



*User Guide*

---

# ***SI-EtherCAT***

---



Part Number: 0478-0152-04  
Issue Number: 4

## Original Instructions

For the purposes of compliance with the EU Machinery Directive 2006/42/EC, the English version of this manual is the Original Instructions. Manuals in other languages are Translations of the Original Instructions.

### Documentation

Manuals are available to download from the following locations:

<http://www.drive-setup.com/ctdownloads>

The information contained in this manual is believed to be correct at the time of printing and does not form part of any contract. The manufacturer reserves the right to change the specification of the product and its performance, and the contents of the manual, without notice.

### Warranty and Liability

In no event and under no circumstances shall the manufacturer be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings. The manufacturer is not liable for consequential and incidental damages. Contact the supplier of the drive for full details of the warranty terms.

### Environmental policy

Control Techniques Ltd operates an Environmental Management System (EMS) that conforms to the International Standard ISO 14001.

Further information on our Environmental Policy can be found at:

<http://www.drive-setup.com/environment>

### Restriction of Hazardous Substances (RoHS)

The products covered by this manual comply with European and International regulations on the Restriction of Hazardous Substances including EU directive 2011/65/EU and the Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products.

### Disposal and Recycling (WEEE)



When electronic products reach the end of their useful life, they must not be disposed of along with domestic waste but should be recycled by a specialist recycler of electronic equipment. Control Techniques products are designed to be easily dismantled into their major component parts for efficient recycling. The majority of materials used in the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates. Smaller products are packaged in strong cardboard cartons which have a high recycled fibre content. Cartons can be re-used and recycled. Polythene, used in protective film and bags for wrapping the product, can be recycled. When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

### REACH legislation

EC Regulation 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) requires the supplier of an article to inform the recipient if it contains more than a specified proportion of any substance which is considered by the European Chemicals Agency (ECHA) to be a Substance of Very High Concern (SVHC) and is therefore listed by them as a candidate for compulsory authorisation.

Further information on our compliance with REACH can be found at: <http://www.drive-setup.com/reach>

### Registered Office

**Nidec Control Techniques Ltd**

**The Gro  
Newtown  
Powys  
SY16 3BE  
UK**

Registered in England and Wales. Company Reg. No. 01236886.

## **Copyright**

The contents of this publication are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the guide, without notice.

All rights reserved. No parts of this guide may be reproduced or transmitted in any form or by any means, electrical or mechanical including photocopying, recording or by an information storage or retrieval system, without permission in writing from the publisher.

Copyright © September 2017 Nidec Control Techniques Ltd

---

# Contents

---

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Safety information</b>                         | <b>6</b>  |
| 1.1      | Warnings, Cautions and Notes                      | 6         |
| 1.2      | Installation and use                              | 6         |
| 1.3      | Enclosure   | 6         |
| 1.4      | Competence of the installer                       | 6         |
| 1.5      | Repairs   | 7         |
| 1.6      | Electric Shock and Fire Hazards                   | 7         |
| 1.7      | Electrical installation                           | 7         |
| 1.8      | Setting up, commissioning and maintenance         | 8         |
| 1.9      | Safety of machinery, safety-critical applications | 9         |
| 1.10     | Electromagnetic compatibility (EMC)               | 9         |
| 1.11     | Copyright   | 9         |
| <b>2</b> | <b>Introduction</b>                               | <b>10</b> |
| 2.1      | Products covered by this User Guide               | 10        |
| 2.2      | Firmware Statement                                | 10        |
| 2.3      | What is EtherCAT?                                 | 10        |
| 2.4      | About SI-EtherCAT                                 | 10        |
| 2.5      | Features  | 10        |
| 2.6      | Option module identification                      | 11        |
| 2.7      | Conventions used in this guide                    | 12        |
| <b>3</b> | <b>Mechanical installation</b>                    | <b>13</b> |
| 3.1      | General installation                              | 13        |
| <b>4</b> | <b>Electrical installation</b>                    | <b>16</b> |
| 4.1      | SI-EtherCAT module information                    | 16        |
| 4.2      | SI-EtherCAT terminal descriptions                 | 17        |
| 4.3      | Module grounding and EMC                          | 17        |
| 4.4      | Network topology                                  | 18        |
| 4.5      | Minimum node-to-node cable length                 | 18        |
| <b>5</b> | <b>Getting started</b>                            | <b>19</b> |
| 5.1      | Quick start guide                                 | 19        |
| 5.2      | Quick start flowchart                             | 23        |
| 5.3      | Supported objects                                 | 24        |
| <b>6</b> | <b>Protocols</b>                                  | <b>30</b> |
| 6.1      | Process Data Objects (PDOs)                       | 30        |
| 6.2      | Service Data Object (SDO) parameter access        | 30        |
| 6.3      | CANopen over EtherCAT (CoE)                       | 31        |
| 6.4      | Ethernet over EtherCAT (EoE)                      | 44        |
| 6.5      | Additional position loop scaling                  | 44        |
| 6.6      | Cyclic data loss behaviour                        | 45        |
| <b>7</b> | <b>Drive profile (CiA402) support</b>             | <b>47</b> |
| 7.1      | 0x6040 Controlword                                | 47        |
| 7.2      | 0x6041 Statusword                                 | 48        |
| 7.3      | Common profile features                           | 49        |
| 7.4      | Interpolated position mode                        | 66        |
| 7.5      | vI velocity mode                                  | 68        |
| 7.6      | Homing mode                                       | 74        |
| 7.7      | Cyclic sync position mode                         | 80        |
| 7.8      | Cyclic Synchronous Velocity Mode                  | 82        |
| 7.9      | Cyclic Synchronous Torque Mode                    | 83        |
| 7.10     | Error Handling                                    | 85        |
| <b>8</b> | <b>Advanced features</b>                          | <b>88</b> |
| 8.1      | Distributed clocks                                | 88        |
| 8.2      | SI-EtherCAT protocol support                      | 90        |
| 8.3      | Advanced Cyclic Data Task Configuration           | 90        |

|           |  |            |
|-----------|--|------------|
| <b>9</b>  | <b>Parameter descriptions .....</b>      | <b>92</b>  |
| 9.1       | Internal menus .....                     | 92         |
| 9.2       | Parameter type codes .....               | 92         |
| 9.3       | Single line parameter descriptions ..... | 93         |
| 9.4       | Full parameter descriptions .....        | 95         |
| <b>10</b> | <b>Diagnostics .....</b>                 | <b>106</b> |
| 10.1      | Module identification parameters .....   | 106        |
| 10.2      | SI-EtherCAT module temperature .....     | 106        |
| 10.3      | Error handling .....                     | 106        |
| 10.4      | Drive trip display codes .....           | 109        |
| 10.5      | Option module trips .....                | 110        |
| 10.6      | Updating SI-EtherCAT firmware .....      | 110        |
| 10.7      | Switching frequency .....                | 110        |
| 10.8      | Sync Task Orun trips .....               | 110        |
| 10.9      | EtherCAT AL status codes .....           | 111        |
| 10.10     | SDO abort codes .....                    | 113        |
| <b>11</b> | <b>Glossary of terms .....</b>           | <b>114</b> |

---

# 1 Safety information

---

## 1.1 Warnings, Cautions and Notes



A **Warning** contains information, which is essential for avoiding a safety hazard.



A **Caution** contains information, which is necessary for avoiding a risk of damage to the product or other equipment.

**NOTE** A **Note** contains information, which helps to ensure correct operation of the product.

## 1.2 Installation and use

The information given in this publication is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the manufacturer takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement.

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation of the equipment.



**WARNING - This warning applies to products intended to be used with variable speed drives.**

The adjustable speed drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant which can cause injury. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction.

System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and the instruction manual carefully.

Failure to observe the following instructions can cause physical injury or death, or damage to the equipment.

## 1.3 Enclosure

The drive is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination.

It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

## 1.4 Competence of the installer

The drive must be installed by professional installers who are familiar with the requirements for safety and EMC. The installer is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

## 1.5 Repairs

Users must not attempt to repair a drive if it is faulty. It must be returned to the supplier of the drive.

## 1.6 Electric Shock and Fire Hazards



### **WARNING - Dangerous voltage**

Where products are supplied by or connected to mains voltages, the voltages used can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the equipment. Refer to the relevant documentation.

### 1.6.1 AC supply

The AC supply must be isolated before any servicing work is performed, other than adjustments to the settings or parameters specified in the manual.

### 1.6.2 Live terminals

Some types of signal and control lines carry hazardous voltages (120/ 240 V) and can cause severe electric shock and may be lethal.

### 1.6.3 Isolation device

The AC supply must be removed from the drive using an approved isolation device before any servicing work is performed, other than adjustments to the settings or parameters specified in the manual.

### 1.6.4 Stored charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the power supply has been disconnected. If the drive has been energized, the power supply must be isolated at least ten minutes before work may continue.

## 1.7 Electrical installation

### 1.7.1 Protective Ground (Earth) connection

The ground loop impedance must conform to the requirements of local safety regulations. The drive must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse or circuit breaker) disconnects the supply. The ground connections must be inspected and tested at appropriate intervals.

### 1.7.2 Fuses

The supply to the drive must be installed with suitable protection against overload and short-circuits. The tables in the relevant documentation show recommended fuse ratings. Failure to observe these installation instructions could result in fire.

### 1.7.3 Cables

The cable sizes in the relevant documentation are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables. Failure to observe these installation instructions could result in fire.

### 1.7.4 Terminal connections and torque settings

Loose power connections can be a fire risk. Always ensure that terminals are tightened to the specified torques. Refer to the tables in the relevant documentation.



### **WARNING - Fire Risk**

Braking resistors operate at very high temperatures for short periods. The following precautions are essential to avoid the risk of fire in the event of unexpectedly high braking energy or loss of control of the braking circuit.

- Locate the braking resistor so that inadvertent personal contact with hot surfaces is not possible.
- Do not mount braking resistors on a combustible surface.
- Provide adequate ventilation.
- Mount the braking resistor or reactor in the orientation specified in the data sheet.
- The metal case of the braking resistor must be grounded.
- Use cable with insulation that is capable of withstanding high temperatures.
- Provide independent protection against a loss of control by the braking control system in the drive - refer to the relevant documentation.

### **1.7.5 High voltage insulation (flash) testing**

High voltage insulation (flash) testing should not be carried out on the drive.

### **1.7.6 ELV terminals**

The control terminals are only single insulated from the mains supply, and hence must be prevented from human contact by an additional isolation barrier, for example a terminal cover.

### **1.7.7 SELV terminals**

Drive terminals that are SELV can be safely connected to other SELV equipment.

ELV terminals require an additional insulation barrier between them and other SELV equipment if it is unacceptable to compromise the SELV classification of the SELV equipment.

### **1.7.8 Products connected by plug and socket**

An electric shock hazard exists if the drive is supplied via a plug and socket. When unplugged, the pins of the plug may carry a potentially lethal voltage until the internal capacitors have discharged. This can take up to 10 minutes.

It is recommended that a shrouded plug is used that complies with IEC 60309. If the use of a shrouded plug is not possible, then to avoid any possibility of electric shock from the pins, a means must be provided for automatically isolating the plug from the drive (for example a latching relay).

## **1.8 Setting up, commissioning and maintenance**



It is essential that changes to the drive settings are given careful consideration. Depending on the application, a change could have an impact on safety. Appropriate precautions must be taken against inadvertent changes or tampering. Some specific settings which require particular care are listed below. This is not an exclusive list. Other settings may have an impact on safety in specific applications.

### **1.8.1 Lifting and handling**

Many of the drives weigh in excess of 15 kg (33 lb). Use appropriate safeguards when lifting these models. A full list of drive weights can be found in the installation instructions.

### **1.8.2 Output circuit and motor protection**

The Motor Rated Current parameter must be set correctly to avoid a risk of overheating and fire in the event of motor overload. In some applications motor temperature protection may also be required.

### **1.8.3 STOP, Enable and Safe Torque Off functions (where applicable)**

These functions do not remove dangerous voltages from the equipment or any external option unit, nor do they isolate the motor from dangerous voltages.



## Automatic start

Some parameter settings may cause the motor to start unexpectedly.

## Restore default parameter set

Depending on the application, this may cause unpredictable or hazardous operation.

## 1.9 Safety of machinery, safety-critical applications

Within the European Union all machinery in which this product is used must comply with Machinery Directive 2006/42/EC.

The design of safety-related control systems must only be done by personnel with the required training and experience. The Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application.

## 1.10 Electromagnetic compatibility (EMC)

The product is designed to comply with international standards in a typical installation. Installation instructions are provided in the *Power Installation Guide* and EMC data sheet. If the installation is poorly designed or other equipment does not comply with international standards for EMC, the product might cause or suffer from disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation in the country of use.

Within the European Union, equipment into which this product is incorporated must comply with the Electromagnetic Compatibility Directive 2014/30/EU.

## 1.11 Copyright

The contents of this publication are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the guide, without notice.

All rights reserved. No parts of this publication may be reproduced or transmitted in any form by any means, electrical or mechanical including photocopying, recording or by an information storage or retrieval system, without permission in writing from the publisher.

---

## 2 Introduction

---

### 2.1 Products covered by this User Guide

This User Guide covers the SI-EtherCAT option module.

The SI-EtherCAT is an option module that provides EtherCAT connectivity and can be installed to the following drives:

- Unidrive M200 / M201 (sizes 2 to 9)
- Unidrive M300 (sizes 2 to 9)
- Unidrive M400 (sizes 2 to 9)
- Unidrive M600 (sizes 3 to 11)
- Unidrive M700 / M701 / M702 (sizes 3 to 11)

### 2.2 Firmware Statement

This product is supplied with the latest firmware version. When retro-fitting to an existing system, all firmware versions should be verified to confirm the same functionality as products of the same type already present. This also applies to products returned from a Control Techniques's Service Centre or Repair Centre. If there is any doubt please contact the supplier of the product.

The firmware version of the product can be identified by looking at Pr **MM.002** where MM is the relevant menu number for the module slot being used.

### 2.3 What is EtherCAT?

EtherCAT is an open high performance Ethernet-based fieldbus system that overcomes the system limitations of other Ethernet solutions. The Ethernet packet is no longer received, then interpreted and copied as process data at every connection; instead the Ethernet frame is processed on the fly. The development goal of EtherCAT was to apply Ethernet to automation applications that require short data update times (also called cycle times) with low communication jitter (for synchronization purposes) and low hardware costs. Typical application fields for EtherCAT are machine controls (e.g. semiconductor tools, metal forming, packaging, injection moulding, assembly systems, printing machines, robotics and many others).

Ethercat® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

### 2.4 About SI-EtherCAT

SI-EtherCAT is an option module that enables the Control Techniques Unidrive M range of variable speed drives to be connected to an EtherCAT network as a slave device. It can be used in a variety of applications, from those requiring accurate synchronization and precise motion control, to those where ease of use and open loop control are appropriate.

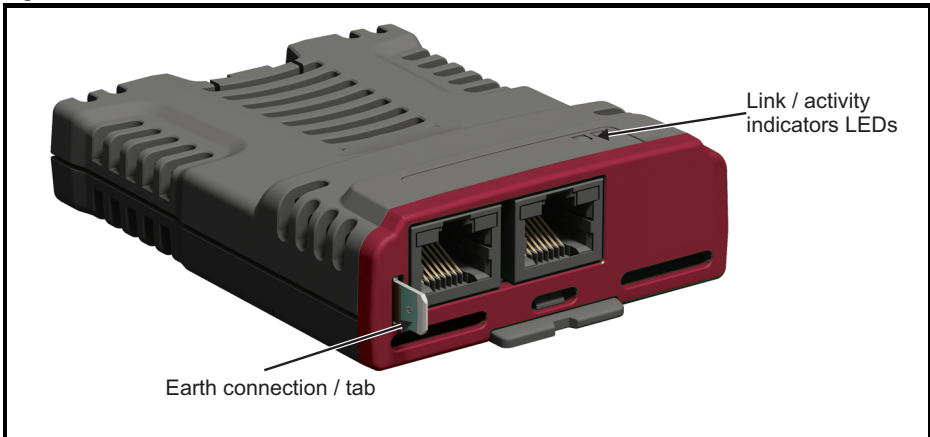
### 2.5 Features

- Standard RJ45 with support for shielded twisted pair, half-duplex / full-duplex and 10 Mbs / 100 Mbs connectivity
- Dual 100 Mbps EtherCAT interfaces for use in line topologies i.e. daisy chaining
- Supports the Unidrive M drives range
- Control loop synchronization
- Control cycle times down to 250 µs
- Configured Station Alias
- CANopen over EtherCAT (CoE) which includes:
  - Support of CANopen CiA402

- Cyclic sync position mode
- Interpolated position mode
- Velocity mode
- Homing mode
- One transmit and one receive PDOs via cyclic synchronous communication
- Additional one transmit and one receive PDOs via non-synchronised cyclic communication
- SDO access to all profile objects and drive parameters
- Cyclic sync velocity mode
- Cyclic sync torque mode

## 2.6 Option module identification

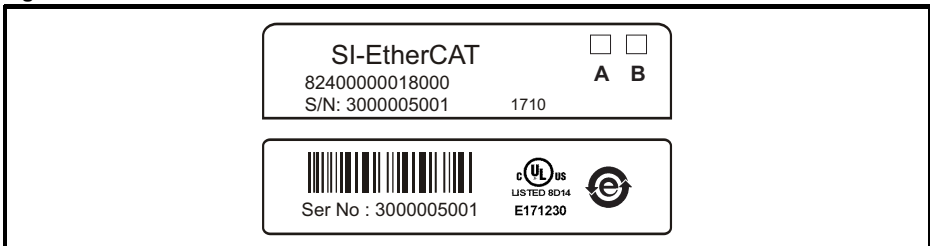
Figure 2-1 SI-EtherCAT



The SI-EtherCAT can be identified by:

- The label located on the underside of the option module.
- The colour coding across the front of the SI-EtherCAT (brown-red).

Figure 2-2 SI-EtherCAT labels



### 2.6.1 Date code format

The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built.

**Example:**

A date code of **1710** would correspond to week 10 of year 2017.

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (CiA402) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

## 2.7 Conventions used in this guide

The configuration of the host drive and option module is done using menus and parameters. A menu is a logical collection of parameters that have similar functionality.

In the case of an option module, the option module set-up parameters in menu 0 will appear in drive menu 15, 16 or 17 depending on which slot the module is installed in.

The setting of the Option Slot Identifiers (Pr **11.056**) may change the slot numbering from those described above.

**NOTE** For M200, M300 and M400 drives, the option module set-up parameters will appear in menu 15.

The method used to determine the menu or parameter is as follows:

- Pr **S.mm.ppp** - Where **S** signifies the option module slot number and **mm.ppp** signifies the menu and parameter number respectively.  
If the option module slot number is not specified then the parameter reference will be a drive parameter.
- Pr **MM.ppp** - Where **MM** signifies the menu allocated to the option module setup menu and **ppp** signifies the parameter number within the set-up menu.
- Pr **mm.000** - Signifies parameter number 000 in any drive menu.

## 3 Mechanical installation

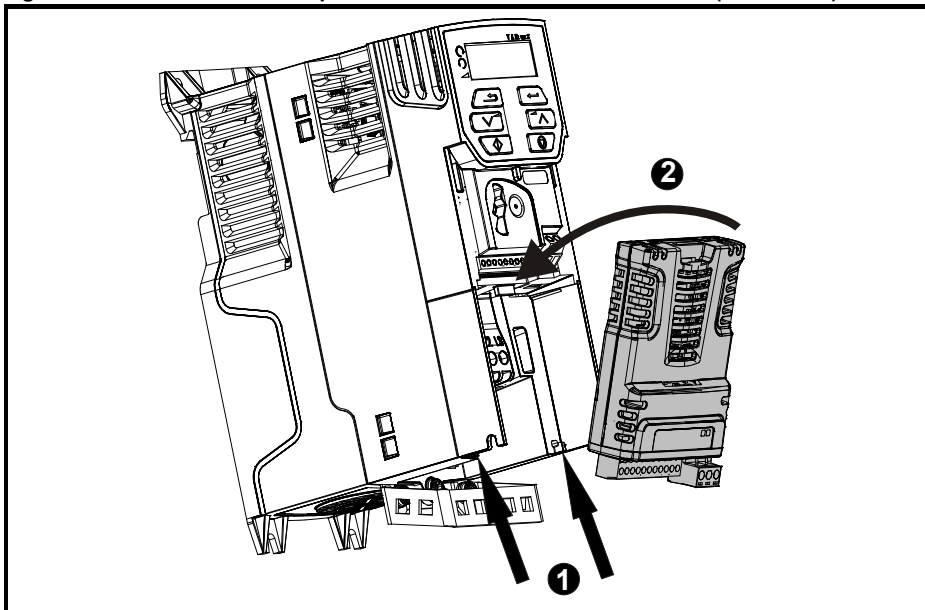


Before installing or removing an option module in any drive, ensure the AC supply has been disconnected for at least 10 minutes and refer to Chapter 1 *Safety information* on page 6. If using a DC bus supply ensure this is fully discharged before working on any drive or option module.

### 3.1 General installation

The installation of an option module is illustrated in Figure 3-1.

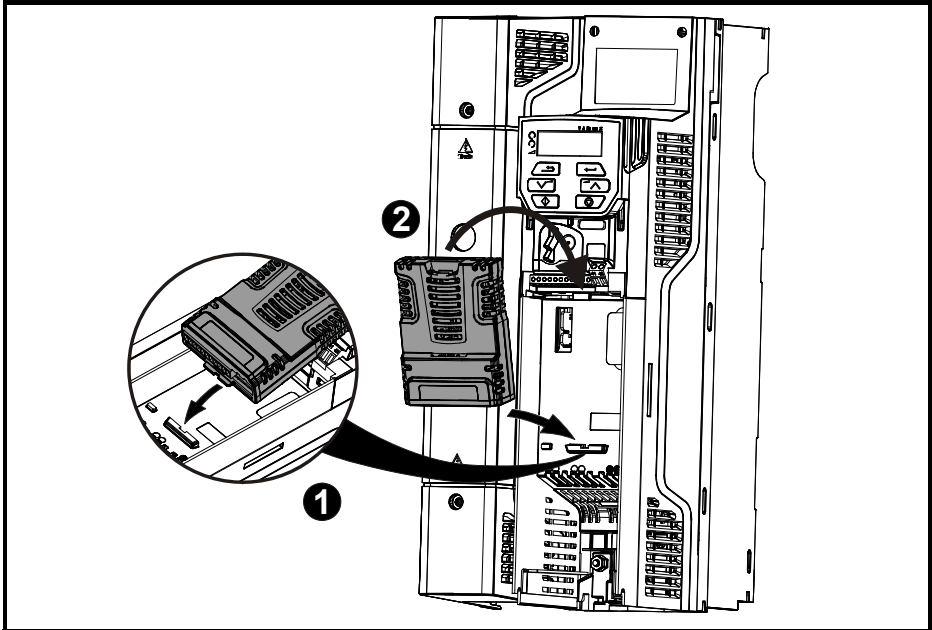
**Figure 3-1** Installation of an SI option module on Unidrive M200 to M400 (sizes 2 to 4)



- With the option module tilted slightly backwards, align and locate the two holes in the rear of the option module onto the two tabs (1) on the drive.
- Place the option module onto the drive as shown in (2) until the module clicks into place. The terminal cover on the drive holds the option module in place, so this must be put back on.

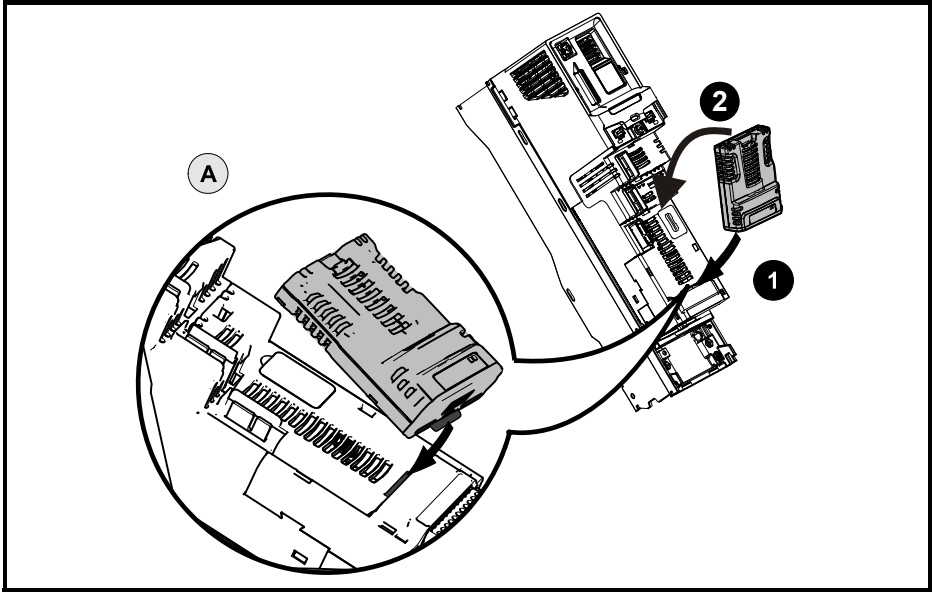
**NOTE** Option modules can only be installed on drives that have the option module slot functionality.

Figure 3-1 Installation of an SI option module on Unidrive M200 to M400 (size 5 to 9)



- Place the option module onto the drive as shown in (2) until the module clicks into place. The terminal cover on the drive holds the option module in place, so this must be put back on.

Figure 3-2 Installation of an SI option module on Unidrive M600 to M702



- Move the option module in direction shown (1/2).
- Align and insert the option module tab in to the slot provided, this is highlighted in the detailed view (A).
- Press down on the option module until it clicks into place.

**NOTE** Option module slots must be used in the following order: Slot 3 (lower), Slot 2 (middle) and then Slot 1(upper).

|                                 |
|---------------------------------|
| Safety Information              |
| Introduction                    |
| <b>Mechanical Installation</b>  |
| Electrical Installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (CI/A402) support |
| Advanced features               |
| Parameter descriptions          |
| Diagnostics                     |
| Glossary of terms               |
| Index                           |

---

## 4 Electrical installation

---

### 4.1 SI-EtherCAT module information

#### 4.1.1 Bus media

The SI-EtherCAT option module incorporates two 100 BASE-TX RJ45 interfaces.

#### 4.1.2 Cabling considerations

To ensure long-term reliability it is recommended that any cables used to connect a system together be tested using a suitable Ethernet cable tester, this is of particular importance when cables are constructed on site.

#### 4.1.3 Cable

Cables should be shielded and as a minimum, meet TIA Cat 5e requirements.

**NOTE** Cabling issues are the single biggest cause of network downtime. Ensure cabling is correctly routed, wiring is correct, connectors are correctly installed and any switches or routers used are rated for industrial use. Office grade Ethernet equipment does not generally offer the same degree of noise immunity as equipment intended for industrial use.

#### 4.1.4 Maximum network length

The main restriction imposed on Ethernet cabling is the length of a single segment of cable. The SI-EtherCAT module has two 100BASE-TX Ethernet ports, which support segment lengths of up to 100 m. This means that the maximum cable length which can be used between one SI-EtherCAT port and another 100BASE-TX port is 100 m however it is not recommended that the full 100 m cable length is used. The total network length is not restricted by the Ethernet standard but depends on the number of devices on the network and the transmission media (copper, fiber optic, etc.).

**NOTE** The EtherCAT system designer must consider the impact that the selected network structure will have on performance.



## 4.2 SI-EtherCAT terminal descriptions

The SI-EtherCAT module has two RJ45 Ethernet ports for the EtherCAT network.

Figure 4-1 SI-EtherCAT connections

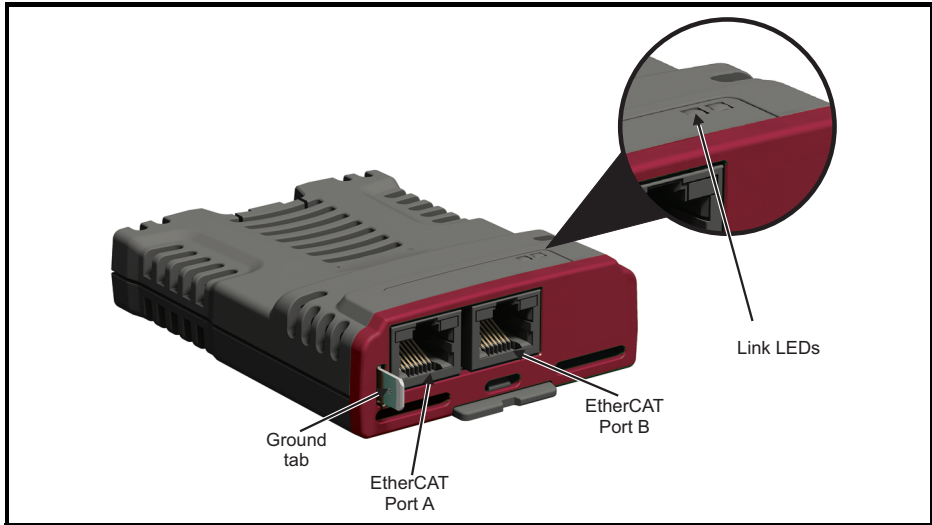


Table 4-1 EtherCAT terminal descriptions

| Pin | A - IN     | Pin | B - OUT    |
|-----|------------|-----|------------|
| 1   | Transmit + | 1   | Transmit + |
| 2   | Transmit - | 2   | Transmit - |
| 3   | Receive +  | 3   | Receive +  |
| 4   | Not used   | 4   | Not used   |
| 5   | Not used   | 5   | Not used   |
| 6   | Receive -  | 6   | Receive -  |
| 7   | Not used   | 7   | Not used   |
| 8   | Not used   | 8   | Not used   |

## 4.3 Module grounding and EMC

SI-EtherCAT is supplied with a grounding tab on the module that should be connected to the closest possible grounding point using the minimum length of cable. This will greatly improve the noise immunity of the module.

It is recommended that the Ethernet cable should be of the shielded type, and connectors should be shielded with a metal body. Tie-wrapping of the Ethernet cable's shield to the grounding bracket of the drive is necessary.

At least one EMC Ferrite inductor should be installed near to each communication port of the SI-EtherCAT module.

At least one EMC Ferrite inductor is necessary near the Master's (PC / PLC) EtherCAT Port. Proper grounding of the EtherCAT cable's shield near the Master (PC / PLC) is necessary.

Drive grounding brackets should be connected to each other by separate cables, and the cable length should be as small as possible.

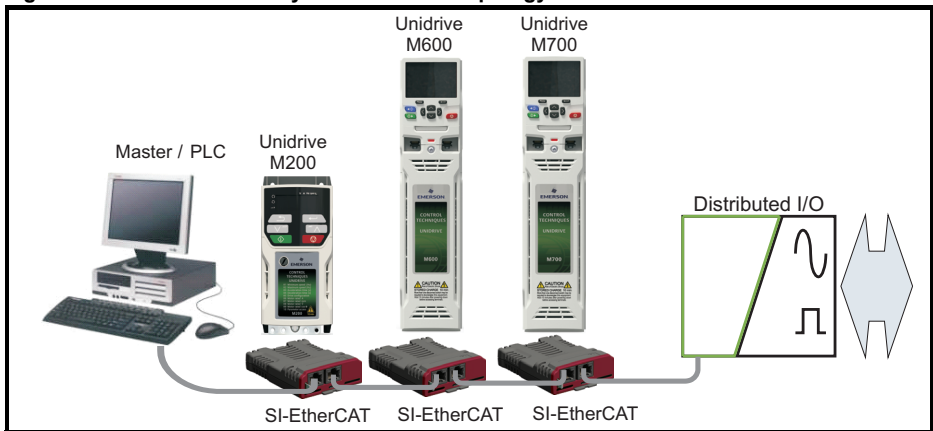
Please note EMC Ferrite inductors of the required specification are available from the following supplier:

Manufacturer: WURTH ELEKTRONIK  
Manufacturer Part No: 74271222  
Order code: 1635620  
Description: Ferrite core, Split type

## 4.4 Network topology

Control Techniques recommend implementing daisy chaining on EtherCAT networks (see Figure 4-2). Other Ethernet network topologies can be used but care must be taken to ensure that the system still operates within the constraints specified by the designer.

**Figure 4-2 SI-EtherCAT daisy chain network topology**



## 4.5 Minimum node-to-node cable length

There is no minimum length of cable recommended in the Ethernet standards. To avoid possible problems it is recommended that you allow sufficient cable length to ensure good bend radii on cables and avoid unnecessary strain on connectors.

# 5 Getting started

## 5.1 Quick start guide

This section is intended to provide a generic guide for setting up SI-EtherCAT with a master/controller PLC. It will cover the basic steps required to get cyclic data communicating using the CANopen over EtherCAT (CoE) protocol on the SI-EtherCAT module.

**Table 5-1 PDO test mappings**

|           | RxPDO1  | TxPDO1   |
|-----------|---|--|
| Mapping 1 | 0x6040 ( <i>controlword</i> )<br>(16-bits)        | 0x6041 ( <i>statusword</i> )<br>(16-bits)            |
| Mapping 2 | 0x6042 ( <i>vl_target_velocity</i> )<br>(16-bits) | 0x6064 ( <i>position_actual_value</i> )<br>(32-bits) |
| Mapping 3 | Pr <b>20.021</b> (32-bits)                        | N/A  |

**NOTE** It is strongly recommended that the latest firmware be used where possible to ensure that all features are supported.

Due to the large number of different masters that support CoE, details cannot be provided for a specific master. Generic support is available through your supplier or local Control Techniques Drive Centre. Before contacting your supplier or local Control Techniques Drive Centre for support please ensure you have read *section 10 Diagnostics* on page 106 of this manual and have checked that the SDO/PDO configurations are correct.

### 5.1.1 SI-EtherCAT XML file

Control Techniques provides EtherCAT device description files (in the form of .xml files). These files provide the master with information about the SI-EtherCAT module and drive configuration to aid with its configuration. These files can be downloaded from the Control Techniques website or from your local Control Techniques Drive Centre or supplier. They should be placed in the directory specified by the master e.g. when using TwinCAT this could be C:\TwinCAT\3.1\Config\lo\EtherCAT.

**NOTE** The master may have to be re-started for the file to be loaded.

### 5.1.2 Configuring the SI-EtherCAT module for cyclic communications

Unlike other Control Techniques fieldbus communication protocols, CoE does not require that any module parameters be changed in order to achieve communications. The baud rate of the network is fixed and the module is automatically allocated an address.

To check that the ethernet cable connected to the SI-EtherCAT module on the drive is connected correctly, look at the LED on the front of the SI-EtherCAT module relating to the connector being used, if this light is a solid green color then a link is established with the master, if this light is off then check the cabling and also check that the master has started communications.

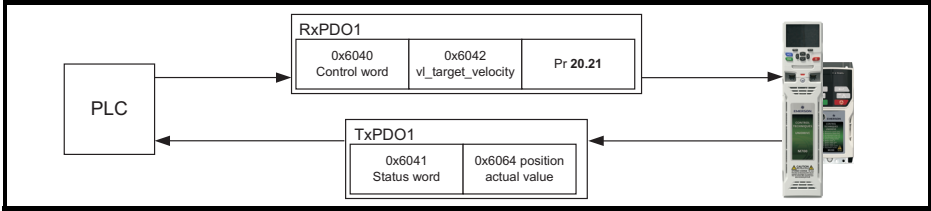
In the master, scan the network ensuring that the SI-EtherCAT module is connected correctly to the master. If the network is configured correctly the SI-EtherCAT node(s) should be visible in the PLC master.

Decide on the input / output data you wish to send cyclically (objects and/or parameters).

Cyclic data is implemented on CoE networks by using "Process Data Objects" or PDOs. Separate data objects are used for receiving (TxPDOs - from the slave to the master) and transmitting (RxPDOs - from the master to the slave) data.

These PDOs contain the cyclic data (objects and/or parameters), the RxPDOs available are 1, 2, 3, 5 and 6, the TxPDOs available are 1, 2, 3, 5 and 6 (for more information on these PDOs including default mappings please see section 6.3.2 *RxPDO mappings* on page 33 and section 6.3.3 *TxPDO mappings* on page 37).

**Figure 5-1 SI-EtherCAT PDO configuration**



RxPDO1 and TxPDO1 will need to be enabled in the master. Once enabled you will need to add mappings to the PDOs.

The format used when mapping objects to PDOs is as follows:

- Index: Object index number (0x0000)
- Sub-index: Object sub-index number (0x00)
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

The format used when mapping drive parameters to PDOs is as follows:

- Index:  $0x2000 + (0x100 \times S) + \text{menu number}$
- Sub-index:  $0x00 + \text{parameter number}$
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

For example Pr **20.21** would be index 0x2014, sub-index 0x15 and the size would be 4 (the parameter is a 32-bit signed value).

**NOTE** The values are normally expressed in hexadecimal, so care must be taken to enter the correct parameter number.

For this example the following objects will need to be set in order to achieve the mappings of the parameters/objects in the PDOs.

**Table 5-2 Cyclic data mapping configuration**

| RxPDO1:    |            | TxPDO1:    |            |
|------------|------------|------------|------------|
| Object:    | 0x1600     | Object:    | 0x1A00     |
| Sub-index: | 0x00       | Sub-index: | 0x00       |
| Size:      | 1          | Size:      | 1          |
| Value:     | 3          | Value:     | 2          |
| Sub-index: | 0x01       | Sub-index: | 0x01       |
| Size:      | 4          | Size:      | 4          |
| Value:     | 0x60400010 | Value:     | 0x60410010 |
| Sub-index: | 0x02       | Sub-index: | 0x02       |
| Size:      | 4          | Size:      | 4          |
| Value:     | 0x60420010 | Value:     | 0x60640020 |
| Sub-index: | 0x03       | Not Used   |            |
| Size:      | 4          |            |            |
| Value:     | 0x20141520 |            |            |

**NOTE** The format used to define the value of a mapped object is as follows:  
 Bit 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).  
 Bit 8 to 15: Sub-index of the mapped object (if a gap, zero).  
 Bit 16 to 31: Index of the mapped object (if a gap, zero).

**NOTE** For M200, M300 and M400 the maximum update time achievable is 4 ms.

### 5.1.3 Configuring the sync managers

The sync manager is used to control the transmission of CANopen PDOs over the EtherCAT network.

SI-EtherCAT module supports two pair of sync managers. In addition to sync manager 2 and sync manager 3 which are used for synchronized cyclic communication, SI-EtherCAT supports sync manager 4 and sync manager 5 which are non-synchronous and can be used for non-synchronized cyclic communication.

The two pair of sync managers can work at the same time in parallel, and each sync manager can be assigned with one PDO (RxPDO or TxPDO).

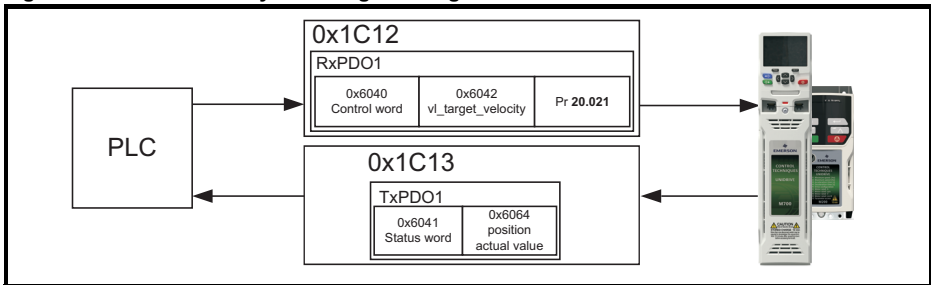
**NOTE** The maximum number of mappings in one PDO is twelve. There are no restrictions on the data length of these parameters (i.e. It is possible to map twelve 32-bit parameters in one PDO).

Special for sync manager 4 and sync manager 5, the number of mappings can be up to thirty two, when PDO 6 (RxPDO 6 or TxPDO 6) is used. These extra number of mappings are helpful to applications which require a large number of non-synchronous low priority data exchange.

**NOTE** The master(PC/PLC) may not support sync manager 4 and sync manager 5, please refer to the master controller documentation for the details on the support for sync manager 4 and sync manager 5.

The following objects 0x1C12 - sync manager 2 PDO assignment (RxPDO) and 0x1C13 - sync manager 3 PDO assignment (TxPDO) are required to assign PDOs to the synchronization task. For the purpose of the example assign one RxPDO to sync manager 2 and one TxPDOs to sync manager 3.

**Figure 5-2 SI-EtherCAT sync manager configuration**



### **Assigning RxPDO to the sync manager**

To assign RxPDO1 to sync manager 2 PDO assignment set the values below to the following objects:

- Index: 0x1C12
- Sub index: 0x00
- Size: 1
- Value: 1

Setting object 0x1C12, sub-index 0 to a value of 1 (as above) indicates that one RxPDO will be assigned to the sync manager 2 assignment.

- Index: 0x1C12
- Sub index: 0x01
- Size: 2
- Value: 0x1600

Setting object 0x1C12, sub-index 1 to a value of 0x1600 (as above) maps RxPDO1 to the process data output sync.

### **Assigning TxPDO to the sync manager**

To assign TxPDO1 to sync manager 3 PDO assignment set the values below to the following objects:

- Index: 0x1C13
- Sub index: 0x00
- Size: 1
- Value: 1

Setting object 0x1C13, sub-index 0 to a value of 1 (as above) indicates that one TxPDOs will be assigned to the sync manager 3 assignment.

- Index: 0x1C13
- Sub index: 0x01
- Size: 2
- Value: 0x1A00

Setting object 0x1C13, sub-index 1 to a value of 0x1A00 (as above) maps TxPDO1 to the process data input sync.

### **Configuring sync manager 4 and sync manager 5**

Similar to the configuration of sync manager 2 and sync manager 3 described above, objects 0x1C14-sync manager 4 PDO assignment (RxPDO) and 0x1C15-sync manager 5 PDO assignment (TxPDO) are used to assign PDOs to non-synchronized task.

Sync manager 4 and sync manager 5 require support from master (PC/ PLC)side. Depending on the master, the PDOs assigned to the sync managers may require to be configured to a different sync unit manually, please refer to the master controller documentation for full details about configuration at master side.

### **Download the configuration to the master.**

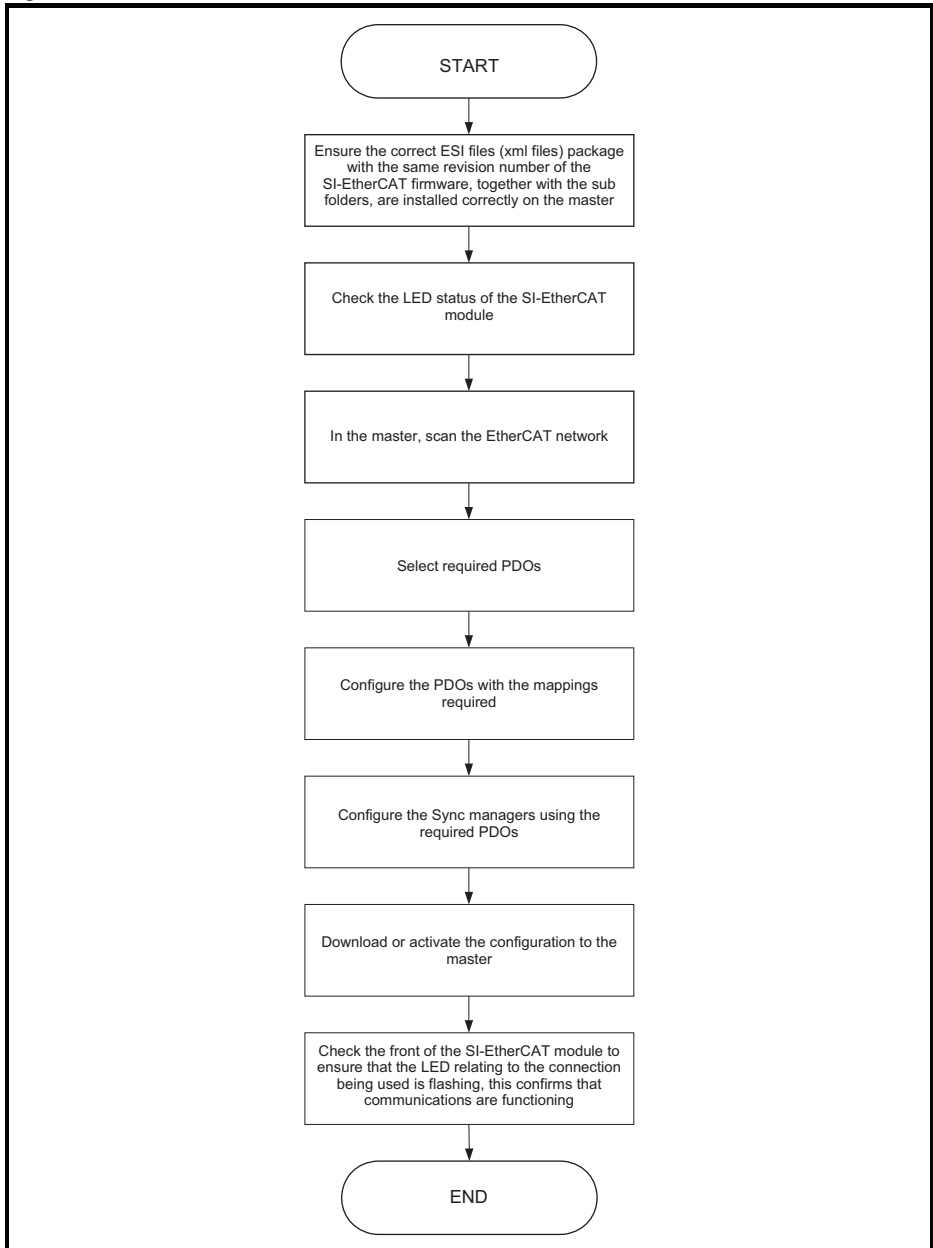
After downloading the configuration to the master the LED(s) on the front of the SI-EtherCAT should flash, depending on the port(s) connected.

Values written to parameters over RxPDOs should now be viewable using the drive's keypad so long as the master has put the slave into the operational state; also, parameter values changed using the drive keypad will be updated on the master.

## 5.2 Quick start flowchart

Figure 5-3 details the steps required to achieve cyclic communications on the EtherCAT network. This flowchart should be used as the starting point for all configurations.

Figure 5-3 Quick start flowchart



|                         |
|-------------------------|
| Safety Information      |
| Introduction            |
| Mechanical Installation |
| Electrical Installation |
| <b>Getting started</b>  |
| Protocols               |
| Drive profile (QIA402)  |
| Advanced features       |
| Parameter descriptions  |
| Diagnostics             |
| Glossary of terms       |
| Index                   |

## 5.3 Supported objects

Table 5-3 lists the objects currently supported by SI-EtherCAT

**Table 5-3 SI-EtherCAT Object Dictionary**

| Object Ref.<br>(0x) | Description  | Data Type |       | Access | Profile  |              |        |             |             |             |
|---------------------|--|-----------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |  | Sub-index | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |  |           |       |        | Y        | Y            | Y      | Y           | Y           | Y           |
| 1000                | Device type  | 0         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1001                | Error register                                     | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1018                | Identity object<br>(Number of last sub-index)      | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Identity object (Vendor ID)                        | 1         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Identity object (Product Code)                     | 2         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Identity object (Software Version)                 | 3         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | (Reserved)   | 4         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1600                | Receive PDO mapping 1<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 1<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1601                | Receive PDO mapping 2<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 2<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1602                | Receive PDO mapping 3<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 3<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1604                | Receive PDO mapping 5<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 5<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1605                | Receive PDO mapping 6<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 6<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1607                | Receive PDO mapping 8<br>(Number of objects)       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Receive PDO mapping 8<br>(Mapped object 1 to si0)  | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1A00                | Transmit PDO mapping 1<br>(Number of objects)      | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 1<br>(Mapped object 1 to si0) | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1A01                | Transmit PDO mapping 2<br>(Number of objects)      | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 2<br>(Mapped object 1 to si0) | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |



| Object Ref.<br>(0x) | Description   | Data Type |       | Access | Profile  |              |        |             |             |             |
|---------------------|---|-----------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |   | Sub-index | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |   |           |       |        |          |              |        |             |             |             |
| 1A02                | Transmit PDO mapping 3<br>(Number of objects)               | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 3<br>(Mapped object 1 to si0)          | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1A04                | Transmit PDO mapping 5<br>(Number of objects)               | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 5<br>(Mapped object 1 to si0)          | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1A05                | Transmit PDO mapping 6<br>(Number of objects)               | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 6<br>(Mapped object 1 to si0)          | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1A07                | Transmit PDO mapping 8<br>(Number of objects)               | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Transmit PDO mapping 8<br>(Mapped object 1 to si0)          | 1 to si0  | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1C00                | Sync manager communication type<br>(Number of SM protocols) | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Sync manager communication type<br>(SM0 Usage)              | 1         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Sync manager communication type<br>(SM1 Usage)              | 2         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Sync manager communication type<br>(SM2 Usage)              | 3         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Sync manager communication type<br>(SM3 Usage)              | 4         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Sync manager communication type<br>(SM4 Usage)              | 5         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1C10                | SM0 PDO assignment<br>(Number of PDOs)                      | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | SM1 PDO assignment<br>(Number of PDOs)                      | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1C12                | SM2 PDO assignment<br>(Number of PDOs)                      | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | SM2 PDO assignment<br>(Assigned PDO index)                  | 1         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1C13                | SM3 PDO assignment<br>(Number of PDOs)                      | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | SM3 PDO assignment<br>(Assigned PDO index)                  | 1         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 1C14                | SM4 PDO assignment<br>(Number of PDOs)                      | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | SM4 PDO assignment<br>(Assigned PDO index)                  | 1         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |

|                         |
|-------------------------|
| Safety Information      |
| Introduction            |
| Mechanical Installation |
| Electrical Installation |
| Getting started         |
| Protocols               |
| Drive profile (CA402)   |
| Advanced features       |
| Parameter descriptions  |
| Diagnostics             |
| Glossary of terms       |
| Index                   |

| Object Ref.<br>(0x) | Description  | Data Type                         |       | Access | Profile  |              |        |             |             |             |
|---------------------|--|-----------------------------------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |  | Sub-index                         | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |  |                                   |       |        |          |              |        |             |             |             |
| 1C15                | SM5 PDO assignment<br>(Number of PDOs)                                   | 0                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | SM5 PDO assignment<br>(Assigned PDO index)                               | 1                                 | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 2smm                | Drive parameter access<br>(s = slot 0x0 to 0xF,<br>mm=menu 0x00 to 0xFF) | pp<br>(pp=par<br>0x00 to<br>0xFF) | [var] | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 3000                | Position feedback encoder configuration                                  | 0                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 3003                | Homing source<br>(Number of last sub-index)                              | 0                                 | USINT | RO     | N        | N            | Y      | N           | N           | N           |
|                     | Homing source<br>(Homing switch source)                                  | 1                                 | USINT | RW     | N        | N            | Y      | N           | N           | N           |
|                     | Homing source<br>(Freeze/marker source)                                  | 2                                 | USINT | RW     | N        | N            | Y      | N           | N           | N           |
| 3004                | Additional position loop scaling<br>(Number of last sub-index)           | 0                                 | USINT | RO     | N        | Y            | Y      | Y           | Y           | Y           |
|                     | Additional position loop scaling<br>(Numerator)                          | 1                                 | DINT  | RW     | N        | Y            | Y      | Y           | Y           | Y           |
|                     | Additional position loop scaling<br>(Denominator)                        | 2                                 | DINT  | RW     | N        | Y            | Y      | Y           | Y           | Y           |
| 3005                | Cyclic data loss behaviour<br>(Number of last sub-index)                 | 0                                 | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Cyclic data loss behaviour<br>(Timeout (ms))                             | 1                                 | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Cyclic data loss behaviour<br>(Timeout (ms))                             | 1                                 | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Cyclic Loss counter  | 3                                 | INT   | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 3006                | Out cyclic data configuration<br>(Number of last sub-index)              | 0                                 | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Out cyclic data configuration<br>(Copy to drive task)                    | 1                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Out cyclic data configuration<br>(Copy from master task)                 | 2                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 3007                | In cyclic data configuration<br>(Number of last sub-index)               | 0                                 | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | In cyclic data configuration<br>(Copy from drive task)                   | 1                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | In cyclic data configuration<br>(Copy to master task)                    | 2                                 | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 3008                | Activate velocity mode redirection                                       | 0                                 | USINT | RW     | Y        | N            | N      | Y           | N           | N           |
| 603F                | Error code   | 0                                 | UINT  | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6040                | Control word   | 0                                 | UINT  | WO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6041                | Status word  | 0                                 | UINT  | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6042                | vl_target_velocity   | 0                                 | INT   | RW     | Y        | N            | N      | N           | N           | N           |
| 6043                | vl_velocity_demand   | 0                                 | INT   | RO     | Y        | N            | N      | N           | N           | N           |

| Object Ref.<br>(0x) | Description  | Data Type |       | Access | Profile  |              |        |             |             |             |
|---------------------|--|-----------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |  | Sub-index | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |  |           |       |        |          |              |        |             |             |             |
| 6044                | vl_velocity_actual_value                                 | 0         | INT   | RO     | Y        | N            | N      | N           | N           | N           |
| 6046                | vl_velocity_min_max_amount<br>(Number of last sub-index) | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_min_max_amount<br>(Minimum velocity (rpm))   | 1         | UDINT | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_min_max_amount<br>(Maximum velocity (rpm))   | 2         | UDINT | RW     | Y        | N            | N      | N           | N           | N           |
| 6048                | vl_velocity_acceleration<br>(Number of last sub-index)   | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_acceleration<br>(Delta speed value (rpm))    | 1         | UDINT | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_acceleration<br>(Delta time value (s))       | 2         | UINT  | RW     | Y        | N            | N      | N           | N           | N           |
| 6049                | vl_velocity_deceleration<br>(Number of last sub-index)   | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_deceleration<br>(Delta speed value (rpm))    | 1         | UDINT | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_deceleration<br>(Delta time value (s))       | 2         | UINT  | RW     | Y        | N            | N      | N           | N           | N           |
| 604A                | vl_velocity_quick_stop<br>(Number of last sub-index)     | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_quick_stop<br>(Delta speed value (rpm))      | 1         | UDINT | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_velocity_quick_stop<br>(Delta time value (s))         | 2         | UINT  | RW     | Y        | N            | N      | N           | N           | N           |
| 604B                | vl_setpoint_factor<br>(Number of last sub-index)         | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_setpoint_factor<br>(Numerator)                        | 1         | INT   | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_setpoint_factor<br>(Denominator)                      | 2         | INT   | RW     | Y        | N            | N      | N           | N           | N           |
| 604C                | vl_dimension_factor<br>(Number of last sub-index)        | 0         | USINT | RO     | Y        | N            | N      | N           | N           | N           |
|                     | vl_dimension_factor<br>(Numerator)                       | 1         | INT   | RW     | Y        | N            | N      | N           | N           | N           |
|                     | vl_dimension_factor<br>(Denominator)                     | 2         | INT   | RW     | Y        | N            | N      | N           | N           | N           |
| 605A                | Quick stop option code                                   | 0         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 605B                | Shutdown option code                                     | 0         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 605C                | Disable operation option code                            | 0         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 605D                | Halt option code   | 0         | INT   | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 605E                | Fault reaction option code                               | 0         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6060                | Modes of operation                                       | 0         | USINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |

|                               |
|-------------------------------|
| Safety Information            |
| Introduction                  |
| Mechanical Installation       |
| Electrical Installation       |
| Getting started               |
| Protocols                     |
| Drive profile (CA402) support |
| Advanced features             |
| Parameter descriptions        |
| Diagnostics                   |
| Glossary of terms             |
| Index                         |

| Object Ref.<br>(0x) | Description   | Data Type |       | Access | Profile  |              |        |             |             |             |
|---------------------|---|-----------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |   | Sub-index | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |   |           |       |        |          |              |        |             |             |             |
| 6061                | Modes of operation display                                | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6062                | Position demand value                                     | 0         | DINT  | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6064                | Position actual value                                     | 0         | DINT  | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6065                | Following error window                                    | 0         | UDINT | RW     | N        | Y            | N      | N           | N           | Y           |
| 6067                | Position window   | 0         | UDINT | RW     | N        | Y            | N      | N           | N           | Y           |
| 606C                | Velocity actual value                                     | 0         | DINT  | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6071                | Target torque   | 0         | INT   | RW     | N        | N            | N      | N           | Y           | N           |
| 6073                | Max current   | 0         | UINT  | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6075                | Motor rated current                                       | 0         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6077                | Torque actual value                                       | 0         | INT   | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6078                | Current actual value                                      | 0         | INT   | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 607A                | Target position   | 0         | DINT  | RW     | N        | N            | N      | N           | N           | Y           |
| 607C                | Home offset   | 0         | DINT  | RW     | N        | N            | Y      | N           | N           | N           |
| 6080                | Max motor speed   | 0         | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6084                | Profile deceleration                                      | 0         | UDINT | RW     | N        | Y            | Y      | Y           | Y           | Y           |
| 6085                | Quick stop deceleration                                   | 0         | UDINT | RW     | N        | Y            | Y      | Y           | Y           | Y           |
| 608F                | Position encoder resolution<br>(Number of last sub-index) | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Position encoder resolution<br>(Encoder increments)       | 1         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Position encoder resolution<br>(Motor revolutions)        | 2         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6091                | Gear ratio<br>(Number of last sub-index)                  | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Gear ratio<br>(Motor revolutions)                         | 1         | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Gear ratio<br>(Shaft revolutions)                         | 2         | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6092                | Feed constant<br>(Number of last sub-index)               | 0         | USINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Feed constant<br>(Feed value)                             | 1         | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
|                     | Feed constant<br>(Shaft revolutions)                      | 2         | UDINT | RW     | Y        | Y            | Y      | Y           | Y           | Y           |
| 6098                | Homing method   | 0         | USINT | RW     | N        | N            | Y      | N           | N           | N           |
| 6099                | Homing speeds<br>(Number of last sub-index)               | 0         | USINT | RO     | N        | N            | Y      | N           | N           | N           |
|                     | Homing speeds<br>(Speed during switch search)             | 1         | UDINT | RW     | N        | N            | Y      | N           | N           | N           |
|                     | Homing speeds<br>(Speed during zero point search)         | 2         | UDINT | RW     | N        | N            | Y      | N           | N           | N           |
| 609A                | Homing acceleration                                       | 0         | UDINT | RW     | N        | N            | Y      | N           | N           | N           |
| 60B1                | Velocity offset   | 0         | DINT  | RW     | N        | N            | N      | Y           | N           | N           |
| 60B2                | Torque offset   | 0         | INT   | RW     | N        | N            | N      | Y           | Y           | Y           |

| Object Ref.<br>(0x) | Description  | Data Type |       | Access | Profile  |              |        |             |             |             |
|---------------------|--|-----------|-------|--------|----------|--------------|--------|-------------|-------------|-------------|
|                     |  | Sub-index | Type  |        | Velocity | Interpolated | Homing | Cyclic Sync | Cyclic Sync | Cyclic Sync |
|                     |  |           |       |        |          |              |        |             |             |             |
| 60C0                | Interpolation sub-mode select                                | 0         | INT   | RW     | N        | Y            | N      | Y           | Y           | Y           |
| 60C1                | Interpolation data record<br>(Number of last sub-index)      | 0         | USINT | RO     | N        | Y            | N      | N           | N           | N           |
|                     | Interpolation data record<br>(Target position)               | 1         | UDINT | RW     | N        | Y            | N      | N           | N           | N           |
| 60C2                | Interpolation time period<br>(Number of last sub-index)      | 0         | USINT | RO     | N        | Y            | N      | Y           | Y           | Y           |
|                     | Interpolation time period<br>(Number of time periods)        | 1         | USINT | RW     | N        | Y            | N      | Y           | Y           | Y           |
|                     | Interpolation time period<br>(Time period exponent)          | 2         | SINT  | RW     | N        | Y            | N      | Y           | Y           | Y           |
| 60F4                | Following error actual value                                 | 0         | DINT  | RO     | N        | Y            | N      | N           | N           | Y           |
| 60FB                | Position control parameter set<br>(Number of last sub-index) | 0         | USINT | RO     | N        | Y            | N      | Y           | Y           | Y           |
|                     | Position control parameter set<br>(Proportional gain)        | 1         | DINT  | RO     | N        | Y            | N      | Y           | Y           | Y           |
|                     | Position control parameter set<br>(Speed feed forward gain)  | 2         | DINT  | RO     | N        | Y            | N      | Y           | Y           | Y           |
| 60FF                | Target velocity  | 0         | DINT  | RW     | N        | N            | N      | Y           | N           | N           |
| 6502                | Supported drive modes  | 0         | UDINT | RO     | Y        | Y            | Y      | Y           | Y           | Y           |

|                         |
|-------------------------|
| Safety Information      |
| Introduction            |
| Mechanical Installation |
| Electrical Installation |
| Getting started         |
| Protocols               |
| Drive profile (C1A402)  |
| Advanced features       |
| Parameter descriptions  |
| Diagnostics             |
| Glossary of terms       |
| Index                   |

---

# 6 Protocols

---

## 6.1 Process Data Objects (PDOs)

Cyclic data is implemented on EtherCAT networks by using "Process Data Objects" or PDOs. Separate data objects are used for transmitting (TxPDOs) and receiving (RxPDOs) data. PDO configuration objects are usually pre-configured in the EtherCAT master controller and downloaded to the SI-EtherCAT at network Initialization using SDOs.

## 6.2 Service Data Object (SDO) parameter access

The service data object (SDO) provides access to all objects in the EtherCAT object dictionary and the drive parameters are mapped into the object dictionary as 0x2XXX objects in the following way:

Index:  $0x2000 + (0x100 \times S) + \text{menu number}$

Sub-index:  $0x00 + \text{parameter number}$

For example Pr **20.021** would be index 0x2014 and the sub-index would be 0x15. The values are usually expressed in base 16 (hexadecimal), so care must be taken to enter the correct parameter number.

All other supported entries in the SI-EtherCAT object dictionary can also be accessed using SDOs. Refer to the master controller documentation for full details about implementing SDO transfers within the particular master controller.

### Bit parameter mapping

When mapping to drive bit parameters, the parameter is stored in the drive as an 8-bit value, therefore for correct operation, the data type SINT (short integer) should be used for mapping to these parameters.

The following table shows the drive bit parameter value for a given value in the EtherCAT master.

| EtherCAT Value |          | Parameter Value |
|----------------|----------|-----------------|
| Decimal        | Hex (0x) |                 |
| -128 to 0      | 80 to 00 | 0 (Off)         |
| 1 to 127       | 01 to 7F | 1 (On)          |

**NOTE** This is contrary to other option modules where any value other than zero will result in the parameter being set to a 1 (On).

**NOTE** Sub-index 0 for any menu will return the highest sub-index available for the object (i.e. the highest parameter number).

**NOTE** The following SDO services are supported:

- Initiate SDO Download (Write)
- Initiate SDO Upload (Read)
- Abort SDO Transfer (Error)

## 6.3 CANopen over EtherCAT (CoE)

The CoE protocol over EtherCAT uses a modified form of the CANopen object dictionary. This is specified in Table 6-1.

**Table 6-1 CoE object dictionary**

| Index            | Object dictionary area     |
|------------------|----------------------------|
| 0x0000 to 0x0FFF | Data type area             |
| 0x1000 to 0x1FFF | CoE communication area     |
| 0x2000 to 0x5FFF | Manufacturer specific area |
| 0x6000 to 0x9FFF | Profile area               |
| 0xA000 to 0xFFFF | Reserved area              |

The object description format describes object related information such as size, range and descriptions and is detailed in Table 6-2.

**Table 6-2 Object description format**

| <index>                    | <object name>  |              |              |
|----------------------------|----------------|--------------|--------------|
| Sub-index 0                |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |

For entries having sub-indices

**Table 6-3 Object description format with sub-indices**

| <index>                    | <object name>  |              |              |
|----------------------------|----------------|--------------|--------------|
| Sub-index 0                |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |
| Sub-index 1                |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |
| Sub-index ...              |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |
| Sub-index n-1              |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |
| Sub-index n                |                |              |              |
| Access: <access>           | Range: <range> | Size: <size> | Unit: <unit> |
| Default: <default>         | Type: <type>   |              |              |
| Description: <description> |                |              |              |

## Definitions:

- <index>: A signed 16-bit number. This is the index of the object dictionary entry specified in four hexadecimal characters.
- <access>: A value describing how the object may be accessed (RW = read/write, RO = read-only and WO = write-only).
- <size>: The size of the object/sub-index in bytes.
- <unit>: The physical unit (e.g. ms, counts per second etc.).
- <type>: Data type:-

| Data type | Size (bytes) | Range                                  | Description             |
|-----------|--------------|--|-------------------------|
| USINT     | 1            | 0 to 255                               | Unsigned short integer  |
| SINT      | 1            | -128 to 127                            | Signed short integer    |
| UINT      | 2            | 0 to 65535                             | Unsigned integer        |
| INT       | 2            | -32768 to 32767                        | Signed integer          |
| UDINT     | 4            | 0 to 2 <sup>32</sup>                   | Unsigned double integer |
| DINT      | 4            | -2 <sup>31</sup> to 2 <sup>31</sup> -1 | Signed double integer   |

### 6.3.1 CoE communication area

The first set of objects specify general communication settings.

**Table 6-4 Device type object**

| 0x1000       | Device type   |               |             |
|--------------|---|---------------|-------------|
| Access: RO   | Range: N/A  | Size: 4 bytes | Unit: N/A   |
| Default:     | Dependent on drive type / mode (see description).   |               | Type: UDINT |
| Description: | <p>The primary CoE functional profile is CiA402, so the value of this object is defined as follows:</p> <p>Bits 0 to 15 (Device Profile Number): 402<br/>           Bit 16 (Frequency Converter): x<br/>           Bit 17 (Servo Drive): y<br/>           Bit 18 (Stepper Motor): 0<br/>           Bit 24 (DC Drive - Control Techniques specific): 0<br/>           Bits 25-31 (Manufacturer specific): 0</p> <p>This value will be dependent on the drive operating mode and / or type. On Unidrive M600 and above in the open-loop, RFC-A or Regen modes or on Unidrive M200 - M400, bit 16 will be set, while bit 17 will be clear. On Unidrive M600 and above in RFC-S mode, bit 17 will be set, while bit 16 will be clear.</p> |               |             |



**Table 6-5 Identity object**

| 0x1018       |  | Identity object |           |
|--------------|--|-----------------|-----------|
| Sub-index 0  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 1 byte    | Unit: N/A |
| Default:     | 4  | Type: USINT     |           |
| Description: | The number of the last sub-index in this object.   |                 |           |
| Sub-index 1  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | 0x000000F9 (249)   | Type: UDINT     |           |
| Description: | This contains the EtherCAT Technology Group vendor ID for Control Techniques (0x000000F9).   |                 |           |
| Sub-index 2  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | 0x01mmvvt  | Type: UDINT     |           |
| Description: | Product code.<br>This contains the drive product code.<br>Byte0 (tt): Drive type (0 = Leroy Somer; 1 = Mentor MP; 2 = M600/M700; 3 = M100 to M400; 4 = MEV; 5 = Elevator ES)<br>Byte1 (vv): Drive variant/derivative (derived from Pr <b>11.028</b> )<br>Byte2 (mm): Drive mode (derived from Pr <b>11.084</b> )<br>Byte3 (gg): Drive generation (0 = Unidrive SP; 1 = Unidrive M) |                 |           |
| Sub-index 3  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | Derived from Pr <b>S.00.002</b>  | Type: UDINT     |           |
| Description: | Module firmware version in the format <i>major.minor.version.build</i>   |                 |           |
| Sub-index 4  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | 0  | Type: UDINT     |           |
| Description: | A value of zero will be returned rather than the module serial number  |                 |           |

### 6.3.2 RxPDO mappings

Objects with indices from 0x1600 to 0x17FF specify receive PDO mappings. The mappings from CiA402 are included as standard (the PDO mappings will have the following default values).

**Table 6-6 RxPDO mappings**

| PDO No. | Mapped object indices | Mapped default object names       |
|---------|-----------------------|-----------------------------------|
| 1       | 0x6040                | controlword                       |
| 2       | 0x6040<br>0x6060      | controlword<br>modes_of_operation |
| 3       | 0x6040<br>0x607A      | controlword<br>target_position    |
| 5       | 0x6040<br>0x6071      | controlword<br>target_torque      |
| 6       | 0x6040<br>0x6042      | controlword<br>vl_target_velocity |
| 8       | 0x2006:2A             | drive controlword                 |

The RxPDO mapping objects are defined in the following tables. Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file (specified as “CF” in the following descriptions).

**NOTE** PDO number 8 is only configured in XML configuration file for Unidrive M600 and above working in regen mode.

Depending on the drive type and operation mode, not all the RxPDO mappings are defined in the XML configuration file.

**Table 6-7 RxPDO mapping 1**

| <b>0x1600</b>  |   | <b>Receive PDO mapping 1</b> |           |
|--|---|------------------------------|-----------|
| Sub-index 0: Number of mapped objects                  |   |                              |           |
| Access: RW   | Range: 0 to 12  | Size: 1 byte                 | Unit: N/A |
| Default: 1   | Type: USINT   |                              |           |
| Description: The number of mapped objects in the PDO   |   |                              |           |
| Sub-index 1: 1st mapped object                         |   |                              |           |
| Access: RW   | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes                | Unit: N/A |
| Default: 0x60400010 - the CiA402 control word (0x6040) | Type: UDINT   |                              |           |
| A mapping to an object with the following format:      |   |                              |           |
| Description:   | Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |                              |           |

**Table 6-8 RxPDO mapping 2**

| <b>0x1601</b>   |   | <b>Receive PDO mapping 2</b> |           |
|---|---|------------------------------|-----------|
| Sub-index 0: Number of mapped objects                               |   |                              |           |
| Access: RW  | Range: 0 to 12  | Size: 1 byte                 | Unit: N/A |
| Default: 2  | Type: USINT   |                              |           |
| Description: The number of mapped objects in this PDO.              |   |                              |           |
| Sub-index 1: 1st mapped object                                      |   |                              |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes                | Unit: N/A |
| Default: 0x60400010 - the CiA402 control word (0x6040)              | Type: UDINT   |                              |           |
| A mapping to an object with the following format:                   |   |                              |           |
| Description:  | Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |                              |           |
| Sub-index 2: 2nd mapped object                                      |   |                              |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes                | Unit: N/A |
| Default: 0x60600008 - the CiA402 modes of operation object (0x6060) | Type: UDINT   |                              |           |
| A mapping to an object with the following format:                   |   |                              |           |
| Description:  | Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |                              |           |

**Table 6-9 RxPDO mapping 3**

| <b>0x1602 Receive PDO mapping 3</b>   |   |               |           |
|---------------------------------------|---|---------------|-----------|
| Sub-index 0: Number of mapped objects |   |               |           |
| Access: RW                            | Range: 0 to 12  | Size: 1 byte  | Unit: N/A |
| Default:                              | 2   | Type: USINT   |           |
| Description:                          | The number of mapped objects in this PDO.   |               |           |
| Sub-index 1: 1st mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x60400010 - the CiA402 control word (0x6040)   | Type: UDINT   |           |
| Description:                          | A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero).  |               |           |
| Sub-index 2: 2nd mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x607A0020 - the CiA402 target position (0x607A).   | Type: UDINT   |           |
| Description:                          | A mapping to an object with the following format:<br><br>A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |               |           |

**Table 6-10 RxPDO mapping 5**

| <b>0x1604 Receive PDO mapping 5</b>   |   |               |           |
|---------------------------------------|---|---------------|-----------|
| Sub-index 0: Number of mapped objects |   |               |           |
| Access: RW                            | Range: 0 to 12  | Size: 1 byte  | Unit: N/A |
| Default:                              | 2   | Type: USINT   |           |
| Description:                          | The number of mapped objects in this PDO.   |               |           |
| Sub-index 1: 1st mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x60400010 - the CiA402 control word (0x6040)   | Type: UDINT   |           |
| Description:                          | A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero).  |               |           |
| Sub-index 2: 2nd mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x60710010 - the CiA402 target torque (0x6071).   | Type: UDINT   |           |
| Description:                          | A mapping to an object with the following format:<br><br>A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |               |           |

**Table 6-11 RxPDO mapping 6**

| <b>0x1605</b>                         |   |               |           |
|---------------------------------------|---|---------------|-----------|
| <b>Receive PDO mapping 6</b>          |   |               |           |
| Sub-index 0: Number of mapped objects |   |               |           |
| Access: RW                            | Range: 0 to 32  | Size: 1 byte  | Unit: N/A |
| Default:                              | 2   | Type: USINT   |           |
| Description:                          | The number of mapped objects in this PDO.   |               |           |
| Sub-index 1: 1st mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x60400010 - the CiA402 control word (0x6040)   | Type: UDINT   |           |
| Description:                          | A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero).  |               |           |
| Sub-index 2: 2nd mapped object        |   |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x60420010 - the CiA402 vl target velocity (0x6042)   | Type: UDINT   |           |
| Description:                          | A mapping to an object with the following format:<br>A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |               |           |

**Table 6-12 RxPDO mapping 8**

| <b>0x1607</b>                         |  |               |           |
|---------------------------------------|--|---------------|-----------|
| <b>Receive PDO mapping 8</b>          |  |               |           |
| Sub-index 0: Number of mapped objects |  |               |           |
| Access: RW                            | Range: 0 to 12   | Size: 1 byte  | Unit: N/A |
| Default:                              | 1  | Type: USINT   |           |
| Description:                          | The number of mapped objects in this PDO.  |               |           |
| Sub-index 1: 1st mapped object        |  |               |           |
| Access: RW                            | Range: 0 to 0xFFFFFFFF   | Size: 4 bytes | Unit: N/A |
| Default:                              | 0x20062A10 - Drive control word (Pr <b>06.042</b> )  | Type: UDINT   |           |
| Description:                          | A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap is required, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |               |           |

### 6.3.3 TxPDO mappings

Objects with the indices from 0x1A00 to 0x1BFF specify transmit PDO mappings. The following mappings from CiA402 are included as standard.

**Table 6-13 TxPDO mappings**

| PDO number | Mapping object index | Mapping object name                                    |
|------------|----------------------|--|
| 1          | 0x6041               | <i>statusword</i>                                      |
| 2          | 0x6041<br>0x6061     | <i>statusword</i><br><i>modes_of_operation_display</i> |
| 3          | 0x6041<br>0x6064     | <i>statusword</i><br><i>position_actual_value</i>      |
| 5          | 0x6041<br>0x6077     | <i>statusword</i><br><i>torque_actual_value</i>        |
| 6          | 0x6041<br>0x6044     | <i>statusword</i><br><i>vl_velocity_actual_value</i>   |
| 8          | 0x200A:28            | <i>drive statusword</i>                                |

The PDO mapping objects are defined below. Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file.

**NOTE** Depending on the drive type and operation mode, not all the TxPDO mappings are defined in the XML configuration file.

**Table 6-14 TxPDO mapping 1**

| 0x1A00  | Transmit PDO mapping 1  |               |           |
|---|---|---------------|-----------|
| Sub-index 0: Number of mapped objects                 |   |               |           |
| Access: RW  | Range: 0 to 12  | Size: 1 byte  | Unit: N/A |
| Default: 1  | Type: USINT   |               |           |
| Description: The number of mapped objects in the PDO  |   |               |           |
| Sub-index 1: 1st mapped object                        |   |               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF  | Size: 4 bytes | Unit: N/A |
| Default: 0x60410010 - the CiA402 status word (0x6041) | Type: UDINT   |               |           |
| A mapping to an object with the following format:     |   |               |           |
| Description:  | Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |               |           |

**Table 6-15 TxPDO mapping 2**

| <b>0x1A01</b>   |  | <b>Transmit PDO mapping 2</b> |           |
|---|--|-------------------------------|-----------|
| Sub-index 0: Number of mapped objects   |  |                               |           |
| Access: RW  | Range: 0 to 12   | Size: 1 byte                  | Unit: N/A |
| Default:  | 2  | Type: USINT                   |           |
| Description: The number of mapped objects in this PDO.  |  |                               |           |
| Sub-index 1: 1st mapped object  |  |                               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF   | Size: 4 bytes                 | Unit: N/A |
| Default:  | 0x60410010 - the CiA402 status word (0x6041)                       | Type: UDINT                   |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                               |           |
| Sub-index 2: 2nd mapped object  |  |                               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF   | Size: 4 bytes                 | Unit: N/A |
| Default:  | 0x60610008 - the CiA402 modes of operation display object (0x6061) | Type: UDINT                   |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                               |           |

**Table 6-16 Tx PDO mapping 3**

| <b>0x1A02</b>   |  | <b>Transmit PDO mapping 3</b> |           |
|---|--|-------------------------------|-----------|
| Sub-index 0: Number of mapped objects   |  |                               |           |
| Access: RW  | Range: 0 to 12                                   | Size: 1 byte                  | Unit: N/A |
| Default:  | 2  | Type: USINT                   |           |
| Description: The number of mapped objects in this PDO.  |  |                               |           |
| Sub-index 1: 1st mapped object  |  |                               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                           | Size: 4 bytes                 | Unit: N/A |
| Default:  | 0x60410010 - the CiA402 status word (0x6041)     | Type: UDINT                   |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                               |           |
| Sub-index 2: 2nd mapped object  |  |                               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                           | Size: 4 bytes                 | Unit: N/A |
| Default:  | 0x60640020 - the CiA402 actual position (0x6064) | Type: UDINT                   |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                               |           |

**Table 6-17 TxPDO mapping 5**

| 0x1A04  |  | Transmit PDO mapping 5 |           |
|---|--|------------------------|-----------|
| Sub-index 0: Number of mapped objects   |  |                        |           |
| Access: RW  | Range: 0 to 12                                 | Size: 1 byte           | Unit: N/A |
| Default:  | 2  | Type: USINT            |           |
| Description: The number of mapped objects in this PDO.  |  |                        |           |
| Sub-index 1: 1st mapped object  |  |                        |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                         | Size: 4 bytes          | Unit: N/A |
| Default:  | 0x60410010 - the CiA402 status word (0x6041).  | Type: UDINT            |           |
| Description: A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |  |                        |           |
| Sub-index 2: 2nd mapped object  |  |                        |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                         | Size: 4 bytes          | Unit: N/A |
| Default:  | 0x60770010 - the CiA402 actual torque (0x6077) | Type: UDINT            |           |
| Description: A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |  |                        |           |

**Table 6-18 TxPDO mapping 6**

| 0x1A05  |  | Transmit PDO mapping 6 |           |
|---|--|------------------------|-----------|
| Sub-index 0: Number of mapped objects   |  |                        |           |
| Access: RW  | Range: 0 to 32                                       | Size: 1 byte           | Unit: N/A |
| Default:  | 2  | Type: USINT            |           |
| Description: The number of mapped objects in this PDO.  |  |                        |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                               | Size: 4 bytes          | Unit: N/A |
| Default:  | 0x60410010 - the CiA402 status word (0x6041).        | Type: UDINT            |           |
| Default:  | 0x60410010 - the CiA402 status word (0x6041)         |                        |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                        |           |
| Sub-index 2: 2nd mapped object  |  |                        |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF                               | Size: 4 bytes          | Unit: N/A |
| Default:  | 0x60440010 - the CiA402 actual motor speed (0x6044). | Type: UDINT            |           |
| Description: A mapping to an object with the following format:<br>Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.<br>Bits 8 to 15: Sub-index of the mapped object.<br>Bits 16 to 31: Index of the mapped object. |  |                        |           |

**Table 6-19 TxPDO mapping 8**

| <b>0x1A07</b>   |  | <b>Transmit PDO mapping 8</b> |           |
|---|--|-------------------------------|-----------|
| Sub-index 0: Number of mapped objects                       |  |                               |           |
| Access: RW  | Range: 0 to 12   | Size: 1 byte                  | Unit: N/A |
| Default: 1  | Type: USINT  |                               |           |
| Description: The number of mapped objects in this PDO.      |  |                               |           |
| Sub-index 1: 1st mapped object                              |  |                               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF   | Size: 4 bytes                 | Unit: N/A |
| Default: 0x200A2810 - Drive status word (Pr <b>10.040</b> ) | Type: UDINT  |                               |           |
| A mapping to an object with the following format:           |  |                               |           |
| Description:  | A mapping to an object. This will have the following format:<br>Bits 0 to 7: Length of the mapped object in bits (if a gap is required, bit length of the gap).<br>Bits 8 to 15: Sub-index of the mapped object (if a gap, zero).<br>Bits 16 to 31: Index of the mapped object (if a gap, zero). |                               |           |



### 6.3.4 Sync manager configuration

The sync managers are the EtherCAT means for setting access attributes for different areas of memory and triggering or notifying the application when the memory is accessed. The following objects specify how the sync managers (and thus corresponding memory areas) are utilized by the CoE protocol.

**Table 6-20 Sync manager communication type object**

| <b>0x1C00 Sync manager communication type</b>   |             |              |           |
|---|-------------|--------------|-----------|
| Sub-index 0 - number of sync manager channels used  |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 6  | Type: USINT |              |           |
| Description: The number of sync manager protocols used by the CoE protocol.                       |             |              |           |
| Sub-index 1 - Usage of sync manager 0   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 1  | Type: USINT |              |           |
| Description: Sync manager 0 is used by CoE as the mailbox receive channel (master to slave).      |             |              |           |
| Sub-index 2 - Usage of sync manager 1   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 2  | Type: USINT |              |           |
| Description: Sync manager 1 is used by CoE as the mailbox send channel (slave to master).         |             |              |           |
| Sub-index 3 - Usage of sync manager 2   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 3  | Type: USINT |              |           |
| Description: Sync manager 2 is used by CoE as the process data output (RxPDOx - master to slave). |             |              |           |
| Sub-index 4 - Usage of sync manager 3   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 4  | Type: USINT |              |           |
| Description: Sync manager 3 is used by CoE as the process data input (TxPDOs - slave to master).  |             |              |           |
| Sub-index 5 - Usage of sync manager 4   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 3  | Type: USINT |              |           |
| Description: Sync manager 4 is used by CoE as the process data output (RxPDOx - master to slave). |             |              |           |
| Sub-index 6 - Usage of sync manager 5   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 4  | Type: USINT |              |           |
| Description: Sync manager 5 is used by CoE as the process data input (TxPDOs - slave to master).  |             |              |           |

**Table 6-21 Sync manager 0 PDO assignment object**

| <b>0x1C10 Sync manager 0 PDO assignment</b>   |             |              |           |
|---|-------------|--------------|-----------|
| Sub-index 0   |             |              |           |
| Access: RO  | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default: 0  | Type: USINT |              |           |
| Description: Number of assigned PDOs. The mailbox received sync manager can never have PDOs assigned to it. |             |              |           |

**Table 6-22 Sync manager 1 PDO assignment object**

| <b>0x1C11 Sync manager 1 PDO assignment</b> |  |              |           |
|---|--|--------------|-----------|
| Sub-index 0                                 |  |              |           |
| Access: RO                                  | Range: N/A   | Size: 1 byte | Unit: N/A |
| Default:                                    | 0  | Type: USINT  |           |
| Description:                                | Number of assigned PDOs. The mailbox send sync manager can never have PDOs assigned to it. |              |           |

**Table 6-23 Sync manager 2 PDO assignment object**

| <b>0x1C12 Sync manager 2 PDO assignment</b> |  |               |           |
|---|--|---------------|-----------|
| Sub-index 0                                 |  |               |           |
| Access: RW                                  | Range: 0 to 255  | Size: 1 byte  | Unit: N/A |
| Default:                                    | 1  | Type: USINT   |           |
| Description:                                | The number of RxPDOs assigned to this sync manager (used for process data output).   |               |           |
| Sub-indices 1 to (sub-index 0)              |  |               |           |
| Access: RW                                  | Range: 0x1600 to 0x17FF  | Size: 2 bytes | Unit: N/A |
| Default:                                    | One of the defined RxPDO mappings  | Type: UINT    |           |
| Description:                                | The object index of an RxPDO to assign to this sync manager. The default RxPDO assigned to the object is depending on the drive type and operation mode. For example, with M700 in open loop mode, by default this is assigned to RxPDO mapping 6 ( <i>vl_target_velocity and controlword</i> ), which is 0x1605 in hexadecimal. |               |           |

**Table 6-24 Sync manager 3 PDO assignment object**

| <b>0x1C13 Sync manager 3 PDO assignment</b> |  |               |           |
|---|--|---------------|-----------|
| Sub-index 0                                 |  |               |           |
| Access: RW                                  | Range: 0 to 255  | Size: 1 byte  | Unit: N/A |
| Default:                                    | 1  | Type: USINT   |           |
| Description:                                | The number of TxPDOs assigned to this sync manager (used for process data input).  |               |           |
| Sub-indices 1 to (sub-index 0)              |  |               |           |
| Access: RW                                  | Range: 0x1A00 to 0x1BFF  | Size: 2 bytes | Unit: N/A |
| Default:                                    | One of the defined TxPDO mappings  | Type: UINT    |           |
| Description:                                | The object index of a TxPDO to assign to this sync manager. The default TxPDO assigned to the object is depending on the drive type and operation mode. For example, with M700 in open loop mode, by default this is assigned to TxPDO mapping 6 ( <i>vl_velocity_actual_value and statusword</i> ), which is 0x1A05 in hexadecimal. |               |           |

**Table 6-25 Sync manager 4 PDO assignment object**

| <b>0x1C14 Sync manager 4 PDO assignment</b> |   |               |           |
|---|---|---------------|-----------|
| Sub-index 0                                 |   |               |           |
| Access: RW                                  | Range: 0 to 255   | Size: 1 byte  | Unit: N/A |
| Default:                                    | 1   | Type: USINT   |           |
| Description:                                | The number of RxPDOs assigned to this sync manager (used for low priority process cyclic data). |               |           |
| Sub-index 1 to (sub-index 0)                |   |               |           |
| Access: RW                                  | Range: 0x1A00 to 0x1BFF   | Size: 2 bytes | Unit: N/A |
| Default:                                    | 0   | Type: UINT    |           |
| Description:                                | The object index of a RxPDO to assign to this sync manager.                                     |               |           |

**Table 6-26 Sync manager 5 PDO assignment object**

| 0x1C15 Sync manager 5 PDO assignment |   |               |           |
|--------------------------------------|---|---------------|-----------|
| Sub-index 0                          |   |               |           |
| Access: RW                           | Range: 0 to 255   | Size: 1 byte  | Unit: N/A |
| Default: 1                           | Type: USINT   |               |           |
| Description:                         | The number of TxPDOs assigned to this sync manager (used for low priority process cyclic data). |               |           |
| Sub-index 1 to (sub-index 0)         |   |               |           |
| Access: RW                           | Range: 0x1A00 to 0x1BFF   | Size: 2 bytes | Unit: N/A |
| Default: 0                           | Type: UINT  |               |           |
| Description:                         | The object index of a TxPDO to assign to this sync manager.                                     |               |           |

Sync managers 2 and 3 are used for high-priority deterministic process cyclic data.

Sync managers 4 and 5 are used for low-priority non-deterministic process cyclic data, they support:

- A maximum of 32 x 32-bit parameters allowed in each PDO when PDO6 is used (maximum of 12 x 32-bit parameters only in other PDOs).
- Slot parameter mapping (e.g. SI-Applications Plus menu 7x parameters)
- Note: when using slot parameter mapping, the data size must be 4 bytes (32 bits)
- Minimum cycle time of 2 ms.

### 6.3.5 Feedback encoder source

**Table 6-27 Feedback encoder source**

| 0x3000 Position Feedback Encoder Configuration |  |              |           |
|--|--|--------------|-----------|
| Sub-index 0                                    |  |              |           |
| Access: RW                                     | Range: 0 to 11   | Size: 1 byte | Unit: N/A |
| Default: 0                                     | Type: USINT  |              |           |
| Description:                                   | <p>This specifies the source for position controller feedback, and the source for CiA402 position feedback objects, even when position control is not being performed. This will have a value as follows:</p> <p>0 - The feedback source for the position controller will match the drive motor control feedback source (as specified in menu 3).</p> <p>1 - Drive feedback source, P1 interface.</p> <p>2 - Drive feedback source, P2 interface.</p> <p>3 - Slot 1 position feedback module, P1 interface.</p> <p>4 - Slot 1 position feedback module, P2 interface.</p> <p>5 - Slot 2 position feedback module, P1 interface.</p> <p>6 - Slot 2 position feedback module, P2 interface.</p> <p>7 - Slot 3 position feedback module, P1 interface.</p> <p>8 - Slot 3 position feedback module, P2 interface.</p> <p>11 - Sensorless (the sensorless algorithm estimates position feedback).</p> <p>This value will be ignored on drives where no encoder input is present.</p> <p>This object will be read upon a transition from the EtherCAT Pre-operational state to the Safe-operational state.</p> |              |           |

**NOTE** If the position feedback encoder configuration is changed then the change will only be made active upon a module reset or changing the mode of operation (0x6060), however, if the module is reset to activate the change then a "Sync Task Orun" trip may be seen.

**NOTE** The value of objects 0x3000 will be ignored on drives which do not support position feedback.

## 6.4 Ethernet over EtherCAT(EoE)

This protocol allows standard Ethernet messages and protocols to be tunnelled through the EtherCAT network; it is an EtherCAT mailbox protocol which provides a means to fragment Ethernet frames and pass the fragments within EtherCAT datagrams.

It is possible to upgrade the host drive firmware via EoE for M600 and above drive.

**NOTE** When a drive firmware update or a file download via EoE is performed, SI-EtherCAT may report a “Drive Sync Loss” warning and send an AL status code to the master, which will lead the EtherCAT to go back to ‘SafeOp’ state.

Some configuration of the PLC is required to establish the EoE tunnel which involves allocation of IP addresses to the EtherCAT modules and to allow forwarding of packets. This is documented with the PLC documentation.

Some additional configuration of the routing tables within the PC is also required to allow the PC operating system to know to route the packets via the PLC. This is standard network routing configuration required whenever there is a gateway or router between it and the destination network.

## 6.5 Additional position loop scaling

For the cases where different feedback devices with different resolutions are required for the drive velocity loop and the position loop, scaling of the position loop output will be provided.

When the value of these objects are configured to non-default values, they will be applied to the AMC scaling ratio. It will be simplified and multiplied to the AMC output user unit's ratio.

In order to prevent the overflow risk of AMC scaling parameters, before the new AMC output user unit's ratio taking action, it will be checked to make sure the numerator and the denominator of the multiplied result are within 1 to  $2^{31}-1$  range. If outside the range, the AMC scaling ratios will stay at the previous values and the module will trip with ‘APLS Failure’.

**NOTE** This calculation occurs only during certain state transitions.

**Table 6-28 Additional position loop scaling**

| <b>0x3004 Additional position loop scaling</b> |   |               |           |
|--|---|---------------|-----------|
| Sub-index 0                                    |   |               |           |
| Access: RO                                     | Range: N/A  | Size: 1 byte  | Unit: N/A |
| Default: 2                                     | Type: USINT   |               |           |
| Description:                                   | The number of the last sub-index in this object.        |               |           |
| Sub-index 1                                    |   |               |           |
| Access: RW                                     | Range: 1 to 0xFFFFFFFF                                  | Size: 4 bytes | Unit: N/A |
| Default: 1                                     | Type: UDINT   |               |           |
| Description:                                   | The additional position loop output scaling numerator   |               |           |
| Sub-index 2                                    |   |               |           |
| Access: RW                                     | Range: 1 to 0xFFFFFFFF                                  | Size: 4 bytes | Unit: N/A |
| Default: 1                                     | Type: UDINT   |               |           |
| Description:                                   | The additional position loop output scaling denominator |               |           |

## 6.6 Cyclic data loss behaviour

If the timeout period in sub-index 1 is set to 0 then no PDO loss actions will occur. If sub-index 1 is set to a non-zero value and no mapped synchronous PDOs have been accessed for longer than a specified timeout period according to Sub-index 1, the cyclic data loss behaviour will occur.

The drive will first be stopped using the Fault reaction option code object; while this is occurring, the PDO Loss alarm will be set. The cyclic data loss trip will occur according to the setting in Sub-index 2. A setting will also be provided to allow a cyclic data loss trip to be forced instantly, if required, regardless of the Fault reaction option code. The number of missed cyclic data objects will be counted and stored in Sub-index 3.

Cyclic data loss detection is only provided for default data task configuration (0x3006, 0x3007).

**Table 6-29 Cyclic data loss behaviour**

| 0x3005       |   | Cyclic data loss behaviour |           |
|--------------|---|----------------------------|-----------|
| Sub-index 0  |   |                            |           |
| Access: RO   | Range: N/A  | Size: 1 byte               | Unit: N/A |
| Default: 2   |   | Type: USINT                |           |
| Description: | The number of the last sub-index in this object.  |                            |           |
| Sub-index 1  |   |                            |           |
| Access: RW   | Range: 0 to 65535   | Size: 2 byte               | Unit: ms  |
| Default: 0   |   | Type: UINT                 |           |
| Description: | <p>The maximum time, in ms, allowed between accesses to synchronous PDOs (read or writes). If no PDO access occurs for this period, the option will start cyclic data loss handling. If a value of zero is set, no cyclic data loss handling will occur.</p> <p>When used in modes that provide interpolation, thus having a mode-specific cycle time, the loss must be for the duration of (maximum time) cycle. The maximum time will be aligned to the start of a cycle.</p> <p>So for a position cycle time of 4 ms and a maximum time configuration of 6 ms, this would result in a loss detection of 2 cycles or 8 ms of PDO's. The time will always be rounded up to the next cycle. If the maximum time is configured to less than the cycle time then this will be rounded up to the cycle time.</p> <p>For a time of 0 ms the cyclic data loss detection will not trigger for any loss.</p> |                            |           |
| Sub-index 2  |   |                            |           |
| Access: RW   | Range: 0 to 3   | Size: 1 byte               | Unit: N/A |
| Default: 0   |   | Type: USINT                |           |
| Description: | <p>Cyclic Data Loss Action; the value will select an action as follows:</p> <p>0: a trip will never occur; however, a cyclic data loss will still be handled by initiating a motor stop according to the Fault reaction option code and indicating an alarm as previously described.</p> <p>1: the cyclic data loss trip will occur only after the motor has been stopped according to the Fault reaction option code; in so far as the motor stop can actually be detected, depending on the feedback actually in use, if any.</p> <p>2: a trip will occur immediately on cyclic data loss (this implies that the motor will coast; no other motor stop will be initiated).</p> <p>3: no trip and no motor stop.</p>   |                            |           |
| Sub-index 3  |   |                            |           |
| Access: RO   | Range: 0 to 32767   | Size: 2 byte               | Unit: N/A |
| Default: 0   |   | Type: INT                  |           |
| Description: | <p>Cyclic loss counter</p> <p>Provides an indication of the number of PDO's lost.</p> <p>The counter is limited so when it reaches 32767 it stops counting.</p> <p>The counter is reset when the EtherCAT profile mode is changed.</p>  |                            |           |

**NOTE**

There are two mechanisms monitoring the cyclic data communication, they are cyclic data loss and PDO loss. Cyclic data loss means the complete cyclic link connection has been lost, for example, unplugging the EtherCAT cable. PDO loss means one or more PDO data packets have been lost within one sync cycle, while the cyclic link connection is still running.

Object 0x3005 configures the behaviour on a cyclic data loss, which allows the user to define the time period of losing cyclic data to be treated as cyclic data loss and what action should the drive take in the event of it.

In the event of the PDO data not being detected within the synchronisation cycle the drive will indicate a 'PDOs Lost' alarm.

# 7 Drive profile (CiA402) support

SI-EtherCAT supports the following modes of the CiA402 profile:

- Homing Mode
- Cyclic Synchronous Position Mode
- Interpolated Position Mode
- vl velocity mode
- Cyclic Synchronous Velocity Mode
- Cyclic Synchronous Torque Mode

## 7.1 0x6040 Controlword

This provides the primary method of controlling the behavior of the drive e.g. enabling, disabling, resetting, etc. Table 7-1 describes the format of the control word. The individual bits are used in combinations (see Table 7-2) to sequence the drive through the state machine described in Figure 7-1.


**Table 7-1 Controlword**

| 0x6040       |   | Controlword       |               |           |  |
|--------------|---|-------------------|---------------|-----------|--|
| Access: RW   |   | Range: 0 to 65535 | Size: 2 bytes | Unit: N/A |  |
| Default:     | N/A   |                   | Type: UINT    |           |  |
| Description: | Provides the primary method of controlling the behavior of the drive. |                   |               |           |  |

| 15       | 14 | 13 | 12 | 11  | 10 | 9   | 8 | 7  | 6   | 5 | 4   | 3  | 2  | 1  | 0  |
|----------|----|----|----|-----|----|-----|---|----|-----|---|-----|----|----|----|----|
| Reserved |    |    |    | ila | r  | oms | h | fr | oms |   | hos | eo | qs | ev | so |

LEGEND: ms = manufacturer-specific; r = reserved; oms = operation mode specific; h = halt; fr = fault reset; hos = homing operation start; eo = enable operation; qs = quick stop; ev = enable voltage; so = switch on

**Table 7-2 Command coding**

| Command                      | Bits of the controlword   |       |       |       |       |
|------------------------------|---|-------|-------|-------|-------|
|                              | Bit 7   | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Shutdown                     | 0   | X     | 1     | 1     | 0     |
| Switch on                    | 0   | 0     | 1     | 1     | 1     |
| Switch on + enable operation | 0   | 1     | 1     | 1     | 1     |
| Disable voltage              | 0   | X     | X     | 0     | X     |
| Quick stop                   | 0   | X     | 0     | 1     | X     |
| Disable operation            | 0   | 0     | 1     | 1     | 1     |
| Enable operation             | 0   | 1     | 1     | 1     | 1     |
| Fault reset                  |  | X     | X     | X     | X     |

NOTE: Automatic transition to Enable operation state after executing SWITCHED ON state functionality.

## 7.2 0x6041 Statusword

This provides feedback about the current operating state of the drive. Table 7-4 describes the format of the status word and illustrates how the individual statusword bits are combined to represent the current state of the drive.

**Table 7-3 Statusword**

| 0x6041       |  | Statusword        |  |               |           |
|--------------|--|-------------------|--|---------------|-----------|
| Access: RW   |  | Range: 0 to 65535 |  | Size: 2 bytes | Unit: N/A |
| Default:     | N/A  |                   |  | Type: UINT    |           |
| Description: | This provides feedback about the current operating state of the drive. |                   |  |               |           |

**Table 7-4 Statusword bit functions**

| 15 | 14 | 13 | 12 | 11  | 10 | 9  | 8  | 7 | 6   | 5  | 4  | 3 | 2  | 1  | 0    |
|----|----|----|----|-----|----|----|----|---|-----|----|----|---|----|----|------|
| ms |    |    | ha | ila | tr | rm | ms | w | sod | qs | ve | f | oe | so | rtso |

LEGEND: ms = manufacturer-specific; ha = homing attained; oms = operation mode specific; ila = internal limit active; tr = target reached; rm = remote; w = warning; sod = switch on disabled; qs = quick stop; ve = voltage enabled; f = fault; oe = operation enabled; so = switched on; rtso = ready to switch on

**Table 7-5 State coding**

| Statusword           | State                  |
|----------------------|------------------------|
| xxxx xxxx x0xx 0000b | Not ready to switch on |
| xxxx xxxx x1xx 0000b | Switch on disabled     |
| xxxx xxxx x01x 0001b | Ready to switch on     |
| xxxx xxxx x01x 0011b | Switched on            |
| xxxx xxxx x01x 0111b | Operation enabled      |
| xxxx xxxx x00x 0111b | Quick stop active      |
| xxxx xxxx x0xx 1111b | Fault reaction active  |
| xxxx xxxx x0xx 1000b | Fault                  |

When using CoE to control the motor position, if the status word indicates a fault due to a drive trip, then to clear the fault, the fault reset command should be executed; if the drive is reset by the keypad then the status word will not be reset and will still indicate a fault condition



## 7.3 Common profile features

### 7.3.1 Sequencing control

These are the supported objects used to control the drive:

**Table 7-6 Sequencing control supported objects**

| Index | Name                          |
|-------|-------------------------------|
| 6040  | Controlword                   |
| 6041  | Statusword                    |
| 605B  | shutdown_option_code          |
| 605C  | disable_operation_option_code |
| 605A  | quick_stop_option_code        |
| 605D  | halt_option_code              |
| 605E  | fault_reaction_option_code    |
| 6060  | modes_of_operation            |
| 6061  | modes_of_operation_display    |
| 6080  | max_motor_speed               |
| 6084  | profile_deceleration          |
| 6085  | quick_stop_deceleration       |
| 6502  | supported_drive_modes         |

The behaviour of the sequencing control is shown in Figure 7-1 on page 51. This state machine indicates how the drive will be controlled. Status word is abbreviated to “SW” in the diagram.

The initial state of the CiA402 state machine is “NOT READY TO SWITCH ON”. The module must be in the EtherCAT operational state before any further state transitions can happen. If the module goes back to pre-operational state when the CiA402 state machine is in the “SWITCH ON DISABLED”, “READY TO SWITCH ON”, “SWITCHED ON”, “OPERATION ENABLE” or “QUICK STOP ACTIVE” states, the option will transition to the “NOT READY TO SWITCH ON” state. This implies that the drive will stop according to the configured stopping method and the drive will be inhibited after the motor has stopped.

In the state “QUICK STOP ACTIVE”, the currently selected mode of operation indicates how a quick stop should be handled. When the drive is stopped (using the ramp defined in 0x605A Quick\_Stop\_Option\_Code object), and the Quick stop option code doesn't indicate that the state should remain at “QUICK STOP ACTIVE”, the state will move to “SWITCH ON DISABLED”.

If one of the drive limit switches becomes active, the drive will be slowed down with the ramp specified by the quick stop option code.

The “internal limit active” bit (11) of the status word will be updated in states “OPERATION ENABLED” and “QUICK STOP ACTIVE”. It will be set as soon as the hardware/software limit becomes active, and it will be cleared as soon as the limit becomes inactive. This bit is supported in cyclic sync position mode, cyclic sync velocity mode, interpolation position mode and homing mode.

The default value in mode\_of\_operation will be 2 (i.e. velocity mode) on an Open loop drive or mode, and it will be 8 (Cyclic Sync Position mode) with RFC-A or RFC-S (and on any drive and mode combination that can support position control). It can be changed at any time as long as the motor is at zero speed. If the mode of operation is correct and any associated data is correct, the change will occur and the new operation mode will be reflected in the mode\_of\_operation\_display object. If the mode is invalid, or data is incorrect, the mode of operation will not be changed.

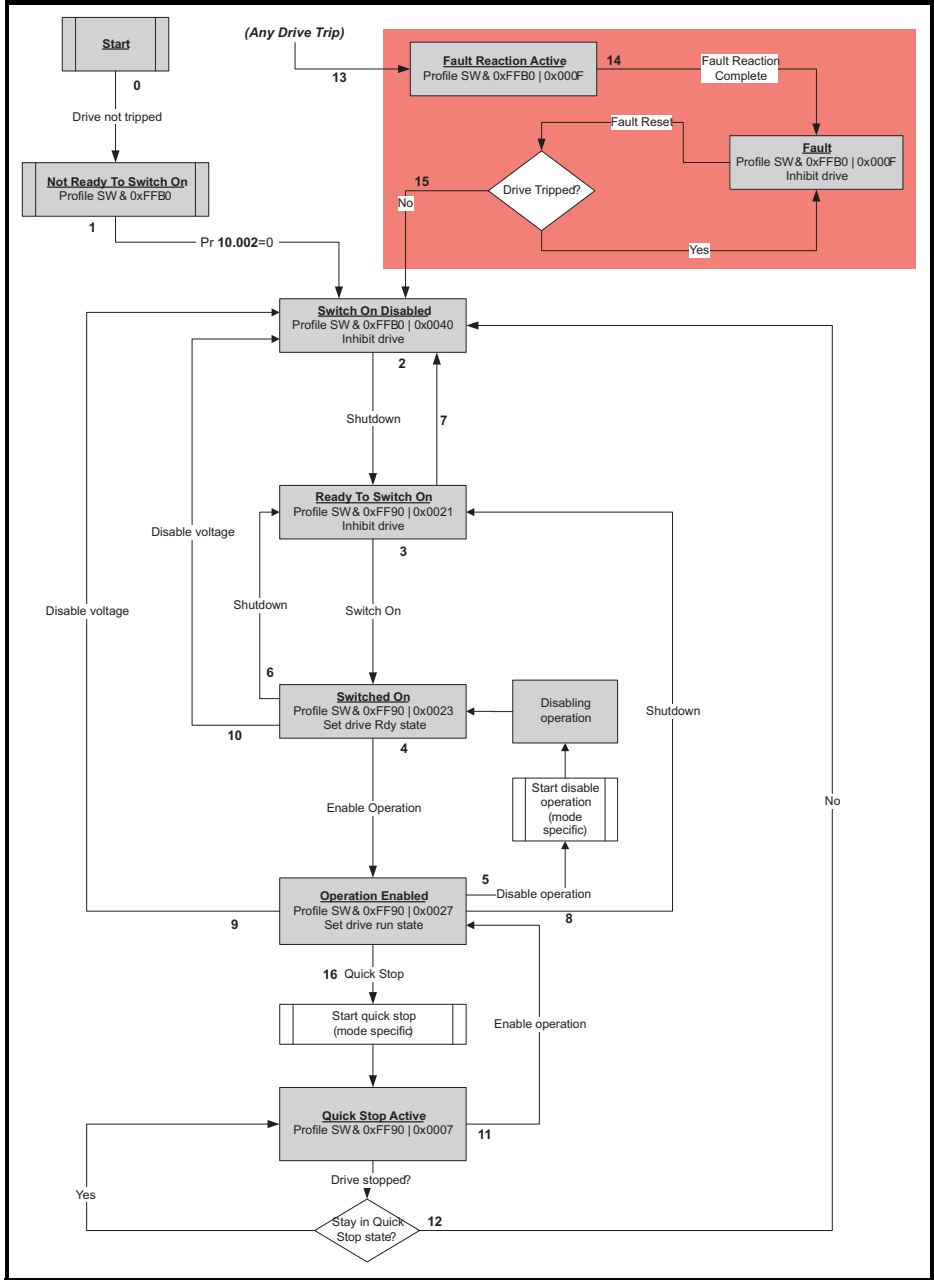
|                                       |
|---------------------------------------|
| Safety Information                    |
| Introduction                          |
| Mechanical Installation               |
| Electrical Installation               |
| Getting started                       |
| Protocols                             |
| <b>Drive profile (CiA402) support</b> |
| Advanced features                     |
| Parameter descriptions                |
| Diagnostics                           |
| Glossary of terms                     |
| Index                                 |

The `mode_of_operation` object is read in all CiA402 states so that the operating mode can be changed at any time, which is necessary for homing: some axes (e.g. vertical axes) have to be homed and start ordinary positioning operation without the need to remove power from the motor, which, on a vertical axis, might allow a tool, to fall and be damaged or cause damage. However, the state machine will not perform a mode change until the motor is at zero speed, as far as can be determined.

The `max_motor_speed` object specifies a maximum speed in RPM; it will have a default value matching the drive parameter Pr **01.006** ("Maximum reference clamp", the object value will be set to the value of Pr **01.006** at power up, or if Pr **01.006** is explicitly changed), and it will be used to set this parameter. It will also be scaled and used to set the position controller output speed clamp (Pr **39.011**). It will be applied in all of the CiA402 operating modes. For example, if the `max_motor_speed` object is set to 6000, the position controller output speed clamp will be set to a value to give a limit of 6000rpm.

The initial value of `gear_ratio`, `feed_constant` and `additional_position_loop_scaling` objects (e.g. user configuration in start-up list) will be checked during the EtherCAT operational state transition 'READY TO SWITCH ON' to 'SWITCHED ON'. During earlier CiA402 state machine transitions, the value of these objects can be changed at any time. However the change won't take effect until a CiA402 state transition from 'READY TO SWITCH ON' to 'SWITCHED ON' happens. If any ratio fails to be applied, the EtherCAT module will not apply new values to the AMC.

Figure 7-1 CoE state machine diagram



|                               |
|-------------------------------|
| Safety Information            |
| Introduction                  |
| Mechanical Installation       |
| Electrical Installation       |
| Getting started               |
| Protocols                     |
| <b>Drive profile (CI-A02)</b> |
| Advanced features             |
| Parameter descriptions        |
| Diagnostics                   |
| Glossary of terms             |
| Index                         |

**Table 7-7 CoE state machine transition and events**

| <b>Transition</b> | <b>Event(s)</b>   | <b>Action(s)</b>  |
|-------------------|---|---|
| 0                 | Automatic transition after power-on or reset application  | Drive device self-test and/or self Initialization shall be performed  |
| 1                 | Automatic transition  | Communication shall be activated  |
| 2                 | Shutdown command from control device or local signal  | None  |
| 3                 | Switch on command received from control device or local signal  | Power section shall be switched on if not already switched on   |
| 4                 | Enable operation command received from control device or local signal   | Drive function shall be enabled and clear all internal set-points   |
| 5                 | Disable operation command received from control device or local signal  | Drive function shall be disabled  |
| 6                 | Shutdown command received from control device or local signal   | The high-power shall be switched off immediately, and the motor shall be free to rotate if not braked; additional action depends on the shutdown option code  |
| 7                 | Quick stop or disable voltage command from control device or local signal   | None  |
| 8                 | Shutdown command from control device or local signal  | The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked   |
| 9                 | Disable voltage command from control device or local signal   | The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked   |
| 10                | Disable voltage or quick stop command from control device or local signal   | The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked   |
| 11                | Quick stop command from control device or local signal  | The quick stop function shall be started  |
| 12                | Automatic transition when the quick stop function is completed and quick stop option code 1, 2, 3 or 4 disable voltage command received from control device (dependant on the quick stop option code) | The power section shall be switched off   |
| 13                | Fault signal  | The configure fault reaction function shall be executed   |
| 14                | Automatic transition  | The drive function shall be disabled; the high-power may be switched off  |
| 15                | Fault reset command from control device or local signal   | A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the controlword shall be cleared by the control device |
| 16                | Enable operation command from control device, if the quick stop option code is 5, 6, 7 or 8   | The drive function shall be enabled   |

### 7.3.2 0x605A Quick stop option code

This object indicates what action is performed when the quick stop function is executed. The slow down ramp is the deceleration value of the used mode of operations.

**Table 7-8 Quick\_stop\_option\_code**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x605A</b> | <b>Quick_stop_option_code</b>   |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: 0 to 6   | Size: 2 bytes | Unit: N/A |
| Default: 2    | Type: INT   |               |           |
| Description:  | Specifies what action is performed in the event of a quick stop function. See Table 7-7 <i>CoE state machine transition and events</i> on page 52 for more information. |               |           |

**Table 7-9 Quick stop value definitions**

| Value | Definition   |
|-------|--|
| 0     | Disable drive function   |
| 1     | Slow down on slow down ramp and transit into Switch on disabled  |
| 2     | Slow down on quick stop ramp and transit into Switch on disabled |
| 5     | Slow down on slow down ramp and stay in Quick stop active        |
| 6     | Slow down on quick stop ramp and stay in Quick stop active       |

### 7.3.3 0x605B Shutdown\_option\_code

This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.

**Table 7-10 Shutdown\_option\_code**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x605B</b> | <b>Shutdown_option_code</b>   |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: -1 to 1  | Size: 2 bytes | Unit: N/A |
| Default: N/A  | Type: INT   |               |           |
| Description:  | Used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state. |               |           |

**Table 7-11 Shutdown\_option\_code values**

| Value | Definition   |
|-------|--|
| 0     | Disable drive function (switch off the drive power stage)  |
| 1     | Slow down with slow down ramp; disable the drive function  |
| -1    | Slow down with slow down ramp, wait for brake to be fully applied (by waiting for Zero Hold (Pr 6.008) to clear); then disable the drive |

### 7.3.4 0x605C Disable\_operation\_option\_code

Disable drive function (switch off the drive power stage).

This object is used to control what action is performed if there is a transition from the 'Operation Enabled' state to the 'Switched On' state.

**Table 7-12 Disabled\_operation\_option\_code**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x605C</b> | <b>Disable_operation_option_code</b>  |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: 0 to 1   | Size: 2 bytes | Unit: N/A |
| Default: N/A  |   |               | Type: INT |
| Description:  | This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Switched On state. |               |           |

**Table 7-13 Disable\_operation\_option\_code values**

| Value | Definition  |
|-------|---|
| 0     | Disable drive function (switch off the drive power stage) |
| 1     | Slow down with slow down ramp; disable the drive function |

**7.3.5 0x605D Halt\_option\_code**

This object shall indicate what action is performed when the halt function is executed.

**Fault\_reaction\_option\_code**

|               |  |                 |           |
|---------------|--|-----------------|-----------|
| <b>0x605D</b> | <b>Halt_option_code</b>  |                 |           |
| Sub-index 0   |  |                 |           |
| Access: RW    | Range: 0 to 2  | Size: Signed 16 | Unit: N/A |
| Default: 0    |  |                 | Type: INT |
| Description:  | This object is used to control what action is performed if a Halt is called. |                 |           |

**Fault\_reaction\_option\_code values**

| Value | Definition  |
|-------|---|
| 0     | Reserved (no action)                                      |
| 1     | Slow down with slow down ramp; stay in Operation enabled  |
| 2     | Slow down with quick stop ramp; stay in Operation enabled |

**7.3.6 0x605E Fault\_reaction\_option\_code**

This object is used to control what action is performed when a fault is detected (PDO loss).

This object is ignored if the drive is tripped.

**Table 7-14 Fault\_reaction\_option\_code**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x605E</b> | <b>Fault_reaction_option_code</b>   |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: 0 to 2   | Size: 2 bytes | Unit: N/A |
| Default: N/A  |   |               | Type: INT |
| Description:  | This object is used to control what action is performed when a fault is detected. |               |           |

**Table 7-15 Fault\_reaction\_option\_code values**

| Value | Definition                                      |
|-------|---|
| 0     | Disable drive function, motor is free to rotate |
| 1     | Slow down on slow down ramp                     |
| 2     | Slow down on quick stop ramp                    |

### 7.3.7 0x6060 Modes\_of\_operation

This object is used to request a change in the mode of operation.

**Table 7-16 Modes\_of\_operation**

|  |                           |              |           |
|--|---------------------------|--------------|-----------|
| <b>0x6060</b>  | <b>Modes_of_operation</b> |              |           |
| Sub-index 0  |                           |              |           |
| Access: RW   | Range: 0 to 10            | Size: 1 byte | Unit: N/A |
| Default: 2   | Type: SINT                |              |           |
| Description: This object is used to request a change in the mode of operation. |                           |              |           |

**NOTE** The default for this object is dependent on the drive operating mode. In Open-loop the default is 2. In RFC-s the default is 8.

**Table 7-17 Modes\_of\_operation values**

| Value | Definition                 |
|-------|----------------------------|
| 0     | No mode change             |
| 2     | vl velocity mode           |
| 6     | Homing mode                |
| 7     | Interpolated Position mode |
| 8     | Cyclic Sync Position mode  |
| 9     | Cyclic Sync Velocity mode  |
| 10    | Cyclic Sync Torque mode    |

### 7.3.8 0x6061 Modes\_of\_operation\_display

This read only object indicates the active mode of operation.

**Table 7-18 Modes\_of\_operation\_display**

|  |                                   |              |           |
|--|-----------------------------------|--------------|-----------|
| <b>0x6061</b>  | <b>Modes_of_operation_display</b> |              |           |
| Sub-index 0  |                                   |              |           |
| Access: RO   | Range: 0 to 10                    | Size: 1 byte | Unit: N/A |
| Default: N/A   | Type: SINT                        |              |           |
| Description: Used to provide the active mode of operation. |                                   |              |           |

**Table 7-19 Modes\_of\_operation\_display values**

| Value | Definition                 |
|-------|----------------------------|
| 0     | No mode change             |
| 2     | vl velocity mode           |
| 6     | Homing mode                |
| 7     | Interpolated Position mode |
| 8     | Cyclic Sync Position mode  |
| 9     | Cyclic Sync Velocity mode  |
| 10    | Cyclic Sync Torque mode    |

### 7.3.9 0x6084 Profile deceleration

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object (0x605A) is set to 1 or 5. This object is also used for shutdown when shutdown option code (0x605B) is set to 1, and for disable operation when disable operation option code (0x605C) is set to 1. It is also used if the fault reaction code object (0x605E) is 1. The value is given in user defined acceleration units. This object will not be used for vl velocity mode. This object will not be used for vl velocity mode.

**Table 7-20 Profile deceleration**

| 0x6084       |  | Profile deceleration |           |
|--------------|--|----------------------|-----------|
| Access: RW   | Range:0 to 65536   | Size: 4 bytes        | Unit: N/A |
| Default:     | 65536  | Type: UDINT          |           |
| Description: | Provides the deceleration ramp for the positioning modes |                      |           |

### 7.3.10 0x6085 Quick\_stop\_deceleration

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object (0x605A) is set to 2 or 6. The quick stop deceleration is also used if the fault reaction code object (0x605E) is 2. The value is given in user-defined acceleration units. This object will not be used for vl velocity mode.

**Table 7-21 Quick\_stop\_deceleration**

| 0x6085       |  | Quick_stop_deceleration |           |
|--------------|--|-------------------------|-----------|
| Sub-index 0  |  |                         |           |
| Access: RW   | Range:Range:0 to 65536                                 | Size: 4 bytes           | Unit: N/A |
| Default:     | 65536  | Type: UDINT             |           |
| Description: | Quick stop function for the positioning related modes. |                         |           |

### 7.3.11 Profile units

The SI-EtherCAT implementation provides a means to convert profile units into position controller and drive units. All scaling values are standard profile objects. The following objects are supported:

**Table 7-22 Supported profile units**

| Index  | Name                               |
|--------|------------------------------------|
| 0x608F | <i>position_encoder_resolution</i> |
| 0x6091 | <i>gear_ratio</i>                  |
| 0x6092 | <i>feed_constant</i>               |

The initial value of the feed constant object (0x6092) shall be calculated from the normalization turns parameter of the associated encoder channel if the default values have not been modified. If either value is non default the values will be taken as is.

For positions, the scaling control will include a feed constant, a gear ratio and an encoder resolution. These values will be combined together to scale the drive position (i.e. encoder increments) to position in user-defined unit by the following formula.

$$\text{user defined unit position} = \frac{\text{drive position} \cdot \text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ratio}}$$

It will be possible to change these values non-cyclically (i.e. using SDOs), It will not, however, be possible to change these values cyclically (i.e. by mapping PDOs to them).



These scaling objects will be combined together to scale drive velocities (i.e. encoder increments per second) to velocity in user-defined unit by the following formula.

$$\text{user defined unit velocity} = \frac{\text{drive velocity} \cdot \text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ration}}$$

It will be possible to change these values non-cyclically (i.e. using SDOs). It will also be necessary to re-scale velocity limit values with the new factor. It will not be possible to change these values cyclically (i.e. by mapping PDOs to them)

The position encoder resolution object 0x608F will be read-only and its value will be derived from drive parameter values. The numerator of 0x608F will be derived from the normalization turns parameter of the associated encoder channel. The denominator of 608F will be always 1.

The user-defined position and velocity values will be handled in signed 32-bit values. The scaled position will rollover the boundary if it is too large.

When the gear ratio or the feed constant is applied, the combination of

$$\frac{\text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ration}}$$

will be calculated and simplified. The result will be applied

to the AMC slave user unit's ratio and its inverse value will be put in the AMC output user unit's ratio. To prevent the overflow risk of AMC ratio parameters, before being applied, the size will be checked to make sure the numerator and the denominator of the combined results are within 1 to  $2^{31}-1$  range. If not, the module will trip with 'Scaling failure' and the AMC scaling ratios will stay previous value.

**NOTE** The Gear ratio object will not be used for Homing mode.

### 7.3.12 0x608F Position\_encoder\_resolution

This read only object indicates the configured encoder increments per number of motor revolutions. The information is read from the drive's encoder configuration.

**Table 7-23 Position\_encoder\_resolution**

| 0x608F   |                        | Position_encoder_resolution |           |
|--|------------------------|-----------------------------|-----------|
| Sub-index 0  |                        |                             |           |
| Access: RO   | Range: N/A             | Size: 1 byte                | Unit: N/A |
| Default: 2   | Type: USINT            |                             |           |
| Description:   |                        |                             |           |
| Sub-index 1  |                        |                             |           |
| Access: RO   | Range: 0 to 0xFFFFFFFF | Size: 4 bytes               | Unit: N/A |
| Default: 65536   | Type: UDINT            |                             |           |
| Description: Encoder increments, derived from the normalization turns of the associate encoder channel |                        |                             |           |
| Sub-index 2  |                        |                             |           |
| Access: RO   | Range: N/A             | Size: 4 bytes               | Unit: N/A |
| Default: 1   | Type: UDINT            |                             |           |
| Description: Motor revolutions, always 1   |                        |                             |           |

### 7.3.13 0x6091 Gear\_ratio

This object is used to apply scaling. When configured, appropriate user units can be used to control the position of the shaft beyond a gearbox. The gear ratio is calculated using the following formula:

$$\text{gear ratio} = \text{motor shaft revolutions} / \text{driving shaft revolutions}$$

Table 7-24 Gear\_ratio

| 0x6091                         |                        | Gear_ratio    |           |
|--------------------------------|------------------------|---------------|-----------|
| Sub-index 0                    |                        |               |           |
| Access: RO                     | Range: N/A             | Size: 1 byte  | Unit: N/A |
| Default: 2                     | Type: USINT            |               |           |
| Description:                   |                        |               |           |
| Sub-index 1                    |                        |               |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 1                     | Type: UDINT            |               |           |
| Description: Motor revolutions |                        |               |           |
| Sub-index 2                    |                        |               |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 1                     | Type: UDINT            |               |           |
| Description: Shaft revolutions |                        |               |           |

### 7.3.14 0x6092 Feed\_constant

This is used to configure a feed constant. This is the measurement distance per one revolution of the output shaft of the gearbox. The feed constant is calculated using the following formula:

$$\text{feed constant} = \text{feed} / \text{driving shaft revolutions}$$

Table 7-25 Feed\_constant

| 0x6092                         |                        | Feed_constant |           |
|--------------------------------|------------------------|---------------|-----------|
| Sub-index 0                    |                        |               |           |
| Access: RO                     | Range: N/A             | Size: 1 byte  | Unit: N/A |
| Default: 2                     | Type: USINT            |               |           |
| Description:                   |                        |               |           |
| Sub-index 1                    |                        |               |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 65536                 | Type: UDINT            |               |           |
| Description: Feed              |                        |               |           |
| Sub-index 2                    |                        |               |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 1                     | Type: UDINT            |               |           |
| Description: Shaft revolutions |                        |               |           |

### 7.3.15 Touch Probe Functionality

#### 7.3.15.1 General touch probe definition

Touch probe function will be supported on Unidrive M600 and above in RFC-S mode and RFC-A mode. It will not be available on Unidrive M600 and above in open-loop or regen mode, or on Unidrive M200 - M400.

Touch probe 1 only will be supported, which will allow a positive and/or a negative edge to be registered and distinguished between; both of the two drive freeze sources will be utilised in order to achieve this function (F1 will be used to detect positive edges and F2 will be used to detect negative edges).

The position capture source of the touch probe 1 will follow the object 0x3000 Position Feedback Encoder Configuration. Currently touch probe function only supports the drive P1 or P2 interface as the position capture source.

The trigger source of the touch probe 1 can be configured to use either: drive digital inputs (currently only digital input 4 and digital input 5 are supported) or, the position encoder zero impulse signal through object 0x60B8 and 0x60D0. When the hardware zero impulse signal is used as the trigger source, the position capture source interface marker input will be used to trigger the freeze system. When the software zero impulse signal is used, the freeze system will be trigger when the normalized position value of the position capture source interface passes through zero in either direction.

The following objects are supported:

| Index | Name                               |
|-------|------------------------------------|
| 60B8  | <i>Touch probe function</i>        |
| 60B9  | <i>Touch probe status</i>          |
| 60BA  | <i>Touch probe 1 positive edge</i> |
| 60BB  | <i>Touch probe 1 negative edge</i> |
| 60D0  | <i>Touch probe source</i>          |

**Table 7-26 Touch probe function**

| 0x60B8   |            | Touche probe function |   |               |
|--|------------|-----------------------|---|---------------|
| Access:  | RW         | Range:                | N/A   | Size: 2 bytes |
| Unit:  | N/A        | Default:              | 0   | Type: UINT    |
| This will specify the touch probe functionality; the following bits are supported: |            |                       |   |               |
| Description:   | <b>Bit</b> | <b>Value</b>          | <b>Definition</b>   |               |
|  | 0          | 0                     | Switch off touch probe 1                                      |               |
|  |            | 1                     | Enable touch probe 1  |               |
|  | 1          | 0                     | Trigger first event   |               |
|  |            | 1                     | Continuous trigger  |               |
|  | 3, 2       | 00 <sub>b</sub>       | Trigger with touch probe 1 input (drive digital input 4)      |               |
|  |            | 01 <sub>b</sub>       | Trigger with hardware zero impulse signal of position encoder |               |
|  |            | 10 <sub>b</sub>       | Touch probe source as defined in object 0x60D0,sub-index 0x01 |               |
|  |            | 11 <sub>b</sub>       | Reserved  |               |
|  | 4          | 0                     | Switch off sampling at positive edge of touch probe 1         |               |
|  |            | 1                     | Enable sampling at positive edge of touch probe 1             |               |
|  | 5          | 0                     | Switch off sampling at negative edge of touch probe 1         |               |
|  |            | 1                     | Enable sampling at negative edge of touch probe 1             |               |
|  | 6-15       | -                     | <Unused; Have no effect>                                      |               |

**Table 7-27 Touch probe status**

| <b>0x60B9</b>   |            | <b>Touch probe status</b>                   |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
|---|------------|---|-----------|-----|-------|------------|---|---|-------------------------------|---|--------------------------|---|---|---|---|---|---|---|---|---|---|------|---|--------------------|
| Access: RO  | Range: N/A | Size: 2 bytes                               | Unit: N/A |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| Default: 0  | Type: UINT |   |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| <p>This indicates the status of the touch probe functionality; the bits, when set, will have the following meanings:</p> <table border="1"> <thead> <tr> <th>Bit</th> <th>Value</th> <th>Definition</th> </tr> </thead> <tbody> <tr> <td rowspan="2">0</td> <td>0</td> <td>Touch probe 1 is switched off</td> </tr> <tr> <td>1</td> <td>Touch probe 1 is enabled</td> </tr> <tr> <td rowspan="2">1</td> <td>0</td> <td>Touch probe 1 no positive edge value stored</td> </tr> <tr> <td>1</td> <td>Touch probe 1 positive edge position stored</td> </tr> <tr> <td rowspan="2">2</td> <td>0</td> <td>Touch probe 1 no negative edge value stored</td> </tr> <tr> <td>1</td> <td>Touch probe 1 negative edge position stored</td> </tr> <tr> <td>3-15</td> <td>-</td> <td>&lt;Unused; Always 0&gt;</td> </tr> </tbody> </table> |            |   |           | Bit | Value | Definition | 0 | 0 | Touch probe 1 is switched off | 1 | Touch probe 1 is enabled | 1 | 0 | Touch probe 1 no positive edge value stored | 1 | Touch probe 1 positive edge position stored | 2 | 0 | Touch probe 1 no negative edge value stored | 1 | Touch probe 1 negative edge position stored | 3-15 | - | <Unused; Always 0> |
| Bit   | Value      | Definition                                  |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| 0   | 0          | Touch probe 1 is switched off               |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
|   | 1          | Touch probe 1 is enabled                    |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| 1   | 0          | Touch probe 1 no positive edge value stored |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
|   | 1          | Touch probe 1 positive edge position stored |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| 2   | 0          | Touch probe 1 no negative edge value stored |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
|   | 1          | Touch probe 1 negative edge position stored |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| 3-15  | -          | <Unused; Always 0>                          |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |
| Description:  |            |   |           |     |       |            |   |   |                               |   |                          |   |   |   |   |   |   |   |   |   |   |      |   |                    |

**Table 7-28 Touch probe source**

| <b>0x60D0</b>   |             | <b>Touch probe source</b> |           |
|---|-------------|---------------------------|-----------|
| Sub-index 0   |             |                           |           |
| Access: RO  | Range: N/A  | Size: 1 byte              | Unit: N/A |
| Default: 1  | Type: USINT |                           |           |
| Description: The number of the highest sub-index of this object |             |                           |           |
| Sub-index 1   |             |                           |           |
| Access: RW  | 1 to 5      | Size: 2 bytes             | Unit: N/A |
| Default: 1  | Type: INT   |                           |           |
| Description: Touch probe 1 source                               |             |                           |           |

The touch probe source can be defined with the following values:

| Value | Definition                                       |
|-------|--|
| 1     | Drive digital input 4                            |
| 2     | Drive digital input 5                            |
| 3     | Not supported                                    |
| 4     | Not supported                                    |
| 5     | Hardware zero impulse signal of position encoder |
| 6     | Software zero impulse signal of position encoder |
| -1    | P1 marker  |
| -2    | P2 marker  |

**Table 7-29 Touch probe 1 positive edge**

| <b>0x60BA</b>   |            | <b>Touch probe 1 positive edge</b> |                                   |
|---|------------|------------------------------------|-----------------------------------|
| Access: RO  | Range: N/A | Size: 4 bytes                      | Unit: User-defined position units |
| Default: 0  | Type: DINT |                                    |                                   |
| Description: This will contain a position value frozen when a positive edge occurred on the touch probe 1 input. The value will only be valid when the positive position stored bit is set. |            |                                    |                                   |

**Table 7-30 Touch probe 1 negative edge**

| 0x60BB       |  | Touch probe 1 negative edge |                                   |
|--------------|--|-----------------------------|-----------------------------------|
| Access: RO   | Range: N/A   | Size: 4 bytes               | Unit: User-defined position units |
| Default: 0   | Type: DINT   |                             |                                   |
| Description: | This will contain a position value frozen when a negative edge occurred on the touch probe 1 input. The value will only be valid when the negative position stored bit is set. |                             |                                   |

The Touch Probe Status (0x60B9), Touch probe 1 positive edge (0x60BA) and Touch probe 1 negative (0x60BB) objects will be updated every 250 μs, and it will be possible to include them in TxPDOs.

The enable touch probe 1 (bit 0), enable positive edge sampling (bit 4) and enable negative edge sampling (bit 5) of the Touch probe function (0x60B8) objects will be read and acted upon every 250 μs.

The other bits of the touch probe function object and the touch probe source object 0x60D0 which are used for touch probe configuration (i.e. trigger source, trigger mode) will be acted up on in the background. However the touch probe configuration will not manipulate the drive freeze system until first time enabled, this is to make sure customer configuration for the drive freeze system will not be changed if they are not using touch probe. After drive system first been configured, the new touch probe configuration will take effect when the CANopen state machine leaves operating states (i.e. operation-enabled and quick-stop-active).

It will be possible to include touch probe function object 0x60B8 in the RxPDOs. The touch probe source (0x60D0) object can only be accessed by SDO.

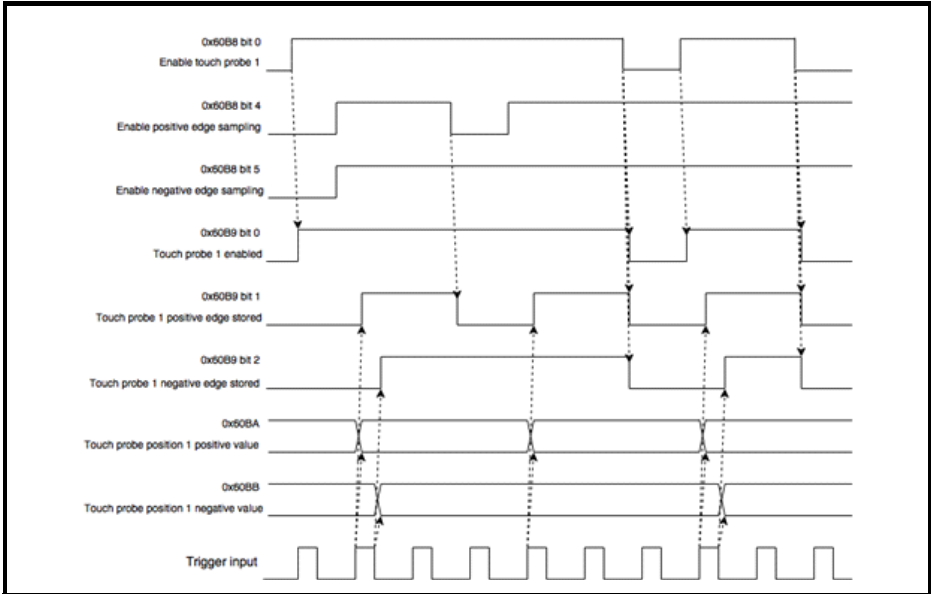
### 7.3.15.2 Trigger mode of touch probe

There are two trigger modes that can be configured via trigger mode (bit 1) of the touch probe function object (0x60B8):

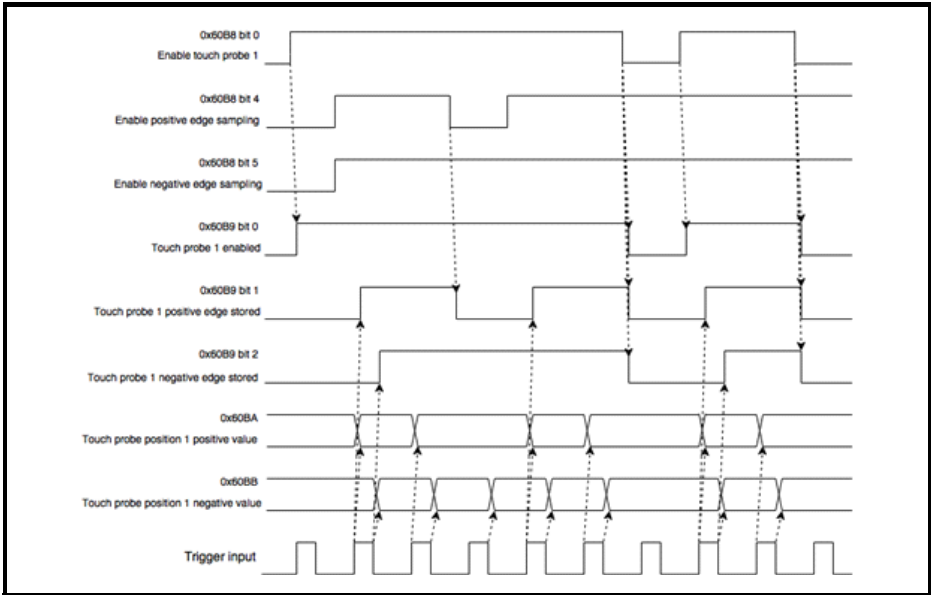
- Trigger first event: this mode captures the position and set the position stored bit when the first event of the trigger source occurs. The further events won't be captured until the enable bit(s) is cleared and reset.
- Continuous: this mode captures the position each time an event occurs from the trigger source. The position stored bit will only set for the first trigger, no further indication when additional events occur. The value in the stored position object(s) will reflect the most recent record. The position stored bit will be cleared once the associate enable bit is cleared, however the stored position will retain.

Here are two example timing diagrams, to explain the operation sequence of the touch probe function:

**Figure 7-3 Trigger first event (0x60B8 bit1 = 0)**



**Figure 7-4 Continuous (0x60B8 bit1 = 1)**



### 7.3.16 Basic position control

Basic position control is supported on the Unidrive M600 and above in RFC-A and RFC-S modes. The position control described here is used under the interpolated position mode of operation. Table 7-31 lists the objects that are supported:

**Table 7-31 Basic position control supported objects**

| Index  | Name                                  |
|--------|---------------------------------------|
| 0x6062 | <i>position_demand_value</i>          |
| 0x6065 | <i>following_error_window</i>         |
| 0x6067 | <i>position_window</i>                |
| 0x60F4 | <i>following_error_actual_value</i>   |
| 0x60FB | <i>position_control_parameter_set</i> |

### 7.3.17 0x6062 Position\_demand\_value

This read only object is used to provide the currently demanded position value. The value is given in user defined position units.

**Table 7-32 Position\_demand\_value**

| 0x6062       |  | Position_demand_value |           |
|--------------|--|-----------------------|-----------|
| Sub-index 0  |  |                       |           |
| Access: RO   | Range: 0x80000000 to 0x7FFFFFFF                        | Size: 4 bytes         | Unit: N/A |
| Default:     | N/A  | Type: DINT            |           |
| Description: | Used to provide the currently demanded position value. |                       |           |

### 7.3.18 0x6064 Position\_actual\_value

This read only object provides the actual value of the position feedback device. The value is given in internal units.

**Table 7-33 Position\_actual\_value**

| 0x6064       |  | Position_actual_value |           |
|--------------|--|-----------------------|-----------|
| Sub-index 0  |  |                       |           |
| Access: RO   | Range: 0x80000000 to 0x7FFFFFFF  | Size: 4 bytes         | Unit: N/A |
| Default:     | N/A  | Type: DINT            |           |
| Description: | This read only object provides the actual value of the position feedback device. The value is given in internal units. |                       |           |

### 7.3.19 Following error window

This object can be used to indicate and configure the range of position values, symmetrical to the position demand value, outside of which a following error occurs. The value is given in user-defined position units.

**Table 7-34 Following error window**

|  |  |                               |  |                               |  |           |  |
|--|--|-------------------------------|--|-------------------------------|--|-----------|--|
| <b>0x6065</b>  |  |                               |  | <b>Following error window</b> |  |           |  |
| Sub-index 0  |  |                               |  |                               |  |           |  |
| Access: RW   |  | Range: Range: 0 to 0x7FFFFFFF |  | Size: 4 bytes                 |  | Unit: N/A |  |
| Default: 0x7FFFFFFF  |  | Type: UDINT                   |  |                               |  |           |  |
| Description: Permitted range of position values before a following error occurs. |  |                               |  |                               |  |           |  |

**7.3.20 Position window**

This object can be used to indicate and configure the symmetrical range of acceptable position values relative to the target position, within which the target position will be regarded as having been reached. The value is given in user-defined position units.

**Table 7-35 Position window**

|  |  |                        |  |                        |  |           |  |
|--|--|------------------------|--|------------------------|--|-----------|--|
| <b>0x6067</b>  |  |                        |  | <b>Position window</b> |  |           |  |
| Sub-index 0  |  |                        |  |                        |  |           |  |
| Access: RW   |  | Range: 0 to 0x7FFFFFFF |  | Size: 4 bytes          |  | Unit: N/A |  |
| Default: 0x7FFFFFFF  |  | Type: UDINT            |  |                        |  |           |  |
| Description: Permitted range of position values for target position to be regarded as reached. |  |                        |  |                        |  |           |  |

**7.3.21 Motor rated current**

This object indicates the configured motor rated current. The value is given in mA.

**Table 7-36 Motor rated current**

|  |  |                        |  |                            |  |          |  |
|--|--|------------------------|--|----------------------------|--|----------|--|
| <b>0x6075</b>  |  |                        |  | <b>Motor rated current</b> |  |          |  |
| Sub-index 0  |  |                        |  |                            |  |          |  |
| Access: RW   |  | Range: 0 to 0xFFFFFFFF |  | Size: 4 bytes              |  | Unit: mA |  |
| Default: 0xFFFFFFFF  |  | Type: UDINT            |  |                            |  |          |  |
| Description: Motor rated current value derived from Pr <b>05.007</b> . |  |                        |  |                            |  |          |  |

**7.3.22 0x6080 Max motor speed****Table 7-37 Max motor speed**

|   |  |                   |  |                        |  |           |  |
|---|--|-------------------|--|------------------------|--|-----------|--|
| <b>0x6080</b>   |  |                   |  | <b>Max motor speed</b> |  |           |  |
| Sub-index 0   |  |                   |  |                        |  |           |  |
| Access: RW  |  | Range: 0 to 40000 |  | 4 bytes                |  | Unit: rpm |  |
| Default: N/A  |  | Type: UDINT       |  |                        |  |           |  |
| Description: This object indicates the configured maximum allowed speed for the motor in either direction. It is used to protect the motor and changing the value of this object will also change Pr <b>1.006</b> . The value is given in rotations per minute (rpm). Changing Pr <b>1.006</b> will also automatically update the value in the objects. |  |                   |  |                        |  |           |  |

**7.3.23 0x60F4 Following\_error\_actual\_value**

This read only object provides the actual value of the following error. The value is given in user-defined position units.



**Table 7-38 Following\_error actual\_value**

| <b>0x60F4</b>  |                        |               |           | <b>Following_error actual_value</b> |
|--|------------------------|---------------|-----------|-------------------------------------|
| Sub-index 0  |                        |               |           |                                     |
| Access: RO   | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |                                     |
| Default:   | N/A                    | Type: DINT    |           |                                     |
| Description: This read only object provides the actual value of the following error. |                        |               |           |                                     |

**7.3.24 0x60FB Position\_control\_parameter\_set object**

**Table 7-39 Position\_control\_parameter\_set object**

| <b>0x60FB</b>   |                         |               |                                   | <b>Position_control_parameter_set</b> |
|---|-------------------------|---------------|-----------------------------------|---------------------------------------|
| Sub-index 0   |                         |               |                                   |                                       |
| Access: RO  | Range: N/A              | Size: 1 byte  | Unit: N/A                         |                                       |
| Default:  | 2                       | Type: USINT   |                                   |                                       |
| Description: The number of control loop parameters.           |                         |               |                                   |                                       |
| Sub-index 1   |                         |               |                                   |                                       |
| Access: RW  | Range: 0 to 500000      | Size: 4 bytes | Unit: Depends on Pr <b>39.007</b> |                                       |
| Default:  | 2500                    | Type: DINT    |                                   |                                       |
| Description: The position controller proportional gain.       |                         |               |                                   |                                       |
| Sub-index 2   |                         |               |                                   |                                       |
| Access: RW  | Range: 0 to 2000        | Size: 2 bytes | Unit: Depends on Pr <b>39.010</b> |                                       |
| Default:  | 1000 (i.e. a gain of 1) | Type: INT     |                                   |                                       |
| Description: The position controller speed feed forward gain. |                         |               |                                   |                                       |

The AMC position controller (Advanced Motion Controller) kernel is used by the basic internal position control, this object is only available with M600 and above drives when the AMC is enabled. The *position\_demand\_value* object contains the value supplied by either the interpolated position mode or the profile position mode (in user units). It is updated every control loop cycle. The values in the *position\_control\_parameter\_set* will be read in the background, so they cannot be mapped cyclically (i.e. including them in PDOs is not allowed).

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (CI-A02) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

### 7.3.25 Supported drive modes

This object provides information on the supported drive modes.

**Table 7-40 Supported drive modes**

| 0x6502  |    | Supported drive modes  |     |  |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|---|----|------------------------|-----|--|-----------|--|----|----|----|----|----|----|---|---|---|---|---|---|---|---|----|---|-------|-----|-----|-----|----|----|---|----|----|----|----|--|--|
| Sub-index 0   |    |                        |     |  |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| Access: RO  |    | Range: 0 to 0xFFFFFFFF |     | Size: 4 bytes                                    | Unit: N/A |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| Default: N/A  |    | Type: UDINT            |     |  |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| Provides information on the supported drive modes as shown below.   |    |                        |     |  |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| <table border="1"> <tr> <td>31</td><td>16</td><td>15</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td> </tr> <tr> <td>ms</td><td>r</td><td>cstca</td><td>cst</td><td>csv</td><td>csp</td><td>ip</td><td>hm</td><td>r</td><td>tq</td><td>pv</td><td>vl</td><td>pp</td><td></td><td></td> </tr> </table> |    |                        |     |  |           | 31   | 16 | 15 | 11 | 10 | 9  | 8  | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | ms | r | cstca | cst | csv | csp | ip | hm | r | tq | pv | vl | pp |  |  |
| 31  | 16 | 15                     | 11  | 10   | 9         | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1 | 0 |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| ms  | r  | cstca                  | cst | csv  | csp       | ip   | hm | r  | tq | pv | vl | pp |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
| Description:  |    |                        |     |  |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | <b>Mnemonic</b>        |     | <b>Description</b>                               |           | <b>Value</b>   |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | r                      |     | Reserved   |           | 0  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | ms                     |     | Manufacturer specific bits                       |           | 0 = Function is not supported<br>1 = Function is supported |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | cstca                  |     | Cyclic sync torque mode with communication angle |           | 0 = Mode is not supported<br>1 = Mode is supported         |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | cst                    |     | Cyclic sync torque mode                          |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | csv                    |     | Cyclic sync velocity mode                        |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | csp                    |     | Cyclic sync position mode                        |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | ip                     |     | Interpolated position mode                       |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | hm                     |     | Homing mode                                      |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | tq                     |     | Torque profile mode                              |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | pv                     |     | Profile velocity                                 |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | vl                     |     | Velocity mode                                    |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |
|   |    | pp                     |     | Profile position mode                            |           |  |    |    |    |    |    |    |   |   |   |   |   |   |   |   |    |   |       |     |     |     |    |    |   |    |    |    |    |  |  |

## 7.4 Interpolated position mode

Interpolated position mode operates on the Unidrive M600 and above in RFC-A and RFC-S modes.

Table 7-41 lists the objects that are supported:

**Table 7-41 Supported Interpolated position mode objects**

| Index  | Name                                |
|--------|-------------------------------------|
| 0x60C0 | <i>interpolation_submode_select</i> |
| 0x60C1 | <i>interpolation_data_record</i>    |
| 0x60C2 | <i>interpolation_time_period</i>    |

**NOTE** When using one of the CiA402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the SI-EtherCAT module going into the SAFE-OPERATIONAL state.

### 7.4.1 0x60C0 Interpolation\_sub-mode\_select

**Table 7-42 0x60C0 Interpolation\_sub-mode\_select**

| 0x60C0                            |   | Interpolation_sub-mode_select |           |  |
|-----------------------------------|---|-------------------------------|-----------|--|
| Sub-index 0                       |   |                               |           |  |
| Access: RW                        | Range: 0  | Size: 2 bytes                 | Unit: N/A |  |
| Default: 0 (Linear interpolation) | Type: INT   |                               |           |  |
| Description:                      | Specifies the interpolation type. At present the only supported Interpolation Sub-Mode is 'Linear Interpolation'. |                               |           |  |

### 7.4.2 0x60C1 Interpolation\_data\_record

This object is used to specify the target position. Linear interpolation is used to generate position demand values every 250  $\mu$ s. The position is specified in user-defined position units. The value is written into sub-index 1.

**Table 7-43 0x60C1 Interpolation\_data\_record**

| 0x60C1       |   | Interpolation_data_record |           |  |
|--------------|---|---------------------------|-----------|--|
| Sub-index 0  |   |                           |           |  |
| Access: RO   | Range: N/A  | Size: 1 byte              | Unit: N/A |  |
| Default: 1   | Type: USINT   |                           |           |  |
| Description: | This object is used to specify the target position. |                           |           |  |
| Sub-index 1  |   |                           |           |  |
| Access: RW   | Range: 0x80000000 to 0x7FFFFFFF                     | Size: 4 bytes             | Unit: N/A |  |
| Default: N/A | Type: DINT  |                           |           |  |
| Description: | The set-point.                                      |                           |           |  |

### 7.4.3 0x60C2 Interpolation\_time\_period

**Table 7-44 Interpolation\_time\_period**

| 0x60C2   |   | Interpolation_time_period |                     |  |
|--|---|---------------------------|---------------------|--|
| Sub-index 0  |   |                           |                     |  |
| Access: RO   | Range: N/A  | Size: 1 byte              | Unit: N/A           |  |
| Default: 2   | Type: USINT   |                           |                     |  |
| Description:   | The number of the last sub-index in this object.  |                           |                     |  |
| Sub-index 1  |   |                           |                     |  |
| Access: RW   | Range: 0 to 255   | Size: 1 byte              | Unit: (sub-index 2) |  |
| Default: 250 (units are dependent on the value in sub-index 2) | Type: USINT   |                           |                     |  |
| Description:   | The number of time units between interpolator re-starts. A time unit is defined by sub-index 2. The interpolator time period value is checked to ensure that it is valid. Valid values are 250 $\mu$ s, 500 $\mu$ s or any multiple of 1 ms. An attempt to write other values results in an SDO Abort code. |                           |                     |  |
| Sub-index 2  |   |                           |                     |  |
| Access: RW   | Range: -6 to 0  | Size: 1 byte              | Unit: N/A           |  |
| Default: -6 (a time unit of 1 $\mu$ s)                         | Type: SINT  |                           |                     |  |
| Description:   | This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is $10^{(\text{sub-index } 2)}$ . The range of values allows for the shortest time unit to be 1 $\mu$ s, and the longest to be 1 s.                                      |                           |                     |  |

The implementation of interpolated position mode allows synchronous operation only, where a fixed, common interpolation interval is defined. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds), see Table 7-45 for more information.

**Table 7-45 Interpolation time period units**

| Value in 0x60C2, sub-index 2 | Description          |
|------------------------------|----------------------|
| 0                            | 1 second             |
| -1                           | 0.1 of a second      |
| -2                           | 0.01 of a second     |
| -3                           | 0.001 of a second    |
| -4                           | 0.0001 of a second   |
| -5                           | 0.00001 of a second  |
| -6                           | 0.000001 of a second |

The time period is checked to ensure that it is an integer multiple of the control loop cycle time. Only linear interpolation is currently supported, this type inserts a delay of one interpolation time period.

The input buffer has a maximum size of 1 data record, and a data record contains one position in profile-defined units. The buffer is a FIFO buffer. On each interpolator time period, a value is read from this buffer. The correct number of data points for a specific interpolation mode are stored internally. When a new position command is loaded in, the oldest position command in the data set is discarded.

## 7.5 vl velocity mode

Velocity mode is supported on Unidrive M200 and above. It is not, however, supported in regen modes.

When the drive is in either of the RFC-A or RFC-S operating modes the scaled velocity is written to the drive internal speed shortcut. When the drive is in an open-loop operating mode the scaled velocity is written to the user preset reference parameter (Pr **01.021**). Table 7-46 lists the objects that are supported:

**Table 7-46 vl velocity mode supported objects**

| Index  | Name                                    |
|--------|---|
| 0x3008 | <i>Active velocity mode redirection</i> |
| 0x6042 | <i>vl_target_velocity</i>               |
| 0x6043 | <i>vl_velocity_demand</i>               |
| 0x6044 | <i>vl_velocity_actual_value</i>         |
| 0x6046 | <i>vl_velocity_min_max_amount</i>       |
| 0x6048 | <i>vl_velocity_acceleration</i>         |
| 0x6049 | <i>vl_velocity_deceleration</i>         |
| 0x604A | <i>vl_velocity_quick_stop</i>           |
| 0x604B | <i>vl_setpoint_factor</i>               |
| 0x604C | <i>vl_dimension_factor</i>              |

### 7.5.1 Activate velocity mode redirection

This object provides the facility to redirect the velocity mode reference from the normal velocity mode object (0x6042) to the cyclic sync velocity mode object (0x60FF).

**Table 7-47 Activate velocity mode redirection**

| 0x3008       |   | Activate velocity mode redirection |           |
|--------------|---|------------------------------------|-----------|
| Sub-index 0  |   |                                    |           |
| Access: RW   | Range: 0 to 1   | Size: 1 byte                       | Unit: N/A |
| Default: 0   | Type: USINT   |                                    |           |
| Description: | <p>Redirects the velocity mode reference from object 0x6042 to object 0x60FF. Normally object 0x60FF is the reference for csv mode and object 0x6042 is the reference for velocity mode. Activating this object means that object 0x60FF will be used as the reference for velocity mode. Units are RPM in the range -32768 to 32767.</p> <p>This object value change will take effect on a CiA402 transition from "Ready to switch on" to "Switched on".</p> |                                    |           |

### 7.5.2 0x6042 vl\_target\_velocity

This object is used to set the required velocity of the system. It is multiplied by the *vl\_dimension\_factor* and the *vl\_setpoint\_factor*. The value is given in rpm, If the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 7-48 vl\_target\_velocity**

| 0x6042       |  | vl_target_velocity |           |
|--------------|--|--------------------|-----------|
| Sub-index 0  |  |                    |           |
| Access: RW   | Range: -32768 to +32767                          | Size: 2 bytes      | Unit: rpm |
| Default: 0   | Type: INT  |                    |           |
| Description: | Used to set the required velocity of the system. |                    |           |

### 7.5.3 0x6043 vl\_velocity\_demand

This read only object provides the instantaneous velocity demand generated by the drive ramp function. The value is given in rpm if the *vl\_dimension\_factor* and the *vl\_setpoint\_factor* have the value 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 7-49 vl\_velocity\_demand**

| 0x6043       |  | vl_velocity_demand |           |
|--------------|--|--------------------|-----------|
| Sub-index 0  |  |                    |           |
| Access: RO   | Range: -32768 to +32767  | Size: 2 bytes      | Unit: rpm |
| Default: 0   | Type: INT  |                    |           |
| Description: | Provides the instantaneous velocity demand generated by the drive ramp function. |                    |           |

### 7.5.4 0x6044 vl\_velocity\_actual\_value

This read only object provides the velocity at the motor spindle or load. In a closed loop system this is determined from the motor feedback device and in an open loop system it is derived from the drive's estimated velocity.

The value is given in rpm if the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 7-50 velocity\_actual\_value**

| 0x6044       |   | vl_velocity_actual_value |           |
|--------------|---|--------------------------|-----------|
| Sub-index 0  |   |                          |           |
| Access: RO   | Range: -32768 to +32767                             | Size: 2 bytes            | Unit: N/A |
| Default: 0   | Type: INT   |                          |           |
| Description: | Provides the velocity at the motor spindle or load. |                          |           |

### 7.5.5 0x6046 vl\_velocity\_min\_max\_amount

This object is used to configure the minimum and maximum velocity.

The value is given in rpm if the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units.

**Table 7-51 vl\_velocity\_min\_max\_amount**

| 0x6046         |  | vl_velocity_min_max_amount |           |
|----------------|--|----------------------------|-----------|
| Sub-index 0    |  |                            |           |
| Access: RO     | Range: N/A   | Size: 1 byte               | Unit: N/A |
| Default: 2     | Type: USINT  |                            |           |
| Description:   | The number of sub-indices in this object.  |                            |           |
| Sub-index 1    |  |                            |           |
| Access: RW     | Range: 0 to 40000  | Size: 4 bytes              | Unit: rpm |
| Default: 0     | Type: UDINT  |                            |           |
| Description:   | Used to configure the minimum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite <i>vl_velocity_min</i> positive and <i>vl_velocity_min</i> negative. |                            |           |
| Sub-index 2    |  |                            |           |
| Access: RW     | Range: 0 to 40000  | Size: 4 bytes              | Unit: rpm |
| Default: 40000 | Type: UDINT  |                            |           |
| Description:   | Used to configure the maximum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite <i>vl_velocity_max</i> positive and <i>vl_velocity_max</i> negative. |                            |           |

## 7.5.6 0x6048 vl\_velocity\_acceleration

This object is used to configure the delta speed and delta time of the slope of the acceleration ramp.

Example: To ramp to 1000 rpm in 5 s, possible values for delta speed and delta time are 10000 and 50 respectively.

$$vl\_velocity\_acceleration = \text{delta speed} / \text{delta time}$$

**Table 7-52 0x6048 vl\_velocity\_acceleration**

| 0x6048  |                        | vl_velocity_acceleration |           |
|---|------------------------|--------------------------|-----------|
| Sub-index 0   |                        |                          |           |
| Access: RO  | Range: N/A             | Size: 1 byte             | Unit: N/A |
| Default: 2  | Type: USINT            |                          |           |
| Description: The number of sub-indices in this object.  |                        |                          |           |
| Sub-index 1   |                        |                          |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes            | Unit: rpm |
| Default: 1000   | Type: UDINT            |                          |           |
| Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units. |                        |                          |           |
| Sub-index 2   |                        |                          |           |
| Access: RW  | Range: 0 to 65535      | Size: 2 bytes            | Unit: s   |
| Default: 2  | Type: UINT             |                          |           |
| Description: The value of delta time is given in seconds.   |                        |                          |           |

## 7.5.7 0x6049 vl\_velocity\_deceleration

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp.

Example: To decelerate by 800 rpm in 10 s, possible values for delta speed and delta time are 8000 and 100 respectively.

$$vl\_velocity\_deceleration = \text{delta speed} / \text{delta time}$$

**Table 7-53 0x6049 vl\_velocity\_deceleration**

| 0x6049  |                        | vl_velocity_deceleration |           |
|---|------------------------|--------------------------|-----------|
| Sub-index 0   |                        |                          |           |
| Access: RO  | Range: N/A             | Size: 1 byte             | Unit: N/A |
| Default: 2  | Type: USINT            |                          |           |
| Description: The number of sub-indices in this object.  |                        |                          |           |
| Sub-index 1   |                        |                          |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes            | Unit: rpm |
| Default: 1000   | Type: UDINT            |                          |           |
| Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units. |                        |                          |           |
| Sub-index 2   |                        |                          |           |
| Access: RW  | Range: 0 to 65535      | Size: 2 bytes            | Unit: s   |
| Default: 2  | Type: UINT             |                          |           |
| Description: The value of delta time is given in seconds.   |                        |                          |           |

### 7.5.8 0x604A vl\_velocity\_quick\_stop

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp for quick stop.

Example: To decelerate by 800 rpm in 10 s, possible values for delta speed and delta time are 8000 and 100 respectively.

$$\text{vl velocity deceleration} = \text{delta speed} / \text{delta time}$$

**Table 7-54 0x604A vl\_velocity\_quick\_stop**

| 0x604A  |                        | vl_velocity_quick_stop |           |
|---|------------------------|------------------------|-----------|
| Sub-index 0   |                        |                        |           |
| Access: RO  | Range: N/A             | Size: 1 byte           | Unit: N/A |
| Default: 2  | Type: USINT            |                        |           |
| Description: The number of sub-indices in this object.  |                        |                        |           |
| Sub-index 1   |                        |                        |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes          | Unit: rpm |
| Default: 1000   | Type: UDINT            |                        |           |
| Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units. |                        |                        |           |
| Sub-index 2   |                        |                        |           |
| Access: RW  | Range: 0 to 65535      | Size: 2 bytes          | Unit: s   |
| Default: 2  | Type: UINT             |                        |           |
| Description: The value of delta time is given in seconds.   |                        |                        |           |

### 7.5.9 0x604B vl\_setpoint\_factor

This object is used to configure the numerator and denominator of the *vl\_setpoint\_factor*. The *vl\_setpoint\_factor* modifies the resolution or directing range of the specified setpoint. It does not influence the velocity limit function and the ramp function. A value of 0 must not be used.

**Table 7-55 0x604B vl\_setpoint\_factor**

| 0x604B  |                         | vl_setpoint_factor |           |
|---|-------------------------|--------------------|-----------|
| Sub-index 0   |                         |                    |           |
| Access: RO  | Range: N/A              | Size: 1 byte       | Unit: N/A |
| Default: 2  | Type: USINT             |                    |           |
| Description: The number of sub-indices in this object.                          |                         |                    |           |
| Sub-index 1   |                         |                    |           |
| Access: RW  | Range: -32768 to +32767 | Size: 2 bytes      | Unit: N/A |
| Default: 1  | Type: INT               |                    |           |
| Description: <i>vl_setpoint_factor</i> numerator (a value of 0 is not valid).   |                         |                    |           |
| Sub-index 2   |                         |                    |           |
| Access: RW  | Range: -32768 to +32767 | Size: 2 bytes      | Unit: N/A |
| Default: 1  | Type: INT               |                    |           |
| Description: <i>vl_setpoint_factor</i> denominator (a value of 0 is not valid). |                         |                    |           |



### 7.5.10 0x604C vl\_dimension\_factor

This object is used to configure the numerator and denominator of the *vl\_dimension\_factor*. The *vl\_dimension\_factor* is used to scale the user units so that they can be used in a way that relates to the specific application.

#### Calculating the vl\_dimension\_factor:

Every user-specific velocity consists of a specific unit referred to as a specific unit of time (e.g. 1/s, bottles/min, m/s,...). The purpose of the *vl\_dimension\_factor* is to convert this specific unit to the revolutions/minute unit. A value of 0 must not be used.

$$\text{Velocity [user-defined unit] / Dimension factor [rpm/user-defined unit]} = \text{Velocity [rpm]}$$

**Table 7-56 0x604C vl\_dimension\_factor**

| 0x604C vl_dimension_factor   |                         |               |           |
|--|-------------------------|---------------|-----------|
| Sub-index 0  |                         |               |           |
| Access: RO   | Range: N/A              | Size: 1 byte  | Unit: N/A |
| Default: 2   | Type: USINT             |               |           |
| Description: The number of sub-indices in this object.                           |                         |               |           |
| Sub-index 1  |                         |               |           |
| Access: RW   | Range: -32768 to +32767 | Size: 2 bytes | Unit: N/A |
| Default: 1   | Type: INT               |               |           |
| Description: <i>vl_dimension_factor</i> numerator (a value of 0 is not valid).   |                         |               |           |
| Sub-index 2  |                         |               |           |
| Access: RW   | Range: -32768 to +32767 | Size: 2 bytes | Unit: N/A |
| Default: 1   | Type: INT               |               |           |
| Description: <i>vl_dimension_factor</i> denominator (a value of 0 is not valid). |                         |               |           |

The *vl\_target\_velocity* object is re-read every new profile cycle. It is scaled to appropriate units using the *vl\_dimension\_factor* and *vl\_setpoint\_factor* objects and then written to the drive preset reference 1 parameter (Pr **01.021**).

The object *vl\_velocity\_min\_max* is handled every profile cycle. The *vl\_target\_velocity* is limited according to the values set in the object *vl\_velocity\_min\_max*, which is read every profile cycle. The object *vl\_velocity\_min\_max\_amount* is mapped to *vl\_velocity\_min\_max*.

The value of the *vl\_velocity\_demand* object is calculated in the background. The option reads the value of parameter Pr **02.001** (post ramp reference), scaled from RPM to user units using *vl\_dimension\_factor* and *vl\_setpoint\_factor*, and writes the value to the *vl\_velocity\_demand* object.

On a closed-loop drive, the speed feedback is calculated internally every profile cycle, scaled to the same units as *vl\_target\_velocity* and written to the *vl\_velocity\_actual\_value* object. On an open-loop drive, the estimated motor speed is read from Pr **05.004** (motor RPM) in the background, scaled to the units of *vl\_target\_velocity* and written to the *vl\_velocity\_actual\_value* object.

The *vl\_velocity\_acceleration* and *vl\_velocity\_deceleration* objects are handled in the background. They are read, scaled to drive acceleration units (depending on the drive operating mode), and written to the drive acceleration rate and deceleration rate presets. In addition, if the drive acceleration rate preset is changed, the *vl\_velocity\_acceleration* object is updated, and if the drive deceleration rate preset is changed (Pr **02.021**), the *vl\_velocity\_deceleration* object is updated.

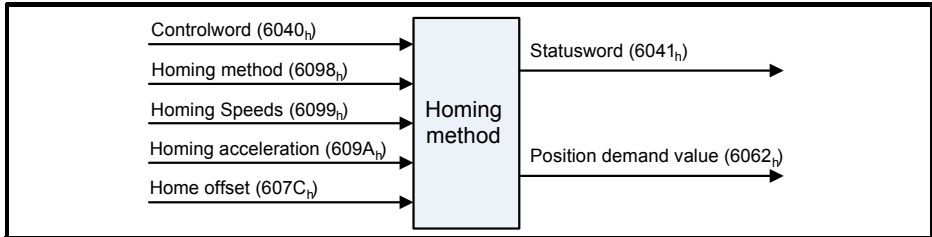
## 7.6 Homing mode

This section describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point).

Figure 7-5 shows the defined input objects as well as the output objects. The user may specify the speeds, acceleration and the method of homing. There is a further object named home offset, which allows the user to displace zero in the user's coordinate system from the home position.

There is no output data except for those bits in the statusword, which return the status or result of the homing process and the demand to the position control loops.

**Figure 7-5 Homing mode function**



By choosing a homing method the following behavior is determined: The homing signal (home switch), the direction of actuation and where appropriate the position of the index pulse.

An encircled number in Figure 7-6 to Figure 7-11 indicates the code for selection of this homing position. The direction of movement is also indicated.

There are two sources of homing signal available: These are the home switch and the index pulse from an encoder.

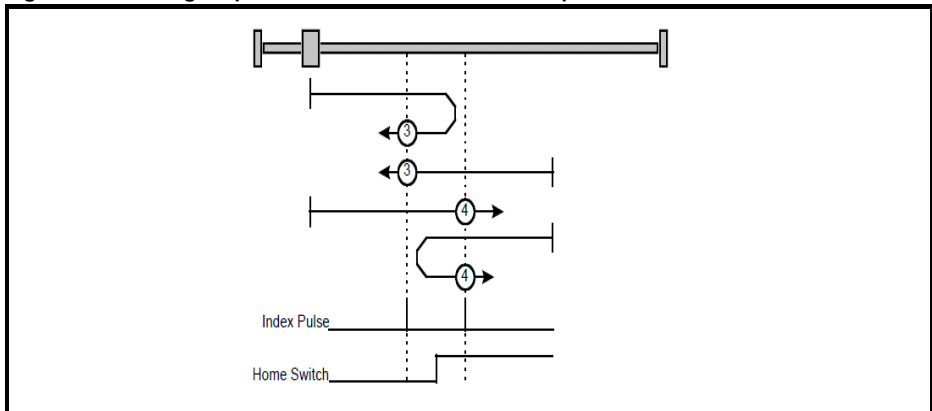
### 7.6.1 General homing definitions

#### Method 3 and 4: Homing on positive home switch and index pulse

Using these methods as shown in Figure 7-6 *Homing on positive home switch and index pulse* on page 74, the initial direction of movement shall be dependent on the state of the home switch.

The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

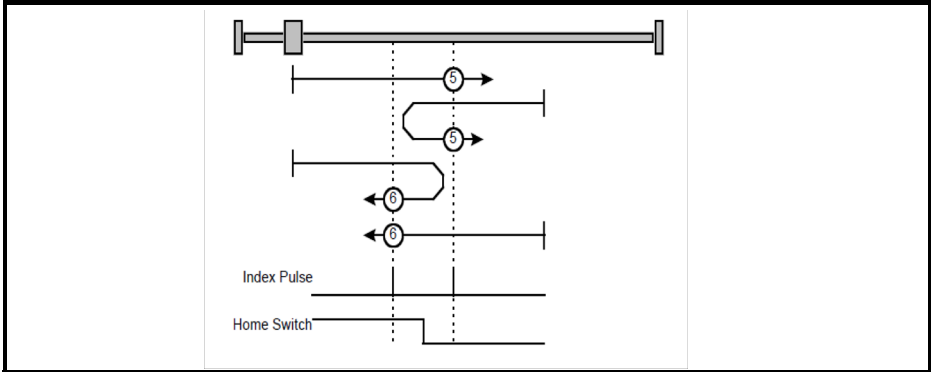
**Figure 7-6 Homing on positive home switch and index pulse**



### Method 5 and 6: Homing on negative home switch and index pulse

Using these methods as shown in Figure 7-7 *Homing on negative home switch and index pulse* on page 75, the initial direction of movement shall be dependent on the state of the home switch. The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

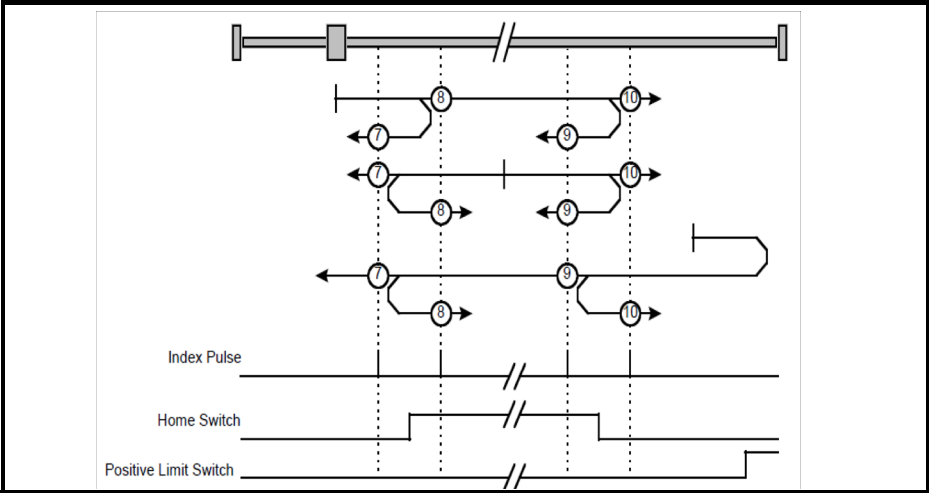
**Figure 7-7 Homing on negative home switch and index pulse**



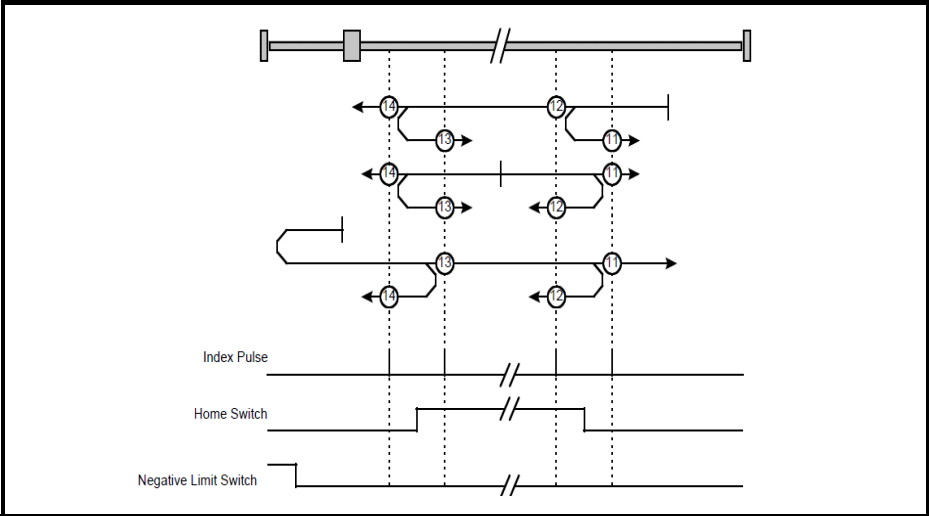
### Method 7 to 14: Homing on home switch and index pulse

These methods use a home switch, which is active over only a portion of the travel; in effect the switch has a 'momentary' action as the axis's position sweeps past the switch. Using the methods 7 to 10, the initial direction of movement shall be to the right, and using methods 11 to 14 the initial direction of movement shall be to the left except if the home switch is active at the start of the motion. In this case the initial direction of motion shall be dependent on the edge being sought. The home position shall be at the index pulse on either side of the rising or falling edges of the home switch, as shown in Figure 7-8 *Homing on home switch and index pulse - positive initial motion* on page 76 and Figure 7-9 *Homing on home switch and index pulse - negative initial motion* on page 76. If the initial direction of movement leads away from the home switch, the drive shall reverse on encountering the relevant limit switch.

**Figure 7-8 Homing on home switch and index pulse - positive initial motion**



**Figure 7-9 Homing on home switch and index pulse - negative initial motion**



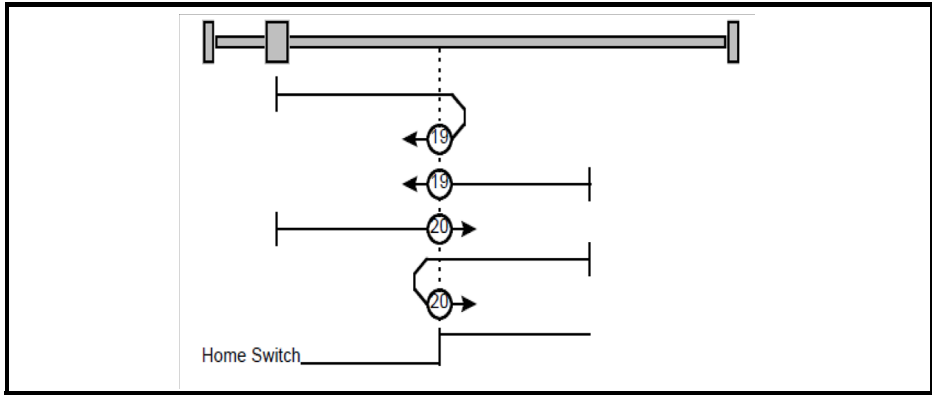
**Method 15 and 16: Reserved**

These methods are reserved.

**Method 17 to 30: Homing without index pulse**

These methods are similar to methods 3 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in Figure 7-10 *Homing on positive home switch* on page 77.

**Figure 7-10 Homing on positive home switch**



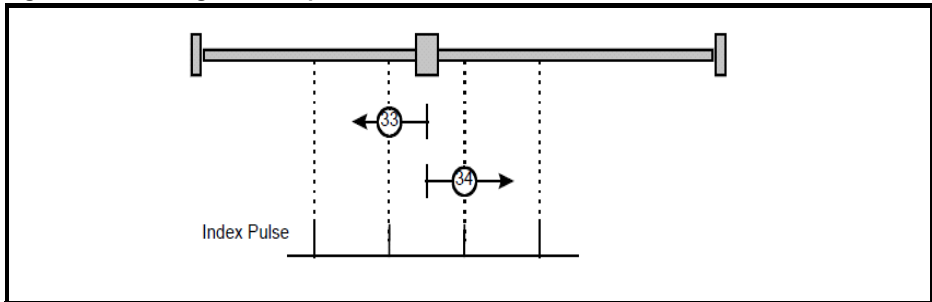
**Method 31 and 32: Reserved**

These methods are reserved.

**Method 33 and 34: Homing on index pulse**

Using these methods, the direction of homing is negative or positive respectively. The home position shall be at the index pulse found in the selected direction as shown in Figure 7-11 *Homing on index pulse* on page 77.

**Figure 7-11 Homing on index pulse**



**Method 35: Homing on the current position**

In this method, the current position shall be taken to be the home position. This method does not require the drive device to be in operational enabled state.

**Use of controlword and statusword**

The homing mode uses some bits of the controlword and the statusword for mode-specific purposes. Table 7-57 *Definition of bits 4 and 8 of the controlword* on page 77 defines the values for bits 4 and 8 of the controlword.

**Table 7-57 Definition of bits 4 and 8 of the controlword**

| Bit | Value | Definition   |
|-----|-------|--|
| 4   | 0     | Do not start homing procedure.                                     |
|     | 1     | Start or continue homing procedure.                                |
| 8   | 0     | Enable bit 4.  |
|     | 1     | Stop Axis according to the configured Slow down or Quick stop ramp |

**Table 7-58 Definition of bits 10 and 12 of the statusword**

| Bit 12 | Bit 10 | Definition                                      |
|--------|--------|---|
| 0      | 0      | Homing procedure is in progress.                |
| 0      | 1      | Homing procedure is interrupted or not started. |
| 1      | 0      | Homing is attained, but target is not reached.  |
| 1      | 1      | Homing procedure was completed successfully.    |
| 0      | 0      | Homing error occurred, velocity is not 0.       |
| 0      | 1      | Homing error occurred, velocity is 0.           |
| 1      | X      | Reserved.                                       |

## 7.6.2 Homing mode object definitions

### 0x3003 Homing source

This object indicates the configured source of the homing switch used during the homing procedure. Table 7-59 *Homing source* on page 78 specifies the object description.

**Table 7-59 Homing source**

| 0x3003   |               | Homing source object |           |
|--|---------------|----------------------|-----------|
| Sub-index 0  |               |                      |           |
| Access: RO   | Range: N/A    | Size: 1 byte         | Unit: N/A |
| Default:   | 2             | Type: USINT          |           |
| Description: The number of the last sub-index in this object.  |               |                      |           |
| Sub-index 1  |               |                      |           |
| Access: RW   | Range: 1 to 6 | Size: 1 byte         | Unit: N/A |
| Default:   | 5             | Type: USINT          |           |
| Description: The source of homing switch. This will specify the number of a drive digital input/output; the selected DIO also needs to be configured as an input.<br>This value will be read when CiA402 homing operation mode is selected.  |               |                      |           |
| Sub-index 2  |               |                      |           |
| Access: RW   | Range: 0 to 1 | Size: 1 byte         | Unit: N/A |
| Default:   | 0             | Type: USINT          |           |
| Description: Freeze or marker source for homing; this value will be read when CiA402 homing operation mode is selected. This will have a value as follows:<br>0 - Use the marker of the feedback source selected for position feedback (see object 0x3000)<br>1 - Use the F1 freeze of the selected feedback source (drive or numbered option module).<br>2 - Use the F2 freeze of the selected feedback source (drive or numbered option module). |               |                      |           |

### 0x607C Home offset

This object indicates the configured difference between the zero position for the application and the machine home position (found during homing). During homing the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position. All subsequent absolute moves shall be taken relative to this new zero position. This is illustrated in Figure 7-12 *Home offset definition* on page 79. The value of this object shall be given in user-defined position units. Negative values indicate the opposite direction.

**Figure 7-12 Home offset definition**



**Table 7-60 Home offset**

| 0x607C                            |                                 | Home offset   |                                   |
|-----------------------------------|---------------------------------|---------------|-----------------------------------|
| Sub-index 0                       |                                 |               |                                   |
| Access: RW                        | Range: 0x80000000 to 0x7FFFFFFF | Size: 4 bytes | Unit: User-defined position units |
| Default: 0                        | Type: DINT                      |               |                                   |
| Description: Homing offset value. |                                 |               |                                   |

### 0x6098 Homing method

This object indicates the configured homing method that shall be used. Table 7-61 *Homing method* on page 79 specifies the object description, and Table 7-62 *Homing method values* on page 79 specifies the value ranges for this object.

**Table 7-61 Homing method**

| 0x6098   |               | Homing method |           |
|--|---------------|---------------|-----------|
| Sub-index 0  |               |               |           |
| Access: RW   | Range: 0 - 37 | Size: 1 byte  | Unit: N/A |
| Default: 0   | Type: USINT   |               |           |
| Description: The homing method that shall be used. |               |               |           |

**Table 7-62 Homing method values**

| Value | Definition                |
|-------|---------------------------|
| 0     | No homing method assigned |
| 3     | Method 3 shall be used    |
|       | to                        |
| 34    | Method 34 shall be used   |
| 35    | Method 35 shall be used   |

### 0x6099 Homing speeds

This object indicates the configured speeds used during the homing procedure. The values shall be given in user-defined velocity units. Table 7-63 *Homing speeds* on page 80 specifies the object description.

**Table 7-63 Homing speeds**

| 0x6099 Homing speeds  |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0   |                        |               |           |
| Access: RO  | Range: 2               | Size: 1 byte  | Unit: N/A |
| Default: 2  |                        | Type: USINT   |           |
| Description: The number of the last sub-index in this object. |                        |               |           |
| Sub-index 1   |                        |               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 0  |                        | Type: UDINT   |           |
| Description: Speed during search for a switch.                |                        |               |           |
| Sub-index 2   |                        |               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 0  |                        | Type: UDINT   |           |
| Description: Speed during search for a zero.                  |                        |               |           |

### 0x609A Homing acceleration

This object indicates the configured acceleration and deceleration to be used during the homing operation. The value shall be given in user-defined acceleration units. Table 7-64 *Homing acceleration* on page 80 specifies the object description.

**Table 7-64 Homing acceleration**

| 0x609A Homing acceleration  |                        |               |                                       |
|---|------------------------|---------------|---------------------------------------|
| Sub-index 0   |                        |               |                                       |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: User-defined acceleration units |
| Default: 65536  |                        | Type: UDINT   |                                       |
| Description: Indicates the configured acceleration and deceleration to be used during homing operation. |                        |               |                                       |

## 7.7 Cyclic sync position mode

Cyclic sync position mode is supported on the Unidrive M600 and above in RFC-A and RFC-S modes. It is not supported in open-loop or regen mode.

**Table 7-65 Cyclic sync position mode**

| Index  | Name                          |
|--------|-------------------------------|
| 0x607A | target_position               |
| 0x60C0 | Interpolation sub-mode select |
| 0x60C2 | interpolation_time_period     |

**NOTE** When using one of the CiA402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the SI-EtherCAT module going into the SAFE-OPERATIONAL state.



Cyclic sync position mode provides linear interpolation which will always insert a delay of one position command. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds). The time period is checked to ensure that it is an integer multiple of the control loop cycle time.

A velocity feed forward will be calculated for the position controller. On each interpolator time period, a value is read from the target\_position object. The correct number of data points for linear interpolation is stored internally. When a new target position is loaded in, the oldest position command in the data set will be discarded.

### 7.7.1 0x607A Target\_position

This object indicates the commanded position that the drive should move to in cyclic sync position mode using the current settings of motion control parameters such as velocity, acceleration, deceleration, motion profile type etc. The value of this object is given in user-defined position units.

**Table 7-66 Target position**

| 0x607A       |   | Target position |                                   |
|--------------|---|-----------------|-----------------------------------|
| Sub-index 0  |   |                 |                                   |
| Access: RW   | Range: 0x8000000 to 0x7FFFFFFF  | Size: 4 bytes   | Unit: User-defined position units |
| Default:     | N/A   | Type: DINT      |                                   |
| Description: | Indicates the command positions that the drive should move to in cyclic sync position mode. |                 |                                   |

**Table 7-67 Interpolation sub-mode select**

| 0x60C0       |  | Interpolation sub-mode select |           |
|--------------|--|-------------------------------|-----------|
| Sub-index 0  |  |                               |           |
| Access: RW   | Range: 0 to 0  | Size: 2 bytes                 | Unit: N/A |
| Default:     | 0 (Linear Interpolation)   | Type: INT                     |           |
| Description: | This will specify the interpolation type. The values have the following meanings:<br>0 = Linear Interpolation. |                               |           |

**Table 7-68 Interpolation time period**

| 0x60C2       |   | Interpolation time period |                     |
|--------------|---|---------------------------|---------------------|
| Sub-index 0  |   |                           |                     |
| Access: RO   | Range: N/A  | Size: 1 byte              | Unit: N/A           |
| Default:     | 2   | Type: USINT               |                     |
| Description: | The number of the last sub-index in this object.  |                           |                     |
| Sub-index 1  |   |                           |                     |
| Access: RW   | Range: 0 to 255   | Size: 1 byte              | Unit: (sub-index 2) |
| Default:     | 250   | Type: USINT               |                     |
| Description: | The number of time units between interpolator restarts. A time unit is defined by sub-index 2. The interpolator time period value will be checked to ensure that it is valid. Valid values are 250 $\mu$ s, 500 $\mu$ s or any multiple of 1 ms. Selecting other values will result in an error indication. |                           |                     |
| Sub-index 2  |   |                           |                     |
| Access: RW   | Range: -6 to 0  | Size: 1 byte              | Unit: N/A           |
| Default:     | -6 (a time unit of 1 $\mu$ s)   | Type: SINT                |                     |
| Description: | This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10 <sup>(sub-index 2)</sup> . The range of values allows for the shortest time unit to be 1 $\mu$ s, and the longest to be 1s.  |                           |                     |

## 7.8 Cyclic Synchronous Velocity Mode

Cyclic Synchronous Velocity mode will be supported on Unidrive M600 and above in RFC-A and RFC-S operating modes.

On Unidrive M600 and above, this profile will operate on the control loop cycle time, using the drive's AMC speed reference (which is read by the drive every 250  $\mu$ s, and the AMC will be configured to run in velocity mode).

The following objects will be supported:

| Index | Name                      |
|-------|---------------------------|
| 606C  | Velocity actual value     |
| 60B1  | Velocity Offset           |
| 60C2  | interpolation_time_period |
| 60FF  | target_velocity           |

The target\_velocity object will be re-read every new profile cycle (as specified by the interpolation\_time\_period. This velocity demand will be scaled appropriately and written to the drive; interpolation will be used to generate additional intermediate values if the interpolation\_time\_period is greater than the interval at which the drive will read the hard speed reference parameter.

### 7.8.1 Velocity actual value

This object provides the facility to read the actual velocity feedback value.

**Table 7-69 Velocity actual value**

| 0x606C       |  | Velocity actual value |           |
|--------------|--|-----------------------|-----------|
| Sub-index 0  |  |                       |           |
| Access: RO   | Range: $-2^{31}$ to $+2^{31}-1$  | Size: 4 bytes         | Unit: N/A |
| Default: 0   | Type: DINT   |                       |           |
| Description: | Indicates the actual velocity feedback value.<br>Value is given in user-defined velocity unit. |                       |           |

### 7.8.2 Target velocity

This object is used to specify the target velocity value. The value is given in user-defined units.

**Table 7-70 Target velocity**

| 0x60FF       |   | Target velocity |           |
|--------------|---|-----------------|-----------|
| Sub-index 0  |   |                 |           |
| Access: RW   | Range: $-2^{31}$ to $+2^{31}-1$                                     | Size: 4 bytes   | Unit: N/A |
| Default: 0   | Type: DINT  |                 |           |
| Description: | Specifies the target velocity value in user-defined velocity units. |                 |           |

### 7.8.3 Velocity offset

This object is used to specify the velocity offset value. The value is given in user-defined units.

**Table 7-71 Velocity offset**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x60B1</b> | <b>Velocity offset</b>  |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: -2 <sup>31</sup> to +2 <sup>31</sup> -1  | Size: 4 bytes | Unit: N/A |
| Default: 0    | Type: DINT  |               |           |
| Description:  | Specifies the velocity offset value in user-defined velocity units. The target velocity value is added to the velocity offset value to give the final velocity reference value. |               |           |

## 7.9 Cyclic Synchronous Torque Mode

*Cyclic Synchronous Torque Mode* is supported on Unidrive M600 and above.

On Unidrive M600 and above, this profile will operate on the control loop cycle time, using the drive's torque reference (which is read by the drive every 250 µs).

The following objects will be supported:

| Index | Name                      |
|-------|---------------------------|
| 6071  | target_torque             |
| 6073  | max_current               |
| 6075  | motor_rated_current       |
| 6077  | torque_actual_value       |
| 6078  | Current actual value      |
| 60B2  | Torque Offset             |
| 60C2  | Interpolation_time_period |

The target\_torque object will be re-read every new control loop cycle; this torque value will be limited by the max\_current object (which is read in the background). This torque demand will be scaled appropriately and written to the drive *Torque Reference* (Pr **04.008**); interpolation will be used to generate additional intermediate values if the interpolation\_time\_period is greater than the interval at which the drive will read the torque reference parameter. The drive *Motor Rated Current* (Pr **05.007** or the second motor map equivalent) will be read in the background and written to the object motor\_rated\_current, which will be read-only.

### 7.9.1 Target torque

This object is used to specify the target torque value. The value is given in user-defined units.

**Table 7-72 Target torque**

|               |   |               |           |
|---------------|---|---------------|-----------|
| <b>0x6071</b> | <b>Target torque</b>  |               |           |
| Sub-index 0   |   |               |           |
| Access: RW    | Range: -32768 to 32767  | Size: 2 bytes | Unit: N/A |
| Default: 0    | Type: INT   |               |           |
| Description:  | Specifies the target torque value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.00 % in Pr <b>04.008</b> ) |               |           |

### 7.9.2 Maximum current

This object is used to specify the maximum current value. The value is given in user-defined units.

**Table 7-73 Maximum current**

| 0x6073       |  | Maximum current |           |
|--------------|--|-----------------|-----------|
| Sub-index 0  |  |                 |           |
| Access: RW   | Range: 0 to 65535  | Size: 2 bytes   | Unit: N/A |
| Default: 0   | Type: UINT   |                 |           |
| Description: | Specifies the maximum current value.<br>Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.007</b> )<br>This value is also changed when Pr <b>04.007</b> is written to. |                 |           |

### 7.9.3 Torque actual value

This object provides the actual instantaneous torque value. The value is given in user-defined units.

**Table 7-74 Torque actual value**

| 0x6077       |  | Torque actual value |           |
|--------------|--|---------------------|-----------|
| Sub-index 0  |  |                     |           |
| Access: RO   | Range: -32768 to 32767   | Size: 2 bytes       | Unit: N/A |
| Default: 0   | Type: INT  |                     |           |
| Description: | Indicates the actual instantaneous torque value.<br>Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.003</b> )<br>For open-loop drives, this value is taken from Pr <b>04.026</b> , on closed-loop drives this value is taken from Pr <b>04.003</b> . |                     |           |

### 7.9.4 Current actual value

This object provides the actual instantaneous current value. The value is given in user-defined units.

**Table 7-75 Current actual value**

| 0x6078       |  | Current actual value |           |
|--------------|--|----------------------|-----------|
| Sub-index 0  |  |                      |           |
| Access: RO   | Range: -32768 to 32767   | Size: 2 bytes        | Unit: N/A |
| Default: 0   | Type: INT  |                      |           |
| Description: | Indicates the actual instantaneous current value.<br>Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.004</b> ) |                      |           |

### 7.9.5 Torque offset

This object is used to specify the torque offset value. The value is given in user-defined units.

**Table 7-76 Torque offset**

| 0x60B2       |  | Torque offset |           |
|--------------|--|---------------|-----------|
| Sub-index 0  |  |               |           |
| Access: RW   | Range: -32768 to 32767   | Size: 2 bytes | Unit: N/A |
| Default: 0   | Type: INT  |               |           |
| Description: | Indicates the required torque value as a percentage of rated motor torque,<br>Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 %). The value is written to Pr <b>04.008</b> . The maximum and minimum is defined by parameter Pr <b>4.024</b> (which itself is limited by drive size and other parameters). It is therefore for this reason that range for 0x60B2 is set as the maximum range for a signed integer. |               |           |

## 7.10 Error Handling

The following objects will be provided to indicate an error condition:

| Index | Name           |
|-------|----------------|
| 1001  | error_register |
| 603F  | error_code     |

**Table 7-77 Error register**

| 0x1001       |   | Error register |           |
|--------------|---|----------------|-----------|
| Sub-index 0  |   |                |           |
| Access: RO   | Range: 0 to 255   | Size: 1 byte   | Unit: N/A |
| Default: 0   | Type: USINT   |                |           |
| Description: | <p>A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits will be supported:</p> <ul style="list-style-type: none"> <li>0: Generic error</li> <li>1: Current</li> <li>2: Voltage</li> <li>3: Temperature</li> </ul> <p>When an error is indicated in this object, the particular error code will be contained in object 0x603F (Error code).</p> |                |           |

**Table 7-78 Error code**

| 0x603F       |  | Error code    |           |
|--------------|--|---------------|-----------|
| Sub-index 0  |  |               |           |
| Access: RO   | Range: 0x0 to 0xFFFF   | Size: 2 bytes | Unit: N/A |
| Default: 0   | Type: UINT   |               |           |
| Description: | <p>A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in the Error code table below.</p> |               |           |

**Table 7-79 Error code definitions**

| <b>Error code</b> | <b>Meaning</b>                                 | <b>Corresponding drive trip code (if available)</b>   |
|-------------------|--|---|
| 0x0000            | Error reset / No error                         | 0 – None  |
| 0xFF01            | Generic error                                  | (Any trip code not elsewhere in table)  |
| 0x2300            | Current, device output side                    | 3 – OI ac   |
| 0x3130            | Phase failure                                  | 32 – Phase Loss<br>98 - Out Phase Loss  |
| 0x2230            | Short circuit/ground leakage (device internal) | 5 – PSU<br>9 – PSU 24V<br>92 - Snubber OI   |
| 0x3210            | DC link over-voltage                           | 2 – Over Volts  |
| 0x3230            | Load error                                     | 38 - Low Load   |
| 0x4310            | Excess temperature drive                       | 21 – OHT Inverter<br>22 – OHT Power<br>23 – OHT Control<br>27 – OHT dc bus<br>101 - OHT Brake   |
| 0x5112            | "Supply low voltage" and "U2 = supply +24 V"   | 91 - User 24V   |
| 0x5200            | Control device hardware                        | 200 - Slot 1 Hardware Fault<br>203 - Slot 1 Not Fitted<br>204 - Slot 1 Different<br>205 - Slot 2 Hardware Fault<br>208 - Slot 2 Not Fitted<br>209 - Slot 2 Different<br>210 - Slot 3 Hardware Fault<br>213 - Slot 3 Not Fitted<br>214 - Slot 3 Different<br>250 - Slot 4 Hardware Fault<br>253 - Slot 4 Not Fitted<br>254 - Slot 4 Different<br>221 - Stored HF |
| 0x5400            | Power section                                  | 111 - Config P<br>220 - Power Data<br>223 - Rating Mismatch   |
| 0x5510            | RAM  | 227 - Sub Array RAM Allocation  |
| 0x5530            | Data storage (Non-volatile data memory)        | 31 – EEPROM Fail<br>36 – User Save<br>37 – Power Down Save  |
| 0x5430            | Input stages                                   | 94 - Rectifier set up   |

| Error code | Meaning                                    | Corresponding drive trip code (if available)   |
|------------|--|--|
| 0x5440     | Contacts                                   | 226 - Soft Start   |
| 0x6010     | Software reset (watchdog)                  | 30 – Watchdog  |
| 0x6320     | Parameter Error                            | 199 - Destination<br>216 - Slot App Menu Crash<br>217 - App menu changed   |
| 0x7112     | Brake chopper (over current brake chopper) | 4 – OI Brake<br>19 – Brake R Too Hot   |
| 0x7113     | Protective circuit break chopper           | 10 - Th Brake Res  |
| 0x7120     | Motor                                      | 11 - Autotune 1<br>12 - Autotune 2<br>13 - Autotune 3<br>20 - Motor Too Hot  |
| 0x7122     | Motor error or commutation malfunction     | 14 – Autotune 4<br>15 – Autotune 5<br>16 – Autotune 6<br>24 - Thermistor<br>25 - Th Short Circuit<br>33 - Resistance   |
| 0x7300     | Sensor                                     | 17 - Autotune 7<br>162 to 163 – Encoder 12 to Encoder 13<br>176 – Name Plate<br>189 to 198 – Encoder 1 to Encoder 10<br>218 - Temp Feedback  |
| 0x7310     | Speed                                      | 7 - Over speed   |
| 0x7500     | Communication                              | 90 - Power Comms<br>103 - Interconnect   |
| 0x7600     | Data storage (external)                    | 174 - Card Slot<br>175 – Card Product<br>177 – Card Boot<br>178 – Card Busy<br>179 – Card Data Exists<br>180 – Card Option<br>181 – Card Read Only<br>182 – Card Error<br>183 – Card No Data<br>184 – Card Full<br>185 – Card Access<br>186 – Card Rating<br>187 – Card Drive Mode<br>188 – Card Compare |

|                                       |
|---------------------------------------|
| Safety Information                    |
| Introduction                          |
| Mechanical Installation               |
| Electrical Installation               |
| Getting started                       |
| Protocols                             |
| <b>Drive profile (C1A402) support</b> |
| Advanced features                     |
| Parameter descriptions                |
| Diagnostics                           |
| Glossary of terms                     |
| Index                                 |

---

## 8 Advanced features

---

### 8.1 Distributed clocks

SI-EtherCAT supports Distributed clocks. This is the scheme used by EtherCAT to accurately time synchronize slave devices. Position, speed and current control loops can all be synchronized.

When the option module is connected to a drive which can take a time synchronization signal (e.g. a Unidrive M600 or above), the EtherCAT Distributed Clocks facility can be used to provide this signal so the drive speed and current tasks are synchronized to the network. The position controller, and appropriate motion features will also be synchronized to the drive speed task.

**NOTE** In CoE interpolated position mode the position command provided by the master every interpolation cycle time is used to generate a position command for the drive every 250  $\mu$ s.

#### 8.1.1 Time synchronization support

When the option module is connected to a drive which can accept a time synchronisation signal (e.g. on Unidrive M600 and above), the EtherCAT distributed clocks facility can be used to provide this signal so that the drive tasks (including the motion, speed and current tasks) are synchronised to the network. On Unidrive M600 and above, the option synchronous task will also be synchronized to the drive OPT\_SYNC signal; on Unidrive M200 to M400 it will be executed every 5 ms, asynchronous with the drive control loops (i.e. there is no synchronization).

If possible, the option will provide a synchronization signal suitable for the longest interval drive cyclic task (this will also, of course, synchronize the higher rate tasks, if they are phase locked to the lowest rate task).

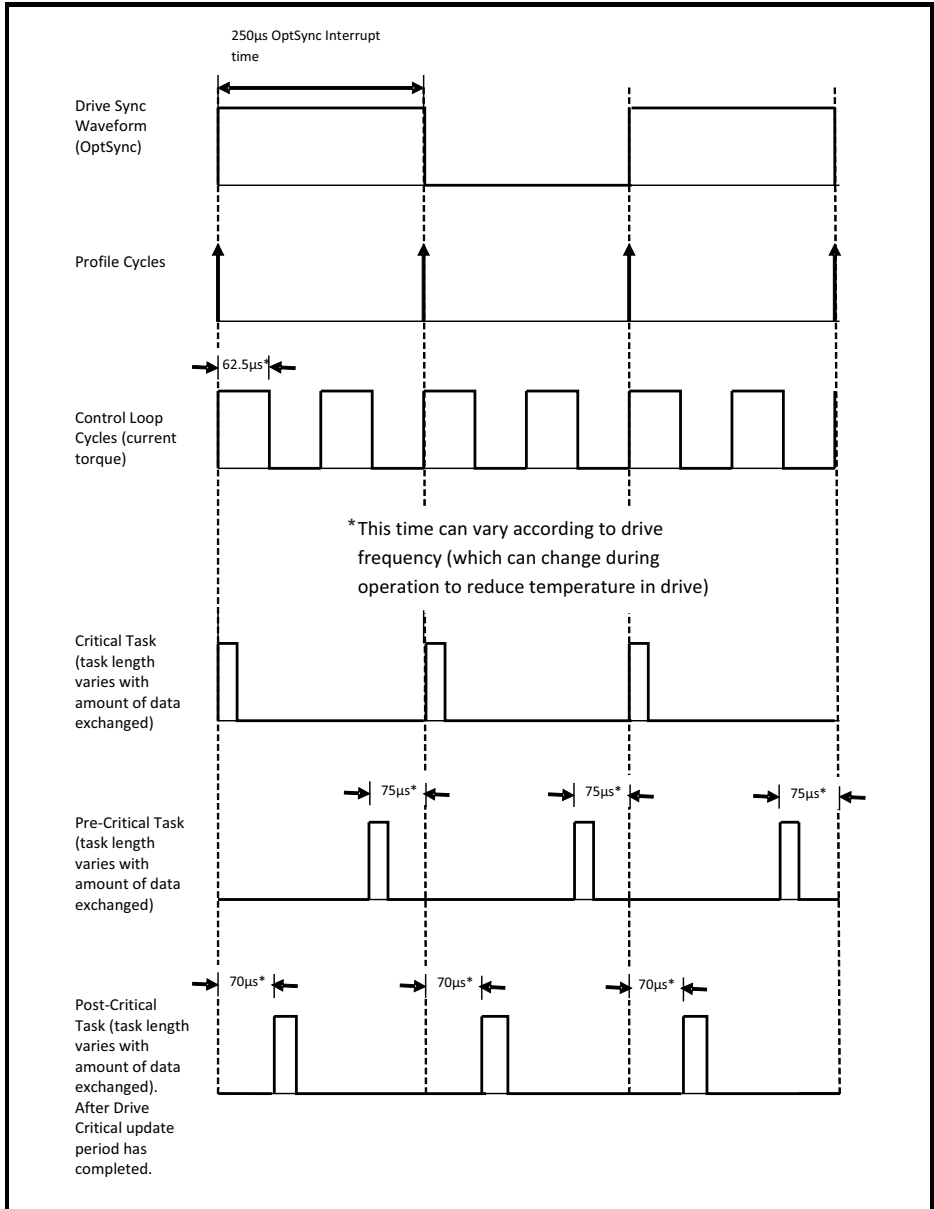
The drive motion and speed loops are executed every 250  $\mu$ s on Unidrive M600 and above, which coincides with OPT\_SYNC edges. This will be referred to as the control loop cycle. Synchronization must be enabled if the Cyclic Sync or Interpolated Position modes are used; an error will be indicated if this is not the case. These modes have an operating mode cycle time of the interpolation cycle time; other modes will have an operating mode cycle time matching the synchronous task (250  $\mu$ s or 5 ms, depending on drive type)

Any operating mode cycle will be restarted every operating mode cycle time, in phase with the synchronisation events; if synchronization is enabled, the operating mode will not start execution until the first synchronization event occurs. If synchronization is lost, an error will be indicated, and the standard EtherCAT action for this event will occur.

Command and feedback values which are handled cyclically will be read at defined times in the cycle. Command values handled/used every cycle (operating mode or control loop) will be cached from the object dictionary in the task immediately before the drive critical update period. Any feedback values read during a cycle will be scaled as appropriate in that cycle, cached, and then written to the object dictionary in the task occurring immediately after the drive critical update period. Feedback values that change internally between control loop cycles (but whose objects are only updated every profile cycle) will be read from the last control loop cycle in the operating mode cycle. PDO data will be copied to and from the object dictionary (from and to the sync manager memory areas) in the drive critical update period at the beginning of every operating mode cycle. PDO data mapped to drive parameters (but not parameters accessed using Inter-Option Communications, or eCMP), will be written to those parameters in the critical update period at the beginning of every control loop cycle. This behaviour can be modified by the advanced cyclic data configuration objects.



**Figure 8-1 Profile Cycle Timing**



|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (C/A402) support |
| <b>Advanced features</b>       |
| Parameter descriptions         |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

## 8.2 SI-EtherCAT protocol support

The following are supported:

- Four Sync Managers. Two are used for the Mailbox Protocol (non-cyclic data) and two are used for process data (cyclic data)
- Distributed Clocks
- CANopen over EtherCAT (CoE)

## 8.3 Advanced Cyclic Data Task Configuration

This configuration will allow the timing behaviour of the cyclic data handling to be modified; specifically, it will allow the tasks in which cyclic data is handled to be changed. The default configuration will be specified to reduce delays as much as possible, in case it is necessary to close control loops over the network.

On Unidrive M200 to Unidrive M400, the cyclic data tasks are asynchronous (i.e. there is no OPT\_SYNC signal, or equivalent) to the drive tasks; there will be tasks corresponding to those described in the object descriptions, but they will not bear any relationship to the a drive critical update period which, from an option module point of view, does not exist. Arguably, these objects are of limited utility on these drives.

**Table 8-1 Out cyclic data configuration**

| <b>0x3006 Out cyclic data configuration</b> |  |              |           |
|---|--|--------------|-----------|
| Sub-index 0                                 |  |              |           |
| Access: RO                                  | Range: N/A   | Size: 1 byte | Unit: N/A |
| Default:                                    | 2  | Type: USINT  |           |
| Description:                                | The number of the last sub-index in this object.   |              |           |
| Sub-index 1                                 |  |              |           |
| Access: RW                                  | Range: 0 to 2  | Size: 1 byte | Unit: ms  |
| Default:                                    | 0  | Type: USINT  |           |
| Description:                                | High priority cyclic data task; selects the task in which high priority out (master to slave) cyclic data is copied from the intermediate buffer to the mapped objects, parameters, etc.<br><br>0 - Pre-Drive Critical update period. The default; this is the task that, on Unidrive M600 and above, starts execution 75 $\mu$ s before the drive critical update period.<br><br>1 - Drive Critical update period. Occurs for the first 70 $\mu$ s following an edge of the OPT_SYNC signal.<br><br>2 - Post-Drive Critical update period. The task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.<br><br>3 - Sync Manager task. This is the AL event task which occurs upon a sync manager access. |              |           |
| Sub-index 2                                 |  |              |           |
| Access: RW                                  | Range: 0 to 2  | Size: 1 byte | Unit: N/A |
| Default:                                    | 3  | Type: USINT  |           |
| Description:                                | Reserved   |              |           |

**Table 8-2 In cyclic data configuration**

| <b>0x3007 In cyclic data configuration</b> |   |              |           |
|--|---|--------------|-----------|
| Sub-index 0                                |   |              |           |
| Access: RO                                 | Range: N/A  | Size: 1 byte | Unit: N/A |
| Default:                                   | 2   | Type: USINT  |           |
| Description:                               | The number of the last sub-index in this object.  |              |           |
| Sub-index 1                                |   |              |           |
| Access: RW                                 | Range: 0 to 2   | Size: 1 byte | Unit: ms  |
| Default:                                   | 2   | Type: USINT  |           |
| Description:                               | <p>High priority cyclic data task; selects the task in which high priority in (slave to master) cyclic data is copied to the intermediate buffer from the mapped objects, parameters, etc.</p> <p>0 - Pre-Drive Critical update period. The default; this is the task that, on M600 and above, starts execution 75 <math>\mu</math>s before the drive critical update period. This time may need to be modified after measuring actual task periods (hopefully it will be possible to start at a time closer to the critical update period).</p> <p>1 - Drive Critical update period. Occurs during the first 70 <math>\mu</math>s following an edge of the OPT_SYNC signal.</p> <p>2 - Post Drive Critical update period. The task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.</p> <p>3 - Sync Manager task. The AL event task which occurs upon a sync manager access.</p> |              |           |
| Sub-index 2                                |   |              |           |
| Access: RW                                 | Range: 0 to 2   | Size: 1 byte | Unit: N/A |
| Default:                                   | 2   | Type: USINT  |           |
| Description:                               | <p>Intermediate buffer copy task. Selects the task in which the high priority in (slave to master) cyclic data is copied from the intermediate buffer into the sync manager space.</p> <p>0 - Pre Drive Critical update period. The task that, on M600 and above, starts execution 75 <math>\mu</math>s before the drive critical update period. This time may need to be modified after measuring actual task periods (hopefully it will be possible to start at a time closer to the critical update period).</p> <p>1 - Drive Critical update period. Occurs during the first 70 <math>\mu</math>s following an edge of the OPT_SYNC signal.</p> <p>2 - Post Drive Critical update period. The default; it is the task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.</p> <p>3 - Sync Manager task. The AL event task which occurs upon a sync manager access.</p>           |              |           |

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (C/A402) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

---

## 9 Parameter descriptions

---

It is intended that it is not necessary to use option module parameters for EtherCAT setup or control of a drive; parameters are mostly provided for status and information. This means that a user will configure the motor and feedback in the usual way, using parameters, install an EtherCAT option, and use CoE; objects to control the drive from that point onwards. Although, with objects which correspond to drive parameters, it should be possible to perform all drive/motor/feedback configuration using the EtherCAT interface.

In the following descriptions, S means the option module slot number.

### 9.1 Internal menus

SI-EtherCAT provides parameters for configuration and information, these parameters are grouped into menus as shown in Table 9-1.

**Table 9-1 SI-EtherCAT internal menus**

| Menu | Name        | Description   |
|------|-------------|---|
| S.0  | Setup       | Provides module information such as firmware version and serial number      |
| S.1  | ECAT Status | Provides information on the EtherCAT network status                         |
| S.2  | EoE Status  | Provides information on the Ethernet over EtherCAT status and configuration |
| S.9  | Resources   | Provides information on the module task resources and PCB temperature       |

### 9.2 Parameter type codes

Table 9-2 lists the coding used for the parameter type in the subsequent parameter description tables.

**Table 9-2 Parameter type codes**

| RW  | Read / Write        | RO  | Read-only        | Bit | Bit parameter    | Txt | Text string             | Date | Date parameter | Time | Time parameter        |
|-----|---------------------|-----|------------------|-----|------------------|-----|-------------------------|------|----------------|------|-----------------------|
| Chr | Character parameter | Bin | Binary parameter | IP  | IP address       | Mac | MAC address             | Ver  | Version number | SMP  | Slot, menu, parameter |
| Num | Number parameter    | DE  | Destination      | ND  | No default value | RA  | Rating dependant        | NC   | Non-copyable   | PT   | Protected             |
| Fl  | Filtered            | US  | User save        | PS  | Power-down save  | BU  | Bit default or unipolar |      |                |      |                       |

## 9.3 Single line parameter descriptions

Table 9-3 Menu 0 parameters (Set-up)

| Parameter       |                                    | Range                      | Default  | Access | Size (Bits) |
|-----------------|------------------------------------|----------------------------|----------|--------|-------------|
| <b>S.00.000</b> | Parameter mm.00                    | 0 to 65535                 |          | RW     | 16          |
| <b>S.00.001</b> | Module ID                          | 0 to 65535                 |          | RO     | 16          |
| <b>S.00.002</b> | Firmware version                   | 00.00.00.00 to 99.99.99.99 |          | RO     | 32          |
| <b>S.00.003</b> | Hardware version                   | 0 to 65535                 |          | RO     | 16          |
| <b>S.00.004</b> | Serial number LS                   | 0 to 99999999              |          | RO     | 32          |
| <b>S.00.005</b> | Serial number MS                   | 0 to 99999999              |          | RO     | 32          |
| <b>S.00.006</b> | Module status                      | -2 to 3                    |          | RO     | 8           |
| <b>S.00.007</b> | Module reset                       | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.008</b> | Module default                     | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.031</b> | Slot indicator                     | 1 to 8                     |          | RO     | 8           |
| <b>S.00.032</b> | Slot menu number                   | 0 to 255                   |          | RO     | 8           |
| <b>S.00.033</b> | Disable drive control              | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.034</b> | Allow EEPROM Upgrade               | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.035</b> | Configured station alias           | 0 to 65535                 | 0        | RW     | 16          |
| <b>S.00.036</b> | Sync OUT consistency enable        | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.037</b> | Sync OUT consistency parameter     | 0.00.000 to 9.99.999       | 0.00.000 | RW     | 32          |
| <b>S.00.038</b> | Sync IN consistency enable         | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.039</b> | Sync IN consistency parameter      | 0.00.000 to 9.99.999       | 0.00.000 | RW     | 32          |
| <b>S.00.040</b> | Non-sync OUT consistency enable    | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.041</b> | Non-sync OUT consistency parameter | 0.00.000 to 9.99.999       | 0.00.000 | RW     | 32          |
| <b>S.00.042</b> | Non-sync IN consistency enable     | 0 (Off) to 1 (On)          | 0 (Off)  | RW     | 1           |
| <b>S.00.043</b> | Non-sync IN consistency parameter  | 0.00.000 to 9.99.999       | 0.00.000 | RW     | 32          |
| <b>S.00.045</b> | Homing position save               | 0(Off) to 1(On)            | 0 (Off)  | RW     | 1           |
| <b>S.00.046</b> | Homing position parameter          | 51 to 54                   | 51       | RW     | 8           |

Table 9-4 Menu 1 parameters (EtherCAT Status)

| Parameter       |                         | Range                       | Default | Access | Size (Bits) |
|-----------------|-------------------------|-----------------------------|---------|--------|-------------|
| <b>S.01.000</b> | Parameter mm.00         | 0 to 65535                  |         | RW     | 16          |
| <b>S.01.001</b> | EtherCAT RUN indicator  | 0 (Unknown State) to 8 (Op) |         | RO     | 8           |
| <b>S.01.002</b> | PDO Accesses per second | 0 to 65535                  |         | RO     | 16          |
| <b>S.01.004</b> | Mapped parameter xx.000 | 0 to 65535                  |         | RW     | 16          |

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (QIA402) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

**Table 9-5 Menu 2 parameters (Ethernet over EtherCAT Status)**

| Parameter       |                         | Range   | Default | Access | Size (Bits) |
|-----------------|-------------------------|---|---------|--------|-------------|
| <b>S.02.000</b> | Parameter mm.00         | 0 to 65535  |         | RW     | 16          |
| <b>S.02.003</b> | EoE Status              | 1 to 6  |         | RO     | 8           |
| <b>S.02.004</b> | EoE Message rate        | 0 to 65536  |         | RO     | 16          |
| <b>S.02.006</b> | EoE IP Address          | 0 to 4294967295<br>(000.000.000.000<br>to<br>255.255.255.255) |         | RO     | 32          |
| <b>S.02.007</b> | EoE Subnet mask         | 0 to 4294967295<br>(000.000.000.000<br>to<br>255.255.255.255) |         | RO     | 32          |
| <b>S.02.008</b> | EoE Default gateway     | 0 to 4294967295<br>(000.000.000.000<br>to<br>255.255.255.255) |         | RO     | 32          |
| <b>S.02.011</b> | EoE Virtual MAC Address | 0 to $2^{48} - 1$<br>(0 to<br>FFFFFFFFFFFFFF)                 |         | RO     | 64          |

**Table 9-6 Menu 9 parameters (Resources)**

| Parameter       |                                 | Range       | Default | Access | Size (Bits) |
|-----------------|---------------------------------|-------------|---------|--------|-------------|
| <b>S.09.000</b> | Parameter mm.00                 | 0 to 65535  |         | RW     | 16          |
| <b>S.09.010</b> | Pre-critical task % free        | 0 to 100    |         | RO     | 8           |
| <b>S.09.011</b> | Critical task % free            | 0 to 100    |         | RO     | 8           |
| <b>S.09.012</b> | Post-critical task % free       | 0 to 100    |         | RO     | 8           |
| <b>S.09.020</b> | Pre-critical task worst % free  | 0 to 100    |         | RO     | 8           |
| <b>S.09.021</b> | Critical task worst % free      | 0 to 100    |         | RO     | 8           |
| <b>S.09.022</b> | Post-critical task worst % free | 0 to 100    |         | RO     | 8           |
| <b>S.09.023</b> | Out Data position %             | 0 to 100    |         | RO     | 8           |
| <b>S.09.030</b> | PCB Temperature                 | -128 to 127 |         | RO     | 8           |

## 9.4 Full parameter descriptions

### 9.4.1 Menu 0 (Setup) - Corresponds to menu 15, 16 or 17

This menu will provide some common fieldbus option parameters used for basic housekeeping and information.

| S.00.001       |                    | Module ID      |                |
|----------------|--------------------|----------------|----------------|
| Minimum        | 0                  | Maximum        | 65535          |
| Default        | 431                | Units          |                |
| Type           | 16 Bit Volatile    | Update Rate    | Power-up write |
| Display Format | None               | Decimal Places | 0              |
| Coding         | RO, ND, NC, PT, BU |                |                |

The option module ID. SI-EtherCAT is 431.

| S.00.002       |                          | Firmware version |                                 |
|----------------|--------------------------|------------------|---------------------------------|
| Minimum        | 0 (Display: 00.00.00.00) | Maximum          | 99999999 (Display: 99.99.99.99) |
| Default        |                          | Units            |                                 |
| Type           | 32 bit volatile          | Update Rate      | Power-up write                  |
| Display Format | Version number           | Decimal Places   | 0                               |
| Coding         | RO, Ver, ND, NC, PT, BU  |                  |                                 |

| S.00.003       |                    | Hardware version |                |
|----------------|--------------------|------------------|----------------|
| Minimum        | 0                  | Maximum          | 655.35         |
| Default        | 0                  | Units            |                |
| Type           | 16 bit volatile    | Update Rate      | Power-up write |
| Display Format | None               | Decimal Places   | 2              |
| Coding         | RO, ND, NC, PT, BU |                  |                |

Contains the module's hardware version information in the format xx.yy.

| S.00.004       |                    | Serial Number LS |                |
|----------------|--------------------|------------------|----------------|
| Minimum        | 0                  | Maximum          | 99999999       |
| Default        | 0                  | Units            |                |
| Type           | 32 bit volatile    | Update Rate      | Power-up write |
| Display Format | None               | Decimal Places   | 0              |
| Coding         | RO, ND, NC, PT, BU |                  |                |

The module serial number is available as a pair of 32-bit values where Serial Number LS (**S.00.004**) provides the least significant 8 decimal digits and Serial Number MS (**S.00.005**) provides the most significant 8 decimal digits. The reconstructed serial number is ((**S.00.005**\* 10000000) + **S.00.004**). For example serial number "0001234567898765" would be stored as **S.00.005** = 12345, **S.00.004** = 67898765.

| S.00.005       |                    | Serial Number MS |                |
|----------------|--------------------|------------------|----------------|
| Minimum        | 0                  | Maximum          | 99999999       |
| Default        | 0                  | Units            |                |
| Type           | 32 bit volatile    | Update Rate      | Power-up write |
| Display Format | None               | Decimal Places   | 0              |
| Coding         | RO, ND, NC, PT, BU |                  |                |

See Serial Number LS (**S.00.004**).

| <b>S.00.006</b> |                                | <b>Status</b>  |                    |
|-----------------|--------------------------------|----------------|--------------------|
| Minimum         | -2 (Display: Bootldr - Update) | Maximum        | 3 (Display: Error) |
| Default         |                                | Units          |                    |
| Type            | 8 bit volatile                 | Update Rate    | Background         |
| Display Format  | Text                           | Decimal Places | 0                  |
| Coding          | RO, Txt, ND, NC, PT            |                |                    |

| <b>Value</b> | <b>Text</b>      | <b>Description</b>  |
|--------------|------------------|---|
| -2           | Bootldr - Update | The bootloader is performing a flash update                           |
| -1           | Bootldr - Idle   | The bootloader is idle  |
| 0            | Initializing     | The firmware is currently initializing.                               |
| 1            | OK               | The firmware is initialised and no errors have been detected.         |
| 2            | Config           | A configuration error has been detected.                              |
| 3            | Error            | An error has occurred preventing the firmware from running correctly. |

| <b>S.00.007</b> |                  | <b>Reset</b>   |  |
|-----------------|------------------|----------------|--|
| Minimum         | 0 (Display: Off) | Maximum        | 1 (Display: On)  |
| Default         | 0                | Units          |  |
| Type            | 1 bit volatile   | Update Rate    | Read every 200 ms<br>Written to 0 on module initialization |
| Display Format  | Bit              | Decimal Places | 0  |
| Coding          | RW, Bit, NC      |                |  |

When set the module performs a warm reset. If a CiA402 profile is currently in control of the drive and motor, the motor will be brought to a stop, if possible (following configured deceleration ramps, etc), and the drive disabled before the reset is performed. When the reset has been performed and the module is performing its initialization routines the parameter will be cleared to zero.

Note: The drive, and any other modules installed to the drive will not be affected by the reset.

| <b>S.00.008</b> |                  | <b>Default</b> |   |
|-----------------|------------------|----------------|---|
| Minimum         | 0 (Display: Off) | Maximum        | 1 (Display: On)   |
| Default         | 0                | Units          |   |
| Type            | 1 bit volatile   | Update Rate    | Read every 200 ms<br>Written to 0 when save is complete |
| Display Format  | Bit              | Decimal Places | 0   |
| Coding          | RW, Bit, NC      |                |   |

If set to "ON" when the module is reset, this parameter will cause the option module to return to its "Out of Box configuration"; any settings stored on the module will be returned to their default values. This will include the CoE object dictionary, if it is saved. Following the default the module will set the parameter to "OFF" and the module will reset.

**NOTE** Take care using this parameter as any configuration information will be irretrievably lost



| <b>S.00.031</b> |                    | <b>Slot Indicator</b> |                     |
|-----------------|--------------------|-----------------------|---------------------|
| Minimum         | 1                  | Maximum               | 8                   |
| Default         |                    | Units                 |                     |
| Type            | 8 bit volatile     | Update Rate           | Written on power-up |
| Display Format  | None               | Decimal Places        | 0                   |
| Coding          | RO, ND, NC, PT, BU |                       |                     |

The parameter displays the number of the virtual option slot on the drive that the module is connected to. The values for the slots are 1 to 8, where the onboard slot is 4.

| <b>S.00.032</b> |                    | <b>Slot Menu Number</b> |                     |
|-----------------|--------------------|-------------------------|---------------------|
| Minimum         | 0                  | Maximum                 | 255                 |
| Default         |                    | Units                   |                     |
| Type            | 8 bit volatile     | Update Rate             | Written on power-up |
| Display Format  | None               | Decimal Places          | 0                   |
| Coding          | RO, ND, NC, PT, BU |                         |                     |

The parameter displays the menu number of the option slot on the drive.

E.g. for Unidrive M the following mapping applies:

Slot 1 - Menu 15

Slot 2 - Menu 16

Slot 3 - Menu 17

Slot 4 - Menu 24

| <b>S.00.033</b> |                  | <b>Disable drive control</b> |                    |
|-----------------|------------------|------------------------------|--------------------|
| Minimum         | 0 (Display: Off) | Maximum                      | 1 (Display: On)    |
| Default         | 0                | Units                        |                    |
| Type            | 1 bit User Save  | Update Rate                  | Read in background |
| Display Format  | Bit              | Decimal Places               | 0                  |
| Coding          | RW, Bit          |                              |                    |

In normal operation, at various points in EtherCAT and CiA402 operation, a number of drive parameter values will be modified by the option module (to enable it to control the drive, other parameters implicitly written by the CiA402 profile, etc).

Setting this parameter to 1 will prevent the option module from writing to these parameters; user-mapped parameter writes will still occur, however.

If Pr **S.00.033** is set to On and the drive isn't running, the SI-EtherCAT will disable the control word and AMC, and pass local control of the drive to the user.

If Pr **S.00.033** is set to On and the drive is running, the SI-EtherCAT module will perform a stop action as defined by 0x605E Fault\_reaction\_option\_code, before disabling the control word and AMC.

The SI-EtherCAT module will not take control of the drive until Pr **S.00.033** is cleared to Off.

| <b>S.00.034</b> |                  | <b>Allow EEPROM Upgrade</b> |                    |
|-----------------|------------------|-----------------------------|--------------------|
| Minimum         | 0 (Display: Off) | Maximum                     | 1 (Display: On)    |
| Default         | 0                | Units                       |                    |
| Type            | 1 bit User Save  | Update Rate                 | Read in background |
| Display Format  | Bit              | Decimal Places              | 0                  |
| Coding          | RW, Bit          |                             |                    |

This allows the data in the EtherCAT configuration EEPROM to be upgraded, and it does this by preventing the EtherCAT ASIC from accessing the EEPROM, so that the processor can access it; this means that EtherCAT communications are disabled. This is achieved by setting this parameter to 'On' and performing an option reset (**S.00.007** = On); this parameter cannot be saved.

| <b>S.00.035</b> |                    | <b>Configured Station Alias</b> |                  |
|-----------------|--------------------|---------------------------------|------------------|
| Minimum         | 0                  | Maximum                         | 65535            |
| Default         | 0                  | Units                           |                  |
| Type            | 16 bit User Save   | Update Rate                     | Read on power up |
| Display Format  | None               | Decimal Places                  | 0                |
| Coding          | RW, NC, PT, BU, US |                                 |                  |

It is unnecessary for a user to set a station address manually in order to initiate EtherCAT communications; however, this parameter can be used to configure an EtherCAT Station Alias, which can be used to uniquely identify a particular slave. If this value is changed, it is necessary to reset the option for the new value to take effect (e.g. by saving parameters and performing a power cycle). If this value is left at the default value of zero, any value stored in the EtherCAT EEPROM will be used, and if a non-zero value is stored here, it will be used in place of the EEPROM value.

| <b>S.00.036</b> |                  | <b>Sync OUT Consistency Enable</b> |                           |
|-----------------|------------------|------------------------------------|---------------------------|
| Minimum         | 0 (Display: Off) | Maximum                            | 1 (Display: On)           |
| Default         | 0 (Display: Off) | Units                              | None                      |
| Type            | 1 bit User Save  | Update Rate                        | EtherCAT state transition |
| Display Format  | Bit              | Decimal Places                     | 0                         |
| Coding          | RW, Bit          |                                    |                           |

| <b>S.00.037</b> |                       | <b>Sync OUT Consistency Trigger Parameter</b> |                           |
|-----------------|-----------------------|---|---------------------------|
| Minimum         | 0 (Display: 0.00.000) | Maximum                                       | 1 (Display: 9.99.999)     |
| Default         | 0 (Display: 0.00.000) | Units   | None                      |
| Type            | 32 bit User Save      | Update Rate                                   | EtherCAT state transition |
| Display Format  | SMP                   | Decimal Places                                | 0                         |
| Coding          | RW, DE                |   |                           |

The SI-EtherCAT module provides an output consistency feature for the synchronized cyclic data which ensures that the data in the output mappings is only updated when the mapped parameters are ready. This prevents data skew between parameters in the output mappings.

When the output consistency is enabled (**S.00.036** = On), the output consistency trigger parameter (**S.00.037**) is used to control the RxPDO data exchange, ensuring skew does not occur; a user program, for example, must check the trigger parameter is 1 before reading the mapped parameters, and it should clear the trigger parameter to 0 after all the mapped parameters have been read. The SI-EtherCAT module will check that the trigger parameter is 0 before writing to the RxPDO destinations and will set the trigger parameter to 1 after the RxPDO destinations have been written.

| <b>S.00.038</b> |                  | <b>Sync IN Consistency Enable</b> |                           |
|-----------------|------------------|-----------------------------------|---------------------------|
| Minimum         | 0 (Display: Off) | Maximum                           | 1 (Display: On)           |
| Default         | 0 (Display: Off) | Units                             | None                      |
| Type            | 1 bit User Save  | Update Rate                       | EtherCAT state transition |
| Display Format  | Bit              | Decimal Places                    | 0                         |
| Coding          | RW, Bit          |                                   |                           |

| <b>S.00.039</b> |                       | <b>Sync IN Consistency Trigger Parameter</b> |                           |
|-----------------|-----------------------|--|---------------------------|
| Minimum         | 0 (Display: 0.00.000) | Maximum                                      | 1 (Display: 9.99.999)     |
| Default         | 0 (Display: 0.00.000) | Units  | None                      |
| Type            | 32 bit User Save      | Update Rate                                  | EtherCAT state transition |
| Display Format  | SMP                   | Decimal Places                               | 0                         |
| Coding          | RW, DE                |  |                           |

The SI-EtherCAT module provides an input consistency feature for the synchronized cyclic data which ensures that the data in the input mappings is only updated when the mapped parameters are ready. This prevents data skew between parameters in the input mappings.

When the input consistency is enabled (**S.00.038** = On), the input consistency trigger parameter (**S.00.039**) is used to control the TxPDO data exchange, ensuring skew does not occur; a user program, for example, must check the trigger parameter is 0 before writing to the mapped parameters, and it should set the parameter to 1 after all the data has been written. The SI-EtherCAT module will check that the trigger parameter is 1 before reading the TxPDO sources and will set the trigger parameter to 0 after the TxPDO sources have been read.

| <b>S.00.040</b> |                  | <b>Non-sync OUT Consistency Enable</b> |                           |
|-----------------|------------------|--|---------------------------|
| Minimum         | 0 (Display: Off) | Maximum                                | 1 (Display: On)           |
| Default         | 0 (Display: Off) | Units                                  | None                      |
| Type            | 1 bit User Save  | Update Rate                            | EtherCAT state transition |
| Display Format  | Bit              | Decimal Places                         | 0                         |
| Coding          | RW, Bit          |  |                           |

| <b>S.00.041</b> |                       | <b>Non-sync OUT Consistency Trigger Parameter</b> |                           |
|-----------------|-----------------------|---|---------------------------|
| Minimum         | 0 (Display: 0.00.000) | Maximum   | 1 (Display: 9.99.999)     |
| Default         | 0 (Display: 0.00.000) | Units   | None                      |
| Type            | 32 bit User Save      | Update Rate                                       | EtherCAT state transition |
| Display Format  | SMP                   | Decimal Places                                    | 0                         |
| Coding          | RW, DE                |   |                           |

The SI-EtherCAT module provides an output consistency feature for the non-synchronized cyclic data which ensures that the data in the output mappings is only updated when the mapped parameters are ready. This prevents data skew between parameters in the output mappings.

When the output consistency is enabled (**S.00.040** = On), the output consistency trigger parameter (**S.00.041**) is used to control the RxPDO data exchange, ensuring skew does not occur; a user program, for example, must check the trigger parameter is 1 before reading the mapped parameters, and it should clear the trigger parameter to 0 after all the mapped parameters have been read. The SI-EtherCAT module will check that the trigger parameter is 0 before writing to the RxPDO destinations and will set the trigger parameter to 1 after the RxPDO destinations have been written.

| <b>S.00.042</b> |                  | <b>Non-sync IN Consistency Enable</b> |                           |
|-----------------|------------------|---------------------------------------|---------------------------|
| Minimum         | 0 (Display: Off) | Maximum                               | 1 (Display: On)           |
| Default         | 0 (Display: Off) | Units                                 | None                      |
| Type            | 1 bit User Save  | Update Rate                           | EtherCAT state transition |
| Display Format  | Bit              | Decimal Places                        | 0                         |
| Coding          | RW, Bit          |                                       |                           |

| <b>S.00.043</b> |                       | <b>Non-sync IN Consistency Trigger Parameter</b> |                           |
|-----------------|-----------------------|--|---------------------------|
| Minimum         | 0 (Display: 0.00.000) | Maximum  | 1 (Display: 9.99.999)     |
| Default         | 0 (Display: 0.00.000) | Units  | None                      |
| Type            | 32 bit User Save      | Update Rate                                      | EtherCAT state transition |
| Display Format  | SMP                   | Decimal Places                                   | 0                         |
| Coding          | RW, DE                |  |                           |

The SI-EtherCAT module provides an input consistency feature for the non-synchronized cyclic data which ensures that the data in the input mappings is only updated when the mapped parameters are ready. This prevents data skew between parameters in the input mappings.

When the input consistency is enabled (**S.00.042** = On), the input consistency trigger parameter (**S.00.043**) is used to control the TxPDO data exchange, ensuring skew does not occur; a user program, for example, must check the trigger parameter is 0 before writing to the mapped parameters, and it should set the parameter to 1 after all the data has been written. The SI-EtherCAT module will check that the trigger parameter is 1 before reading the TxPDO sources and will set the trigger parameter to 0 after the TxPDO sources have been read.

| <b>S.00.045</b> |                       | <b>Homing Position Save</b> |                    |
|-----------------|-----------------------|-----------------------------|--------------------|
| Minimum         | 0 (Display: 0.00.000) | Maximum                     | 1 (Display: On)    |
| Default         | 0 (Display: 0.00.000) | Units                       | None               |
| Type            | 1 bit User Save       | Update Rate                 | Read in background |
| Display Format  | Bit                   | Decimal Places              | 0                  |
| Coding          | RW, Bit               |                             |                    |

| <b>S.00.046</b> |                 | <b>Homing Position Parameter</b> |                    |
|-----------------|-----------------|----------------------------------|--------------------|
| Minimum         | 51              | Maximum                          | 54                 |
| Default         | 51              | Units                            | None               |
| Type            | 8 bit User Save | Update Rate                      | Read in background |
| Display Format  | None            | Decimal Places                   | 0                  |
| Coding          | RW              |                                  |                    |

The SI-EtherCAT module provides a method to save the absolute home position. If homing position save is enabled the parameter detailed in **S.00.046** will be used as the location to write the value. The locations available to write the value are all long integer power down save parameters. The value is updated at the end of homing.

## 9.4.2 Menu 1 (EtherCAT Status)

This menu provides status information on the EtherCAT network.

| <b>S.01.001</b> |                         | <b>EtherCAT RUN Indicator</b> |            |
|-----------------|-------------------------|-------------------------------|------------|
| Minimum         | 0                       | Maximum                       | 8          |
| Default         | 0                       | Units                         |            |
| Type            | 8 bit volatile          | Update Rate                   | Background |
| Display Format  | Text                    | Decimal Places                | 0          |
| Coding          | RO, Txt, ND, NC, PT, BU |                               |            |

This parameter displays the EtherCAT Run state, as required by the EtherCAT Indicator and Marking Specification. It will contain one of the following values:

| <b>Value</b> | <b>Display String</b> | <b>Corresponding ESM State</b>        |
|--------------|-----------------------|---------------------------------------|
| 1            | "Init"                | INIT                                  |
| 2            | "PreOp"               | PRE-OPERATIONAL                       |
| 4            | "SafeOp"              | SAFE-OPERATIONAL                      |
| 6            | "SafeOp to OP"        | SAFE OPERATIONAL to OPERATIONAL state |
| 8            | "Op"                  | OPERATIONAL                           |

All other values will correspond to "Unknown State."

| <b>S.01.002</b> |                    | <b>PDO Accesses per second</b> |                      |
|-----------------|--------------------|--------------------------------|----------------------|
| Minimum         | 0                  | Maximum                        | 65535                |
| Default         | 0                  | Units                          |                      |
| Type            | 16 bit volatile    | Update Rate                    | Written every second |
| Display Format  | None               | Decimal Places                 | 0                    |
| Coding          | RO, ND, NC, PT, BU |                                |                      |

This will count the number of PDO accesses per second. For example, if there are two PDOs configured in Sync Manager 2, and two PDOs configured in Sync Manager 3, and both Sync Manager memory areas are written every 250  $\mu$ s, this parameter will contain a value of approximately 16000 (the value may fluctuate slightly because it is not updated synchronously with the accesses).

| <b>S.01.004</b> |                    | <b>Mapped Parameter xx.000</b> |       |
|-----------------|--------------------|--------------------------------|-------|
| Minimum         | 0                  | Maximum                        | 65535 |
| Default         | 0                  | Units                          |       |
| Type            | 16 bit volatile    | Update Rate                    |       |
| Display Format  | None               | Decimal Places                 | 0     |
| Coding          | RW, ND, NC, PT, BU |                                |       |

This parameter is purely a mapping to Pr **mm.000** to allow Pr **mm.000** to be accessed using a CoE object (in the Control Techniques scheme, mapped CoE object indices correspond to menu numbers and sub-indices correspond to parameter numbers; since sub-index zero is already used for another CoE purpose, this cannot be used to access parameter zero of any menu).

### 9.4.3 Menu 2 (Ethernet over EtherCAT Status)

This menu provides information on the Ethernet over EtherCAT configuration.

| <b>S.02.003</b> |                     | <b>EoE Status</b> |                            |
|-----------------|---------------------|-------------------|----------------------------|
| Minimum         | 1                   | Maximum           | 6                          |
| Default         | None                | Units             |                            |
| Type            | 8 bit volatile      | Update Rate       | On EtherCAT Initialization |
| Display Format  | Text                | Decimal Places    | N/A                        |
| Coding          | RO, Txt, ND, NC, PT |                   |                            |

This parameter displays the EoE status. It will contain one of the following values:

| <b>Value</b> | <b>Display String</b> | <b>Corresponding ESM State</b>                 |
|--------------|-----------------------|--|
| 1            | Link Down             | EoE Not configured                             |
| 3            | No Address            | EoE Link Up but had no IP Address              |
| 4            | Ready                 | EoE link up, but no activity                   |
| 5            | Active                | EoE Link is up and active                      |
| 6            | Active with Errors    | EoE Link is up and active, but errors detected |

All other values will correspond to Not Applicable

| <b>S.02.004</b> |                    | <b>EoE Message rate</b> |                            |
|-----------------|--------------------|-------------------------|----------------------------|
| Minimum         | 0                  | Maximum                 | 65536                      |
| Default         | None               | Units                   |                            |
| Type            | 16 bit volatile    | Update Rate             | On EtherCAT Initialization |
| Display Format  | Decimal            | Decimal Places          | 1                          |
| Coding          | RO, ND, NC, PT, BU |                         |                            |

The number of messages per second.

| <b>S.02.006</b> |                                 | <b>EoE IP Address</b> |  |
|-----------------|---------------------------------|-----------------------|--|
| Minimum         | 0<br>(Display: 000.000.000.000) | Maximum               | 4294967295<br>(Display: 255.255.255.255) |
| Default         | None                            | Units                 |  |
| Type            | 32 bit volatile                 | Update Rate           | On EtherCAT Initialization               |
| Display Format  | IP                              | Decimal Places        | 0  |
| Coding          | RO, ND, NC, PT, BU              |                       |  |

This parameter shows the EoE IP address of the SI-EtherCAT module assigned by the EtherCAT master.

| <b>S.02.007</b> |                                 | <b>EoE Subnet Mask</b> |  |
|-----------------|---------------------------------|------------------------|--|
| Minimum         | 0<br>(Display: 000.000.000.000) | Maximum                | 4294967295<br>(Display: 255.255.255.255) |
| Default         | None                            | Units                  |  |
| Type            | 32 bit volatile                 | Update Rate            | On EtherCAT Initialization               |
| Display Format  | IP                              | Decimal Places         | 0  |
| Coding          | RO, ND, NC, PT, BU              |                        |  |

This parameter shows the EoE Subnet mask of the SI-EtherCAT module assigned by the EtherCAT master.

| <b>S.02.008</b> |                                 | <b>EoE Default Gateway</b> |  |
|-----------------|---------------------------------|----------------------------|--|
| Minimum         | 0<br>(Display: 000.000.000.000) | Maximum                    | 4294967295<br>(Display: 255.255.255.255) |
| Default         | None                            | Units                      |  |
| Type            | 32 bit volatile                 | Update Rate                | On EtherCAT Initialization               |
| Display Format  | IP                              | Decimal Places             | 0  |
| Coding          | RO, ND, NC, PT, BU              |                            |  |

This parameter shows the EoE default gateway IP address of the SI-EtherCAT module assigned by the EtherCAT master.

| <b>S.02.011</b> |                              | <b>EoE MAC Address</b> |  |
|-----------------|------------------------------|------------------------|--|
| Minimum         | 0<br>(Display: 000000000000) | Maximum                | 281474976710655<br>(Display: FFFFFFFF0000) |
| Default         | None                         | Units                  |  |
| Type            | 64 bit volatile              | Update Rate            | On EtherCAT Initialization                 |
| Display Format  | Mac                          | Decimal Places         | 0  |
| Coding          | RO, ND, NC, PT, BU           |                        |  |

This parameter displays the MAC address of the EoE virtual Ethernet interface as a 48 bit hexadecimal value.

#### 9.4.4 Menu 9 (Resources)

This menu provides information on the SI-EtherCAT module resources.

| <b>S.09.010</b> |                    | <b>Pre-critical task % free</b> |                       |
|-----------------|--------------------|---------------------------------|-----------------------|
| Minimum         | 0                  | Maximum                         | 100                   |
| Default         | None               | Units                           | %                     |
| Type            | 8 bit volatile     | Update Rate                     | Written in background |
| Display Format  | None               | Decimal Places                  | 0                     |
| Coding          | RO, ND, NC, PT, BU |                                 |                       |

This parameter shows the current resource available for the pre-critical task. In the SI-EtherCAT option, this is the task executed 75  $\mu$ s before the end of the 250  $\mu$ s task executed synchronously with the drive control loops.

| <b>S.09.011</b> |                    | <b>Critical task % free</b> |                       |
|-----------------|--------------------|-----------------------------|-----------------------|
| Minimum         | 0                  | Maximum                     | 100                   |
| Default         | None               | Units                       | %                     |
| Type            | 8 bit volatile     | Update Rate                 | Written in background |
| Display Format  | None               | Decimal Places              | 0                     |
| Coding          | RO, ND, NC, PT, BU |                             |                       |

This parameter shows the current resource available for the critical task. In the SI-EtherCAT option, this is the task executed synchronously with the drive control loops every 250  $\mu$ s.

| <b>S.09.012</b> |                    | <b>Post-critical task % free</b> |                       |
|-----------------|--------------------|----------------------------------|-----------------------|
| Minimum         | 0                  | Maximum                          | 100                   |
| Default         | None               | Units                            | %                     |
| Type            | 8 bit volatile     | Update Rate                      | Written in background |
| Display Format  | None               | Decimal Places                   | 0                     |
| Coding          | RO, ND, NC, PT, BU |                                  |                       |

This parameter shows the current resource available for the post-critical task. In the SI-EtherCAT option, this is the task executed 70  $\mu$ s after start of the 250  $\mu$ s task executed synchronously with the drive control loops.

| <b>S.09.020</b> |                    | <b>Pre-critical task worst % free</b> |                       |
|-----------------|--------------------|---------------------------------------|-----------------------|
| Minimum         | 0                  | Maximum                               | 100                   |
| Default         | None               | Units                                 | %                     |
| Type            | 8 bit volatile     | Update Rate                           | Written in background |
| Display Format  | None               | Decimal Places                        | 0                     |
| Coding          | RO, ND, NC, PT, BU |                                       |                       |

This parameter shows the worst case resource available for the pre-critical task.

| <b>S.09.021</b> |                    | <b>Critical task worst % free</b> |                       |
|-----------------|--------------------|-----------------------------------|-----------------------|
| Minimum         | 0                  | Maximum                           | 100                   |
| Default         | None               | Units                             | %                     |
| Type            | 8 bit volatile     | Update Rate                       | Written in background |
| Display Format  | None               | Decimal Places                    | 0                     |
| Coding          | RO, ND, NC, PT, BU |                                   |                       |

This parameter shows the worst case resource available for the critical task.

| <b>S.09.022</b> |                    | <b>Post-critical task worst % free</b> |                       |
|-----------------|--------------------|--|-----------------------|
| Minimum         | 0                  | Maximum                                | 100                   |
| Default         | None               | Units                                  | %                     |
| Type            | 8 bit volatile     | Update Rate                            | Written in background |
| Display Format  | None               | Decimal Places                         | 0                     |
| Coding          | RO, ND, NC, PT, BU |  |                       |

This parameter shows the worst case resource available for the post-critical task.

| <b>S.09.023</b> |                    | <b>Out Data Position %</b> |                       |
|-----------------|--------------------|----------------------------|-----------------------|
| Minimum         | 0                  | Maximum                    | 100                   |
| Default         | None               | Units                      | %                     |
| Type            | 8 bit volatile     | Update Rate                | Written in background |
| Display Format  | None               | Decimal Places             | 0                     |
| Coding          | RO, ND, NC, PT, BU |                            |                       |

This parameter shows the Out Data Position.



| <b>S.09.030</b> |                | <b>SI-EtherCAT Module Temperature</b> |                       |
|-----------------|----------------|---------------------------------------|-----------------------|
| Minimum         | -128           | Maximum                               | 127                   |
| Default         | None           | Units                                 | °C                    |
| Type            | 8 bit volatile | Update Rate                           | Written in background |
| Display Format  | None           | Decimal Places                        | 0                     |
| Coding          | RO, ND, NC     |                                       |                       |

This parameter shows the SI-EtherCAT option module temperature in degrees Celsius.

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (CI4402) support |
| Advanced features              |
| <b>Parameter descriptions</b>  |
| Diagnostics                    |
| Glossary of terms              |
| Index                          |

---

# 10 Diagnostics

---

## 10.1 Module identification parameters

### 10.1.1 SI-EtherCAT module ID code

Table 10-1 SI-EtherCAT module ID code

| SI-EtherCAT module ID code |         |                   |
|----------------------------|---------|-------------------|
| S.00.001                   | Default | 431 (SI-EtherCAT) |
|                            | Range   | 0 to 65535        |
|                            | Access  | RO                |

The module ID code indicates the type of module installed in the slot. This is useful for checking the module is of the correct type.

### 10.1.2 SI-EtherCAT firmware version

Table 10-2 SI-EtherCAT firmware version

| SI-EtherCAT firmware version |         |   |
|------------------------------|---------|---|
| S.00.002                     | Default | N/A   |
|                              | Range   | 0(Display:00.00.00.00) to 99999999(Display:99.99.99.99) |
|                              | Access  | RO  |

## 10.2 SI-EtherCAT module temperature

Table 10-3 SI-EtherCAT module temperature

| SI-EtherCAT module temperature |         |         |
|--------------------------------|---------|---------|
| S.09.030                       | Default | N/A     |
|                                | Range   | 0 - 255 |
|                                | Access  | RO      |

This parameter shows the option module temperature reading in degrees Celsius.

## 10.3 Error handling

The following objects are provided to indicate an error condition

Table 10-4 Error handling objects

| Index  | Name           |
|--------|----------------|
| 0x1001 | Error_register |
| 0x603F | Error_code     |

### 10.3.1 Error register

**Table 10-5 Error register**

| 0x1001       |   | Error register  |                  |           |
|--------------|---|-----------------|------------------|-----------|
| Access: RO   |   | Range: 0 to 255 | Size: Unsigned 8 | Unit: N/A |
| Default:     | 0   |                 |                  |           |
| Description: | A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits are supported:<br>0: Generic error, 1: Current, 2: Voltage, 3: Temperature<br>When an error is indicated in this object, the particular error code will be contained in object 0x603F (Error code). |                 |                  |           |

### 10.3.2 Error code

**Table 10-6 Error code**

| 0x603F       |   | Error code         |               |           |
|--------------|---|--------------------|---------------|-----------|
| Access: RO   |   | Range: 0 to 0xFFFF | Size: 2 bytes | Unit: N/A |
| Default:     | 0   |                    |               |           |
| Description: | A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in Table 10-7 below. |                    |               |           |

**Table 10-7 Error codes**

| Error code | Meaning  | Corresponding drive trip Code (if available)  |
|------------|--|---|
| 0x0000     | Error reset / No error                         | 0 – None  |
| 0xFF01     | Generic error                                  | (Any trip code not elsewhere in table)  |
| 0x2300     | Current, device output side                    | 3 – OI ac   |
| 0x3130     | Phase failure                                  | 32 – Phase Loss<br>98 – Out Phase Loss  |
| 0x2230     | Short circuit/ground leakage (device internal) | 5 – PSU<br>9 – PSU 24V<br>92 – Snubber OI   |
| 0x3210     | DC link over-voltage                           | 2 – Over Volts  |
| 0x3230     | Load error                                     | 38 - Low Load   |
| 0x4310     | Excess temperature drive                       | 21 – OHT Inverter, 22 – OHT Power<br>23 – OHT Control, 27 – OHT dc bus<br>101 – OHT Brake   |
| 0x5112     | "Supply low voltage" and "U2 = supply +24 V"   | 91 - User 24V   |
| 0x5200     | Control device hardware                        | 200 - Slot 1 Hardware Fault<br>203 - Slot 1 Not Fitted, 204 - Slot 1 Different<br>205 - Slot 2 Hardware Fault<br>208 - Slot 2 Not Fitted, 209 - Slot 2 Different<br>210 - Slot 3 Hardware Fault<br>213 - Slot 3 Not Fitted, 214 - Slot 3 Different<br>250 - Slot 4 Hardware Fault<br>253 - Slot 4 Not Fitted, 254 - Slot 4 Different<br>221 - Stored HF |
| 0x5400     | Power section                                  | 111 - Config P<br>220 - Power Data<br>223 - Rating Mismatch   |

| <b>Error code</b> | <b>Meaning</b>                             | <b>Corresponding drive trip Code (if available)</b>   |
|-------------------|--|---|
| 0x5510            | RAM  | 227 - Sub Array RAM Allocation  |
| 0x5530            | Data Storage (Non-volatile data memory)    | 31 – EEPROM Fail<br>36 – User Save<br>37 – Power Down Save  |
| 0x5430            | Input stages                               | 94 - Rectifier set up   |
| 0x5440            | Contacts                                   | 226 - Soft Start  |
| 0x6010            | Software reset (watchdog)                  | 30 – Watchdog   |
| 0x6320            | Parameter Error                            | 199 - Destination<br>216 - Slot App Menu Crash<br>217 - App menu changed  |
| 0x7112            | Brake Chopper (Over current brake chopper) | 4 – OI Brake<br>19 – Brake R Too Hot  |
| 0x7113            | Protective circuit break chopper           | 10 - Th Brake Res   |
| 0x7120            | Motor                                      | 11 - Autotune 1, 12 - Autotune 2<br>13 - Autotune 3, 20 - Motor Too Hot   |
| 0x7122            | Motor error or commutation malfunc.        | 14 – Autotune 4, 15 – Autotune 5<br>16 – Autotune 6, 24 - Thermistor<br>25 - Th Short Circuit, 33 - Resistance  |
| 0x7300            | Sensor                                     | 17 - Autotune 7<br>162 to 163 – Encoder 12 to Encoder 13<br>176 – Name Plate<br>189 to 198 – Encoder 1 to Encoder 10<br>218 - Temp Feedback   |
| 0x7310            | Speed                                      | 7 - Over speed  |
| 0x7500            | Communication                              | 90 - Power Comms<br>103 - Interconnect  |
| 0x7600            | Data storage (external)                    | 174 - Card Slot, 175 – Card Product<br>177 – Card Boot, 178 – Card Busy<br>179 – Card Data Exists, 180 – Card Option<br>181 – Card Read Only, 182 – Card Error<br>183 – Card No Data, 184 – Card Full<br>185 – Card Access, 186 – Card Rating<br>187 – Card Drive Mode,<br>188 – Card Compare |

## 10.4 Drive trip display codes

Table shows the possible trip codes that will be displayed on the drive when a problem is detected with SI-EtherCAT or when SI-EtherCAT initiates a trip.

**Table 10-8 Trip display codes**

| Value<br>(Pr 10.070) | Display text     | Description   |
|----------------------|------------------|---|
| 100                  | Invalid Fdbk Src | An unknown or invalid feedback source has been configured                 |
| 101                  | ECAT Init Error  | An error occurred whilst initialising the EtherCAT communications         |
| 102                  | TO ECAT PDO      | A PDO has not been written for longer than the specified timeout          |
| 103                  | Sync Task Orun   | The synchronous task has overrun its allowed interval                     |
| 104                  | Scaling Failure  | Configured gear ratio or feed constant values fail to be implement in AMC |
| 105                  | APLS Failure     | Configured additional position loop scaling fails to be implement in AMC  |
| 106                  | TO ECAT STOP     | The Master has requested a STOP   |
| 107                  | Pre Task Overrun | The Pre critical task has overrun   |

|                         |
|-------------------------|
| Safety Information      |
| Introduction            |
| Mechanical Installation |
| Electrical Installation |
| Getting started         |
| Protocols               |
| Drive profile (C1A402)  |
| Advanced features       |
| Parameter descriptions  |
| <b>Diagnostics</b>      |
| Glossary of terms       |
| Index                   |

## 10.5 Option module trips

Table 10-9 Option module trips

| Value<br>(Pr 10.070) | Display Text                   | Description  |
|----------------------|--------------------------------|--|
| 200                  | SW fault                       | Software Fault   |
| 201                  | BG Orun                        | Background task overrun                                |
| 202                  | FW invalid                     | Invalid firmware for hardware version                  |
| 203                  | Drv unknown                    | Unknown drive type                                     |
| 204                  | Drv unsupported                | Unsupported drive type                                 |
| 205                  | Mode unknown                   | Unknown drive mode                                     |
| 206                  | Mode unsupported               | Unsupported drive mode                                 |
| 207                  | FLASH corrupt                  | Corrupted non-volatile FLASH                           |
| 208                  | Dbase init                     | Database initialisation error                          |
| 209                  | FS init                        | File system initialisation error                       |
| 210                  | Memory alloc                   | Memory allocation error                                |
| 211                  | Filesystem                     | File system error                                      |
| 212                  | Configuration                  | Configuration file save error                          |
| 213                  | Oht                            | Overheated   |
| 214                  | TO drv                         | The drive has not responded within the watchdog period |
| 215                  | ECMP                           | eCMP communication failure                             |
| 216                  | TO ECMP slot 1                 | eCMP communication to slot 1 timeout                   |
| 217                  | TO ECMP slot 2                 | eCMP communication to slot 2 timeout                   |
| 218                  | TO ECMP slot 3                 | eCMP communication to slot 3 timeout                   |
| 219                  | TO ECMP slot 4                 | eCMP communication to slot 4 timeout                   |
| 220                  | Reserved                       | Reserved   |
| 221                  | ERROR_MISSING_FACTORY_SETTINGS | Factory settings file is missing                       |
| 222                  | ERROR_FUNCTIONAL_TEST          | Functional test failed                                 |
| 223                  | ERROR_CONFIG_FILE_LOAD         | Configuration file failed to load                      |
| 224                  | ERROR_POWER_ON_TEST            | Power on self test failed                              |
| 225                  | ERROR_RUNTIME_CONFIG           | Runtime configuration error                            |

## 10.6 Updating SI-EtherCAT firmware

The latest SI-EtherCAT firmware is available from your local Control Techniques Drive Centre or supplier. To upload firmware to SI-EtherCAT a copy of Unidrive M Connect and a suitable communications lead for the option module's host drive is required.

## 10.7 Switching frequency

In applications where greater synchronization is required, it is suggested that the drive's automatic switching frequency option is switched off. If automatic frequency switching is required, then the network will continue to operate, however the synchronization jitter may increase for a short time when the switching frequency changes. To disable the drive's automatic switching frequency control, set the drive Pr **05.035** to Disabled (1).

## 10.8 Sync Task Orun trips

If SI-EtherCAT cannot complete the assigned tasks within its 250  $\mu$ s Synchronous Task, a Sync Task Orun trip will be initiated; a Sync Task Orun trip indicates that the user is trying to accomplish too much within the Synchronous task. The user can influence the Synchronous Task by reducing the amount of cyclic data, or disabling drive control CiA402. To disable drive control set the Pr **S.00.033** to On (1), and perform an option reset via Pr **S.00.007**.

## 10.9 EtherCAT AL status codes

Table 10-10 shows the possible AL (Application Layer) status codes returned to the EtherCAT master controller during configuration or operational mode.

**Table 10-10 Application Layer status codes**

| Code (0x) | Meaning                            | Description   | Comment  |
|-----------|------------------------------------|---|--|
| 0000      | No error                           | No error  |  |
| 0001      | Unspecified error                  | No error code has been defined                              | Contact supplier   |
| 0002      | No memory                          | Insufficient memory for operation                           | Contact supplier   |
| 0011      | Invalid requested state changed    | Requested state change is invalid                           | Follow the EtherCAT State Machine sequence to change state                       |
| 0012      | Unknown requested state change     | Requested state change is unknown                           | Use only the EtherCAT State Machine state values                                 |
| 0013      | Boot state not supported           | Device does not support BOOT state                          | Contact supplier   |
| 0014      | No valid firmware                  | Downloaded firmware application file is invalid             | Download correct firmware application file                                       |
| 0015      | Invalid mailbox configuration      | Mailbox configuration differs from expected settings        | Replace network description file with the correct file for device                |
| 0016      | Invalid mailbox configuration      | Slave device changed but network configuration is unchanged | Replace previous network description of old slave with the one of the new slave. |
| 0017      | Invalid Sync Manager configuration | PDO length, address or direction mismatch                   | Issue a re-calculation of the EtherCAT configuration.                            |
| 0018      | No valid inputs available          | No valid inputs available on Slave device                   | Check slave input objects  |
| 0019      | No valid outputs available         | Slave device cannot receive valid output values             | Check slave output objects   |
| 001A      | Synchronization error              | Too many RxPDO toggle errors have occurred                  | Check configuration  |
| 001B      | Sync Manager watchdog              | No process data received within specified timeout           | Check process data configuration   |
| 001C      | Invalid Sync Manager Types         | Specified Sync Manager type is invalid                      | Use correct Sync Manager   |
| 001D      | Invalid output configuration       | Sync Manager for output process data is invalid             | Use correct Sync Manager   |
| 001E      | Invalid input configuration        | Sync Manager for input process data is invalid              | Use correct Sync Manager   |
| 001F      | Invalid watchdog configuration     | The watchdog configuration is invalid                       | Check watchdog setting   |
| 0020      | Slave needs cold restart           | Slave device requires a cold restart or power cycle         | Restart the slave device   |

| <b>Code (0x)</b> | <b>Meaning</b>                 | <b>Description</b>  | <b>Comment</b>   |
|------------------|--------------------------------|---|--|
| 0021             | Slave needs INIT               | Slave application requests INIT state   | Re-initialise the slave device   |
| 0022             | Slave needs PREOP              | Slave application requests, PREOP state   | Instruct slave device to enter PREOP state                                   |
| 0023             | Slave needs SAFEOP             | Slave application requests SAFEOP state   | Instruct slave device to enter SAFEOP state                                  |
| 0024             | Invalid input mapping          | Invalid input mapping object  | Check slave input mapping  |
| 0025             | Invalid output mapping         | Invalid output mapping object   | Check slave output mapping   |
| 0026             | Inconsistent settings          | General settings mismatch   | Check configuration settings   |
| 0027             | Freerun not supported          | Freerun not supported on slave  |  |
| 0028             | Synchronization not supported  | Synchronization not supported on slave  |  |
| 0029             | Freerun needs 3 Buffer Mode    | Sync Manager requires 3 Buffer Mode to run  |  |
| 002A             | Background Watchdog            | Background task watchdog activated  |  |
| 002B             | No valid inputs and outputs    | Slave device does not provide valid inputs and outputs  |  |
| 002C             | Fatal Sync error               | The hardware synchronization signal has stopped   | Set master to INIT and back to OP so that the DCs are initialized again.     |
| 002D             | No Sync error                  | Hardware synchronization signal not detected  |  |
| 0030             | Invalid DC SYNC configuration  | Distributed Clocks configuration is invalid   | Check DC configuration   |
| 0031             | Invalid DC Latch configuration | Distributed Clocks Latch configuration is invalid   | Check DC configuration   |
| 0032             | PLL error                      | Master not synchronized, at least one DC event received   | Check wiring and synchronization settings                                    |
| 0033             | DC Sync IO error               | Multiple sync errors: At least one sync signal was received but the slave is no longer synchronized | Check network jitter<br>Increase cycle time<br>Use Distributed Clocks scheme |
| 0034             | DC Sync timeout error          | Multiple sync errors: Excessive Sync Manager events missed  | Check DC configuration   |
| 0035             | DC invalid sync cycle time     | DC sync cycle time is invalid   | Check DC configuration   |
| 0036             | DC Sync0 cycle time            | DC Sync0 cycle time invalid for application   | Check DC configuration   |
| 0037             | DC Sync1 cycle time            | DC Sync1 cycle time invalid for application   | Check DC configuration   |



## 10.10 SDO abort codes

SDO messages use a request-response mechanism and the EtherCAT master will always expect a response from the slave device. If an error occurs with an SDO transfer SI-EtherCAT will return an SDO abort code to indicate the reason for the failure, the SDO abort codes are listed in Table 10-11.

**Table 10-11 SDO abort codes**

| Abort code (in hex.) | Description   |
|----------------------|---|
| 0x05030000           | Toggle bit not alternated   |
| 0x05040000           | SDO protocol timed out  |
| 0x05040001           | Client/server command specifier not valid or unknown  |
| 0x05040002           | Invalid block size (block mode only)  |
| 0x05040003           | Invalid sequence number (block mode only)   |
| 0x05040004           | CRC error (block mode only)   |
| 0x05040005           | Out of memory   |
| 0x06010000           | Unsupported access to an object   |
| 0x06010001           | Attempt to read a write only object   |
| 0x06010002           | Attempt to write a read only object   |
| 0x06020000           | Object does not exist in the object dictionary  |
| 0x06040041           | Object cannot be mapped to the PDO  |
| 0x06040042           | The number and length of the objects to be mapped would exceed PDO length                   |
| 0x06040043           | General parameter incompatibility   |
| 0x06040047           | General internal incompatibility in the device  |
| 0x06060000           | Access failed due to a hardware error   |
| 0x06070010           | Data type does not match, length of service parameter does not match                        |
| 0x06070012           | Data type does not match, length of service parameter too high                              |
| 0x06070013           | Data type does not match, length of service parameter too low                               |
| 0x06090011           | Sub-index does not exist  |
| 0x06090030           | Value range of parameter exceeded (only for write access)                                   |
| 0x06090031           | Value of parameter written too high   |
| 0x06090032           | Value of parameter written too low  |
| 0x06090036           | Maximum value is less than minimum value  |
| 0x08000000           | General error   |
| 0x08000020           | Data cannot be transferred or stored to the application                                     |
| 0x08000021           | Data cannot be transferred or stored to the application because of local control            |
| 0x08000022           | Data cannot be transferred or stored to the application because of the present device state |
| 0x08000023           | Object dictionary dynamic generation fails or no object dictionary is present               |

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (CI/A02) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnosics                     |
| Glossary of terms              |
| Index                          |

---

## 11 Glossary of terms

---

**Address:** This is the unique network identification given to a networked device to allow communication on a network. When a device sends or receives data the address is used to determine the source and the destination of the message.

**Bit:** A binary digit, this may have the value of 1 or 0.

**Byte:** A collection of eight binary digits that collectively store a value. This may be signed or unsigned.

**Control word:** A collection of binary digits that are used to control the drive. Features typically include directional controls, run controls and other similar functions.

**Cyclic:** Data that is transmitted at regular intervals over the network.

**Data rate:** Determines the communication speed of the network, the higher the value the more data can be sent across the network in the same time period.

**Device:** A piece of equipment connected to a network, this may be any type of equipment including repeaters, hubs, masters or slaves.

**Double word:** A 32-bit word, this may be signed or unsigned.

**Grounding / Earthing:** Describes the electrical safety or shielding connections for the module.

**LED:** Light emitting diode.

**Long word:** A 32-bit data word that may be signed or unsigned.

**LSB:** Least significant bit/byte.

**MSB:** Most significant bit/byte.

**Node:** A device on the network. This may be either a device such as a drive or part of the network such as a repeater.

**Non cyclic data:** Data that is requested or sent as required and not on a regular basis.

**Octet:** A collection of eight binary digits which form a byte.

**PC:** Personal computer.

**PLC:** Programmable logic controller.

**Poll rate:** The rate at which cyclic data is sent and received on the network.

**Polled data:** See *Cyclic data*.

**Scan rate:** See *Poll rate*.

**Shielding:** A connection to provide additional immunity to noise used on a network cable.

**Status word:** A value that denotes the status of the drive. Each bit within the word will have a specific meaning.

**Word:** A collection of sixteen binary digits.

|                                |
|--------------------------------|
| Safety Information             |
| Introduction                   |
| Mechanical Installation        |
| Electrical Installation        |
| Getting started                |
| Protocols                      |
| Drive profile (CUA402) support |
| Advanced features              |
| Parameter descriptions         |
| Diagnostics                    |
| <b>Glossary of terms</b>       |
| Index                          |

---

# Index

---

|  |     |
|--|-----|
| <b>A</b>                               |     |
| Address .....                          | 114 |
| <b>B</b>                               |     |
| Bit .....                              | 114 |
| Byte .....                             | 114 |
| <b>C</b>                               |     |
| Cautions .....                         | 6   |
| Control word .....                     | 114 |
| Cyclic data .....                      | 114 |
| Cyclic sync position mode .....        | 80  |
| Cyclic Synchronous Velocity Mode ..... | 82  |
| <b>D</b>                               |     |
| Data rate .....                        | 114 |
| Device .....                           | 114 |
| Diagnostics .....                      | 106 |
| Distributed clocks .....               | 88  |
| Double word .....                      | 114 |
| <b>E</b>                               |     |
| Earthing / grounding .....             | 114 |
| Electrical installation .....          | 16  |
| Electrical safety .....                | 6   |
| Error handling .....                   | 106 |
| <b>F</b>                               |     |
| Features .....                         | 10  |
| <b>G</b>                               |     |
| Getting started .....                  | 19  |
| Glossary of terms .....                | 114 |
| <b>H</b>                               |     |
| Homing mode .....                      | 74  |
| <b>I</b>                               |     |
| Installation .....                     | 13  |
| Introduction .....                     | 10  |
| <b>L</b>                               |     |
| LED .....                              | 114 |
| Long word .....                        | 114 |
| LSB .....                              | 114 |
| <b>M</b>                               |     |
| Mechanical installation .....          | 13  |
| MSB .....                              | 114 |
| <b>N</b>                               |     |
| Node .....                             | 114 |

|   |     |
|---|-----|
| Non cyclic data .....                     | 114 |
| <b>O</b>                                  |     |
| Octet .....                               | 114 |
| Option module .....                       | 10  |
| <b>P</b>                                  |     |
| Parameter descriptions .....              | 92  |
| PC .....                                  | 114 |
| PLC .....                                 | 114 |
| Poll rate .....                           | 114 |
| Polled data .....                         | 114 |
| Products covered by this User Guide ..... | 10  |
| <b>Q</b>                                  |     |
| Quick start guide .....                   | 19  |
| <b>S</b>                                  |     |
| Safety information .....                  | 6   |
| Scan rate .....                           | 114 |
| Shielding .....                           | 115 |
| SI-EtherCAT Object Dictionary .....       | 24  |
| SI-EtherCAT terminal descriptions .....   | 17  |
| Status word .....                         | 115 |
| Supported objects .....                   | 24  |
| <b>V</b>                                  |     |
| vi velocity mode .....                    | 68  |
| <b>W</b>                                  |     |
| Word .....                                | 115 |

|                               |
|-------------------------------|
| Safety Information            |
| Introduction                  |
| Mechanical Installation       |
| Electrical Installation       |
| Getting started               |
| Protocols                     |
| Drive profile (CI402) support |
| Advanced features             |
| Parameter descriptions        |
| Diagnostics                   |
| Glossary of terms             |
| <b>Index</b>                  |



**0478-0152-04**