

## *User Guide*

---

# ***SM-EtherCAT***

---

Unidrive SP  
Affinity  
Digitax ST  
Commander SK  
Mentor MP

**EtherCAT®**  
Conformance tested

Part Number: 0471-0128-05  
Issue Number: 5



[www.controltechniques.com](http://www.controltechniques.com)

## General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional parameters of the equipment or from mismatching the variable speed drive with the motor.

The contents of this guide are believed to be correct at the time of printing. In the interests of 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 content 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.

## Environmental Statement

Control Techniques is committed to minimising the environmental impacts of its manufacturing operations and of its products throughout their life cycle. To this end, we operate an Environmental Management System (EMS) which is certified to the International Standard ISO 14001. Further information on the EMS, our Environment Policy and other relevant information is available on request, or can be found at [www.greendrives.com](http://www.greendrives.com).

The electronic variable speed drives manufactured by Control Techniques have the potential to save energy and (through increased machine/process efficiency) reduce raw material consumption and scrap throughout their long working lifetime. In typical applications, these positive environmental effects far outweigh the negative impacts of product manufacture and end-of-life disposal.

Nevertheless, when the products eventually reach the end of their useful life, they must not be discarded but should instead be recycled by a specialist recycler of electronic equipment. Recyclers will find the products easy to dismantle into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, while other parts are secured with conventional fasteners. Virtually all parts of the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, while smaller products come in strong cardboard cartons which themselves have a high-recycled fibre content. If not re-used, these containers can be recycled. Polythene, used on the protective film and bags from wrapping product, can be recycled in the same way. Control Techniques' packaging strategy prefers easily recyclable materials of low environmental impact, and regular reviews identify opportunities for improvement.

When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

## Software Statement

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

The software version of the Solutions Module can be identified by looking at Pr **MM.02** and Pr **MM.51**, where **MM** is the relevant menu number for the Solutions Module slot being used.

See Pr **MM.02** and Pr **MM.51** description later in this manual for more information.

The software version takes the form of xx.yy.zz, where Pr **MM.02** displays xx.yy and Pr **MM.51** displays zz (e.g. for software version 01.01.00 Pr **15.02** will display 1.01 and Pr **15.51** will display 0).

## 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.

For current information on how this requirement applies in relation to specific Control Techniques products, please approach your usual contact in the first instance. Control Techniques position statement can be viewed at:

<http://www.controltechniques.com/REACH>

---

# Contents

---

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>Safety information .....</b>                  | <b>5</b>  |
| 1.1      | Warnings, cautions and notes .....               | 5         |
| 1.2      | Electrical safety - general warning .....        | 5         |
| 1.3      | System design and safety of personnel .....      | 5         |
| 1.4      | Environmental limits .....                       | 6         |
| 1.5      | Compliance with regulations .....                | 6         |
| 1.6      | Motor .....                                      | 7         |
| 1.7      | Adjusting parameters .....                       | 7         |
| 1.8      | Electrical installation .....                    | 7         |
| <b>2</b> | <b>Introduction .....</b>                        | <b>8</b>  |
| 2.1      | Features .....                                   | 8         |
| 2.2      | Introduction to SM-EtherCAT .....                | 8         |
| 2.3      | What is EtherCAT? .....                          | 8         |
| 2.4      | Solution module identification .....             | 9         |
| 2.5      | Product Conformance Certificate .....            | 9         |
| 2.6      | Conventions used in this guide .....             | 9         |
| <b>3</b> | <b>Mechanical installation .....</b>             | <b>11</b> |
| 3.1      | General installation .....                       | 11        |
| <b>4</b> | <b>Electrical installation .....</b>             | <b>12</b> |
| 4.1      | SM-EtherCAT module information .....             | 12        |
| 4.2      | SM-EtherCAT terminal descriptions .....          | 12        |
| 4.3      | Module grounding .....                           | 13        |
| 4.4      | Network topology .....                           | 13        |
| 4.5      | Minimum node-to-node cable length .....          | 13        |
| <b>5</b> | <b>Getting started .....</b>                     | <b>14</b> |
| 5.1      | Quick start guide .....                          | 14        |
| 5.2      | Quick start flowchart .....                      | 18        |
| 5.3      | Saving parameters to the drive .....             | 19        |
| 5.4      | SM-EtherCAT Node address .....                   | 19        |
| 5.5      | SM-EtherCAT RUN .....                            | 19        |
| 5.6      | Re-initializing the SM-EtherCAT .....            | 20        |
| 5.7      | Re-initialize all Solutions Modules .....        | 20        |
| <b>6</b> | <b>Protocols .....</b>                           | <b>21</b> |
| 6.1      | Process Data Objects (PDOs) .....                | 21        |
| 6.2      | Service Data Object (SDO) parameter access ..... | 21        |
| 6.3      | CANopen over EtherCAT (CoE) .....                | 22        |
| 6.4      | Ethernet over EtherCAT (EoE) .....               | 32        |

|           |  |           |
|-----------|--|-----------|
| <b>7</b>  | <b>Drive profile (DSP-402) support .....</b> | <b>36</b> |
| 7.1       | 0x6040 Controlword .....                     | 36        |
| 7.2       | 0x6041 Statusword .....                      | 37        |
| 7.3       | Common profile features .....                | 37        |
| 7.4       | Interpolated position mode .....             | 48        |
| 7.5       | vi velocity mode .....                       | 50        |
| 7.6       | Profile torque mode .....                    | 56        |
| 7.7       | Homing mode .....                            | 57        |
| 7.8       | Cyclic sync position mode .....              | 65        |
| <b>8</b>  | <b>Advanced features .....</b>               | <b>67</b> |
| 8.1       | Distributed Clocks .....                     | 67        |
| 8.2       | SM-EtherCAT protocol support .....           | 68        |
| 8.3       | Menu 61 - General Module Setup .....         | 68        |
| 8.4       | Advanced cyclic data configuration .....     | 72        |
| 8.5       | Internal shortcuts .....                     | 73        |
| <b>9</b>  | <b>Diagnostics .....</b>                     | <b>74</b> |
| 9.1       | Module identification parameters .....       | 74        |
| 9.2       | Network configuration objects .....          | 75        |
| 9.3       | Diagnostic parameters .....                  | 76        |
| 9.4       | Drive trip display codes .....               | 77        |
| 9.5       | SM-EtherCAT module temperature .....         | 77        |
| 9.6       | SM-EtherCAT serial number .....              | 77        |
| 9.7       | SM-EtherCAT error codes .....                | 77        |
| 9.8       | Error handling .....                         | 78        |
| 9.9       | Critical task % free .....                   | 80        |
| 9.10      | SDO abort codes .....                        | 81        |
| 9.11      | FLASH file system % free .....               | 81        |
| 9.12      | Updating SM-EtherCAT firmware .....          | 82        |
| <b>10</b> | <b>Quick reference .....</b>                 | <b>83</b> |
| <b>11</b> | <b>Glossary of terms .....</b>               | <b>87</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 Electrical safety - general warning

The voltages used in the drive 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 drive.

Specific warnings are given at the relevant places in this User Guide.

## 1.3 System design and safety of personnel

The drive is intended as a component for professional incorporation into complete equipment or a system. If installed incorrectly, the drive may present a safety hazard.

The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment 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, start up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

The STOP and SAFE TORQUE OFF functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

**With the sole exception of the SAFE TORQUE OFF function on Unidrive SP and Digitax ST, none of the drive functions must be used to ensure safety of personnel, i.e. they must not be used for safety-related functions.**

**NOTE** The SAFE TORQUE OFF function is only available as standard on the Unidrive SP and Digitax ST.

Careful consideration must be given to the functions of the drive which might result in a hazard, either through their intended behavior or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

The SAFE TORQUE OFF function has been approved by BGIA as meeting the requirements of the following standards, for the prevention of unexpected starting of the drive:

EN 61800-5-2:2007 SIL 3

EN ISO 13849-1:2006 PL e

EN 954-1:1997 Category 3

The SAFE TORQUE OFF function may be used in a safety-related application. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

## 1.4 Environmental limits

Instructions in the *Unidrive SP User Guide*, *Commander SK Getting Started Guide*, *Commander SK Technical Data Guide*, *Digitax ST User Guide* and *Mentor MP User Guide* regarding transport, storage, installation and use of the drive must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

## 1.5 Access

Drive access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

## 1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.

## 1.7 Compliance with regulations

The installer is responsible for complying with all relevant regulations, such as national wiring regulations, accident prevention regulations and electromagnetic compatibility (EMC) regulations. Particular attention must be given to the cross-sectional areas of conductors, the selection of fuses or other protection, and protective earth (ground) connections.

The *Unidrive SP User Guide*, *Digitax ST User Guide* and *Mentor MP User Guide* contain instructions for achieving compliance with specific EMC standards.

Within the European Union, all machinery in which this product is used must comply with the following directives:

- 2006/42/EC: Safety of machinery.
- 2004/108/EC: Electromagnetic Compatibility.

## 1.8 Motor

Ensure the motor is installed in accordance with the manufacturer's recommendations and that the motor shaft is not exposed.

Standard squirrel cage induction motors are designed for single speed operation. If it is intended to use the capability of the drive to run a motor at speeds above its designed maximum, it is strongly recommended that the manufacturer is consulted first.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. The motor should be installed with a protection thermistor. If necessary, an electric forced vent fan should be used.

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive should not be relied upon.

It is essential that the correct value is entered in the motor rated current parameter, Pr **5.07** (or Pr **0.46** in Unidrive SP, Affinity and Digitax ST, or Pr **0.28 {SE07}** in Mentor MP, or Pr **0.06** in Commander SK). This affects the thermal protection of the motor.

## 1.9 Adjusting parameters

Some parameters have a profound effect on the operation of the drive. They must not be altered without careful consideration of the impact on the controlled system. Measures must be taken to prevent unwanted changes due to error or tampering.

## 1.10 Electrical installation

### 1.10.1 Electric shock risk

The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

### 1.10.2 Stored charge

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

---

## 2 Introduction

---

### 2.1 Features

- Standard RJ45 with support for shielded twisted pair, half-duplex / full-duplex and 10Mbps / 100Mbps connectivity
- Dual 100Mbps EtherCAT interfaces for use in line topologies i.e. daisy chaining
- Supports the Unidrive SP drives range, Mentor MP, Affinity, Digitax ST and Commander SK
- Control loop synchronization
- Control cycle times down to 250µs
- Configured Station Alias
- CANopen over EtherCAT (CoE) which includes:
  - Support of CANopen DSP-402 (Device Profile for Drives and Motion)
  - Cyclic sync position mode
  - Interpolated position mode
  - Velocity mode
  - Profile torque mode
  - Homing mode
  - Two transmit and two receive PDOs
  - SDO access to all profile objects and drive parameters
  - Two digital inputs available for use in homing mode
- EoE (Ethernet over EtherCAT)

### 2.2 Introduction to SM-EtherCAT

SM-EtherCAT is a Solutions Module that enables the Control Techniques 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.

### 2.3 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).

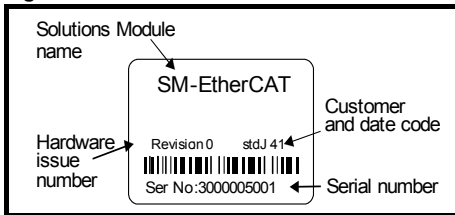


## 2.4 Solution module identification

The SM-EtherCAT can be identified by:

1. The label located on the underside of the Solutions Module.
2. The color coding across the front of the SM-EtherCAT (brown-red).

**Figure 2-1 SM-EtherCAT label**



### 2.4.1 Date code format

The date code is split into two sections: a letter followed by a number.

The letter indicates the year and the number indicates the week number (within the year) in which the Solutions Module was built.

The letters are alphabetical in order, starting with A in 1991 (B in 1992, C in 1993 etc.).

Example:

A date code of Q46 would correspond to week 46 of year 2007.

## 2.5 Product Conformance Certificate

SM-EtherCAT has been awarded full EtherCAT Conformance Certification by the EtherCAT Technology Group (ETG). A copy of the certificate is available on request from your supplier or local Control Techniques Drive Centre.

## 2.6 Conventions used in this guide

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

In the case of a Solutions Module, the parameters will appear in one of three menus 15, 16 or 17 depending on the drive type and slot the module is installed into as shown in Table 2.1 *Drive menu availability* below. The menu is denoted by the number before the decimal point.

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

- Pr **xx.00** - signifies any menu and parameter number 00.
- Pr **MM.xx** - where **MM** signifies the menu allocated to the solutions module (as shown in Table 2.1 *Drive menu availability*) and **xx** signifies the parameter number.

**Table 2.1 Drive menu availability**

| Drive Type   | Slot 1<br>15.xx | Slot 2<br>16.xx | Slot 3<br>17.xx |
|--------------|-----------------|-----------------|-----------------|
| Unidrive SP  | Yes             | Yes             | Yes             |
| Affinity     | Yes             | Yes             | No              |
| Mentor MP    | Yes             | Yes             | Yes             |
| Commander SK | Yes             | No              | No              |
| Digitax ST   | Yes             | Yes             | No              |

**NOTE** All references in this manual to SM-Applications/Plus should also extend to SM-Applications Lite/Lite V2. The exceptions to this are references to SM-Applications/Plus input/output, CTSync or the EIA (RS) -485 port, as these are not supported on SM-Applications Lite/Lite V2. For full details of the differences see the *SM-Applications Modules and Motion Processors User Guide*.

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

## 3 Mechanical installation

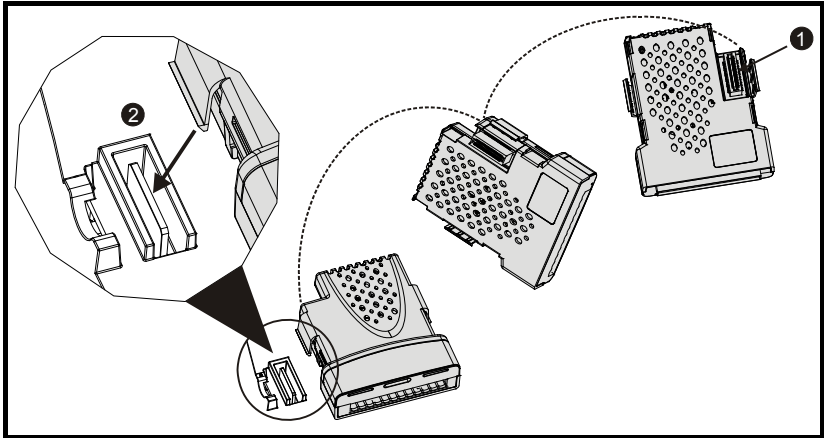


Before installing or removing a Solutions Module in any drive, ensure the AC supply has been disconnected for at least 10 minutes and refer to Chapter 1 *Safety information* on page 5. If using a DC bus supply ensure this is fully discharged before working on any drive or Solutions Module.

### 3.1 General installation

The installation of a Solutions Module is illustrated in Figure 3-1.

**Figure 3-1 Installing a Solutions Module**



The Solutions Module connector is located on the underside of the module (1). Push this into the Solutions Module slot located on the drive until it clicks into place (2). Note that some drives require a protective tab to be removed from the Solutions Module slot. For further information, refer to the appropriate drive manual.

---

## 4 Electrical installation

---

### 4.1 SM-EtherCAT module information

#### 4.1.1 Bus media

The SM-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

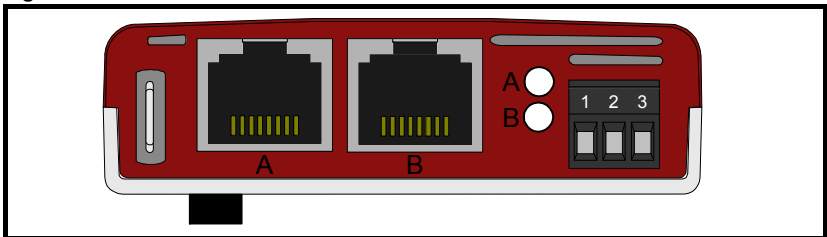
The main restriction imposed on Ethernet cabling is the length of a single segment of cable. The SM-EtherCAT module has two 100BASE-TX Ethernet ports, which support segment lengths of up to 100m. This means that the maximum cable length which can be used between one SM-EtherCAT port and another 100BASE-TX port is 100m however it is not recommended that the full 100m 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 SM-EtherCAT terminal descriptions

The SM-EtherCAT module has two RJ45 Ethernet ports for the EtherCAT network. There are also two digital inputs available for use in Homing Mode.

**Figure 4-1 EtherCAT connection**



**Table 4.1 EtherCAT terminal descriptions**

| Pin | A - IN     | Pin | B - OUT    | Digital Inputs | Function        |
|-----|------------|-----|------------|----------------|-----------------|
| 1   | Transmit + | 1   | Transmit + | 1              | 0V Common       |
| 2   | Transmit - | 2   | Transmit - | 2              | Digital input 0 |
| 3   | Receive +  | 3   | Receive +  | 3              | Digital input 1 |
| 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   |                |                 |

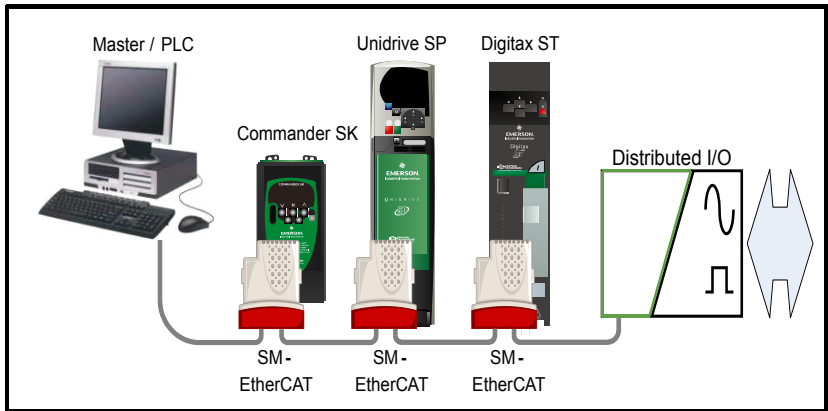
### 4.3 Module grounding

SM-EtherCAT is supplied with a grounding tag 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.

### 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 SM-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 SM-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 SM-EtherCAT module.

### 5.1.1 SM-EtherCAT version compatibility

**Table 5.1 SM-EtherCAT version compatibility**

| Drive type   | Drive firmware     | SM-EtherCAT firmware |
|--------------|--------------------|----------------------|
| Unidrive SP  | V01.08.00 or later | V01.00.00 or later   |
| Affinity     | V01.02.00 or later | V01.00.00 or later   |
| Digitax ST   | V01.02.00 or later | V01.00.00 or later   |
| Commander SK | V01.06.00 or later | V01.00.00 or later   |
| Mentor MP    | V01.00.00 or later | V01.02.00 or later   |

For the purpose of the example this section will follow the steps required to set up cyclic communications using one RxPDO and two TxPDOs. These PDOs will consist of the mappings shown in Table 5.2:

**Table 5.2 PDO test mappings**

|           | RxPDO1  | TxPDO1  | TxPDO6                    |
|-----------|---|---|---------------------------|
| Mapping 1 | 0x6040 ( <i>controlword</i> )<br>(16-bits)        | 0x6041 ( <i>statusword</i> )<br>(16-bits)               | Pr <b>18.22</b> (16-bits) |
| Mapping 2 | 0x6042 ( <i>vl_target_velocity</i> )<br>(16-bits) | 0x6064<br>( <i>position_actual_value</i> )<br>(32-bits) | Pr <b>20.21</b> (32-bits) |
| Mapping 3 | Pr <b>20.21</b> (32-bits)                         | N/A   | 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 9 Diagnostics* on page 74 of this manual and have checked that the SDO/PDO configurations are correct.

### 5.1.2 SM-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 SM-EtherCAT module and drive configuration to aid with its configuration. These files can be downloaded from the Control Techniques CTSupport.com 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\Io\EtherCAT.

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

### 5.1.3 Configuring the SM-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 SM-EtherCAT module on the drive is connected correctly, look at the LED on the front of the SM-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.

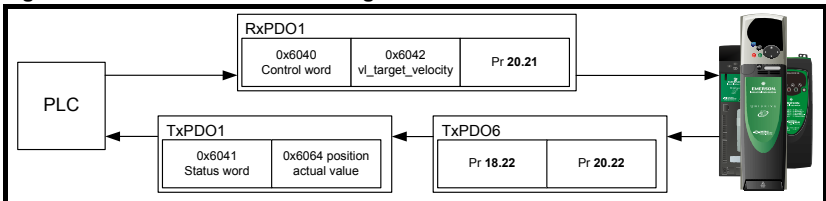
In the master, scan the network ensuring that the SM-EtherCAT module is connected correctly to the master. If the network is configured correctly the SM-EtherCAT node(s) should be visible in the PLC master.

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, 6 and 22, the TxPDOs available are 1, 2, 3, 6 and 22 (for more information on these PDOs including default mappings please see section 6.3.2 *RxPDO mappings* on page 24 and section 6.3.3 *TxPDO mappings* on page 27).

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



RxPDO1, TxPDO1 and TxPDO6 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 + menu number
- Sub-index: 0x00 + 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 5.3 Cyclic data mapping configuration**

| RxPDO1:    |            | TxPDO1:    |            | TxPDO6:    |            |
|------------|------------|------------|------------|------------|------------|
| Object:    | 0x1600     | Object:    | 0x1A00     | Object:    | 0x1A05     |
| Sub-index: | 0x00       | Sub-index: | 0x00       | Sub-index: | 0x00       |
| Size:      | 1          | Size:      | 1          | Size:      | 1          |
| Value:     | 3          | Value:     | 2          | Value:     | 2          |
| Sub-index: | 0x01       | Sub-index: | 0x01       | Sub-index: | 0x01       |
| Size:      | 4          | Size:      | 4          | Size:      | 4          |
| Value:     | 0x60400010 | Value:     | 0x60410010 | Value:     | 0x20121610 |
| Sub-index: | 0x02       | Sub-index: | 0x02       | Sub-index: | 0x02       |
| Size:      | 4          | Size:      | 4          | Size:      | 4          |
| Value:     | 0x60420010 | Value:     | 0x60640020 | Value:     | 0x20141620 |
| Sub-index: | 0x03       | Not Used   |            | 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).

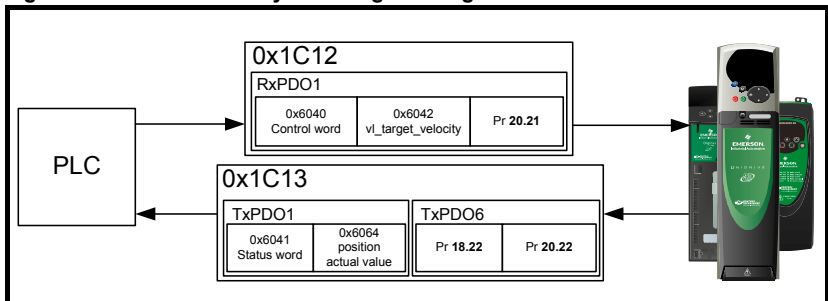
**NOTE** The maximum number of mappings in one PDO is five. There are no restrictions on the data length of these 5 parameters (i.e. It is possible to map five, 32-bit parameters in one PDO). It is also possible to use a maximum of two RxPDOs and two TxPDOs.

### 5.1.4 Configuring the sync managers

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

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 two TxPDOs to sync manager 3.

**Figure 5-2 SM-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: 2

Setting object 0x1C13, sub-index 0 to a value of 2 (as above) indicates that two TxPDOs will be assigned to the sync manager 3 assignment.

- Index: 0x1C13
- Sub index: 0x01
- Size: 2
- Value: 0x1A00
  
- Index: 0x1C13
- Sub index: 0x02
- Size: 2
- Value: 0x1A05

Setting object 0x1C13, sub-index 1 to a value of 0x1A00 and sub-index 2 to a value of 0x1A05 (as above) maps TxPDO1 and TxPDO6 to the process data input sync.

Download the configuration to the master.

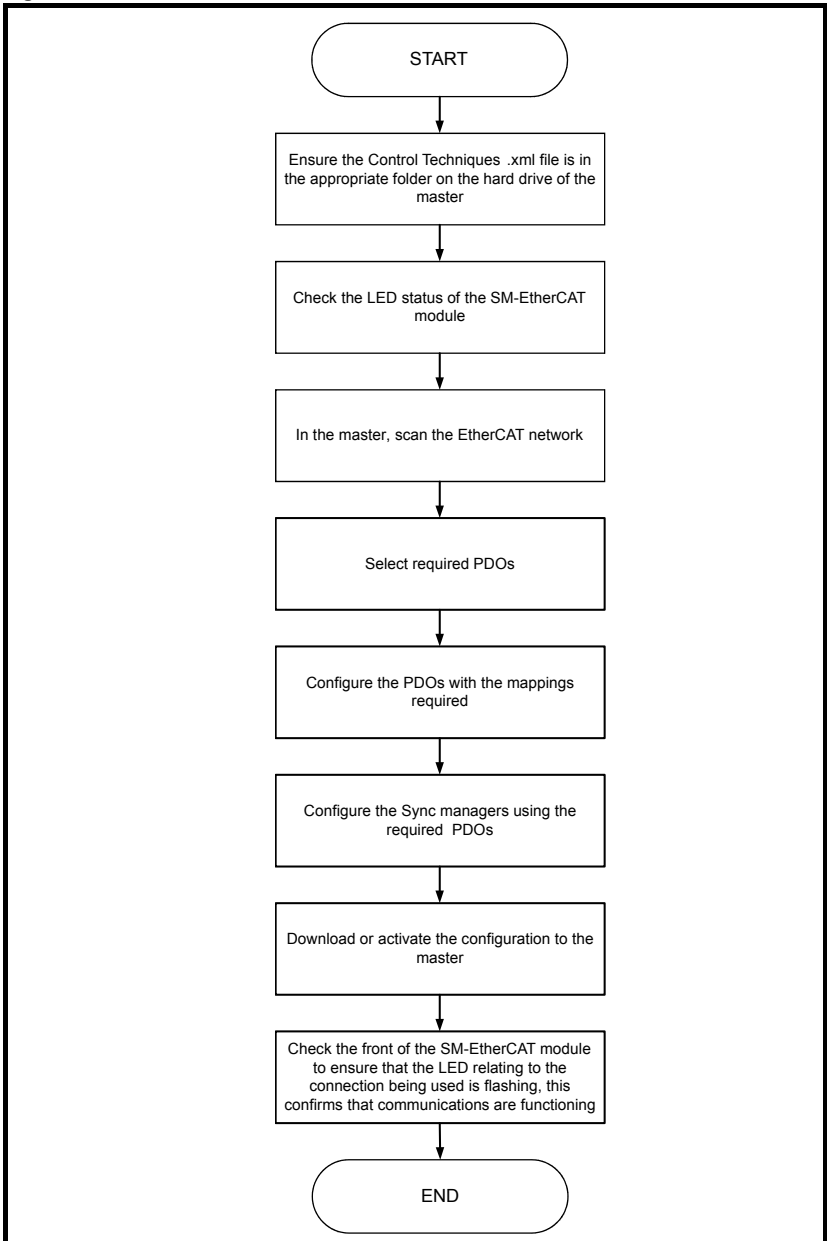
After downloading the configuration to the master the LED(s) on the front of the SM-EtherCAT should flash, depending on the port(s) connected.

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



### 5.3 Saving parameters to the drive

On the Unidrive SP, Affinity, Digitax ST and Commander SK to avoid loss of the configured settings when the drive is powered down it is necessary to write 1000 to Pr **MM.00** followed by pressing the reset button to perform a drive save. On Mentor MP Pr **MM.00** needs to be set to a value of 'SAVE' followed by pressing the reset button.

To store drive parameters:

- Set Pr **MM.00** to 1000 (Mentor MP, Pr **MM.00**=SAVE).
- Press the red RESET button.

The drive will store all parameters (except Menu 20) but the operation of the SM-EtherCAT will not be affected. Changes made to the SM-EtherCAT configuration parameters will not take effect until the SM-EtherCAT is reset.

**NOTE** Unidrive-SP, Mentor MP, Affinity and Digitax ST: Menu 20 applications parameters may be saved if an Applications Module is installed, menu 20 is stored in the Applications Module's memory. See the relevant Applications Module documentation for more information. If the drive is running on backup supply only, Pr **MM.00** must be set to 1001 to perform a save.

**NOTE** This saves only drive and module parameters and not SM-EtherCAT related objects.

### 5.4 SM-EtherCAT Node address

**Table 5.4 SM-EtherCAT Node address**

| SM-EtherCAT Node address |         |            |
|--------------------------|---------|------------|
| Pr <b>MM.03</b>          | Default | 0          |
|                          | Range   | 0 to 65535 |
|                          | Access  | RW         |

It is not necessary for a user to set a node address manually in order to initiate EtherCAT communications; however, this parameter can be used to configure an EtherCAT Station Alias. When changed, this value will be stored in the option non-volatile storage upon a transition from the INIT state to the PRE-OPERATIONAL state; this change will also cause an AL Status Code to be set to indicate that the option needs to be reset. It will be possible to read the value at the 16-bit word address 0x0004 of the SII (Slave Information Interface) data, and in EtherCAT register 0x0012 (a 16-bit word).

### 5.5 SM-EtherCAT RUN

**Table 5.5 SM-EtherCAT RUN**

| SM-EtherCAT RUN |         |        |
|-----------------|---------|--------|
| Pr <b>MM.04</b> | Default | 1      |
|                 | Range   | 1 to 8 |
|                 | Access  | RW     |

This parameter displays the SM-EtherCAT RUN state as required by the EtherCAT indicator and Marking Specification. It will contain one of the values in Table 5.6.

**Table 5.6 EtherCAT State Machine State**

| Value | ESM State        |
|-------|------------------|
| 1     | INIT             |
| 2     | PRE-OPERATIONAL  |
| 4     | SAFE-OPERATIONAL |
| 8     | OPERATIONAL      |

Although this parameter has the read/write attribute, it will be forced to the state value continuously to prevent it being written by another entity.

## 5.6 Re-initializing the SM-EtherCAT

**Table 5.7 SM-EtherCAT re-initialize**

| SM-EtherCAT re-initialize |         |                   |
|---------------------------|---------|-------------------|
| Pr <b>MM.32</b>           | Default | 0 (OFF)           |
|                           | Range   | 0 (OFF) to 1 (ON) |
|                           | Access  | RW                |

Changes to the SM-EtherCAT configuration in menu 15, 16 or 17 parameters on Unidrive SP and Mentor MP, menu 15 or 16 on Affinity and Digitax ST or menu 15 on Commander SK will not take effect until the SM-EtherCAT has been re-initialized.

To re-initialize SM-EtherCAT:

1. Set Pr **MM.32** to ON.
2. When the sequence has been completed, Pr **MM.32** will be reset to OFF.
3. The SM-EtherCAT will re-initialize using the updated configuration.

**NOTE** The above sequence does NOT store the SM-EtherCAT configuration parameters in the drive or the SM-EtherCAT's internal FLASH memory. This parameter will change back to OFF immediately and as such the change may not be visible on the display.

## 5.7 Re-initialize all Solutions Modules

To re-initialize all Solutions Modules installed on a drive:

1. Set Pr **MM.00** to 1070 (see note below).
2. Press the red RESET button on the drive. Another parameter (e.g. Pr **01.00**) must be used.

**NOTE** This sequence does NOT store the SM-EtherCAT configuration parameters in the drive or the SM-EtherCAT FLASH memory.

**NOTE** On Commander SK drives, Pr **00.00** is not available.

# 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 SM-EtherCAT at network Initialization using SDOs.

### 6.1.1 PDO Priority

If 2 PDOs are mapped in a sync manager then the second PDO will always be considered to be low priority (and, as such, should not be used for deterministic process data).

Mappings to slow parameters (such as SM-Applications PLC parameters, etc) should always be placed in the second PDO. When there is more than one PDO mapping in a Sync Manager, placing a slow parameter in the first PDO will trigger an SDO abort code. If only one PDO is mapped to a sync manager, then placing a slow parameter in that PDO will make it low priority (so slow parameter accesses should not be placed in PDOs where deterministic data access is required).

It is possible to map any drive parameters in PDOs.

## 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 + menu

Sub-index: parameter

For example Pr **20.21** 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 SM-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.

**NOTE** Sub-index 0 for any menu will return the highest sub-index available for the object (i.e. the highest parameter number). Pr **MM.00** in any drive can only be accessed as Pr **61.01** (0x203D, sub-index changes to 1).

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

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

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| <b>Protocols</b>                |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

## 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>  |              |              |
|------------------|----------------|--------------|--------------|
| Access: <access> | Range: <range> | Size: <size> | Unit: <unit> |
| Default:         | <default>      |              |              |
| 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>      |              |              |
| Description:     | <description>  |              |              |
| Sub-index 1      |                |              |              |
| Access: <access> | Range: <range> | Size: <size> | Unit: <unit> |
| Default:         | <default>      |              |              |
| Description:     | <description>  |              |              |
| ...              |                |              |              |
| Access: <access> | Range: <range> | Size: <size> | Unit: <unit> |
| Default:         | <default>      |              |              |
| Description:     | <description>  |              |              |
| Sub-index n-1    |                |              |              |
| Access: <access> | Range: <range> | Size: <size> | Unit: <unit> |
| Default:         | <default>      |              |              |
| Description:     | <description>  |              |              |
| Sub-index n      |                |              |              |
| Access: <access> | Range: <range> | Size: <size> | Unit: <unit> |
| Default:         | <default>      |              |              |
| 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.).

**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:     | 0x00030192   |               |           |
| Description: | <p>The primary CoE functional profile is DSP-402, the value of the object is defined as follows:</p> <p>Bits 0 to 15 (Device profile number): 402 (0x192)<br/>           Bit 16 (Frequency converter): x<br/>           Bit 17 (Servo drive): y<br/>           Bit 18 (Stepper motor): 0<br/>           Bit 24 (DC drive - manufacturer specific) : z<br/>           Bits 25 to 31 (Manufacturer specific): 0</p> <p>This value will depend on the drive operating mode and/or type. On a Unidrive SP in open-loop or closed-loop mode or a Mentor MP in closed-loop mode, bit 16 will be set, while bits 17 and 24 will be cleared. On a Unidrive SP in Servo mode or a Digitax ST, bit 17 will be set, while bits 16 and 24 will be cleared.</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  |                 |           |
| 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:     | 0x00000F9  |                 |           |
| Description: | This contains the EtherCAT Technology Group vendor ID for Control Techniques (0x00000F9).  |                 |           |
| Sub-index 2  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | See Pr <b>MM.01</b>  |                 |           |
| Description: | This has the value of the option ID code.  |                 |           |
| Sub-index 3  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | High word: Pr <b>MM.02</b> Low word: Pr <b>MM.51</b>   |                 |           |
| Description: | Contains the option module software version number (the major and minor version parameter placed in the high word of this object, and the sub-version parameter (Pr <b>MM.51</b> ) is the low word). |                 |           |
| Sub-index 4  |  |                 |           |
| Access: RO   | Range: N/A   | Size: 4 bytes   | Unit: N/A |
| Default:     | See Pr <b>MM.35</b>  |                 |           |
| Description: | Contains the option hardware serial number.  |                 |           |

### 6.3.2 RxPDO mappings

Objects with indices from 0x1600 to 0x17FF specify receive PDO mappings. The mappings from DSP-402 are included as standard (the PDO mappings will have the following default values).

**Table 6.6 RxPDO mappings**

| PDO number | Mapping object index | Mapping object name                             |
|------------|----------------------|---|
| 1          | 0x6040               | <i>controlword</i>                              |
| 2          | 0x6040<br>0x6060     | <i>controlword</i><br><i>modes of operation</i> |
| 6          | 0x6040<br>0x6042     | <i>controlword</i><br><i>vl_target_velocity</i> |

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).



**Table 6.7 RxPDO mapping 1**

| <b>0x1600 Receive PDO mapping 1</b>   |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 1  |                        |               |           |
| 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 DSP-402 control word (0x6040)   |                        |               |           |
| 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 6.8 RxPDO mapping 2**

| <b>0x1601 Receive PDO mapping 2</b>   |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 2  |                        |               |           |
| 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 DSP-402 control word (0x6040)   |                        |               |           |
| 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: 0x60600008 - the DSP-402 modes of operation object (0x6060)  |                        |               |           |
| 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. |                        |               |           |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| <b>Protocols</b>                |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

**Table 6.9 RxPDO mapping 6**

| <b>0x1605 Receive PDO mapping 6</b>   |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 2  |                        |               |           |
| 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 DSP-402 control word (0x6040)   |                        |               |           |
| 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: 0x60600008 - the DSP-402 modes of operation object (0x6060)  |                        |               |           |
| 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 6.10 RxPDO mapping 22**

| <b>0x1615 Receive PDO mapping 22</b>  |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 0  |                        |               |           |
| Description: The number of mapped objects in this PDO   |                        |               |           |
| Sub-indices 1 to 255: 1st to 255th mapped objects in this PDO.  |                        |               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 0  |                        |               |           |
| 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. |                        |               |           |

### 6.3.3 TxPDO mappings

Objects with the indices from 0x1A00 to 0x1BFF specify transmit PDO mappings. The following mappings from DSP-402 are included as standard.

**Table 6.11 TxPDO mappings**

| PDO number | Mapping object index | Mapping object name               |
|------------|----------------------|-----------------------------------|
| 1          | 0x6041               | <i>statusword</i>                 |
| 2          | 0x6041               | <i>statusword</i>                 |
|            | 0x6061               | <i>modes_of_operation_display</i> |
| 3          | 0x6041               | <i>statusword</i>                 |
|            | 0x6064               | <i>position_actual_value</i>      |
| 6          | 0x6041               | <i>statusword</i>                 |
|            | 0x6044               | <i>vl_velocity_actual_value</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.

**Table 6.12 TxPDO mapping 1**

| 0x1A00   |   | Transmit PDO mapping 1 |           |
|--|---|------------------------|-----------|
| Sub-index 0: Number of mapped objects                  |   |                        |           |
| Access: RW   | Range: 0 to (CF)  | Size: 1 byte           | Unit: N/A |
| Default: 1   |   |                        |           |
| 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 DSP-402 status word (0x6041) |   |                        |           |
| 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. |                        |           |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| <b>Protocols</b>                |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

**Table 6.13 TxPDO mapping 2**

| <b>0x1A01 Transmit PDO mapping 2</b>   |                        |               |           |
|--|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects  |                        |               |           |
| Access: RW   | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 2   |                        |               |           |
| 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 DSP-402 status word (0x6041)   |                        |               |           |
| 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: 0x60610008 - the DSP-402 modes of operation display object (0x6061)   |                        |               |           |
| 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 6.14 Tx PDO mapping 3**

| <b>0x1A02 Transmit PDO mapping 3</b>   |                        |               |           |
|--|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects  |                        |               |           |
| Access: RW   | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 2   |                        |               |           |
| 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 DSP-402 status word (0x6041)   |                        |               |           |
| 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: 0x60640020 - the DSP-402 actual position (0x6064)   |                        |               |           |
| 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 6**

| <b>0x1A05 Transmit PDO mapping 6</b>  |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 2  |                        |               |           |
| 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 DSP-402 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 DSP-402 actual motor speed (0x6044).  |                        |               |           |
| 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 TxPDO mapping 22**

| <b>0x1A15 Transmit PDO mapping 22</b>   |                        |               |           |
|---|------------------------|---------------|-----------|
| Sub-index 0: Number of mapped objects   |                        |               |           |
| Access: RW  | Range: 0 to (CF)       | Size: 1 byte  | Unit: N/A |
| Default: 0  |                        |               |           |
| Description: The number of mapped objects in this PDO   |                        |               |           |
| Sub-indices 1 to 255: 1st to 255th mapped objects in this PDO.  |                        |               |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: 4 bytes | Unit: N/A |
| Default: 0  |                        |               |           |
| 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. |                        |               |           |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| <b>Protocols</b>                |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

### 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 6.17 Sync manager communication type object**

| 0x1C00  | Sync manager communication type |              |           |
|---|---------------------------------|--------------|-----------|
| Sub-index 0 - number of sync manager channels used  |                                 |              |           |
| Access: RO  | Range: N/A                      | Size: 1 byte | Unit: N/A |
| Default: 4  |                                 |              |           |
| 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  |                                 |              |           |
| 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  |                                 |              |           |
| 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  |                                 |              |           |
| 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  |                                 |              |           |
| Description: Sync manager 3 is used by CoE as the process data input (TxPDOs - slave to master).  |                                 |              |           |

**Table 6.18 Sync manager 0 PDO assignment object**

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

**Table 6.19 Sync manager 1 PDO assignment object**

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

**Table 6.20 Sync manager 2 PDO assignment object**

| 0x1C12   |                         | Sync manager 2 PDO assignment |           |  |
|--|-------------------------|-------------------------------|-----------|--|
| Sub-index 0  |                         |                               |           |  |
| Access: RW   | Range: 0 to 255         | Size: 1 byte                  | Unit: N/A |  |
| Default: 1   |                         |                               |           |  |
| 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: 0x1605  |                         |                               |           |  |
| Description: The object index of a RxPDO to assign to this sync manager. By default this is assigned to RxPDO mapping 6 ( <i>v_target_velocity</i> and <i>controlword</i> ). |                         |                               |           |  |

**Table 6.21 Sync manager 3 PDO assignment object**

| 0x1C13  |                         | Sync manager 3 PDO assignment |           |  |
|---|-------------------------|-------------------------------|-----------|--|
| Sub-index 0   |                         |                               |           |  |
| Access: RW  | Range: 0 to 255         | Size: 1 byte                  | Unit: N/A |  |
| Default: 1  |                         |                               |           |  |
| 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: 0x1A05   |                         |                               |           |  |
| Description: The object index of a TxPDO to assign to this sync manager. By default this is assigned to TxPDO mapping 6 ( <i>v_velocity_actual_value</i> and <i>statusword</i> ). |                         |                               |           |  |

### 6.3.5 Feedback encoder source

**Table 6.22 Feedback encoder source**

| 0x2802   |               | Feedback encoder source |           |  |
|--|---------------|-------------------------|-----------|--|
| Sub-index 0  |               |                         |           |  |
| Access: RW   | Range: 0 to 3 | Size: 1 byte            | Unit: N/A |  |
| Default: 0   |               |                         |           |  |
| Description: This object specifies the source position for position controller feedback. |               |                         |           |  |

- 0 = Use drive as the feedback source
- 1 = Use the encoder module in slot 1 as the encoder source
- 2 = Use the encoder module in slot 2 as the encoder source
- 3 = Use the encoder module in slot 3 as the encoder source

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

## 6.4 Ethernet over EtherCAT (EoE)

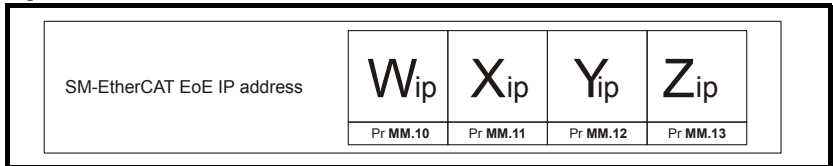
This protocol allows standard Ethernet messages and protocols to be tunnelled through the EtherCAT network. This provides users with the possibility of connecting to the Control Techniques PC Tools (SyPT Pro, SyPTLite, CTSOft, CTScope and Winflasher) along the same connection currently being used for SM-EtherCAT communications.

**NOTE** For help configuring this protocol with the Control Techniques PC Tools, please refer to Knowledge Base document *COMMS046* on CTSupport titled *Connecting to the Control Techniques' PC Tools using the SM-EtherCAT module and EoE (Ethernet over EtherCAT)*.

### 6.4.1 EoE IP address

The SM-EtherCAT EoE IP address is defined in the EtherCAT Master and is displayed in the module parameters as shown in Figure 6-1.

**Figure 6-1 EoE IP address format**



**Table 6.23 EoE - IP address W<sub>ip</sub>**

| EoE - IP address W <sub>ip</sub> |         |          |
|----------------------------------|---------|----------|
| Pr MM.10                         | Default | 0        |
|                                  | Range   | 0 to 255 |
|                                  | Access  | RW       |

This is the most significant octet of the SM-EtherCAT EoE IP address.

**Table 6.24 EoE - IP address X<sub>ip</sub>**

| EoE - IP address X <sub>ip</sub> |         |          |
|----------------------------------|---------|----------|
| Pr MM.11                         | Default | 0        |
|                                  | Range   | 0 to 255 |
|                                  | Access  | RW       |

This is the second most significant octet of the SM-EtherCAT EoE IP address.

**Table 6.25 EoE - IP address Y<sub>ip</sub>**

| EoE - IP address Y <sub>ip</sub> |         |          |
|----------------------------------|---------|----------|
| Pr MM.12                         | Default | 0        |
|                                  | Range   | 0 to 255 |
|                                  | Access  | RW       |

This is the third most significant octet of the SM-EtherCAT EoE IP address.



**Table 6.26 EoE - IP address  $Z_{ip}$**

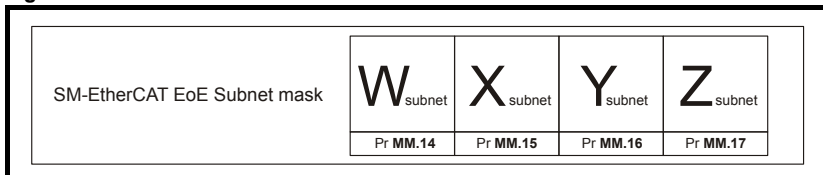
| EoE - IP address $Z_{ip}$ |         |          |
|---------------------------|---------|----------|
| Pr MM.13                  | Default | 0        |
|                           | Range   | 0 to 255 |
|                           | Access  | RW       |

This is the least significant octet of the SM-EtherCAT EoE IP address.

### 6.4.2 EoE Subnet mask

The SM-EtherCAT EoE Subnet mask is defined in the EtherCAT Master and is displayed in the module parameters as shown in Figure 6-2.

**Figure 6-2 EoE Subnet mask format**



**Table 6.27 EoE - Subnet mask  $W_{subnet}$**

| EoE - Subnet Mask $W_{subnet}$ |         |          |
|--------------------------------|---------|----------|
| Pr MM.14                       | Default | 0        |
|                                | Range   | 0 to 255 |
|                                | Access  | RW       |

This is the most significant octet of the SM-EtherCAT EoE Subnet mask.

**Table 6.28 EoE - Subnet mask  $X_{subnet}$**

| EoE - Subnet Mask $X_{subnet}$ |         |          |
|--------------------------------|---------|----------|
| Pr MM.15                       | Default | 0        |
|                                | Range   | 0 to 255 |
|                                | Access  | RW       |

This is the second most significant octet of the SM-EtherCAT EoE Subnet mask.

**Table 6.29 EoE - Subnet mask  $Y_{subnet}$**

| EoE - Subnet Mask $Y_{subnet}$ |         |          |
|--------------------------------|---------|----------|
| Pr MM.16                       | Default | 0        |
|                                | Range   | 0 to 255 |
|                                | Access  | RW       |

This is the third most significant octet of the SM-EtherCAT EoE Subnet mask.

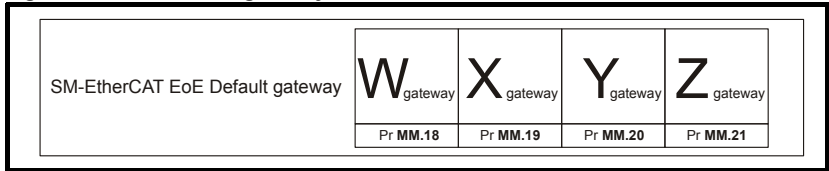
**Table 6.30 EoE - Subnet mask  $Z_{\text{subnet}}$** 

| EoE - Subnet Mask $Z_{\text{subnet}}$ |         |          |
|---------------------------------------|---------|----------|
| Pr MM.17                              | Default | 0        |
|                                       | Range   | 0 to 255 |
|                                       | Access  | RW       |

This is the least significant octet of the SM-EtherCAT EoE Subnet mask.

### 6.4.3 EoE Default gateway

The SM-EtherCAT EoE Default gateway is defined in the EtherCAT Master and is displayed in the module parameters as shown in Figure 6-3.

**Figure 6-3 EoE Default gateway****NOTE**

The default gateway is a routing device that allows a host to reach other devices that are not on the same subnet. The default gateway must be on the same subnet as the host that is trying to use it.

**Table 6.31 EoE - Default gateway  $W_{\text{gateway}}$** 

| EoE - Default gateway $W_{\text{gateway}}$ |         |          |
|--|---------|----------|
| Pr MM.18                                   | Default | 0        |
|  | Range   | 0 to 255 |
|  | Access  | RW       |

This is the most significant octet of the SM-EtherCAT EoE Default gateway.

**Table 6.32 Default gateway  $X_{\text{gateway}}$** 

| EoE - Default gateway $X_{\text{gateway}}$ |         |          |
|--|---------|----------|
| Pr MM.19                                   | Default | 0        |
|  | Range   | 0 to 255 |
|  | Access  | RW       |

This is the second most significant octet of the SM-EtherCAT EoE Default gateway.

**Table 6.33 Default gateway  $Y_{\text{gateway}}$** 

| EoE - Default gateway $Y_{\text{gateway}}$ |         |          |
|--|---------|----------|
| Pr MM.20                                   | Default | 0        |
|  | Range   | 0 to 255 |
|  | Access  | RW       |

This is the third most significant octet of the SM-EtherCAT EoE Default gateway.

**Table 6.34 Default gateway  $Z_{gateway}$**

| EoE - Default gateway $Z_{gateway}$ |         |          |
|-------------------------------------|---------|----------|
| Pr <b>MM.21</b>                     | Default | 0        |
|                                     | Range   | 0 to 255 |
|                                     | Access  | RW       |

This is the least significant octet of the SM-EtherCAT EoE Default gateway.

**NOTE**

Although parameters Pr **MM.10** - Pr **MM.21** have RW access, changing them via the parameters will have no affect to the EoE settings. The EoE configuration for the SM-EtherCAT module can only be done with an EtherCAT master which supports the EoE protocol (e.g. TwinCAT). The settings for Pr **MM.10** - Pr **MM.21** will need to be set by the Master and these parameters are for display purposes only.

**6.4.4 SM-EtherCAT reduce serial interface priority**

**Table 6.35 Reduce Drive serial interface priority**

| Reduce Drive serial interface priority |         |          |
|--|---------|----------|
| Pr <b>MM.37</b>                        | Default | OFF      |
|  | Range   | OFF - ON |
|  | Access  | RW       |

It is not possible for the both the Drive and the SM-EtherCAT module to support all of the available serial communication protocols simultaneously. This means that the user must decide if they wish the drive to provide the primary communication interface via its serial RJ45 connector, or the SM-EtherCAT module. In the default state the primary interface will be provided by the drive.

Pr **MM.37** = OFF (default):

It will not be possible to forward on messages that are intended for either the drive or another option module. The SM-EtherCAT module will be able to handle two types of messages:

1. Those that access Drive parameters
2. Those that access SM-Applications parameters.

Pr **MM.37** = ON:

The SM-EtherCAT module will request that the drive permits it to become the primary communication interface. If the drive is able to transfer control then the following restrictions will be imposed:

1. The drives serial interface will only be able to handle messages that are 32 bytes or less. A Remote LCD keypad would continue to work, although SM-Application parameters would not be visible. If a message is received that is too long for the drive to handle, no reply will be sent.
2. Any LCD keypad fitted (not remotely mounted) to the drive will stop working.

**NOTE**

Pr **MM.37** must be set to ON to achieve EoE communications.

**NOTE**

Pr **MM.37** only needs to be considered when used with a Unidrive SP, Digitax ST, Mentor MP of Affinity. It has no use when used with a Commander SK.

# 7 Drive profile (DSP-402) support

SM-EtherCAT supports the following modes of the DSP-402 profile:

- Cyclic sync position mode
- Interpolated position mode
- vl velocity mode
- Profile torque mode
- Homing 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: Unsigned 16 |     |   |     | Unit: N/A |    |    |    |
| Default:     |    | N/A   |    |                   |    |     |   |                   |     |   |     |           |    |    |    |
| 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: Unsigned 16    Unit: N/A                    |
| Default:     | N/A  |
| 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                  |

## 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                                 |
|--------|--------------------------------------|
| 0x6040 | <i>controlword</i>                   |
| 0x6041 | <i>statusword</i>                    |
| 0x605B | <i>shutdown_option_code</i>          |
| 0x605C | <i>disable_operation_option_code</i> |
| 0x605A | <i>quick_stop_option_code</i>        |
| 0x605D | <i>halt_option_code</i>              |
| 0x605E | <i>fault_reaction_option_code</i>    |
| 0x6060 | <i>modes_of_operation</i>            |
| 0x6061 | <i>modes_of_operation_display</i>    |
| 0x6085 | <i>quick_stop_deceleration</i>       |

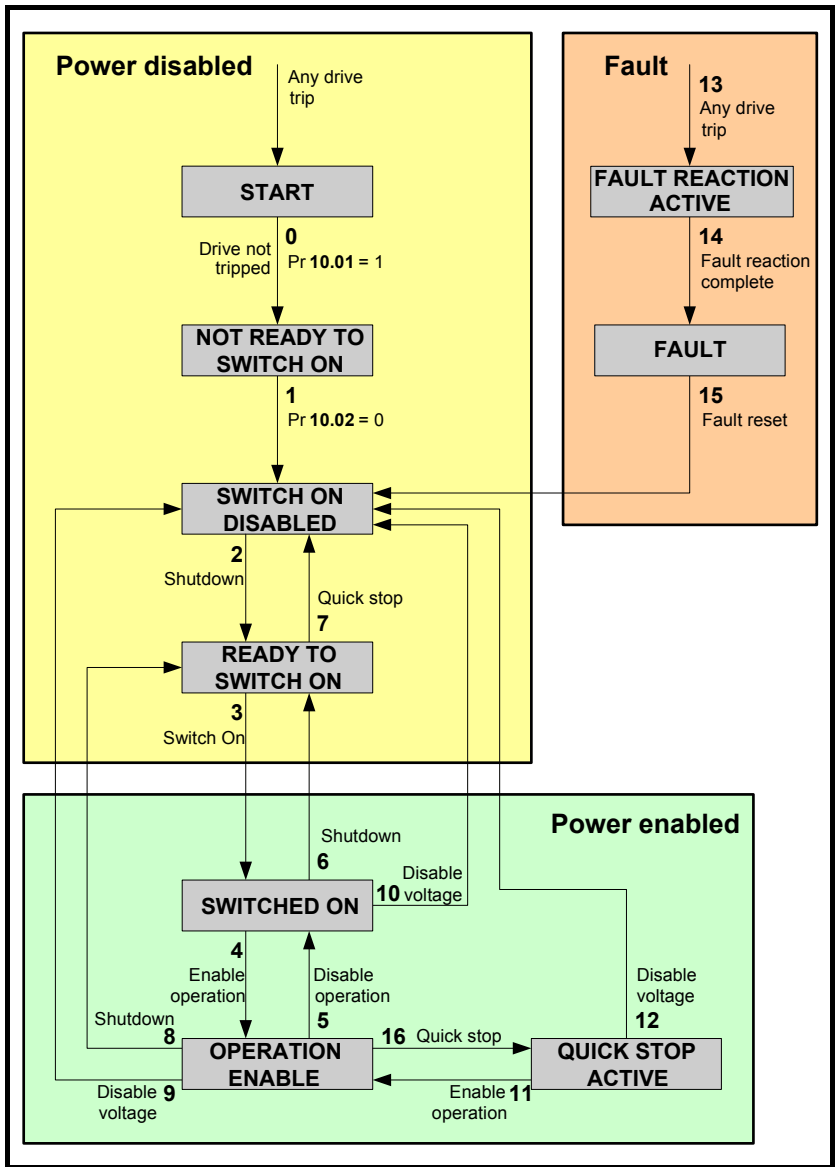
The behavior of the sequencing control is shown in Figure 7-1 *CoE state machine diagram* . This state machine indicates how the drive will be controlled. For clarity the Statusword is abbreviated to 'SW' in the diagram.

When in the 'QUICK STOP ACTIVE' state, the currently selected mode of operation indicates how a quick stop function should be handled. When the drive is stopped, 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'.

When in the 'OPERATION ENABLED' or 'QUICK STOP ACTIVE' states it is not possible to change the *mode\_of\_operation* object. This is to ensure that the motor is stopped before changing the operation mode.

The SM-EtherCAT master device must be in the operational state before the state machine can move from the 'SWITCH ON DISABLED' state to the 'READY TO SWITCH ON' state. If the master leaves the operational state while the state machine is in the 'SWITCH ON', 'OPERATION ENABLE' , 'QUICK STOP ACTIVE' or 'READY TO SWITCH ON' state then the option will transition to the 'SWITCH ON DISABLED' state. This implies that the drive will be inhibited and the motor will coast.

Figure 7-1 CoE state machine diagram



**NOTE**

On the Digitax ST, Unidrive SP, Affinity and Mentor MP with the default drive parameters the 'Switched on' state will correspond to a drive status of 'STOP'. If the STOP state is not acceptable for any SM-EtherCAT applications that do not use the menu 12 brake controller, Pr 6.08 will have to be set to OFF. With Pr 6.08 set to OFF the 'Switched on' state will now correspond to a drive status of 'Rdy'.

|  |
|--|
| Safety information                     |
| Introduction                           |
| Mechanical installation                |
| Electrical installation                |
| Getting started                        |
| Protocols                              |
| <b>Drive profile (DSP-402) support</b> |
| Advanced features                      |
| Diagnostics                            |
| Quick reference                        |
| Glossary of terms                      |
| Index                                  |

**Table 7.7 CoE state machine transition and events**

| Transition | Event(s)  | Action(s)   |
|------------|---|---|
| 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   |



When the SM-EtherCAT module transitions from the EtherCAT Safe-operational state to the EtherCAT Operational state, a number of drive parameters are set to allow the CoE profiles to control the drive and motor. These parameters are set in the following order:

- Pr **6.42** to 0
- Pr **6.43** to On (1)
- Pr **3.22** to 0 (where present)
- Pr **3.23** to On (1) (where present)
- Pr **3.13** to OFF (0) (In open-loop operating modes)
- Pr **2.10** to 1
- Pr **2.20** to 1
- Pr **2.02** to On (1)
- Pr **1.04** to 0
- Pr **1.21** to 0
- Pr **1.38** to 0
- Pr **1.08** to OFF (0)
- Pr **1.10** to On (1)
- Pr **1.09** to OFF (0)
- Pr **1.15** to 1
- Pr **1.14** to 3

These values are set once and not continuously forced. They are not reset when leaving the Operational state. In addition, the option starts to write parameters implicitly mapped by the CoE profiles, when moving to the Operational state.

### 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**

| 0x605A       | Quick_stop_option_code  |                   |           |
|--------------|---|-------------------|-----------|
| Access: RW   | Range: 0 to 6   | Size: Unsigned 16 | Unit: N/A |
| Default:     | 2   |                   |           |
| 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 40 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       |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

### 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**

| 0x605B       |   | Shutdown_option_code |           |  |
|--------------|---|----------------------|-----------|--|
| Access: RW   | Range: 0 to 1   | Size: Unsigned 16    | Unit: N/A |  |
| Default:     | N/A   |                      |           |  |
| 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 |

### 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**

| 0x605C       |   | Disable_operation_option_code |           |  |
|--------------|---|-------------------------------|-----------|--|
| Access: RW   | Range: 0 to 1   | Size: Unsigned 16             | Unit: N/A |  |
| Default:     | N/A   |                               |           |  |
| 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 0x605E Fault\_reaction\_option\_code

This object is used to control what action is performed when a fault is detected. This object is ignored if the drive is tripped.

**Table 7.14 Fault\_reaction\_option\_code**

| 0x605E       |   | Fault_reaction_option_code |           |  |
|--------------|---|----------------------------|-----------|--|
| Access: RW   | Range: 0 to 2   | Size: Unsigned 16          | Unit: N/A |  |
| Default:     | N/A   |                            |           |  |
| 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                    |

### 7.3.6 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>   |                  |           |
| Access: RW    | Range: 0 to 8   | Size: Unsigned 8 | Unit: N/A |
| Default:      | 2   |                  |           |
| Description:  | This object is used to request a change in the mode of operation. |                  |           |

**Table 7.17 Modes\_of\_operation values**

| Value | Definition                 |
|-------|----------------------------|
| 0     | No mode change             |
| 2     | vl velocity mode           |
| 4     | Profile torque mode        |
| 6     | Homing mode                |
| 7     | Interpolated position mode |
| 8     | Cyclic sync position mode  |

### 7.3.7 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>             |                  |           |
| Access: RO    | Range: 0 to 8                                 | Size: Unsigned 8 | Unit: N/A |
| Default:      | N/A   |                  |           |
| 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           |
| 4     | Profile torque mode        |
| 6     | Homing mode                |
| 7     | Interpolated position mode |
| 8     | Cyclic sync position mode  |

### 7.3.8 0x6084 Profile declaration

**Table 7.20 Profile declaration**

|               |  |                   |           |
|---------------|--|-------------------|-----------|
| <b>0x6084</b> | <b>Profile deceleration</b>                              |                   |           |
| Access: RW    | Range:0 to 0xFFFFFFFF                                    | Size: Unsigned 32 | Unit: N/A |
| Default:      | 65536  |                   |           |
| Description:  | Provides the deceleration ramp for the positioning modes |                   |           |

### 7.3.9 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.

**Table 7.21 Quick\_stop\_deceleration**

| 0x6085       |  | Quick_stop_deceleration |           |
|--------------|--|-------------------------|-----------|
| Sub-index 0  |  |                         |           |
| Access: RW   | Range: 0 to 0xFFFFFFFF                                 | Size: Unsigned 32       | Unit: N/A |
| Default:     | 2  |                         |           |
| Description: | Quick stop function for the positioning related modes. |                         |           |

### 7.3.10 Profile units

The SM-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>               |

For positions, the scaling control includes a feed constant, a gear ratio and an encoder revolution. These values are combined by the implementation into a simple scaling numerator and denominator. It is possible to change these values non-cyclically (i.e. using SDOs), in which case the scaling numerator and denominator and any position limit values are recalculated in the background. It is not, however, possible to change these values cyclically (i.e. by mapping PDOs to them).

For velocities, in addition to the position constants described above, these values are combined into a simple numerator and denominator to scale velocities to internal velocity units. This scaling also properly handles remainders (i.e. when used on a reference or feedback, accumulate the remainder and add it to subsequent velocity values, and when used with a limit, round up or down). It is possible to change these values non-cyclically (i.e. using SDOs), in which case the scaling numerator and denominator is recalculated in the background. It is also necessary to re-scale velocity limit values with the new factor. It is not possible to change these values cyclically (i.e. by mapping PDOs to them).

### 7.3.11 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: Unsigned 8            | Unit: N/A |  |
| Default: 2                      |                        |                             |           |  |
| Description:                    |                        |                             |           |  |
| Sub-index 1                     |                        |                             |           |  |
| Access: RO                      | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32           | Unit: N/A |  |
| Default: 1                      |                        |                             |           |  |
| Description: Encoder increments |                        |                             |           |  |
| Sub-index 2                     |                        |                             |           |  |
| Access: RO                      | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32           | Unit: N/A |  |
| Default: 1                      |                        |                             |           |  |
| Description: Motor revolutions  |                        |                             |           |  |

### 7.3.12 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: Unsigned 8  | Unit: N/A |  |
| Default: 2                     |                        |                   |           |  |
| Description:                   |                        |                   |           |  |
| Sub-index 1                    |                        |                   |           |  |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |  |
| Default: 1                     |                        |                   |           |  |
| Description: Motor revolutions |                        |                   |           |  |
| Sub-index 2                    |                        |                   |           |  |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |  |
| Default: 1                     |                        |                   |           |  |
| Description: Shaft revolutions |                        |                   |           |  |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

### 7.3.13 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: Unsigned 8  | Unit: N/A |
| Default: 2                     |                        |                   |           |
| Description:                   |                        |                   |           |
| Sub-index 1                    |                        |                   |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |
| Default: 1                     |                        |                   |           |
| Description: Feed              |                        |                   |           |
| Sub-index 2                    |                        |                   |           |
| Access: RW                     | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |
| Default: 1                     |                        |                   |           |
| Description: Shaft revolutions |                        |                   |           |

### 7.3.14 Basic position control

Basic position control is supported on the Unidrive SP in servo mode, closed-loop vector mode and RFC mode. It works on the Digitax ST and Mentor MP but is not supported in open-loop or regen mode on any of the drives. It is also not available on Commander SK or Affinity. The position control described here is used under the interpolated position mode of operation. Table 7.26 lists the objects that are supported:

**Table 7.26 Basic position control supported objects**

| Index  | Name                                  |
|--------|---------------------------------------|
| 0x6062 | <i>position_demand_value</i>          |
| 0x6064 | <i>position_actual_value</i>          |
| 0x6065 | <i>following_error_window</i>         |
| 0x6067 | <i>position_window</i>                |
| 0x6080 | <i>max motor speed</i>                |
| 0x60F4 | <i>following_error_actual_value</i>   |
| 0x60FB | <i>position_control_parameter_set</i> |

### 7.3.15 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 7.27 Position\_demand\_value**

| 0x6062  |                        | Position_demand_value |           |
|---|------------------------|-----------------------|-----------|
| Access: RO  | Range: 0 to 0xFFFFFFFF | Size: signed 32       | Unit: N/A |
| Default: N/A  |                        |                       |           |
| Description: Used to provide the currently demanded position value. |                        |                       |           |

### 7.3.16 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 7.28 Position\_actual\_value**

| 0x6064       |  | Position_actual_value |           |
|--------------|--|-----------------------|-----------|
| Access: RO   | Range: 0 to 0xFFFFFFFF   | Size: signed 32       | Unit: N/A |
| Default:     | N/A  |                       |           |
| Description: | This read only object provides the actual value of the position feedback device. The value is given in internal units. |                       |           |

### 7.3.17 0x6080 Max motor speed

**Table 7.29 Max motor speed**

| 0x6080       |   | Max motor speed   |           |
|--------------|---|-------------------|-----------|
| Sub-index 0  |   |                   |           |
| Access: RW   | Range: 0 to 0xFFFFFFFF  | Size: Unsigned 32 | Unit: rpm |
| Default:     | 3000  |                   |           |
| 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 1.06. The value is given in rotations per minute (rpm). |                   |           |

### 7.3.18 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 7.30 Following\_error actual\_value**

| 0x60F4       |   | Following_error actual_value |           |
|--------------|---|------------------------------|-----------|
| Access: RO   | Range: 0 to 0xFFFFFFFF  | Size: signed 32              | Unit: N/A |
| Default:     | N/A   |                              |           |
| Description: | This read only object provides the actual value of the following error. |                              |           |

### 7.3.19 0x60FB Position\_control\_parameter\_set object

**Table 7.31 Position\_control\_parameter\_set object**

| 0x60FB       |  | Position_control_parameter_set |                      |
|--------------|--|--------------------------------|----------------------|
| Sub-index 0  |  |                                |                      |
| Access: RO   | Range: N/A                                       | Size: Unsigned 8               | Unit: N/A            |
| Default:     | 2  |                                |                      |
| Description: | The number of control loop parameters.           |                                |                      |
| Sub-index 1  |  |                                |                      |
| Access: RW   | Range: 0 to 65535                                | Size: Unsigned 16              | Unit: 0.01 rad/s/rad |
| Default:     | 2500   |                                |                      |
| Description: | The position controller proportional gain.       |                                |                      |
| Sub-index 2  |  |                                |                      |
| Access: RW   | Range: 0 to 65535                                | Size: Unsigned 16              | Unit: 1 / 1000       |
| Default:     | 1000 (i.e. a gain of 1)                          |                                |                      |
| Description: | The position controller speed feed forward gain. |                                |                      |

The APC position controller kernel is used by the basic internal position control.

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. This object can be mapped as cyclic data.

## 7.4 Interpolated position mode

Interpolated position mode operates on the Unidrive SP in servo mode, closed-loop vector mode and RFC mode. This mode also operates on the Digitax ST and Mentor MP. Table 7.32 lists the objects that are supported:

**Table 7.32 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 DSP-402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the SM-EtherCAT module going into the SAFE-OPERATIONAL state (Pr **MM.04** = 4).

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

**Table 7.33 0x60C0 Interpolation\_sub-mode\_select**

| 0x60C0       | Interpolation_sub-mode_select   |                 |           |
|--------------|---|-----------------|-----------|
| Access: RW   | Range: 0  | Size: Signed 16 | Unit: N/A |
| Default:     | 0 (Linear interpolation)  |                 |           |
| 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 250µs. The position is specified in user-defined position units. The value is written into sub-index 1.

**Table 7.34 0x60C1 Interpolation\_data\_record**

| 0x60C1       | Interpolation_data_record                           |                   |           |
|--------------|---|-------------------|-----------|
| Sub-index 0  |   |                   |           |
| Access: RO   | Range: N/A  | Size: Unsigned 8  | Unit: N/A |
| Default:     | 1   |                   |           |
| Description: | This object is used to specify the target position. |                   |           |
| Sub-index 1  |   |                   |           |
| Access: RW   | Range: 0 to 0xFFFFFFFF                              | Size: Unsigned 32 | Unit: N/A |
| Default:     | N/A   |                   |           |
| Description: | The set-point.                                      |                   |           |



## 7.4.3 0x60C2 Interpolation\_time\_period

**Table 7.35 Interpolation\_time\_period**

| 0x60C2  |                 | Interpolation_time_period |                     |
|---|-----------------|---------------------------|---------------------|
| Sub-index 0   |                 |                           |                     |
| Access: RO  | Range: N/A      | Size: Unsigned 8          | Unit: N/A           |
| Default: 2  |                 |                           |                     |
| Description: The number of the last sub-index in this object.   |                 |                           |                     |
| Sub-index 1   |                 |                           |                     |
| Access: RW  | Range: 0 to 255 | Size: Unsigned 8          | Unit: (sub-index 2) |
| Default: 250 (units are dependant on the value in sub-index 2)  |                 |                           |                     |
| 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 250µs, 500µs or any multiple of 1ms. An attempt to write other values results in an SDO Abort code. |                 |                           |                     |
| Sub-index 2   |                 |                           |                     |
| Access: RW  | Range: -6 to 0  | Size: Signed 8            | Unit: N/A           |
| Default: -6 (a time unit of 1µs)  |                 |                           |                     |
| Description: This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10(sub-index 2). The range of values allows for the shortest time unit to be 1µs, and the longest to be 1s.  |                 |                           |                     |

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 7.36 for more information.

**Table 7.36 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.

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

## 7.5 vl velocity mode

Velocity mode is supported on Unidrive SP, Digitax ST, Affinity, Mentor MP and Commander SK. It is not, however, supported in regen modes.

When the drive is in either of the closed-loop or servo 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 1.21). Table 7.37 lists the objects that are supported:

**Table 7.37 vl velocity mode supported objects**

| Index  | Name                              |
|--------|-----------------------------------|
| 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> |
| 0x6047 | <i>vl_velocity_min_max</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 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 7.38 vl\_target\_velocity**

| 0x6042       | vl_target_velocity                               |                 |           |
|--------------|--|-----------------|-----------|
| Access: RW   | Range: -32768 to +32767                          | Size: Signed 16 | Unit: rpm |
| Default:     | 0  |                 |           |
| Description: | Used to set the required velocity of the system. |                 |           |

### 7.5.2 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 7.39 vl\_velocity\_demand**

| 0x6043       | vl_velocity_demand   |                 |           |
|--------------|--|-----------------|-----------|
| Access: RO   | Range: -32768 to +32767  | Size: Signed 16 | Unit: rpm |
| Default:     | 0  |                 |           |
| Description: | Provides the instantaneous velocity demand generated by the drive ramp function. |                 |           |

### 7.5.3 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 a copy of *vl\_velocity\_demand*.

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 7.40 velocity\_actual\_value**

| 0x6044       |   | vl_velocity_actual_value |           |  |
|--------------|---|--------------------------|-----------|--|
| Access: RO   | Range: -32768 to +32767                             | Size: Signed 16          | Unit: N/A |  |
| Default:     | 0   |                          |           |  |
| Description: | Provides the velocity at the motor spindle or load. |                          |           |  |

### 7.5.4 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 7.41 vl\_velocity\_min\_max\_amount**

| 0x6046       |  | vl_velocity_min_max_amount |           |  |
|--------------|--|----------------------------|-----------|--|
| Sub-index 0  |  |                            |           |  |
| Access: RO   | Range: N/A   | Size: Unsigned 8           | Unit: N/A |  |
| Default:     | 2  |                            |           |  |
| Description: | The number of sub-indices in this object.  |                            |           |  |
| Sub-index 1  |  |                            |           |  |
| Access: RW   | Range: 0 to 0xFFFFFFFF   | Size: Unsigned 32          | Unit: rpm |  |
| Default:     | 0  |                            |           |  |
| 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 0xFFFFFFFF   | Size: Unsigned 32          | Unit: rpm |  |
| Default:     | 2147483647   |                            |           |  |
| 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. |                            |           |  |

### 7.5.5 0x6047 vl\_velocity\_min\_max

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 7.42 0x6047 vl\_velocity\_min\_max**

| 0x6047 vl_velocity_min_max  |                        |                   |           |
|---|------------------------|-------------------|-----------|
| Sub-index 0   |                        |                   |           |
| Access: RO  | Range: N/A             | Size: Unsigned 8  | Unit: N/A |
| Default: 4  |                        |                   |           |
| Description: The number of sub-indices in this object.  |                        |                   |           |
| Sub-index 1   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: rpm |
| Default: 0  |                        |                   |           |
| Description: Used to configure the minimum positive velocity at which the system can operate. |                        |                   |           |
| Sub-index 2   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: rpm |
| Default: 2147483647   |                        |                   |           |
| Description: Used to configure the maximum positive velocity at which the system can operate. |                        |                   |           |
| Sub-index 3   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: rpm |
| Default: 0  |                        |                   |           |
| Description: Used to configure the minimum negative velocity at which the system can operate. |                        |                   |           |
| Sub-index 4   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: rpm |
| Default: 2147483647   |                        |                   |           |
| Description: Used to configure the maximum negative velocity at which the system can operate. |                        |                   |           |

### 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 5s, possible values for delta speed and delta time are 10000 and 50 respectively.

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

**Table 7.43 0x6048 vl\_velocity\_acceleration**

|   |                                 |                   |           |
|---|---------------------------------|-------------------|-----------|
| <b>0x6048</b>   | <b>vl_velocity_acceleration</b> |                   |           |
| Sub-index 0   |                                 |                   |           |
| Access: RO  | Range: N/A                      | Size: Unsigned 8  | Unit: N/A |
| Default: 2  |                                 |                   |           |
| Description: The number of sub-indices in this object.  |                                 |                   |           |
| Sub-index 1   |                                 |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF          | Size: Unsigned 32 | Unit: rpm |
| Default: 1000   |                                 |                   |           |
| 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: Unsigned 16 | Unit: s   |
| Default: 2  |                                 |                   |           |
| 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 10s, possible values for delta speed and delta time are 8000 and 100 respectively.

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

**Table 7.44 0x6049 vl\_velocity\_deceleration**

|   |                                 |                   |           |
|---|---------------------------------|-------------------|-----------|
| <b>0x6049</b>   | <b>vl_velocity_deceleration</b> |                   |           |
| Sub-index 0   |                                 |                   |           |
| Access: RO  | Range: N/A                      | Size: Unsigned 8  | Unit: N/A |
| Default: 2  |                                 |                   |           |
| Description: The number of sub-indices in this object.  |                                 |                   |           |
| Sub-index 1   |                                 |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF          | Size: Unsigned 32 | Unit: rpm |
| Default: 1000   |                                 |                   |           |
| 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: Unsigned 16 | Unit: s   |
| Default: 2  |                                 |                   |           |
| 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 10s, possible values for delta speed and delta time are 8000 and 100 respectively.

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

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

**Table 7.45 0x604A vl\_velocity\_quick\_stop**

| 0x604A  |                        | vl_velocity_quick_stop |           |  |
|---|------------------------|------------------------|-----------|--|
| Sub-index 0   |                        |                        |           |  |
| Access: RO  | Range: N/A             | Size: Unsigned 8       | Unit: N/A |  |
| Default: 2  |                        |                        |           |  |
| Description: The number of sub-indices in this object.  |                        |                        |           |  |
| Sub-index 1   |                        |                        |           |  |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32      | Unit: rpm |  |
| Default: 1000   |                        |                        |           |  |
| 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: Unsigned 16      | Unit: s   |  |
| Default: 2  |                        |                        |           |  |
| 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 7.46 0x604B vl\_setpoint\_factor**

| 0x604B  |                         | vl_setpoint_factor |           |  |
|---|-------------------------|--------------------|-----------|--|
| Sub-index 0   |                         |                    |           |  |
| Access: RO  | Range: N/A              | Size: Unsigned 8   | Unit: N/A |  |
| Default: 2  |                         |                    |           |  |
| Description: The number of sub-indices in this object.                          |                         |                    |           |  |
| Sub-index 1   |                         |                    |           |  |
| Access: RW  | Range: -32768 to +32767 | Size: Signed 16    | Unit: N/A |  |
| Default: 1  |                         |                    |           |  |
| Description: <i>vl_setpoint_factor</i> numerator (a value of 0 is not valid).   |                         |                    |           |  |
| Sub-index 2   |                         |                    |           |  |
| Access: RW  | Range: -32768 to +32767 | Size: Signed 16    | Unit: N/A |  |
| Default: 1  |                         |                    |           |  |
| 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.

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

**Table 7.47 0x604C vl\_dimension\_factor**

| 0x604C  |                         | vl_dimension_factor |           |
|---|-------------------------|---------------------|-----------|
| Sub-index 0   |                         |                     |           |
| Access: RO  | Range: N/A              | Size: Unsigned 8    | Unit: N/A |
| Default: 2  |                         |                     |           |
| Description: The number of sub-indices in this object.                    |                         |                     |           |
| Sub-index 1   |                         |                     |           |
| Access: RW  | Range: -32768 to +32767 | Size: Signed 16     | Unit: N/A |
| Default: 1  |                         |                     |           |
| Description: vl_dimension_factor numerator (a value of 0 is not valid).   |                         |                     |           |
| Sub-index 2   |                         |                     |           |
| Access: RW  | Range: -32768 to +32767 | Size: Signed 16     | Unit: N/A |
| Default: 1  |                         |                     |           |
| Description: vl_dimension_factor 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 1.21).

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 2.01 (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 read from the drive 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 5.04 (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 2.21), the vl\_velocity\_deceleration object is updated.

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

## 7.6 Profile torque mode

The profile torque mode is supported on Unidrive SP, Digitax ST, Affinity, Mentor MP and Commander SK. It is possible to use this profile in regen mode on the Unidrive SP. On the Unidrive SP and Digitax ST in closed-loop or servo mode, this mode operates on the profile cycle time, using the drives internal torque shortcut (which is read by the drive every 250µs). On the Commander SK, Unidrive SP and Affinity in open-loop mode, the torque reference is written to the drive user torque parameter, which is handled every 4ms. When using profile torque mode object 0x604A *vl\_velocity\_quick\_stop* will be used in the event of a quick stop (also for quick stop option codes 2 and 6 the 0x6049 *vl\_velocity\_deceleration* object will be used). Table 7.48 shows the objects that are supported:

**Table 7.48 Profile torque mode supported objects**

| Index  | Name                        |
|--------|-----------------------------|
| 0x6071 | <i>Target_torque</i>        |
| 0x6075 | <i>Motor_rated_current</i>  |
| 0x6078 | <i>Current_actual_value</i> |
| 0x6087 | <i>Torque_slope</i>         |

### 7.6.1 0x6071 Target\_torque

This object indicates the configured input value for the torque controller in profile torque mode. The value of this object is given per thousand of rated torque.

**Table 7.49 0x6071 Target\_torque**

| 0x6071       | Target_torque  |                 |                            |
|--------------|--|-----------------|----------------------------|
| Access: RW   | Range: -32768 to +32767  | Size: Signed 16 | Unit: 0.1% of rated torque |
| Default:     | 0  |                 |                            |
| Description: | Indicates the configured input value for the torque controller in profile torque mode. |                 |                            |

### 7.6.2 0x6075 Motor\_rated\_current

This object indicates the configured motor rated current. It is taken from the motor's name-plate. Depending on the motor and drive technology this current is DC, peak or rms (root-mean-square) current. All relative current data refers to this value. The value of this object is given in mA.

**Table 7.50 0x6075 Motor\_rated\_current**

| 0x6075       | Motor_rated_current                                     |                   |          |
|--------------|---|-------------------|----------|
| Access: RO   | Range: 0 to 0xFFFFFFFF                                  | Size: Unsigned 32 | Unit: mA |
| Default:     | 0   |                   |          |
| Description: | Indicates the configured motor rated current (Pr 5.07). |                   |          |



### 7.6.3 0x6078 Current\_actual\_value

This object provides the actual value of the current. It shall correspond to the current in the motor. The value of this object is given per thousand of rated current.

**Table 7.51 0x6078 Current\_actual\_value**

| 0x6078   |                         | Current_actual_value |                             |
|--|-------------------------|----------------------|-----------------------------|
| Access: RO   | Range: -32768 to +32767 | Size: Signed 16      | Unit: 0.1% of rated current |
| Default: 0   |                         |                      |                             |
| Description: Provides the actual value of the current. |                         |                      |                             |

### 7.6.4 0x6087 Torque\_slope

This object indicates the configured rate of change of torque. The value of this object is given in units of per thousand of rated torque per second.

**Table 7.52 Torque\_slope**

| 0x6087  |                        | Torque_slope      |                                       |
|---|------------------------|-------------------|---------------------------------------|
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: 0.1% of rated torque per second |
| Default: 0  |                        |                   |                                       |
| Description: Indicates the configured rate of change of torque. |                        |                   |                                       |

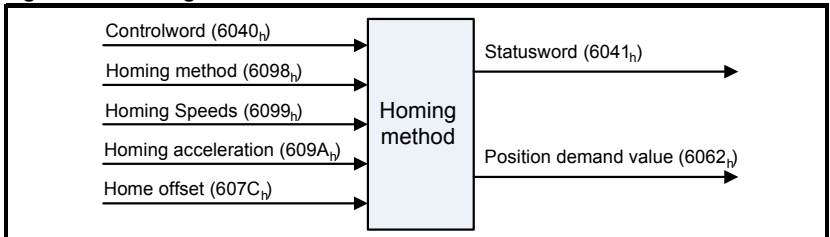
## 7.7 Homing mode

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

Figure 7-2 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 7-2 Homing mode function**



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

An encircled number in Figures 7-3 to 7-10 indicates the code for selection of this homing position. The direction of movement is also indicated.

There are four sources of homing signal available: These are the negative and positive limit switches, the home switch and the index pulse from an encoder.

In the diagrams of homing sequences in Figure 7-3, the encoder count increases as the axis's position moves to the right, in other words the left is the minimum position and the right is the maximum position.

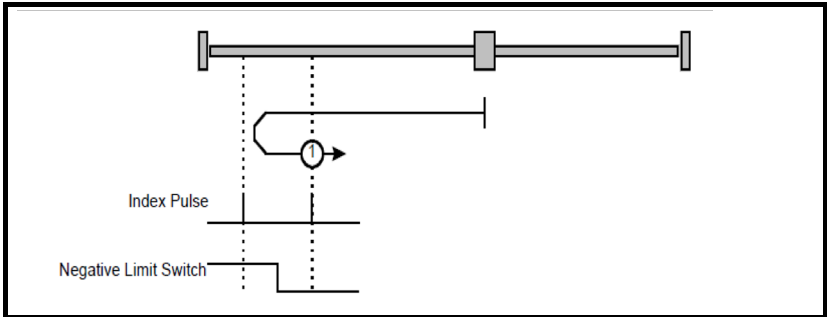
There are two digital inputs on the front of the SM-EtherCAT module that can be used in Homing Mode, more information is given in the following section.

### 7.7.1 General homing definitions

#### Method 1: Homing on negative limit switch and index pulse

Using this method as shown in Figure 7-3 *Homing on negative limit switch and index pulse* on page 58, the initial direction of movement shall be leftward if the negative limit switch is inactive (here: low). The home position shall be at the first index pulse to the right of the position where the negative limit switch becomes inactive.

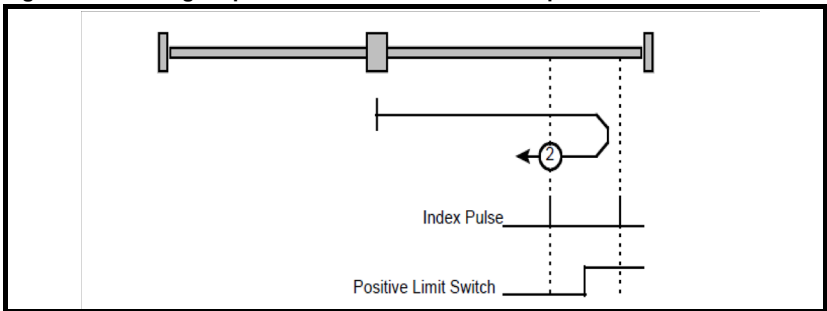
Figure 7-3 Homing on negative limit switch and index pulse



#### Method 2: Homing on positive limit switch and index pulse

Using this method as shown in Figure 7-4 *Homing on positive limit switch and index pulse* on page 58, the initial direction of movement shall be rightward if the positive limit switch is inactive (here: low). The position of home shall be at the first index pulse to the left of the position where the positive limit switch becomes inactive.

Figure 7-4 Homing on positive limit switch and index pulse

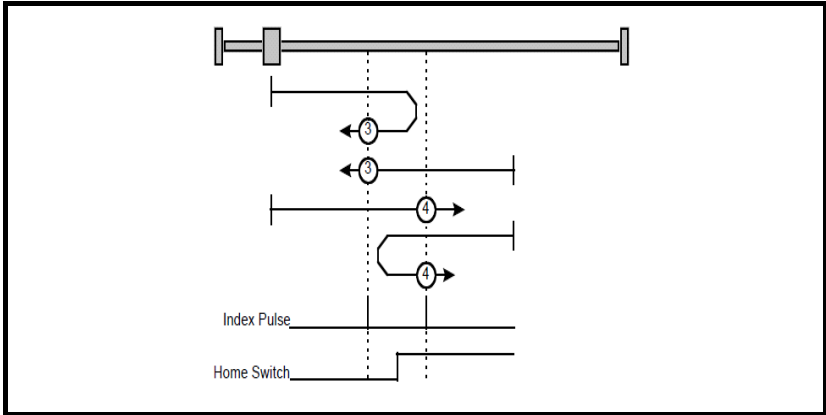


### Method 3 and 4: Homing on positive home switch and index pulse

Using these methods as shown in Figure 7-5 *Homing on positive home switch and index pulse* on page 59, 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.

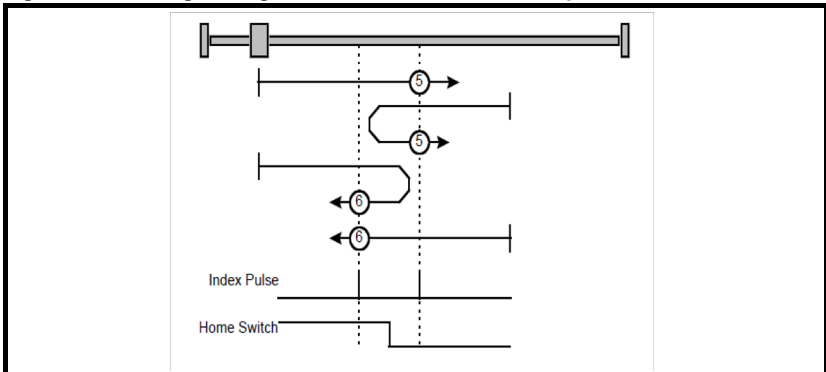
**Figure 7-5 Homing on positive home switch and index pulse**



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

Using these methods as shown in Figure 7-6 *Homing on negative home switch and index pulse* on page 59, 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.

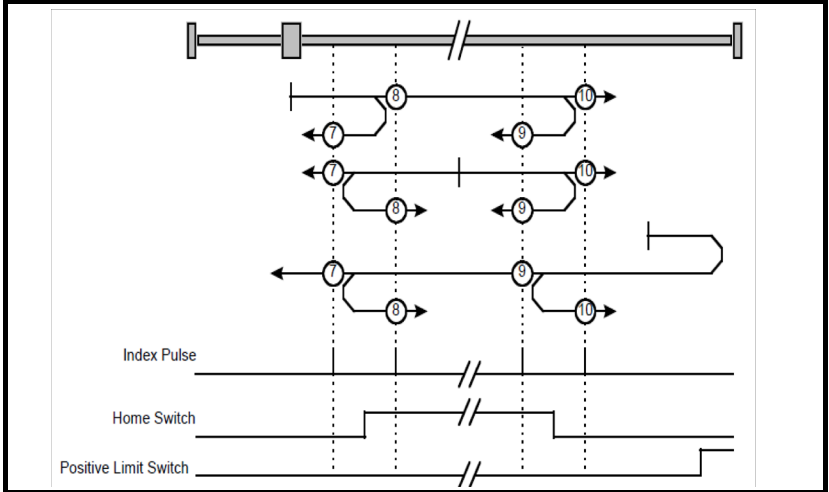
**Figure 7-6 Homing on negative home switch and index pulse**



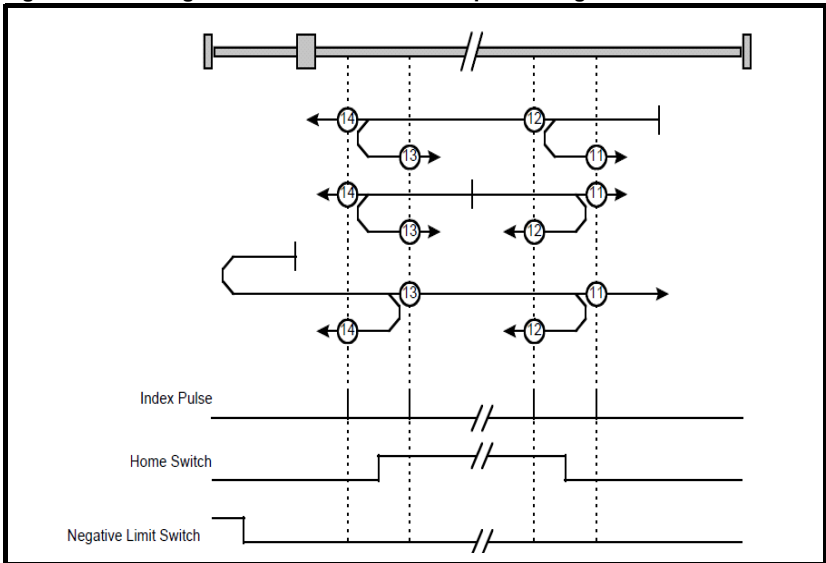
### Method 7 to 14: Homing on home switch and index pulse

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 7-7 *Homing on home switch and index pulse - positive initial motion* on page 60 and Figure 7-8 *Homing on home switch and index pulse - negative initial motion* on page 61. If the initial direction of movement leads away from the home switch, the drive shall reverse on encountering the relevant limit switch.

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



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



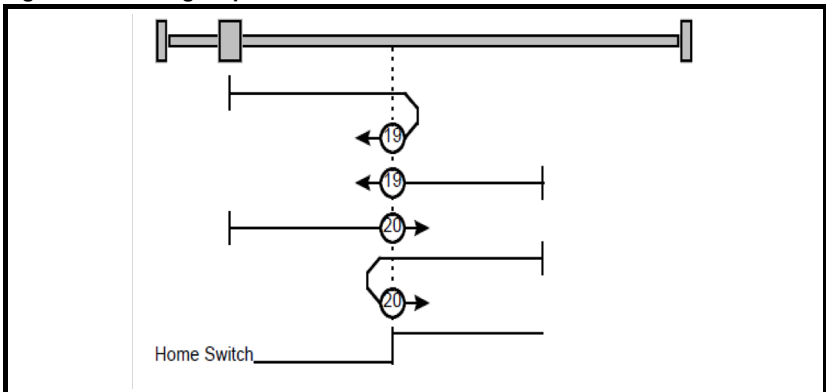
**Method 15 and 16: Reserved**

These methods are reserved.

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

These methods are similar to methods 1 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home or limit switch transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in Figure 7-9 *Homing on positive home switch* on page 61.

**Figure 7-9 Homing on positive home switch**



**Method 31 and 32: Reserved**

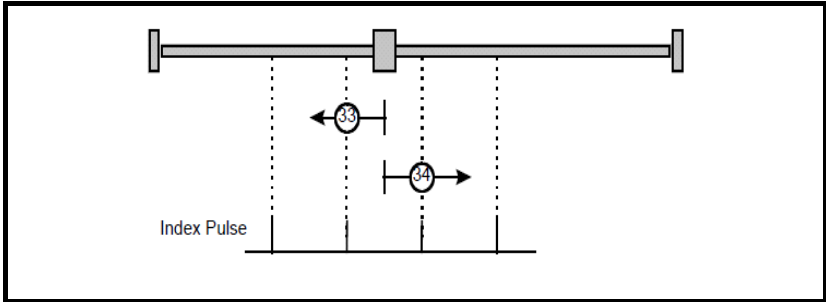
These methods are reserved.

|  |
|--|
| Safety information                     |
| Introduction                           |
| Mechanical installation                |
| Electrical installation                |
| Getting started                        |
| Protocols                              |
| <b>Drive profile (DSP-402) support</b> |
| Advanced features                      |
| Diagnostics                            |
| Quick reference                        |
| Glossary of terms                      |
| Index                                  |

### 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 7-10.

Figure 7-10 Homing on index pulse



### Method 35: Homing on index pulse

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 7.53 *Definition of bits 4 and 8 of the controlword* on page 62 defines the values for bits 4 and 8 of the controlword.

Table 7.53 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 halt option code (0x605D). |

Table 7.54 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.                                       |

## 7.7.2 Homing mode object definitions

### 0x2803 Homing source

This object indicates the configured source of the homing switch used during the homing procedure. Table 7.55 *Homing source* on page 63 specifies the object description.

**Table 7.55 Homing source**

| 0x2803   |               | Homing source    |           |
|--|---------------|------------------|-----------|
| Sub-index 0  |               |                  |           |
| Access: RO   | Range: N/A    | Size: Unsigned 8 | Unit: N/A |
| Default: 2   |               |                  |           |
| Description: The number of the last sub-index in this object.  |               |                  |           |
| Sub-index 1  |               |                  |           |
| Access: RW   | Range: 1 to 8 | Size: Unsigned 8 | Unit: N/A |
| Default: 5   |               |                  |           |
| Description: The source of the homing switch. This will specify a digital input as follows:<br>1 to 6 - The number of a drive digital input<br>7 to 8 - SM-EtherCAT option module digital input 0 or 1 |               |                  |           |
| Sub-index 2  |               |                  |           |
| Access: RW   | Range: 0 to 1 | Size: Unsigned 8 | Unit: N/A |
| Default: 0   |               |                  |           |
| Description: Use the feedback source freeze for homing. This will cause the freeze from the selected feedback device to be used instead of the index (marker) pulse when it is required during homing. |               |                  |           |

### 0x2804 Freeze object

This object is used to configure the freeze function that can be used within the Homing mode profile. Table 7.56 *Freeze object* on page 63 specifies the object description.

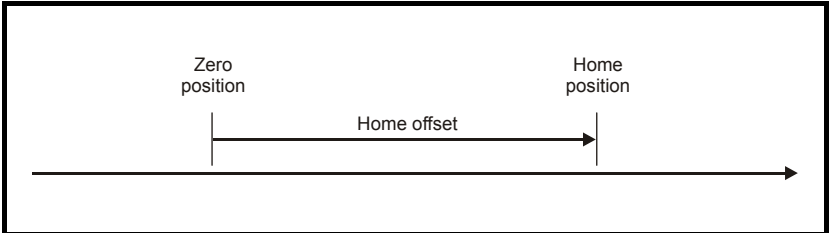
**Table 7.56 Freeze object**

| 0x2804  |               | Freeze object    |           |
|---|---------------|------------------|-----------|
| Sub-index 0   |               |                  |           |
| Access: RO  | Range: N/A    | Size: Unsigned 8 | Unit: N/A |
| Default: 2  |               |                  |           |
| Description: The number of the last sub-index in this object.   |               |                  |           |
| Sub-index 1   |               |                  |           |
| Access: RW  | Range: 0 to 1 | Size: Unsigned 8 | Unit: N/A |
| Default: 0  |               |                  |           |
| Description: Route the option freeze onto the drive. Setting a value of 1 here will route the option digital input 0 onto the drive freeze line.  |               |                  |           |
| Sub-index 2   |               |                  |           |
| Access: RW  | Range: 0 to 1 | Size: Unsigned 8 | Unit: N/A |
| Default: 0  |               |                  |           |
| Description: Option to drive freeze invert. Setting a value of 1 will invert the freeze signal routed onto the drive from the option input 0 (if 0x2804, sub-index 1 is set to 1). This value will be read only on a transition from 0 to 1 in sub-index 1. |               |                  |           |

### 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 7-11 *Home offset definition* on page 64. The value of this object shall be given in user-defined position units. Negative values indicate the opposite direction.

**Figure 7-11 Home offset definition**



**Table 7.57 Home offset**

| 0x607C       | Home offset            |                 |                                   |
|--------------|------------------------|-----------------|-----------------------------------|
| Access: RW   | Range: 0 to 0xFFFFFFFF | Size: Signed 32 | Unit: User-defined position units |
| Default:     | 0                      |                 |                                   |
| Description: | Homing offset value.   |                 |                                   |

### 0x6098 Homing method

This object indicates the configured homing method that shall be used. Table 7.58 *Homing method* on page 64 specifies the object description, and Table 7.59 *Homing method values* on page 64 specifies the value ranges for this object.

**Table 7.58 Homing method**

| 0x6098       | Homing method                         |                  |           |
|--------------|---------------------------------------|------------------|-----------|
| Access: RW   | Range: 0 - 35                         | Size: Unsigned 8 | Unit: N/A |
| Default:     | 0                                     |                  |           |
| Description: | The homing method that shall be used. |                  |           |

**Table 7.59 Homing method values**

| Value | Definition                |
|-------|---------------------------|
| 0     | No homing method assigned |
| 1     | Method 1 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 7.60 *Homing speeds* on page 65 specifies the object description.

**Table 7.60 Homing speeds**

| 0x6099  |                        | Homing speeds     |           |
|---|------------------------|-------------------|-----------|
| Sub-index 0   |                        |                   |           |
| Access: RO  | Range: 2               | Size: Signed 8    | Unit: N/A |
| Default: 2  |                        |                   |           |
| Description: The number of the last sub-index in this object. |                        |                   |           |
| Sub-index 1   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |
| Default: 0  |                        |                   |           |
| Description: Speed during search for a switch.                |                        |                   |           |
| Sub-index 2   |                        |                   |           |
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32 | Unit: N/A |
| Default: 0  |                        |                   |           |
| 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 7.61 *Homing acceleration* on page 65 specifies the object description.

**Table 7.61 Homing acceleration**

| 0x609A  |                        | Homing acceleration |                                       |
|---|------------------------|---------------------|---------------------------------------|
| Access: RW  | Range: 0 to 0xFFFFFFFF | Size: Unsigned 32   | Unit: User-defined acceleration units |
| Default: 0  |                        |                     |                                       |
| Description: Indicates the configured acceleration and deceleration to be used during homing operation. |                        |                     |                                       |

## 7.8 Cyclic sync position mode

Cyclic sync position mode is supported on the Unidrive SP in servo mode, closed-loop vector mode and RFC mode. It is also supported on the Digitax ST Servo and Mentor MP drives. It is not supported on a Unidrive SP in open-loop or regen mode. It is also not supported on a Commander SK or an Affinity.

**Table 7.62 Cyclic sync position mode**

| Index  | Name                      |
|--------|---------------------------|
| 0x6077 | torque_actual_value       |
| 0x607A | target_position           |
| 0x60B1 | velocity_offset           |
| 0x60C2 | interpolation_time_period |

**NOTE** When using one of the DSP-402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the SM-EtherCAT module going into the SAFE-OPERATIONAL state (Pr **MM.04** = 4).

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.

### 7.8.1 0x6077 Torque\_actual\_value

This object provides the actual value of the torque. It shall correspond to the instantaneous torque in the motor. The value is given per thousand of rated torque.

**Table 7.63 Torque actual value**

| 0x6077       |  | Torque actual value |                            |
|--------------|--|---------------------|----------------------------|
| Access: RO   | Range: -32768 to +32767                  | Size: Signed 16     | Unit: 0.1% of rated torque |
| Default:     | 0  |                     |                            |
| Description: | Provides the actual value of the torque. |                     |                            |

### 7.8.2 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 7.64 Target position**

| 0x607A       |   | Target position |                                   |
|--------------|---|-----------------|-----------------------------------|
| Access: RW   | Range: 0 to 0xFFFFFFFF  | Size: Signed 32 | Unit: User-defined position units |
| Default:     | N/A   |                 |                                   |
| Description: | Indicates the command positions that the drive should move to in cyclic sync position mode. |                 |                                   |

### 7.8.3 0x60B1 Velocity\_offset

This object provides the offset for the velocity value. The offset is given in user defined velocity units. In cyclic synchronous position mode this object contains the input value for velocity feed forward.

**Table 7.65 Velocity offset**

| 0x60B1       |   | Velocity offset |                                   |
|--------------|---|-----------------|-----------------------------------|
| Access: RW   | Range: 0 to 0xFFFFFFFF                      | Size: Signed 32 | Unit: User-defined velocity units |
| Default:     | 0   |                 |                                   |
| Description: | Provides the offset for the velocity value. |                 |                                   |

# 8 Advanced features

## 8.1 Distributed Clocks

SM-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 SP or Digitax ST), 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 250µs.

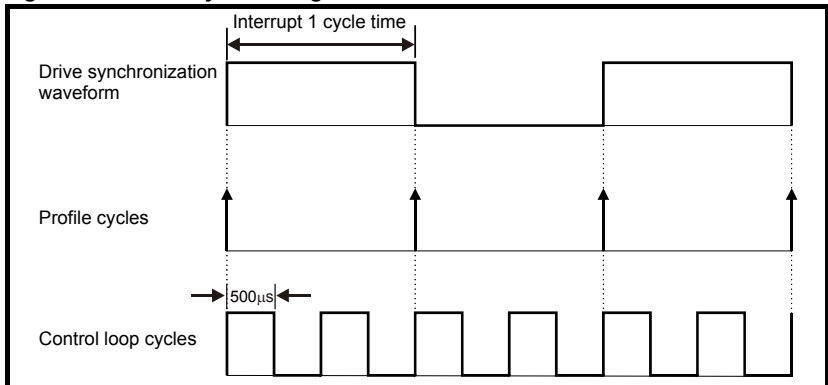
### 8.1.1 Time synchronization support

When the option module is connected to a drive which can take a time synchronization signal (e.g. a Unidrive SP or Digitax ST), 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.

The time between edges of the drive synchronization square wave (referred to as the drive synchronization interval) will be an integer multiple of 250µs (up to a maximum value of 15ms).

The position controller will be executed at the interval defined in the Distributed Clock settings, if Distributed Clocks is disabled the controller will execute each 250µs. When the profile torque or velocity control mode is used with Distributed Clocks enabled, a new profile cycle will be started every sync interval in the control loop cycle starting at the sync signal edge as shown in Figure 8-1. This will be referred to as a profile cycle. When Distributed Clocks are not enabled, a new profile cycle will be started every 250µs.

Figure 8-1 Profile Cycle Timing



It is expected that most systems will have the interpolation cycle time equal to the drive synchronization interval. An interpolation cycle is referred to as a profile cycle. The interoperation between a profile cycle when interpolation position mode is being used and the drive synchronization interval is described as follows:

1. Interpolation cycle time = drive synchronization interval. In this case, each new interpolation cycle will be synchronized to the drive synchronization interval. Interpolation will be performed in each of the subsequent control loop cycles until the next sync signal edge.

Command and feedback values which are handled cyclically will be read at defined times in the cycle. Command values handled/used every cycle (profile or control loop) will be cached from the object dictionary in the 90µs period at the beginning of that cycle.

Any feedback values read during a cycle will be scaled as appropriate in that cycle, cached, and then written during the 90µs period at the beginning of the next cycle. 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 profile cycle.

PDO data will be copied to and from the object dictionary (from and to the sync manager memory areas) in the 90µs period at the beginning of every profile cycle. PDO data mapped to drive parameters (but not SM-Applications PLC parameters or other parameters accessed using Inter-Option Communications), will be written to those parameters in the 90µs period at the beginning of every control loop cycle.

## 8.2 SM-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)
- Ethernet over EtherCAT (EoE)
- CMP protocol through Modbus RTU (only on the Unidrive SP, Digitax ST, Mentor MP and Affinity)

## 8.3 Menu 61 - General Module Setup

### 8.3.1 Parameter 1.00 shortcut

**Table 8.1 Parameter 1.00 shortcut**

| Parameter 1.00 shortcut |         |            |
|-------------------------|---------|------------|
| Pr 61.01                | Default | 0          |
|                         | Range   | 0 to 32767 |
|                         | Access  | RW         |

This Parameter can be used as a shortcut to Pr 1.00 as DSP-402 objects do not permit access to parameter zero.

### 8.3.2 Drive synchronization control

**Table 8.2 Drive synchronization control**

| Drive synchronization control |         |        |
|-------------------------------|---------|--------|
| Pr 61.03                      | Default | 1      |
|                               | Range   | 0 to 2 |
|                               | Access  | RW     |

**Table 8.3 synchronization control values**

| Value | Description   |
|-------|---|
| 0     | Independent.<br>Module should not try to become synchronization master to the drive.  |
| 1     | Master with sync.<br>Module should try to become synchronization master to the drive only when fieldbus specific synchronization has been achieved. |
| 2     | Master always.<br>Module should always try to become synchronization master to the drive.   |

### 8.3.3 Inter-option module synchronization control

**Table 8.4 Inter-option module synchronization control**

| Inter-option module synchronization control |         |        |
|---|---------|--------|
| Pr 61.04                                    | Default | 1      |
|   | Range   | 0 to 2 |
|   | Access  | RW     |

**Table 8.5 Inter-option module synchronization control values**

| Value | Description   |
|-------|---|
| 0     | Independent.<br>Module should not try to become synchronization master to other modules.  |
| 1     | Master with sync.<br>Module should try to become synchronization master to other modules only when fieldbus specific synchronization has been achieved. |
| 2     | Master always.<br>Module should always try to become synchronization master to other modules.   |

### 8.3.4 Inter-option clock synchronization control

**Table 8.6 Inter-option clock synchronization control**

| Inter-option clock synchronization control |         |        |
|--|---------|--------|
| Pr 61.05                                   | Default | 0      |
|  | Range   | 0 to 2 |
|  | Access  | RW     |

This parameter provides control of the inter-option module clock synchronization mechanism.

**Table 8.7 Inter-option clock synchronization control values**

| Value | Description   |
|-------|---|
| 0     | Independent.<br>Module should not try to be come synchronization master to clocks in other modules. |
| 1     | Master.<br>Module should try to become synchronization master to clocks in other modules.           |
| 2     | Slave.<br>Module should become a synchronization slave to clocks in another module.                 |

### 8.3.5 Option slot indicator

**Table 8.8 Option slot indicator**

| Option slot indicator |         |        |
|-----------------------|---------|--------|
| Pr 61.07              | Default | 0      |
|                       | Range   | 0 to 3 |
|                       | Access  | RO     |

The parameter displays the number of the option slot on the drive that the SM-EtherCAT module is connected to. The values for the slots are 1, 2 and 3.

### 8.3.6 Option hardware issue

**Table 8.9 Option hardware issue**

| Option hardware issue |         |          |
|-----------------------|---------|----------|
| Pr 61.40              | Default | 0        |
|                       | Range   | 0 to 255 |
|                       | Access  | RO       |

The parameter displays the hardware revision number of the module.

### 8.3.7 500ms Task % free

**Table 8.10 500ms Task % free**

| 500ms Task % free |         |          |
|-------------------|---------|----------|
| Pr 61.42          | Default | 0        |
|                   | Range   | 0 to 100 |
|                   | Access  | RO       |

This parameter indicates what percentage of the 500ms system task is unused and still available.

### 8.3.8 External memory % free

**Table 8.11 External memory % free.**

| External memory % free |         |          |
|------------------------|---------|----------|
| Pr 61.43               | Default | 0        |
|                        | Range   | 0 to 100 |
|                        | Access  | RO       |

This parameter indicates what percentage of the external memory is unused and still available.

### 8.3.9 Internal memory % free

Table 8.12 Internal memory % free

| Internal memory % free |         |          |
|------------------------|---------|----------|
| Pr 61.44               | Default | 0        |
|                        | Range   | 0 to 100 |
|                        | Access  | RO       |

This parameter indicates what percentage of the internal memory is unused and still available.

### 8.3.10 Option module error sub-code

Table 8.13 Option module error sub-code

| Option module error sub-code |         |          |
|------------------------------|---------|----------|
| Pr 61.49                     | Default | 0        |
|                              | Range   | 0 to 255 |
|                              | Access  | RO       |

This parameter provides more detailed information of the cause of the current SM-EtherCAT slot error.

### 8.3.11 Bootloader software version

Table 8.14 Bootloader software version

| Bootloader software version (XX.YY) |         |           |
|-------------------------------------|---------|-----------|
| Pr 61.50                            | Default | 0         |
|                                     | Range   | 0 to 9999 |
|                                     | Access  | RO        |

### 8.3.12 Bootloader software sub-version

Table 8.15 Bootloader software sub-version

| Bootloader software subversion (ZZ) |         |         |
|-------------------------------------|---------|---------|
| Pr 61.51                            | Default | 0       |
|                                     | Range   | 0 to 99 |
|                                     | Access  | RO      |

These parameters provide the XX.YY and ZZ parts of the bootloader firmware version number while the main application is running.

## 8.4 Advanced cyclic data configuration

This configuration will allow the behavior of the cyclic data handling to be modified; specifically, it will allow the tasks in which cyclic data is handled to be changed.

**Table 8.16 Out cyclic data configuration**

| 0x2820 Out cyclic data configuration |   |               |              |
|--------------------------------------|---|---------------|--------------|
| Sub-index 0                          |   |               |              |
| <b>Access:</b>                       | RO  | <b>Range:</b> | N/A          |
| <b>Size:</b>                         | Unsigned 8  |               | <b>Unit:</b> |
| <b>Default:</b>                      | 2   |               |              |
| <b>Description:</b>                  | The number of the last sub-index in this object.  |               |              |
| Sub-index 1                          |   |               |              |
| <b>Access:</b>                       | RW  | <b>Range:</b> | 0 to 2       |
| <b>Size:</b>                         | Unsigned 8  |               | <b>Unit:</b> |
| <b>Default:</b>                      | 0   |               |              |
| <b>Description:</b>                  | <p>High priority cyclic data task; selects the task in which high priority out (master to slave) cyclic data is copied between the intermediate buffer and the mapped objects, parameters, etc.</p> <p>0 – Critical task (<b>default</b>). This is the first 90µs of the critical task.</p> <p>1 – Critical+90 task. This is the task that commences 90µs after the critical task start, and finishes before the next critical task.</p> <p>2 – Sync Manager task. This is the AL event task which occurs upon a sync manager access.</p> |               |              |
| Sub-index 2                          |   |               |              |
| <b>Access:</b>                       | RW  | <b>Range:</b> | 0 to 2       |
| <b>Size:</b>                         | Unsigned 8  |               | <b>Unit:</b> |
| <b>Default:</b>                      | 2   |               |              |
| <b>Description:</b>                  | <p>Intermediate buffer copy task. Selects the task in which the high priority out (master to slave) cyclic data is copied into the intermediate buffer.</p> <p>0 – Critical task. This is the first 90µs of the critical task.</p> <p>1 – Critical+90 task. This is the task that commences 90µs after the critical task start, and finishes before the next critical task.</p> <p>2 – Sync Manager task (<b>default</b>). This is the AL event task which occurs upon a sync manager access.</p>   |               |              |



**Table 8.17 In cyclic data configuration**

|                     |   |               |        |  |
|---------------------|---|---------------|--------|--|
| <b>0x2821</b>       | <b>In cyclic data configuration</b>   |               |        |  |
| Sub-index 0         |   |               |        |  |
| <b>Access:</b>      | RO  | <b>Range:</b> | N/A    | <b>Size:</b> Unsigned 8 <b>Unit:</b> N/A |
| <b>Default:</b>     | 2   |               |        |  |
| <b>Description:</b> | The number of the last sub-index in this object.  |               |        |  |
| Sub-index 1         |   |               |        |  |
| <b>Access:</b>      | RW  | <b>Range:</b> | 0 to 2 | <b>Size:</b> Unsigned 8 <b>Unit:</b> ms  |
| <b>Default:</b>     | 1   |               |        |  |
| <b>Description:</b> | High priority cyclic data task; selects the task in which high priority in (slave to master) cyclic data is copied between the intermediate buffer and the mapped objects, parameters, etc.<br>0 – Critical task. This is the default task. This is the first 90µs of the critical task.<br>1_Critical+90 task ( <b>Default</b> ). This is the task that commences 90µs after the critical task start, and finishes before the next critical task.<br>2 – Sync Manager task (default). This is the AL event task which occurs upon a sync manager access. |               |        |  |
| Sub-index 2         |   |               |        |  |
| <b>Access:</b>      | RW  | <b>Range:</b> | 0 to 2 | <b>Size:</b> Unsigned 8 <b>Unit:</b> N/A |
| <b>Default:</b>     | 1   |               |        |  |
| <b>Description:</b> | Intermediate buffer copy task. Selects the task in which the high priority in (slave to master) cyclic data is copied into the intermediate buffer.<br>0 – Critical task. This is the first 90µs of the critical task.<br>1_Critical+90 task ( <b>Default</b> ). This is the task that commences 90µs after the critical task start, and finishes before the next critical task.<br>2 – Sync Manager task (default). This is the AL event task which occurs upon a sync manager access.   |               |        |  |

## 8.5 Internal shortcuts

Internal shortcuts are provided for very fast operation. It is not possible to read the values non-cyclically; they can only be accessed at certain parts of the cycle in order to read and write correct values.

**Table 8.18 Internal position feedback shortcut**

|                     |  |               |   |  |
|---------------------|--|---------------|---|--|
| <b>0x2830</b>       | <b>Internal position feedback shortcut</b>   |               |   |  |
| Sub-index 0         |  |               |   |  |
| <b>Access:</b>      | RO   | <b>Range:</b> | -2 <sup>31</sup> to +2 <sup>31</sup> -1 | <b>Size:</b> Signed 32 <b>Unit:</b> Counts |
| <b>Default:</b>     | 0  |               |   |  |
| <b>Description:</b> | This value is the <i>drive</i> feedback source. It consists of the coarse position in the most significant 16 bits and the fine position in the least significant 16 bits.<br>It will then have a number of turns bits shifted into the most significant bits ("pushing" as many fine position bits as required out).<br>This should not be read in the first 90µs after the RMINT edge, because data skew may result. |               |   |  |

**Table 8.19 Internal torque shortcut**

|                     |  |               |     |  |
|---------------------|--|---------------|-----|--|
| <b>0x2831</b>       | <b>Internal torque shortcut</b>  |               |     |  |
| Sub-index 0         |  |               |     |  |
| <b>Access:</b>      | RW   | <b>Range:</b> | N/A | <b>Size:</b> Signed 16 <b>Unit:</b> 0.01% rated torque |
| <b>Default:</b>     | 0  |               |     |  |
| <b>Description:</b> | This represents the drive internal torque shortcut, scaled to 0.01% units. |               |     |  |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

---

# 9 Diagnostics

---

## 9.1 Module identification parameters

The basic menu parameters can be accessed through the slot menu in the drive, Pr **MM.PP**, where **MM** is the menu for SM-EtherCAT in the host drive. The basic menu parameters may also be accessed using menu 60, i.e. Pr **60.PP**.

### 9.1.1 SM-EtherCAT module ID code

**Table 9.1 SM-EtherCAT module ID code**

| SM-EtherCAT module ID code |         |                   |
|----------------------------|---------|-------------------|
| Pr <b>MM.01</b>            | Default | 421 (SM-EtherCAT) |
|                            | Range   | -                 |
|                            | Access  | RO                |

The module ID code indicates the type of module installed in the slot corresponding to menu **MM**. This is useful for checking the module is of the correct type.

### 9.1.2 SM-EtherCAT firmware version

**Table 9.2 SM-EtherCAT firmware version - (major and minor)**

| SM-EtherCAT firmware version - (major and minor) (xx.yy) |         |                |
|--|---------|----------------|
| Pr <b>MM.02</b>  | Default | N/A            |
|  | Range   | 00.00 to 99.99 |
|  | Access  | RO             |

**Table 9.3 SM-EtherCAT firmware version - (subversion)**

| SM-EtherCAT firmware version (subversion) (zz) |         |         |
|--|---------|---------|
| Pr <b>MM.51</b>                                | Default | N/A     |
|  | Range   | 0 to 99 |
|  | Access  | RO      |

#### **Unidrive SP (Sizes 1 to 6) / Unidrive SPM / Mentor MP**

The software version of the Solutions Modules can be identified by looking at Pr **15.02** or Pr **16.02** or Pr **17.02** and Pr **15.51** or Pr **16.51** or Pr **17.51**.

Menu 15,16 or 17 is Solutions Module slot dependent with menu 17 being the lowest position nearest the control terminal connections.

The software version takes the form of xx.yy.zz, where Pr **15.02** or Pr **16.02** or Pr **17.02** displays xx.yy and Pr **15.51** or Pr **16.51** or Pr **17.51** displays zz (e.g. for software version 01.01.00 on a module in the middle Solutions Module slot, Pr **16.02** will display 1.01 and Pr **16.51** will display 0).

#### **Unidrive SP (Size 0) / Digitax ST / Unidrive ES / Affinity**

The software version of the Solutions Modules can be identified by looking at Pr **15.02** or Pr **16.02** and Pr **15.51** or Pr **16.51**.

Menu 15 or 16 is Solutions Module slot dependent with menu 15 (Unidrive SP size 0 and Digitax ST) or menu 16 (Unidrive ES and Affinity) being the position nearest the control terminal connections.

The software version takes the form of xx.yy.zz, where Pr **15.02** or Pr **16.02** displays xx.yy and Pr **15.51** or Pr **16.51** displays zz (e.g. for software version 01.01.00 on a module in the middle Solutions Module slot (Unidrive ES and Affinity) or for Unidrive SP size 0 and Digitax ST, the Solutions Module slot nearest the incoming supply terminals, Pr **16.02** will display 1.01 and Pr **16.51** will display 0).

### Commander SK (Sizes B to D and 2 to 6)

The software version of the Solutions Module can be identified by looking at Pr **15.02** and Pr **15.51**. The software version takes the form of xx.yy.zz, where Pr **15.02** displays xx.yy and Pr **15.51** displays zz (e.g. for software version 01.01.00 Pr **15.02** will display 1.01 and Pr **15.51** will display 0).

The full version of the SM-EtherCAT firmware can be assembled by combining the major version (xx.yy) and the minor version (zz) as follows: xx.yy.zz.

## 9.2 Network configuration objects

### 9.2.1 SM-EtherCAT network loss trip

**Table 9.4 Network loss behavior object**

| 0x2813  | Network loss behavior |               |           |
|---|-----------------------|---------------|-----------|
| Sub-index 0:  |                       |               |           |
| Access: RO  | Range: N/A            | Size: 1 byte  | Unit: N/A |
| Default: 2  |                       |               |           |
| Description: The number of sub-indices in this object.  |                       |               |           |
| Sub-index 1: Maximum time interval  |                       |               |           |
| Access: RW  | Range: 0 to 65535     | Size: 2 bytes | Unit: ms  |
| Default: 0 (by default the network loss behavior is disabled).  |                       |               |           |
| Description: The maximum time, in ms, allowed between accesses to PDOs (read or write). If no PDO access occurs for this period, the option will start network loss handling. If a value of zero is set, no network loss handling will occur.   |                       |               |           |
| Sub-index 2: Trip type  |                       |               |           |
| Access: RW  | Range: 0 to 2         | Size: 1 byte  | Unit: N/A |
| Default: 0  |                       |               |           |
| Description: Network loss trip type. If this value is set to 0, a network loss trip will never occur; however, a network loss will still be handled by stopping the drive and indicating a warning as previously described. If this value is set to 1, the network loss trip will occur only after the motor has been stopped according to the Fault reaction option code. If the value is set to 2, the network loss trip will occur immediately on network loss (this implies that the motor will coast). |                       |               |           |

SM-EtherCAT resets an internal timer when a valid message is received from the EtherCAT network. The network loss trip is triggered when no new messages are received before the timer times out. The SM-EtherCAT will trip the drive and the SM-EtherCAT error code parameter (Pr **MM.50**) will show 120.

After power-up or reset the network loss trip is not armed until one of the following events occur:

- SYNC message is received
- RxPDO is received

Once the trip has been armed, a minimum of one of the above messages must be received or transmitted in each time period set in sub-index 2 of the Network loss behavior object (0x2813).

## 9.3 Diagnostic parameters

**Table 9.5 SM-EtherCAT operating status**

| SM-EtherCAT operating status |         |               |
|------------------------------|---------|---------------|
| Pr MM.06                     | Default | N/A           |
|                              | Range   | -9999 to 9999 |
|                              | Access  | RO            |

### 9.3.1 Running states

**Table 9.6 Diagnostic information - running states**

| Pr MM.06 | Meaning                     | Description  |
|----------|-----------------------------|--|
| 0        | Link established            | A link has been established but no frames are being transmitted or received.       |
| >0       | Handled messages per second | The number of cyclic PDO messages that the active EtherCAT is handling per second. |

**Table 9.7 Diagnostic information - application**

| Pr MM.06 | Meaning                  | Description  |
|----------|--------------------------|--|
| -99      | Application started      | The main application has been launched.  |
| -70      | Initializing file system | The file system is initializing.   |
| -50      | Initializing databases   | The databases are initializing.  |
| -30      | Initializing fieldbus    | The fieldbus is initializing.  |
| -25      | Starting fieldbus        | The fieldbus is starting.  |
| -1       | Initialization complete  | The option module has initialized correctly but no network communication is taking place. i.e. no EtherCAT frames have been transmitted or received. |

**Table 9.8 Diagnostic information - bootloader**

| Pr MM.06 | Meaning                  | Description   |
|----------|--------------------------|---|
| -199     | Boot loader start        | The bootloader is starting up.  |
| -180     | Initializing memory      | The memory manager is being initialized.  |
| -150     | Initializing file system | The file system handler is being initialized.                                   |
| -149     | Format file system       | The file system is being formatted.   |
| -148     | Verify file system       | The file system is being verified.  |
| -130     | Check boot mode          | The required boot mode is being checked.  |
| -110     | Loading application      | The requested application image is being copied from the file system to memory. |
| -101     | Launching application    | The application is being launched.  |
| -100     | Default mode             | The bootloader has finished but no application was launched.                    |

## 9.4 Drive trip display codes

If the SM-EtherCAT detects an error during operation, it will force a trip on the drive. However, the trip code displayed on the drive will only indicate which slot initiated the trip. The exact reason for the trip will be indicated in the SM-EtherCAT error code parameter, Pr **MM.50**.

Table 9.9 shows the possible trip codes that will be displayed on the drive when a problem is detected with SM-EtherCAT or when SM-EtherCAT initiates a trip.

**Table 9.9 Drive trip display codes**

| Trip Code        | Fault                      | Description  |
|------------------|----------------------------|--|
| SLX.HF/<br>SL.HF | Hardware fault             | The drive has detected that a Solutions Module is present, but is unable to communicate with it. If this occurs, please contact your supplier or local Control Techniques Drive Centre.            |
| SLX.Er/<br>SL.Er | Error                      | Error trip generated by SM-EtherCAT  |
| SLX.nF/<br>SL.nF | Not installed              | This trip will occur if a drive slot is configured for an option module, but no module is installed in the slot.   |
| SLX.dF/<br>SL.dF | Different module installed | The slot configuration parameters stored in the drive are not valid SM-EtherCAT configuration parameters. This trip will also occur when an SM-EtherCAT is installed to a previously un-used slot. |

## 9.5 SM-EtherCAT module temperature

**Table 9.10 SM-EtherCAT module temperature**

| SM-EtherCAT module temperature |         |         |
|--------------------------------|---------|---------|
| Pr <b>MM.44</b>                | Default | N/A     |
|                                | Range   | 0 - 255 |
|                                | Access  | RO      |

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

## 9.6 SM-EtherCAT serial number

**Table 9.11 SM-EtherCAT serial number**

| SM-EtherCAT serial number |         |              |
|---------------------------|---------|--------------|
| Pr <b>MM.35</b>           | Default | N/A          |
|                           | Range   | 0 - 16777215 |
|                           | Access  | RO           |

The serial number is loaded into the SM-EtherCAT during manufacture and cannot be changed. It contains the last eight digits of the 10-digit serial number of the label.

## 9.7 SM-EtherCAT error codes

**Table 9.12 SM-EtherCAT error codes**

| SM-EtherCAT error codes |         |          |
|-------------------------|---------|----------|
| Pr <b>MM.50</b>         | Default | N/A      |
|                         | Range   | 0 to 255 |
|                         | Access  | RO       |

If an error is detected during operation the module will force a trip on the drive and update the error code parameter (Pr **MM.50**). Table 9.13 shows the SM-EtherCAT error codes.

**Table 9.13 SM-EtherCAT error codes**

| Error code | Fault  |
|------------|--|
| 1          | No fieldbus mode has been selected                       |
| 2          | Critical task over-run                                   |
| 3          | Invalid feedback source                                  |
| 4          | Unknown drive type                                       |
| 5          | Unsupported drive type                                   |
| 10         | Invalid or missing application                           |
| 62         | Database Initialization error                            |
| 63         | File system Initialization error                         |
| 64         | Error initializing fieldbus stack                        |
| 74         | The option module has overheated                         |
| 75         | The drive is not responding                              |
| 76         | The Modbus connection has timed out                      |
| 80         | Inter-option communication failure                       |
| 81         | Inter-option communication to slot 1 timeout             |
| 82         | Inter-option communication to slot 2 timeout             |
| 83         | Inter-option communication to slot 3 timeout             |
| 84         | Memory allocation error                                  |
| 85         | File system error  |
| 86         | Configuration file error                                 |
| 98         | The option module background task has not been completed |
| 99         | Software fault   |
| 120        | Network loss trip  |

## 9.8 Error handling

The following objects are provided to indicate an error condition

**Table 9.14 Error handling objects**

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

### 9.8.1 Error register

**Table 9.15 Error register**

| 0x1001       | Error register  |
|--------------|---|
| Access: RO   | Range: 0 to 255    Size: Unsigned 8    Unit: N/A  |
| Default:     | 0   |
| 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 are 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> |

## 9.8.2 Error code

**Table 9.16 Error code**

| 0x603F       | Error code  |                   |           |  |
|--------------|---|-------------------|-----------|--|
| Access: RO   | Range: 0 to 0xFFFF  | Size: Unsigned 16 | 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 9.17 Error codes below. |                   |           |  |

**Table 9.17 Error codes**

| Error Code | Meaning                                 | Corresponding Drive Trip Code   |
|------------|---|---|
| 0x0000     | Error reset / No error                  | 0 – No trip   |
| 0x1000     | Generic error                           | (Any trip code not elsewhere in table)  |
| 0x2200     | Internal current                        | 109 - OldC.P<br>189 – O.cL (SK Only)  |
| 0x2300     | Current, device output side             | 3 – OI.AC<br>20 – It.AC<br>104 - OIAC.P   |
| 0x3000     | Voltage                                 | 8 – PS.10V  |
| 0x3130     | Phase failure                           | 32 – PH<br>107 – PH.P   |
| 0x3200     | Voltage inside the device               | 1 – UU<br>2 – OU<br>5 – PS<br>9 – PS.24V<br>108 – PS.P  |
| 0x3210     | dc bus over-voltage                     | 106 - OV.P  |
| 0x4200     | Temperature device                      | 21 – O.ht1<br>22 – O.ht2<br>23 – O.CtL<br>27 – O.ht3<br>102 – Oht4.P<br>105 – Oht2.P  |
| 0x5000     | Device hardware                         | 200 – SL1.HF<br>201 – SL1.t0<br>202 – SL1.Er<br>203 – SL1.nF<br>204 – SL1.dF<br>205 – SL2.HF<br>206 – SL2.t0<br>207 – SL2.Er<br>208 – SL2.nF<br>209 – SL2.dF<br>210 – SL3.HF<br>211 – SL3.t0<br>212 – SL3.Er<br>213 – SL3.nF<br>214 – SL3.dF<br>215 – SL.rtd<br>217 – HF17<br>218 – HF18<br>219 – HF19<br>220-232 – HF20-HF32 |
| 0x5530     | Data Storage (Non-volatile data memory) | 31 – EEF<br>36 – SAVE.Er<br>37 – PSAVE.Er   |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-4/2) support |
| Advanced features               |
| <b>Diagnosics</b>               |
| Quick reference                 |
| Glossary of terms               |
| Index                           |

|        |  |  |
|--------|--|--|
| 0x6200 | Device Software (User Software)            | 10 – t010<br>32 – t038<br>40 to 89 – t040 to t089<br>90 to 99 – UP --- / t090 to t099<br>101 – t101<br>112 to 160 – t112 to t160<br>168 to 174 – t168 to t174<br>216 – t216                          |
| 0x6320 | Parameter Error                            | 199 - dESt   |
| 0x7112 | Brake Chopper (Over current brake chopper) | 4 – Ol.br<br>19 – lt.br<br>103 – Olbr.P  |
| 0x7200 | Measurement Circuit                        | 33 – rS  |
| 0x7300 | Sensor                                     | 14 – tunE4<br>15 – tunE5<br>16 – tunE6<br>161 to 167 – Enc11 to Enc17<br>176 – EnP,Er<br>189 – Enc1 (SP Only)<br>190 to 198 – Enc2 to Enc10  |
| 0x7510 | Communication (Serial Interface 1)         | 30 – SCL   |
| 0x7600 | Additional Modules (Data storage)          | 175 – C.Prod<br>177 – C.boot<br>178 – c.bUSY<br>179 – C.Chg<br>180 – C.OPtn<br>181 – C.RdO<br>182 – C.Err<br>183 – C.dAt<br>184 – C.FULL<br>185 – C.Acc<br>186 – C.rtg<br>187 – C.TyP<br>188 – C.cPr |
| 0x9000 | External Error                             | 6 – Et   |

## 9.9 Critical task % free

**Table 9.18 SM-EtherCAT critical task % free**

| SM-EtherCAT critical task % free |         |          |
|----------------------------------|---------|----------|
| Pr <b>MM.46</b>                  | Default | N/A      |
|                                  | Range   | 0 to 100 |
|                                  | Access  | RO       |

**Table 9.19 Worst case critical task % free**

| SM-EtherCAT worst case critical task % free |         |          |
|---|---------|----------|
| Pr <b>MM.47</b>                             | Default | N/A      |
|   | Range   | 0 to 100 |
|   | Access  | RO       |

Parameters Pr **MM.46** and Pr **MM.47** indicate how much of the cycle time allocated to the critical task is remaining and available for other module tasks.



## 9.10 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 SM-EtherCAT will return an SDO abort code to indicate the reason for the failure, the SDO abort codes are listed in Table 9.20.

**Table 9.20 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               |

## 9.11 FLASH file system % free

**Table 9.21 SM-EtherCAT FLASH file system % free**

| SM-EtherCAT FLASH file system % free |         |          |
|--------------------------------------|---------|----------|
| Pr MM.48                             | Default | N/A      |
|                                      | Range   | 0 to 100 |
|                                      | Access  | RO       |

Indicates what percentage of the flash based file system is unused and still available.

|                         |
|-------------------------|
| Safety information      |
| Introduction            |
| Mechanical installation |
| Electrical installation |
| Getting started         |
| Protocols               |
| Drive profile (DSP-4I2) |
| Advanced features       |
| Diagnosics              |
| Quick reference         |
| Glossary of terms       |
| Index                   |

## 9.12 Updating SM-EtherCAT firmware

The SM-EtherCAT firmware is available from your local Control Techniques Drive Centre or supplier and can also be downloaded from [CTSupport.com](http://CTSupport.com). To upload firmware to the SM-EtherCAT module the use of Winflasher is required, this application is also available from your local Control Techniques Drive Centre or supplier.

**NOTE** It is important that the filename of the SM-EtherCAT firmware application file is not altered, doing so may result in problems with the firmware upload process.

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

**NOTE** The minimum Winflasher firmware version with SM-EtherCAT support is V03.07.00.

# 10 Quick reference

Table 10.1 and Table 10.3 list of all the SM-EtherCAT set-up objects and parameters that are required to configure the module.

**Table 10.1 SM-EtherCAT objects reference**

| Object | Name                            | Description  | Cross reference          |
|--------|---------------------------------|--|--------------------------|
| 0x1000 | Device type                     | Specifies the device profile being used (DSP-402).                                     | Section 6.3.1 on page 23 |
| 0x1018 | Identity object                 | Contains SM-EtherCAT specific identity information.                                    | Section 6.3.1 on page 23 |
| 0x1600 | Receive PDO mapping 1           | Contains the mapping information for receive PDO mapping 1.                            | Section 6.3.2 on page 24 |
| 0x1601 | Receive PDO mapping 2           | Contains the mapping information for receive PDO mapping 2.                            | Section 6.3.2 on page 24 |
| 0x1605 | Receive PDO mapping 6           | Contains the mapping information for receive PDO mapping 6.                            | Section 6.3.2 on page 24 |
| 0x1615 | Receive PDO mapping 22          | Contains the mapping information for receive PDO mapping 22.                           | Section 6.3.2 on page 24 |
| 0x1A00 | Transmit PDO mapping 1          | Contains the mapping information for transmit PDO mapping 1.                           | Section 6.3.3 on page 27 |
| 0x1A01 | Transmit PDO mapping 2          | Contains the mapping information for transmit PDO mapping 2.                           | Section 6.3.3 on page 27 |
| 0x1A02 | Transmit PDO mapping 3          | Contains the mapping information for transmit PDO mapping 3.                           | Section 6.3.3 on page 27 |
| 0x1A05 | Transmit PDO mapping 6          | Contains the mapping information for transmit PDO mapping 6.                           | Section 6.3.3 on page 27 |
| 0x1A15 | Transmit PDO mapping 22         | Contains the mapping information for transmit PDO mapping 22.                          | Section 6.3.3 on page 27 |
| 0x1C00 | Sync manager communication type | This read-only object provides sync manager usage details.                             | Section 6.3.4 on page 30 |
| 0x1C10 | Sync manager 0 PDO assignment   | This read-only object contains information relating to the non-cyclic receive mailbox. | Section 6.3.4 on page 30 |
| 0x1C11 | Sync manager 1 PDO assignment   | This read-only object contains information relating to the non-cyclic send mailbox.    | Section 6.3.4 on page 30 |
| 0x1C12 | Sync manager 2 PDO assignment   | Contains the currently in use receive PDOs.  | Section 6.3.4 on page 30 |
| 0x1C13 | Sync manager 3 PDO assignment   | Contains the currently in use transmit PDOs.   | Section 6.3.4 on page 30 |
| 0x2802 | Feedback encoder source         | Specifies the source position for position controller feedback.                        | Section 6.3.5 on page 31 |
| 0x2803 | Homing source                   | Indicates the configured source of the homing switch used during the homing procedure. | Section 7.7.2 on page 63 |
| 0x2804 | Freeze object                   | Used to configure the freeze function that can be used within the Homing mode profile. | Section 7.7.2 on page 63 |
| 0x2813 | Network loss behavior object    | Used to configure the network loss trip behavior (watchdog).                           | Section 9.2.1 on page 75 |
| 0x2820 | Out cyclic data configuration   | The number of the last sub-index in this object  | Section 8.4 on page 72   |
| 0x2821 | In cyclic data configuration    | The number of the last sub-index in this object  | Section 8.18 on page 73  |

|                         |
|-------------------------|
| Safety information      |
| Introduction            |
| Mechanical installation |
| Electrical installation |
| Getting started         |
| Protocols               |
| Drive profile (DSP-402) |
| Advanced features       |
| Diagnostics             |
| <b>Quick reference</b>  |
| Glossary of terms       |
| Index                   |

| Object | Name                                | Description  | Cross reference           |
|--------|-------------------------------------|--|---------------------------|
| 0x2830 | Internal position feedback shortcut | This value is the <i>drive</i> feedback source. It consists of the coarse position in the most significant 16 bits and the fine position in the least significant 16 bits. It will then have a number of turns bits shifted into the most significant bits ("pushing" as many fine position bits as required out). This should not be read in the first 90µs after the RMINT edge, because data skew may result. | Section 8.18 on page 73   |
| 0x2831 | Internal torque shortcut            | This represents the drive internal torque shortcut scaled to 0.01% units.  | Section 8.19 on page 73   |
| 0x603F | Error code                          | Indicates the current drive error code.  | Section 9.8.2 on page 79  |
| 0x6040 | Controlword                         | Provides the primary method of controlling the behavior of the drive.  | Section 7.1 on page 36    |
| 0x6041 | Statusword                          | This provides feedback about the current operating state of the drive.   | Section 7.2 on page 37    |
| 0x6042 | vl_target_velocity                  | Used to set the required velocity of the system.   | Section 7.5.1 on page 50  |
| 0x6043 | vl_velocity demand                  | Provides the instantaneous velocity demand generated by the drive ramp function.   | Section 7.5.2 on page 50  |
| 0x6044 | vl_velocity_actual value            | Provides the velocity at the motor spindle or load.  | Section 7.5.3 on page 51  |
| 0x6046 | vl_velocity_min max_amount          | This object is used to configure the minimum and maximum velocity.   | Section 7.5.4 on page 51  |
| 0x6047 | vl_velocity_min max                 | This object is used to configure the minimum and maximum velocity.   | Section 7.5.5 on page 52  |
| 0x6048 | vl_velocity acceleration            | This object is used to configure the delta speed and delta time of the slope of the acceleration ramp.   | Section 7.5.6 on page 52  |
| 0x6049 | vl_velocity deceleration            | This object is used to configure the delta speed and delta time of the slope of the deceleration ramp.   | Section 7.5.7 on page 53  |
| 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.  | Section 7.5.8 on page 53  |
| 0x604B | vl_setpoint factor                  | This object is used to configure the numerator and denominator of the vl_setpoint_factor.  | Section 7.5.9 on page 54  |
| 0x604C | vl_dimension_factor                 | This object is used to configure the numerator and denominator of the vl_dimension_factor.   | Section 7.5.10 on page 54 |
| 0x605A | Quick_stop option_code              | Specifies what action is performed in the event of a quick stop function   | Section 7.3.2 on page 41  |
| 0x605B | Shutdown_option code                | Used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.  | Section 7.3.3 on page 42  |
| 0x605C | Disable operation_option code       | 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.  | Section 7.3.4 on page 42  |
| 0x605E | Fault_reaction option_code          | This object is used to control what action is performed when a fault is detected.  | Section 7.3.5 on page 42  |
| 0x6060 | Modes_of operation                  | This object is used to request a change in the mode of operation.  | Section 7.3.6 on page 43  |
| 0x6061 | Modes of operation display          | This read only object is used to provide the active mode of operation.   | Section 7.3.7 on page 43  |

| Object | Name                                  | Description  | Cross reference           |                                 |
|--------|---------------------------------------|--|---------------------------|---------------------------------|
| 0x6062 | Position_demand value                 | Used to provide the currently demanded position value.   | Section 7.3.15 on page 46 | Safety information              |
| 0x6064 | Position_actual value                 | This read only object provides the actual value of the position feedback device.   | Section 7.3.16 on page 47 | Introduction                    |
| 0x6071 | Target_torque                         | This object indicates the configured input value for the torque controller in profile torque mode.   | Section 7.6.1 on page 56  |                                 |
| 0x6075 | Motor_rated_current                   | This object indicates the motor rated current.   | Section 7.6.2 on page 56  | Mechanical installation         |
| 0x6077 | Torque_actual_value                   | This object provides the actual torque value   | Section 7.8.1 on page 66  |                                 |
| 0x6078 | Current_actual_value                  | This object provides the actual value of the current.  | Section 7.6.3 on page 57  | Electrical installation         |
| 0x607A | Target_position                       | Indicates the command positions that the drive should move to in cyclic sync position mode.  | Section 7.8.2 on page 66  |                                 |
| 0x607C | Home offset                           | this object indicates the configured difference between the zero position for the application and the machine home position (found during homing).                               | Section 7.57 on page 64   | Getting started                 |
| 0x6080 | Max motor speed                       | This object indicated the configured maximum allowed speed for the motor in either direction.  | Section 7.29 on page 47   |                                 |
| 0x6084 | Profile deceleration                  | Provides the deceleration ramp for the positioning modes   | Section 7.3.8 on page 43  | Protocols                       |
| 0x6085 | Quick_stop deceleration               | This object is used to configure the deceleration rate used to stop the motor when the quickstop function is activated and the quick stop code object (0x605A) is set to 2 or 6. | Section 7.3.8 on page 43  |                                 |
| 0x608F | Position_encoder resolution           | This read only object indicates the configured encoder increments per number of motor revolutions.   | Section 7.3.11 on page 45 | Drive profile (DSP-402) support |
| 0x6091 | Gear_ratio                            | This object is used to apply scaling.  | Section 7.3.12 on page 45 |                                 |
| 0x6092 | Feed_constant                         | This is used to configure a feed constant.   | Section 7.3.13 on page 46 | Advanced features               |
| 0x6098 | Homing Method                         | This object indicates the configured homing method that shall be used.   | Section 7.58 on page 64   |                                 |
| 0x6099 | Homing speeds                         | This object indicated the configured speeds used during the homing procedure.  | Section 7.60 on page 65   | Diagnostics                     |
| 0x609A | Homing acceleration                   | Indicates the configured acceleration and deceleration to be used during homing operation.   | Section 7.61 on page 65   |                                 |
| 0x60B1 | Velocity_offset                       | This object provides the value of the velocity offset.   | Section 7.8.3 on page 66  | Quick reference                 |
| 0x60F4 | Following_error actual_value          | This read only object provides the actual value of the following error.  | Section 7.3.18 on page 47 |                                 |
| 0x60FB | Position_control parameter_set object | Used to configure the positional control gains.  | Section 7.3.19 on page 47 | Glossary of terms               |
| 0x60C0 | Interpolation sub-mode_select         | Specifies the interpolation type.  | Section 7.4.1 on page 48  |                                 |
| 0x60C1 | Interpolation data_record             | This object is used to specify the target position.  | Section 7.4.2 on page 48  | Index                           |
| 0x60C2 | Interpolation time_period             | The number of time units between interpolator re-starts.   | Section 7.36 on page 49   |                                 |

**Table 10.2 Virtual parameter reference**

| Parameter | Default | Description   | Cross reference           |
|-----------|---------|---|---------------------------|
| Pr 61.01  | 0       | Parameter 1.00 shortcut                               | Section 8.3.1 on page 68  |
| Pr 61.03  | 1       | Drive synchronization control                         | Section 8.3.2 on page 69  |
| Pr 61.04  | 1       | Inter-option module synchronization control           | Section 8.3.3 on page 69  |
| Pr 61.05  | 0       | Inter-option clock synchronization control            | Section 8.3.4 on page 69  |
| Pr 61.07  | 0       | Option slot indicator                                 | Section 8.3.5 on page 70  |
| Pr 61.40  | 0       | Option hardware issue                                 | Section 8.3.6 on page 70  |
| Pr 61.42  | 0       | 500mS Task % free                                     | Section 8.3.7 on page 70  |
| Pr 61.43  | 0       | External memory % free                                | Section 8.3.8 on page 70  |
| Pr 61.44  | 0       | Internal memory % free                                | Section 8.3.9 on page 71  |
| Pr 61.49  | 0       | Option module error sub-code                          | Section 8.3.10 on page 71 |
| Pr 61.50  | 0       | Bootloader software version - major and minor (XX.YY) | Section 8.3.11 on page 71 |
| Pr 61.51  | 0       | Bootloader software version -subversion (ZZ)          | Section 8.3.12 on page 71 |

**Table 10.3 SM-EtherCAT parameter reference**

| Object   | Description                                    | Default | Range          | Cross reference          |
|----------|--|---------|----------------|--------------------------|
| Pr MM.01 | SM-EtherCAT module ID code                     | 421     | - - - -        | Section 9.1.1 on page 74 |
| Pr MM.02 | SM-EtherCAT firmware - major and minor version | N/A     | 00.00 to 99.99 | Section 9.1.2 on page 74 |
| Pr MM.03 | Node address                                   | 0       | 0 to 65535     | Section 5.4 on page 19   |
| Pr MM.04 | EtherCAT RUN                                   | 1       | 1 to 8         | Section 5.5 on page 19   |
| Pr MM.06 | SM-EtherCAT operating status                   | N/A     | -9999 to 9999  | Section 9.3 on page 76   |
| Pr MM.10 | EoE - IP address $W_{ip}$                      | 0       | 0 to 255       | Section 6.23 on page 32  |
| Pr MM.11 | EoE - IP address $X_{ip}$                      |         |                | Section 6.24 on page 32  |
| Pr MM.12 | EoE - IP address $Y_{ip}$                      |         |                | Section 6.25 on page 32  |
| Pr MM.13 | EoE - IP address $Z_{ip}$                      |         |                | Section 6.26 on page 33  |
| Pr MM.14 | EoE - Subnet mask $W_{subnet}$                 |         |                | Section 6.27 on page 33  |
| Pr MM.15 | EoE - Subnet mask $X_{subnet}$                 |         |                | Section 6.28 on page 33  |
| Pr MM.16 | EoE - Subnet mask $Y_{subnet}$                 |         |                | Section 6.29 on page 33  |
| Pr MM.17 | EoE - Subnet mask $Z_{subnet}$                 |         |                | Section 6.30 on page 34  |
| Pr MM.18 | EoE - Default gateway $W_{gateway}$            |         |                | Section 6.31 on page 34  |
| Pr MM.19 | EoE - Default gateway $X_{gateway}$            |         |                | Section 6.32 on page 34  |
| Pr MM.20 | EoE - Default gateway $Y_{gateway}$            |         |                | Section 6.33 on page 34  |
| Pr MM.21 | EoE - Default gateway $Z_{gateway}$            |         |                | Section 6.34 on page 35  |
| Pr MM.32 | SM-EtherCAT re-initialize                      |         |                | 0 (OFF)                  |
| Pr MM.35 | SM-EtherCAT serial number                      | N/A     | 0 to 16777215  | Section 9.6 on page 77   |
| Pr MM.37 | Reduce Drive serial interface priority         | OFF     | OFF - ON       | Section 6.35 on page 35  |
| Pr MM.44 | SM-EtherCAT module temperature                 | N/A     | 0 to 255       | Section 9.5 on page 77   |
| Pr MM.46 | Critical task % free                           | N/A     | 0 to 100       | Section 9.14 on page 78  |
| Pr MM.47 | Worst case critical task % free                | N/A     | 0 to 100       | Section 9.19 on page 80  |
| Pr MM.48 | Flash file system % free                       | N/A     | 0 to 100       | Section 9.11 on page 81  |
| Pr MM.50 | SM-EtherCAT error code                         | N/A     | 0 to 255       | Section 9.7 on page 77   |
| Pr MM.51 | SM-EtherCAT firmware - subversion              | N/A     | 0 to 99        | Section 9.1.2 on page 74 |

# 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.

**Earthing / Grounding:** 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*.

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Advanced features               |
| Diagnostics                     |
| Quick reference                 |
| <b>Glossary of terms</b>        |
| Index                           |

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

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

**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.



# Index

|                                 |    |
|---------------------------------|----|
| <b>A</b>                        |    |
| Address .....                   | 87 |
| <b>B</b>                        |    |
| Bit .....                       | 87 |
| Byte .....                      | 87 |
| <b>C</b>                        |    |
| Compliance .....                | 6  |
| Control word .....              | 87 |
| Cyclic data .....               | 87 |
| Cyclic sync position mode ..... | 65 |
| <b>D</b>                        |    |
| Data rate .....                 | 87 |
| Device .....                    | 87 |
| Diagnostics .....               | 74 |
| Domain .....                    | 87 |
| <b>E</b>                        |    |
| Earthing / grounding .....      | 87 |
| Electrical installation .....   | 12 |
| Electrical safety .....         | 5  |
| Environmental limits .....      | 6  |
| Error handling .....            | 78 |
| <b>F</b>                        |    |
| Functional blocks .....         | 21 |
| <b>G</b>                        |    |
| Getting started .....           | 14 |
| Glossary of terms .....         | 87 |
| Grounding .....                 | 13 |
| <b>H</b>                        |    |
| Homing mode .....               | 57 |
| <b>I</b>                        |    |
| Index .....                     | 89 |
| Installation .....              | 11 |
| Introduction .....              | 8  |
| <b>L</b>                        |    |
| Long word .....                 | 87 |
| LSB .....                       | 87 |
| <b>M</b>                        |    |
| Mechanical installation .....   | 11 |
| MSB .....                       | 87 |
| <b>N</b>                        |    |
| Node .....                      | 87 |

|                                 |
|---------------------------------|
| Safety information              |
| Introduction                    |
| Mechanical installation         |
| Electrical installation         |
| Getting started                 |
| Protocols                       |
| Drive profile (DSP-402) support |
| Diagnostics                     |
| Advanced features               |
| Quick reference                 |
| Glossary of terms               |
| <b>Index</b>                    |

|                                      |    |
|--------------------------------------|----|
| Non cyclic data .....                | 87 |
| <b>O</b>                             |    |
| Octet .....                          | 87 |
| <b>P</b>                             |    |
| Parameters - adjusting .....         | 7  |
| PC .....                             | 87 |
| PLC .....                            | 87 |
| Poll rate .....                      | 87 |
| Profile torque mode .....            | 56 |
| <b>Q</b>                             |    |
| Quick Reference .....                | 83 |
| Quick start guide .....              | 14 |
| <b>S</b>                             |    |
| Safety information .....             | 5  |
| Safety of personnel .....            | 5  |
| Saving parameters .....              | 19 |
| SECURE DISABLE .....                 | 5  |
| Solution module identification ..... | 9  |
| Status word .....                    | 88 |
| <b>V</b>                             |    |
| vi velocity mode .....               | 50 |
| <b>W</b>                             |    |
| Word .....                           | 88 |





---

## SCIGATE AUTOMATION (S) PTE LTD

No.1 Bukit Batok Street 22 #01-01 Singapore 659592

Tel: (65) 6561 0488

Fax: (65) 6562 0588

Email: [sales@scigate.com.sg](mailto:sales@scigate.com.sg)

Web: [www.scigate.com.sg](http://www.scigate.com.sg)

Business Hours: Monday - Friday 8.30am - 6.15pm



**0471-0128-05**