

# Altivar 32

Variable speed drives  
for synchronous and asynchronous motors

## EtherCAT<sup>®</sup> Communication Manual VW3A3601

09/2012



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When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

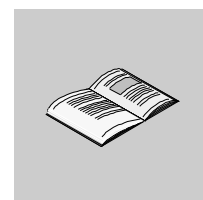
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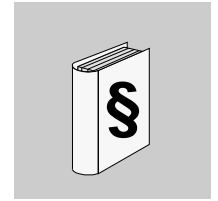


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## Safety Information



### 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 messages 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

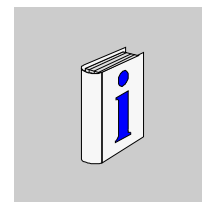
The word "drive" as used in this manual refers to the controller portion of the adjustable speed drive as defined by NEC.

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 product.

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## About the Book



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### Document Scope

The purpose of this document is to:

- show you how to install the EtherCAT module on your Altivar 32,
- show you how to configure the Altivar 32 to use EtherCAT fieldbus.

**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 EtherCAT 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 CANopen manual	S1A28699
ATV32 Communication Parameters	S1A44568
ATV32 Atex manual	S1A45605
ATV32 Safety integrated functions manual	S1A45606
ATV32 certificates and other option manuals: see <a href="http://www.schneider-electric.com">www.schneider-electric.com</a>	

You can download the latest versions of these technical publications and other technical information from [www.schneider-electric.com](http://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.**

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."





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# ATV32 EtherCAT Overview



# 1

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## What's in this Chapter?

This chapter contains the following topics:

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Overview	10
Software and protocols supported	11
Communication and Services	12
Notation rules in this manual	13

## Overview

The VW3 A3 601 communication card enables the integration of an Altivar 32 variable speed drive into an EtherCAT network.



## Software and protocols supported

### ATV32 compatibility

Note: The VW3 A3 601 EtherCAT card is compliant with ATV32 minimum version V1.3

### ATV32 Profile with EtherCAT®

EtherCAT® is a registered trademark and patented technology licenced by Beckhoff Automation GmbH, Germany. The ATV32 supports CANopen CiA®402 V3 drive profile, using CoE (CANopen Over EtherCAT).

### BECKHOFF® software

The ATV32 communication card is compliant with BECKHOFF software TwinCAT® V2.x with CodeSys V2.

### Further reading

Recommended literature for further reading  
EtherCAT Technology Group (ETG), see [www.ethercat.org](http://www.ethercat.org)

## Communication and Services

### Cyclical Communication: PDO

- PDO is intended for use with the communication scanner according to CiA402.
- PDO provides scan cycle optimization which allows short reaction time application (< 5 ms). See [Optimizing the Response Time](#), page 48.
- PDO overview

CMD	LFRD	OCA3	OCA4	OCA5	OCA6	= RPDO
ETA	RFRD	OMA3	OMA4	OMA5	OMA6	= TPDO

The configuration means are:

- EtherCAT configuration tool, then the configuration is downloaded by the master,
- SoMove or SoMachine: DTM ATV32.

### Acyclic Services: SDO

The ATV32 manages a SDO server (Service Data Object). SDO telegrams are used for configuration and adjustment, they are 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)

### Other Supported Services

Assignment by default of address-based identifiers.

- EtherCAT state machine commands
- Emergency (EMCY)

### ESI file (EtherCAT Slave Information)

Download the ESI file in XML format for the ATV32 on [www.schneider-electric.com](http://www.schneider-electric.com).

## Notation rules in this manual

### Drive Terminal Displays

The graphic display terminal (to be ordered separately - reference VW3 A1 101) menus are shown in square brackets.

Example: **[COMMUNICATION]**

The integrated 7-segment display terminal menus are shown in round brackets.

Example: **(L D Π-)**

Parameter names are displayed on the graphic display terminal in square brackets.

Example: **[Fallback speed]**

Parameter codes are displayed on the integrated 7-segment display terminal in round brackets.

Example: **(L F F)**

### Formats

In this manual, hexadecimal values are written as follows: 16#



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# Hardware Setup



# 2

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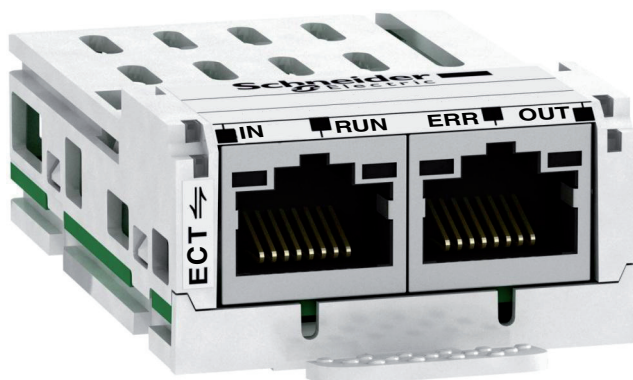
## What's in this Chapter?

This chapter contains the following topics:

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## Hardware presentation

The following figure shows the dual RJ45 connector, EtherCAT module:



### EtherCAT 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

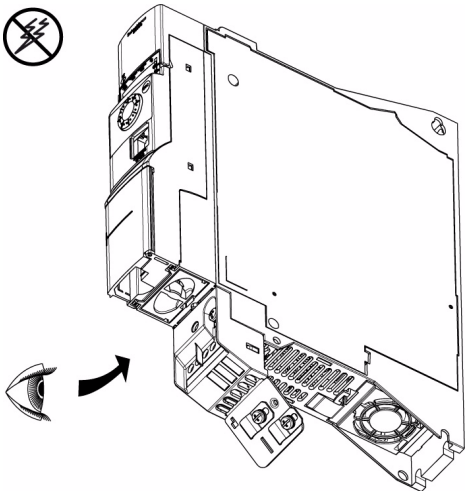
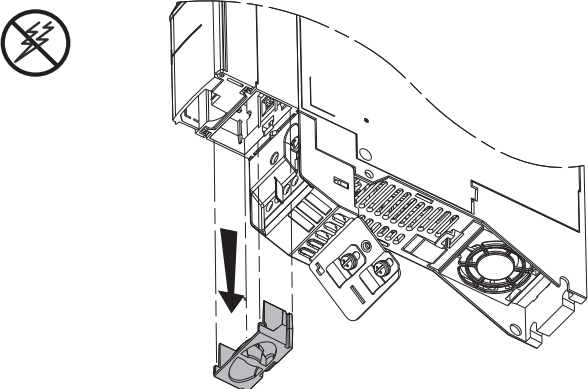
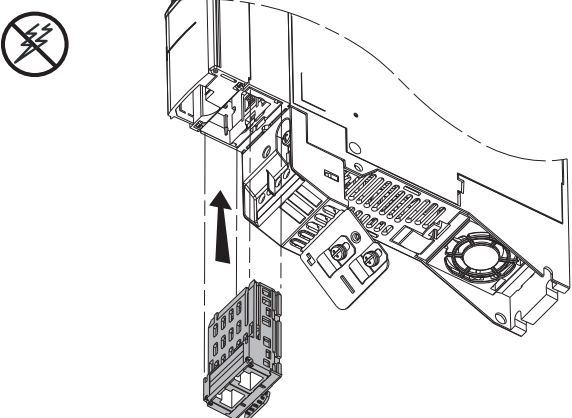
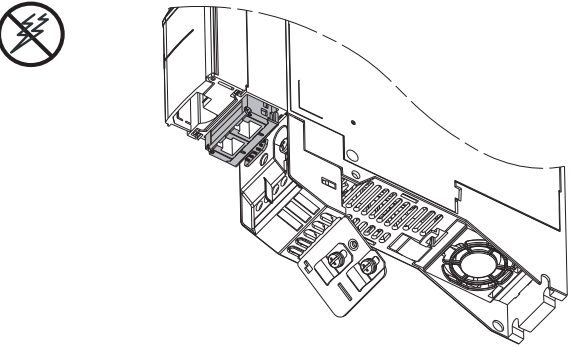
Read and understand the precautions in the About the book section before performing the procedure in this section.

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


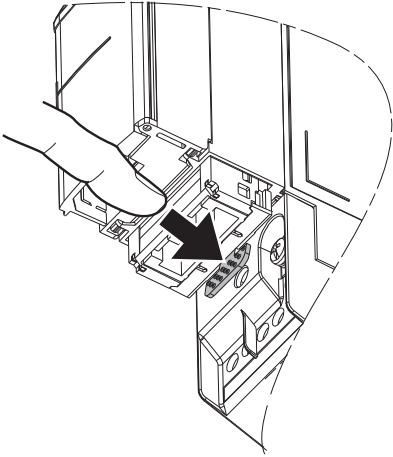

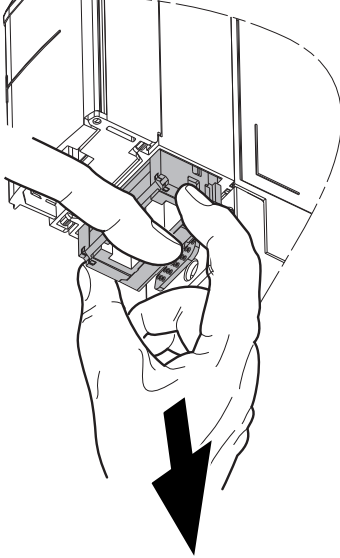
**NOTE:** The CANopen signals on the base port are deactivated if an option card is plugged in the drive.



Install the communication module in ATV32 as follows:

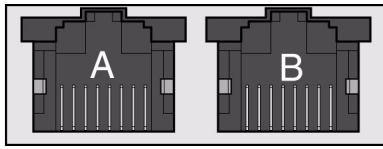
Step	Action	Comment
1	Ensure that the power is off. Locate the option card port on the bottom of the ATV32.	
2	Extract the cover.	
3	Insert the module	
4	Check that the module is correctly inserted and locked mechanically in the drive.	

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,	 

## Wiring

The VW3 A3 601 option card is equipped with 2 RJ45 female sockets for the Ethernet connection.



Port	Fieldbus
A	EtherCAT IN
B	EtherCAT OUT

8 7 6 5 4 3 2 1 8 7 6 5 4 3 2 1

### Cable specifications

- Minimum Cat 5e,
- Use equipotential bonding conductors,
- Connector RJ45, no crossover cable
- Shield: both ends grounded
- Twisted pair cable
- Cable : 8 x 0.25 mm<sup>2</sup> (8 x AWG 22)
- Use pre-assembled cables to reduce the wiring mistakes,
- Verify that wiring, cables and connected interfaces meet the PELV requirements.
- Maximum cable length between devices = 100 m (328 ft)

The following table describes the pin out of each RJ45:

Pin	Signal	Meaning
1	Tx+	Ethernet transmit line +
2	Tx-	Ethernet transmit line -
3	Rx+	Ethernet receive line +
4	-	-
5	-	-
6	Rx-	Ethernet receive line -
7	-	-
8	-	-



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# Configuration



# 3

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## What's in this Chapter?

This chapter contains the following topics:

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Configuring the Communication Parameters	22
Configuring Monitor Parameters	26
Configuring Communication Interruption Management	27

## ESI file (EtherCAT Slave Information)

Download the ESI file in XML format for the ATV32 on [www.schneider-electric.com](http://www.schneider-electric.com).

The ESI file must be integrated into the system of the master controller.

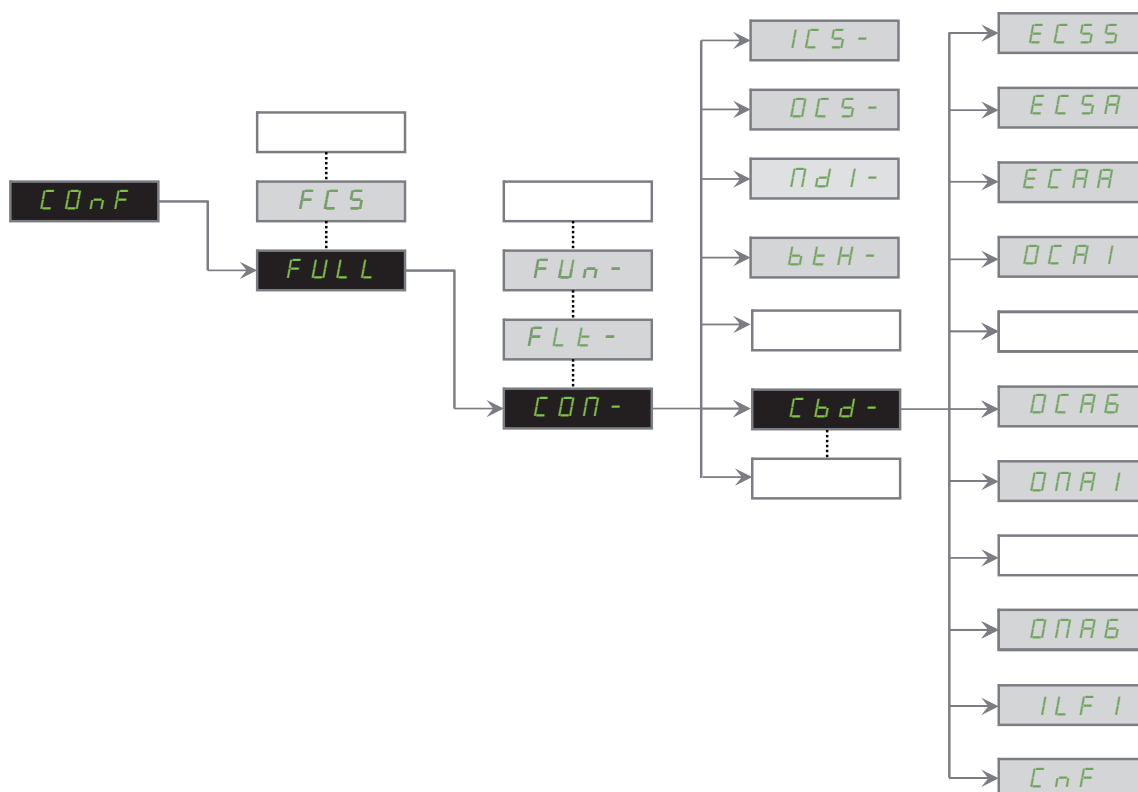
## Configuring the Communication Parameters

The parameters described are accessible with the ATV32 Integrated display terminal, the Graphic display terminal option or with SoMove software. The parameters are visible only if an EtherCAT card is plugged in the drive

The configuration of the EtherCAT communication functions on the Altivar 32 is reachable with the drive menu;

[CONFIGURATION] (C D n F) --> [FULL] (F U L L) --> [COMMUNICATION] (C D n -) --> [COMMUNICATION CARD] (C b d -).

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



Communication Parameters

Parameter description	Range or listed values (1)	Default value	Access	Parameter address
<b>[EthCat slave status]</b> (E C 5 5) EtherCAT slave status.	1: <b>[Init]</b> ( I n I t ) Initialization 2: <b>[PreOp]</b> ( P r O p ) Pre-operational 3: <b>[Boot]</b> ( b O O t ) Bootstrap 4: <b>[SafeOp]</b> ( S F O p ) Safe operational In <b>[SafeOp]</b> mode, inputs are updated in PDOs, outputs are not valid. 8: <b>[Op]</b> ( O p ) Operational In <b>[Op]</b> mode, inputs and outputs are valid		R	6690
<b>[EthCat 2nd addr]</b> (E C 5 A) EtherCAT 2 <sup>nd</sup> address	0 to 65535 Address changeable from drive or from master via the 2 <sup>nd</sup> address dialog.	0	R/W	6691 UINT
<b>[EthCat addr]</b> (E C A A) EtherCAT Actual Address Changed settings become active immediately.	0 to 65535	0	R	6692 UINT
<b>[Scan.Out1 address]</b> (O C A 1)	0 to 65535	RPDO	8501 <b>[CMD]</b>	15421 UINT
<b>[Scan.Out2 address]</b> (O C A 2)	0 to 65535		8602 <b>[LFRD]</b>	15422 UINT
<b>[Scan.Out3 address]</b> (O C A 3)	0 to 65535		0	15423 UINT
<b>[Scan.Out4 address]</b> (O C A 4)	0 to 65535		0	15424 UINT
<b>[Scan.Out5 address]</b> (O C A 5)	0 to 65535		0	15425 UINT
<b>[Scan.Out6 address]</b> (O C A 6)	0 to 65535		0	15426 UINT
<b>[Scan. IN1 address]</b> (O P A 1)	0 to 65535	TPDO	3201 <b>[ETA]</b>	15401 UINT
<b>[Scan. IN2 address]</b> (O P A 2)	0 to 65535		8604 <b>[RFRD]</b>	15402 UINT
<b>[Scan. IN3 address]</b> (O P A 3)	0 to 65535		0	15403 UINT
<b>[Scan. IN4 address]</b> (O P A 4)	0 to 65535		0	15404 UINT
<b>[Scan. IN5 address]</b> (O P A 5)	0 to 65535		0	15405 UINT
<b>[Scan. IN6 address]</b> (O P A 6)	0 to 65535		0	15406 UINT
<b>[Internal link fault 1]</b> ( I L F 1) EtherCAT card 1 ILF detected fault	0 to 65535 see the fault codes with ILF page <a href="#">45</a>	0	R	7134 UINT
<b>[Network fault]</b> ( C n F) Network detected faults	0 to 65535 see the fault codes with (C n F) page <a href="#">45</a>	0	R	7132 UINT

## Configuring the Control Channels

This chapter explains through 2 examples how to configure the drive for operation from communication network:

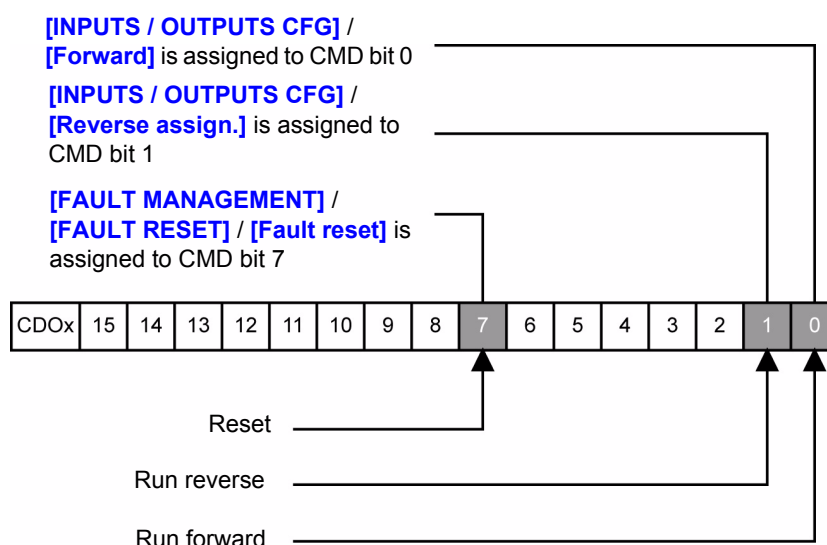
- I/O Mode - a simple command Word (based on Forward, reverse and reset binary commands).
- Combined Mode (with native profile CiA402) - Both reference and command word come from the communication network.

### PDOs Configuration

See Detailed Description of Services on page 69.

### Configuration of the Drive for Operation in I/O Profile

To illustrate the I/O Profile, we will describe a quick 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 in the Command Menu **[Command] (C E L -)**:

Menu	Parameter	Value
<i>d r l - &gt; C D n F &gt; F U L L &gt; C E L -</i>	<b>[Ref.1 channel] (F r l)</b>	<b>[Com. card] (n E E)</b>
	<b>[RV Inhibition] (r l n)</b>	Default
	<b>[Stop Key priority] (P S E)</b>	Default
	<b>[Profile] (C H C F)</b>	<b>[I/O profile] ( I D)</b>
	<b>[Cmd switching] (C C S)</b>	Default
	<b>[Cmd channel 1] (C d l)</b>	<b>[Com. card] (n E E)</b>

The bits of the command word must now be configured.

In the **[INPUTS / OUTPUTS CFG] ( I \_ D -)** Menu, configure:

Menu	Parameter	Value
<i>d r l - &gt; C D n F &gt; F U L L &gt; I _ D -</i>	<b>[Forward] (F r d)</b>	<b>[Cd00] (C d 0 0)</b>
	<b>[Reverse assign.] (r r S)</b>	<b>[Cd01] (C d 0 1)</b>

In the **[FAULT MANAGEMENT] (F L E -)** menu, **[FAULT RESET] (r S E -)** submenu, configure:

Menu	Parameter	Value
<i>d r l - &gt; C D n F &gt; F U L L &gt; F L E - &gt; r S E -</i>	<b>[Fault reset] (r S F)</b>	<b>[Cd07] (C d 0 7)</b>



### 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]** (**CEL -**):

Menu	Parameter	Value
<b>dr I - &gt; [DnF] &gt; FULL &gt; CEL -</b>	<b>[Ref.1 channel]</b> ( <b>F r I</b> )	<b>[Com. card]</b> ( <b>n E t</b> )
	<b>[Profile]</b> ( <b>E H C F</b> )	<b>[Not separ.]</b> ( <b>5 I n</b> ) CiA402 Combined mode, (factory setting)

## 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.]** --> **[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]** (**L C r**): logic address 3204, signed decimal format.
- Parameter 2 = **[Motor torque]** (**D E r**): logic address 3205, signed decimal format.
- Parameter 3 = **[Last fault occurred]** 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
<b>Code</b>		<b>Quick</b>	▼
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	<b>[Hex]</b>
Signed decimal	-32 767 ... 32 767	<b>[Signed]</b>
Unsigned decimal	0 ... 65 535	<b>[Unsigned]</b>

**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 and monitoring" on page 41).

## Configuring Communication Interruption Management

### ▲ WARNING

#### LOSS OF CONTROL

If Network fault management **[Network fault mgt]** (C L 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.**

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

With the graphic display terminal or the integrated display terminal, select the drive menu: **[Configuration]** (C o n F) -->, **[FULL]** (F U L L) -->, **[FAULT MANAGEMENT]** (F L E -) -->, **[COM. FAULT MANAGEMENT]** (C L L -), via the **[Network fault mgt]** (C L L) parameter.

RDY	nEt	+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 **[Network fault mgt]** (C L L) parameter, which trigger a drive detected fault **[Com. network]** (C n F), are:

Value	Meaning
<b>[Freewheel]</b> (Y E S)	Freewheel stop (factory setting)
<b>[Ramp stop]</b> (r n P)	Stop on ramp
<b>[Fast stop]</b> (F S E)	Fast stop
<b>[DC injection]</b> (d C I)	DC injection stop. This type of stop cannot be used with certain other functions. See the Programming manual.

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

Value	Meaning
<b>[Ignore]</b> (n D)	Detected fault ignored
<b>[Per STT]</b> (S E E)	Stop according to configuration of <b>[Type of stop]</b> (S E E), see the Programming manual for more details.
<b>[fallback speed]</b> (L F F)	Change to fallback speed, maintained as long as the detected fault persists and the run command has not been removed
<b>[Spd maint.]</b> (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.



---

# Example with TwinCAT®



# 4

---

## What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Example: Altivar 32 with TwinCAT® "PLC - Configuration"	30

## Example: Altivar 32 with TwinCAT® "PLC - Configuration"

### 1. Hardware

Connect your computer and the ATV32 EtherCAT option with a standard Cat 5e minimum cable (2 x RJ45, shielded twisted pair cable)

### 2. TwinCAT® software installation

Install the TwinCAT® software copyright BECKHOFF. Example realized with TwinCAT® software version 2.11.

**Note:** The screenshots or procedure in this example can change with a new TwinCAT® software version.

### 3. ESI file (EtherCAT Slave Information)

Download the ESI file in XML format for the ATV32 on [www.schneider-electric.com](http://www.schneider-electric.com).

The ESI file must be integrated into the system of the master controller.

Filename: Schneider\_Electric\_ATV32\_Vxxx.xml

Copy this XML file on your computer in C:\TwinCAT\Io\EtherCAT.

### 4. Altivar 32 configuration

Realize the configuration of the Drive for Operation With CiA402 Profile in Combined Mode, see page [25](#).

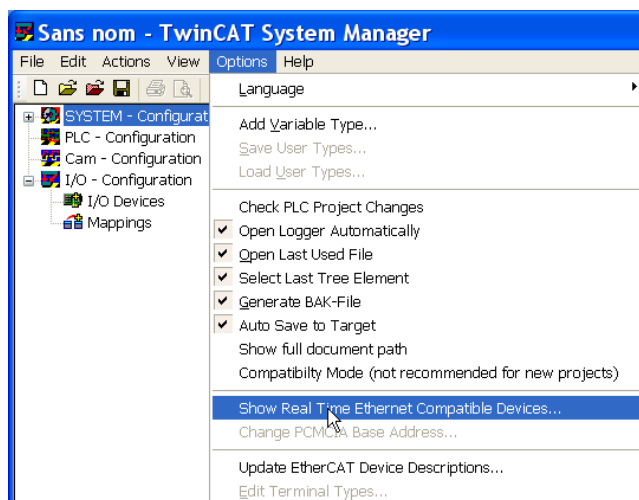
Set [Ref.1 channel] (*F r I*) to [Com. card] (*n E k*),

Set [Profile] (*C H C F*) to [Not separ.] (*S I N*) CiA402 Combined mode, (factory setting).

### 5. System Manager: Declare your computer on Ethernet network

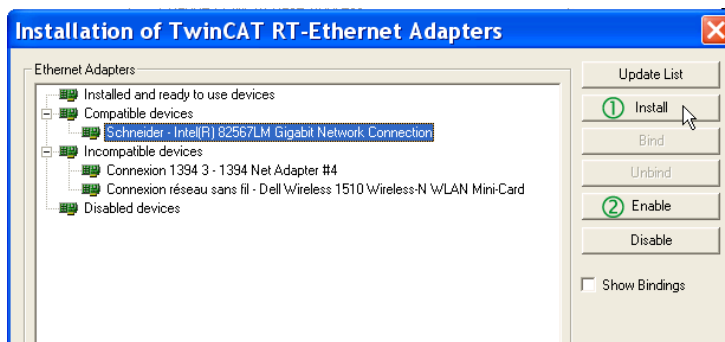
Start TwinCAT® system-manager®  TwinCAT System Manager

Select Option --> "Show Real Time Ethernet Compatible devices"



① Select your Computer Ethernet board, and "Install".

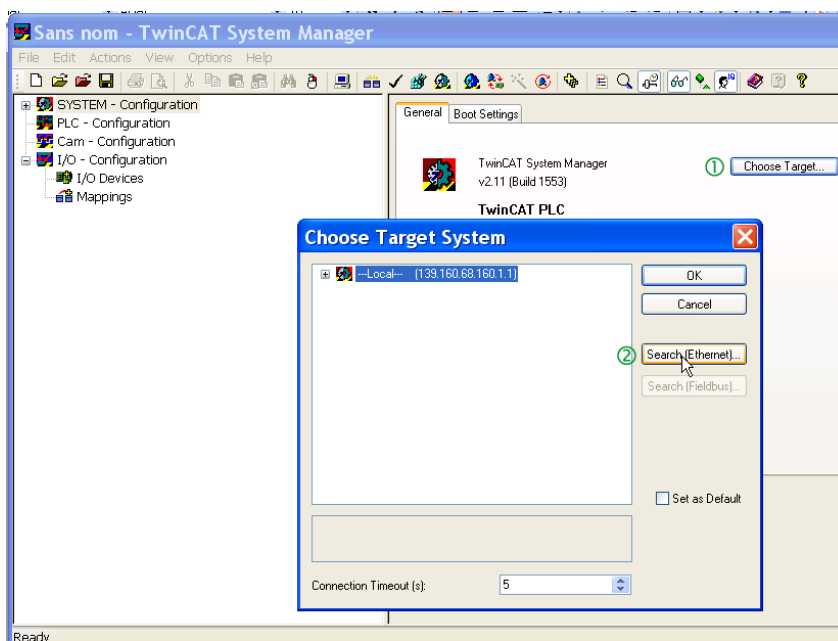
② Enable it.



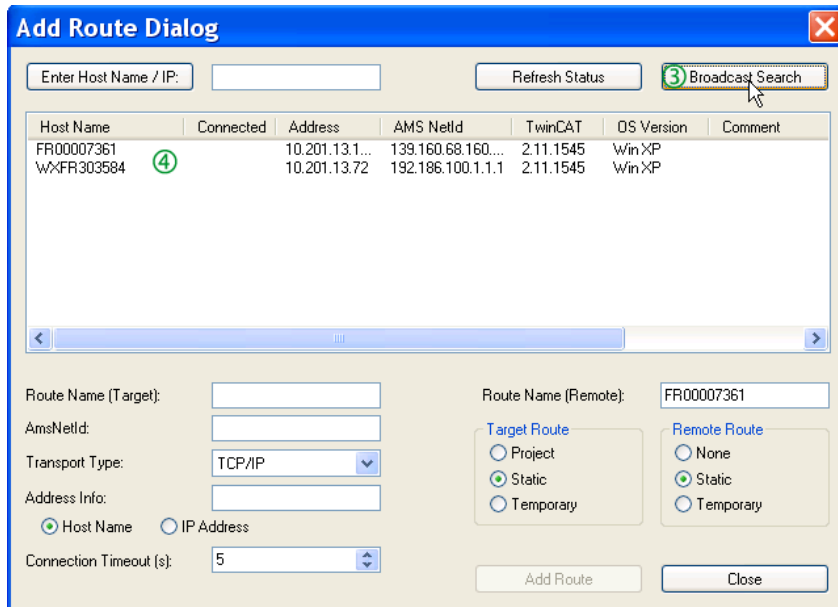
## 6. System Manager: Install the master

In this example we use the computer to run TwinCAT® and PLC runtime as Master.

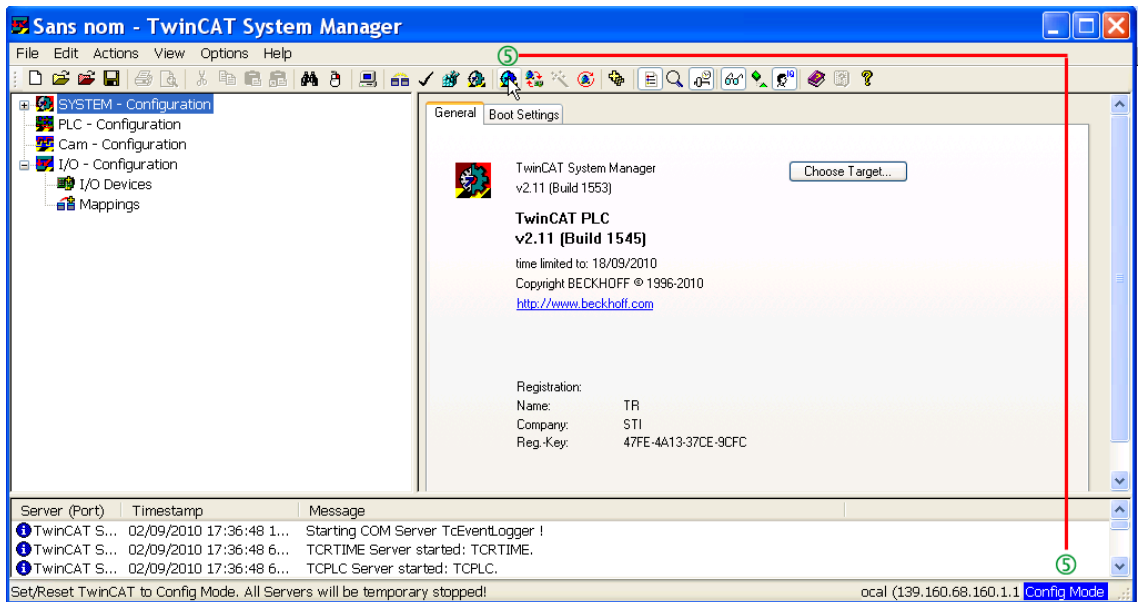
- ① Select “Choose Target”
- ② Select “Search (Ethernet)”



- ③ Start the “Broadcast Search”
- ④ Select your Master in the Host Name list (your computer in this example)



⑤ Check that you are in “config mode”





## 7. System Manager - Install the slave: Altivar 32 in "PLC – Configuration"

①

②

③

④

⑤

ATV32 created

⑥

## 8. PLC – Control: initialization

Start TwinCAT PLC control® software TwinCAT PLC Control

File -> new

**Choose Target System Type**

PC or CX (x86)     CX (ARM)

BC via AMS

BC serial

BCxx50 or BX via AMS

BCxx50 or BX via serial

**New POU**

Name of the new POU: MAIN

Type of POU:  Program

Language of the POU:  ST (Structured language)

IL

LD

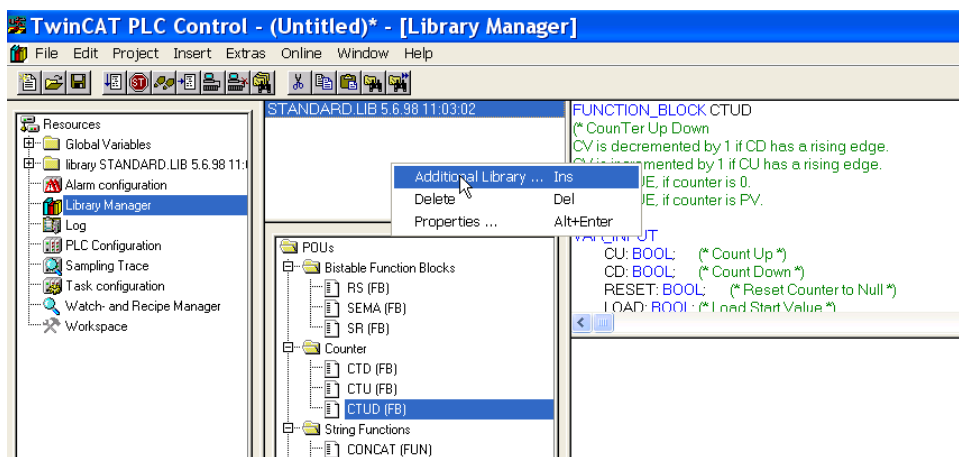
FBD

SFC

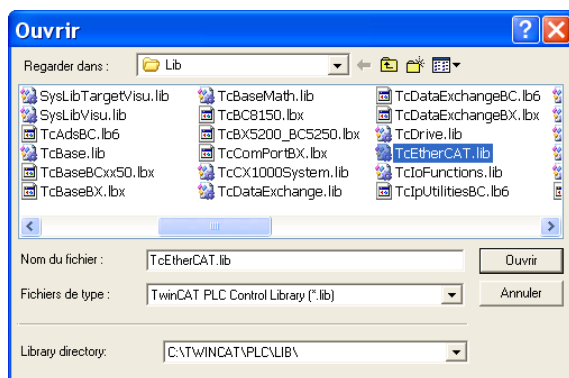
CFC

Select: Resources -> Library Manager

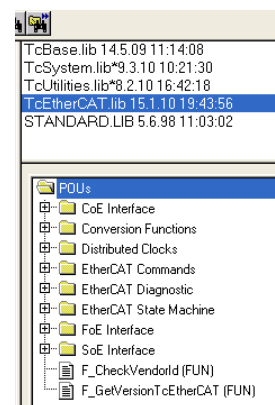
Add EtherCAT libraries



Add TcEtherCAT.lib

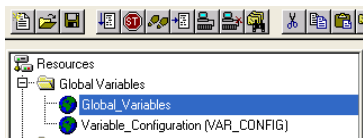


All EtherCAT libraries are added:



## 9. PLC - Control: Declare the variables

Select Global\_Variables



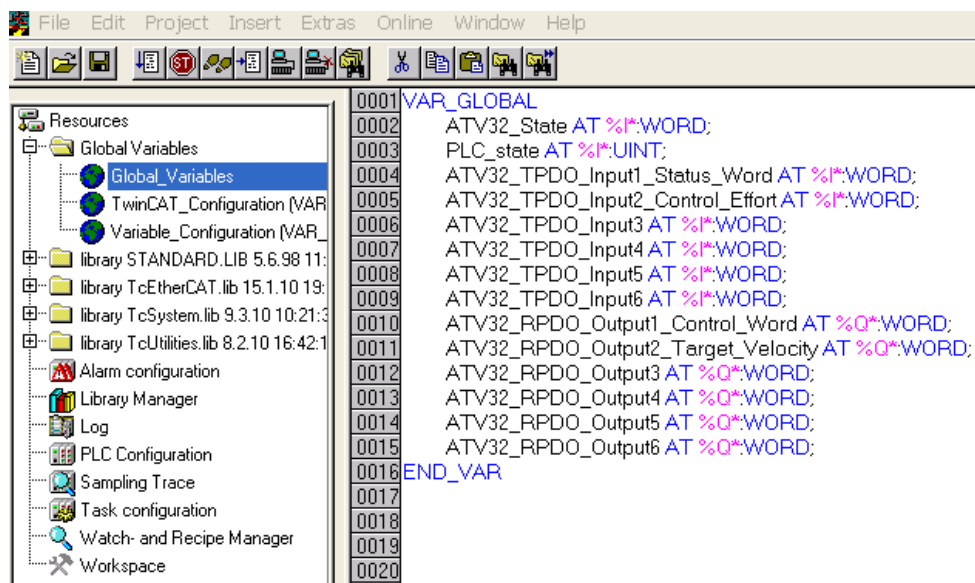
Create the Master Global\_Variables for ATV32 as below. Copy/paste the variables :

VAR\_GLOBAL

```

ATV32_State AT %I*:WORD;
PLC_state AT %I*:UINT;
ATV32_TPDO_Input1_Status_Word AT %I*:WORD;
ATV32_TPDO_Input2_Control_Effort AT %I*:WORD;
ATV32_TPDO_Input3 AT %I*:WORD;
ATV32_TPDO_Input4 AT %I*:WORD;
ATV32_TPDO_Input5 AT %I*:WORD;
ATV32_TPDO_Input6 AT %I*:WORD;
ATV32_RPDO_Output1_Control_Word AT %Q*:WORD;
ATV32_RPDO_Output2_Target_Velocity AT %Q*:WORD;
ATV32_RPDO_Output3 AT %Q*:WORD;
ATV32_RPDO_Output4 AT %Q*:WORD;
ATV32_RPDO_Output5 AT %Q*:WORD;
ATV32_RPDO_Output6 AT %Q*:WORD;
    
```

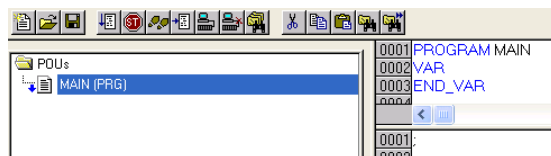
END\_VAR



Reminder:

- RPDO (Receive PDO), containing 6 input words of the communication scanner OCA1 to OCA6.
- TPDO (Transmit PDO), containing 6 output words of the communication scanner OMA1 to OMA6.

Add 1 instruction minimum in POU's before rebuild;

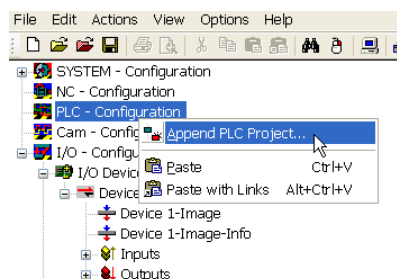


- Select: Project -> Rebuild All
- Check the compilation result without error.
- This action creates files in: C:\TwinCAT\Plc\  
As example, create: ATV32\_PLC.tpy

## 10. System Manager - Append PLC Project

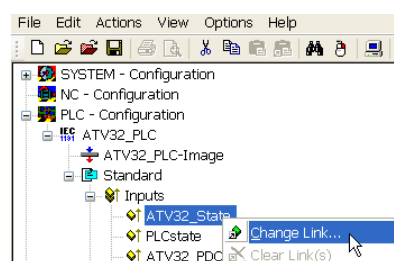
In System Manager software, realize the link between the Master and the slave. Creation of the links between "PLC - Configuration" and "I/O - Configuration"

Select "Append PLC Project...":

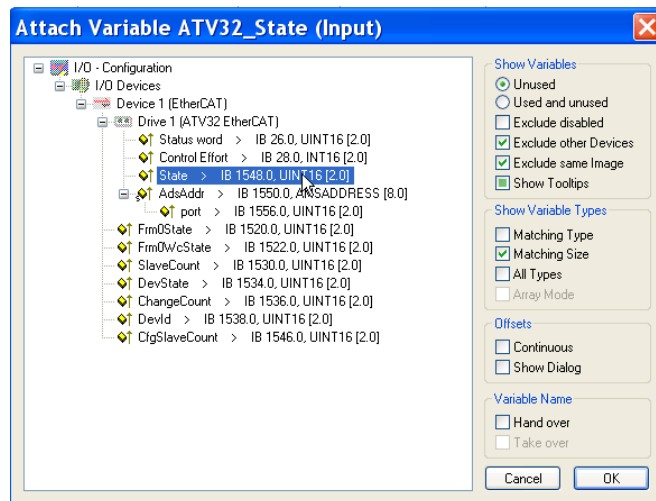


As example, select: C:\TwinCAT\Pic\ATV32\_PLC.tpy

For each parameter, create the link with the ATV32 I/O listing



Example for "ATV32\_State"



Links to create

PLC - Configuration		I/O - Configuration
Inputs	ATV32_State	State
Inputs	PLC_state	DevState (with Device1)
Inputs	ATV32_TPDO_Input1_Status_Word	Status word
Inputs	ATV32_TPDO_Input2_Control_Effort	Control effort
Inputs	ATV32_TPDO_Input3	Available for other parameter
Inputs	ATV32_TPDO_Input4	Available for other parameter
Inputs	ATV32_TPDO_Input5	Available for other parameter
Inputs	ATV32_TPDO_Input6	Available for other parameter
Outputs	ATV32_RPDO_Output1_Control_Word	Control word
Outputs	ATV32_RPDO_Output2_Target_Velocity	Target Velocity
Outputs	ATV32_RPDO_Output3	Available for other parameter
Outputs	ATV32_RPDO_Output4	Available for other parameter
Outputs	ATV32_RPDO_Output5	Available for other parameter
Outputs	ATV32_RPDO_Output6	Available for other parameter

**Note:** if more than 6 input or output parameters are created in TwinCAT® System Manager, the ATV32 will be blocked in "PreOp" state. The ATV32 has maximum 6 TPDO and 6 RPDO.

Select: Actions -> Generate Mappings.

**11. PLC - Control: new compilation**

Select: Project -> Rebuild All

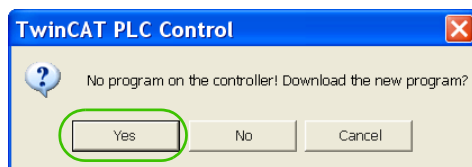
This action updates the information.

**12. System Manager: Activate configuration**

Select: Actions -> Activate Configurations

**13. PLC - Control : new compilation**

Select: Online -> login



Select : Online -> Run

The PLC and the EtherCAT fieldbus are now running

In TwinCAT® PLC Control, you see the list of the variables and values:

```

0001 ATV32_State (%I12) = 16#0008
0002 PLC_state (%I16) = 16#0000
0003 ATV32_TPDO_Input1_Status_Word (%I18) = 16#0250
0004 ATV32_TPDO_Input2_Control_Effort (%I20) = 16#0000
0005 ATV32_TPDO_Input3 (%I22) = 16#0000
0006 ATV32_TPDO_Input4 (%I24) = 16#0000
0007 ATV32_TPDO_Input5 (%I26) = 16#0000
0008 ATV32_TPDO_Input6 (%I28) = 16#0000
0009 ATV32_RPDO_Output1_Control_Word (%QB0) = 16#0002
0010 ATV32_RPDO_Output2_Target_Velocity (%QB2) = 16#0000
0011 ATV32_RPDO_Output3 (%QB4) = 16#0000
0012 ATV32_RPDO_Output4 (%QB6) = 16#0000
0013 ATV32_RPDO_Output5 (%QB8) = 16#0000
0014 ATV32_RPDO_Output6 (%QB10) = 16#0000
0015 SystemInfo (%MB32768)
0016 SystemTaskInfoArr (%MB32832)
0017
0018
    
```

#### 14. PLC - Control: start and stop the motor

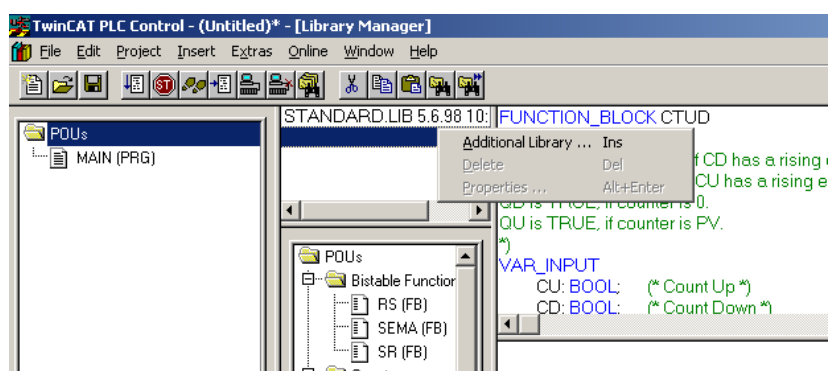
To modify the ATV32 state, refer to CiA402 state chart page 55.

Example to start the motor:

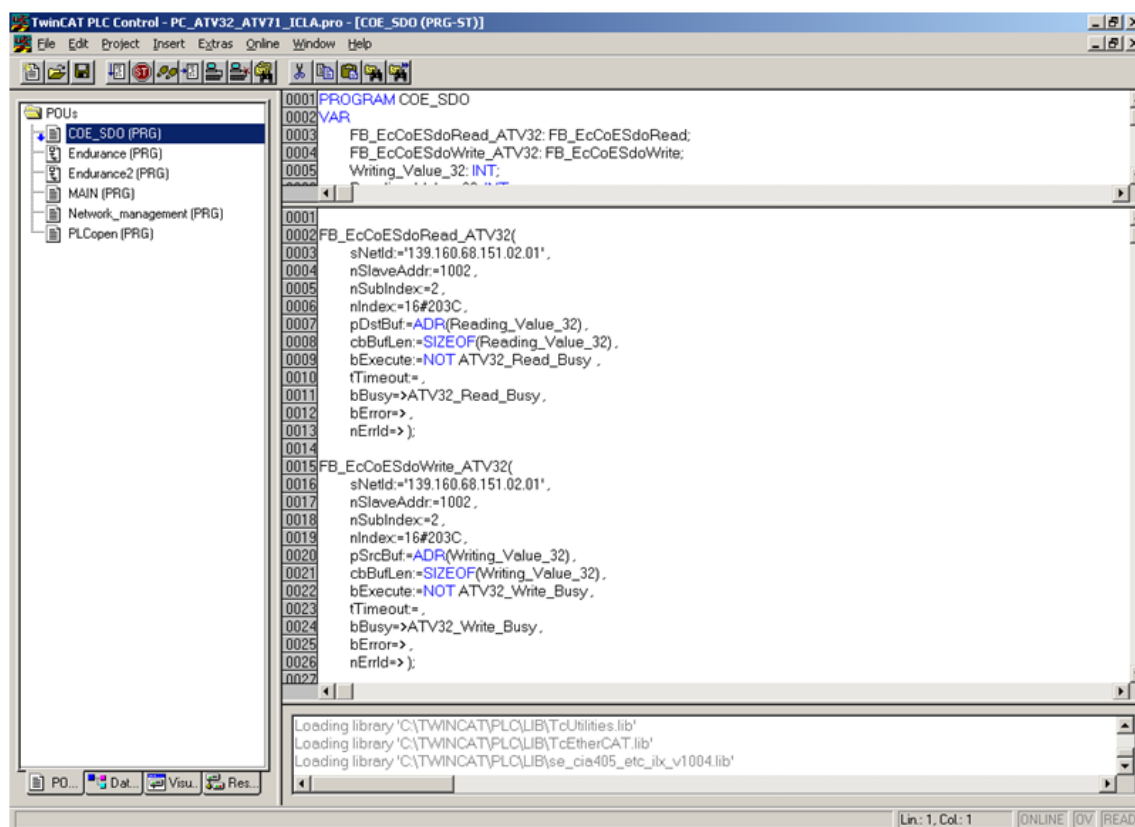
- The ATV32 is on "switch on disabled" state and (n 5 E) display on ATV32
- Set "ATV32\_RPDO\_Output1\_Control\_Word (%QB0) = 16#0006
- The ATV32 is on "ready to switch on" state and (r d Y) display on ATV32
- Set "ATV32\_RPDO\_Output1\_Control\_Word (%QB0) = 0x000F
- The ATV32 is on "operational Enable".state
- Set "ATV32\_RPDO\_Output2\_Target\_Velocity (%QB2) = 16#05DC
- The Motor starts, and the ATV32 displays (5 0. 0) Hz
- Set "ATV32\_RPDO\_Output1\_Control\_Word (%QB0) = 16#000
- The motor stops and ATV32 go back on "switch on disabled" state with (n 5 E) display

#### 15. PLC - Control: add a library for other services

Install the library: TcEtherCAT.lib



Example for exchanges with SDO



Example for exchanges with ESM states

The screenshot shows the TwinCAT PLC Control software interface. The title bar indicates the project is 'PLC\_ATV32\_ATV71\_LXM32.pro' with a sub-project 'Network\_management (PRG-ST)'. The menu bar includes File, Edit, Project, Insert, Extras, Online, Window, and Help. The toolbar contains various icons for file operations and execution. The project tree on the left shows a hierarchy of programs: POU's, COE\_SDD (PRG), Endurance (PRG), Endurance2 (PRG), Endurance3 (PRG), MAIN (PRG), Network\_management (PRG), and test (PRG). The main editor area displays the following code:

```

0018 boot_32: BOOL;
0019 boot_71: BOOL;
0020 FB_EcSetSlaveState_ATV71: FB_EcSetSlaveState;
0021 init_71: BOOL;
0022 Preop_71: BOOL;
0023 Safeop_71: BOOL;
0024 op_71: BOOL;
...
0001 FB_GetLocalAmsNetId_1(
0002   bExecute:=TRUE,
0003   tTimeout=,
0004   bBusy=>,
0005   bError=>,
0006   nErrId=>,
0007   AddrString=>SnetId,
0008   AddrBytes=>);
0009 SnetId:=REPLACE(SnetId, '3', 1, LEN(SnetId)-2);
0010
0011 (*EC_DEVICE_STATE_INIT 0x01 Set slave in Init state.
0012 EC_DEVICE_STATE_PREOP 0x02 Set slave in pre-operational state.
0013 EC_DEVICE_STATE_BOOTSTRAP 0x03 Set slave in bootstrap state.
0014 EC_DEVICE_STATE_SAFEOP 0x04 Set slave in safe-operational state.
0015 EC_DEVICE_STATE_OP 0x08 Set slave in operational state.
0016 EC_DEVICE_STATE_ERROR 0x10 If the error bit at the EtherCAT Slave is set in the status byte ( currState.deviceState AND EC_DI
0017 FB_EcSetMasterState_1(
0018   sNetId:=SnetId,
0019   bExecute:=,
0020   tTimeout=,
0021   reqState=,
0022   bBusy=>,
0023   bError=>,
0024   nErrId=>,
0025   currState=>);
0026

```

At the bottom of the window, there is a status bar showing 'Lin.: 9, Col.: 48' and buttons for 'ONLINE', 'OV', and 'READ'. A message box at the bottom indicates 'Loading library 'C:\TWINCAT\PLC\LIB\TcSystem.lib' and 'Loading library 'C:\TWINCAT\PLC\LIB\TcUtilities.lib''.





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# Diagnostics and monitoring



# 5

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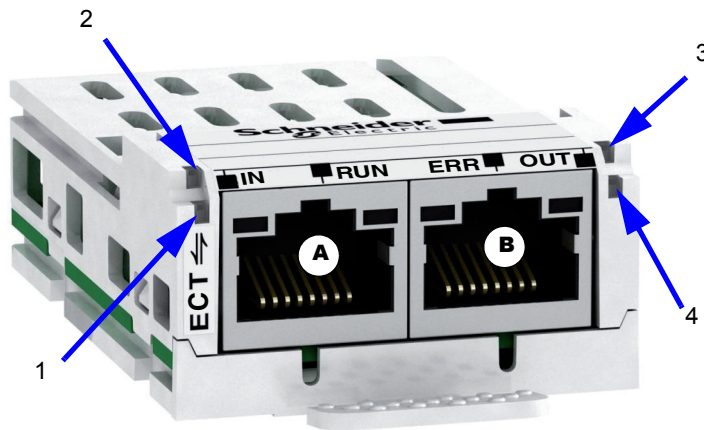
## What's in this Chapter?

This chapter contains the following topics:

Topic	Page
LED Indicators	42
Communication Diagnostics	44
Control-Signal Diagnostics	46

## LED Indicators

The following figure describes the LEDs status module:



Port	Fieldbus
<b>A</b>	EtherCAT IN
<b>B</b>	EtherCAT OUT

LED	Description
1: IN	Link/Activity (IN)
2: RUN	Network RUN
3: ERR	Network ERRor status
4: OUT	Link/Activity (OUT)

### LEDs 1 and 4: Link / Activity

These LEDs indicate the status of the EtherCAT port A (IN) and EtherCAT port B (OUT)

Color & Status	Description
OFF	No link
Green ON	Link, no activity
Green Flickering	Link, activity

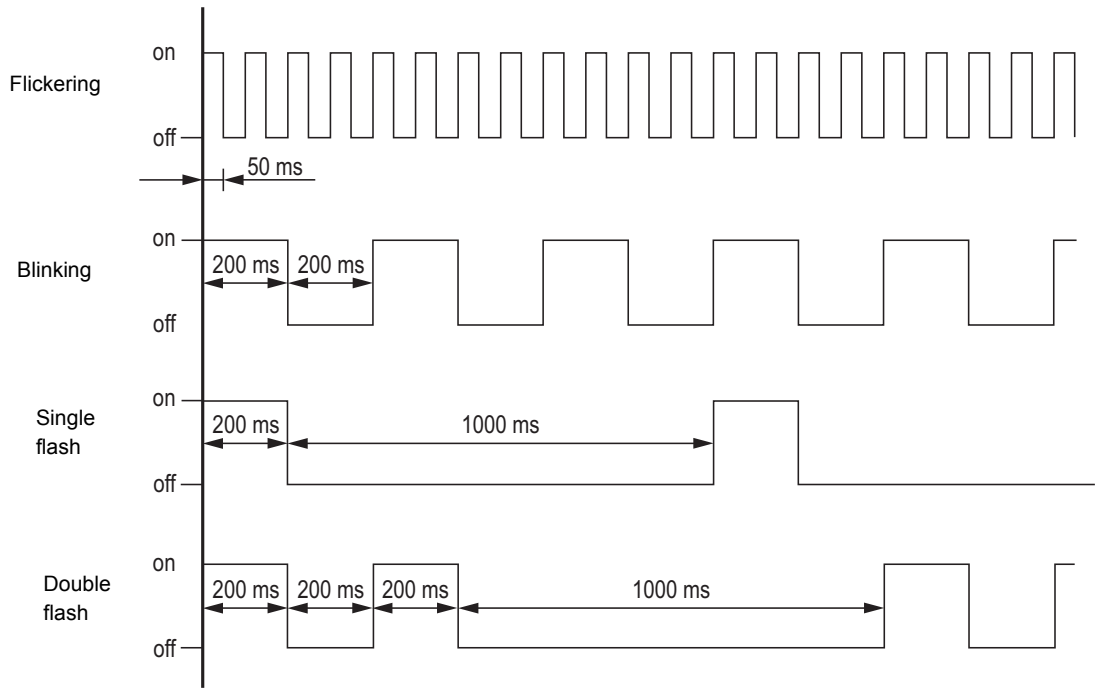
### LED 2: RUN Status

Color & Status	Description
OFF	EtherCAT state: INIT
Green blinking	EtherCAT state: PRE-OPERATIONAL
Green single flashing	EtherCAT state: SAFE-OPERATIONAL.
Green ON	EtherCAT state: OPERATIONAL

### LED 3: Network ERROR Status

Color & Status	Description
OFF	No detected fault
Red blinking	Invalid configuration
Red single flashing	Local error (such as synchronization error)
Red double flashing	Watchdog timeout

### LED Behavior Detail



## Communication Diagnostics

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

### 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	(C Nd)	(C Nd 1)	(C Nd 2)	(C Nd 3)
Extended control word	(C N 1)	(C N 1 1)	(C N 1 2)	(C N 1 3)
Speed reference (rpm)	(L F r d)	(L F r d 1)	(L F r d 2)	(L F r d 3)
Frequency reference (0.1 Hz)	(L F r)	(L F r 1)	(L F r 2)	(L F r 3)
PI regulator reference	(P I S P)	(P I r 1)	(P I r 2)	(P I r 3)
Analog multiplier reference	(N F r)	(N F r 1)	(N F r 2)	(N F r 3)

### Monitoring of Communication Channels

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

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

## Communication Interruptions

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), page [72](#).

In factory settings, an EtherCAT communication interruption triggers a drive detected fault that can be cleared **[Network fault mgt] (C L L)** and a freewheel stop.

The response of the drive in the event of an EtherCAT communication interruption can be changed:

- Drive fault **[Network fault mgt] (C L L)** (freewheel stop, stop on ramp, fast stop or DC injection stop).
- No drive detected fault (stop, maintain, fallback).

In the event of a **[Network fault mgt] (C L L)**, the drive sends an EMCY message to the EtherCAT master, see Emergency Object (EMCY), page [72](#).

## Communication detected Faults: CnF and ILF

After a detected fault occurred, here are the values to read:

Parameter	Description	Possible values and descriptions
<b>[int. com.link] (ILF)</b>	This parameter indicates a detected error and can be cleared: It needs a drive Power Off / Power On.	18: Interface connection timeout 19: EEPROM/NVS detected fault 21: 'No memory' or 'background watchdog' or 'IOC scanner detected fault'
<b>[Com. network] (CnF)</b>	This parameter indicates that a network interruption occurred. A value is recorded depending of the interruption type. When the detected fault has disappeared, the option writes 0. <b>Note:</b> <b>(CnF)</b> is available only in "operational" state and if the motor is running.	0: No network interruption 1: Unspecified interruption 11: lost of link (2ports) 23: invalid Sync Manager configuration 25: No valid outputs 27: Sync Manager watchdog (1port) 29: invalid Sync Manager out configuration 30: invalid Sync Manager in configuration 31: invalid watchdog configuration 36: invalid input mapping 37: invalid output mapping 38: inconsistent settings 43: No valid inputs and outputs 44: Sync error 80: EE no access 81: EE error 96: 0x60

## EtherCAT state machine

For the status, see **[EthCAT slave status] (E L 5 5)** page [23](#).

For the EtherCAT state machine diagram, see page [70](#).

## 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] (FLDL)**.
- Drive control only takes effect once the drive has received the reference and the command from the active channel.

## Control-Signal Diagnostics

On the terminal, the **[1.2 - MONITORING]** (**Π Δ ρ -**) 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]** (**Ε Ε Η**)
- Values of the four parameters selected by the user (W---)
- The **[COM. SCANNER INPUT MAP]** submenu: contains the parameter value mapped DRIVE scanner (NMAx). NOT necessary for EtherCAT.
- The **[COM SCAN OUTPUT MAP]** submenu: contains the parameter value mapped DRIVE scanner (NCAx). NOT necessary for EtherCAT.
- 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	nEt	+50.00Hz	80A
COMMUNICATION MAP			
Command Channel	:		Com.Card
Cmd value	:		000FHex
Active ref. channel	:		Com.Card
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			

### 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 Π Δ Σ**) 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]** (**ρ F Σ Σ**) 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 (**[COM. card cmd]** parameter) is used to display the value (in 0.1 Hz units) of the speed target sent by the network.

### 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.] (M F -)** menu (**[COM. MAP CONFIG.] (M L -)** 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).

## Optimizing the Response Time

The response time can be optimized for the PDO configurations. In these configurations:

- the RPDO (receive) is processed with the same priority as a logic input from the terminals.
- TPDO (transmit) is updated with the same priority as an output from the terminals.

### Quick response time parameters

Only these parameters are available for fast tasks:

Fast read: TPDO	Parameters
PDO input objects	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: RPDO	Parameters
PDO output objects	OL1R, AO1R, AO1C, CMD, LFR, PISP, LFRD, M001, M002, M003, M004, M005, M006, M007, M008

### Normal response time parameters

All other parameters are taken into account by the drive's background task.

**Note:** In this case we can't ensure the response time.

### Examples for quick response time parameters

The following table describes the receive PDO parameter (RPDO):

Parameters configured		Comment
Index	Name	
16#6040	Control word (CMD)	Drive control in speed regulation mode
16#6042	Speed target (LFRD)	

The following tables describes the transmit PDO parameter (TPDO):

Parameters configured		Comment
Index	Name	
16#6041	Status word (ETA)	Drive monitoring in speed regulation mode
16#6044	Output speed (RFRD)	



# Profiles



# 6

---

## What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Definition of a Profile	50
Functional Profiles Supported by the Altivar 32	51

## 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, EtherCAT 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, EtherCAT 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]** (5 E P)
- Not separate mode **[Not separ.]** (5 I N)

See CiA402 State Chart, page 55.



# CiA® 402 - IEC61800-7 Functional Profile

# 7

## What's in this Chapter?

This chapter contains the following topics:

Topic	Page
Functional Description	54
CiA402 State Chart	55
Description of States	56
Summary	57
Stop Commands	59
Assigning Control Word Bits	59
Status Word (EtA)	60
Starting Sequence	61
Sequence for a Drive Powered by the Power Section Line Supply	62
Sequence for a Drive With Separate Control Section	64
Sequence for a Drive with Line Contactor Control	67

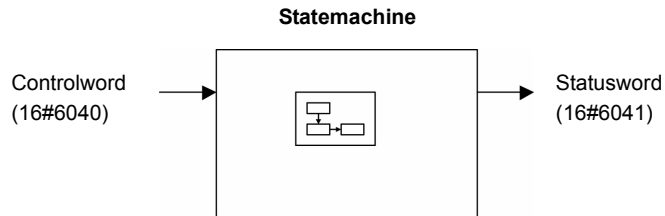
## Functional Description

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

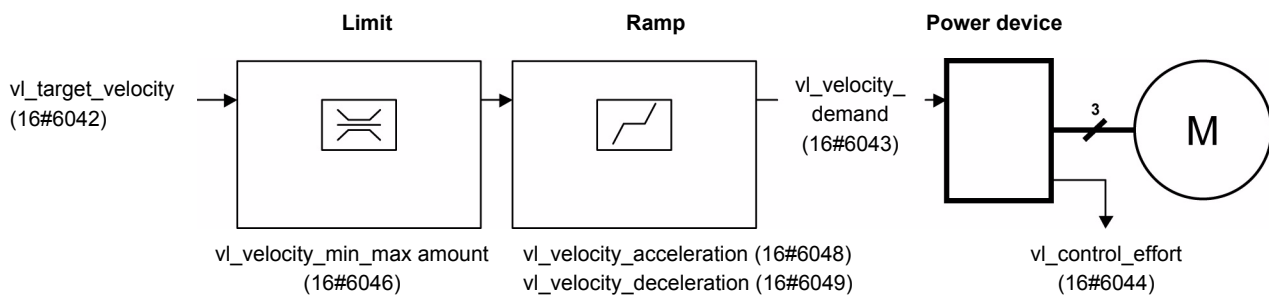
### CiA402

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:**



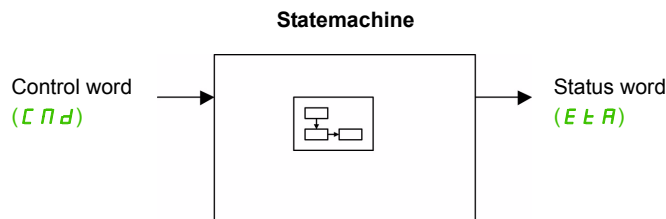
**Simplified diagram of speed control in “Velocity” mode:**



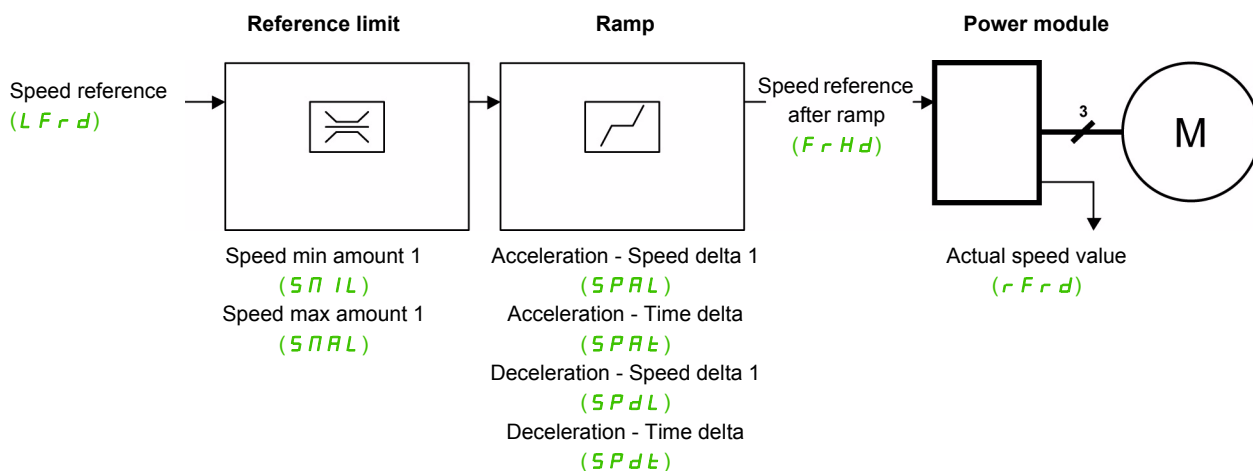
### Altivar 32

These diagrams translate as follows for the Altivar system:

**Control diagram:**



**Simplified diagram of speed control in “Velocity” mode:**





## 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 P 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	The drive is inactive. The drive is locked, no power is supplied to the motor. For a separate control section, it is not necessary to supply AC power to the power section. For a separate control section with line contactor, the contactor is not controlled. The configuration and adjustment parameters can be modified.
3 - Ready to switch on	Awaiting power section line supply. 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". For a separate control section with line contactor, the contactor is not controlled. The drive is locked, no power is supplied to the motor. The configuration and adjustment parameters can be modified.
4 - Switched on	The drive is supplied with AC power but is stationary. For a separate control section, the power section line supply must be present. For a separate control section with line contactor, the contactor is controlled. The drive is locked, no power is supplied to the motor. The power stage of the drive is ready to operate, but voltage has not yet been applied to the output. The adjustment parameters can be modified. Modification of a configuration parameter returns the drive to state "2 - Switch on disabled".
5 - Operation enabled	The drive is running. For a separate control section, the power section line supply must be present. For a separate control section with line contactor, the contactor is controlled. The drive is unlocked, power is supplied to the motor. The drive functions are activated and voltage is applied to the motor terminals. If the reference is zero or the "Halt" command is applied, no power is supplied to the motor and no torque is applied. <b>[Auto tuning] (E U n)</b> requires an injection of current into the motor. The drive must therefore be in state "5 - Operation enabled" for this command. The adjustment parameters can be modified. The configuration parameters cannot be modified. <b>NOTE:</b> 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. The reaction of the drive to a "Disable operation" command depends on the value of the <b>[Dis. operat opt code] (d D E d)</b> parameter: <ul style="list-style-type: none"> <li>- If the <b>[Dis. operat opt code] (d D E d)</b> parameter has the value 0, the drive changes to "4 - Switched on" and stops in freewheel stop.</li> <li>- If the <b>[Dis. operat opt code] (d D E d)</b> parameter has the value 1, the drive stops on ramp and then changes to "4 - Switched on".</li> </ul>
6 - Quick stop active	Emergency stop. The drive performs a fast stop, after which restarting will only be possible once the drive has changed to the "Switch on disabled" state. During fast stop, the drive is unlocked and power is supplied to the motor. The configuration parameters cannot be modified. The condition for transition 12 to state "2 - Switch on disabled" depends on the value of the parameter <b>[Quick stop mode] (q S E d)</b> : <ul style="list-style-type: none"> <li>If the <b>q S E d</b> parameter has the value <b>F S E 2</b>, the drive stops according to the fast stop ramp and then changes to state "2 - Switch on disabled".</li> <li>If the <b>q S E d</b> parameter has the value <b>F S E 6</b>, the drive stops according to the fast stop ramp and then remains in state "6 - Quick stop active" until: <ul style="list-style-type: none"> <li>- A "Disable voltage" command is received.</li> <li>- Or the STOP key is pressed.</li> <li>- Or there is a freewheel stop command via the terminals.</li> </ul> </li> </ul>



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	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 (active at 0)	Enable voltage	Switch on
0 to 1 transition = Ack. fault				1 = Run command			

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] (S E E)** parameter.

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] (S E E)** parameter (**[Fast stop assign] (F S E)**, **[Ramp stop] (r P P)**, **[Freewheel] (r S E)**, or **[DC injection assign.] (d C I)**), 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	EtherCAT
bit 11	C311
bit 12	C312
bit 13	C313
bit 14	C314
bit 15	C315

For example, to assign the DC injection braking to bit 13 of EtherCAT, configure the **[DC injection assign.] (d C I)** parameter with the **[C313] (C 3 I 3)** value.

Bit 11 is assigned by default to the operating direction command **[Reverse assign.] (r r 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 <sup>(1)</sup>
	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 <sup>(2)</sup> or 16#0028

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

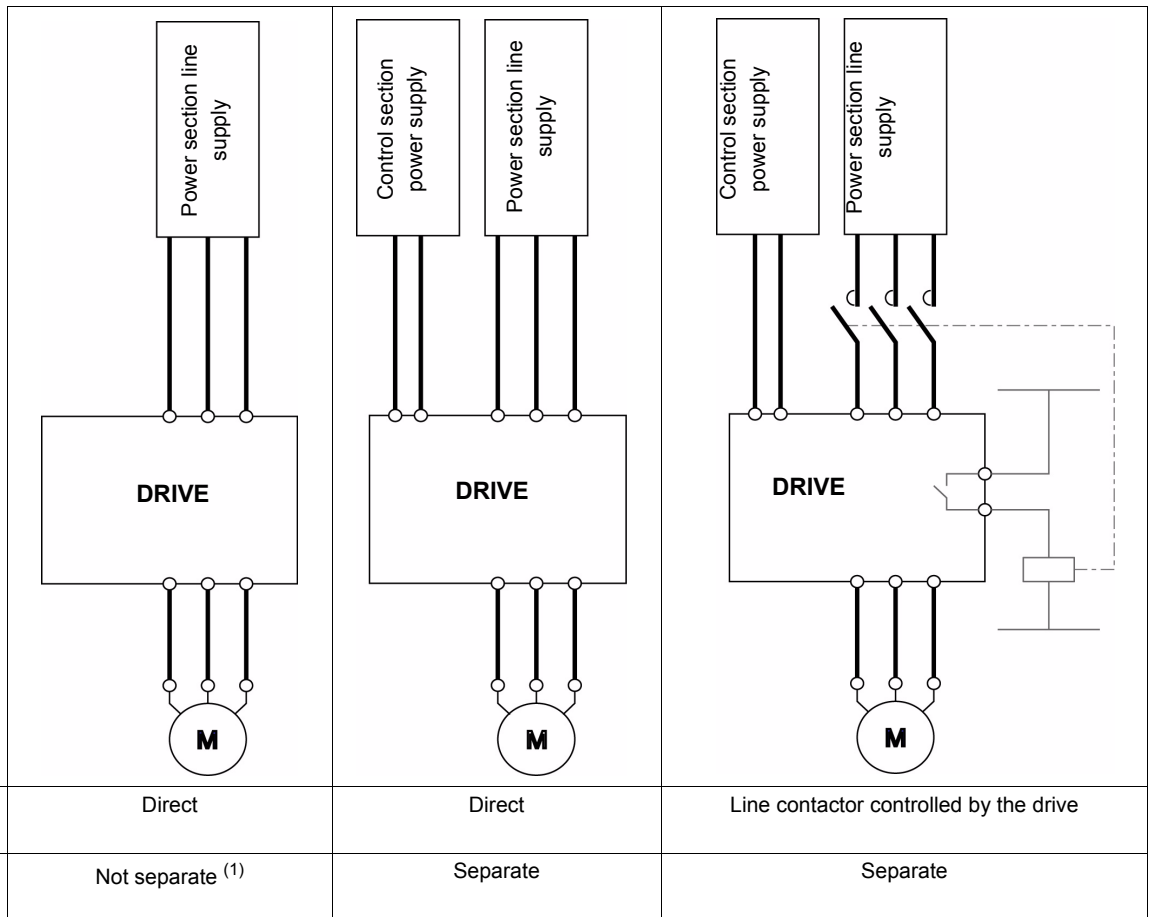
(2) Detected fault following state "6 - Quick stop active".

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:



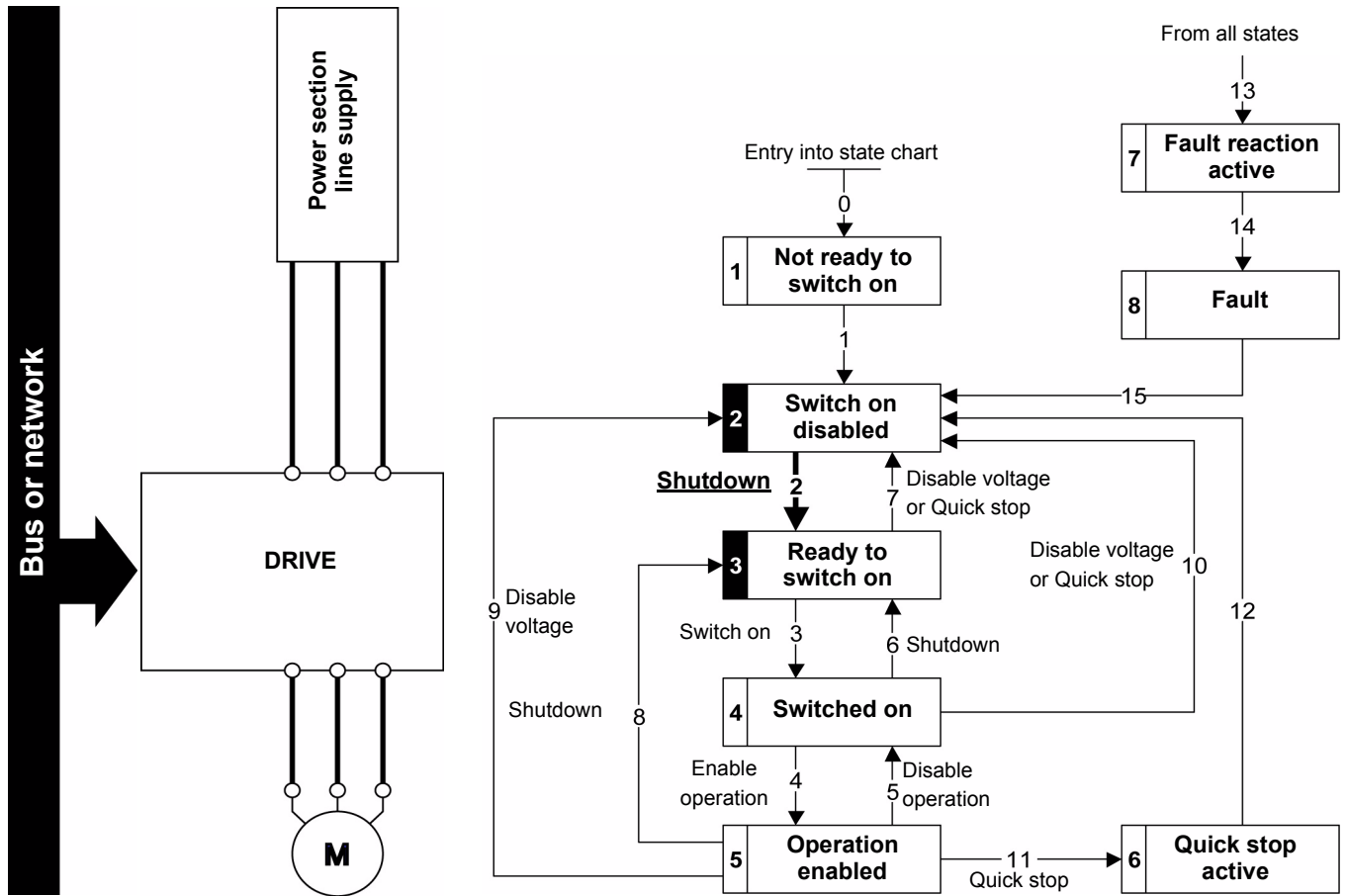
(1) The power section supplies the control section.

### 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:

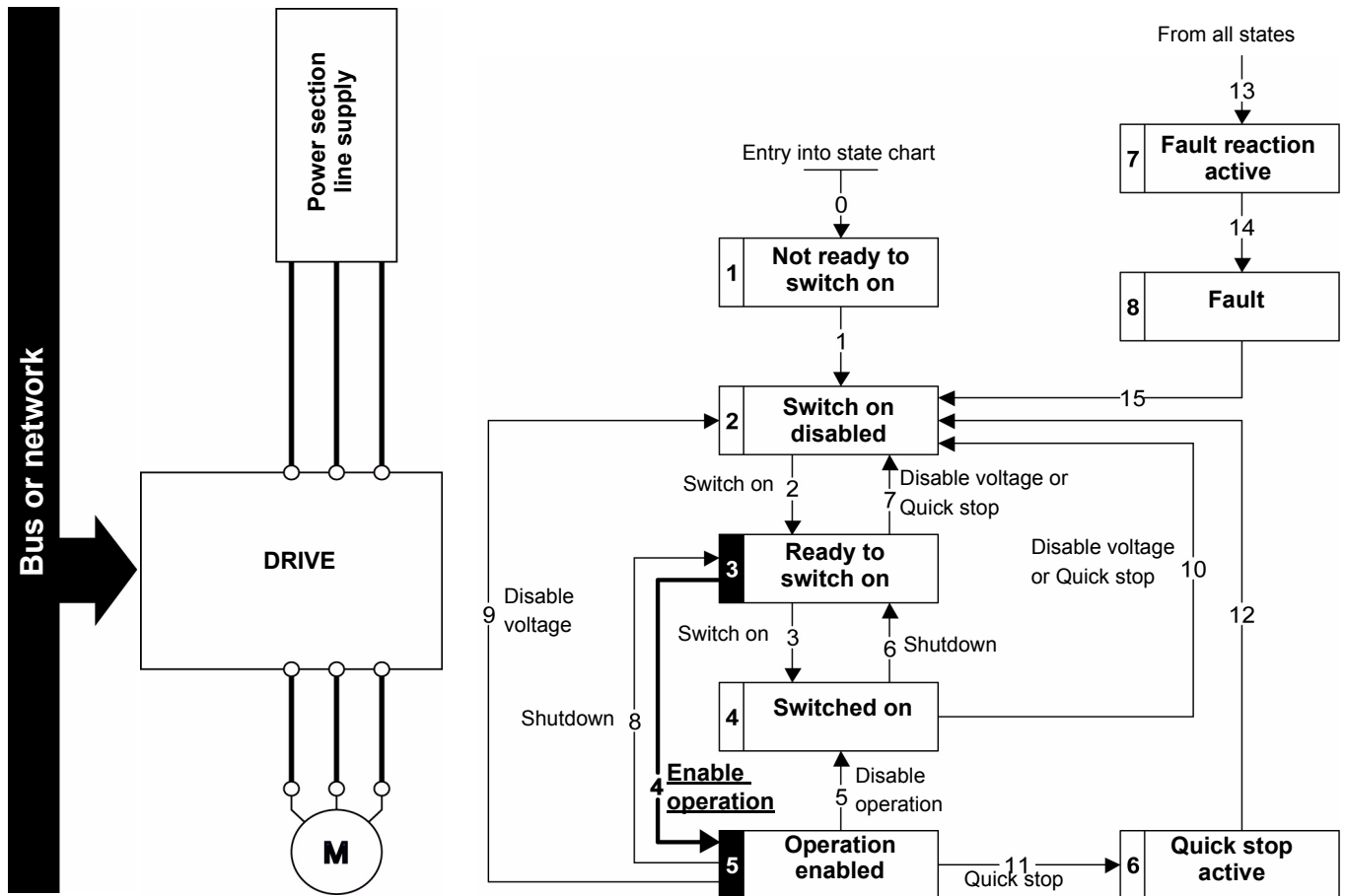
#### Step 1

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

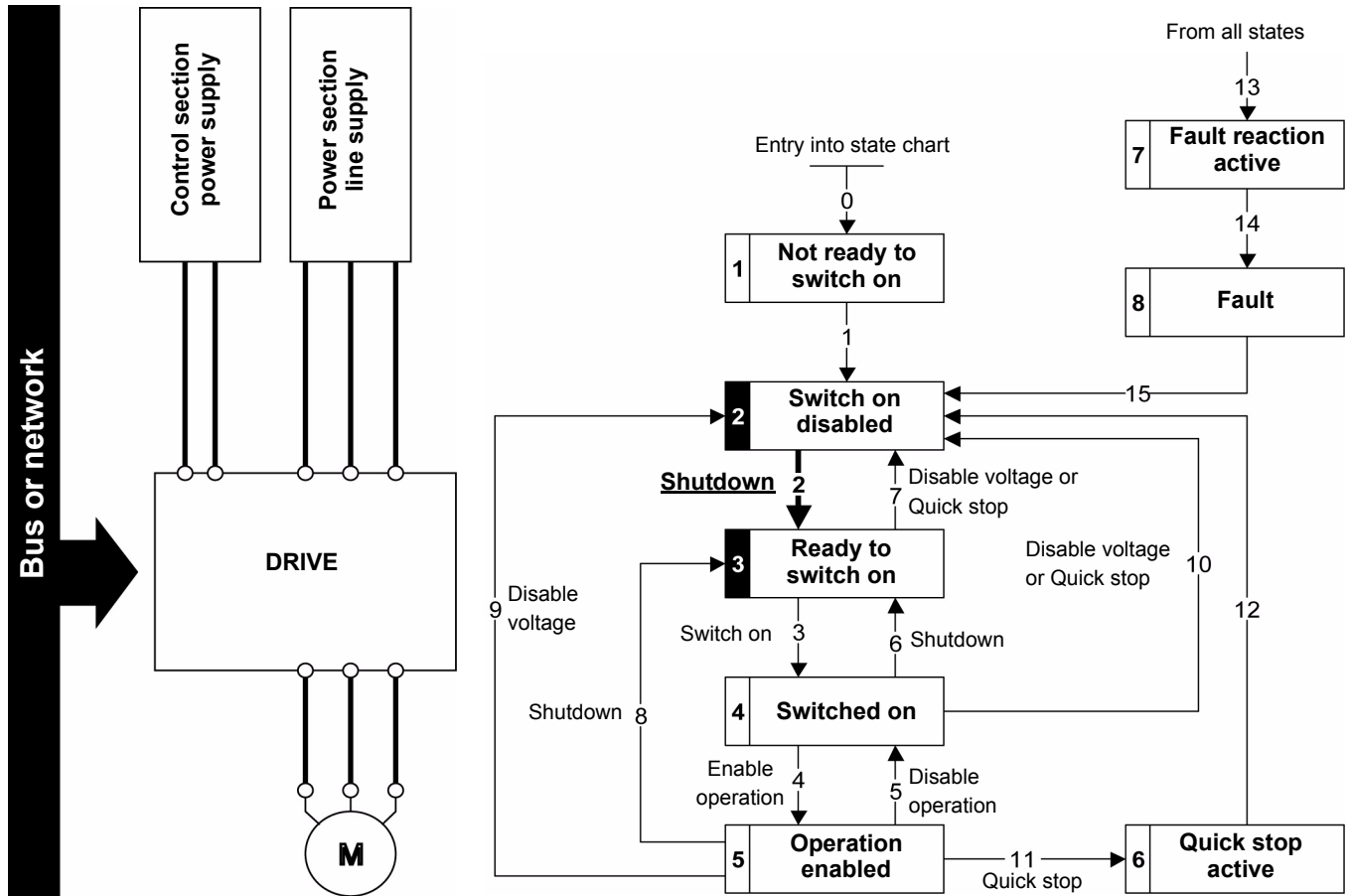
Power is supplied separately to the power and control sections.

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



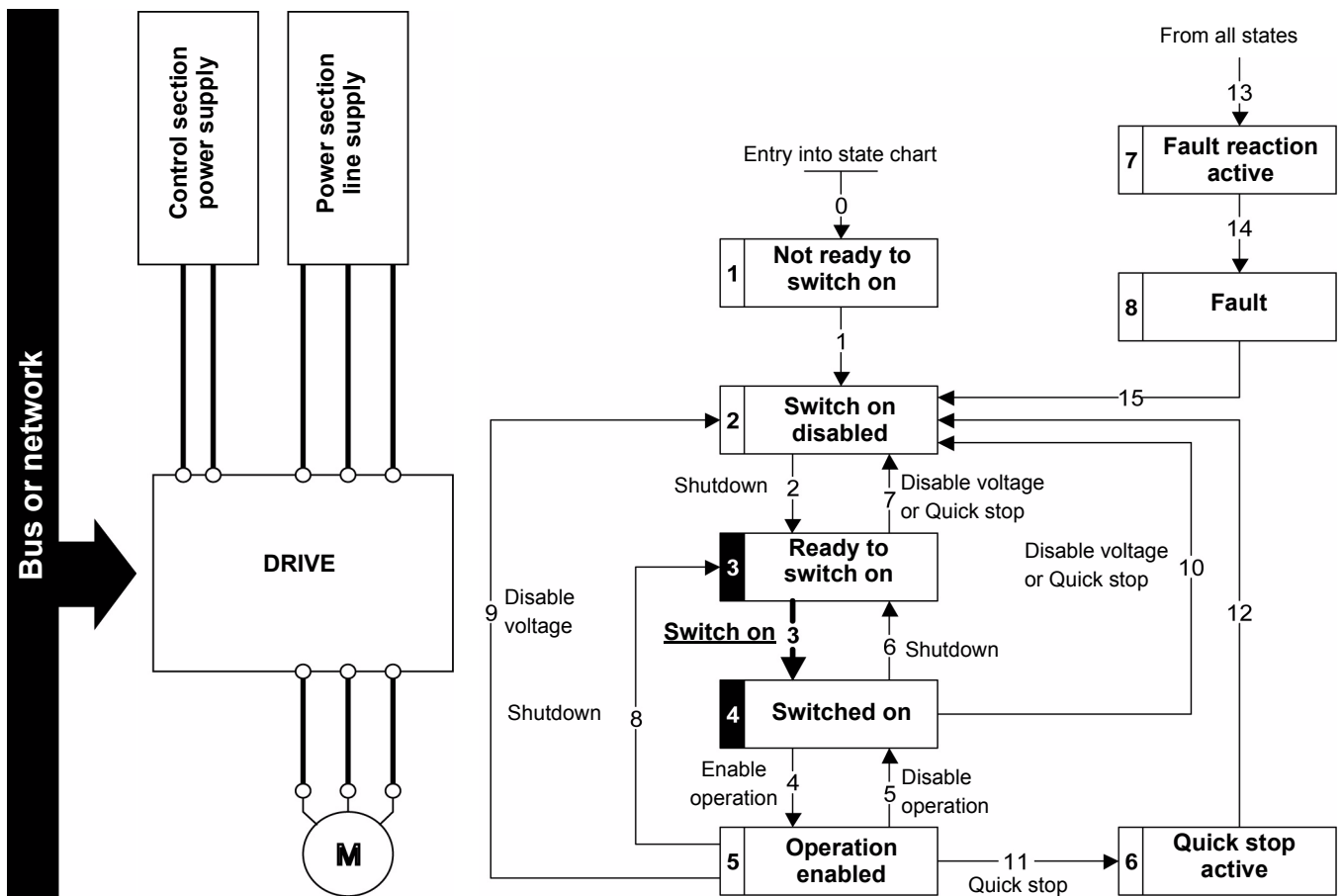


**Step 2**

- 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).

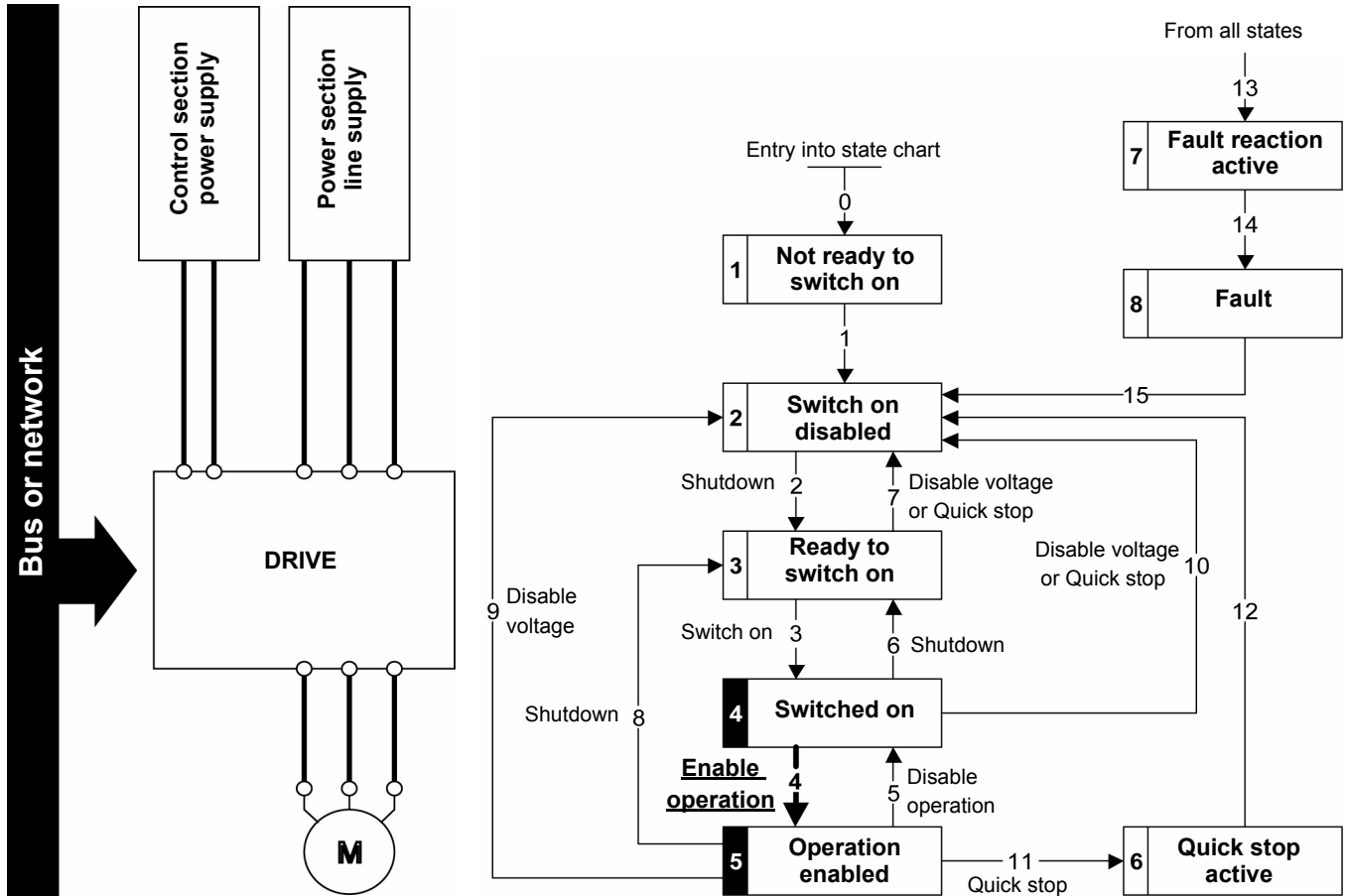
Power section line supply	Terminal display	Status word
Absent	<i>n L P</i>	16#●●21
Present	<i>r d Y</i>	16#●●31

- 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

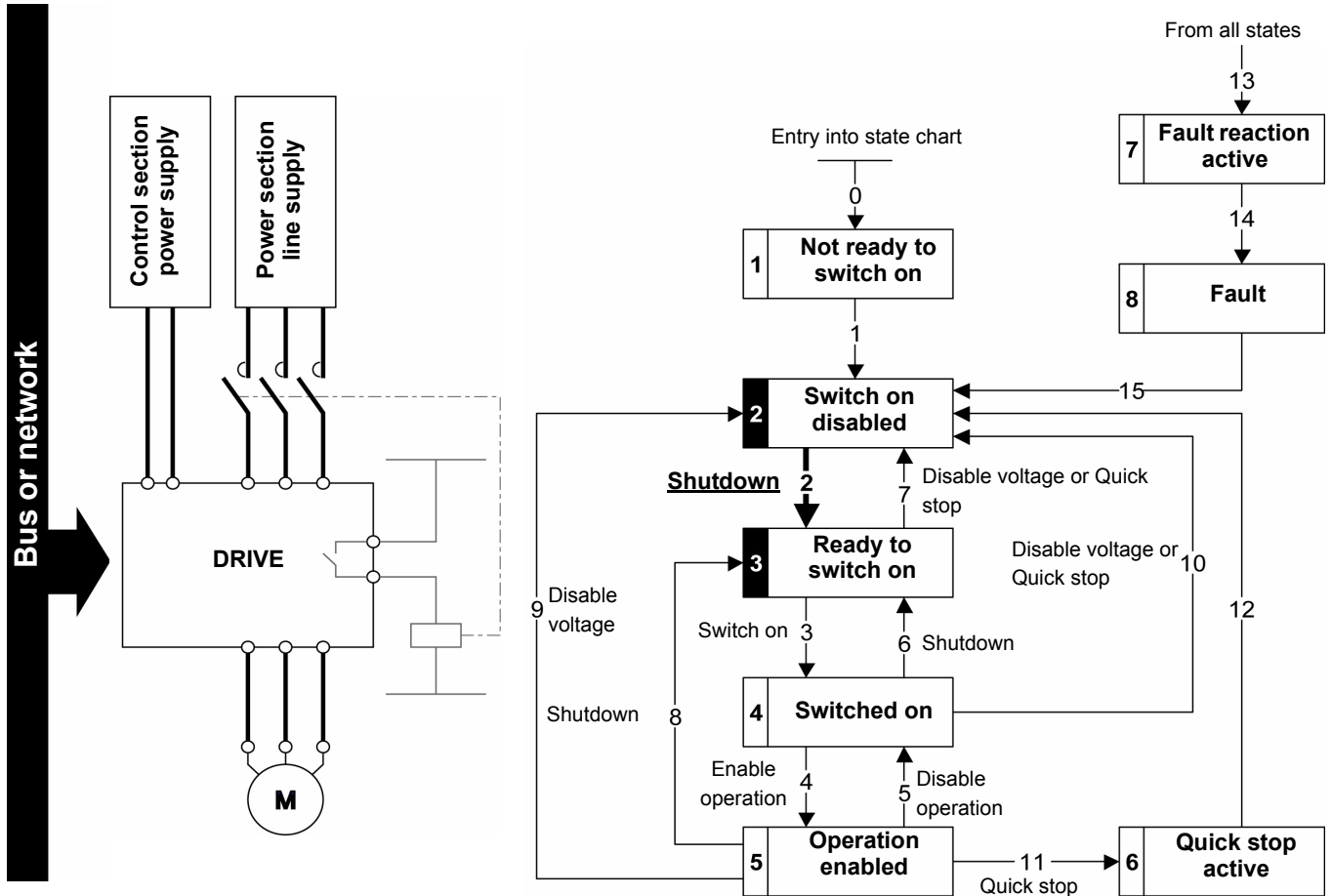
Power is supplied separately to the power and control sections.

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:

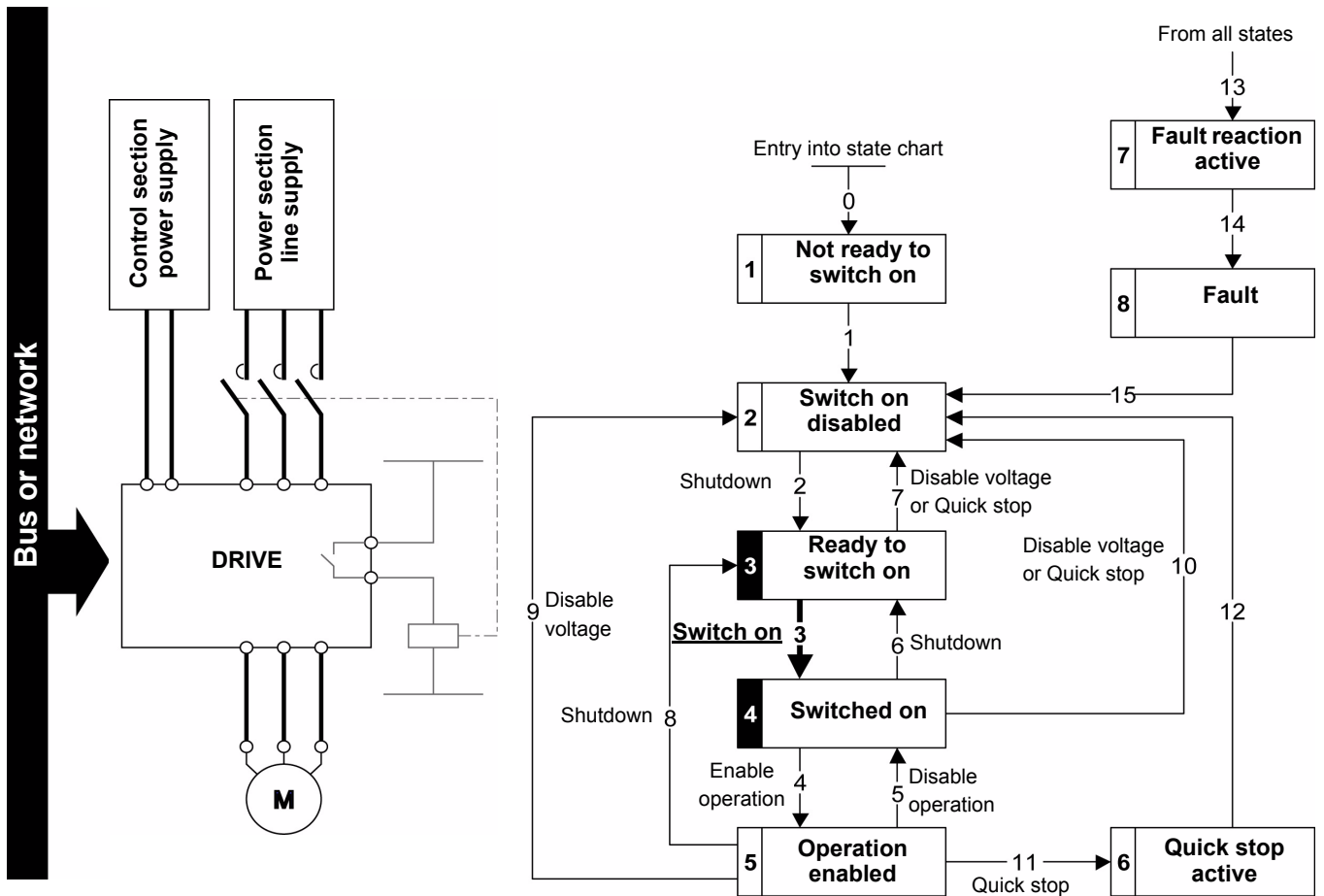
### Step 1

- 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.



---

# Detailed Description of Services



# 8

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## What's in this Chapter?

This chapter contains the following topics:

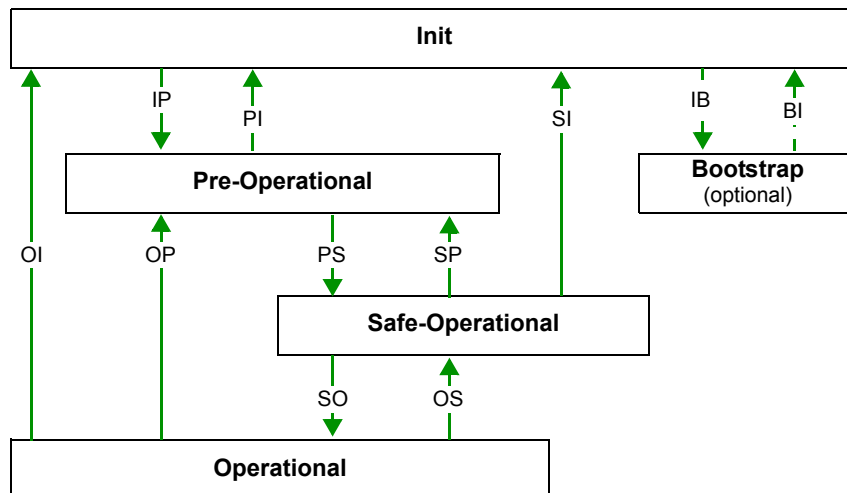
Topic	Page
EtherCAT State Machine (ESM)	70
Emergency Object (EMCY)	72

## EtherCAT State Machine (ESM)

### ESM Diagram

The EtherCAT State machine coordinates the master and slave applications at start up and during operation. State changes are typically initiated by requests of the master. They are acknowledged by the local application after the associated operations have been executed.

### Description of the states management



### ESM states

The state **Init** defines the foundation of the communication relationship between the master and the slaves at the application layer. Direct communication between the master and the slave is impossible at the application layer. The master uses the Init state to initialize a set of configuration registers of the EtherCAT slave controllers. If the slaves support mailbox services, the Sync Manager is also configured in this state.

In the **Pre-Operational** state, the mailbox is active. Both master and slave use the mailbox and the corresponding protocol to interchange application-specific initialization data and parameters. In this state, process data communication is not possible.

If the drive does not receive a valid mapping for the process data from the EtherCAT master, it remains in this state.

In the **Safe-Operational** state, the slave application provides current input data such as limit switch data. Output data of the master are ignored

in this state. This state is not a safety function.

In the state **Operational**, the slave applications deliver current input data and the drive processes the current output data from the drive, such as target positions.

**Note:** if the PDO are deactivated, it is not possible to control the drive by the SDO.

**State transitions**

State transition	Local management service	Value
IP	Start Mailbox Communication	0x02
PI	Stop Mailbox Communication	0x01
PS	Start Input Update	0x04
SP	Stop Input Update	0x02
SO	Start Output Update	0x08
OS	Stop Output Update	0x04
OP	Stop Output Update and Stop Input Update	0x02
SI	Stop Input Update, Stop Mailbox Communication	0x01
OI	Stop Input Update, Stop Input Update, Stop Mailbox Communication	0x01
IB	Start Bootstrap Mode, redirection to (BI)	0x03
BI	Restart Device	0x01

**ESM states management**

The ESM states are managed with the library: TC EtherCAT lib. See the example, step 15 page [38](#).

**ESM states and communication interruptions**

The ESM states are managed with the library: TC EtherCAT lib. See the example, step 15 page [38](#).

Some transitions in the ESM state chart will trigger a communication interruption.

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).

State transition	Service lost	[Com. network] (C n F)
PI	SDO	No possible C n F
SI	SDO, TPDO	
SP	TPDO	
OS	RPDO	If drive was enabled (E t F = 16#xxx7) then the C n F value must be updated to 0x0060
OP	PDO	
OI	SDO, PDO	

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

	Init	Pre-operational	Safe-Operational	Operational
PDO			TPDO, inputs only active, no outputs to drive active	X
SDO		X	X	X
Emergency (EMCY)		X	X	X

## 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 <i>dp</i>   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 Fit] (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)
16#6300	[Invalid config.] (CFI)



EMCY detected error code (Errd)	Description (accessible also in <a href="#">dP</a>   see programming manual)
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 fdbck 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)



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# Object Dictionary



# 9

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## 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	unsigned32	16#00410192	Device type and profile: Bits 16-23 = Device type mode Bits 00-15 = Device profile number (402)
16#1001	16#00	R	unsigned8	16#00	Detected error register: detected error (1) or no detected error (0)
16#1003	16#00	R	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 to 16#10	R	unsigned32	16#00000000	Standard detected error Field: Bits 16-31 = Additional information (all 0s) Bits 00-15 = detected error code (Errd)
16#1008	16#00	R	visible string	ATV32●●●●●●	Device name, ATV32 reference
16#1018	16#00	R	unsigned32		Identity object
	16#01	R	unsigned32	16#0800005A	Vendor ID
	16#02	R	unsigned32	16#00000020	Product code
	16#04	R	unsigned32		Revision number
	16#05	R	unsigned32		Serial number

## RPDO: Receive PDO

Index	Sub-Index	Access	Type	Default value	Description
16#1600	16#00	R/W	unsigned8	16#02	Receive PDO mapping - Number of mapped objects: 0 to 4 objects can be mapped for this PDO
	16#01	R/W	unsigned32	16#60400010	Receive PDO mapping - 1st mapped object: Control word "CMD" (16#6040)
	16#02	R/W	unsigned32	16#60420010	Receive PDO mapping - 2nd mapped object: Velocity reference "LFRD" (16#6042)
	16#03	R/W	unsigned32	16#00000000	Receive PDO mapping: 3rd mapped object
	16#04	R/W	unsigned32	16#00000000	Receive PDO mapping: 4th mapped object
	16#05	R/W	unsigned32	16#00000000	Receive PDO mapping: 5rd mapped object
	16#06	R/W	unsigned32	16#00000000	Receive PDO mapping: 6th mapped object

## TPDO: Transmit PDO

Index	Sub-Index	Access	Type	Default value	Description
16#1A00	16#00	R/W	unsigned8	16#02	Transmit PDO mapping - Number of mapped objects.
	16#01	R/W	unsigned32	16#60410010	Transmit PDO mapping - 1st mapped object: Status word "ETA" (16#6041)
	16#02	R/W	unsigned32	16#60440010	Transmit PDO mapping - 2nd mapped object: Output speed "RFRD" (16#6044/00) default value
	16#03	R/W	unsigned32	16#00000000	Transmit PDO mapping: 3rd mapped object
	16#04	R/W	unsigned32	16#00000000	Transmit PDO mapping: 4rd mapped object
	16#05	R/W	unsigned32	16#00000000	Transmit PDO mapping: 5rd mapped object
	16#06	R/W	unsigned32	16#00000000	Transmit PDO mapping: 6th mapped object

## Sync Manager

Index	Sub-Index	Access	Type	Default value	Description
16#1C12	16#00	R	unsigned8		Sync manager channel 2. Number of assigned RPDO (0 or 1)
	16#01	R	unsigned16		Assigned RPDO number 1
16#1C13	16#00	R	unsigned8		Sync manager channel 3. Number of assigned TPDO (0 or 1)
	16#01	R	unsigned16		Assigned TPDO number 1

## Manufacturer Specific Area

- The ATV32 specific profile area range is 16#2000 to 16#5FFF.
- The ATV32 parameters are based on Modbus addresses and CANopen addresses.
- To get the address list, download on [www.schneider-electric.com](http://www.schneider-electric.com), the ATV32 Communication Parameters (document reference S1A44568)

## 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#6077	Torque actual value	
16#6502	Supported drive modes	

# Glossary

# 10

Term	Definition
AL	Application Layer
CAN	Controller Area Network is an internally standardized serial bus system
CNC	Computer Numerical Control
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
CoDeSys	Controller Development System
CoE	CANopen over EtherCAT
COF	CANopen Communication interruption
DC	Distributed Clock
DINT	Signed Double INTegeR
DL	DataLink layer
ENI	EtherCAT Network Information (network configuration in XML format, generated by the master)
EoE	Ethernet over EtherCAT
ERCO	Error Code
ESI	EtherCAT Slave Information (device description in XML format)
ESM	EtherCAT State Machine
INT	Signed INTegeR
NC	Numerical Control
NMT	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 Objects
PL	Physical Layer
PLC	Programmable Logic controller
RPDO	Receive PDO
SDO	Service Data Objects
SoMove	Windows setup software for drives and softstarters You can download it on <a href="http://www.schneider-electric.com">www.schneider-electric.com</a>
ST	Structured Language
SYNC	Synchronization Object
TPDO	Transmit PDO
TwinCAT	Windows Control and Automation Technology system software copyright Beckhoff®
UDINT	Unsigned Double INTegeR
UINT	Unsigned INTegeR
XML	eXtended Markup Language





