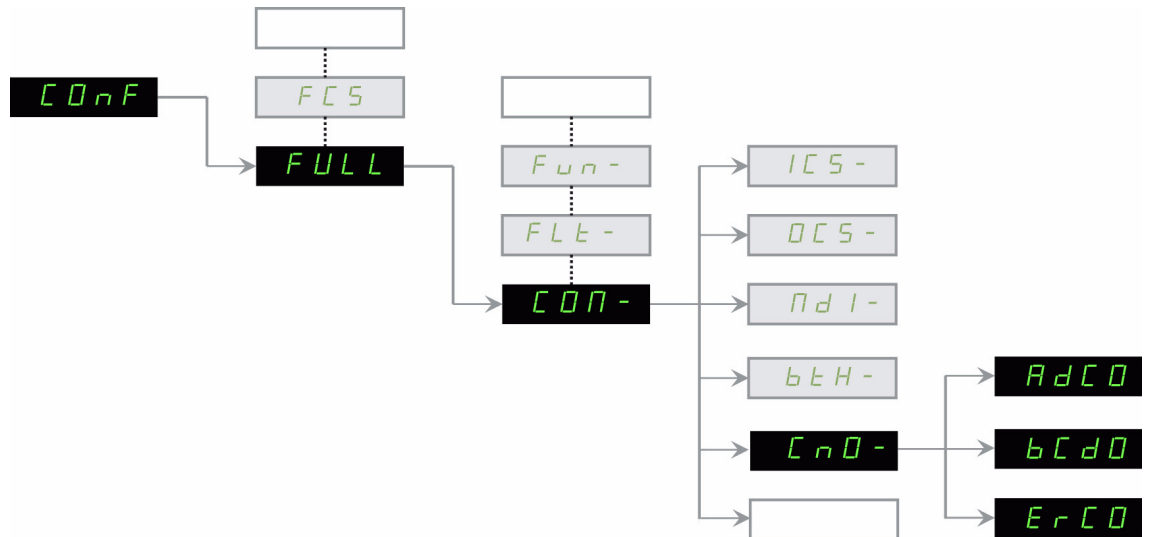
Topic	Page
Configuring the Communication Parameters	23
Configuring the Control Channels	24
Configuring Monitor Parameters	26
Configuring Communication Interruption Management	27

Configuring the Communication Parameters

The configuration of the CANopen communication functions on the Altivar is accessed via the **[CONFIGURATION]** (C O N F) menu, **[FULL]** (F U L L), **[COMMUNICATION]** (C O M -) and **[CANopen]** (C n O -) submenu, on the graphic display terminal or integrated display terminal.

NOTE: the configuration can only be modified when the motor is stopped and the drive stopped.

In order for modifications to take effect, the drive must be shut down then restarted.



Parameter	Possible values	Terminal display	Default value
[CANopen address] (A d C O) (b d C O)	CANopen deactivated 1 to 127	[OFF] (O F F) [1] (1)....[127] (1 2 7)	[OFF] (O F F)
[CANopen bit rate] (b d C O) (b d C O)	50 kbps	[50 kbps] (5 0)	[250 kbps] (2 5 0)
	125 kbps	[125 kbps] (1 2 5)	
	250 kbps	[250 kbps] (2 5 0)	
	500 kbps	[500 kbps] (5 0 0)	
	1 000 kbps	[1000 kbps] (1 0 0 0)	

The **[CANopen address]** (A d C O) parameter will thereafter be referred to as “Node-ID” in the present communication manual.

The default value (OFF) of this parameter disables the CANopen communications of the Altivar.

In order to enable CANopen on the Altivar 32, you must set a non-zero value for **[CANopen address]** (A d C O).

The value of the **[CANopen bit rate]** (b d C O) parameter must match the communication speed of all the other devices connected to the CANopen bus. In addition, the maximum length of the bus depends on the communication speed.

The drive must be restarted in order to take into account the CANopen parameters.

Configuring the Control Channels

This chapter explains through 3 examples how to configure the drive for operation from communication network:

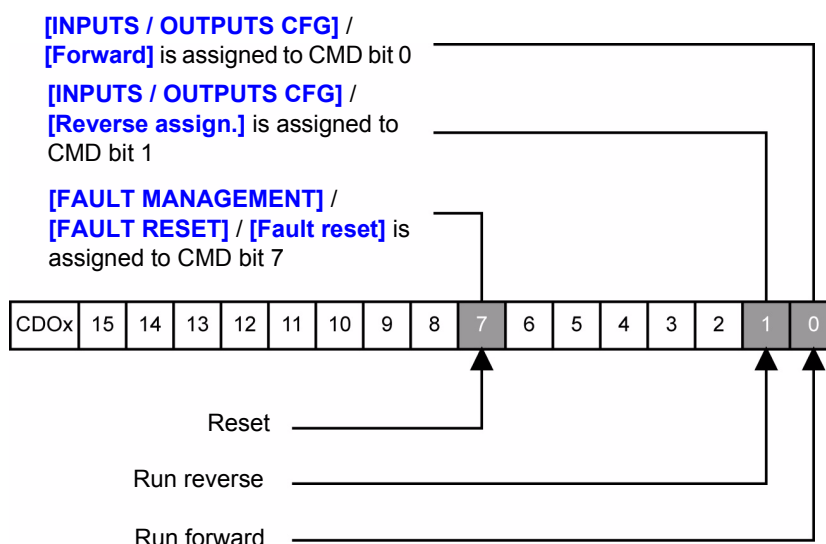
- I/O Mode - a simple command Word (based on Forward, reverse and reset binary commands).
- Combined Mode (with native profile CiA402) - Both reference and command word come from the communication network.
- Separate (with native profile CiA402) - Reference and command come from separate sources: for example, the command (in CiA402) comes from the communication network and the reference from the HMI.

PDO's Configuration

See "Detailed Description of Services" on page 76.

Configuration of the Drive for Operation in I/O Profile

To illustrate the I/O Profile, we will describe a simple example, which can be of course extended with additional features. The Command word is made of Run forward (bit 0 of CMD), run reverse (bit 1 of CMD), and a detected fault reset (bit 7 of CMD).



The settings will be the following:

	CANopen communication adapter CANopen base port on ATV32
[Ref.1 channel] (F r l)	[CANopen] (C A N o p e n)
[RV Inhibition] (r i n)	Default
[Stop Key priority] (P S t)	Default
[Profile] (C H C F)	[I/O profile] (I O)
[Cmd switching] (C C S)	Default
[Cmd channel 1] (C d l)	[CANopen] (C A N o p e n)

The bits of the command word must now be configured.

In the **[INPUTS / OUTPUTS CFG]** Menu, configure:

[Forward] (F r d)	[Cd00] (C d 0 0)
[Reverse assign.] (r r S)	[Cd01] (C d 0 1)

In the **[FAULT MANAGEMENT]** menu, **[FAULT RESET]** submenu, configure:

[Fault reset] (r S F)	[Cd07] (C d 0 7)
-----------------------	------------------

Configuration of the Drive for Operation With CiA402 Profile in Combined Mode

This chapter describes how to configure the settings of the drive if it is controlled in CiA402 Mode. The example focuses on the Not separate mode (Combined). Additional modes such separate Mode are detailed in the ATV32 Programming manual.

In the Command Menu [Command] (CLL-):

- [Ref.1 channel] (FrI): is set to [CANopen] (CRn) regardless of the communication source you can choose:

Origin of the control	Ref.1 channel setting
CANopen communication adapter	[CANopen] (CRn)
CANopen base port on ATV32	

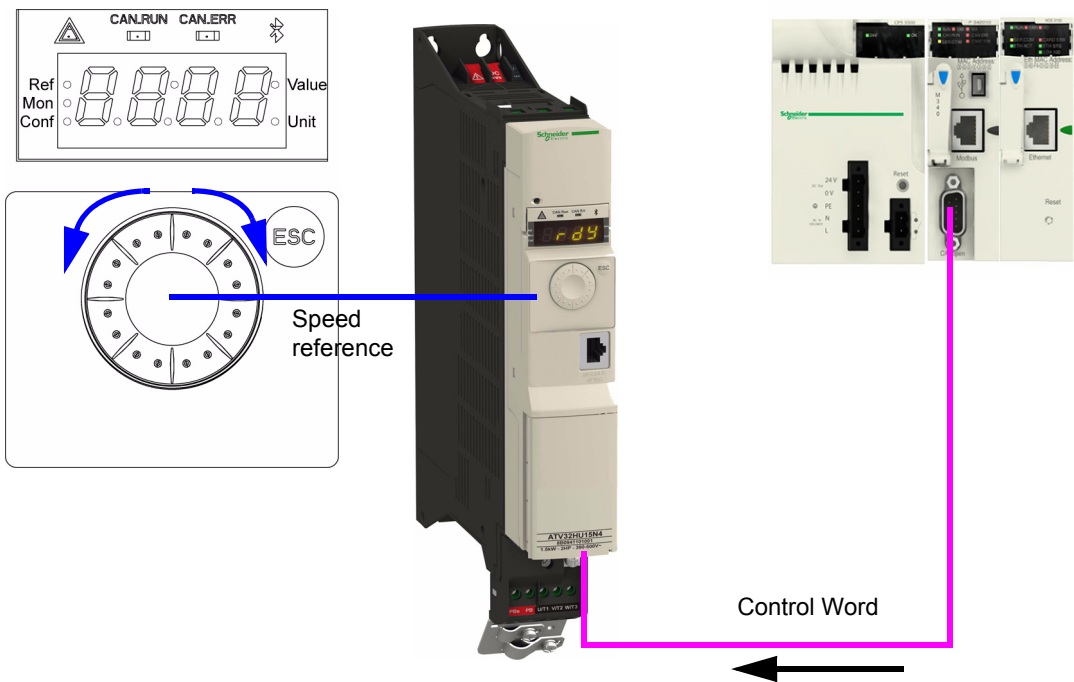
- [Profile] (CHCF): defines if the drives operates in combined mode (reference and command from the same channel)

For the current example, CHCF will be adjusted to SIM, as reference and control are originated from the communication network.

Profile	Ref.1 channel setting
CiA402 Combined mode	[Not separ.] (5IN) (factory setting)

Configuration of the Drive for Operation with CiA402 Profile in Separate Mode

Alternate combinations are possible, see the ATV32 programming manual for the list of possible settings.
Example:



The drive is controlled from the communication (1 of the 3 following settings MDB, CAN or NET) but the reference is adjusted on the HMI. The control word comes from the controller and is written according to CiA402 profile.
The impacted settings will be as follows (and other settings are not modified):

	CANopen communication adapter CANopen base port on ATV32
[Ref.1 channel] (FrI)	[AI virtual 1] (RIU I)
[Profile] (CHCF)	[Separate] (SEP)
[Cmd switching] (CL5)	Default
[Cmd channel 1] (CdI)	[CANopen] (CRn)

Configuring Monitor Parameters

It is possible to select up to 4 parameters to display their values in the [\[1.2 MONITORING\]](#) menu on the graphic display terminal (to be ordered separately - reference VW3 A1 101).

The selection is made via the [\[3. INTERFACE\]](#) / [\[3.3 MONITORING CONFIG.\]](#) menu ([\[COM. MAP CONFIG.\]](#) submenu).

Each parameter in the range [\[Word 1 add. select.\]](#) ... [\[Word 4 add. select.\]](#) can be used to select the parameter logic address. An address at zero is used to disable the function.

Example

In the example given here, the monitored words are:

- Parameter 1 = Motor current (LCR): logic address 3204, signed decimal format.
- Parameter 2 = Motor torque (OTR): logic address 3205, signed decimal format.
- Parameter 3 = Last detected fault occurred (LFT): logic address 7121, hexadecimal format.
- Disabled parameter: 0; default format: Hexadecimal format

RDY	CAN	+0.00Hz	0A
COM. MAP CONFIG.			
Address 1 select	:		3204
FORMAT 1	:		Signed
Address 2 select	:		3205
FORMAT 2	:		Signed
Address 3 select	:		7121
Code		Quick	▼
FORMAT 3	:		Hex
Address 4 select	:		0
FORMAT 4	:		Hex

One of the three display formats below can be assigned to each monitored word:

Format	Range	Terminal display
Hexadecimal	0000 ... FFFF	[Hex]
Signed decimal	-32 767 ... 32 767	[Signed]
Unsigned decimal	0 ... 65 535	[Unsigned]

NOTE: If a monitored parameter:

- has been assigned to an unknown address,
- has been assigned to a protected parameter,
- has not been assigned,

the value displayed in the [\[COMMUNICATION MAP\]](#) screen is: "...." (see "Diagnostics" on page 28).

Configuring Communication Interruption Management

The response of the drive in the event of a CANopen communication interruption can be configured. It can be configured via the graphic display terminal or the integrated display terminal, from the **[FAULT MANAGEMENT]** (F L E -) menu, **[COM. FAULT MANAGEMENT]** (C L L -) submenu, via the **[CANopen fault mgt]** (C D L) parameter.

RDY	CAN	+0.00Hz	0A
COM. FAULT MANAGEMENT			<input type="checkbox"/>
Network fault mgt	:	Freewheel	
CANopen fault mgt	:	Freewheel	
Modbus fault mgt	:	Freewheel	
Code			Quick <input type="checkbox"/>

The values of the **[CANopen fault mgt]** (C D L) parameter, which trigger a drive detected fault **[CANopen com.]** (C D F), are:

Value	Meaning
[Freewheel] (Y E S)	Freewheel stop (factory setting)
[Ramp stop] (r P P)	Stop on ramp
[Fast stop] (F S E)	Fast stop
[DC injection] (d C I)	DC injection stop

The values of the **[CANopen fault mgt]** (C D L) parameter, which do not trigger a drive detected fault, are:

Value	Meaning
[Ignore] (n D)	Detected fault ignored
[Per STT] (S E E)	Stop according to configuration of [Type of stop] (S E E)
[fallback speed] (L F F)	Change to fallback speed, maintained as long as the detected fault persists and the run command has not been removed
[Spd maint.] (r L S)	The drive maintains the speed at the time the detected fault occurred, as long as the detected fault persists and the run command has not been removed

The fallback speed can be configured in the **[FAULT MANAGEMENT]** (F L E -) / **[FALLBACK SPEED]** (L F F -) menu using the **[Fallback speed]** (L F F) parameter.

⚠ WARNING

LOSS OF CONTROL

If CANopen fault management **[Unld. Thr. 0. Speed.]** (C D L) is set to **[Ignore]** (n D), communication control will be inhibited.

For safety reasons, inhibiting the communication interruption detection should be restricted to the debug phase or to special applications.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Diagnostics

5

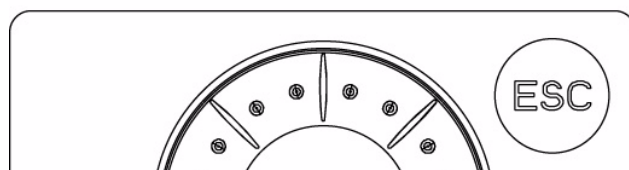
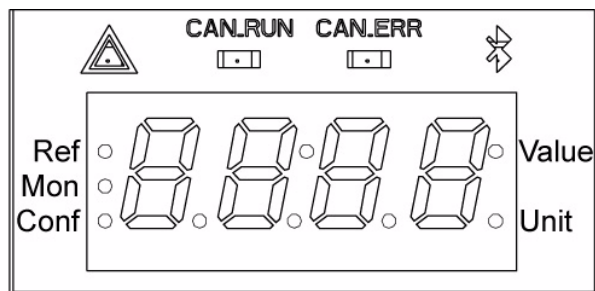
What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Status LEDs	29
Communication Diagnostics Introduction	31
Communication Diagnostics	31
Control-Signal Diagnostics	33
Monitoring of Communication Channels	35

Status LEDs

CANopen activity LEDs (CAN ERR and CAN RUN) are located on the HMI of the ATV32:.



LED state		Altivar 32 / CANopen state
CAN_RUN		The CANopen controller is in "OFF" state
		The Altivar 32 is in "STOPPED" state
		The Altivar 32 is in "PRE-OPERATIONAL" state
		The Altivar 32 is in "OPERATIONAL" state
CAN_ERR		No detected error reported
		Detected error reported by the CANopen controller of the Altivar 32 (example: too many detected error frames)
		Detected error due to the occurrence of a node-guarding event or a heartbeat event
		The CANopen controller is in "bus-off" state

Description of the various LED states

LED state	Visual description of the LED state
	The LED is OFF
	The LED is SINGLE FLASHING (200 ms ON and 1 second OFF)
	The LED is DOUBLE FLASHING (200 ms ON, 200 ms OFF, 200 ms ON, and 1 second OFF)
	The LED is BLINKING at 2.5 Hz (200 ms ON and 200 ms OFF)
	The LED is ON

Communication Diagnostics Introduction

A properly operating fieldbus is essential for evaluating operating and detected faults messages.

Connections for Fieldbus Mode

If the product cannot be addressed via the fieldbus, first check the connections. The product manual contains the technical data of the device and information on network and device installation. Check the following:

- 24Vdc power supply
- Power connections to the device
- Fieldbus cable and fieldbus wiring
- Network connection to the device

You can also use the commissioning software for troubleshooting.

Baud Rate and Address

If it is impossible to connect to a device, check the baud rate and node address:

- The baud rate must be the same for all devices in the network.
- The node address of each device must be between 1 and 127 and unique for each device. To set the baud rate and node address See "Configuring the Communication Parameters" on page 23.

Communication Interruptions

CANopen communication interruptions are displayed by **[Past fault 1] (d P I)** indicator of the integrated display terminal or graphic display terminal or by Emergency object (EMCY), described in "Emergency Object (EMCY)" on page 82.

In factory settings, a CANopen communication interruption triggers a resettable drive detected fault **[CANopen com.] (C D F)** and a freewheel stop.

The response of the drive in the event of a CANopen communication interruption can be changed.

- Drive fault **[CANopen com.] (C D F)** (freewheel stop, stop on ramp, fast stop or DC injection stop).
- No drive detected fault (stop, maintain, fallback).

In the event of a **[CANopen com.] (C D F)**, the drive sends an EMCY message to the CANopen master, see "Emergency Object (EMCY)" on page 82.

The Diagnostics and Troubleshooting are described in the programming manual:

- After initialisation (power up), the drive checks that at least one of the command or target parameters has been written once via CANopen.
- Then, if a CANopen communication interruption occurs, the drive reacts according to the configuration (stop, maintain, fallback...).

The source of this detected fault is displayed on the terminal: **[MONITORING] (S U P -)** menu, **[COMMUNICATION MAP] (C P P -)** submenu, **[CANopen MAP] (C n P -)** submenu, **[Error code] (E r C D)** parameter.

Fieldbus Function Test

After correct configuration of the transmission data, test fieldbus mode. This requires installation of a CAN configuration tool that displays CAN messages. Feedback from the product is indicated in the form of a boot up message:

- Switch the power supply off and on again.
- Observe the network messages after switching on. After initialization of the bus, the device sends a boot-up message (COB ID 700h+ node ID and 1 data byte with the content 00h).

If operation on the network cannot be started, the network function of the device must be checked by your local sales office. Contact your local sales office.

Communication Diagnostics

On the display terminal, the **[1.2 - MONITORING]** (**1 2 n -**) menu (**[COMMUNICATION MAP]** (**1 2 n -**) submenu, **[CANopen MAP]** (**1 2 n -**) submenu) can be used to display the communication status on CANopen.

LED Display

[RUN LED] LED ("OFF", "Stopped", "Pre-operational" or "Operational" state of the CANopen controller)

[ERR LED] LED (CANopen error)

These LEDs are equivalent to the "CAN RUN" and "CAN ERR" LEDs on the 7-segment integrated terminal (where supplied together with the drive).

The display on the screen opposite indicates that the CANopen controller is in the "Operational" state (**[RUN LED]** LED permanently lit) and that the controller has not detected any errors present (**[ERR LED]** not lit).

RUN	CAN	+50.00Hz	80A
CANopen MAP			
RUN LED	:		⊗
ERR LED	:		⊗
PDO1 IMAGE	:		
PDO2 IMAGE	:		
PDO3 IMAGE	:		
Code		Quick	
Canopen NMT state	:	Operational	
Number of TX PDO	:	2438	
Number of RX PDO	:	2438	
Error code		0	
RX Error Counter		0	
TX Error Counter		0	

⊗ indicates a LED, which is not lit.

⊗ indicates a LED, which is lit.

NMT Chart Display

The **[CANopen NMT state]** (**1 2 5**) parameter (logic address 6057, CANopen index/subindex 16#201E/3A) indicates the NMT chart state. The various possible values are **[Boot]**, **[Stopped]**, **[Operational]** and **[Pre-Op]** (Pre-operational).

PDO Counter Display

[Number of RX PDO] (**1 2 6**) and **[Number of TX PDO]** (**1 2 7**) indicate the number of PDOs received and the number of PDOs transmitted by the drive (all PDO sets - PDO1, PDO2 and PDO3 - combined).

The values of the counters are reseted to zero once 65 535 is reached.

Last CANopen Detected Fault

The **[Error code]** (**1 2 8**) parameter (index/subindex 16#201E/39) indicates the last active CANopen detected fault and maintains its value until the last detected fault has disappeared.

The possible values are listed below:

Display	Description
[0]	No errors detected since the start of CANopen communication
[1]	"Bus Off"
[2]	"Node Guarding" detected fault requiring a return to the NMT "Initialization" state
[3]	"CAN overrun"
[4]	"Heartbeat" detected fault requiring a return to the NMT "Initialization" state
[5]	NMT state chart detected fault

Counters

The **[RX Error Counter]** (**r E C I**) parameter (logic address 6059, CANopen index/subindex 16#201E/3C) counts the number of frames received with errors for all types of frame (PDO, SDO, etc.).

The **[TX Error Counter]** (**E E C I**) parameter (logic address 6058, CANopen index 16#201E/3B) counts the number of frames transmitted with errors for all types of frame (PDO, SDO, etc.).

These types of error can be caused, for example, by network load problems or the short-circuiting of electrical signals on the bus.

The maximum count value supported by these two counters is 65 535.

PDO Value Display

A second level of submenus can be accessed via the **[CANopen map]** (**C n P -**) submenu:

[PDO1 IMAGE] (**P D I -**), **[PDO2 IMAGE]** (**P D 2 -**) and **[PDO3 IMAGE]** (**P D 3 -**).

Each of these submenus can be used to access a screen displaying the values transmitted and received by each set respectively (PDO1, PDO2 and PDO3).

RUN	CAN	+50.00Hz	80A
PDO3 IMAGE			<input type="checkbox"/>
Received PDO3-1	:		1237
Received PDO3-2	:		50
Received PDO3-3	:		0
Received PDO3-4	:		304
Transmit PDO3-1	:		231
<input type="checkbox"/>	Code		Quick <input checked="" type="checkbox"/>
Transmit PDO3-2	:		642
Transmit PDO3-3	:		10
Transmit PDO3-4	:		9432

NOTE: In each of these screens and for each PDO transmitted or received, only the **[Transmit PDO--]** or **[Received PDO--]** words actually transmitted and received on the CANopen bus are displayed.

This means, for example, that for a receive PDO2 containing only 4 data bytes (i.e., RP21 and RP22), the fields **[Received PDO2-3]** and **[Received PDO2-4]** will not be displayed.

Control-Signal Diagnostics

On the terminal, the **[1.2 - MONITORING]** (**Π Δ η -**) menu (**[COMMUNICATION MAP]** (**Σ Π Π -**) submenu) can be used to display control-signal diagnostic information between the Altivar drive and the CANopen master:

- Active command channel **[Command channel]** (**Σ Π Δ Σ**)
- Value of the control word (CMD) from the active command channel **[Cmd value]** (**Σ Π Δ**)
- Active target channel **[Active ref. channel]** (**ρ F Σ Σ**)
- Value of the target from the active target channel **[Frequency ref.]** (**F ρ H**)
- Value of the status word **[ETA state word]** (**E E H**)
- Values of the four parameters selected by the user (W---)
- The **[COM. SCANNER INPUT MAP]** submenu: is NOT necessary for CANopen
- The **[COM SCAN OUTPUT MAP]** submenu: is NOT necessary for CANopen
- In the **[CMD. WORD IMAGE]** submenu: control words from all channels
- In the **[FREQ. REF. WORD MAP]** submenu: frequency targets produced by all channels

Example

Example of the display of communication diagnostic information:

RUN	CAN	+50.00Hz	80A
COMMUNICATION MAP			
Command Channel	:		CANopen
Cmd value	:		000FHex
Active ref. channel	:		CANopen
Frequency ref.	:		500.0Hz
ETA state word	:		8627Hex
Code		Quick	✓
W3204	:		73
W3205	:		725
W7132	:		0000Hex
W0	:		----
COM. SCANNER INPUT MAP			
COM SCAN OUTPUT MAP			
CMD. WORD IMAGE			
FREQ. REF. WORD MAP			
MODBUS NETWORK DIAG			
MODBUS HMI DIAG			
CANopen MAP			
PROG. CARD SCANNER			

Control Word Display

The **[Command Channel]** (**Σ Π Δ Σ**) parameter indicates the active command channel.

The **[Cmd value]** (**Σ Π Δ**) parameter indicates the hexadecimal value of the control word (CMD) used to control the drive.

The **[CMD. WORD IMAGE]** (**Σ I -**) submenu (**[CANopen cmd.]** (**Σ Π Δ Σ**) parameter) is used to display the hexadecimal value of the control word sent by CANopen.

Frequency Target Display

The **[Active ref. channel]** (**r F L L**) parameter indicates the active target channel.

The **[Frequency ref]** parameter indicates the value (in 0.1 Hz units) of the frequency target (LFR) used to control the drive.

The **[FREQ. REF. WORD MAP]** submenu (**[CANopen ref.]** parameter) is used to display the value (in 0.1 Hz units) of the speed target sent by CANopen.

Status Word Display

The **[ETA state word]** (**E L R**) parameter gives the value of the status word (ETA).

Display of the Parameters Selected by the User

The four **[W...]** parameters give the value of the four monitored words selected by the user.

The address and display format of these parameters can be configured in the **[3.3 MONITORING CONFIG.]** (**FLF -**) menu (**[COM. MAP CONFIG.]** (**RL -**) submenu).

The value of a monitored word equals “....” if:

- Monitoring has not been activated (address equals W0)
- The parameter is protected
- The parameter is not known (example: W3200)

Monitoring of Communication Channels

Command and Reference Channels

All the drive's command and reference parameters are managed on a channel-by-channel basis.

It is possible to identify the last value written for each channel and each command or reference parameter:

Parameter name	Parameter code			
	Taken into account by the drive	Modbus	CANopen	Communication card
Control word	<i>C N d</i>	<i>C N d 1</i>	<i>C N d 2</i>	<i>C N d 3</i>
Extended control word	<i>C N 1</i>	<i>C N 1 1</i>	<i>C N 1 2</i>	<i>C N 1 3</i>
Speed reference (rpm)	<i>L F r d</i>	<i>L F r d 1</i>	<i>L F r d 2</i>	<i>L F r d 3</i>
Frequency reference (0.1 Hz)	<i>L F r</i>	<i>L F r 1</i>	<i>L F r 2</i>	<i>L F r 3</i>
PI regulator reference	<i>P I S P</i>	<i>P I r 1</i>	<i>P I r 2</i>	<i>P I r 3</i>
Analog multiplier reference	<i>Π F r</i>	<i>Π F r 1</i>	<i>Π F r 2</i>	<i>Π F r 3</i>

Network Monitoring Criteria

The network is monitored according to the protocol-specific criteria.

Protocol	Criteria	Related detected fault
Integrated Modbus port	Adjustable time-out for received requests destined for the drive.	[Modbus fault] (<i>5 L F</i>)
CANopen port	Heartbeat Bus Off Overrun NMT state machine transition	[CANopen FAULT] (<i>C D F</i>)

Monitoring of Communication Channels

Communication channels are monitored if they are involved in one of the following parameters:

- The control word (**[Cmd value]** (*C N d*)) from the active command channel
- The control word containing the command switch (bit configured on **[Cmd switching]** (*C C S*))
- The control word containing the switch for reference 1'1B (bit configured on **[Ref 1B switching]** (*r C b*))
- The control word containing the switch for reference 1'2 (bit configured on **[Ref. 2 switching]** (*r F C*))
- The frequency or speed reference (**[HMI Frequency ref.]** (*L F r*) or LFRD : Nominal speed value) from the active reference channel
- Summing frequency or speed reference (**[HMI Frequency ref.]** (*L F r*) or LFRD : Nominal speed value) 2 (assigned to **[Summing ref. 2]** (*5 R 2*))
- Summing frequency or speed reference (**[HMI Frequency ref.]** (*L F r*) or LFRD : Nominal speed value) 3 (assigned to **[Summing ref. 3]** (*5 R 2*))
- Subtracting frequency or speed reference (**[HMI Frequency ref.]** (*L F r*) or LFRD : Nominal speed value) 2 (assigned to **[Subtract ref. 2]** (*d R 2*))
- Subtracting frequency or speed reference (**[HMI Frequency ref.]** (*L F r*) or LFRD : Nominal speed value) 3 (assigned to **[Subtract ref. 3]** (*d R 3*))
- The PID regulator reference (PISP)
- The PID regulator feedback (**[AI Virtual 2]** (*A I U 2*))
- The reference multiplication coefficient (**[Multiplying coeff.]** (*Π F r*)) 2 (assigned to **[Multiplier ref. 2]** (*Π R 2*))
- The reference multiplication coefficient (**[Multiplying coeff.]** (*Π F r*)) 3 (assigned to **[Multiplier ref. 3]** (*Π R 3*))

As soon as one of these parameters has been written once to a communication channel, it activates monitoring for that channel.

If a communication alarm is sent (in accordance with the protocol criteria) by a monitored port or network card, the drive will trigger a communication interruption.

The drive reacts according to the communication interruption configuration (detected fault, maintenance, fallback, etc.)

If a communication alarm occurs on a channel that is not being monitored, the drive will not trigger a communication interruption.

Enabling of Communication Channels

A communication channel is enabled once all the parameters involved have been written at least one time. The drive is only able to start if all channels involved in command and reference are enabled.

Example:

A drive in DSP402 profile is connected to an active communication channel.

It is mandatory to write at least one time the reference and the command in order to switch from "4-Switched on" to "5-Operation enabled" state.

A communication channel is disabled:

- In the event of a communication alarm
- In "forced local" mode.

NOTE: On exiting "forced local" mode:

- The drive copies the run commands, the direction and the forced local reference to the active channel (maintained).
- Monitoring of the active command and reference channels resumes following a time delay [Time-out forc. local] (FLOt).
- Drive control only takes effect once the drive has received the reference and the command from the active channel.

CiA[®]402 - IEC61800-7 Functional Profile

6

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Functional Description	38
CiA402 State Chart	39
Description of States	40
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Control Word (CMd)	42
Stop Commands	43
Assigning Control Word Bits	43
Status Word (EtA)	44
Starting Sequence	45
Sequence for a Drive Powered by the Power Section Line Supply	46
Sequence for a Drive With Separate Control Section	48
Sequence for a Drive with Line Contactor Control	51

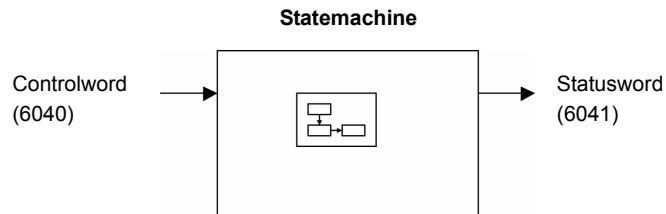
Functional Description

Drive operation involves two main functions, which are illustrated in the diagrams below:

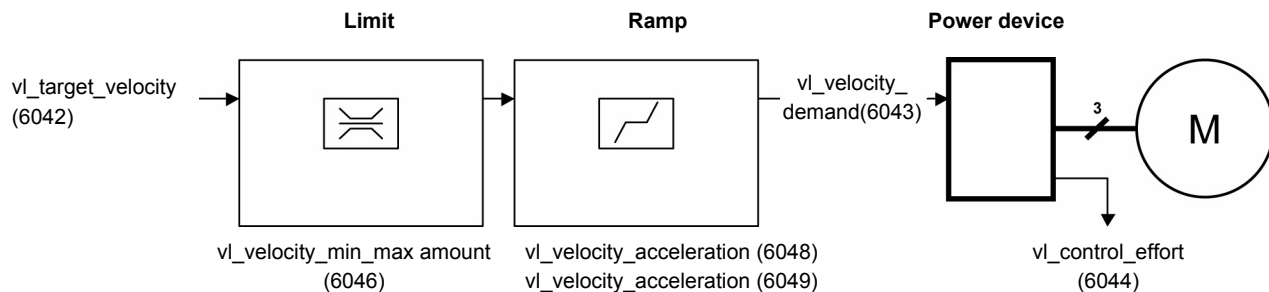
CiA402

The main parameters are shown with their CiA402 name and their CiA402/Drivecom index (the values in brackets are the CANopen addresses of the parameter).

Control diagram:



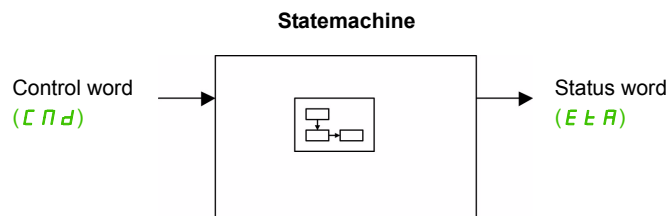
Simplified diagram of speed control in “Velocity” mode:



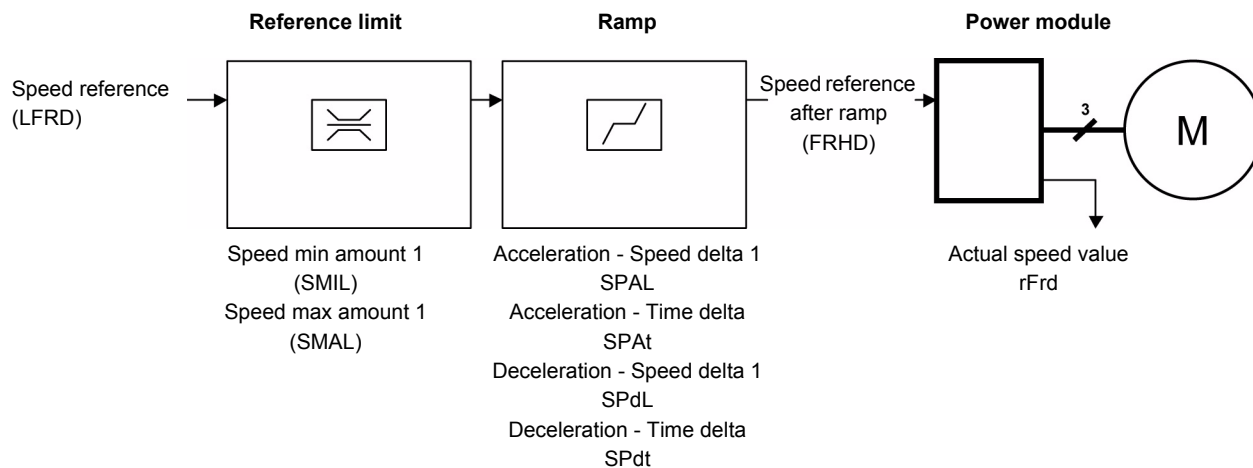
Altivar 32

These diagrams translate as follows for the Altivar system:

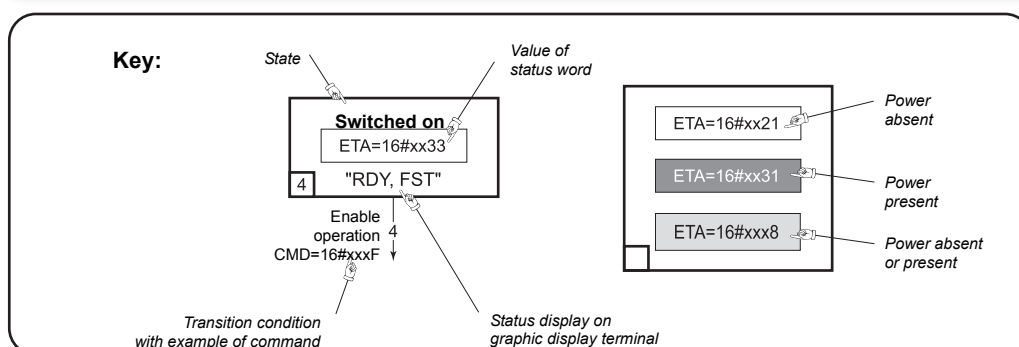
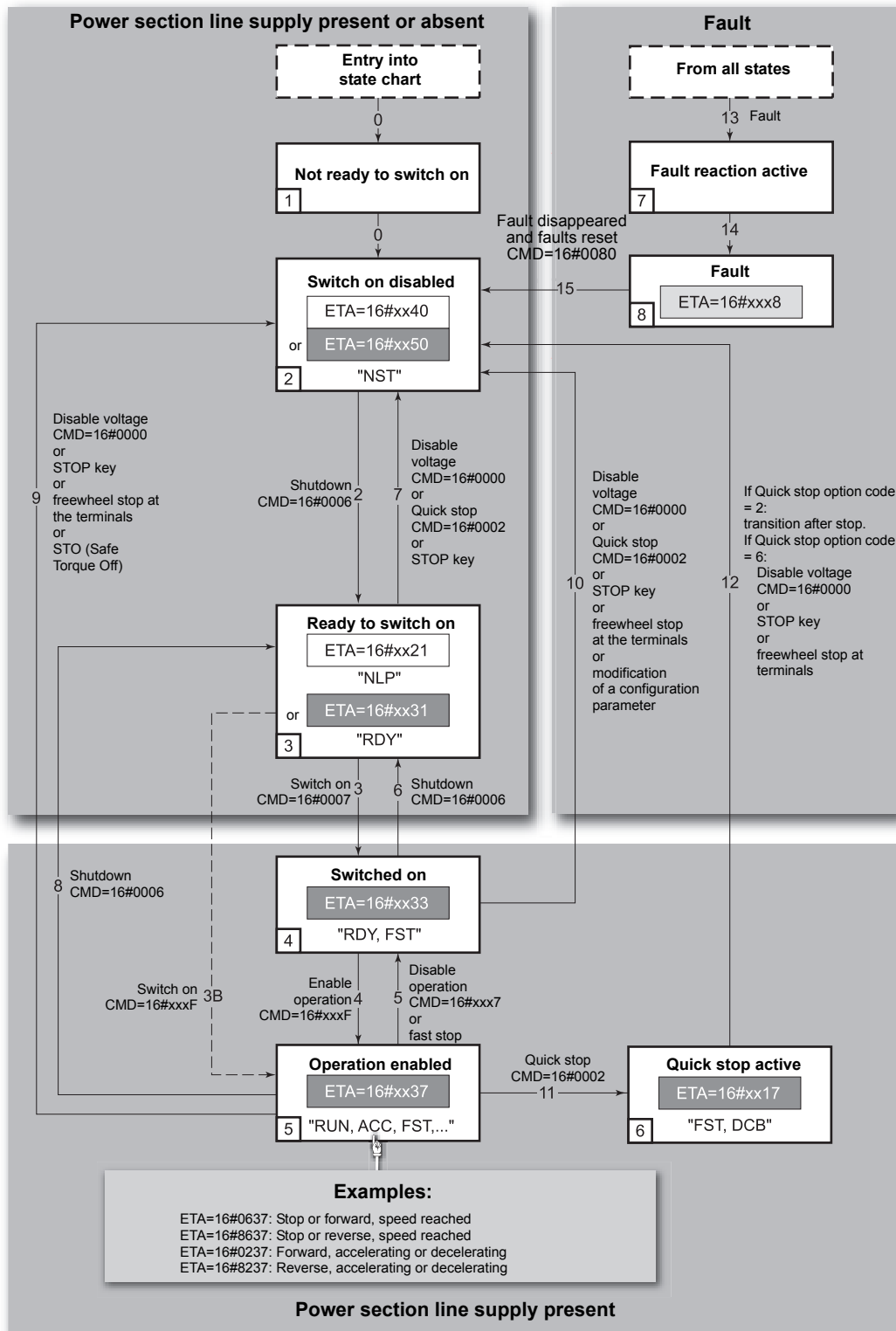
Control diagram:



Simplified diagram of speed control in “Velocity” mode:



CiA402 State Chart



Description of States

Each state represents an internal reaction by the drive.

This chart will change depending on whether the control word is sent (**C n d**) or an event occurs (a detected fault, for example).

The drive state can be identified by the value of the status word (**E L R**).

State	Drive internal reaction
1 - Not ready to switch on	Initialization starts. This is a transient state invisible to the communication network.
2 - Switch on disabled	<p>The drive is inactive.</p> <p>The drive is locked, no power is supplied to the motor.</p> <p>For a separate control section, it is not necessary to supply AC power to the power section.</p> <p>For a separate control section with line contactor, the contactor is not controlled.</p> <p>The configuration and adjustment parameters can be modified.</p>
3 - Ready to switch on	<p>Awaiting power section line supply.</p> <p>For a separate control section, it is not necessary to supply AC power to the power section, but the system will expect it in order to change to state "4 - Switched on".</p> <p>For a separate control section with line contactor, the contactor is not controlled.</p> <p>The drive is locked, no power is supplied to the motor.</p> <p>The configuration and adjustment parameters can be modified.</p>
4 - Switched on	<p>The drive is supplied with AC power but is stationary.</p> <p>For a separate control section, the power section line supply must be present.</p> <p>For a separate control section with line contactor, the contactor is controlled.</p> <p>The drive is locked, no power is supplied to the motor.</p> <p>The power stage of the drive is ready to operate, but voltage has not yet been applied to the output.</p> <p>The adjustment parameters can be modified.</p> <p>Modification of a configuration parameter returns the drive to state "2 - Switch on disabled".</p>
5 - Operation enabled	<p>The drive is running.</p> <p>For a separate control section, the power section line supply must be present.</p> <p>For a separate control section with line contactor, the contactor is controlled.</p> <p>The drive is unlocked, power is supplied to the motor.</p> <p>The drive functions are activated and voltage is applied to the motor terminals.</p> <p>However, in the case of an open-loop drive, if the reference is zero or the "Halt" command is applied, no power is supplied to the motor and no torque is applied.</p> <p>[Auto tuning] (E U n) requires an injection of current into the motor. The drive must therefore be in state "5 - Operation enabled" for this command.</p> <p>The adjustment parameters can be modified.</p> <p>The configuration parameters cannot be modified.</p> <p>NOTE: The command "4 - Enable operation" must be taken into consideration only if the channel is valid. In particular, if the channel is involved in the command and the reference, transition 4 will take place only after the reference has been received for the first time.</p> <p>The reaction of the drive to a "Disable operation" command depends on the value of the [Dis. operat opt code] (d D E d) parameter:</p> <ul style="list-style-type: none"> - If the [Dis. operat opt code] (d D E d) parameter has the value 0, the drive changes to "4 - Switched on" and stops in freewheel stop. - If the [Dis. operat opt code] (d D E d) parameter has the value 1, the drive stops on ramp and then changes to "4 - Switched on".
6 - Quick stop active	<p>Emergency stop.</p> <p>The drive performs a fast stop, after which restarting will only be possible once the drive has changed to the "Switch on disabled" state.</p> <p>During fast stop, the drive is unlocked and power is supplied to the motor.</p> <p>The configuration parameters cannot be modified.</p> <p>The condition for transition 12 to state "2 - Switch on disabled" depends on the value of the parameter Quick stop mode (QStd):</p> <p>If the Quick stop mode parameter has the value FST2, the drive stops according to the fast stop ramp and then changes to state "2 - Switch on disabled".</p> <p>If the Quick stop mode parameter has the value FST6, the drive stops according to the fast stop ramp and then remains in state "6 - Quick stop active" until:</p> <ul style="list-style-type: none"> - A "Disable voltage" command is received. - Or the STOP key is pressed. - Or there is a freewheel stop command via the terminals.

State	Drive internal reaction
7 - Fault reaction active	Transient state during which the drive performs an action appropriate to the type of detected fault. The drive function is activated or deactivated according to the type of reaction configured in the detected fault management parameters.
8 - Fault	Drive has detected a fault. The drive is locked, no power is supplied to the motor.

Summary

State	Power section line supply for separate control section	Power supplied to motor	Modification of configuration parameters
1 - Not ready to switch on	Not required	No	Yes
2 - Switch on disabled	Not required	No	Yes
3 - Ready to switch on	Not required	No	Yes
4 - Switched on	Required	No	Yes, return to "2 - Switch on disabled" state
5 - Operation enabled	Required	Yes, apart from an open-loop drive with a zero reference or in the event of a "Halt" command for an open-loop drive.	No
6 - Quick stop active	Required	Yes, during fast stop	No
7 - Fault reaction active	Depends on detected fault management configuration	Depends on detected fault management configuration	-
8 - Fault	Not required	No	Yes

Control Word (CWD)

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Fault reset	Reserved (=0)	Reserved (=0)	Reserved (=0)	Enable operation	Quick stop	Enable voltage	Switch on
0 to 1 transition = Ack. fault				1 = Run command	0 = Emergency stop	Authorization to supply AC power	Contactor control

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
Manufacturer specific Assignable	Manufacturer specific Assignable	Manufacturer specific Assignable	Manufacturer specific Assignable	Manufacturer specific	Reserved (=0)	Reserved (=0)	Halt
				0 = Forward direction asked 1 = Reverse direction asked			Halt

Command	Transition address	Final state	bit 7	bit 3	bit 2	bit 1	bit 0	Example value
			Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	2, 6, 8	3 - Ready to switch on	x	x	1	1	0	16#0006
Switch on	3	4 - Switched on	x	x	1	1	1	16#0007
Enable operation	4	5 - Operation enabled	x	1	1	1	1	16#000F
Disable operation	5	4 - Switched on	x	0	1	1	1	16#0007
Disable voltage	7, 9, 10, 12	2 - Switch on disabled	x	x	x	0	x	16#0000
Quick stop	11	6 - Quick stop active	x	x	0	1	x	16#0002
	7, 10	2 - Switch on disabled						
Fault reset	15	2 - Switch on disabled	0 → 1	x	x	x	x	16#0080

x: Value is of no significance for this command.

0 → 1: Command on rising edge.

Stop Commands

The “Halt” command enables movement to be interrupted without having to leave the “5 - Operation enabled” state. The stop is performed in accordance with the **[Type of stop] (5 5 5)** parameter.

In the case of an open-loop drive, if the “Halt” command is active, no power is supplied to the motor and no torque is applied.

Regardless of the assignment of the **[Type of stop] (5 5 5)** parameter (**[Fast stop assign] (F 5 5)**, **[Ramp stop] (r 11 P)**, **[Freewheel] (n 5 5)**, or **[DC injection assign.] (d 5 1)**), the drive remains in the “5 - Operation enabled” state.

A Fast Stop command at the terminals or using a bit of the control word assigned to Fast Stop causes a change to the “4 - Switched on” state. A “Halt” command does not cause this transition.

A Freewheel Stop command at the terminals or using a bit of the control word assigned to Freewheel Stop causes a change to the “2 - Switch on disabled” state. A “Halt” command does not cause this transition.

Assigning Control Word Bits

In the CiA402 profile, fixed assignment of a function input is possible using the following codes:

Bit	CANopen
bit 11	C211
bit 12	C212
bit 13	C213
bit 14	C214
bit 15	C215

For example, to assign the DC injection braking to bit 13 of CANopen, simply configure the **[DC injection assign.] (d 5 1)** parameter with the **[C213] (5 2 1 3)** value.

Bit 11 is assigned by default to the operating direction command **[Reverse assign.] (r 5 5)**.

Status Word (E L F)

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
Alarm	Power section line supply disabled	0 = Emergency stop	Power section line supply present	Fault	Running	Ready	1 = Awaiting power section line supply

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8
Manufacturer specific Direction of rotation	Manufacturer specific Stop via STOP key	Reserved (=0)	Reserved (=0)	Internal limit active	Target reached	Remote	Reserved (=0)
				Reference outside limits	Reference reached	Command or reference via network	

Status	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	ETA masked by 16#006F ⁽¹⁾
	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on	
1 -Not ready to switch on	0	x	x	0	0	0	0	-
2 -Switch on disabled	1	x	x	0	0	0	0	16#0040
3 -Ready to switch on	0	1	x	0	0	0	1	16#0021
4 -Switched on	0	1	1	0	0	1	1	16#0023
5 -Operation enabled	0	1	1	0	1	1	1	16#0027
6 -Quick stop active	0	0	1	0	1	1	1	16#0007
7 -Fault reaction active	0	x	x	1	1	1	1	-
8 -Fault	0	x	x	1	0	0	0	16#0008 ⁽²⁾ or 16#0028

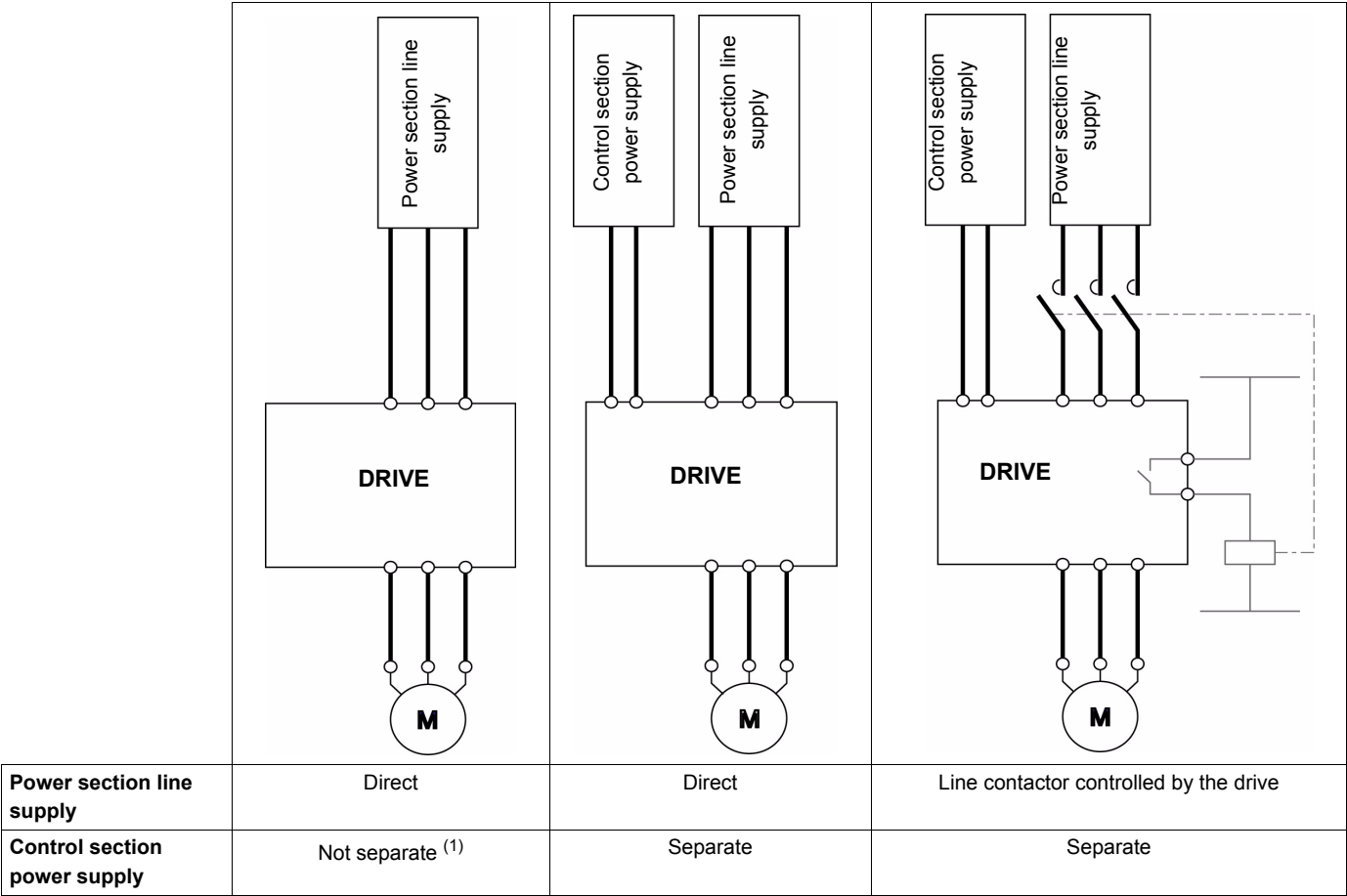
(1) This mask can be used by the PLC program to test the chart state.

(2) Detected fault following state "6 - Quick stop active".

x: In this state, the value of the bit can be 0 or 1.

Starting Sequence

The command sequence in the state chart depends on how power is being supplied to the drive.
There are three possible scenarios:



(1) The power section supplies the control section.

Sequence for a Drive Powered by the Power Section Line Supply

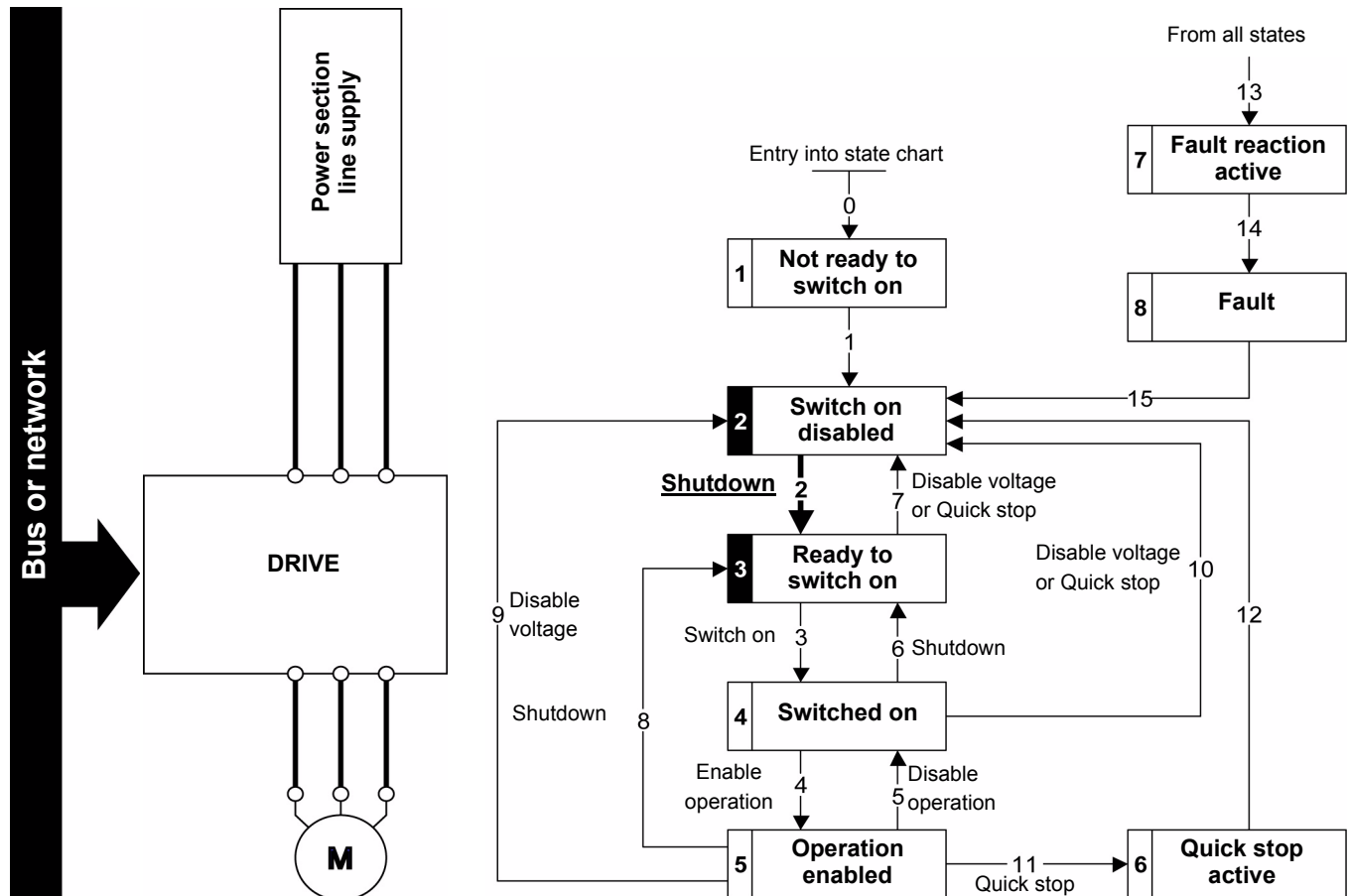
Both the power and control sections are powered by the power section line supply.

If power is supplied to the control section, it has to be supplied to the power section as well.

The following sequence must be applied:

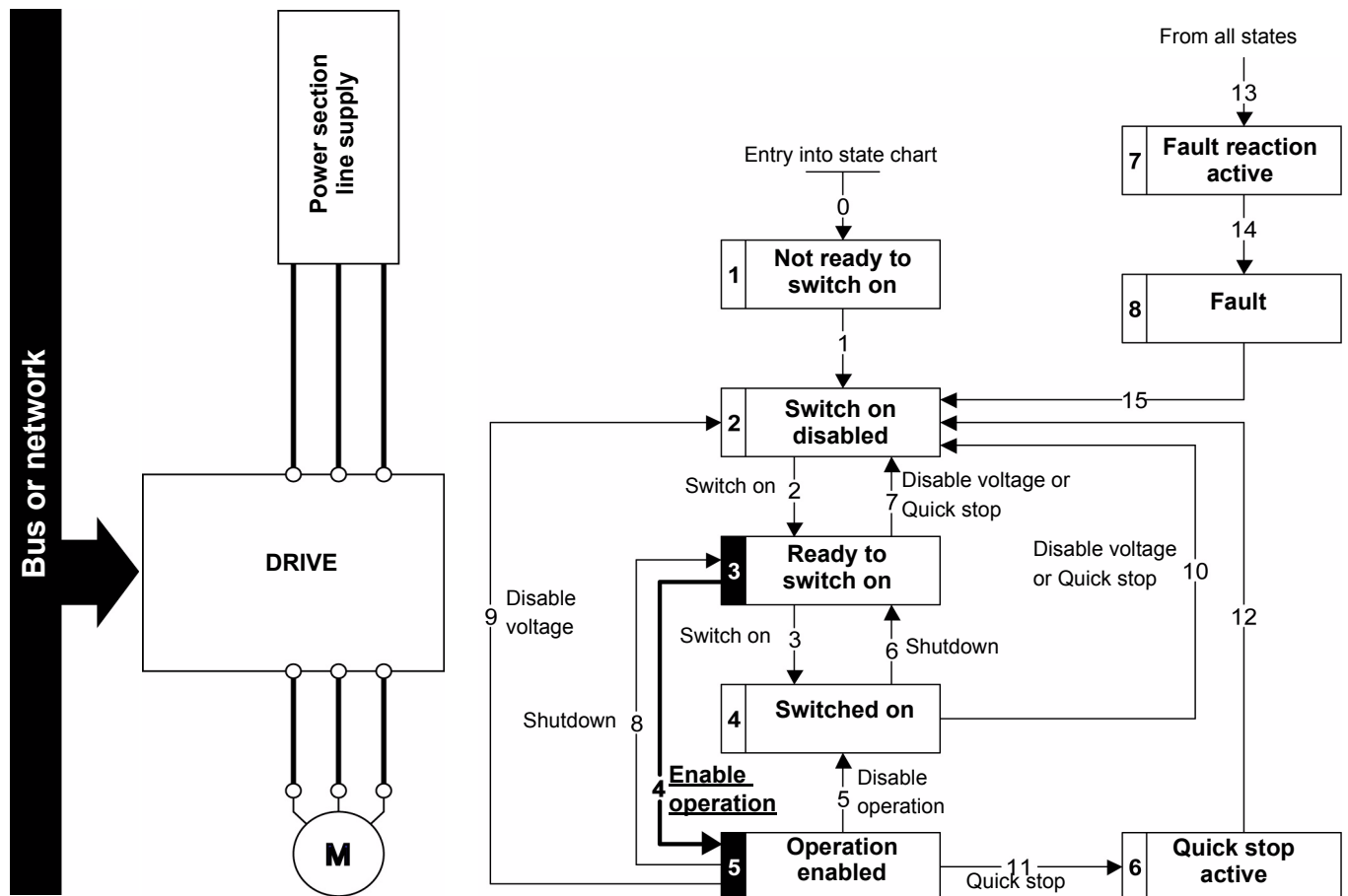
Step 1

Send the “2 - Shutdown” command



Step 2

- Check that the drive is in the “3 - Ready to switch on” state.
- Then send the “4 - Enable operation” command.
- The motor can be controlled (send a reference not equal to zero).



NOTE: It is possible, but not necessary, to send the “3 - Switch on” command followed by the “4 - Enable Operation” command to switch successively into the states “3 - Ready to Switch on”, “4 - Switched on” and then “5 - Operation Enabled”.

The “4 - Enable operation” command is sufficient.

Sequence for a Drive With Separate Control Section

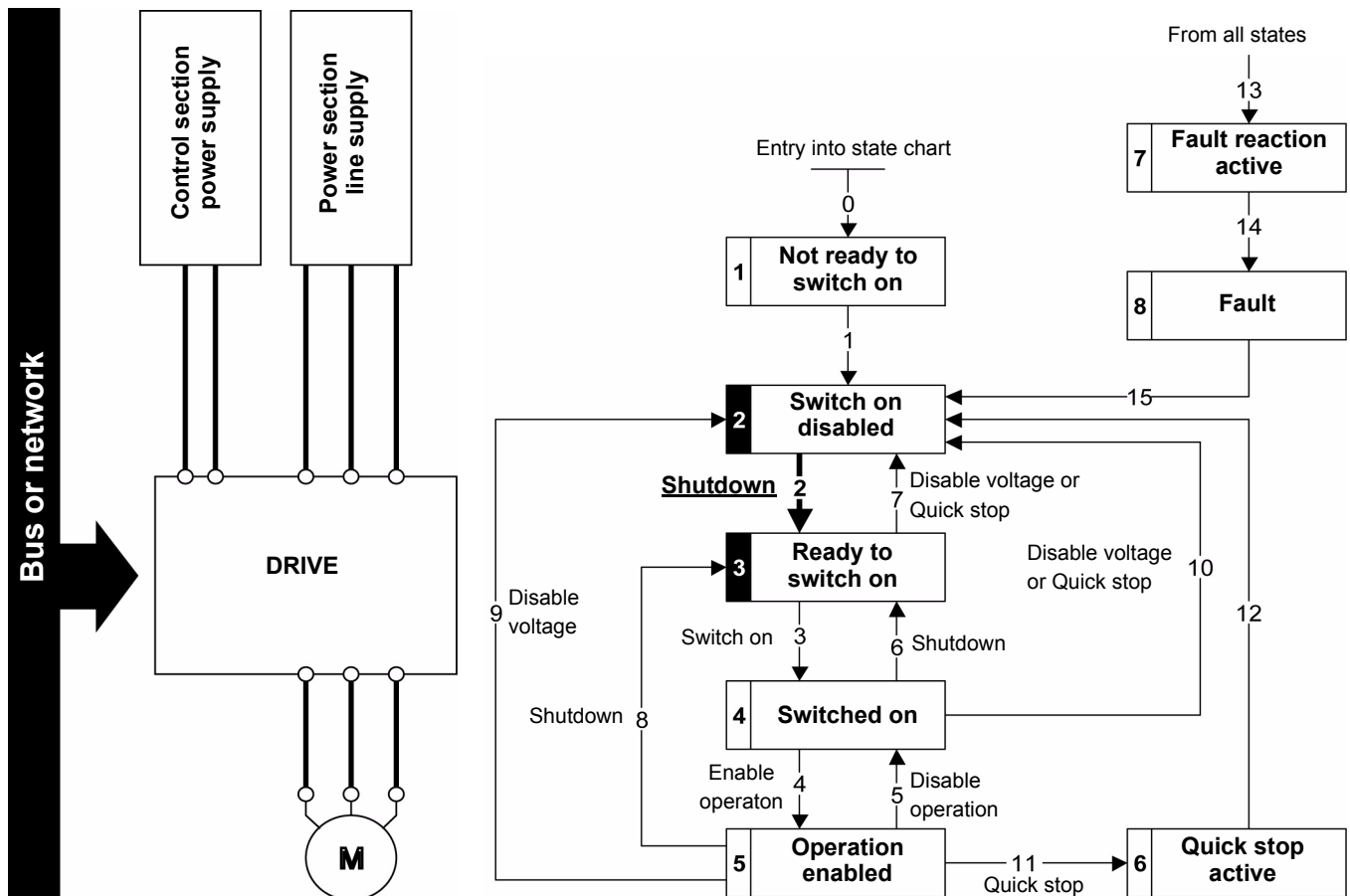
Power is supplied separately to the power and control sections.

If power is supplied to the control section, it does not have to be supplied to the power section as well.

The following sequence must be applied:

Step 1

- The power section line supply is not necessarily present.
- Send the “2 - Shutdown” command

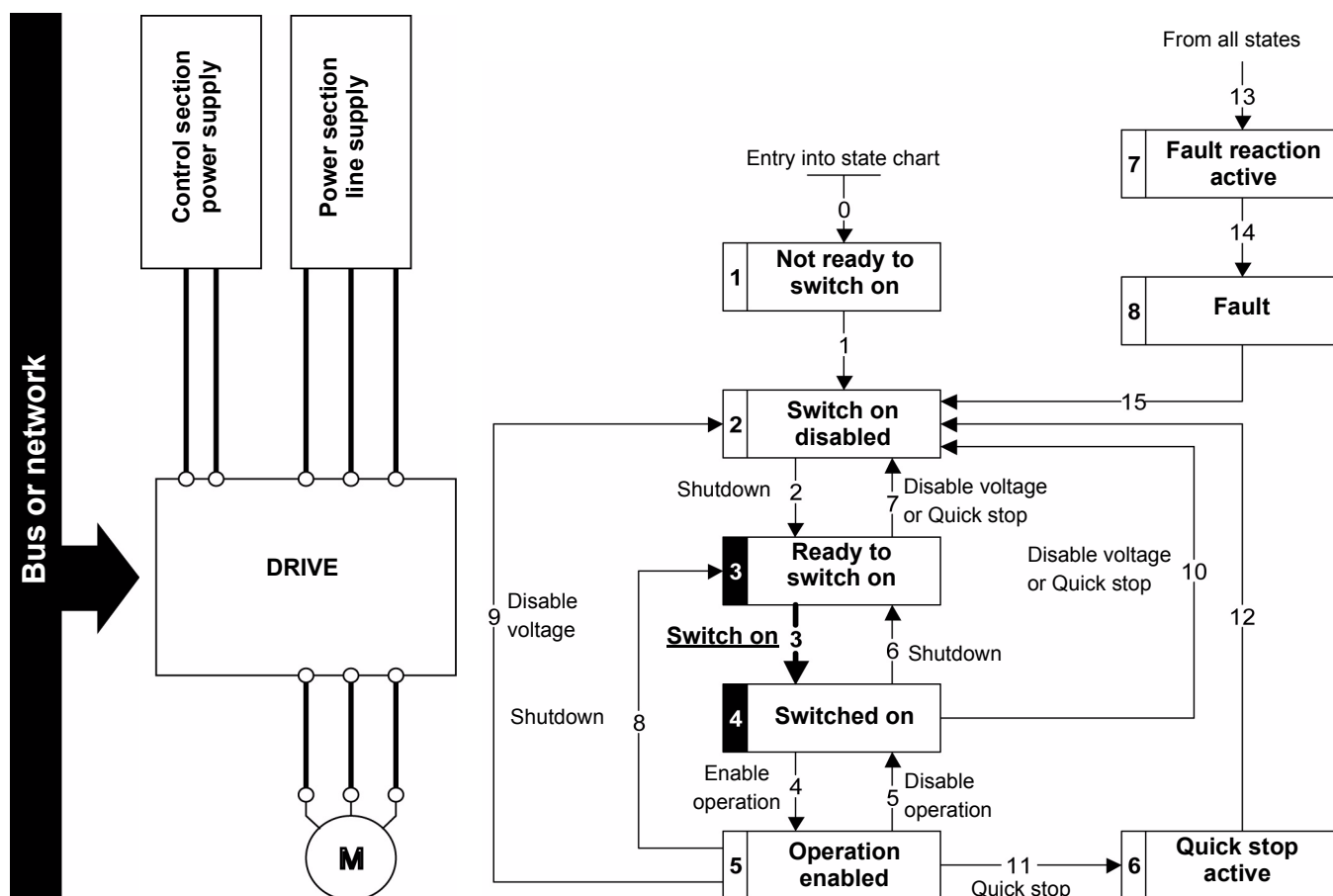


Step 2

- Check that the drive is in the “3 - Ready to switch on” state.
- Check that the power section line supply is present (“Voltage enabled” of the status word).

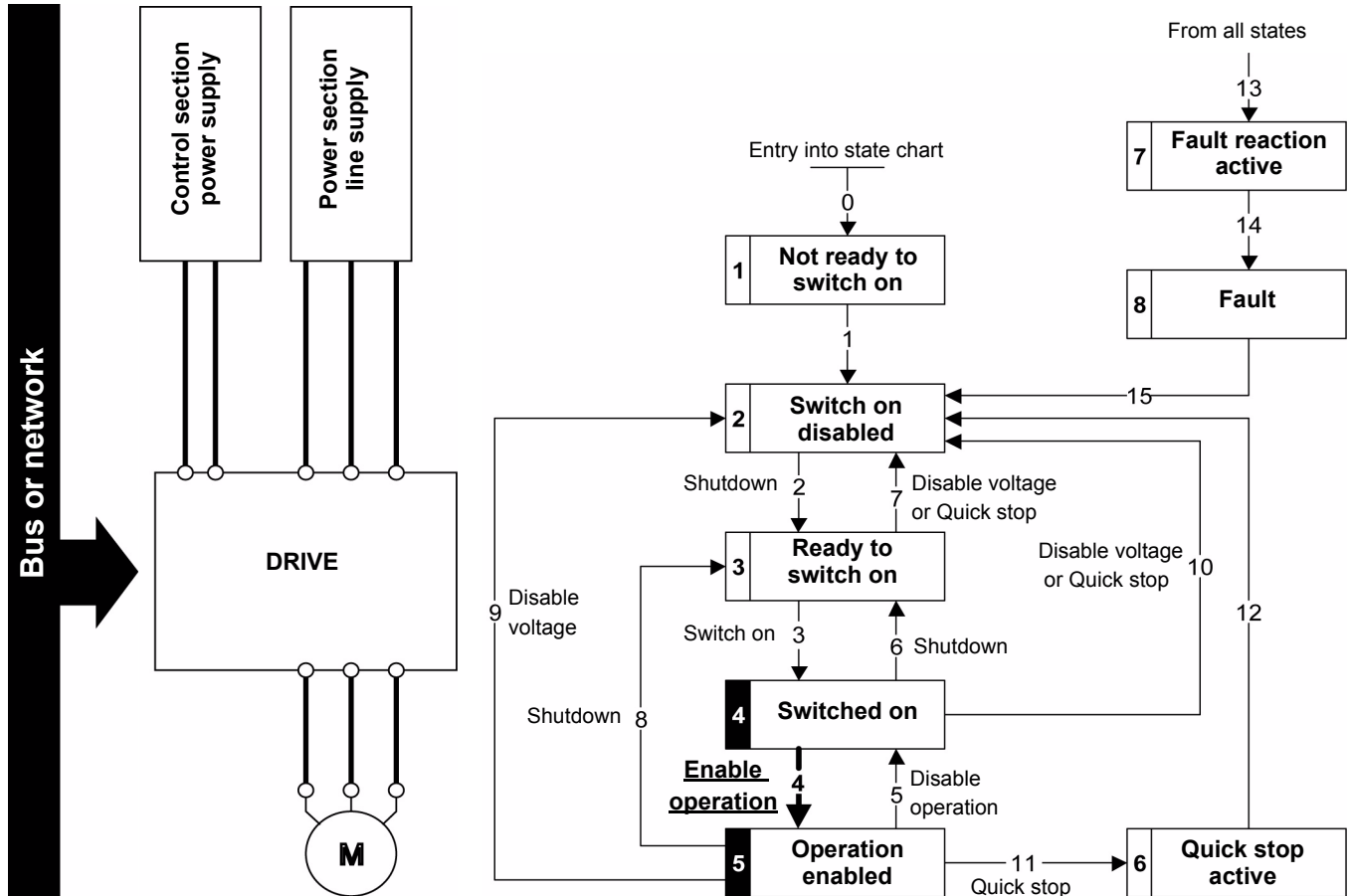
Power section line supply	Terminal display	Status word
Absent	<i>n L P</i>	16#●●21
Present	<i>r d Y</i>	16#●●31

- Send the “3 - Switch on” command



Step 3

- Check that the drive is in the “4 - Switched on” state.
- Then send the “4 - Enable operation” command.
- The motor can be controlled (send a reference not equal to zero).
- If the power section line supply is still not present in the “4 - Switched on” state after a time delay **[Mains V. time out]** (**L C E**), the drive will switch to detected fault mode **[input contactor]** (**L C F**).



Sequence for a Drive with Line Contactor Control

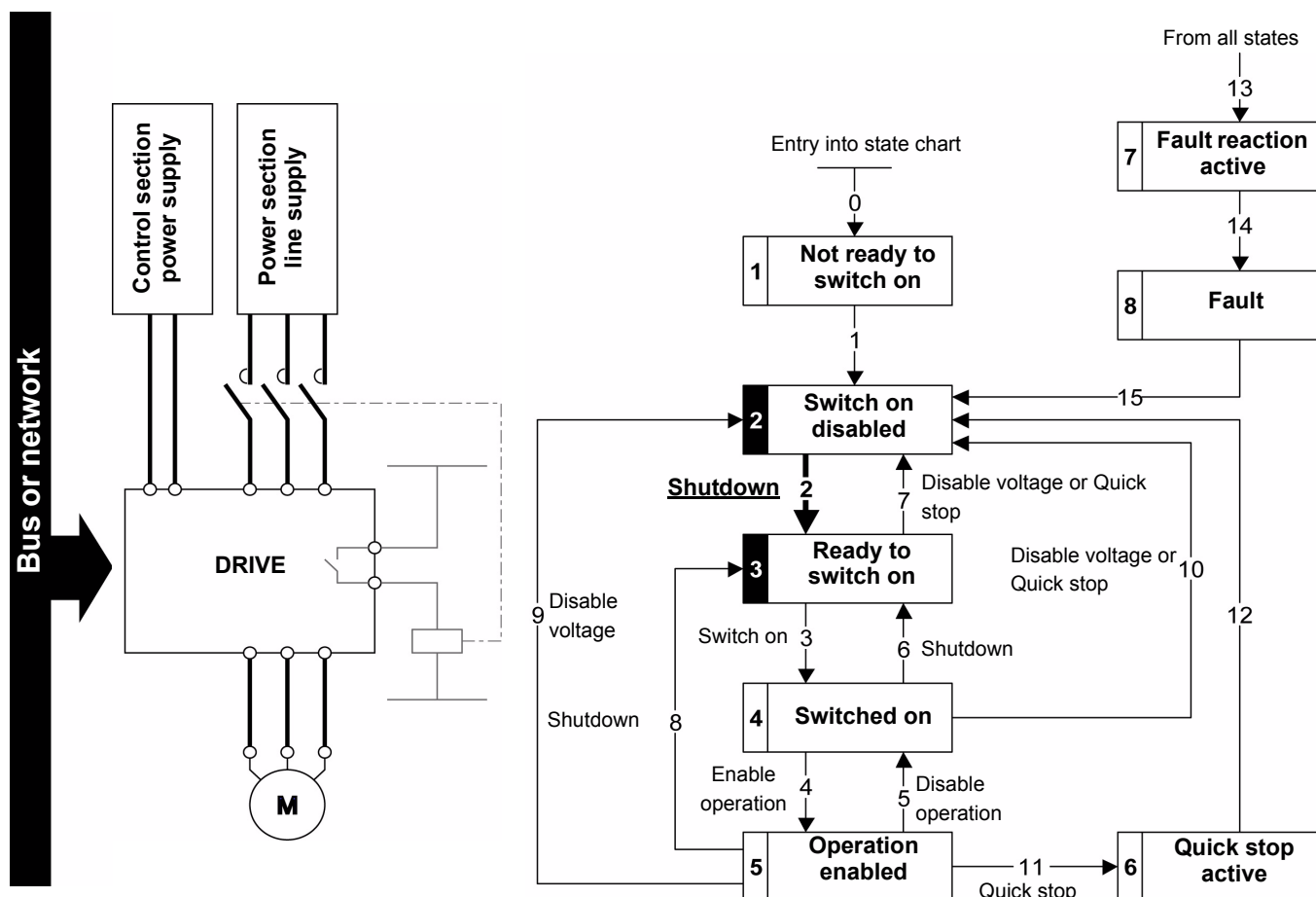
Power is supplied separately to the power and control sections.

If power is supplied to the control section, it does not have to be supplied to the power section as well. The drive controls the line contactor.

The following sequence must be applied:

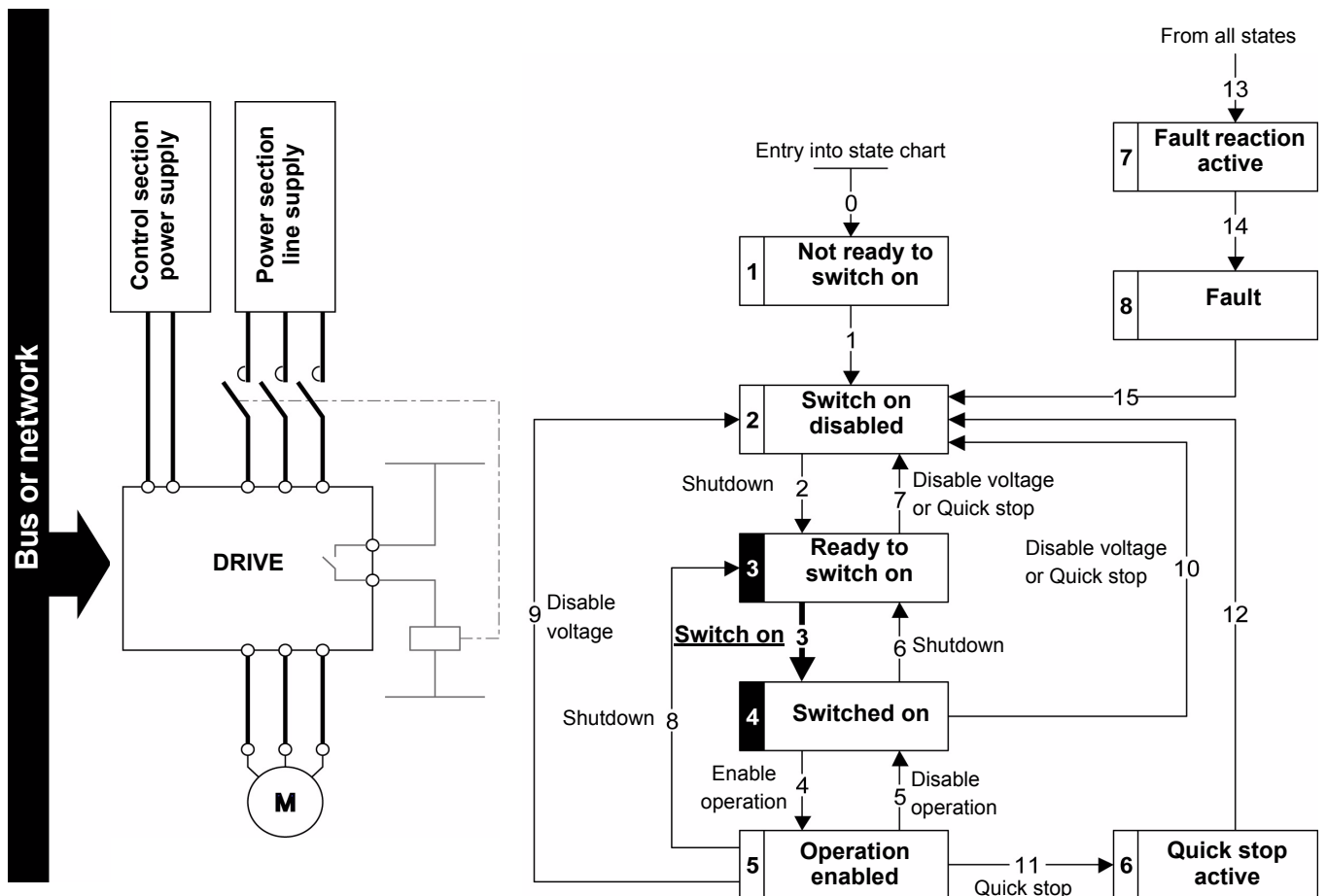
Step 1

- The power section line supply is not present as the line contactor is not being controlled.
- Send the “2 - Shutdown” command



Step 2

- Check that the drive is in the “3 - Ready to switch on” state.
- Send the “3 - Switch on” command, which will close the line contactor and switch on the power section line supply.



Software Setup (CANopen Services)

7

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Communication Profile	54
PDO (Process Data Objects)	55
SDO (Service Data Objects)	58
Other Available Services	58
Description of Identifiers Taken into Account	59

Communication Profile

The Altivar communication profile is based on:

- CAN 2.A
- The CANopen specification (DS301 V4.02)

Simplified Telegram Structure (Communication Object)

Identifier (11 bits)	Data (maximum length 8 bytes)							
COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

Function code (bit 10 ... bit 7)	Service	Range of possible identifiers	Index of parameterization objects ⁽¹⁾
2#0000	NMT	16#000	-
2#0001	SYNC	16#080	16#1005
	EMCY	16#081 to 16#0FF	-
2#0011	Transmit PDO1 (TPD01)	16#181 to 16#1FF	16#1800, 16#1A00
2#0100	Receive PDO1 (RPD01)	16#201 to 16#27F	16#1400, 16#1600
2#0101	Transmit PDO2 (TPD02)	16#281 to 16#2FF	16#1801, 16#1A01
2#0110	Receive PDO2 (RPD02)	16#301 to 16#37F	16#1401, 16#1601
2#0111	Transmit PDO3 (TPD03)	16#381 to 16#3FF	16#1802, 16#1A02
2#1000	Receive PDO3 (RPD03)	16#401 to 16#47F	16#1402, 16#1602
2#1011	Transmit SDO	16#581 to 16#5FF	16#1200
2#1100	Receive SDO	16#601 to 16#67F	16#1200
2#1110	Heartbeat	16#701 to 16#77F	16#1016, 16#1017

(1) These objects are described in "Object Dictionary" on page 92

For more detailed information, visit the *Can In Automation* website at: <http://www.can-cia.org>.

PDO (Process Data Objects)

PDO telegrams are used to exchange periodic I/O data between the PLC and the drive.

The Altivar 32 has 3 predefined PDO sets:

- PDO1 is in accordance with the CiA402 specification: velocity mode,
- PDO2 is fully configurable by the user. By default, this PDO is disabled,
- PDO3 is linked to the communication scanner. By default, this PDO is disabled.

PDO1 Details

The first PDO is by default compliant with the PDO 1 of the Velocity Mode of the CiA402. It is asynchronous and contains two data: the control word (6040h / ATV32 CMD) and the target velocity (6042h / ATV32 LFRD) for the input (from PLC to device) and the status word (6041h / ATV32 ETA) and the control effort (6044h / ATV32 RFRD) for the output (from device to PLC).

PDO detailed properties:

- The COB-Id of the transmit and receive PDO1 is fully configurable.
- The transmission type of the receive and transmit PDO are fully configurable.
- The mapping of the receive and transmit PDO are fully configurable.

PDO2 Details

The second PDO set (PDO2) is deactivated by default and can be configured in full (1 to 4 words of the user's choice). It is reserved for adjustments and for additional control and monitoring functions. By default, TPD02 (transmit) and RPD02 (receive) are disabled and not configured.

PDO3 Details

The third PDO set (PDO3) is reserved. Deactivated by default, it cannot be configured and comprises:

- RPD03 (receive), containing 4 input words of the communication scanner NC1 to NC4
- TPDO3 (transmit), containing 4 output words of the communication scanner NM1 to NM4

RPDO1, TPDO1, RPD02, TPDO2, RPD03, and TPDO3 can each be enabled or disabled independently. Each PDO can be activated or deactivated using bit 31 of its COB-ID. Set this bit to 1 to deactivate the PDO. Reset it to zero to activate the PDO. By default, these three PDO are asynchronous, although the transmission mode of each PDO can be reconfigured by the user in accordance with requirements:

- Asynchronous mode (255): The transmit PDO is only sent when the value of its data changes. In this mode, the "inhibit time" and "event timer" (example: objects 16#1800/03 and 16#1800/05 for TPDO1) can be modified in order to adjust the PDO transmission frequency on the bus.
- Cyclic synchronous mode (1...240): the transmit PDO is sent each time a synchronization object (SYNC) is received or when a preconfigured number of synchronization objects (between 1 and 240) are received.
- Acyclic synchronous mode (0): the transmit PDO is sent each time the value of its data changes, but only during the synchronous "window" authorized by the next synchronization object (SYNC, not available for the receive PDO).

The drive optimizes the size of the TPDO frames (transmit); only useful data bytes are transmitted.

The length of PDO3 is 8 data bytes.

PDO Default Configuration

The following tables describes the receive PDOs parameters:

No. of PDOs	Parameters configured by default		Comment
	Index	Name	
1	16#6040	Control word (CMDD)	Drive control in speed regulation mode This PDO can be reconfigured. It is activated by default.
	16#6042	Speed target (LFRD)	
2		No parameter configured by default	Additional settings or commands This PDO can be reconfigured. It is deactivated by default.
3	16#2061/3E	Receive PDO3 mapping - 1st mapped object: NC1 (Comm. Scanner 1st data)	Mapped to the communication scanner
	16#2061/3F	Receive PDO3 mapping - 2nd mapped object: NC2 (Comm. Scanner 2nd data)	
	16#2061/40	Receive PDO3 mapping - 3rd mapped object: NC3 (Comm. Scanner 3rd data)	
	16#2061/41	Receive PDO3 mapping - 4th mapped object: NC4 (Comm. Scanner 4th data)	

The following tables describes the transmit PDOs parameters:

No. of PDOs	Parameters configured by default		Comment
	Index	Name	
1	16#6041	Status word (ETAD)	Drive monitoring in speed regulation mode This PDO can be reconfigured. It is activated by default.
	16#6044	Output speed (RFRD)	
2		No parameter configured by default.	Additional monitoring This PDO can be reconfigured. It is deactivated by default.
3	16#2061/2A	Transmit PDO3 mapping - 2nd mapped object: NM1 - Comm. Scanner 2nd data	Mapped to the communication scanner
	16#2061/2B	Transmit PDO3 mapping - 2nd mapped object: NM2 - Comm. Scanner 2nd data	
	16#2061/2C	Transmit PDO3 mapping - 3rd mapped object: NM3 - Comm. Scanner 3rd data	
	16#2061/2D	Transmit PDO3 mapping - 4th mapped object: NM4 - Comm. Scanner 4th data	

Optimizing the Response Time

The response time can be optimized for the PDO1 and PDO3 configurations described below. In these configurations:

- the RPD01 or RPDO3 (receive) is processed with the same priority as a logic input from the terminals.
- TPD01 or TPDO3 (transmit) is updated with the same priority as an output from the terminals.

In all other configurations, a receive PDO is taken into account by the drive's background task.

The following tables describes the receive PDO1 parameters:

No. of PDOs	Parameters configured		Comment
	Index	Name	
1	16#6040	Control word (CMD)	Drive control

No. of PDOs	Parameters configured		Comment
	Index	Name	
1	16#6040	Control word (CMD)	Drive control in speed regulation mode
	16#6042	Speed target (LFRD)	

The following tables describes the transmit PDO1 parameters:

No. of PDOs	Parameters configured		Comment
	Index	Name	
1	16#6041	Status word (ETA)	Drive state monitoring

No. of PDOs	Parameters configured		Comment
	Index	Name	
1	16#6041	Status word (ETA)	Drive monitoring in speed regulation mode
	16#6044	Output speed (RFRD)	

NOTE: See “PDO3” on page 90 for more information of the PDO3's configuration.

Fast Tasks

Only these parameters are available for fast tasks:

Fast read	Parameters
	ETA, RFR, FRH, LCR, OTR, ETI, ULN, UOP, THD, OPR, THR1, THR2, THR3, IL1I, IL1R, OL1R, AI1C, AI2C, AI3C, AO1R, AO1C, RFRD, FRHD, LRS1, LRS2, LRS3, LRS4, LRS5, LRS6, LRS7, LRS8, M001, M002, M003, M004, M005, M006, M007, M008
Fast write	Parameters
	OL1R, AO1R, AO1C, CMD, LFR, PISP, LFRD, M001, M002, M003, M004, M005, M006, M007, M008

SDO (Service Data Objects)

SDO telegrams are used for configuration and adjustment.

The Altivar manages an SDO server, characterized by two identifiers:

- One for requests (telegrams sent from the PLC to the Altivar)
- One for responses (telegrams sent back to the PLC by the Altivar)

Although the Altivar supports segmented transfer, this is only required by the reading of object 16#1008 (device name).

Other Available Services

Assignment by default of address-based identifiers:

- NMT commands
- Bootup
- Heartbeat producer and consumer
- Node Guarding
- Emergency (EMCY)
- SYNC, for all PDOs on the Altivar
- General broadcast support on identifier 0
- Service not available: Time-stamping object (TIME)

Description of Identifiers Taken into Account

The identifiers will be referred to as COB-IDs (Communication Object IDentifiers) in the rest of this communication manual

Direction			Identifier (COB-ID)		Description
Master	V	Drive	0 16#000		Service Network Management (NMT)
Master	V	Drive	128 16#080		SYNChronization service (SYNC)
Master	V	Drive	128 16#080	+ Node-ID	EMergenCY service (EMCY)
Master	X	Drive	384 16#180	+ Node-ID	Drive monitoring (TPDO1)
Master	V	Drive	512 16#200	+ Node-ID	Drive control (RPDO1)
Master	X	Drive	640 16#280	+ Node-ID	Drive periodic input words (TPDO2)
Master	V	Drive	768 16#300	+ Node-ID	Drive periodic output words (RPDO2)
Master	X	Drive	896 16#380	+ Node-ID	Periodic input words on the Altivar's communication scanner (TPDO3)
Master	V	Drive	1024 16#400	+ Node-ID	Periodic output words on the Altivar's communication scanner (RPDO3)
Master	X	Drive	1408 16#580	+ Node-ID	Response to a drive setting (transmit SDO)
Master	V	Drive	1536 16#600	+ Node-ID	Drive setting request (receive SDO)
Master	V	Drive	1792 16#700	+ Node-ID	Network management (NMT, Node Guard, Heartbeat)
Master	X	Drive			Network management (Bootup)

The Altivar supports the automatic assignment of identifiers (COB-IDs), based on its CANopen address.

The term “master” designates a device transmitting a request to a variable speed drive (example: a PLC).

Bit 31 of PDO COB-ID entry, coded on 32 bits, is equal to 1 for TPDO2, RPDO2, TPDO3, and RPDO3, as they are inactive by default.

Software Setup With Unity (M340)

8

What's in this Chapter?

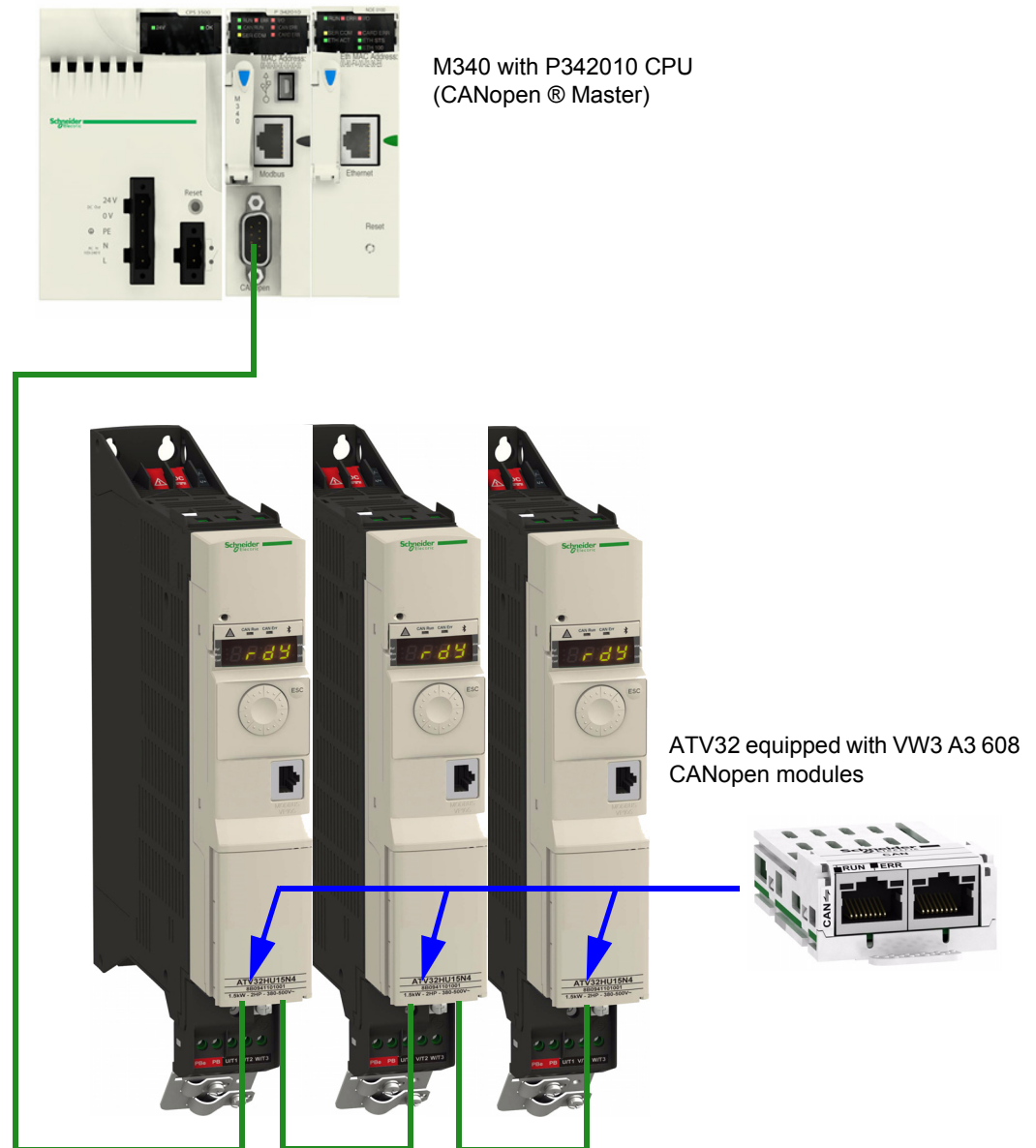
This chapter contains the following topics:

Topic	Page
Introduction	61
Drive Configuration	62
ATV32 EDS Integration	63
Configuring the ATV32 in the CANopen Master Project	64
ATV32 Control Block Example According to CiA402	67

Introduction

This chapter describes how to integrate an ATV32 in a unity project and to control it from a M340 PLC.

Example of configuration:



Drive Configuration

Factory Setting

Before configuring the drive, it's strongly advised to make a factory setting. Goto to:

- **[1.3 CONFIGURATION]** (**C D n F**) menu,
- **[FACTORY SETTINGS]** (**F C S -**) sub-menu.

Then configure the following parameters:

- **[PARAMETER GROUP LIST]** (**F r Y -**) = **[ALL]** (**A L L**),
- **[Goto FACTORY SETTINGS]** (**G F S**) = enter.

Command Configuration

To control the drive with a CANopen Master, it is necessary to select CANopen as command channel active.

Goto to:

- **[1.3 CONFIGURATION]** (**C D n F**),
- **[FULL]** (**F U L L**),
- **[COMMAND]** (**C t L -**) menu

And then configure: **[Ref. 1 channel]** (**F r I**) parameter to **[CANopen]** (**C A n**) value.

Communication Configuration

Select the CANopen address in the menu:

- **[1.3 CONFIGURATION]** (**C D n F**)
- **[FULL]** (**F U L L**)
- **[COMMUNICATION]** (**C D n -**) menu
- **[CANopen]** (**C n D -**)

And then configure:

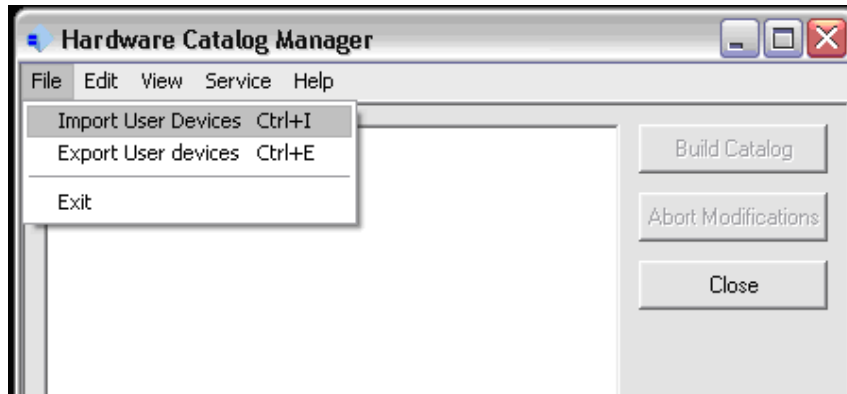
- **[CANopen address]** (**A d C D**) parameter to **[1]** (**I**) value,
- **[Baud Rate]** (**B d C D**) parameter to **[500 kbps]** (**S D D**).

The drive must be restarted in order to take into account the CANopen address.

ATV32 EDS Integration

If your Unity Software doesn't contain the ATV32 in the CANopen catalog. You must add the EDS file to the hardware Catalog Manager installed with Unity, or use the ATV32_XXX.cpx file provided as example with the ATV32 EDS file. The cpx file is an export from an existing catalog and doesn't need any configuration in the Hardware catalog manager.

Importing a .cpx File



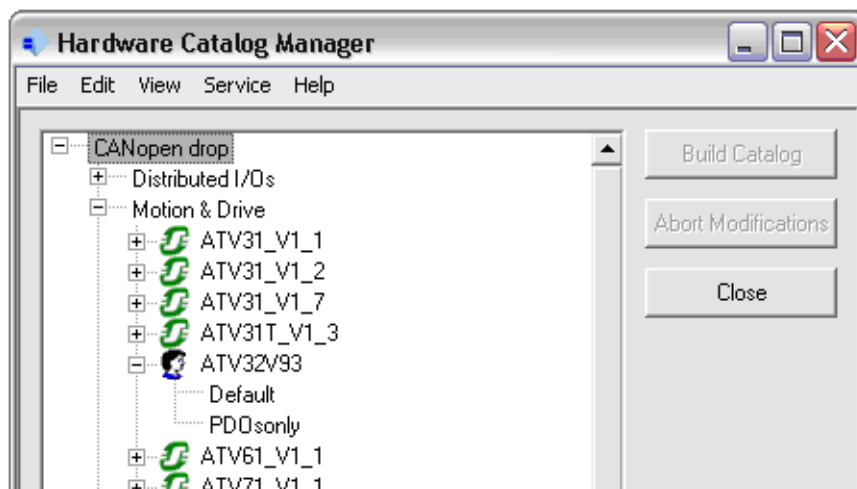
In the file menu, select Import User devices to load the .cpx file.

A file dialog box will ask you to select the file and its location on your PC.

Importing EDS File

If you add the EDS file.

Checking the Imported .cpx in the Hardware Catalog Manager



Once imported, you should see the ATV32 in the Motion & drive section. The two topics "default" and "PDOsonly" are used in the CANopen device configuration screen of Unity to select which objects are mapped and linked to an application variable.

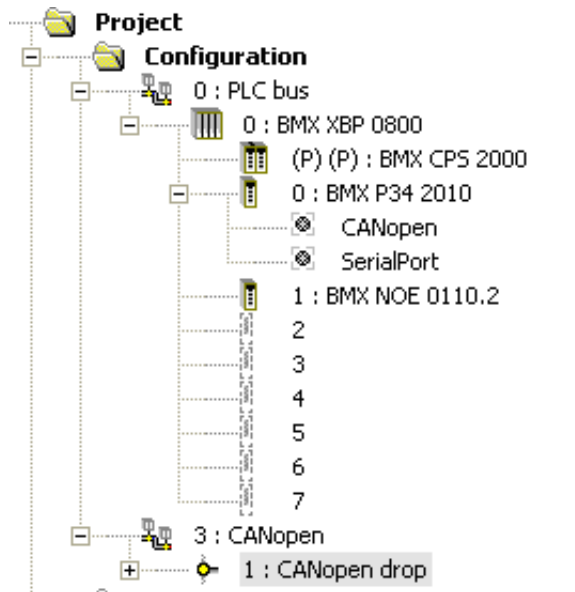
- Default: all the objects described in the EDS will have reserved memory in the PLC application.
- PDOs only: Only the TPDO and RPDO objects are mapped in PLC memory. (The current example will use this "function").

Your Hardware catalog manager is now updated and contains the ATV32. If you import only the EDS file you will have only the default choice. You must create new functions in the Hardware catalog manager if you need several choices.

NOTE: Don't remove an existing device from the hardware catalog manager unless you are sure that this device is not used in an existing Unity project: You will not be able to re open this project.

Configuring the ATV32 in the CANopen Master Project

From the project browser open the CANopen configuration tool by double clicking the CANopen drop:



Configuration of the Master

The master configuration consists of:

- Setting the baud rate
- Setting the SYNC message period
- Configuring the memory area which is the image of the whole PDOs handled by the PLC.

The screenshot shows the 'Configuration' dialog box for the CANopen master. The left pane shows the project structure with 'CANopen comm head' and 'Channel 2 (CANOPEN)' selected. The right pane is titled 'Configuration' and contains the following settings:

Inputs		Outputs	
Nb. of words (%Mw)	500	Nb. of words (%Mw)	500
Index of 1st %Mw	300	Index of 1st %Mw	1300
Nb. of bits (%M)	34	Nb. of bits (%M)	32
Index of 1st %M	200	Index of 1st %M	300

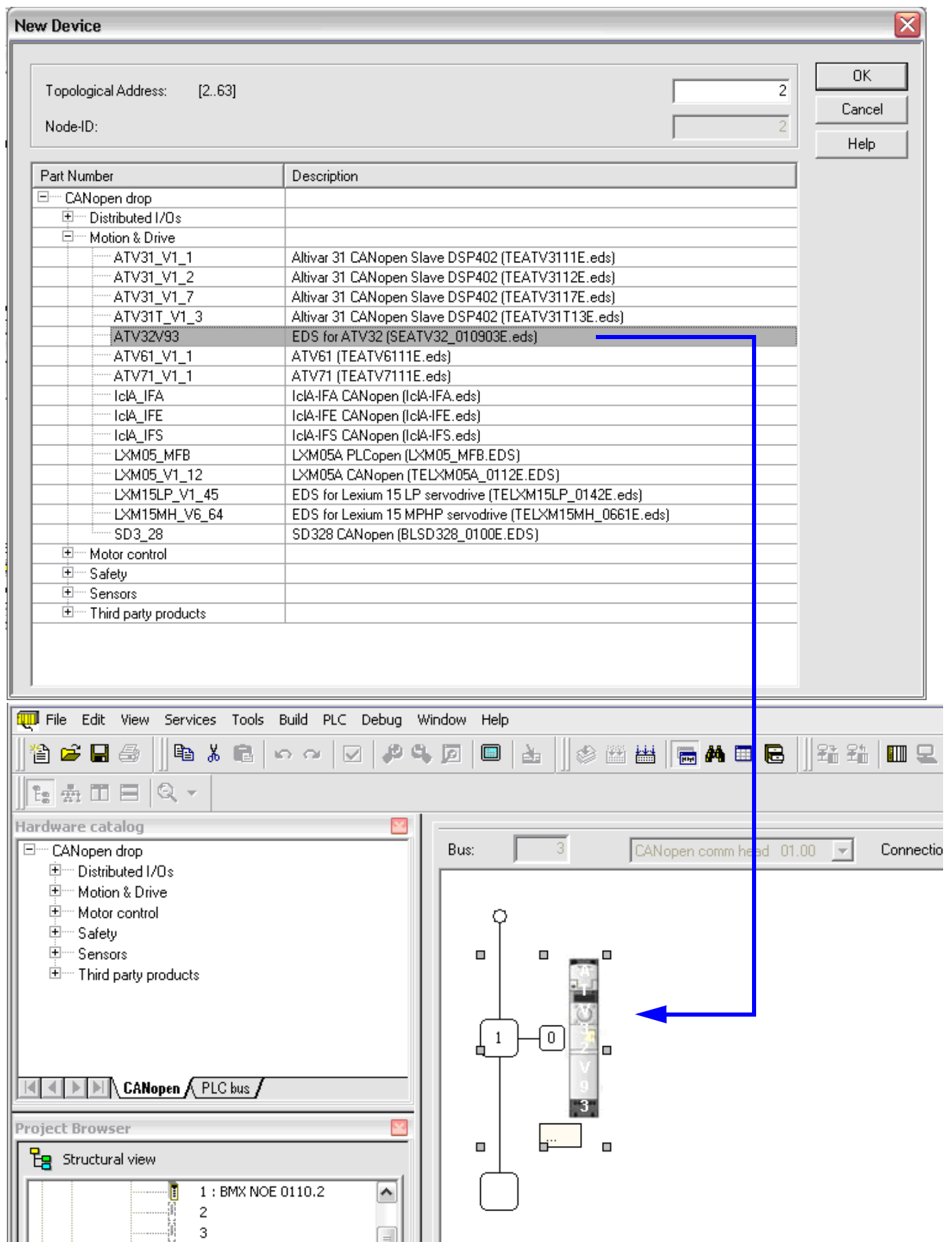
Below the input/output settings, there is a 'Bus parameters' section:

Bus parameters	
Transmission speed	500 kBaud
SYNC Message COB-ID	128
SYNC Message Period	200 ms

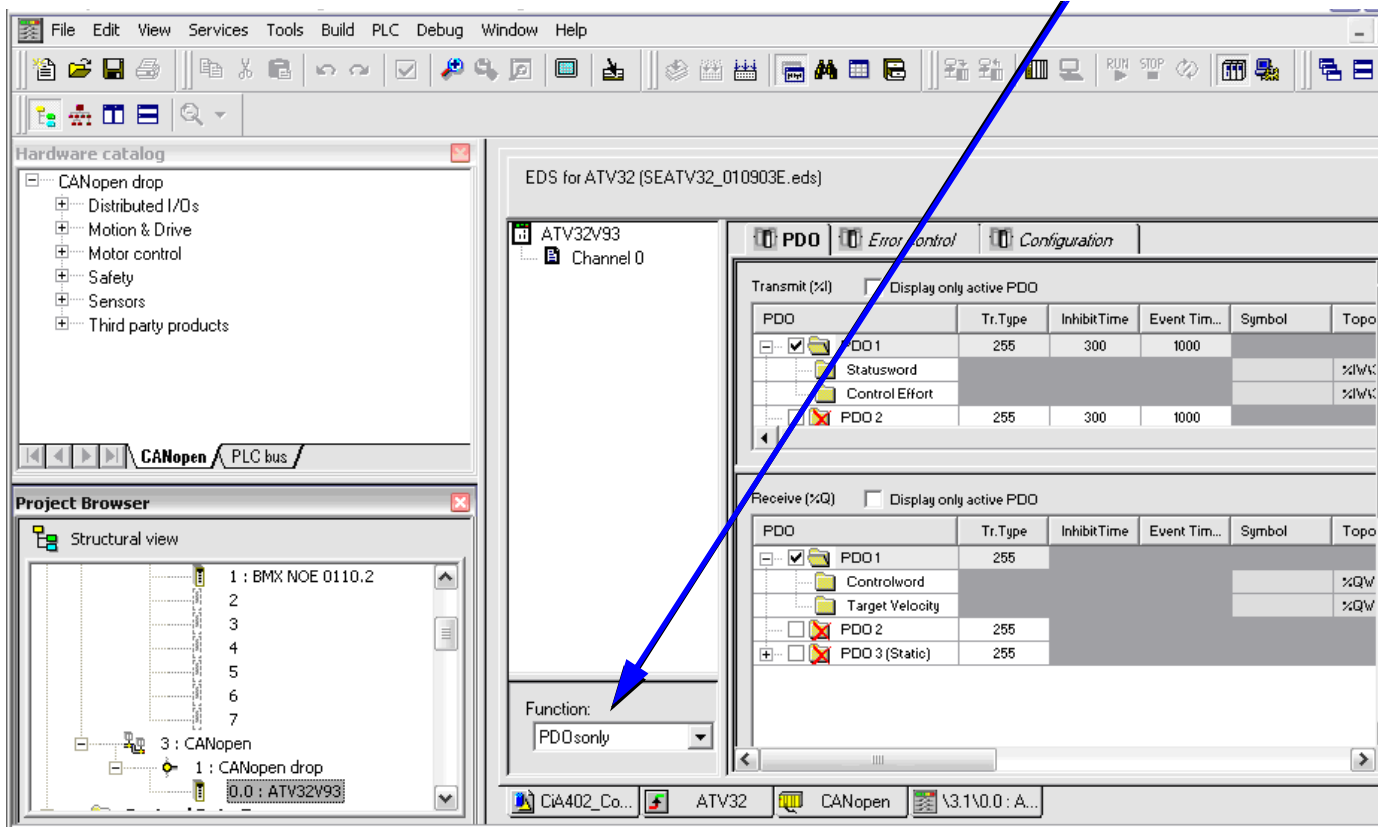
The 'Outputs' section also includes radio buttons for 'Maintain' and 'RESET', with 'RESET' selected.

Configuration of the Slave

Add a new device and select the ATV32 in the catalog. The ATV32V93 was previously added to the catalog by importing the .cpx file or by creating the device from the EDS file.



Then double click on the device and select in the “function” drop menu PDOs only:



In the example above, we select only TPDO1 and RPDO1 which provides the basic control command of the drive with the CiA402 velocity mode profile.

PDO									
Transmit (%I) <input checked="" type="checkbox"/> Display only active PDO									
PDO	Tr.Type	InhibitTime	Event Tim...	Symbol	Topo.Addr.	%M...	COBID	Index	
<input checked="" type="checkbox"/> PDO 1	255	300	1000				16#181		
Statusword					%Iw13.10.0.0.4	%Mw304		6041:00	
Control Effort					%Iw13.10.0.0.5	%Mw305		6044:00	
Receive (%Q) <input checked="" type="checkbox"/> Display only active PDO									
PDO	Tr.Type	InhibitTime	Event Tim...	Symbol	Topo.Addr.	%M...	COBID	Index	
<input checked="" type="checkbox"/> PDO 1	255						16#201		
Controlword					%Qw13.10.0.0.4	%Mw1304		6040:00	
Target Velocity					%Qw13.10.0.0.5	%Mw1305		6042:00	

PDOs are linked to the %Mw variables, The mapping is automatically generated by Unity according to the index defined in the master configuration panel and to the PDOs and to the slave Node ID.

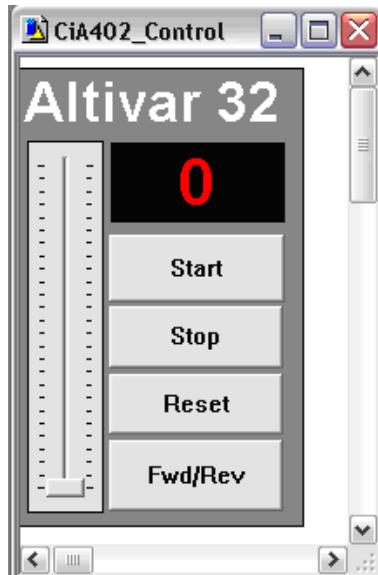
Status Word (object 6041)	%MW304	
Control effort (Object 6044)	%MW305	
Control Word (Object 6040)		%MW1304
Target velocity (Object 6041)		%MW1305

You can now build the project and start the PLC to check the cyclic exchanges with an animation table:

Name	Value	Type	Comment
ATV32_1_ControlWord	16#0000	WORD	
ATV32_1_TargetSpeed	0	WORD	
ATV32_1_StatusWord	16#0040	WORD	
ATV32_1_CurrentSpeed	0	WORD	

ATV32 Control Block Example According to CiA402

In the example below The drive state machine is managed from a control block (written in a DFB). This control block is linked to an animation screen which reproduces a basic Motor control. For more detail on the Drive state machine please refer to “CiA[®]402 - IEC61800-7 Functional Profile” on page 37.



The objects of the animation screen are used as input and output parameters of the control Block. The Block is called cyclically in a SR part of the Mast task. The variables used as parameters in the following control block call are used in the previous animated table.

```
ATV32_1_Control (Status_in := ATV32_1_StatusWord,
CurrentSpeed := ATV32_1_CurrentSpeed,
Start := Atv32Start,
Stop := Atv32Stop,
Reset := Atv32Reset,
AtvFwdRev := Atv32FwdRev,
SpeedSp := Atv32SpdSP,
ControlWord => ATV32_1_ControlWord,
Reference => ATV32_1_TargetSpeed);
```



DFB code:

```
(* state machine basic management *)
MaskedStatus:= Status_in and 16#000f;

(* Shutdown *)
if (MaskedStatus=0) and (Status_in <> 6) then ControlWord:=6;
end_if;

(* Switch ON *)
If (MaskedStatus=1) and (Status_in <> 7) then ControlWord:=7;
end_if;





















(* START *)
If ((MaskedStatus=3) and (Status_in <> 15))and Start then ControlWord:=15;
end_if;

(* STOP *)
If ((MaskedStatus=7) and (Status_in <> 7))and Stop then ControlWord:=7;
end_if;

(* basic speed management *)
if AtvFwdRev then reference := SpeedSp * -1; else Reference := SpeedSp;
END_IF;

(* reset control *)
ControlWord.7 := Reset;
```

DFB interface

Variables DDT Types Function Blocks DFB Types					
Filter   Name *					
Name	no.	Type	Value	Comment	
 CiA402Control		<DFB>			
 <inputs>					
 Status_in	1	INT			
 CurrentSpeed	2	INT			
 Start	3	BOOL			
 Stop	4	BOOL			
 Reset	5	BOOL			
 AtvFwdRev	6	BOOL			
 SpeedSp	7	INT			
 <outputs>					
 ControlWord	1	INT			
 Reference	2	INT			
 <inputs/outputs>					
 <public>					
 <private>					
 MaskedStatus		INT			
 <sections>					
 main		<ST>			

Software Setup With SoMachine (M238)

9

What's in this Chapter?

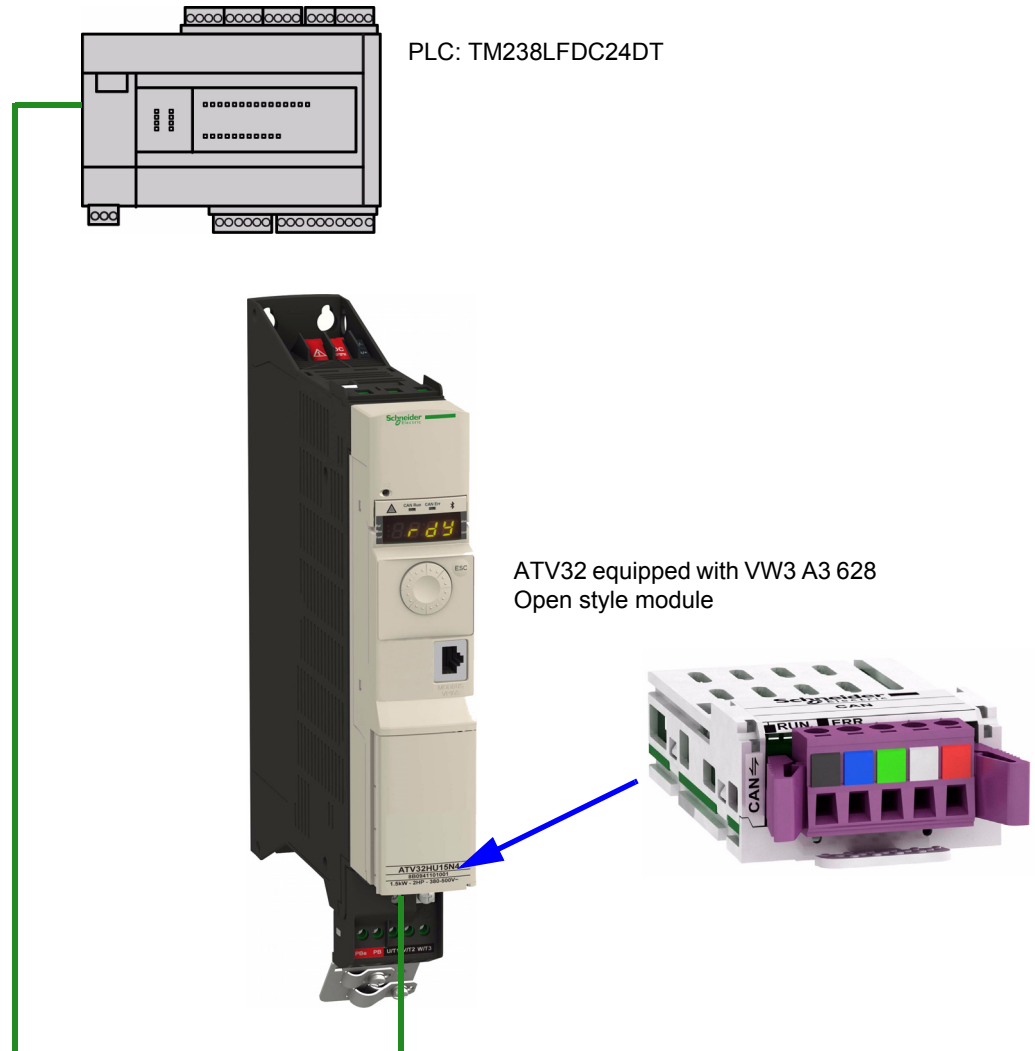
This chapter contains the following topics:

Topic	Page
Introduction	70
Drive Configuration	71
CANopen Master Configuration	72

Introduction

Here is an example of an application that shows how to control an ATV32 with a M238 PLC equipped with a CANopen master port. The operator can control the drive directly from SoMachine.

In the example, the PDO1 of the ATV32 is used. The PLC will send the command and the speed reference to the ATV32 and will read the status word and the actual speed of the drive.



Drive Configuration

Factory Setting

Before configuring the drive, it's strongly advised to make a factory setting. Goto to:

- **[1.3 CONFIGURATION]** (**C** **D** **n** **F**) menu,
- **[FACTORY SETTINGS]** (**F** **C** **S** -) sub-menu.

Then configure the following parameters:

- **[PARAMETER GROUP LIST]** (**F** **r** **y** -) = **[ALL]** (**A** **L** **L**),
- **[Goto FACTORY SETTINGS]** (**G** **F** **S**) = enter.

Command Configuration

To control the drive with a CANopen Master, it is necessary to select CANopen as command channel active.

Goto to:

- **[1.3 CONFIGURATION]** (**C** **D** **n** **F**),
- **[FULL]** (**F** **U** **L** **L**),
- **[COMMAND]** (**C** **L** **L** -) menu.

And then configure: **[Ref. 1 channel]** (**F** **r** **I**) parameter to **[CANopen]** (**C** **A** **n**) value.

Communication Configuration

Select the CANopen address in the menu:

- **[1.3 CONFIGURATION]** (**C** **D** **n** **F**),
- **[FULL]** (**F** **U** **L** **L**),
- **[COMMUNICATION]** (**C** **O** **m** -) menu,
- **[CANopen]** (**C** **A** **n** -).

And then configure:

- **[CANopen address]** (**A** **d** **C** **D**) parameter to **[2]** (**2**) value,
- **[Baud Rate]** (**B** **a** **d** **R** **a** **t** **e**) parameter to **[125 kbps]** (**1** **2** **5**).

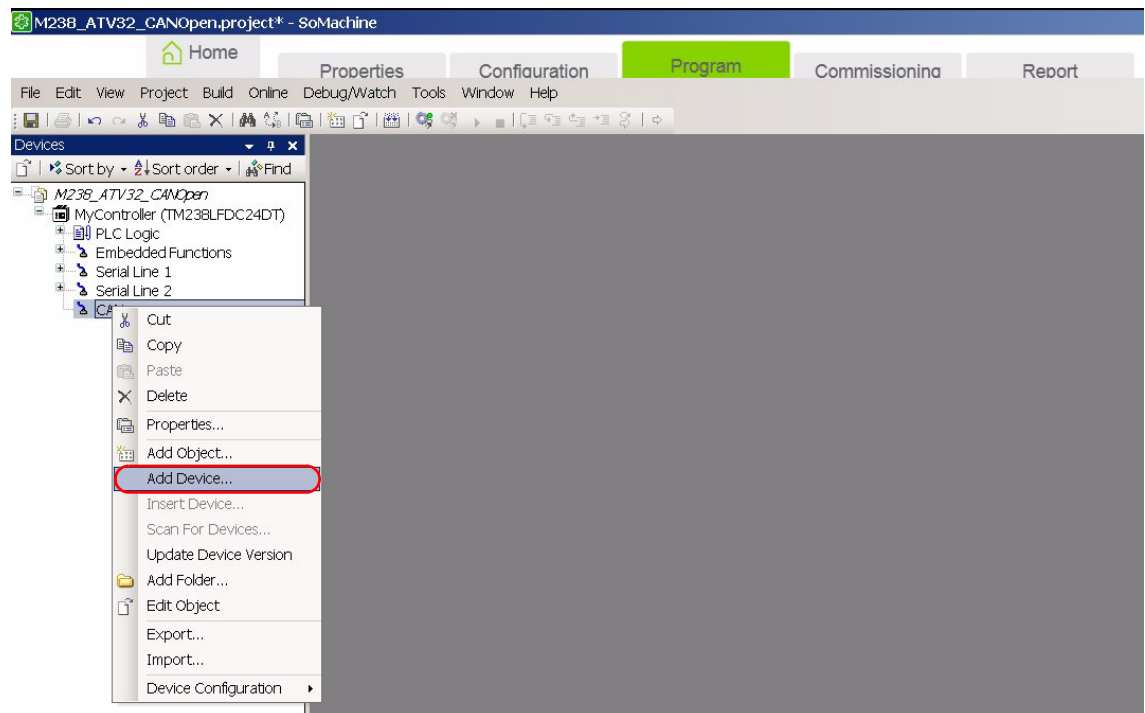
The drive must be restarted in order to take into account the CANopen address.

CANopen Master Configuration

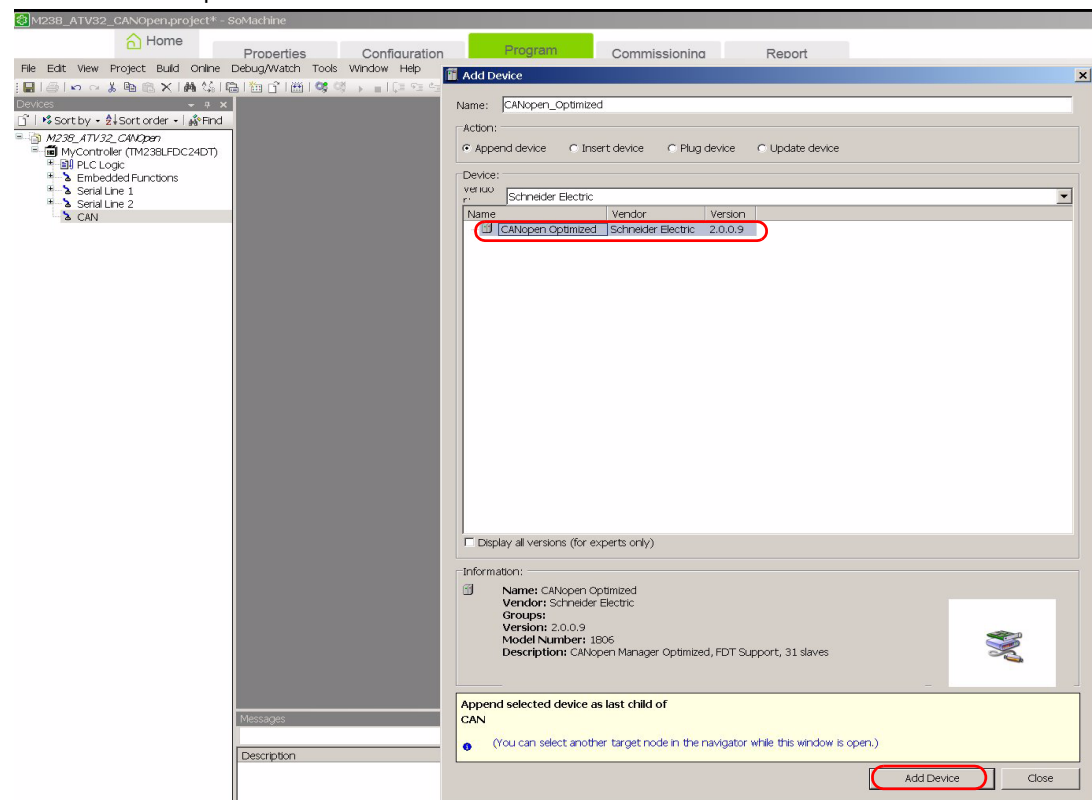
In this example, the CANopen Master configuration is done with SoMachine.

Add Device

Make a right click on CANopen and select *Add Device*.

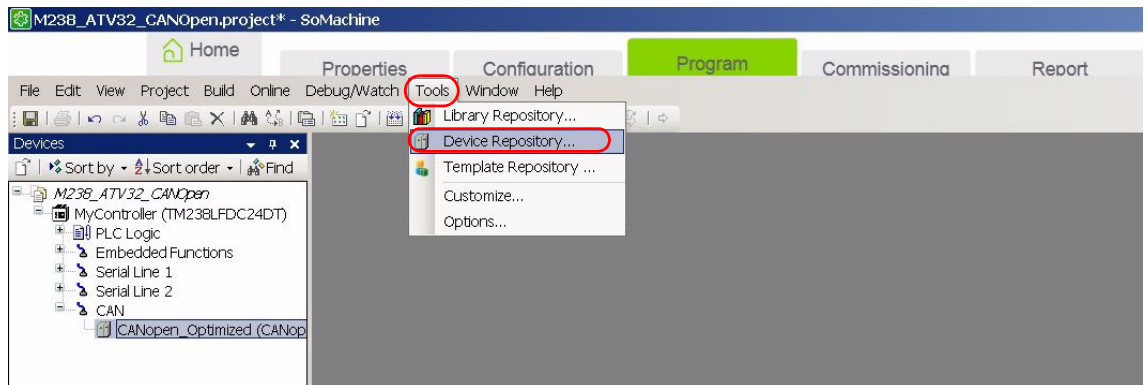


Then select CANopen Schneider Electric and click on *Add Device*.

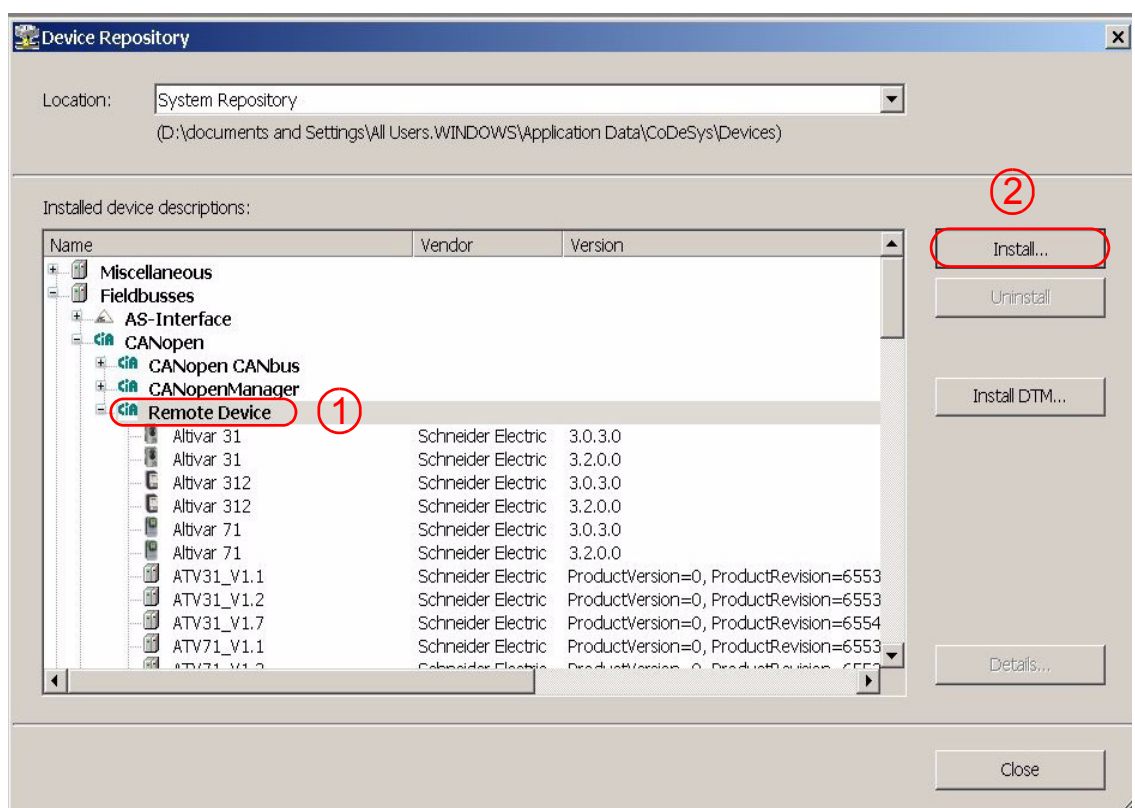


Import EDS file

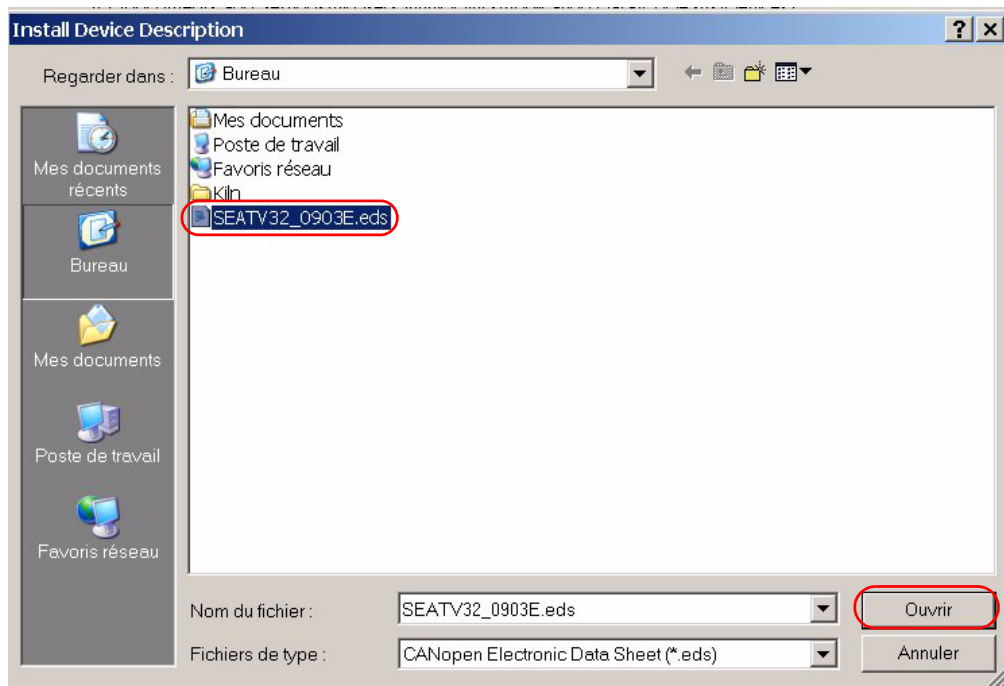
It is necessary to import the EDS file corresponding to the product.



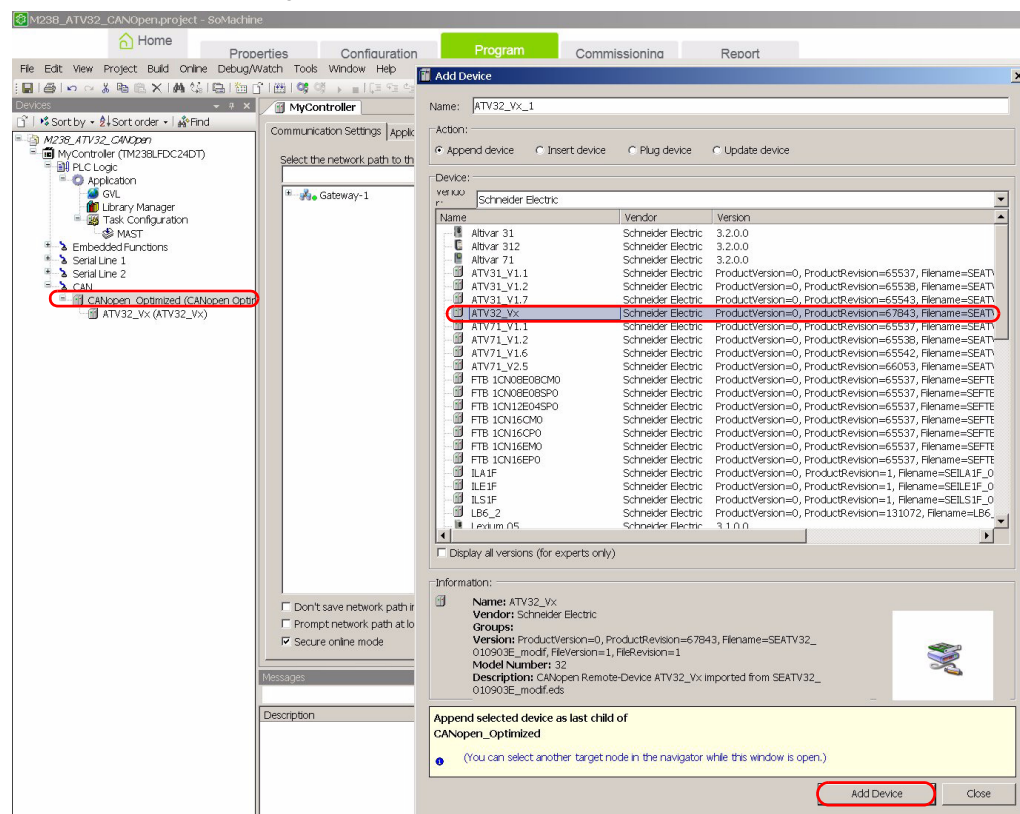
Select *Remote Device* and click on *Install*.



Find where is located the EDS file on your hard disk and select it. The EDS file can be downloaded from our web site www.schneider-electric.com.

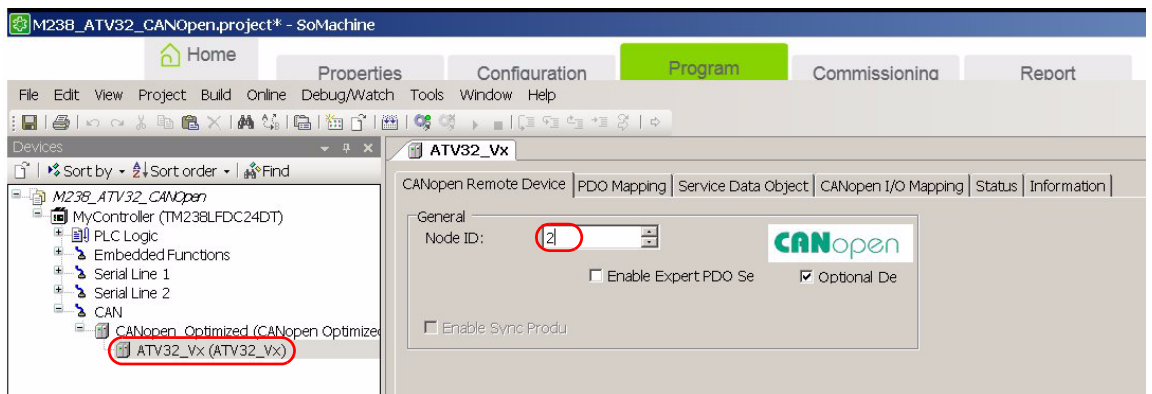
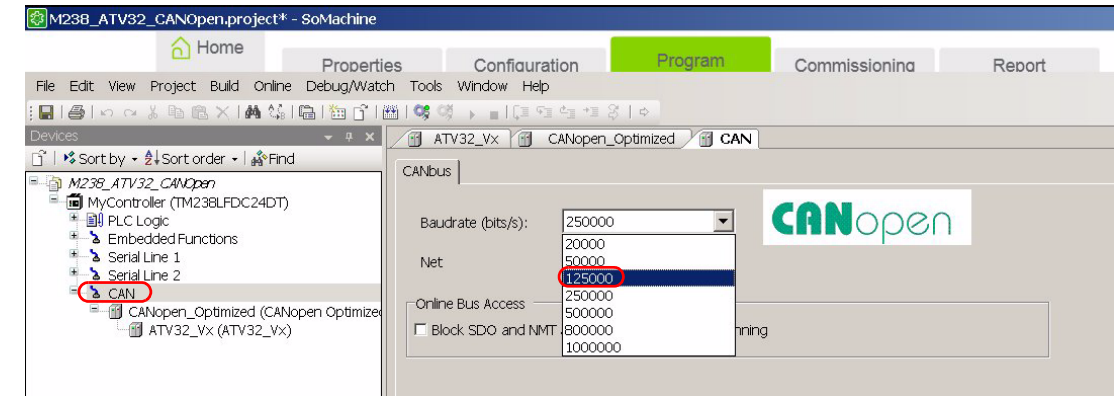


Then **Add Device** selecting ATV32.



CANopen Port Configuration

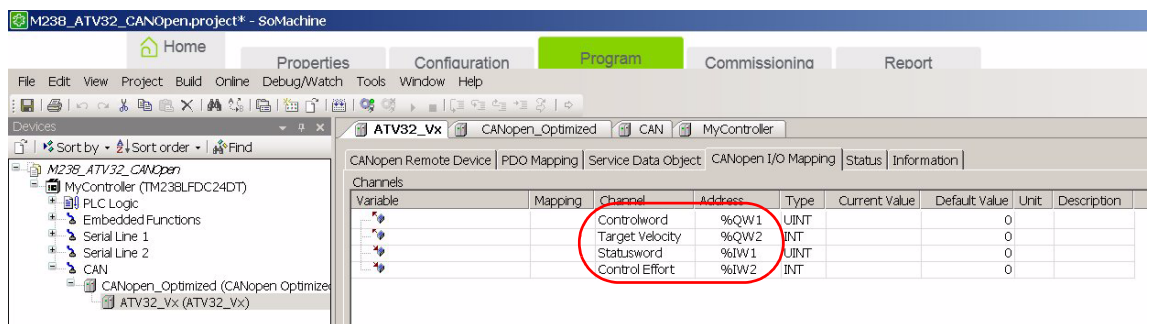
Configure the baud rate (125 bits/s) and the node ID (ATV32 CANopen address = 2).



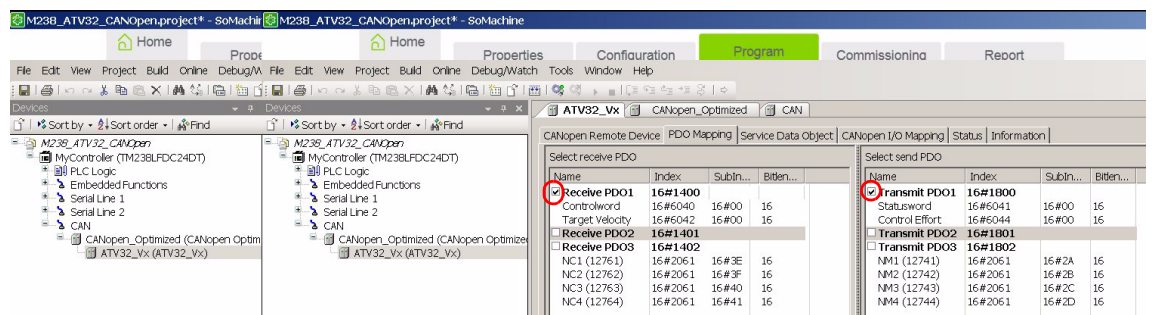
Data Exchange

In the window CANopen I/O Mapping tick *Always update variables*. In this example, we use the first PDO. PDO1 contains two data (default setting):

- Control word (CMDD) and target velocity (LFRD) for the input and
- Status word (ETAD) and control effort (RFRD) for the output.



PDO1 is activated by default.



Build the project, download it to the PLC and start it.

Detailed Description of Services

10

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Network Management	77
Boot Up Service	79
Node Guarding Service	80
Heartbeat Service	81
Emergency Object (EMCY)	82
Synchronization Object (SYNC)	84
PDO1	85
PDO2	89
PDO3	90
SDO Service	91

Network Management

NMT Commands

Master ⇒ Drive

COB-ID	Byte 0	Byte 1
0 (16#000)	Command specifier (CS)	Node-ID ⁽¹⁾

(1) If Node-ID = 0, the “command specifier” is broadcast to all CANopen slaves (including the Altivar). Each slave must then execute this NMT command, thereby completing the corresponding transition (see below). Check that your CANopen slaves support broadcast communication on COB-ID 0, which the Altivar does

Command specifier (CS)	Meaning
1 (16#01)	Start_Remote_Node
2 (16#02)	Stop_Remote_Node
128 (16#80)	Enter_Pre-Operational_State
129 (16#81)	Reset_Node
130 (16#82)	Reset_Communication

Example

Transition to pre-operational state (Enter_Pre-Operational_State = 16#80) of the Altivar located at CANopen address 4 (16#04).

16#000	16#80	16#04
--------	-------	-------

Network Management State Machine

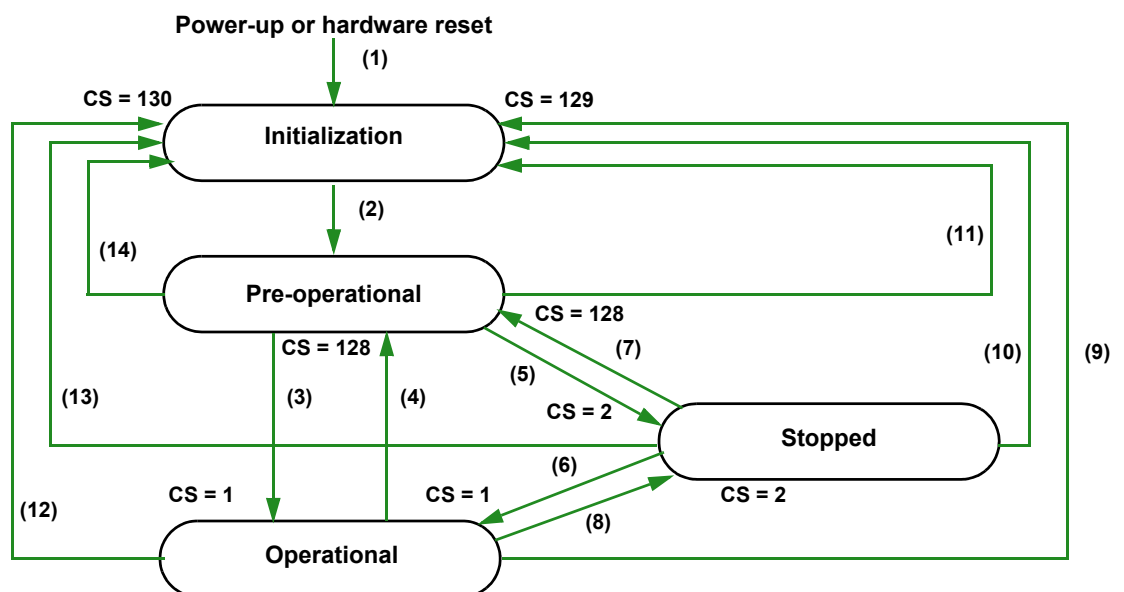
The product respects the NMT state machine.

The CANopen NMT Slave device implements a state machine, which brings automatically after power-on and internal initialisation every device in Pre-operational state. In this state the node may be configured and parameterized via SDO (example: using a configuration tool), no PDO communication is allowed.

The NMT Master device may switch all nodes or a single node to Operational state and vice versa. In Operational state PDO transfer is allowed. By switching a device into the Stopped state it is forced to stop PDO and SDO communication. Furthermore, this state can be used to achieve certain application behavior.

In the Operational state all communication objects are active. Object Dictionary access via SDO is possible.

- NMT state chart



Transition	Description
(1)	On power-up, the node automatically changes to the initialization state
(2)	Once initialization is complete, the pre-operational state is activated automatically
(3), (6)	Start_Remote_Node
(4), (7)	Enter_Pre-Operational_State
(5), (8)	Stop_Remote_Node
(9), (10), (11)	Reset_Node
(12), (13), (14)	Reset_Communication

Depending on the communication status of the drive, the following services are available:

	Initialization	Pre-operational	Operational	Stopped
PDO			X	
SDO		X	X	
Synchronization (SYNC)		X	X	
Emergency (EMCY)		X	X	
Bootup service	X		X	
Network management (NMT)		X	X	X

In pre-Operational mode, the master can only perform SDO. In operational mode, the master can perform SDO and PDO.

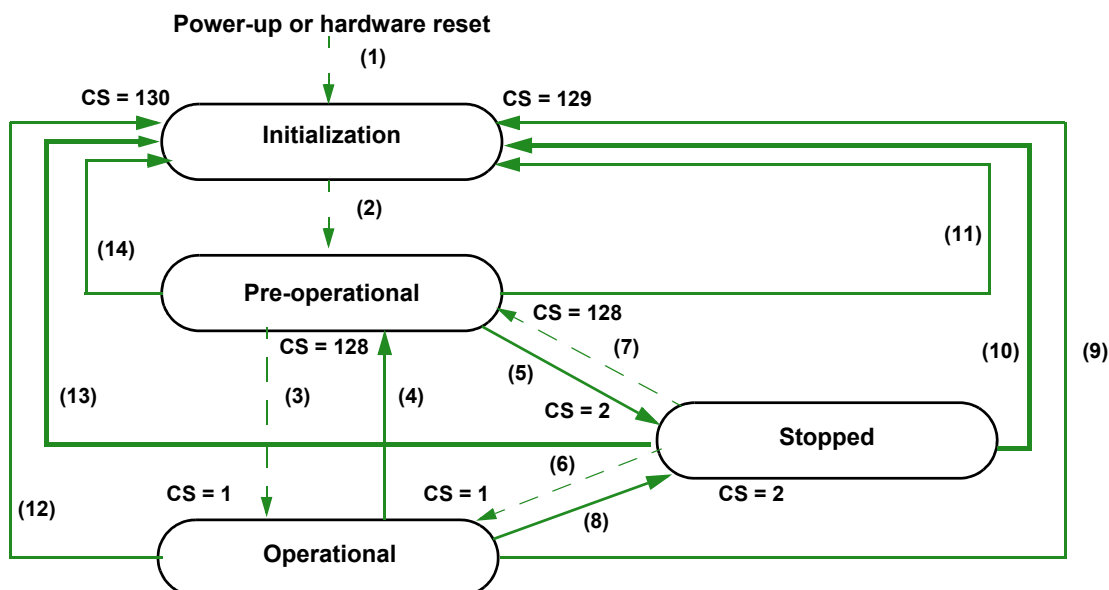
In Stop mode, the master can't perform SDO and PDO (it's impossible to start the drive).

In operational mode, the device can be controlled only if the user has selected CANopen as the command channel.

In the event of a resettable detected fault, the drive must be in the "Operational" NMT state in order that the PDO carrying the control word CMD (receive PDO1, preferably) can reset the drive using the CMD "reset fault" bit. Then, the CANopen "master" will have to set the drive to the "Operational" state using an NMT telegram, with CS = 1 (Start_Remote_Node) and Node-ID = drive node address.

- NMT state chart

Some transitions in the NMT state chart will trigger a CANopen communication interruption. These transitions are listed in the table and illustrated in the chart below (solid lines with arrows):



NOTE: The trip will appear only if the drive is running.

Transition	Description
(4)	Enter_Pre-Operational_State
(5), (8)	Stop_Remote_Node
(9), (10), (11)	Reset_Node
(12), (13), (14)	Reset_Communication

These transitions suppress a service, which can be used to control the drive. A detected fault is triggered in order to avoid losing control of the drive (only if the drive is running).

Transition	Service lost
(4)	PDO
(5)	SDO
(8), (9), (10), (11), (12), (13), (14)	PDO and SDO

Boot Up Service

This protocol is used to signal that a NMT slave has entered the node state Pre-Operational after the state Initialization. The protocol uses the same identifier as the detected error control protocols. The boot up messages is transmitted also after reset-communication, reset-application and recovering from power-off.

The only data byte sent in a Bootup frame is equal to 16#00.

Master ⇄ Drive

COB-ID	Byte 0
1792 (16#700) +Node-ID	16#00

Node Guarding Service

Either the Node Guarding service described here or the Heartbeat service described below can be used for communication monitoring. Only one of these two services can be active at any one time. The Node Guarding service is deactivated by default on the Altivar.

Master ⇄ Drive

The master scans the drive at regular intervals ("Life Time") by sending "remote transmit requests" (RTR). The "Life Time" is calculated by multiplying the "Guard Time" by the "Life Time Factor". These two parameters are described below.

If, once the "Life Time" has expired, the drive has not received the RTR:

- It triggers a "Life Guarding" detected fault (see "Configuring Communication Interruption Management" on page 27),
- and sends an emergency telegram (EMCY) (See "Emergency Object (EMCY)" on page 82.).

Master ⇄ Drive

COB-ID	Byte 0 = NMT information	
1792 (16#700) + Node-Id	Bit 7	Bit 6-0
	Toggle bit	Node State

The drive response indicates its NMT state via the "NMT information" field, described here:

Bits 6-0 (node state): Current NMT state of the drive:

- Initialization (16#00),
- Stopped (16#04),
- Operational (16#05),
- or Pre-operational (16#7F).

The **[Canopen NMT state] (n 11 5)** parameter (16#201E/3A) can be accessed via the drive display terminal.

If the drive does not send a response or if it sends an incorrect state, the master will trigger a "Node Guarding" event.

Bit 7 (toggle bit): The value of this bit must alternate from one drive response to the other. The value of the toggle bit for the first response following activation of the Node Guarding service is 0. This bit can only be reset to 0 by sending the "Reset_Communication" command to the drive. If a response is received with the same toggle bit value as the previous response, the new response is treated as if it had not been received.

Example Configuration for the Node Guarding Service

The Altivar "Life Time" can be modified using the SDO service in order to write new values for the "Guard Time" and "Life Time Factor" parameters.

Parameter	Index	Subindex	Format	Unit
Guard Time	16# 100C	16# 00	16-bit unsigned integer	1 ms
Life Time Factor	16# 100D	16# 00	Unsigned byte	-

In our example, we are going to configure a Life Time of 2 seconds, with a Guard Time of 500 ms and a Life Time Factor of 4 ($500 \text{ ms} \times 4 = 2 \text{ s}$).

Setting the "Guard Time" parameter to 500 ms

- COB-ID = 16#600 + Node-ID for the write request or 16#580 + Node-ID for the write response
- Request code (byte 0) = 16#2B to write data 2 bytes in length
- Response code (byte 0) = 16#60 if the write operation has been completed without detected errors
- Object index (bytes 1 and 2) = 16#100C
- Object subindex (byte 3) = 16#00
- Request data (bytes 4 and 5) = 16#01F4 (500)

Request: Master ⇄ Drive

16#604	16#2B	16#0C	16#10	16#00	16#F4	16#01	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

Response: Master ⇄ Drive

16#584	16#60	16#0C	16#10	16#00	16#00	16#00	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

Heartbeat Service

If you do not activate the Node Guarding service described above, you can use the Heartbeat service to monitoring communication with another node, provided that it supports this service.

The Heartbeat service is deactivated by default on the Altivar (the “Consumer Heartbeat Time” and “Producer Heartbeat Time” parameters are both set to 0).

Producer ⇒ Consumer

COB-ID	Byte 0
1792 (16#700) +Node-ID	Heartbeat Producer state

Each “Heartbeat Producer” sends Heartbeat messages at regular intervals (the “Producer Heartbeat Time” 16#1017/00).

All “Heartbeat Consumers” check that they receive these messages in a time less than the “Consumer Heartbeat Time” (16#1016/01).

The “Producer Heartbeat Time” must be less than the “Consumer Heartbeat Time”.

If the drive has been configured as a consumer and a period of time equal to the “Consumer Heartbeat Time” elapses without a “Heartbeat message” being received, the drive will trigger a “Heartbeat” event and send an emergency telegram (EMCY).

If CANopen is the active channel, a CANopen detected fault (COF) will be triggered.

The “Heartbeat message” sent from the drive contains a “Heartbeat Producer state” field (byte 0), described here:

Bit 7 = Reserved: This bit is equal to 0.

Bits 6-0 = Heartbeat Producer state: Current NMT state of the drive:

- Initialization (16#00).
- Stopped (16#04).
- Operational (16#05).
- or Pre-operational (16#7F).

Emergency Object (EMCY)

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
128 (16#080) +NODE-ID	Fault code (Errd)		Error register	0	0	0	0	0
	LSB	MSB	Bit 0 = 0 (no fault) or 1 (fault)	-	-	-	-	-

An EMCY object is sent by the drive to other CANopen devices, with a high priority, every time a detected fault appears (byte 2/bit 0 = 1) or disappears (byte 2/bit 0 = 0). This is the case in particular for “Heartbeat” or “Life Guard” type detected faults. An Emergency object is never repeated.

The detected error code parameter Errd (CANopen index = 16#2038/7) is described in the table below:

EMCY detected error code (Errd)	Description (accessible also in dP / see programming manual)
16#0000	[No fault] (nOF)
16#1000	[Precharge] (CrF)
16#1000	[Motor overload] (OLF)
16#1000	[Overspeed] (SOF)
16#1000	[Diff. I fault] (dCF)
16#1000	[IGBT desaturation] (HdF)
16#1000	[internal- CPU] (InFE)
16#1000	[Ch.sw. fault] (CSF)
16#1000	[Angle error] (ASF)
16#2230	[IGBT short circuit] (SCF4)
16#2310	[Overcurrent] (OCF)
16#2311	[Proc.Overload Flt] (OLC)
16#2320	[Motor short circuit] (SCF1)
16#2320	[Motor short circuit] (SCF5)
16#2330	[Ground short circuit] (SCF3)
16#3110	[Mains overvoltage] (OSF)
16#3120	[Undervoltage] (USF)
16#3130	[Input phase loss] (PHF)
16#3310	[Overbraking] (ObF)
16#3310	[1 output phase loss] (OPF1)
16#3310	[3out ph loss] (OPF2)
16#4210	[Drive overheat] (OHF)
16#4210	[IGBT overheat] (tJF)
16#4310	[PTC fault] (OtFL)
16#5000	[Out. contact. stuck] (FCF1)
16#5000	[Out. contact. open.] (FCF2)
16#5000	[input contactor] (LCF)
16#5210	[Internal- I measure] (InF9)
16#5210	[Internal-mains circuit] (InFA)
16#5210	[Internal- th. sensor] (InFb)
16#5530	[Control Eeprom] (EEF1)
16#5530	[Power Eeprom] (EEF2)
16#6100	[Rating error] (InF1)
16#6100	[PWR Calib.] (InF2)
16#6100	[Int.serial link] (InF3)
16#6100	[Int.Mfg area] (InF4)
16#6100	[Cards pairing] (HCF)
16#6300	[Incorrect config.] (CFF)

EMCY detected error code (Errd)	Description (accessible also in dP / see programming manual)
16#6300	[Invalid config.] (CF1)
16#6300	[Bad conf] (CFI2)
16#7000	[Internal-option] (InF6)
16#7110	[Brake feedback] (brF)
16#7300	[LI6=PTC probe] (PtFL)
16#7300	[AI3 4-20mA loss] (LFF3)
16#7310	[Speed fedback loss] (SPF)
16#7400	[FB fault] (FbE)
16#7400	[FB stop flt.] (FbES)
16#7510	[Modbus com.] (SLF1)
16#7510	[HMI com.] (SLF3)
16#7520	[int. com.link] (ILF)
16#7520	[Com. network] (CnF)
16#7530	[PC com.] (SLF2)
16#8100	[CAN com.] (COF)
16#9000	[External flt-LI/Bit] (EPF1)
16#9000	[External fault com.] (EPF2)
16#FF00	[Auto-tuning] (tnF)
16#FF01	[Brake control] (bLF)
16#FF02	[Torque/current lim] (SSF)
16#FF03	[Pr.Underload.Flt] (ULF)
16#FF03	[Safety fault] (SAFF)
16#FF80	[Load fault] (dLF)

Synchronization Object (SYNC)

The SYNC object is sent cyclically by the CANopen master.

It does not contain data and its frame is, therefore, limited to its unique COB-ID identifier.

The purpose of this object is essentially to authorize synchronous communication modes for CANopen slaves. In the case of the Altivar, none of the PDOs used can be defined in cyclic or acyclic synchronous communication mode.

Master ⇄ Drive

COB-ID
128 (16#080)

PDO1

Default Assignment

- Transmit TPDO1

Master ⇌ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3
384 (16#180) +Node-ID	Status word "ETA"		Output speed "RFRD"	
	LSB	MSB	LSB	MSB

Example: The Altivar located at CANopen address 4 (COB-ID = 16#180 + 4) is in the "Operation enabled" state and is not faulty (status word "ETA" = 16#xxx7). In our example, the status word "ETA" is equal to 16#0607.

Furthermore, the speed of the motor is equal to 1500 rpm (16#05DC).

16#184	16#07	16#06	16#DC	16#05
--------	-------	-------	-------	-------

- Receive RPDO1

Master ⇌ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3
512 16#200 +Node-ID	Control word "CMD"		Speed target "LFRD"	
	LSB	MSB	LSB	MSB

Example: The Altivar located at CANopen address 4 (COB-ID = 16#200 + 4) receives the command called "Enable operation" (control word "CMD" = 16#xxxF). In our example, the control word "CMD" is equal to 16#000F.

Furthermore, the speed of the motor is equal to 1200 rpm (16#04B0).

16#204	16#0F	16#00	16#B0	16#04
--------	-------	-------	-------	-------

Extended Default Assignment

- Transmit TPDO1

Master ⇌ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
384 (16#180) + Node-ID	Status word "ETA"		Output speed "RFRD"		Motor torque	
	LSB	MSB	LSB	MSB	LSB	MSB

Example: The Altivar located at CANopen address 4 (COB-ID = 16#180 + 4) is in the "Operation enabled" state and is not faulty (status word "ETA" = 16#xxx7). In our example, the status word "ETA" is equal to 16#0607, the speed of the motor is equal to 1500 rpm (16#05DC) and the motor torque is equal to 50% (500 x 0.1% = 16#01F4).

16#184	16#07	16#06	16#DC	16#05	16#F4	16#01
--------	-------	-------	-------	-------	-------	-------

- Receive RPDO1

Master ⇌ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
512 (16#200) + Node-ID	Control word "CMD"		Speed target "LFRD"		Torque target "LTR"	
	LSB	MSB	LSB	MSB	LSB	MSB

Example: The Altivar located at CANopen address 4 (COB-ID = 16#200 + 4) receives the command called "Enable operation" (control word "CMD" = 16#xxxF). In our example, the control word "CMD" is equal to 16#000F, the speed target of the motor is equal to 1200 rpm (16#04B0) and its torque target is equal to 50% (500 x 0.1% = 16#01F4).

16#204	16#0F	16#00	16#B0	16#04	16#F4	16#01
--------	-------	-------	-------	-------	-------	-------

Restricted Default Assignment

- Transmit TPDO1

Master ⇄ Drive

COB-ID	Byte 0	Byte 1
384 (16#180) + Node-ID	Status word "ETA"	
	LSB	MSB

- Receive RPDO1

Master ⇄ Drive

COB-ID	Byte 0	Byte 1
512 (16#200) + Node-ID	Control word "CMD"	
	LSB	MSB

User Assignment

- Transmit TPDO1

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
384 (16#180) +Node-ID	Altivar variable (by default: status word "ETA")		Altivar variable (by default: output speed "RFRD")		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

NOTE: Any bytes left unused at the end of this PDO will not be transmitted on the bus by the Altivar. For example, if no parameters have been assigned to bytes 6 and 7, the data length of transmit PDO1 will be 6 bytes.

Example: The two default assignment parameters are maintained (16#6041/00 and 16#6044/00) and are suffixed (i.e., in bytes 4 and 5) with the "Torque Actual Value" motor torque parameter (16#6077/00), thereby producing the extended default assignment of transmit PDO1.

This extended default assignment then becomes a user assignment by means of the suffixing (i.e., in bytes 6 and 7) of the parameters of the current in the motor object "LCR" (16#2002/05), thereby producing the following user assignment:

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
384 (16#180) +Node-ID	Status word "ETA"		Output speed "RFRD"		Motor torque "OTR"		Current in the motor "LCR"	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

Consider an Altivar located at CANopen address 4 (COB-ID = 16#180 + 4) and in the following state:

- Current state = "Operation enabled" and no detected faults (status word "ETA" = 16#xxx7). In our example, the status word "ETA" is equal to 16#0607.
- The output speed "RFRD" is equal to 1500 rpm (16#05DC).
- The motor torque is equal to 83% (830 x 0.1% = 16#033E).
- The current in the motor "LCR" is equal to 4.0 A (16#0028).

The corresponding telegram sent for this transmit PDO is therefore as follows (8 data bytes):

16#184	16#07	16#06	16#DC	16#05	16#3E	16#03	16#28	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

- Receive RPDO1

Master ⇒ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
512 (16#200) +Node-ID	Altivar variable (by default: control word "CMD")		Altivar variable (by default: speed target "LFRD")		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

Example: The first default assignment object is maintained (16#6040/00) but the second is deleted (16#6042/00), thereby producing the *restricted default assignment* of receive PDO1.

This restricted default assignment then becomes a user assignment by means of the suffixing of the Acceleration ramp time "ACC"/"Acceleration" (16#203C/02) and Deceleration ramp time "DEC"/"Deceleration" (16#203C/03) parameters in bytes 2 to 5, thereby producing the following user assignment:

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
512 (16#200) +Node-ID	Control word "CMD"		Acceleration ramp time "ACC"		Deceleration ramp time "DEC"	
	LSB	MSB	LSB	MSB	LSB	MSB

Consider an Altivar located at CANopen address 4 (COB-ID = 16#200 + 4) and controlled as follows:

- "Enable operation" command (control word "CMD" = 16#xxxF). In our example, the control word "CMD" is equal to 16#000F.
- The acceleration ramp time "ACC" is 1 s (10 = 16#000A).
- The deceleration ramp time "DEC" is 2 s (20 = 16#0014).

The corresponding telegram received for this receive PDO is therefore as follows (6 data bytes):

16#204	16#0F	16#00	16#0A	16#00	16#14	16#00
--------	-------	-------	-------	-------	-------	-------

Cancellation code ⁽¹⁾	Description
16# 0503 0000	<i>Segmented transfer</i> : The toggle bit has not been modified.
16# 0504 0001	"Request code" invalid or unknown
16# 0601 0000	Parameter access detected error (example: write request on "read-only" parameter)
16# 0601 0002	Attempt to execute a write request on a "read-only" parameter
16# 0602 0000	The "index" sent in the request refers to an object, which does not exist in the object dictionary
16# 0604 0041	PDO object assignment: The parameter cannot be assigned to the PDO; this detected error occurs when writing to parameters 16#1600, 16#1601, 16#1602, 16#1A00, 16#1A01, and 16#1A02 (assignments of PDO1, 2 and 3)
16# 0604 0042	PDO object assignment: The number and/or length of the parameters to be assigned exceeds the maximum PDO length.
16# 0609 0011	The "subindex" sent in the request does not exist
16# 0609 0030	Outside parameter value limits (for a write request only)
16# 0609 0031	Value of parameter written too high
16# 0800 0000	A general detected error has occurred

(1) Please note that the "cancellation codes" listed in this table have been written in accordance with general convention and must, therefore, be inverted in the case of byte-by-byte representation for "bytes 4 to 7" (example: 16# 0609 0030 becomes byte 4 = 16#30, byte 5 = 16#00, byte 6 = 16#09, byte 7 = 16#06).

Important notes about the SDO service

Do not try to use SDO write requests to a parameter that has been assigned in an RPDO (receive).

Example: If the speed target (rpm) is assigned in RPDO1, there is no point using an SDO to write this target.

Any parameter connected to one of the parameters configured in an RPDO (receive) must not be modified using an SDO write request.

Example: If the speed target in (rpm) is assigned in RPDO1, there is no point using an SDO to modify the frequency target (0.1 Hz).

Example of a read operation using the SDO service

This example explains how to read the “acceleration ramp time (ACC)” parameter on an Altivar located at CANopen address 4 (COB-ID = 16#580 + Node-ID or 16#600 + Node-ID). The “index/subindex” value of this parameter is equal to 16#203C/02.

Read request: Master ⇒ Drive

16#604	16#40	16#3C	16#20	16#02	16#00	16#00	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

Read response: Master ⇐ Drive

16#584	16#4B	16#3C	16#20	16#02	16#E8	16#03	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

The value of the parameter read is equal to 1000 (16#03E8), equivalent to an “acceleration ramp time (ACC)” of 100 s, as the unit of this parameter is “0.1 s”.

Example of a write operation using the SDO service

This example explains how to write the value 100 s to the “acceleration ramp time (ACC)” parameter on an Altivar located at CANopen address 4 (COB-ID = 16#580 + Node-ID or 16#600 + Node-ID). The “index/subindex” value of this parameter is equal to 16#203C/02.

Write request: Master ⇒ Drive

The “request code” is 16#2B as we are trying to modify the value of an item of data 2 bytes in length.

16#604	16#2B	16#3C	16#20	16#02	16#E8	16#03	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

The “Request data” field indicates that the value we are trying to assign to the parameter is equal to 1000 (16#03E8), equivalent to an “acceleration ramp time (ACC)” of 100 s, as the unit of this parameter is “0.1 s”.

Write response: Master ⇐ Drive

16#584	16#60	16#3C	16#20	16#02	16#00	16#00	16#00	16#00
--------	-------	-------	-------	-------	-------	-------	-------	-------

PDO2

Set PDO2 on the Altivar is disabled by default ("PDO COB-ID entry" parameter = 16#80000XXX).

To enable it, use the SDO service in write mode to set bit 31 of the "PDO COB-ID entry" parameter in transmit PDO2 (16#1801/01) and/or receive PDO2 (16#1401/01) to zero.

Unlike set PDO1, it is also possible to modify bits 0 to 6 of the COB-IDs in set PDO2 in order to authorize slave-to-slave communication.

- Transmit TPDO2

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
640 (16#280) +Node-ID	Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

NOTE: Any bytes left unused at the end of this PDO will not be transmitted on the bus by the Altivar. For example, if no parameters have been assigned to bytes 6 and 7, the data length of transmit PDO2 will be 6 bytes.

Example: Assignment of 3 parameters: Last detected fault occurred "LFT" (16#2029/16), Current in the motor "LCR" (16#2002/05) and Motor power "OPR" (16#2002/0C). This produces the following user assignment:

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
640 (16#280) +Node-ID	Last detected fault occurred "LFT"		Current in the motor "LCR"		Motor power "OPR"	
	LSB	MSB	LSB	MSB	LSB	MSB

Consider an Altivar located at CANopen address 4 (COB-ID = 16#280 + 4) and in the following state:

- The last detected fault occurred "LFT" is "nOF"/no detected fault stored (16#0000).
- The current in the motor "LCR" is equal to 4.0 A (16#0028).
- The motor power "OPR" is equal to 50% (16#0032).

The corresponding telegram sent for this transmit PDO is therefore as follows (8 data bytes):

16#284	16#00	16#00	16#28	16#00	16#32	16#00
--------	-------	-------	-------	-------	-------	-------

- Receive RPDO2

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
768 (16#300) +Node-ID	Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)		Altivar variable (by default: no parameter)	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

PDO3

This PDO set is reserved for the Altivar 32 programmable card and must only be used on a drive equipped with this card.

Set PDO3 on the Altivar is disabled by default (bit 31 of PDO COB-ID entry = 1).

To enable it, use the SDO service in write mode to set bit 31 of the “PDO COB-ID entry” parameter in transmit PDO3 (16#1802/01) and/or receive PDO3 (16#1402/01) to zero.

Unlike set PDO2, it is also possible to modify bits 0 to 6 of the COB-IDs in set PDO3 in order to authorize slave-to-slave communication.

Unlike the assignment of PDO1 and PDO2 objects, the assignment of PDO3 objects cannot be modified.

- Transmit TPDO3

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
896 (16#380) +Node-ID	Output word of the NM1 Communication scanner		Output word of the NM2 Communication scanner		Output word of the NM3 Communication scanner		Output word of the NM4 Communication scanner	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

- Receive RPDO3

Master ⇄ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
1024 (16#400) +Node-ID	Input word of the NC1 Communication scanner		Input word of the NC2 Communication scanner		Input word of the NC3 Communication scanner		Input word of the NC4 Communication scanner	
	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB

SDO Service

Request: Master ⇒ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
1536 (16#600) +Node-ID	Request code	Object index		Object subindex	Request data			
		LSB	MSB		Bits 7-0	Bits 15-8	Bits 23-16	Bits 31-24

Response: Master ⇐ Drive

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
1408 (16#580) +Node-ID	Response code	Object index		Object subindex	Request data			
		LSB	MSB		Bits 7-0	Bits 15-8	Bits 23-16	Bits 31-24

The content of the “request data” and “response data” will vary depending on the “request code” and the “response code”. The two tables below indicate the various possible scenarios:

Request code	Description of the command	Byte 4	Byte 5	Byte 6	Byte 7
16#23	Write data 4 bytes in length (e.g., UNSIGNED 32)	Bits 7-0	Bits 15-8	Bits 23-16	Bits 31-24
16#2B	Write data 2 bytes in length (e.g., UNSIGNED 16)	Bits 7-0	Bits 15-8	16#00	16#00
16#2F	Write data 1 byte in length (e.g., UNSIGNED 8)	Bits 7-0	16#00	16#00	16#00
16#40	Read data 1/2/4 bytes in length	16#00	16#00	16#00	16#00
16#80	Cancel current SDO command (1)	16#00	16#00	16#00	16#00

Response code	Description of the response	Byte 4	Byte 5	Byte 6	Byte 7
16#43	Read data: 4 bytes of data: response ⁽¹⁾	Bits 7-0	Bits 15-8	Bits 23-16	Bits 31-24
16#4B	Read data: 2 bytes of data: response ⁽¹⁾	Bits 7-0	Bits 15-8	16#00	16#00
16#4F	Read data: 1 byte of data: response ⁽¹⁾	Bits 7-0	16#00	16#00	16#00
16#60	Write data 1/2/4 bytes in length: response	16#00	16#00	16#00	16#00
16#80	Detected error sending cancellation code ⁽²⁾	Bits 7-0	Bits 15-8	Bits 23-16	Bits 31-24

(1) To use an SDO service reserved for reading multi-byte data, such as “manufacturer name” (parameter 16#1008: 16#00), *segmented transfer* is triggered between the master and the drive.

The “request code” 16#80 is used to stop this type of transfer.

(2) The response data (bytes 4 to 7) correspond to a 32-bit “cancellation code” (a complete list of all cancellation codes supported by the Altivar appears in the table on the next page).

NOTE: Segmented transfer can only be used for items of data larger than 4 bytes. It is only used for “Device name” (object 16#1008) in conjunction with the Altivar.

Object Dictionary

11

What's in this Chapter?

This chapter contains the following topics:

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Introduction

The description object dictionary is made of separate chapters:

- Communication profile area
- RPDO
- TPDO
- Manufacturer specific
- Application profile (CiA402)

Index	Object
16#0000	Unused
16#0001 - 16#001F	Static data types
16#0020 - 16#003F	Complex data types
16#0040 - 16#005F	Unused (Manufacturer specific complex data types)
16#0060 - 16#007F	Device profile specific static data types
16#0080 - 16#009F	Device profile specific complex data types
16#00A0 - 16#0FFF	Reserved for further use
16#1000 - 16#1FFF	Communication profile area
16#2000 - 16#5FFF	ATV32 specific profile area
16#6000 - 16#9FFF	Standardised device profile area
16#A000 - 16#FFFF	Reserved for further use

Communication Profile Area

Index	Sub-Index	Access	Type	Default value	Description
16#1000	16#00	R/O	unsigned32	16#00410192	Device type: Bits 16-23 = Device type mode Bits 00-15 = Device profile number (402)
16#1001	16#00	R/O	unsigned8	16#00	Detected error register: detected error (1) or no detected error (0)
16#1003	16#00	R/O	unsigned32	16#00000005	Number of detected errors: No detected error (0) or one or more detected errors (>0) in object 16#1003; only the value 0 can be written
	16#01	R/O	unsigned32	16#00000000	Standard detected error Field: Bits 16-31 = Additional information (all 0s) Bits 00-15 = detected error code (Errd)
16#1005	16#00	R/W	unsigned32	16#00000080	COB ID SYNC MESSAGE
16#1008	16#00	R/O	visible string	ATV32XXX	Device name
16#100C	16#00	R/W	unsigned16	16#0000	Guard Time: By default, the Node Guarding Protocol is inhibited; the unit of this object is 1 ms.
16#100D	16#00	R/W	unsigned16	16#0000	Life Time Factor: Multiplier applied to the "Guard Time" in order to obtain a "Life Time"
16#1010	16#00	R/O	unsigned32	16#0002	Store parameters: Number of entries
	16#01	R/W	unsigned32	16#0000	Store parameters: Save All parameters
	16#02	R/W	unsigned32	16#0000	Store parameters: Save Communication parameters
16#1011	16#00	R/O	unsigned8	16#0002	Restore default parameters: Number of entries
	16#01	R/W	unsigned32	16#0000	Restore default parameters: Restore All parameters
	16#02	R/W	unsigned32	16#0000	Restore default parameters: Restore COM parameters
16#1014	16#00	R/O	unsigned32	16#00000080 + Node ID	COB-ID Emergency message: COB-ID used for the EMCY service
16#1016	16#00	R/O	unsigned8	16#01	Consumer Heartbeat Time - Number of entries
	16#01	R/W	unsigned32	16#00000000	Consumer Heartbeat Time: Bits 16-23 = Node-ID of the producer Bits 00-15 = Heartbeat time (unit = 1 ms)
16#1017	16#00	R/W	unsigned32	16#00000000	Producer Heartbeat time

SDO Server Parameter

Index	Sub-index	Access	Type	Default value	Description
16#1200	16#00	R/O	Unsigned8	16#02	Server SDO - Number of entries
	16#01	R/O	Unsigned32	16#00000600 + Node ID	Server SDO - COB-ID Client ⇨ Drive (receive)
	16#02	R/O	Unsigned32	16#00000580 + Node ID	Server SDO - COB-ID Client ⇐ Drive (transmit)

Receive PDOs

Index	Sub-Index	Access	Type	Default value	Description
16#1400	16#00	R/O	unsigned8	16#02	Receive PDO1 - Number of entries
	16#01	R/W	unsigned32	16#00000200 + Node ID	Receive PDO1 - COB-ID
	16#02	R/W	unsigned32	16#000000FF	Receive PDO1 - Transmission type: Default value: event driven
16#1401	16#00	R/O	unsigned8	16#02	Receive PDO2 - Number of entries
	16#01	R/W	unsigned32	16#80000300 + Node ID	Receive PDO2 - COB-ID
	16#02	R/W	unsigned32	16#FF	Receive PDO2 - Transmission type: Default value: event driven
16#1402	16#00	R/O	unsigned8	16#02	Receive PDO3 - Number of entries
	16#01	R/W	unsigned32	16#80000400 + Node ID	Receive PDO3 - COB-ID
	16#02	R/W	unsigned8	16#FF	Receive PDO3 - Transmission type: Default value: event driven

Receive PDO1, PDO2, and PDO3 Mapping

Index	Sub-Index	Access	Type	Default value	Description
16#1600	16#00	R/W	unsigned8	16#02	Receive PDO1 mapping - Number of mapped objects: 0 to 4 objects can be mapped for this PDO
	16#01	R/W	unsigned32	16#60400010	Receive PDO1 mapping - 1st mapped object: Control word "CMDD" (16#6040)
	16#02	R/W	unsigned32	16#60420010	Receive PDO1 mapping - 2nd mapped object: Velocity reference "LFRD" (16#6042)
	16#03	R/W	unsigned32	16#00000000	Receive PDO1 mapping: No 3rd mapped object
	16#04	R/W	unsigned32	16#00000000	Receive PDO1 mapping: No 4th mapped object
16#1601	16#00	R/W	unsigned8	16#00	Receive PDO2 mapping - Number of mapped objects: 0 to 4 objects can be mapped for this PDO
	16#01	R/W	unsigned32	16#00000000	Receive PDO2 mapping -: No 1st mapped object
	16#02	R/W	unsigned32	16#00000000	Receive PDO2 mapping -: No 2nd mapped object
	16#03	R/W	unsigned32	16#00000000	Receive PDO2 mapping: No 3rd mapped object
	16#04	R/W	unsigned32	16#00000000	Receive PDO2 mapping: No 4th mapped object
16#1602	16#00	R0	unsigned8	16#04	Receive PDO3 mapping - Number of mapped objects: 0 to 4 objects can be mapped for this PDO
	16#01	R0	unsigned32	16#20613E10	Receive PDO3 mapping - 1st mapped object - NC1 (Comm. Scanner 1st data)
	16#02	R0	unsigned32	16#20613F10	Receive PDO3 mapping - 2nd mapped object: NC2 (Comm. Scanner 2nd data)
	16#03	R0	unsigned32	16#20614010	Receive PDO3 mapping - 3rd mapped object: NC3 (Comm. Scanner 3rd data)
	16#04	R0	unsigned32	16#20614110	Receive PDO3 mapping - 4th mapped object: NC4 (Comm. Scanner 4th data)

Transmit PDO

Index	Sub-Index	Access	Type	Default value	Description
16#1800	16#00	R/O	unsigned8	16#05	Transmit PDO1 - Number of entries
	16#01	R/W	unsigned32	16#00000180 + Node ID	Transmit PDO1 - COB-ID
	16#02	R/W	unsigned8	16#FF	Transmit PDO1 - - Transmission type: Three modes are available for this PDO: "asynchronous" (255), "synchronously cyclic" (1-240), and "synchronously acyclic" (0)
	16#03	R/W	unsigned16	300	Transmit PDO1 - Inhibit time: Minimum time between two transmissions; unit = 100µs
	16#04	R/W	unsigned8	-	Transmit PDO1 - Reserved
	16#05	R/W	unsigned16	1000	Transmit PDO1 - Event timer: In "asynchronous" mode, this object sets a minimum rate of transmission for this PDO; unit = 1 ms
16#1801	16#00	R/O	unsigned8	16#05	Transmit PDO2 - Number of entries
	16#01	R/W	unsigned32	16#80000280 + Node ID	Transmit PDO2 - COB-ID
	16#02	R/W	unsigned8	16#FF	Transmit PDO2 - - Transmission type: Three modes are available for this PDO: "asynchronous" (255), "synchronously cyclic" (1-240), and "synchronously acyclic" (0)
	16#03	R/W	unsigned16	300	Transmit PDO2 - Inhibit time: Minimum time between two transmissions; unit = 100µs
	16#04	R/W	unsigned8	-	Transmit PDO2 - Reserved
	16#05	R/W	unsigned16	1000	Transmit PDO2 - Event timer: In "asynchronous" mode, this object sets a minimum rate of transmission for this PDO; unit = 1 ms
16#1802	16#00	R/O	unsigned8	16#05	Transmit PDO3 - Number of entries
	16#01	R/W	unsigned32	16#80000380 + Node ID	Transmit PDO3 - COB-ID
	16#02	R/W	unsigned8	16#FF	Transmit PDO3 - Transmission type: Three modes are available for this PDO: "asynchronous" (255), "synchronously cyclic" (1-240), and "synchronously acyclic" (0)
	16#03	R/W	unsigned16	30	Transmit PDO3 - Inhibit time: Minimum time between two transmissions; unit = 1 ms
	16#04	R/W	unsigned8	-	Transmit PDO3 - Reserved
	16#05	R/W	unsigned16	1000	Transmit PDO3 - Event timer: In "asynchronous" mode, this object sets a minimum rate of transmission for this PDO; unit = 1 ms

Transmit PDO1, PDO2 and PDO3 Mapping

Index	Sub-Index	Access	Type	Default value	Description
16#1A00	16#00	R/W	unsigned8	16#02	Transmit PDO1 mapping - Number of mapped objects.
	16#01	R/W	unsigned32	16#60410010	Transmit PDO1 mapping - 1st mapped object: Status word "ETA" (16#6041)
	16#02	R/W	unsigned32	16#60440010	Transmit PDO1 mapping - 2nd mapped object: Output speed "RFRD" (16#6044/00) default value
	16#03	R/W	unsigned32	16#00000000	Not mapped
	16#04	R/W	unsigned32	16#00000000	Not mapped
16#1A01	16#00	R/W	unsigned8	16#00	Transmit PDO2 mapping - Number of mapped objects
	16#01	R/W	unsigned32	16#00000000	Not mapped
	16#02	R/W	unsigned32	16#00000000	Not mapped
	16#03	R/W	unsigned32	16#00000000	Not mapped
	16#04	R/W	unsigned32	16#00000000	Not mapped
16#1A02	16#00	R/O	unsigned8	16#04	Transmit PDO3 mapping - Number of mapped objects
	16#01	R/O	unsigned32	16#20612A10	Transmit PDO3 mapping - 1st mapped object: NM1 - Comm. Scanner 1st data
	16#02	R/O	unsigned32	16#20612B10	Transmit PDO3 mapping - 2nd mapped object: NM2 - Comm. Scanner 2nd data
	16#03	R/O	unsigned32	16#20612C10	Transmit PDO3 mapping - 3rd mapped object: NM3 - Comm. Scanner 3rd data
	16#04	R/O	unsigned32	16#20612D10	Transmit PDO3 mapping - 4th mapped object: NM4 - Comm. Scanner 4th data

Manufacturer Specific Area

The ATV32 parameters are based and documented with their Modbus address, however the pending CANopen address of these parameters can be easily retrieved with the formula described below, and vice-versa.

NOTE: In the communication parameters excel sheet you will find also both addresses (Modbus and CANopen).

- Modbus internal address to CANopen
- CANopen object number = Modbus address

Application Profile Area

These area contains standardized parameters in conformance with CiA402 velocity mode.

Index	Description	
16#603F	Detected error code	
16#6040	Control Word	
16#6041	Status Word	
16#6042	Target velocity	
16#6043	Velocity demand	
16#6044	Control Effort	
16#6046	01	Velocity min. amount
	02	Velocity max amount
16#6048	Velocity acceleration	
	01	Delta speed
	02	Delta time
16#6049	Velocity deceleration	
	01	Delta speed
	02	Delta time
16#604b	Set Point factor	
	01	Set Point factor numerator
	02	Set Point factor denominator
16#605A	Quick stop option code	
16#605C	Disable option code	
16#6060	Modes of operation	
16#6061	Modes of operation Display	
16#6077	Torque actual value	
16#6502	Supported drive modes	

Abbreviations

12

Abbreviation	Definition
CAN	Controller Area Network is an internally standardized serial bus system
COB	Communication Object. A unit of transportation in a CAN network. Data must be sent across a CAN Network inside a COB. There are 2048 different COB's in a CAN network. A COB can contain at most 8 bytes of data
COB-ID	Each COB is uniquely identified in a CAN network by a number called the COB Identifier (COB-ID). The COB-ID determines the priority of that COB for the MAC sub-layer
COF	CANopen Detected Fault
CRC	Cyclic Redundancy Check
CS	Command Specifier
LLC	Logical Link Control. One of the sub-layers of the Data Link Layer in the CAN Reference Model that gives the user an interface that is independent from the underlying MAC layer
LSB	Least Significant Byte
MAC	Medium Access Control. One of the sub-layers of the Data Link Layer in the CAN Reference Model that controls who gets access to the medium to send a message
MSB	Most Significant Byte
NMT	Network Management. One of the service elements of the application layer in the CAN Reference Model. The NMT serves to configure, initialise, and handle detected errors in a CAN network
OSI	Open Systems Interconnection
PDO	Process Data Object
Remote COB	A COB whose transmission can be requested by another device
RPDO	Receive PDO
RTR	Remote Transmit Requests
SDO	Service Data Object
SYNC	Synchronisation Object
TPDO	Transmit PDO
ERCO	Error Code

