User Guide

SI-EtherCAT

Part Number: 0478-0152-05 Issue 5

Compliance Information

Manufacturer: Nidec Control Techniques Limited ("we", "our")
Registered office: The Gro, Newtown, Powys, SY16 3BE United Kingdom
Registered in: England and Wales, company registration number 01236886
Manufacturer's EU Authorised Representative: Nidec Netherlands B.V., Kubus 155, 3364 DG Sliedrecht, the Netherlands, registered at the Dutch Trade Register under number 33213151; Tel. +31 (0)184 420 555, info.nl@mail.nidec.com

Original instructions

With reference to the UK Supply of Machinery (Safety) Regulations 2008 and the EU Machinery Directive 2006/42/EC, the English version of this Manual constitutes the original instructions. Manuals published in other languages are translations of the original instructions and the English language version of this Manual prevails over any other language version in the event of inconsistency.

Documentation and user software tools

Manuals, datasheets and software that we make available to users of our products can be downloaded from: **http://www.controltechniques.com/support.**
Manuals may be accompanied by an Errata list. This will be located alongside the manuals if applicable.

Warranty and liability

The contents of this Manual are presented for information purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs, specifications or performance of our products at any time without notice. For full details of the warranty terms applicable to the product, contact the supplier of the product.

In no event and under no circumstances shall we be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings for the product, nor shall we be liable for consequential and incidental damages of any kind.

Environmental management

We operate an Environmental Management System which complies with the requirements of ISO 14001:2015. Further information on our Environmental Statement can be found at: **http://www.controltechniques.com/environment**.

Restriction and control of hazardous substances

The products covered by this Manual comply with the following legislation and regulations on the restriction and control of hazardous substances:

UK Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
UK REACH etc. (Amendment etc.) (EU Exit) Regulations 2020, European Union REACH Regulation EC 1907/2006
EU restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) - Directive 2011/65/EU
EC Regulation 1907/2006 on the Registration, Evaluation, authorisation, and restriction of Chemicals (REACH)
Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products 2016/07/01
U.S. Environmental Protection Agency ("EPA") regulations under the Toxic Substances Control Act ("TSCA")
MEPC 68/21 / Add.1, Annex 17, Resolution MEPC.269(68) 2015 Guidelines for the development of the inventory of hazardous materials

The products covered by this Manual do not contain asbestos.

Further information on REACH and RoHS can be found at: **http://www.controltechniques.com/environment**.

Conflict minerals

With reference to the Conflict Minerals (Compliance) (Northern Ireland) (EU Exit) Regulations 2020, the U.S. Dodd-Frank Wall Street Reform and Consumer Protection Act and Regulation (EU) 2017/821 of the European Parliament and of the European Council:

We have implemented due diligence measures for responsible sourcing, we conduct conflict minerals surveys of relevant suppliers, we continually review due diligence information received from suppliers against company expectations and our review process includes corrective action management. We are not required to file an annual conflict minerals disclosure. Nidec Control Techniques Limited is not an issuer as defined by the U.S. SEC.

Disposal and recycling (WEEE)

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

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

CONTROL TECHNIQUES

Contents

1 Safety information

1.1 Warnings, Cautions and Notes

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

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

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

1.2 Installation and use

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

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

WARNING - This warning applies to products intended to be used with variable speed drives.
The adjustable speed drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant which can cause injury. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction.
System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and the instruction manual carefully.
Failure to observe the following instructions can cause physical injury or death, or damage to the equipment.

1.3 Enclosure

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

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

1.4 Competence of the installer

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

1.5 Repairs

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

1.6 Electric Shock and Fire Hazards

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

1.6.1 AC supply

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

1.6.2 Live terminals

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

1.6.3 Isolation device

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

1.6.4 Stored charge

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

1.7 Electrical installation

1.7.1 Protective Ground (Earth) connection

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

1.7.2 Fuses

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

1.7.3 Cables

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

1.7.4 Terminal connections and torque settings

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

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

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

1.7.5 High voltage insulation (flash) testing

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

1.7.6 ELV terminals

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

1.7.7 SELV terminals

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

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

1.7.8 Products connected by plug and socket

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

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

1.8 Setting up, commissioning and maintenance

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

1.8.1 Lifting and handling

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

1.8.2 Output circuit and motor protection

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

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

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

Automatic start

Some parameter settings may cause the motor to start unexpectedly.

Restore default parameter set

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

1.9 Safety of machinery, safety-critical applications

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

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

1.10 Electromagnetic compatibility (EMC)

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

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

1.11 Copyright

2 Introduction

2.1 Products covered by this User Guide

This User Guide covers the SI-EtherCAT option module.

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

- Unidrive M200 / M201
- Commander C200/C300
- Unidrive M300
- Unidrive M400
- Unidrive M60x/M70x/M88x/HS7x
- Digitax HD

2.2 Firmware Statement

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

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

2.3 What is EtherCAT?

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

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

2.4 About SI-EtherCAT

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

2.5 Features

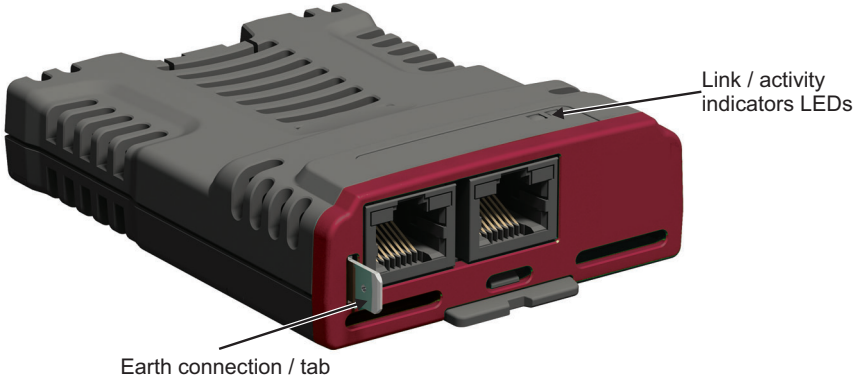
- Standard RJ45 with support for shielded twisted pair, half-duplex / full-duplex and 10 Mbs / 100 Mbs connectivity
- Dual 100 Mbps EtherCAT interfaces for use in line topologies i.e. daisy chaining
- Supports the Unidrive M drives range
- Control loop synchronisation
- Control cycle times down to 250 µs
- Configured explicit ID (EtherCAT Device ID)
- Ethernet over EtherCAT (EoE)

- File transfer over EtherCAT (FoE)
- CANopen over EtherCAT (CoE) which includes:
  - Support of CANopen CiA402
  - Cyclic sync position mode
  - Interpolated position mode
  - Velocity mode
  - Homing mode
  - One transmit and one receive PDOs via cyclic synchronous communication
  - Additional one transmit and one receive PDOs via non-synchronised cyclic communication
  - SDO access to all profile objects and drive parameters
  - Cyclic sync velocity mode
  - Cyclic sync torque mode
  - Profile Position mode
- Functional Safety over EtherCAT (FSoE)

NOTE For more details on implementing an FSoE network with the MiS210 and MiS250 safety modules, please refer to MiS210 and MiS250 Safety Modules Installation and Operating Manual (Part Number:0478-0665-03)

2.6 Option module identification

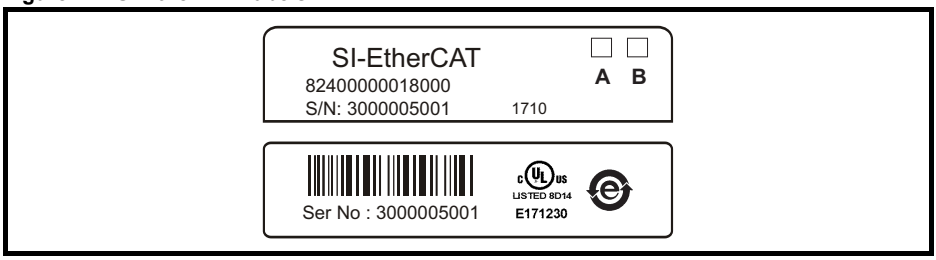
Figure 2-1 SI-EtherCAT



The SI-EtherCAT can be identified by:

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

Figure 2-2 SI-EtherCAT labels



2.6.1 Date code format

Before January 2017
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 option module was built.

The letters are in alphabetical order, starting with A in 1990 (B in 1991, C in 1992 etc.).

Example:
A date code of R15 would correspond to week 15 of year 2008.

From January 2017
The date code consists of four digits in the format 'yyww', the first two digits (yy) represent the year of manufacture and the last two digits (ww) represent the calendar full week number within the year.

Example:
A date code of 1715 would correspond to week 15 of year 2017.

2.7 Conventions used in this guide

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

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

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

NOTE For M200, M400 and Commander C200/C300 drives, the option module set-up parameters will appear in menu 15.

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

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

3 Mechanical installation

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

3.1 General installation

For information on the installation of the SI-EtherCAT option module please refer to the installation sheet provided with the option module.

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

4 Electrical installation

4.1 SI-EtherCAT module information

4.1.1 Bus media

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

4.1.2 Cabling considerations

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

4.1.3 Cable

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

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

4.1.4 Maximum network length

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

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

4.2 SI-EtherCAT terminal descriptions

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

Figure 4-1 SI-EtherCAT connections

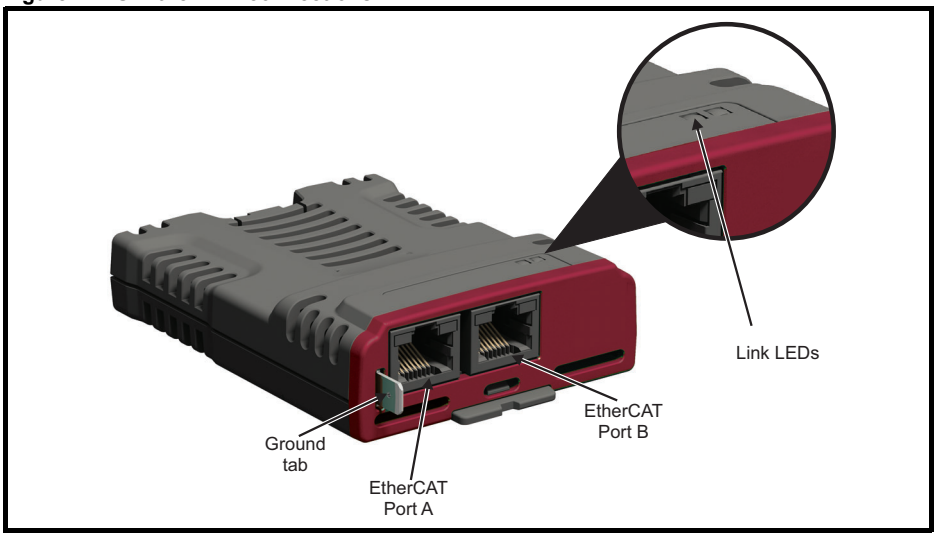


Table 4-1 EtherCAT terminal descriptions

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

4.3 Module grounding and EMC

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

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

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

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

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

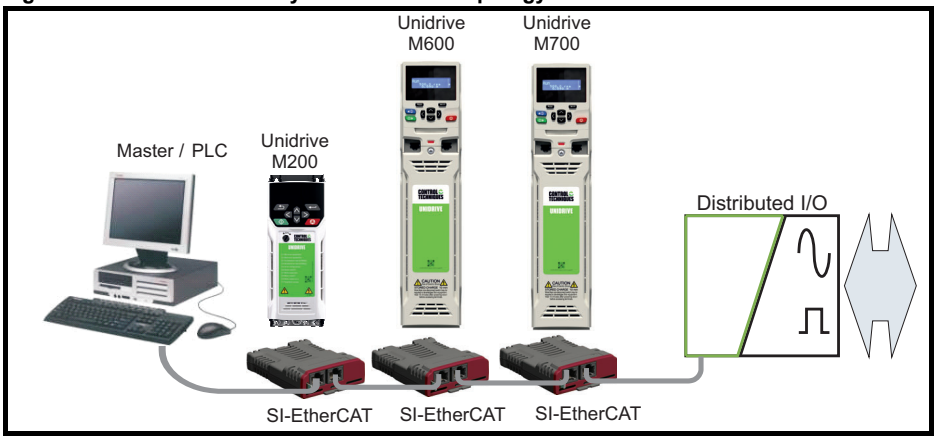
Please note EMC Ferrite inductors of the required specification are available from the following supplier:

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

4.4 Network topology

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

Figure 4-2 SI-EtherCAT daisy chain network topology



4.5 Minimum node-to-node cable length

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

5 Getting started

5.1 Quick start guide

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

Table 5-1 PDO test mappings

	RxPDO1	TxPDO1
Mapping 1	0x6040 (*controlword*) (16-bits)	0x6041 (*statusword*) (16-bits)
Mapping 2	0x6042 (*vl_target_velocity*) (16-bits)	0x6064 (*position_actual_value*) (32-bits)
Mapping 3	Pr **20.021** (32-bits)	N/A

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

Due to the large number of different masters that support CoE, details cannot be provided for a specific master. Generic support is available through your supplier or local Control Techniques Drive Centre. Before contacting your supplier or local Control Techniques Drive Centre for support please ensure you have read *section 10 Diagnostics* on page 153 of this manual and have checked that the SDO/PDO configurations are correct.

5.1.1 SI-EtherCAT ESI file

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

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

5.1.2 Configuring the SI-EtherCAT module for cyclic communications

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

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

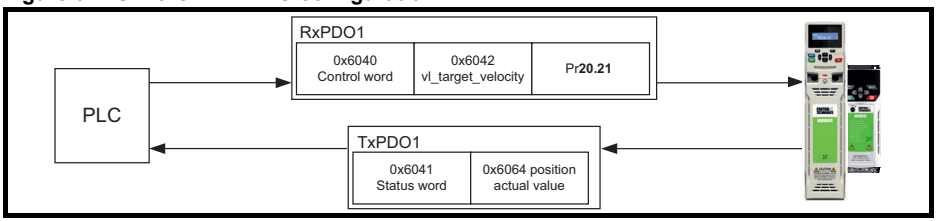
In the master, scan the network ensuring that the SI-EtherCAT module is connected correctly to the master. If the network is configured correctly the SI-EtherCAT node(s) should be visible in the PLC master.

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

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

These PDOs contain the cyclic data (objects and/or parameters), the RxPDOs available are 1, 2, 3, 5 and 6, the TxPDOs available are 1, 2, 3, 5 and 6 (for more information on these PDOs including default mappings please see section 6.3.2 *RxPDO mappings* on page 34 and section 6.3.3 *TxPDO mappings* on page 39).

Figure 5-1 SI-EtherCAT PDO configuration



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

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

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

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

- Index: 0x2000 + (0x100 x S) + 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 **20.021** would be index 0x2014, sub-index 0x15 and the size would be 4 (the parameter is a 32-bit signed value).

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

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

Table 5-2 Cyclic data mapping configuration

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

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

NOTE For M200 to M400 and Commander C200/C300 the maximum update time achievable is 4 ms.

5.1.3 Configuring the sync managers

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

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

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

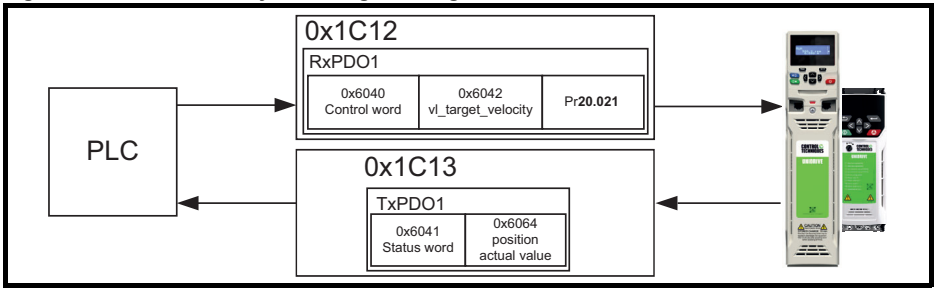
NOTE The maximum number of mappings in one PDO is twelve. There are no restrictions on the data length of these parameters (i.e. It is possible to map twelve 32-bit parameters in one PDO).

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

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

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

Figure 5-2 SI-EtherCAT sync manager configuration



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

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

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

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

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

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

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

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

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

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

Configuring sync manager 4 and sync manager 5

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

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

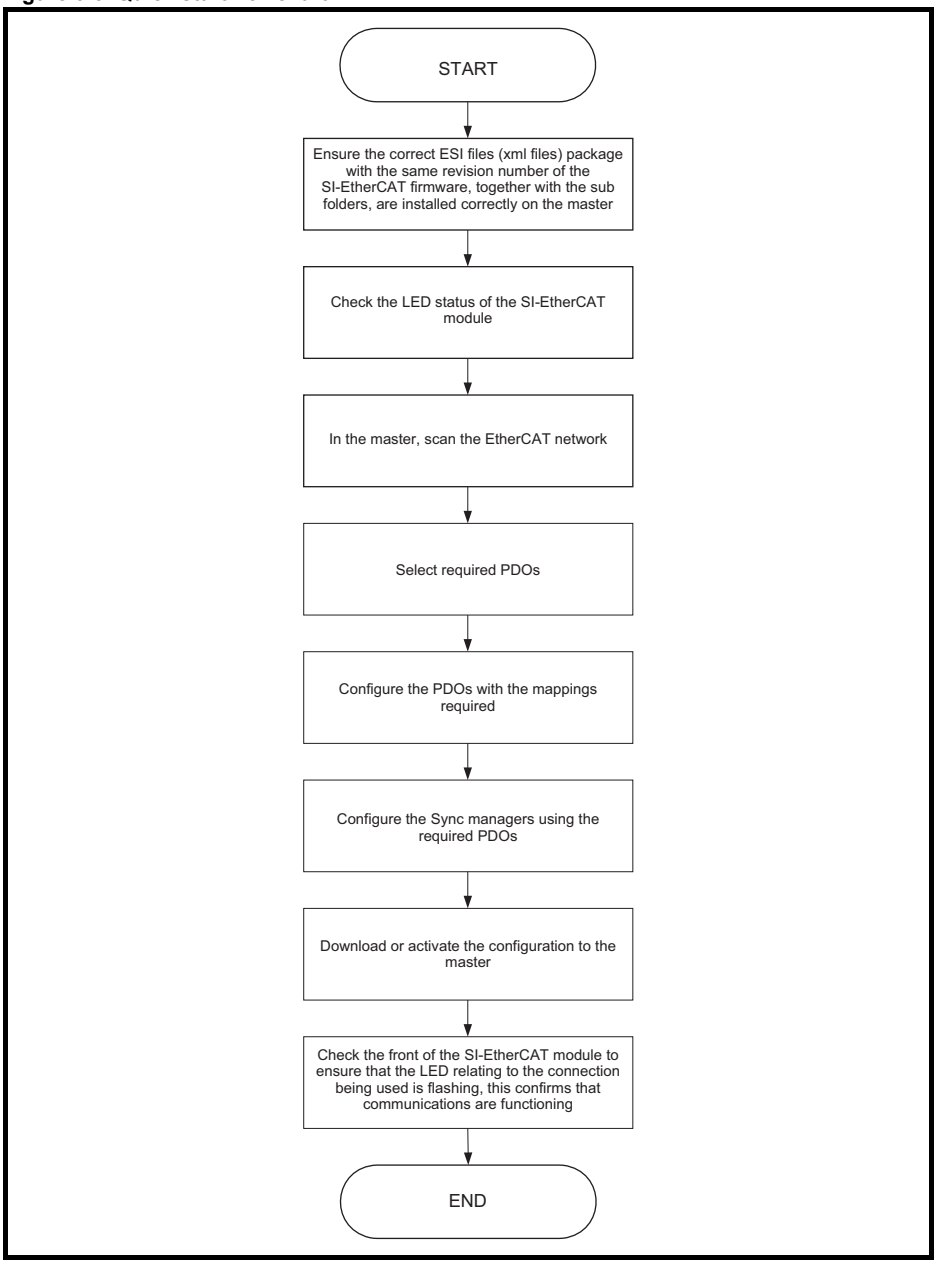
Download the configuration to the master.
After downloading the configuration to the master the LED(s) on the front of the SI-EtherCAT should flash, depending on the port(s) connected.

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

5.2 Quick start flowchart

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

Figure 5-3 Quick start flowchart



5.3 Supported objects

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

Table 5-3 SI-EtherCAT Object Dictionary

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
1000	Device type	0	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
1001	Error register	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
1003	Error history (Number of last-sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Error history records	1 to N	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
1008	Manufacture device name	0	String	RO	Y	Y	Y	Y	Y	Y	Y
1009	Manufacture hardware version	0	String	RO	Y	Y	Y	Y	Y	Y	Y
100A	Manufacture software version	0	String	RO	Y	Y	Y	Y	Y	Y	Y
1018	Identity object (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Identity object (Vendor ID)	1	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
	Identity object (Product Code)	2	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
	Identity object (Software Version)	3	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
	(Reserved)	4	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
10F1	Error settings (number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Local error reaction	1	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync error counter limit	2	UINT	RO	Y	Y	Y	Y	Y	Y	Y
1600	Receive PDO mapping 1 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 1 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1601	Receive PDO mapping 2 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 2 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1602	Receive PDO mapping 3 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 3 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1604	Receive PDO mapping 5 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 5 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1605	Receive PDO mapping 6 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 6 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1607	Receive PDO mapping 8 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 8 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
1609	Receive PDO mapping 10 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 10 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A00	Transmit PDO mapping 1 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 1 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A01	Transmit PDO mapping 2 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 2 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A02	Transmit PDO mapping 3 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 3 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A04	Transmit PDO mapping 5 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 5 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A05	Transmit PDO mapping 6 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 6 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A07	Transmit PDO mapping 8 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 8 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1A09	Transmit PDO mapping 10 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 10 (Mapped object *1 to si0*)	*1 to si0*	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
1C00	Sync manager communication type (Number of SM protocols)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM0 Usage)	1	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM1 Usage)	2	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM2 Usage)	3	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM3 Usage)	4	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM4 Usage)	5	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM5 Usage)	6	USINT	RO	Y	Y	Y	Y	Y	Y	Y
1C10	SM0 PDO assignment (Number of PDOs)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
1C12	SM2 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	SM2 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y	Y
1C13	SM3 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	SM3 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y	Y
1C14	SM4 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	SM4 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y	Y
1C15	SM5 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	SM5 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y	Y
1C32	Sync Manager 2 Synchronisation (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync Manager 2 synchronisation configuration	1 to 12	[var]	[var]	Y	Y	Y	Y	Y	Y	Y
1C33	Sync Manager 3 Synchronisation (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync Manager 3 synchronisation configuration	1 to 12	[var]	[var]	Y	Y	Y	Y	Y	Y	Y
1C34	Sync Manager 4 Synchronisation (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync Manager 4 synchronisation configuration	1 to 4	[var]	[var]	Y	Y	Y	Y	Y	Y	Y
1C35	Sync Manager 5 Synchronization (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Sync Manager 5 synchronisation confirguration	1 to 4	[var]	[var]	Y	Y	Y	Y	Y	Y	Y
2smm	Drive parameter access (s = slot 0x0 to 0xF, mm=menu 0x00 to 0xFF)	pp (pp=par 0x00 to 0xFF)	[var]	RW	Y	Y	Y	Y	Y	Y	Y
3000	Position feedback encoder configuration	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
3003	Homing source (Number of last sub-index)	0	USINT	RO	N	N	Y	N	N	N	N
	Homing source (Homing switch source)	1	USINT	RW	N	N	Y	N	N	N	N
	Homing source (Freeze/marker source)	2	USINT	RW	N	N	Y	N	N	N	N
3004	Additional position loop scaling (Number of last sub-index)	0	USINT	RO	N	Y	Y	Y	Y	Y	Y
	Additional position loop scaling (Numerator)	1	DINT	RW	N	Y	Y	Y	Y	Y	Y
	Additional position loop scaling (Denominator)	2	DINT	RW	N	Y	Y	Y	Y	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
3005	Cyclic data loss behaviour (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Cyclic data loss behaviour (Timeout (ms))	1	UINT	RW	Y	Y	Y	Y	Y	Y	Y
	Cyclic data loss behaviour (Timeout (ms))	2	UINT	RW	Y	Y	Y	Y	Y	Y	Y
	Cyclic Loss counter	3	INT	RO	Y	Y	Y	Y	Y	Y	Y
	PDO loss re-arm delay	4	UINT	RW	Y	Y	Y	Y	Y	Y	Y
	Max Weighted Internal SM event missed counter	5	UINT	RW	Y	Y	Y	Y	Y	Y	Y
	Reserved	6	N/A	RO	Y	Y	Y	Y	Y	Y	Y
	Max PDO loss duration	7	UINT	RO	Y	Y	Y	Y	Y	Y	Y
	Too many PDO counter	8	UINT	RO	Y	Y	Y	Y	Y	Y	Y
3006	Out cyclic data configuration (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Out cyclic data configuration (Copy to drive task)	1	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	Reserved	2	N/A	RW	Y	Y	Y	Y	Y	Y	Y
3007	In cyclic data configuration (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	In cyclic data configuration (Copy from drive task)	1	USINT	RW	Y	Y	Y	Y	Y	Y	Y
	In cyclic data configuration (Copy to master task)	2	USINT	RW	Y	Y	Y	Y	Y	Y	Y
3008	Activate velocity mode redirection	0	USINT	RW	Y	N	N	Y	N	N	N
3009	Enhanced loop control	0	USINT	RW	N	Y	Y	N	N	Y	Y
300A	Window filter size	0	USINT	RW	N	Y	Y	Y	Y	Y	Y
6007	Abort connection option code	0	INT	RW	Y	Y	Y	Y	Y	Y	Y
603F	Error code	0	UINT	RO	Y	Y	Y	Y	Y	Y	Y
6040	Control word	0	UINT	WO	Y	Y	Y	Y	Y	Y	Y
6041	Status word	0	UINT	RO	Y	Y	Y	Y	Y	Y	Y
6042	vl_target_velocity	0	INT	RW	Y	N	N	N	N	N	N
6043	vl_velocity_demand	0	INT	RO	Y	N	N	N	N	N	N
6044	vl_velocity_actual_value	0	INT	RO	Y	N	N	N	N	N	N

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
6046	vl_velocity_min_max_ amount (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_velocity_min_max_ amount (Minimum velocity (rpm))	1	UDINT	RW	Y	N	N	N	N	N	N
	vl_velocity_min_max_ amount (Maximum velocity (rpm))	2	UDINT	RW	Y	N	N	N	N	N	N
6048	vl_velocity_acceleration (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_velocity_acceleration (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N	N
	vl_velocity_acceleration (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N	N
6049	vl_velocity_deceleration (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_velocity_deceleration (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N	N
	vl_velocity_deceleration (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N	N
604A	vl_velocity_quick_stop (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_velocity_ quick_stop (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N	N
	vl_velocity_ quick_stop (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N	N
604B	vl_setpoint_factor (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_setpoint_factor (Numerator)	1	INT	RW	Y	N	N	N	N	N	N
	vl_setpoint_factor (Denominator)	2	INT	RW	Y	N	N	N	N	N	N
604C	vl_dimension_factor (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N	N
	vl_dimension_factor (Numerator)	1	INT	RW	Y	N	N	N	N	N	N
	vl_dimension_factor (Denominator)	2	INT	RW	Y	N	N	N	N	N	N
605A	Quick stop option code	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
605B	Shutdown option code	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
605C	Disable operation option code	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
605D	Halt option code	0	INT	RW	Y	Y	Y	Y	Y	Y	Y
605E	Fault reaction option code	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
6060	Modes of operation	0	USINT	RW	Y	Y	Y	Y	Y	Y	Y
6061	Modes of operation display	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
6062	Position demand value	0	DINT	RO	Y	Y	Y	Y	Y	Y	Y
6064	Position actual value	0	DINT	RO	Y	Y	Y	Y	Y	Y	Y
6065	Following error window	0	UDINT	RW	N	Y	N	N	N	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
6067	Position window	0	UDINT	RW	N	Y	N	N	N	Y	Y
6068	Position window time	0	UINT	RW	N	N	N	N	N	N	Y
606B	Velocity demand value	0	DINT	RO	N	N	N	N	N	N	Y
606C	Velocity actual value	0	DINT	RO	Y	Y	Y	Y	Y	Y	Y
6071	Target torque	0	INT	RW	N	N	N	N	Y	N	N
6073	Max current	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
6075	Motor rated current	0	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
6076	Motor rated torque	0	INT	RW	Y	Y	Y	Y	Y	Y	Y
6077	Torque actual value	0	INT	RO	Y	Y	Y	Y	Y	Y	Y
6078	Current actual value	0	INT	RO	Y	Y	Y	Y	Y	Y	Y
607A	Target position	0	DINT	RW	N	N	N	N	N	Y	Y
607B	Position range limit (Number of last sub-index)	0	USINT	RO	N	N	N	N	N	N	Y
	Min position range limit	1	DINT	RW	N	N	N	N	N	N	Y
	Max position range limit	2	DINT	RW	N	N	N	N	N	N	Y
607C	Home offset	0	DINT	RW	N	N	Y	N	N	N	N
607D	Software position limit (Number of last sub-index)	0	USINT	RO	N	N	N	N	N	N	Y
	Min position range limit	1	DINT	RW	N	N	N	N	N	N	Y
	Max position range limit	2	DINT	RW	N	N	N	N	N	N	Y
6080	Max motor speed	0	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
6081	Profile Velocity	0	UDINT	RW	N	N	N	N	N	N	Y
6083	Profile acceleration	0	UDINT	RW	N	N	N	N	N	N	Y
6084	Profile deceleration	0	UDINT	RW	N	Y	Y	Y	Y	Y	Y
6085	Quick stop deceleration	0	UDINT	RW	N	Y	Y	Y	Y	Y	Y
6086	Motion profile type	0	INT	RW	N	N	N	N	N	Y	Y
608F	Position encoder resolution (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Position encoder resolution (Encoder increments)	1	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
	Position encoder resolution (Motor revolutions)	2	UDINT	RO	Y	Y	Y	Y	Y	Y	Y
6091	Gear ratio (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Gear ratio (Motor revolutions)	1	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
	Gear ratio (Shaft revolutions)	2	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
6092	Feed constant (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y	Y
	Feed constant (Feed value)	1	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
	Feed constant (Shaft revolutions)	2	UDINT	RW	Y	Y	Y	Y	Y	Y	Y
6098	Homing method	0	USINT	RW	N	N	Y	N	N	N	N

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated Position	Homing	Cyclic Sync Velocity	Cyclic Sync Torque	Cyclic Sync Position	Profile Position
6099	Homing speeds (Number of last sub-index)	0	USINT	RO	N	N	Y	N	N	N	N
	Homing speeds (Speed during switch search)	1	UDINT	RW	N	N	Y	N	N	N	N
	Homing speeds (Speed during zero point search)	2	UDINT	RW	N	N	Y	N	N	N	N
609A	Homing acceleration	0	UDINT	RW	N	N	Y	N	N	N	N
60A4	Profile jerk (Number of last sub index)	0	USINT	RO	N	N	N	N	N	N	Y
	Profile jerk	1	DINT	RW	N	N	N	N	N	N	Y
60B1	Velocity offset	0	DINT	RW	N	N	N	Y	N	N	N
60B2	Torque offset	0	INT	RW	N	N	N	Y	Y	Y	Y
60B8	Touch probe function	0	UINT	RW	Y	Y	Y	Y	Y	Y	Y
60B9	Touch probe status	0	UINT	RO	Y	Y	Y	Y	Y	Y	Y
60BA	Touch Probe 1 positive edge	0	DINT	RO	Y	Y	Y	Y	Y	Y	Y
60BB	Touch Probe 1 negative edge	0	DINT	RO	Y	Y	Y	Y	Y	Y	Y
60C0	Interpolation sub-mode select	0	INT	RW	N	Y	N	Y	Y	Y	Y
60C1	Interpolation data record (Number of last sub-index)	0	USINT	RO	N	Y	N	N	N	N	N
	Interpolation data record (Target position)	1	UDINT	RW	N	Y	N	N	N	N	N
60C2	Interpolation time period (Number of last sub-index)	0	USINT	RO	N	Y	N	Y	Y	Y	Y
	Interpolation time period (Number of time periods)	1	USINT	RW	N	Y	N	Y	Y	Y	Y
	Interpolation time period (Time period exponent)	2	SINT	RW	N	Y	N	Y	Y	Y	Y
60C5	Max Acceleration	0	DINT	RW	N	N	N	N	N	N	Y
60C6	Max Deceleration	0	DINT	RW	N	N	N	N	N	N	Y
60DO	Touch probe source (Number of last sub-index)	0	USINT	RO	Y	Y	N	Y	Y	Y	Y
	Touch probe 1 source (Target position)	1	UINT	RW	Y	N	Y	Y	Y	Y	Y
60F2	Positioning option code	0	UINT	RW	N	N	N	N	N	N	Y
60F4	Following error actual value	0	DINT	RO	N	Y	N	N	N	Y	Y
60FA	Control effect	0	DINT	RW	N	N	N	N	N	N	Y
60FB	Position control parameter set (Number of last sub-index)	0	USINT	RO	N	Y	N	Y	Y	Y	Y
	Position control parameter set (Proportional gain)	1	DINT	RO	N	Y	N	Y	Y	Y	Y
	Position control parameter set (Speed feed forward gain)	2	DINT	RO	N	Y	N	Y	Y	Y	Y
60FF	Target velocity	0	DINT	RW	N	N	N	Y	N	N	N
6502	Supported drive modes	0	UDINT	RO	Y	Y	Y	Y	Y	Y	Y

Please refer to the *SI-EtherCAT* Parameter Guide integrated in Connect which contains an *EtherCAT* Object Reference Guide with detailed information of all the supported objects.

6 Protocols

6.1 Process Data Objects (PDOs)

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

6.2 Service Data Object (SDO) parameter access

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

Index: 0x2000 + (0x100 x S) + menu number

Sub-index: 0x00 + parameter number

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

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

Bit parameter mapping

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

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

Table 6-1 Drive bit parameter value

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

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

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

NOTE The following SDO services are supported:

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

6.3 CANopen over EtherCAT (CoE)

The CoE protocol over EtherCAT uses a modified form of the CANopen object dictionary. This is specified in Table 6-2.

Table 6-2 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 6-3.

Table 6-3 Object description format

<index>	**<object name>**		
Sub-index 0			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how often>	
Description: <description>			

For entries having sub-indices

Table 6-4 Object description format with sub-indices

<index>	**<object name>**		
Sub-index 0			
Access: <access>	Range: <range>	Size: <size>	Unit: <N/A>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how often>	
Description: <description>			
Sub-index 1			
Access: <access>	Range: <range>	Size: <size>	Unit: <N/A>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how often>	
Description: <description>			
Sub-index …			
Access: <access>	Range: <range>	Size: <size>	Unit: <N/A>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how often>	
Description: <description>			
Sub-index n-1			
Access: <access>	Range: <range>	Size: <size>	Unit: <N/A>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how oftene>	
Description: <description>			

<index>	<object name>		
Sub-index n			
Access: <access>	Range: <range>	Size: <size>	Unit: <N/A>
Default: <default>		Type: <Data Type>	
PDO mappable:<All/Rx/Tx/No>		Update Rate: <when and how often>	
Description: <description>			

Definitions:

- <index>: A 16-bit unsigned number. This is the index of the object dictionary entry. Specified in 4 hexadecimal digits.
- <access>: A value describing how the object may be accessed (RW = read-write, RO = read-only, WO = write-only). Some objects become read only when the Network State reaches OP
- <size>: The size of the object / sub-index in bytes.
- <unit>: The physical unit (e.g. microseconds, counts per second).
- <type>: How the data is interpreted, and then the actual type defined in the ESI

Table 6-5 Data type definitions

Data type	Description
Bit Mask	A group of values where each bit (or group of bits) defines a value. Further details will be provided in the description.
Unsigned integer	A value from 0 to $2^{(8*size)}$-1. For example a size of 1 would have the range 0 to 255.
Signed integer	2's compliment, a value from $-2^{(8*size-1)}$ to $2^{(8*size-1)}$-1. For example, a size of 1 would have the range -128 to 127.
String	A series of bytes where each byte represents a character encoded using ASCII.

Sub-indices are always an 8-bit unsigned decimal; they are usually expressed as decimal, rather than hexadecimal.

When bits and bytes are numbered, bit 0 or byte 0 is the least-significant bit or byte.

Power on reset and Start-up lists

In general, Object values are volatile and therefore not saved across a module power cycle.

When objects are linked directly or indirectly to parameters, if the underlying parameter value has been saved and a power cycle performed, the initial object value will reflect that new parameter value. For example. 0x6075 Motor rated Current is linked to parameter 05.007. At power up, object 0x6075 will contain the value derived from parameter 05.007. To initialise the values of objects, Start-up lists can be used to list object values to be applied during the different network transitions from INIT to PRE-OP to SAFE-OP to OP. Care has to be taken to ensure the order of the objects is correct. That is, the fundamental unit scaling, motor and encoder configuration should be done first. This is because some of the object / parameter relationships rely on the unit scaling to be known and those scaling values themselves can be based on motor or encoder configuration, etc. For example, setting 0x6048 results in a write to parameter 02.011. The conversion from object 0x6048 value to parameter 02.011 value, uses values read from parameters 02.039, 01.006 and 03.057; therefore those parameters need to be configured first, before setting object 0x6048.

6.3.1 CoE communication area

The first set of objects specify general communication settings.

Table 6-6 Device type object

0x1000	Device type		
Access: RO	Range: N/A - Bit Mask	Size: 4 bytes	Unit: Bit Mask
Default:	Dependent on drive type / mode (see description).	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The primary CoE functional profile is CiA402, so the value of this object is defined as follows: Bits 0 to 15 (Device Profile Number): 402 Bit 16 (Frequency Converter): x Bit 17 (Servo Drive): y Bit 18 (Stepper Motor): 0 Bit 24 (DC Drive - Control Techniques specific): 0 Bits 25-31 (Manufacturer specific): 0		

The device type value will be dependent on the drive operating mode and/or type. Bit 16 & 17

On High Performance drives in the open-loop, RFC-A or Regen modes or on General Purpose drives, bit 16 will be set, while bit 17 will be clear. On High Performance drives in RFC-S mode, bit 17 will be set, while bit 16 will be clear.

Table 6-7 Manufacturer Device Name

0x1008	Manufacturer Device Name		
Access: RO	Range: String	Size: up to 40 bytes	Unit: UTF-8
Default:	“SI-EtherCAT”	Type: String / STRING (40)	
PDO Mappable: No		Update Rate: On module reset	
Description:	A string of characters that represents the name of the Ethernet interface (either SI-EtherCAT or FF-EtherCAT). If a Safety Module is also fitted to the drive and FSoE enabled, the device name becomes "SI-EtherCAT with FSoE".		

Table 6-8 Manufacturer Hardware Version

0x1009	Manufacturer Hardware Version		
Access: RO	Range: String	Size: Up to 40 bytes	Unit: UTF-8
Default:	See description	Type: String / STRING(40)	
PDO Mappable: No		Update Rate: On Hardware update	
Description:	A string of characters that represents the hardware version of the Ethernet interface. This will also include the Safety Module if FSoE is enabled.		

Table 6-9 Manufacturer Software Version

0x100A	Manufacturer Software Version		
Access: RO	Range: String	Size: Up to 40 bytes	Unit: UTF-8
Default:	See description	Type: String / STRING (40)	
PDO Mappable: No		Update Rate: On firmware update	
Description:	A string of characters that represents the software version of the Ethernet interface. This will also include the Safety Module if FSoE is enabled.		

Table 6-10 Identity object

0x1018	Identity object		
Sub-index 0			
Access: RO	Range: 4	Size: 1 byte	Unit: N/A
Default: 4		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never Changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1: Vendor ID			
Access: RO	Range: 0x000000F9	Size: 4 bytes	Unit: N/A
Default: 0x000000F9 (249)		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	This will contain the EtherCAT Technology Group vendor ID for Control Techniques. This is the same value as the vendor ID used for SM-EtherCAT and SM-CANopen.		
Sub-index 2: Product Code			
Access: RO	Range: N/A	Size: 4 bytes	Unit: See description
Default: 0x01mmvvtt		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: On drive mode change	
Description:	This will contain a value identifying the drive type, variant, and mode.		
Sub-index 3: Revision Number			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: See description
Default: 0xaaaabbbb		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: On firmware update	
Description:	This will contain the version of the Control Techniques EtherCAT interface implemented. **Note**: This is not the same as the EtherCAT option module software version number as the interface is defined to cover both the EtherCAT and Safety Modules. This number is used by the EtherCAT master to find the matching ESI file. The Revision number is made of two parts, aaaa & bbbb. If aaaa changes this is a major change to the interface (and the Object dictionary). If bbbb changes it is a minor change.		
Sub-index 4: Serial Number			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	Lower 32-bit value of the drive serial number.		

The product code, a 32 bit value, is made up as follows:

- Byte 3: Generation - 0x01
- Byte 2: Drive Mode - derived from drive parameter 11.084
- Byte 1: Drive Variant/Derivative - derived from drive parameter 11.028.
- Byte 0: Drive Type; 2 = High performance, 3 = General Purpose.

The Product Code includes the Drive Mode. Therefore, changing mode will mean the product Code will change. If the PLC checks the product code

this will lead to loss of connection if the drive mode changes. To avoid this, the EtherCAT parameter S.00.049 should be set to “Mode Agnostic”.

When set to “Mode Agnostic”, byte 2 will always be zero.

If parameter S.00.049 is set to either “M200 override” or “M300 override” and the drive type is general purpose, the product code reported will be either 0x01xx0303 or 0x01xx0503 respectively (xx = mode)

If parameter S.00.049 is set to “Unidrive SP”, the product code will be as follows:

Mode	Product Code
Open Loop	0x10003
RFC-A	0x30003
RFC-S	0x40003

NOTE Firmware V01.03.05.02 and earlier firmware versions indicated the module firmware version number.

6.3.2 RxPDO mappings

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

It is possible to map up to twelve objects in a PDO, except the Rx PDO mapping 6 & 10. RxPDO 6 can accept 32 objects, if it is mapped in sync manager 4. RxPDO 10 can accept 51 objects but is exclusively used for FSoE. All of this is checked on the transition from PreOp to SafeOp. The following mappings are included by default (in the ESI files), and it is possible to change the objects mapped in each; all except PDO number 8 & 10 are standard, defined in the CiA402 specification:

Table 6-11 RxPDO mappings

PDO No.	Mapped object indices	Mapped default object names
1	0x6040	controlword
2	0x6040 0x6060	controlword modes_of_operation
3	0x6040 0x607A	controlword target_position
5	0x6040 0x6071	controlword target_torque
6	0x6040 0x6042	controlword vl_target_velocity
8	0x2006:2A	drive controlword
10	Depends on ESI module loaded	FSoE related

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

NOTE The above shows the default values. All except PDO 10, can be changed from their default values. PDO 10 is available for FSoE only.

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

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

Table 6-12 RxPDO mapping 1

0x1600	Receive PDO mapping 1		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in the PDO			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object with the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

Table 6-13 RxPDO mapping 2

0x1601	Receive PDO mapping 2		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60600008 - the CiA402 modes of operation object (0x6060)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

Table 6-14 RxPDO mapping 3

0x1602	Receive PDO Mapping 3		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: Unsigned integer	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x607A0020 - the CiA402 target position (0x607A).		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

Table 6-15 RxPDO mapping 5

0x1604	Receive PDO Mapping 5		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

0x1604	Receive PDO Mapping 5		
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60710010 - the CiA402 target torque (0x6071).	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 6-16 RxPDO mapping 6

0x1605	Receive PDO mapping 6		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 32	Size: 1 byte	Unit: N/A
Default:	2	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the CiA402 control word (0x6040)	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60420010 - the CiA402 vl target velocity (0x6042)	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 6-17 RxPDO mapping 8

0x1607	Receive PDO mapping 8		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default:	1 (Regen mode), 0 other modes	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st Mapped Object (Only Present in Regen Mode)			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x20062A10	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

NOTE This object is only supported when the host drive is in Regen mode.

Table 6-18 RxPDO mapping 10

0x1609	Receive PDO Mapping 10		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 51	Size: 1 byte	Unit: N/A
Default:	0	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of mapped objects in this PDO.		

This object is available for FSoE only. The sub-indices will be depending on the FSoE configuration.

6.3.3 TxPDO mappings

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

Table 6-19 TxPDO mappings

PDO number	Mapping object index	Mapping object name
1	0x6041	*statusword*
2	0x6041 0x6061	*statusword* *modes_of_operation_display*
3	0x6041 0x6064	*statusword* *position_actual_value*
5	0x6041 0x6077	*statusword* *torque_actual_value*
6	0x6041 0x6044	*statusword* *vl_velocity_actual_value*
8	0x200A:28	*drive statusword*
10	Depends on ESI module loaded	*FSoE related*

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

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

Table 6-20 TxPDO mapping 1

0x1A00	**Transmit PDO mapping 1**		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of mapped objects in the PDO		
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the CiA402 status word (0x6041)	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 6-21 TxPDO mapping 2

0x1A01	Transmit PDO mapping 2		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60610008 - the CiA402 modes of operation display object (0x6061)		Type: Bit Mask	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

Table 6-22 TxPDO mapping 3

0x1A02	Transmit PDO mapping 3		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

0x1A02	Transmit PDO mapping 3		
Sub-index 2: 2nd Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60640020 - the CiA402 actual position (0x6064)	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 6-23 TxPDO mapping 5

0x1A04	Transmit PDO mapping 5		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default:	2	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on PreOp -> SafeOp transition	
Description:	The number of mapped objects in this PDO.		
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60410010 - the CiA402 status word (0x6041).	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		
Sub-index 2: 2nd mapped object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x60770010 - the CiA402 actual torque (0x6077)	Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.		

Table 6-24 TxPD mapping 6

0x1A05	Transmit PDO mapping 6		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 32	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041).		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd mapped object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60440010 - the CiA402 vl control effort (0x6044)		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

Table 6-25 TxPDO mapping 8

0x1A07	Transmit PDO mapping 8		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st Mapped Object			
Access: RW	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041).		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: A mapping to an object. This will have the following format: 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. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

NOTE This object is only supported when the host drive is in Regen mode.

Table 6-26 Transmit PDO Mapping 10

0x1A09	Transmit PDO Mapping 10		
Sub-index 0: Number Of Mapped Objects			
Access: RW	Range: 0 to 51	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The number of mapped objects in this PDO.			

This object is available for FSoE only. The sub-indices will be depending on the FSoE configuration.

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.

It is possible to map one PDO into each of the Sync Managers. The Sync managers 2 and 3 are used for high-priority deterministic process cyclic data. The Sync manager 4 and 5 are used for low-priority non-deterministic process cyclic data.

Table 6-27 Sync manager communication type object

0x1C00	**Sync Manager Communication Type**		
Sub-index 0 - Number of Sync Manager Channels Used			
Access: RO	Range: 6	Size: 1 byte	Unit: N/A
Default: 6		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description: The number of Sync Manager protocols used by the CoE protocol.			
Sub-index 1 - Usage of Sync Manager 0			
Access: RO	Range: 1	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description: Sync Manager 0 is used by CoE as the mailbox receive channel (SDO, master to slave).			
Sub-index 2 - Usage of sync manager 1			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description: Sync Manager 1 is used by CoE as the mailbox send channel (SDO, slave to master).			
Sub-index 3 - Usage of Sync Manager 2			
Access: RO	Range:3	Size: 1 byte	Unit: N/A
Default: 3		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description:			
Sub-index 4 - Usage of Sync Manager 3			
Access: RO	Range: 4	Size: 1 byte	Unit: N/A
Default: 4		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description: Sync Manager 3 is used by CoE as the process data input (TxPDOs, slave to master). PDOs will be read, by the master, from the space described by this sync manager.			
Sub-index 5 - Usage of Sync Manager 4			
Access: RO	Range: 3	Size: 1 byte	Unit: N/A
Default: 3		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description: Sync Manager 4 is used by CoE as a slow/non-deterministic process data output (RxPDOs, master to slave). PDOs will be read, by the master, from the space described by this sync manager.			

0x1C00	Sync Manager Communication Type		
Sub-index 6 - Usage of Sync Manager 5			
Access: RO	Range: 4	Size: 1 byte	Unit: N/A
Default:	4	Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A Never changes	
Description:	Sync Manager 5 is used by CoE as a slow/non-deterministic process data input (TxPDOs, slave to master). PDOs will be read, by the master, from the space described by this sync manager.		

Table 6-28 Sync manager 2 PDO assignment object

0x1C12	Sync Manager 2 PDO Assignment		
Sub-index 0			
Access: RW	Range: 0 to 1	Size: 1 byte	Unit: N/A
Default:	1	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
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	Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The object index of an RxPDO to assign to this sync manager. By default, this will be assigned to Receive PDO mapping 6 (vl target velocity and control word).		

Table 6-29 Sync manager 3 PDO assignment object

0x1C13	Sync manager 3 PDO assignment		
Sub-index 0			
Access: RW	Range: 0 to 1	Size: 1 byte	Unit: N/A
Default:	1	Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of TxPDOs assigned to this sync manager (used for deterministic process data input).		
Sub-indices 1 to (sub-index 0)			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default:	0x1A05	Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The object index of a TxPDO to assign to this sync manager. By default, this will be assigned to Transmit PDO mapping 6 (vl velocity actual value and status word).		

Table 6-30 Sync manager 4 PDO assignment object

0x1C14	Sync manager 4 PDO assignment		
Sub-index 0			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of RxPDOs assigned to this sync manager (used for non-deterministic process data output).		
Sub-index 1			
Access: RW	Range: 0x1600 - 0x17FF	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The object index of a RxPDO to assign to this sync manager. The second PDO is only for FSoE and hence maps to 0x1609 when used.		

Table 6-31 Sync manager 5 PDO assignment object

0x1C15	Sync manager 5 PDO assignment		
Sub-index 0			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The number of TxPDOs assigned to this sync manager (used for non-deterministic process data input).		
Sub-index 1			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	The object index of a TxPDO to assign to this sync manager. The second PDO is only for FSoE and hence maps to 0x1A09 when used.		

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

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

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

When FSoE is used, sync managers 4 and 5 are used and mapped to 0x1609 and 0x1A09.

Table 6-32 Sync manager 2 synchronisation

0x1C32	Sync manager 2 synchronisation		
Sub-index 0			
Access: RO	Range: 12	Size: 1 byte	Unit: N/A
Default: 12		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: The highest sub-index supported.			
Sub-index 1: Synchronisation Type			
Access: RW	Range: 0 to 2	Size: 2 bytes	Unit: N/A
Default: 1		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	Synchronisation Type. The following values are supported: 0 = Free Running (all drives) 1 = SM Sync (All drives) 2 = DC SYNC0 - this will be selected if DC SYNC0 is enabled and in use. (for drives that support synchronisation e.g. High Performance drives)		
Sub-index 2: DC SYNC0 Cycle Time			
Access: RO	Range: 250000 upwards in multiples of 250000	Size: 4 bytes	Unit: Nanoseconds
Default: N/A		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description: The DC SYNC0 cycle time.			
Sub-index 3: Shift Time - not supported			
Sub-index 4: Synchronisation Types Supported			
Access: RO	Range: Bit Mask	Size: 2 bytes	Unit: N/A
Default: 0x0005		Type: Bit Mask / UINT	
PDO Mappable: No		Update Rate: Power on / reset	
Description:	Synchronisation types supported. 0x0001 = Free Run 0x0002 = SM Sync 0x0004 = DC Sync 0 0x0200 = Measure Delay For drives that support DC SYNC0 it will be 0x0207. For drives that don't support DC Sync0 then 0x0003		
Sub-index 5: Minimum Allowed SYNC0 Cycle Time			
Access: RO	Range: 250,000 to 250,000	Size: 4 bytes	Unit: Nanoseconds
Default: 250,000		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: Minimum allowed SYNC0 cycle time			
Sub-index 6: Calc and Copy Time			
Access: RO	Range: 0 to Max cycle time	Size: 4 bytes	Unit: Nanoseconds
Default: 0		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: When any value written to subindex 8	
Description:	Calc and Copy Time; this minimum amount time between SM2 event and the sync 0 event that guarantees new out data will be applied to the outputs.		
Sub-index 7: Minimum Delay Time - not supported			

0x1C32	Sync manager 2 synchronisation		
Sub-index 8: Get Cycle Time			
Access: RO	Range: 0 to 3	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: Immediately actioned on SDO write	
Description:	Get Cycle Time. If bit 1 is set the SM missed counter is reset to zero.		
Sub-index 9: Delay Time			
Access: RO	Range: 0 upwards	Size: 4 bytes	Unit: Nanoseconds
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	Delay Time - Always zero, due to the nature of a drive, the time at which PDO mapping objects are actioned depends on the nature of that object.		
Sub-index 10: Sync0 Cycle Time			
Access: RO	Range: 250000 upwards in multiples of 250000	Size: 4 bytes	Unit: Nanoseconds
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	Sync0 cycle time always same as cycle time 0x1C32:02		
Sub-index 11: Number of SM Events Missed			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: Count
Default: N/A		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: On a missed SM event	
Description:	Number of SM events missed		
Sub-index 12: Count of Cycle Time too Small Errors			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	Count of cycle time too small errors - Always zero.		
Sub-index 13: Shift Time too Short Counter - not supported			
Sub-index 14: RxPDO Toggle Failed - not supported			
Sub-index 15: Minimum Cycle Distance - not supported			
Sub-index 16: Maximum Cycle Distance - not supported			
Sub-index 17: Minimum SM Sync Distance - not supported			
Sub-index 18: Maximum SM Sync Distance - not supported			
Sub-index 19: 31 - reserved in ETG1020			
Sub-index 32: Sync Error Detected			
Access: RO	Range: 0 or 1	Size: 1 bit	Unit: N/A
Default: N/A		Type: Boolean / BOOL	
PDO Mappable: No		Update Rate: Updates when sync0 lost	
Description:	Sync Error detected, based on a weighted loss counter see 0x10F1:01.		

Table 6-33 Sync manager 3 synchronisation

0x1C33	Sync manager 3 synchronisation		
Sub-index 0			
Access: RO	Range: 12	Size: 1 byte	Unit: N/A
Default: 12		Type: Unsigned / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: The highest sub-index supported.			
Sub-index 1:			
Access: RO	Range: 1 to 0x22	Size: 2 bytes	Unit: N/A
Default: 1		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: PreOp -> SafeOp transition	
Description:	Synchronisation Type. The following values are supported: 0x00 = Free run (All drives) 0x22 = SM Sync with SM2 Event (All drives) 0x02 = DC SYNC0 - this will be selected if DC SYNC0 is enabled and in use.		
Sub-index 2: same as 0x1C32:02			
Sub-index 3: Shift Time - Not supported			
Sub-index 4: same as 0x1C32:04			
Sub-index 5: same as 0x1C32:05			
Sub-index 6:			
Access: RO	Range: N/A	Size: 4 bytes	Unit: Nanoseconds
Default: 0		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: Updated when subindex 8 is written to	
Description:	Calc and Copy Time; minimum time after sync 0 event that input date will be ready for the SM3 event.		
Sub-index 7: not supported			
Sub-index 8: same as 0x1C32:08			
Sub-index 9:			
Access: RO	Range: 0 upwards	Size: 4 bytes	Unit: Nanoseconds
Default: 0		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	Delay Time - Always zero, due to the nature of a drive, the time at which PDO mapping objects hardware inputs are read depends on the nature of that object.		
Sub-index 10: same as 0x1C32:10			
Sub-index 11: same as 0x1C32:11			
Sub-index 12: same as 0x1C32:12			
Sub-index 13: Shift time too Short Counter - not supported			
Sub-index 14: RxPDO Toggle Failed - not supported			
Sub-index 15: 31 - reserved in ETG1020			
Sub-index 32: same as 0x1C32:32			

Table 6-34 Sync manager 4 synchronisation

0x1C34	Sync manager 4 synchronisation		
Sub-index 0			
Access: RO	Range: 4	Size: 1 byte	Unit: N/A
Default: 4		Type: Unsigned Integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: The highest sub-index supported.			
Sub-index 1: Synchronisation Type			
Access: RO	Range: 0	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: Fixed value	
Description: Synchronisation Type. The following values are supported: 0 = Free Running (all drives)			
Sub-index 2: Cycle Time - not supported			
Sub-index 3: Shift time - not supported			
Sub-index 4: Synchronisation Types Supported			
Access: RO	Range: 1	Size: 2 bytes	Unit: N/A
Default: 0x0001		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: On PreOp -> SafeOp transition	
Description: Synchronisation types supported. For drives that support DC SYNC0 then free-run, SM sync and SYNC0 will be available. For drives that don't support DC SYNC0 then only free run and SM-Sync will be available. The following values are supported: 0x00 = Free run (All drives) 0x22 = SM Sync with SM2 Event (All drives) .			

Table 6-35 Sync manager 5 synchronisation

0x1C35	Sync manager 5 synchronisation		
Sub-index 0			
Access: RO	Range: 4	Size: 1 byte	Unit: N/A
Default: 4		Type: Unsigned Integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: The highest sub-index supported.			
Sub-index 1: same as 0x1C34:1			
Sub-index 2: Cycle Time - not supported			
Sub-index 3: Shift Time - not supported			
Sub-index 4: same as 0x1C34:4			

6.3.5 Feedback encoder source

Table 6-36 Feedback encoder source

0x3000	Position Feedback Encoder Configuration		
Access: RW	Range: 0 to 11	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned Integer / USINT	
PDO Mappable: No		Update Rate: On change of CiA402 profile	
Description:	This specifies the source for position controller feedback, and the source for CiA402 position feedback objects.		

The source will have a value as follows:

0 – The feedback source for the position controller will match the drive motor control feedback source (see below for details).

1 – Drive feedback source, P1 interface.
2 – Drive feedback source, P2 interface.
3 – Slot 1 position feedback module, P1 interface.
4 – Slot 1 position feedback module, P2 interface.
5 – Slot 2 position feedback module, P1 interface.
6 – Slot 2 position feedback module, P2 interface.
7 – Slot 3 position feedback module, P1 interface.
8 – Slot 3 position feedback module, P2 interface.
11 – Sensorless (the sensorless algorithm estimates position feedback).

This value will be ignored on drives where no encoder input is present.

This object will be read upon a transition from the EtherCAT Pre-operational state to the Safe operational state.

NOTE The object is only used if the Drive supports position based feedback, otherwise the value is ignored.

If the position feedback encoder configuration is changed then the change will only be made active upon the Network Transition to OP or changing

the mode of operation (0x6060).

When object 0x3000 is processed the following actions are performed:

- If 0x3000 is zero,
  - Drive parameter 03.078 is read to determine if the drive is in Sensorless mode.
  - If the drive is not in Sensorless mode, Drive parameter 03.026 is read to determine current drive feedback source
- Parameter 33.001 is then set so the AMC is also using the same feedback source.

6.4 Ethernet over EtherCAT(EoE)

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

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

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

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

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

6.5 Additional position loop scaling

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

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

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

NOTE This calculation occurs only during certain state transitions.

Table 6-37 Additional position loop scaling

0x3004	**Additional position loop scaling**		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned Integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 1 to 2^{31}-1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: On CiA402 transition to SWITCH_ON	
Description: The additional position loop output scaling numerator			
Sub-index 2			
Access: RW	Range: 1 to 2^{31}-1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned Integer / UDINT	
PDO Mappable: No		Update Rate: On CiA402 transition to SWITCH_ON	
Description: The additional position loop output scaling denominator			

6.6 Cyclic data loss behaviour

When in EtherCAT Operational state regular updates of PDO data is expected from the Master. If these updates fail to occur (due to PDO data corruption, or lateness in arrival of the PDO) then old data will be reused. This can be a problem, if a motion profile is enabled then the next position, velocity or torque target value will not be available.

If the timeout period in sub-index 1 is set to 0 then PDO loss actions will occur immediately. If sub-index 1 is set to a non-zero value and no mapped synchronous PDOs have been accessed for longer than a specified timeout period according to Sub-index 1, the cyclic data loss behaviour will occur. The drive will first be stopped using the Fault reaction option code object; while this is occurring, the PDO Loss alarm will be set. The cyclic data loss trip will occur according to the setting in Sub-index 2. A setting will also be provided to allow a cyclic data loss trip to be forced instantly, if required, regardless of the Fault reaction option code. The number of missed cyclic data objects will be counted and stored in Sub-index 3.

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

Table 6-38 Cyclic data loss behaviour

0x3005	**Cyclic data loss behaviour**		
Sub-index 0			
Access: RO	Range: 8	Size: 1 byte	Unit: N/A
Default: 8		Type: Unsigned Integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1: Time out			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: Milliseconds
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: On SafeOp to Op transition	
Description:	The length of the loss validation period approximately in milliseconds, the exact period checked depends not only on the timeout, but the cyclic period set by the master. Further details below this table		
Sub-index 2: Cyclic Data Loss Action			
Access: RW	Range: 0 to 4	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used transition from SafeOp to Op	
Description:	Cyclic Data Loss Action. The value will select an action as follows: 0: Raise a warning and initiate a motor stop according to the Fault reaction option code. 1: Raise a warning and initiate a motor stop according to the Fault reaction option code. When the motor has reached zero speed raise the cyclic data loss trip. 2: Raise the cyclic data loss trip and disabled the drive invertor. 3: Only raise a warning of PDO loss. [Note: For CSP mode a PDO loss will mean SI-EtherCAT will hold the motor at the current position (if extrapolation is disabled), this could be incorrectly interpreted, by the user, as a motor stop, if it was previously moving] 4: Ignore the cyclic loss completely (i.e. disabled cyclic loss detection). [Note: For CSP mode a PDO loss will mean SI-EtherCAT will hold the motor at the current position (if extrapolation is disabled), this could be incorrectly interpreted, by the user, as a motor stop, if it was previously moving]		

0x3005	Cyclic data loss behaviour		
Sub-index 3: CiA402 Cyclic Data Missed Count			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: On each PDO loss	
Description:	A count of the number of times the PDO data arrived late for the CiA402 motion profiles to use that data. For example, in CSP, the motion profile code is expecting a new updated target position a certain defined time after the Sync0 event. If this fails, this counter is incremented. The counter can be reset by writing a zero to this sub-index.		
Sub-index 4: PDO Loss re-arm delay			
Access: RW	Range: 1 to 65535	Size: 2 bytes	Unit: Seconds
Default: N/A		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: New value used transition from SafeOp to Op and each time the PDO lost detection is re-armed.	
Description:	The delay after a PDO loss action has been completed and the PDO loss mechanism is re-armed. Note: the delay starts from the point at which the trip is cleared (if a trip was raised). The PDO Loss function is always armed when moving from SafeOp to Op states.		
Sub-index 5: Max Weighted Internal SM event missed counter			
Access: RW	Range: 0 to 4	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: On each PDO loss	
Description:	The maximum value seen for the weighted "internal" SM event missed counter as defined in ETG 1020 and used by object 0x10F1 to determine when to exit OP state due to excess network errors. This counter only operates when DC Sync is active. The maximum can be reset by writing a zero to this sub-index.		
Sub-index 6: Reserved			
Access: RO	Range: 0	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: N/A	
Description:	Not used		
Sub-index 7: Max PDO loss duration			
Access: RW	Range: 0 to 4	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: On SafeOp to Op transition and each time the PDO lost detection is re-armed.	
Description:	The maximum PDO loss duration seen so far, when this value exceeds 0x3005:1 then the action in 0x3005:2 will be performed. The maximum can be reset by writing a zero to this sub-index.		
Sub-index 8: Too many PDO counter			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Unsigned Integer / UINT	
PDO Mappable: No		Update Rate: On each excess PDO event	
Description:	A count of the number of times two PDOs were seen in a single Cycle. This counter only operates when DC Sync is active.		

When the drive profiles have been disabled by setting Pr S.00.033 to ON, then Cyclic Data loss actions 0 & 1 will still raise a warning and trip respectively, but the motor will not be stopped as it is not under the control of EtherCAT.

The table below shows the number of lost PDOs before the motor will be placed into the stopping state (0x3005:2 values 0 or 1) for each network cycle time.

Table 6-39 The number of lost PDOs

Network Cycle Period	0x3005:1 Timeout value						
	0	**1**	**2**	**3**	**4**	**5**	**6**
250 µs	1	8-11	12-15	16-19	20-23	24-27	28-31
500 µs	1	4-5	6-7	8-9	10-11	12-13	14-15
1 ms	1	2-3	3-4	4-5	5-6	6-7	7-8
2 ms	1	1	1-2	2	2-3	3	3-4
4 ms	1	1	1	1	1	1	2

Setting a value of the timeout below the value of the network cyclic time, sets the fast reaction mode. In this mode a late or missing PDO will cause the PDO action to be applied. Lateness can be due to incorrect Shift offset setting in the Master.

7 Drive profile (CiA402) support

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

- Homing Mode
- Cyclic Synchronous Position Mode
- Interpolated Position Mode
- vl velocity mode
- Cyclic Synchronous Velocity Mode
- Cyclic Synchronous Torque Mode
- Profile Position 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	**Control Word**		
Access: RW	Range: Bit mask	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Bit Mask / UINT	
PDO Mappable: RxPDO		Motion Profiles: All	
Description:	Provides the primary method of controlling the behaviour of the drive. Bit 0 - See command table. Bit 1 - See command table. Bit 2 - See command table. Bit 3 - See command table. Bit 4 - HM only - Start homing, PP only - New Setpoint Bit 5 - PP only -Immediate Setpoint change Bit 6 - PP only - Relative move Bit 7 - See command table. Bit 8 - IP, VL, HM and PP only - halt Bit 9 - PP only -Change on setpoint.		

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

There is a finite time needed by the drive, between setting the control word and the drive moving to that new state. This period is dependent on various factors, so it is advisable that any program after setting a new control word value, should poll the status word until the desired state has been reached. Simply adding a fixed delay after setting the control word is not recommended.

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: Bit mask	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Bit mask / UINT	
PDO Mappable: TxPDO		Update Rate: Every 40 ms, although some bits are updated more frequently.	
Motion Profiles: ALL			
Description:	This provides feedback about the current operating state of the drive. Bit 0 - See state table. Bit 1 - See state table. Bit 2 - See state table. Bit 3 - See state table. Bit 4 - Voltage enabled. Bit 5 - See state table. Bit 6 - See state table. Bit 7 - Warning active. Bit 10 - CSP, CSV, CST, IP, HM, VL, PP target reached. Bit 11 - CSP, CSV, IP, PP limit switch reached. Bit 12 - HM only - Homing Attained; CSP, CSV, CST, & IP - Active; PP only - Setpoint ack. Bit 13 - HM only - Homing Error; CSP, IP & PP - following error.		

Table 7-4 Statusword bit functions

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

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

Table 7-5 State coding

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

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

7.3 Common profile features

7.3.1 Sequencing control

These are the supported objects used to control the drive:

Table 7-6 Sequencing control supported objects

Index	Name
6040	Controlword
6041	Statusword
605B	shutdown_option_code
605C	disable_operation_option_code
605A	quick_stop_option_code
605D	halt_option_code
605E	fault_reaction_option_code
6007	abort_connection_option_code
6060	modes_of_operation
6061	modes_of_operation_display
6080	max_motor_speed
6084	profile_deceleration
6085	quick_stop_deceleration
6502	supported_drive_modes

The behaviour of the sequencing control is shown in Figure 7-1 on page 61. This state machine indicates how the drive will be controlled. Status word is abbreviated to “SW” in the diagram.

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

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

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

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

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

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

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

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

Figure 7-1 CoE state machine diagram

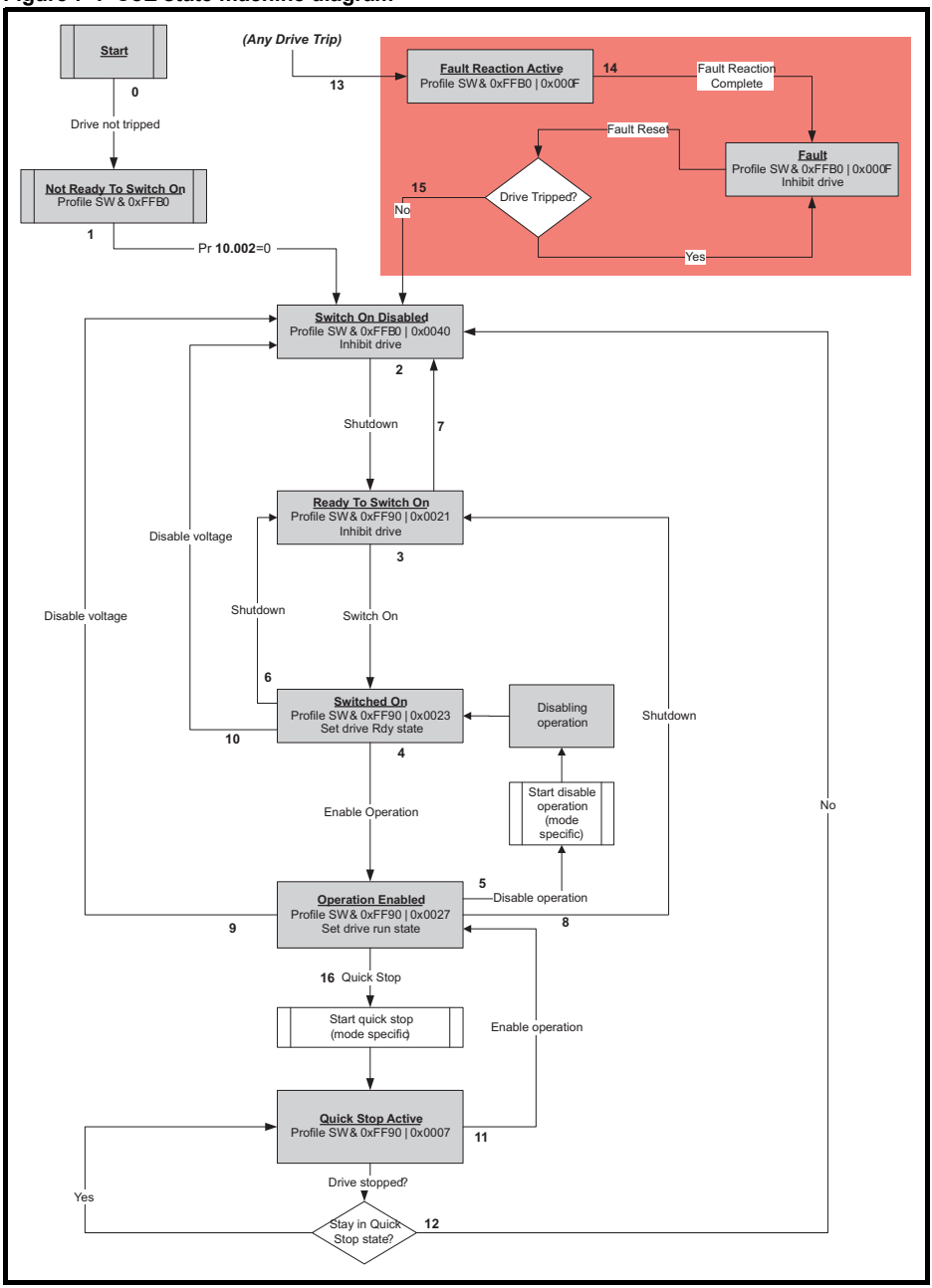


Table 7-7 CoE state machine transition and events

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

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: 2 bytes	Unit: N/A
Default: 2		Type: Signed Integer / INT	
PDO Mappable: No		Update Rate: Before applying Quick Stop	
Motion Profiles: ALL			
Description: Specifies what action is performed in the event of a quick stop function.			

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

Option Code 1 and 2 will also wait for the brake to engage before Switch Off, if drive parameter 12.041 is enabled.

NOTE The Ramp rate used can be over-ridden by setting the EtherCAT comms parameter S.03.010 to “Controlled Stop”. When set to “Controlled Stop” the ramp profile used is that defined by Pr 02.028 “Deceleration Rate 8” and the ramp will have been initiated by clearing the Run bit in Pr 06.042. This is different to the default stopping mechanism which is profile specific.

The speed of reaction to a Quick Stop command depends on several factors:

- The profile Mode. Currently only Quick Stop in CSP, CSV, CST and Homing have a very fast reaction, in other profile modes it is the time to perform one background loop of the CiA402 state machine (40 ms)
- For CSP only, the State of the fault reaction object (Fault reaction ramps are pre-configured in the drive AMC and a change of ramp requirement takes time to configure)
- If Controlled Stop is enabled the reaction time is up to 2 ms (update rate of Pr 06.042).

Table 7-10 CSP Quick Stop reaction time

CSP Quick Stop reaction time		Fault Reaction Option code		
		0	**1**	**2**
Quick Stop Option Code (0x605A)	**0**	Within a network cycle	Within a network cycle	Within a network cycle
	1	Within a network cycle	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)
	2	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)	Within a network cycle
	5	Within a network cycle	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)
	6	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)	Within a network cycle

Once a Quick stop reaction starts, it will complete before a fault reaction is applied (if the fault was not due to a drive trip). i.e. the Quick stop ramp will not change to the fault reaction ramp part way through the ramping.

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 7-11 Shutdown_option_code

0x605B	Shutdown_option_code		
Access: RW	Range: -1 to 1	Size: 2 bytes	Unit: N/A
Default: 0		Type: Signed integer / INT	
PDO Mappable: No		Update Rate: When applying Shutdown	
Motion Profiles: ALL			
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 7-12 Shutdown_option_code values

Value	Definition
-1	Disable drive function (switch off the drive power stage)
0	Slow down with slow down ramp; disable the drive function
1	Slow down with slow down ramp, wait for brake to be fully applied (by waiting for Zero Hold (Pr **06.008**) to clear); then disable the drive

Option Code -1 and 1 will also wait for the brake to engage before Switch Off, if drive parameter 12.041 is enabled.

NOTE The Ramp rate used can be over-ridden by setting the EtherCAT comms parameter S.03.010 to “Controlled Stop”. When set to “Controlled Stop” the ramp profile used is that defined by Pr 02.028 “Deceleration Rate 8” and the ramp will have been initiated by clearing the Run bit in Pr 06.042. This is different to the default stopping mechanism which is profile specific.

The speed of reaction to a Shutdown command depends on several factors:

- The profile Mode. Currently only Shutdown in CSP, CSV, CST and Homing have a very fast reaction, in other profile modes it is the tim to perform one background loop of the CiA402 state machine (40 ms)
- If Controlled Stop is enabled the reaction time is up to 2 ms (update rate of Pr 06.042).

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 7-13 Disabled_operation_option_code

0x605C	Disable_operation_option_code		
Access: RW	Range: 0 to 1	Size: 2 bytes	Unit: N/A
Default: 0		Type: Signed integer / INT	
PDO Mappable: No		Update Rate: When applying Disable	
Motion Profiles: ALL			
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 7-14 Disable_operation_option_code values

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

7.3.5 0x605D Halt_option_code

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

Table 7-15 Halt_reaction_option_code

0x605D	Halt_option_code		
Access: RW	Range: 0 to 2	Size: 2 bytes	Unit: N/A
Default: 0		Type: Signed integer / INT	
PDO Mappable: No		Update Rate: When applying Halt Stop	
Motion Profiles: IP, VL, HM, PP			
Description:	This object is used to control what action is performed if a Halt is called. Halt only applies to some motion profiles as he Halt bit in the control word is profile specific.		

Table 7-16 Fault_reaction_option_code values

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

NOTE The Ramp rate used can be over-ridden by setting the EtherCAT comms parameter S.03.010 to “Controlled Stop”. When set to “Controlled Stop” the ramp profile used is that defined by Pr 02.028 “Deceleration Rate 8” and the ramp will have been initiated by clearing the Run bit in Pr 06.042. This is different to the default stopping mechanism which is profile specific.

The speed of reaction to a Halt command depends on several factors:

• The profile Mode. Currently only Homing has a very fast reaction, in other profile modes it is the time to perform one background loop of the CiA402 state machine (40 ms)

• If Controlled Stop is enabled the reaction time is up to 2 ms (update rate of Pr 06.042).

7.3.6 0x605E Fault_reaction_option_code

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

Table 7-17 Fault_reaction_option_code

0x605E	Fault_reaction_option_code		
Access: RW	Range: 0 to 2	Size: 2 bytes	Unit: N/A
Default: 2		Type: Signed integer / INT	
PDO Mappable: No		Update Rate: When applying Fault reaction	
Motion Profiles: ALL			
Description:	This object is used to control what action is performed when a fault is detected.		

Table 7-18 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

Option Code 1 and 2 will also wait for the brake to engage before Switch Off, if drive parameter 12.041 is enabled.

NOTE The Ramp rate used can be over-ridden by setting the EtherCAT comms parameter Pr S.03.010 to “Controlled Stop”. When set to “Controlled Stop” the ramp profile used is that defined by Pr 02.028 “Deceleration Rate 8” and the ramp will have been initiated by clearing the Run bit in Pr 06.042. This is different to the default stopping mechanism which is profile specific.

7.3.7 0x6007 Abort_connection_option_code

Table 7-19 Abort_connection_option_code

0x6007	**Abort connection option code**		
Access: RW	Range: -3 to 3	Size: 2 bytes	Unit: N/A
Default: 1		Type: Integer / INT	
PDO Mappable: TxPDO		Update Rate: When connection failure is detected	
Motion Profiles: All			
Description:	Defines network loss behaviour: (-3) - Perform Quick stop ramp (0x605A) to a stop and then raise a trip. (-2) - Disable voltage and raise a trip. (-1) - Perform Fault reaction (0x605E) and then raise a trip. 0 - No reaction 1 - Perform Fault reaction (0x605E) 2 - Disable voltage 3 - Perform Quick stop ramp (0x605A) to a stop		

NOTE If a PDO loss event and a network loss event overlaps, the Network loss event takes precedence.

The network loss error could have already precepted a fault reaction which would take precedence over this object.

7.3.8 0x6060 Modes_of_operation

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

Table 7-20 Modes_of_operation

0x6060	**Modes_of_operation**		
Access: RW	Range: 0 to 10	Size: 1 byte	Unit: N/A
Default: 2		Type: Signed Integer / SINT	
PDO Mappable: RxPDO		Update Rate: Every 40 ms	
Motion Profiles: ALL			
Description:	This object is used to request a change in the mode of operation.		

Value	Definition
0	No mode change
1	Profile Position mode
2	vl velocity mode
3 - 6	Reserved
6	Homing mode
7	Interpolated Position mode
8	Cyclic Sync Position mode
9	Cyclic Sync Velocity mode
10	Cyclic Sync Torque mode

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

Where a profile mode is available depends on drive type and mode, see object 0x6502 for details.

7.3.9 0x6061 Modes_of_operation_display

This read only object indicates the active mode of operation.

Table 7-21 Modes_of_operation_display

0x6061	Modes_of_operation_display		
Access: RO	Range: 0 to 10	Size: 1 byte	Unit: N/A
Default: N/A		Type: Signed integer / SINT	
PDO Mappable: TxPDO		Update rate: Every 40 ms	
Motion Profiles: ALL			
Description: Used to provide the active mode of operation.			

Table 7-22 Modes_of_operation_display values

Value	Definition
0	No mode change
1	Profile Position mode
2	vl velocity mode
3 - 5	Reserved
6	Homing mode
7	Interpolated Position mode
8	Cyclic Sync Position mode
9	Cyclic Sync Velocity mode
10	Cyclic Sync Torque mode

7.3.10 0x6084 Profile deceleration

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

In addition to the above, with Profile Position mode, it also limits the profile deceleration rate during normal profile position operation.

Table 7-23 Profile deceleration

0x6084	Profile deceleration		
Access: RW	Range:0 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 65536		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: See notes below	
Motion Profiles: IP, CSP, CSV, CST, HM, PP			
Description: Provides the deceleration ramp for the positioning modes			

IP, CSP, CSV, CST, HM

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object

(0x605A) is set to 1 or 5. This object is also used for shutdown when shutdown option code (0x605B) is set to 1, and for disable operation when disable operation option code (0x605C) is set to 1. It is also used if the fault reaction code object (0x605E) is 1. The value is given in user defined acceleration units.

PP

In addition to the above, It also limits the profile deceleration rate during normal profile position operation. Updated when new Setpoint set (PP)

7.3.11 0x6085 Quick_stop_deceleration

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

Table 7-24 Quick_stop_deceleration

0x6085	Quick_stop_deceleration		
Access: RW	Range: 0 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 65536		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: Value used when Quick Stop deceleration is triggered	
Motion Profiles: IP, CSP, CSV, CST, HM, PP			
Description: Quick stop function for the positioning related modes.			

NOTE To improve the reaction time for using a Quick stop ramp, the parameter 38.002 will be updated in the background with a scaled version of this object under the following conditions:

- The Motion profile selected is either CSP or IP.
- The Fault reaction option code is configured to use the Quick Stop ramp OR
- The fault reaction code is configured to immediate stop and the Quick Stop option code is set to use the Quick Stop ramp.

7.3.12 Profile units

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

Table 7-25 Supported profile units

Index	Name
0x608F	*position_encoder_resolution*
0x6091	*gear_ratio*
0x6092	*feed_constant*

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

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

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

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

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

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

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

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

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

When the gear ratio or the feed constant is applied, the combination of $\frac{\text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ration}}$ will be calculated and simplified. The result will be applied to the AMC slave user unit's ratio and its inverse value will be put in the AMC output user unit's ratio. To prevent the overflow risk of AMC ratio parameters, before being applied, the size will be checked to make sure the numerator and the denominator of the combined results are within 1 to 2^{31}-1 range. If not, the module will trip with 'Scaling failure' and the AMC scaling ratios will stay previous value.

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

7.3.13 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 7-26 Position_encoder_resolution

0x608F	Position_encoder_resolution		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A	
Motion Profiles: When feedback encoder is available			
Description:			
Sub-index 1			
Access: RO	Range: 1 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 65536		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Encoder increments, derived from the normalization turns of the associate encoder channel.			
Sub-index 2			
Access: RO	Range: 1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Motor revolutions, always 1.			

7.3.14 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:

gear ratio = motor shaft revolutions / driving shaft revolutions

Table 7-27 Gear_ratio

0x6091	**Gear_ratio**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A	
Motion Profiles: When feedback encoder is available			
Description:			
Sub-index 1			
Access: RW	Range: 1 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Motor revolutions.			
Sub-index 2			
Access: RW	Range: 1 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Shaft revolutions.			

Beware when using a gear ratio that is not 1:1 and rollover of encoder position occurs, to maintain a contiguous position, EtherCAT tracks the rollover events. For more detail see description for object 0x6064.

7.3.15 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:

feed constant = feed / driving shaft revolutions

Table 7-28 Feed_constant

0x6092	**Feed_constant**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A	
Motion Profiles: When feedback encoder is available			
Description:			
Sub-index 1			
Access: RW	Range: 1 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 5536 unless using CSP, CSV or IP profiles when it		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Feed.			
Sub-index 2			
Access: RW	Range: 1 to 2^{32}-1	Size: 4 bytes	Unit: N/A
Default: 1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background	
Description: Shaft revolutions.			

7.3.16 Touch Probe Functionality

7.3.16.1 General touch probe definition

Touch probe function will be supported on Unidrive M70x and Digitax HD drives in RFC-S mode and RFC-A mode. It will not be available on Unidrive M70x and Digitax HD drives in open-loop or regen mode, Unidrive M200 - M400 or Commander C200/C300.

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

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

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

Table 7-29 Touch probe function supported objects

Index	Name
60B8	*Touch probe function*
60B9	*Touch probe status*
60BA	*Touch probe 1 positive edge*
60BB	*Touch probe 1 negative edge*
60D0	*Touch probe source*

Table 7-30 Touch probe function

0x60B8	**Touch probe function**		
Access: RW	Range: Bit Mask	Size: 2 bytes	Unit: N/A
Default: 0		Type: Bit Mask / UINT	
PDO Mappable: RxPDO		Update Rate: Background	
Motion Profiles: When feedback encoder is available			

Description:

This will specify the touch probe functionality; the following bits are supported:

Bit	Value	Definition
0	0	Switch off touch probe 1
	1	Enable touch probe 1
1	0	Trigger first event
	1	Continuous trigger
3, 2	00_b	Trigger with touch probe 1 input (drive digital input 4)
	01_b	Trigger with hardware zero impulse signal of position encoder
	10_b	Touch probe source as defined in object 0x60D0,sub-index 1
	11_b	Reserved
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1
6-15	-	<Unused; Have no effect>

Table 7-31 Touch probe status

0x60B9	Touch probe status		
Access: RO	Range: N/A	Size: 2 bytes	Unit: N/A
Default: 0		Type: Bit Mask / UINT	
PDO Mappable: TxPDO		Update rate: Every network cycle period	
Motion Profiles: When feedback encoder is available			

Description:

This indicates the status of the touch probe functionality; the bits, when set, will have the following meanings:

Bit	Value	Definition
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled
1	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge position stored
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge position stored
3-15	-	<Unused; Always 0>

Table 7-32 Touch probe source

0x60D0	Touch probe source		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: When feedback encoder is available			
Description: The number of the highest sub-index of this object.			
Sub-index 1			
Access: RW	-2 to 6	Size: 2 bytes	Unit: N/A
Default: 1		Type: Integer / INT	
PDO Mappable: No		Update rate: Background	
Description: Touch probe 1 source.			

Table 7-33 Touch probe source values

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

Table 7-34 Touch probe 1 positive edge

0x60BA	Touch probe 1 positive edge		
Access: RO	Range: N/A	Size: 4 bytes	Unit: User-defined position units
Default: 0		Type: Integer / DINT	
PDO Mappable: TxPDO		Update rate: When touch probe 1 is triggered by positive edge.	
Motion Profiles: When feedback encoder is available			
Description:	This will contain a position value frozen when a positive edge occurred on the touch probe 1 input. The value will only be valid when the positive position stored bit is set.		

Table 7-35 Touch probe 1 negative edge

0x60BB	Touch probe 1 negative edge		
Access: RO	Range: N/A	Size: 4 bytes	Unit: User-defined position units
Default: 0		Type: Integer / UDINT	
PDO Mappable: TxPDO		Update rate: When touch probe 1 is triggered by negative edge.	
Motion Profiles: When feedback encoder is available			
Description:	This will contain a position value frozen when a negative edge occurred on the touch probe 1 input. The value will only be valid when the negative position stored bit is set.		

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

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

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

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

7.3.16.2 Trigger mode of touch probe

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

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

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

Figure 7-2 Trigger first event (0x60B8 bit1 = 0)

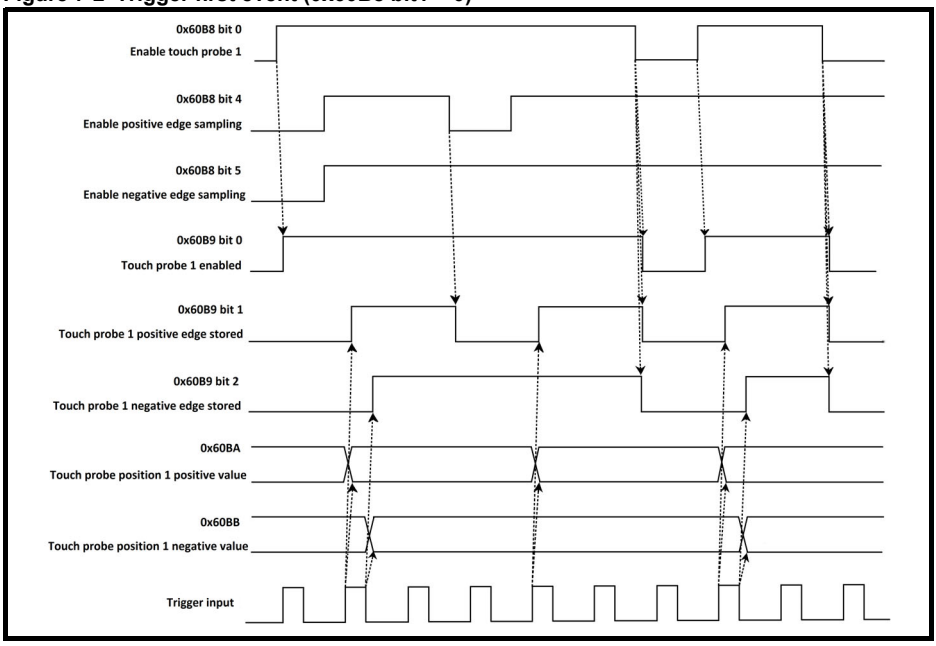
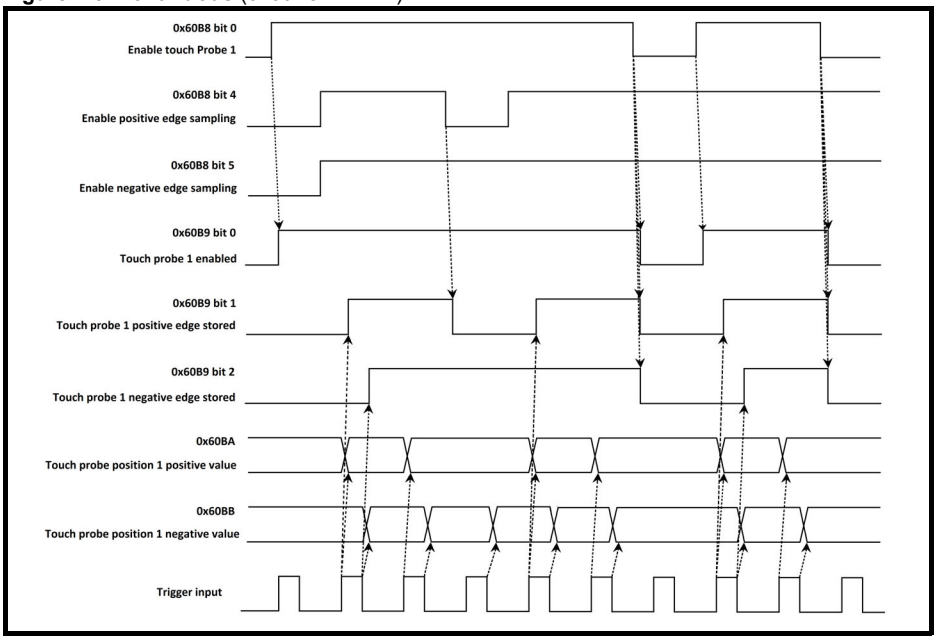


Figure 7-3 Continuous (0x60B8 bit1 = 1)



7.3.17 Basic position control

Basic position control is supported on the Unidrive M70x and Digitax HD in RFC-A and RFC-S modes. The position control described here is used under the interpolated position mode of operation. Table 7-36 lists the objects that are supported:

Table 7-36 Basic position control supported objects

Index	Name
0x6062	*position_demand_value*
0x6065	*following_error_window*
0x6067	*position_window*
0x6068	*Position window time*
0x60F4	*following_error_actual_value*
0x60FB	*position_control_parameter_set*

7.3.18 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 7-37 Position_demand_value

0x6062	**Position_demand_value**		
Access: RO	Range: -2^{32} to $2^{32}-1$	Size: 4 bytes	Unit: User units
Default: N/A		Type: Signed integer / DINT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: CSP, IP, PP			
Description: Used to provide the currently demanded position value.			

7.3.19 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 7-38 Position_actual_value

0x6064	**Position_actual_value**		
Access: RO	Range: -2^{31} to 2^{31}	Size: 4 bytes	Unit: N/A
Default: N/A		Type: Signed integer / DINT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: ALL (when position feedback is available)			
Description: This read only object provides the actual value of the position in User-defined position units.			

Although Actual position is an absolute value, there are various conditions that the user must be aware of. When setting gear ratios that are not 1:1 and the encoder count rolls over, EtherCAT module attempts to keep the position contiguous at the point of rollover; BUT this means keeping track of the rollovers so that a suitable offset can be added to the raw encoder count to keep position contiguous. This cannot be maintained after the following events:

- Drive Power cycle
- Drive reset
- EtherCAT module reset
- Change of CiA402 mode to VL Velocity or CST
- EtherCAT communications state moving out of Operational state

7.3.20 0x6065 Following error window

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

Table 7-39 Following error window

0x6065	**Following error window**		
Access: RW	Range: 0 to 2^{31}-1	Size: 4 bytes	Unit: N/A
Default: 2^{31}-1		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update rate: Background	
Motion Profiles: CSP, IP, PP			
Description:	Permitted range of position values before a following error occurs.		

7.3.21 Position window

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

Table 7-40 0x6067 Position window

0x6067	**Position window**		
Access: RW	Range: 0 to 2^{31}-1	Size: 4 bytes	Unit: N/A
Default: 2^{31}-1		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: Background	
Motion Profiles: CSP, IP, PP			
Description:	Permitted range of position values for target position to be regarded as reached.		

Table 7-41 0x6068 Position Window Time

0x6068	**Position window Time**		
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: milliseconds
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO		Update rate: Read in background	
Motion Profiles: PP			
Description:	This object shall indicate the configured time, during which the actual position within the position window is measured.		

7.3.22 0x6072 Max Torque

Table 7-42 0x6072 Max Torque

0x6072	**Max Torque**		
Access: RW	Range: -32768 to 32767	Size: 4 bytes	Unit: TBA
Default: N/A		Type: Unsigned integer	
PDO Mappable: No		Update rate: Background, sync with Pr **04.120** and Pr **04.121**	
Motion Profiles: ALL			
Description:	Maximum torque		

7.3.23 Motor rated current

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

Table 7-43 0x6075 Motor rated current

0x6075	Motor rated current		
Access: RW	Range: 0 to 2^{31}-1	Size: 4 bytes	Unit: mA
Default: Derived from Pr 05.007		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background sync with Pr **05.007**	
Motion Profiles: ALL			
Description: Motor rated current value derived from Pr **05.007**.			

The drive motor rated current parameter 05.007 will be read in the background and written to the object motor_rated_current and vice-versa.

7.3.24 0x6076 Motor rated Torque

This object indicates the configured motor rated torque.

Table 7-44 0x6076 Motor rated Torque

0x6076	Motor rated Torque		
Access: RW	Range: 0 to Max(*)	Size: 4 bytes	Unit: milli-Newton metre
Default: N/A		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update rate: Background sync with Pr **04.041**	
Motion Profiles: ALL			
Description: Motor rated torque (*) The maximum value is depends on Drive Type. It is based on the maximum value allowed for Pr 04.041			

7.3.25 0x6080 Max motor speed

Table 7-45 Max motor speed

0x6080	Max motor speed		
Access: RW	Range: 0 to 40000	4 bytes	Unit: rpm
Default: Taken from Pr 01.006 and scaled		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: Background sync with Pr **01.006**	
Motion Profiles: ALL			
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 **01.006**. The value is given in rotations per minute (rpm).			

The scaling between 0x6080 and Pr 01.006 is governed by the Drive Type, Mode, parameter Pr 02.039 and Pr 03.057 and also some other related objects. Therefore, those parameters and objects need to be set first.

7.3.26 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 7-46 Following_error actual_value

0x60F4	Following_error actual_value		
Access: RO	Range: -2^{32} to $2^{32}-1$	Size: 4 bytes	Unit: N/A
Default: N/A		Type:Signed integer / DINT	
PDO Mappable: TxPDO		Update rate: Every network cycle period	
Motion Profiles: CSP, IP, PP			
Description: This read only object provides the actual value of the following error.			

7.3.27 0x60FB Position_control_parameter_set object

Table 7-47 Position_control_parameter_set object

0x60FB	Position_control_parameter_set		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: ALL			
Description: The number of control loop parameters.			
Sub-index 1			
Access: RW	Range: 0 to 500000	Size: 4 bytes	Unit: See Pr **39.007**
Default: The default value, is that of drive parameter Pr 39.007 for the drive derivative		Type: Signed integer / UDINT	
PDO Mappable: RxPDO & TxPDO		Update rate: Background sync with Pr **39.007**	
Description: The position controller proportional gain.			
Sub-index 2			
Access: RW	Range: 0 to 2000	Size: 2 bytes	Unit: See Pr **39.010**
Default: The default value, is that of drive parameter Pr 39.010 for the drive derivative		Type: Signed integer / UINT	
PDO Mappable: RxPDO & TxPDO		Update rate: Background sync with Pr **39.010**	
Description: The position controller speed feed forward gain.			

The AMC position controller (Advanced Motion Controller) kernel is used by the basic internal position control, this object is only available with drives support AMC and when the AMC is enabled.

The *position_demand_value* object contains the value supplied by either the interpolated position mode or the profile position mode (in user units). It is updated every control loop cycle. The values in the position_control_parameter_set will be read in the background, so they cannot be mapped cyclically (i.e. including them in PDOs is not allowed).

NOTE DO NOT USE THIS OBJECT. It is not supported by EtherCAT standard and will be removed in future releases.

7.3.28 Supported Drive Modes

This object provides information on the supported drive modes.

Table 7-48 Supported Drive Modes

0x6502	Supported drive modes		
Sub-index 0			
Access: RO	Range: Bit Mask	Size: 4 bytes	Unit: N/A
Default: N/A		Type: Bit Mask / UDINT	
PDO Mappable: No		Update rate: Reset	
Motion Profiles: ALL			

Description: Provides information on the supported drive modes as shown below.

31 16	15 11	10	9	8	7	6	5	4	3	1	0
ms	r	cstca	cst	csv	csp	ip	hm	r	tq	vl	pp

Provides information on the supported drive modes as shown below.
Bit 0 - PP => Set if drive has AMC feature
Bit 1 - VL => Always Set
Bit 5 - HM => Set if drive has AMC feature
Bit 6 - IP => Set if drive has AMC feature and supports Opt Sync
Bit 7 - CSP => Set if drive has AMC feature and supports Opt Sync
Bit 8 - CSV => Set if drive has AMC feature and supports Opt Sync
Bit 9 - CST => Set if drive supports Opt Sync and drive current feedback

7.4 Interpolated position mode

Interpolated position mode operates on the Unidrive M600 and above in RFC-A and RFC-S modes. Table 7-49 lists the objects that are supported:

Table 7-49 Supported Interpolated position mode objects

Index	Name
0x60C0	*interpolation_submode_select*
0x60C1	*interpolation_data_record*
0x60C2	*interpolation_time_period*

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

7.4.1 0x60C0 Interpolation_sub-mode_select

Table 7-50 0x60C0 Interpolation_sub-mode_select

0x60C0	Interpolation_sub-mode_select		
Access: RW	Range: 0	Size: 2 bytes	Unit: N/A
Default: 0 (Linear interpolation)		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO		Update rate: New value used on change of CiA402 profile	
Motion Profiles: CSP, CSV, CST, IP			
Description:	This will specify the interpolation type. The values have the following meanings: 0 = Linear Interpolation.		

7.4.2 0x60C1 Interpolation_data_record

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

Table 7-51 0x60C1 Interpolation_data_record

0x60C1	Interpolation_data_record		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: IP			
Description:	This object is used to specify the target position.		
Sub-index 1			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: N/A
Default: N/A		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: Every network cycle period	
Description:	The set-point.		

7.4.3 0x60C2 Interpolation_time_period

Table 7-52 Interpolation_time_period

0x60C2	Interpolation_time_period		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: CSP, CSV, CST, IP			
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: (sub-index 2)
Default: 250		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: On CiA402 transition to SWITCH_ON	
Description:	The number of time units between interpolator restarts. A time unit is defined by sub-index 2. The interpolator time period value will be checked to ensure that it is valid. Valid values are 250 µs, 500 µs or any multiple of 1 ms. Selecting other values will result in an error indication.		
Sub-index 2			
Access: RW	Range: -6 to 0	Size: 1 byte	Unit: N/A
Default: -6 (a time unit of 1 µs)		Type: Signed integer / SINT	
PDO Mappable: No		Update rate: On CiA402 transition to SWITCH_ON	
Description:	This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is $10^{(\text{sub-index 2})}$. The range of values allows for the shortest time unit to be 1 µs, and the longest to be 1 s.		

The implementation of interpolated position mode allows synchronous operation only, where a fixed, common interpolation interval is defined. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds), see Table 7-53 for more information.

Table 7-53 Interpolation time period units

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

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

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

7.5 vl velocity mode

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

When the drive is in either of the RFC-A or RFC-S operating modes the scaled velocity is written to the drive internal speed shortcut. When the drive is in an open-loop operating mode the scaled velocity is written to the user preset reference parameter (Pr **01.021**). Table 7-54 lists the objects that are supported:

Table 7-54 vl velocity mode supported objects

Index	Name
0x3008	*Active velocity mode redirection*
0x6042	*vl_target_velocity*
0x6043	*vl_velocity_demand*
0x6044	*vl_velocity_actual_value*
0x6046	*vl_velocity_min_max_amount*
0x6048	*vl_velocity_accleration*
0x6049	*vl_velocity_deceleration*
0x604A	*vl_velocity_quick_stop*
0x604B	*vl_setpoint_factor*
0x604C	*vl_dimension_factor*

7.5.1 Activate velocity mode redirection

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

Table 7-55 Activate velocity mode redirection

0x3008	Activate velocity mode redirection		
Access: RW	Range: 0 to 1	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on change of CiA402 profile	
Description:	This will switch on redirection from 0x60FF to 0x6042. Normally, 0x60FF is the reference for the CSV mode, and 0x6042 is for velocity mode. Activating this means that 0x60FF will be used as the reference for velocity mode; its units will be RPM, with an allowable range between -32768 and 32767. This object value will take effect on a CiA402 transition from "Ready to switch on" to "Switched on".		

7.5.2 0x6042 vl_target_velocity

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

Table 7-56 vl_target_velocity

0x6042	vl_target_velocity		
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: rpm
Default: 0		Type: Signed integer / INT	
PDO Mappable: RxPDO		Update rate: Every network cycle period.	
Motion Profiles: VL			
Description:	Used to set the required velocity of the system. The value is scaled based on other VL velocity objects and written to drive parameter 01.021 when in VL Velocity profile mode and the CiA402 Status Word reports “Operational Enabled”. **NOTE** If Object 0x3008 is set to On, the value in this object (0x6042) is ignored and 0x60FF is used instead		

7.5.3 0x6043 vl_velocity_demand

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

Table 7-57 vl_velocity_demand

0x6043	vl_velocity_demand		
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: rpm
Default: 0		Type: Signed integer / INT	
PDO Mappable: TxPDO		Update rate: Updated in the background	
Motion Profiles: VL			
Description:	Provides the instantaneous velocity demand generated by the drive ramp function.		

7.5.4 0x6044 vl_velocity_actual_value

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

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

Table 7-58 velocity_actual_value

0x6044	**vl_velocity_actual_value**		
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0		Type: Signed integer / INT	
PDO Mappable: TxPDO		Update Rate: Every network cycle period	
Motion Profiles: All			
Description:	Provides the velocity at the motor spindle or load.		

7.5.5 0x6046 vl_velocity_min_max_amount

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

The value is given in rpm if the *vl_dimension_factor* has the value of 1, otherwise the value is in user units.

Table 7-59 vl_velocity_min_max_amount

0x6046	**vl_velocity_min_max_amount**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never	
Motion Profiles: VL			
Description:	The number of sub-indices in this object.		
Sub-index 1			
Access: RW	Range: 0 to 40000	Size: 4 bytes	Unit: rpm
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: background	
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 *vl velocity min* positive and *vl velocity min* negative.		
Sub-index 2			
Access: RW	Range: 0 to 40000	Size: 4 bytes	Unit: rpm
Default: 40000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: Background	
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 *vl_velocity_max* positive and *vl_velocity_max* negative.		

7.5.6 0x6048 vl_velocity_acceleration

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

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

vl_velocity_acceleration = delta speed / delta time

Table 7-60 0x6048 vl_velocity_acceleration

0x6048	**vl_velocity_acceleration**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A	
Motion Profiles: VL			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 2^{32}-1	Size: 4 bytes	Unit: rpm
Default: 1000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: Background sync with Pr **02.021**	
Description: The value of delta speed 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.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: seconds
Default: 2		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO		Update Rate: Background sync with Pr **02.021**	
Description: The value of delta time is given in seconds.			

7.5.7 0x6049 vl_velocity_deceleration

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

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

vl_velocity_deceleration = delta speed / delta time

Table 7-61 0x6049 vl_velocity_deceleration

0x6049	**vl_velocity_deceleration**			
Sub-index 0				
Access: RO		Range: N/A	Size: 1 byte	Unit: N/A
Default:	2		Type: Unsigned integer / USINT	
PDO Mappable: No			Update rate: N/A	
Motion Profiles: VL				
Description:	The number of sub-indices in this object.			
Sub-index 1				
Access: RW		Range: 0 to 2^{32}-1	Size: 4 bytes	Unit: rpm
Default:	1000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO			Background sync with Pr **02.021**	
Description:	The value of delta speed 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.			
Sub-index 2				
Access: RW		Range: 0 to 65535	Size: 2 bytes	Unit: seconds
Default:	2		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO			Background sync with Pr **02.021**	
Description:	The value of delta time is given in seconds.			

7.5.8 0x604A vl_velocity_quick_stop

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

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

vl velocity deceleration = delta speed / delta time

Table 7-62 0x604A vl_velocity_quick_stop

0x604A	**vl_velocity_quick_stop**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: VL			
Description:	The number of sub-indices in this object.		
Sub-index 1			
Access: RW	Range: 0 to 2^{32}-1	Size: 4 bytes	Unit: rpm
Default: 1000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: Background sync with Pr **02.022**	
Description:	The value of delta speed 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.		
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: seconds
Default: 2		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO		Update rate: Background sync with Pr **02.022**	
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 7-63 0x604B vl_setpoint_factor

0x604B	**vl_setpoint_factor**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: VL			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: Dimensionless
Default: 1		Type: Signed integer / INT	
PDO Mappable: RxPDO		Update rate: Background	
Description: *vl_setpoint_factor* numerator (a value of 0 is not valid).			
Sub-index 2			
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: Dimensionless
Default: 1		Type: Signed integer / INT	
PDO Mappable: RxPDO		Update rate: Background	
Description: *vl_setpoint_factor* 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.

Velocity [user-defined unit] / Dimension factor [rpm/user-defined unit] = Velocity [rpm]

Table 7-64 0x604C vl_dimension_factor

0x604C	**vl_dimension_factor**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: VL			
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: Dimensionless
Default: 1		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: Background	
Description: *vl_dimension_factor* numerator (a value of 0 is not valid).			
Sub-index 2			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: Dimensionless
Default: 1		Type: Signed integer / DINT	
PDO Mappable: RxPDO			
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 **01.021**).

The object *vl_velocity_min_max* is handled every profile cycle. The *vl_target_velocity* is limited according to the values set in the object *vl_velocity_min_max*, which is read every profile cycle. The object *vl_velocity_min_max_amount* is mapped to *vl_velocity_min_max*.

The value of the *vl_velocity_demand* object is calculated in the background. The option reads the value of parameter Pr **02.001** (post ramp reference), scaled from RPM to user units using *vl_dimension_factor* and *vl_setpoint_factor*, and writes the value to the *vl_velocity_demand* object.

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

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

deceleration rate preset is changed (Pr **02.021**), the *vl_velocity_deceleration* object is updated.

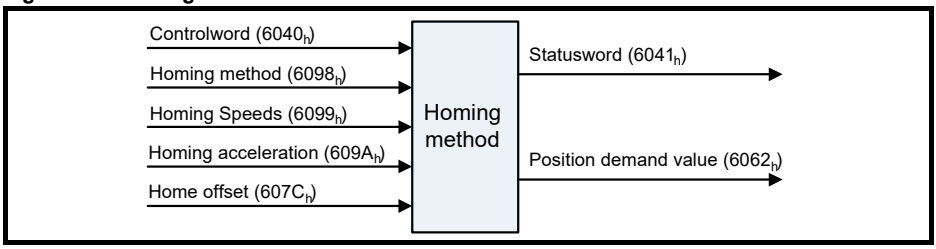
7.6 Homing mode

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

Figure 7-4 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 7-4 Homing mode function



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

An encircled number in Figure 7-5 to Figure 7-10 indicates the code for selection of this homing position. The direction of movement is also indicated.

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

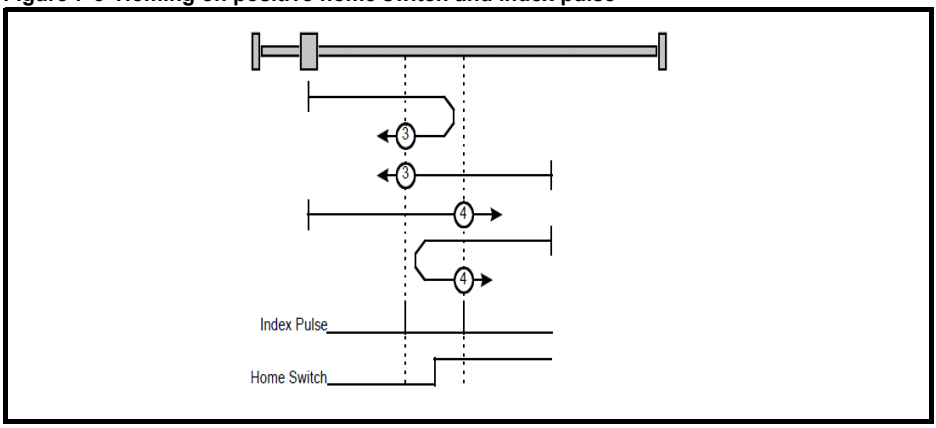
7.6.1 General homing definitions

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

Using these methods as shown in Figure 7-5 *Homing on positive home switch and index pulse* on page 93, 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.

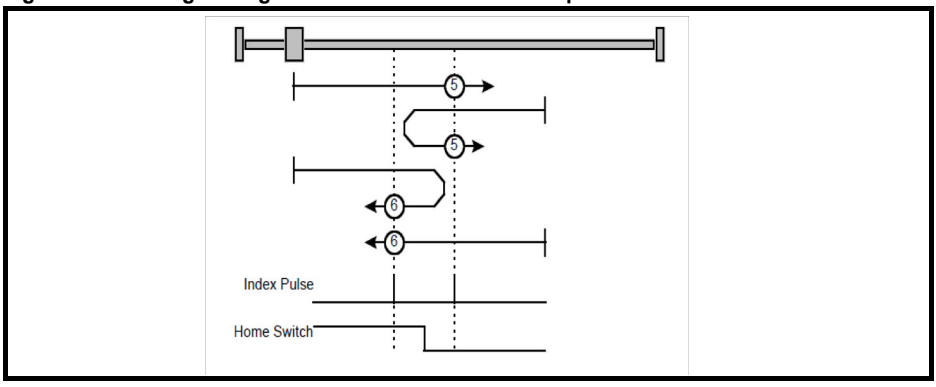
Figure 7-5 Homing on positive home switch and index pulse



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 93, 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 94 and Figure 7-8 *Homing on home switch and index pulse - negative initial motion* on page 94. 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

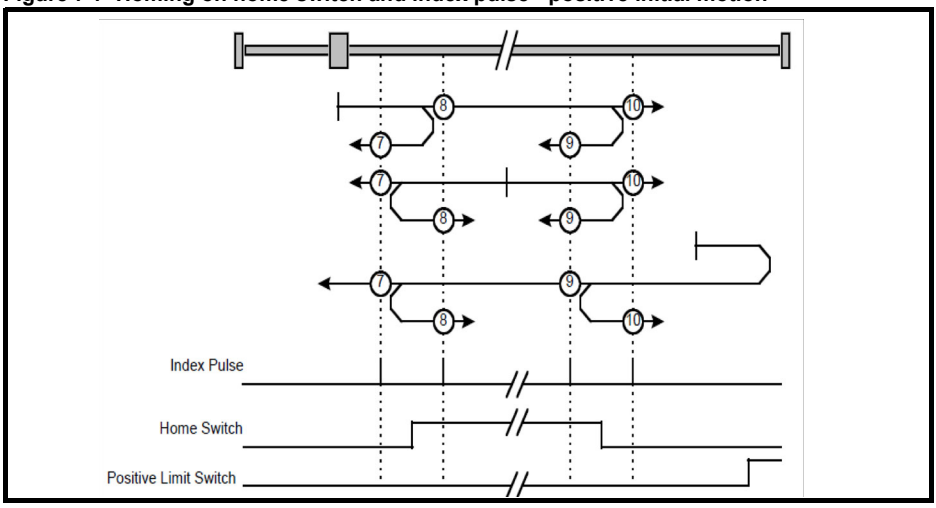
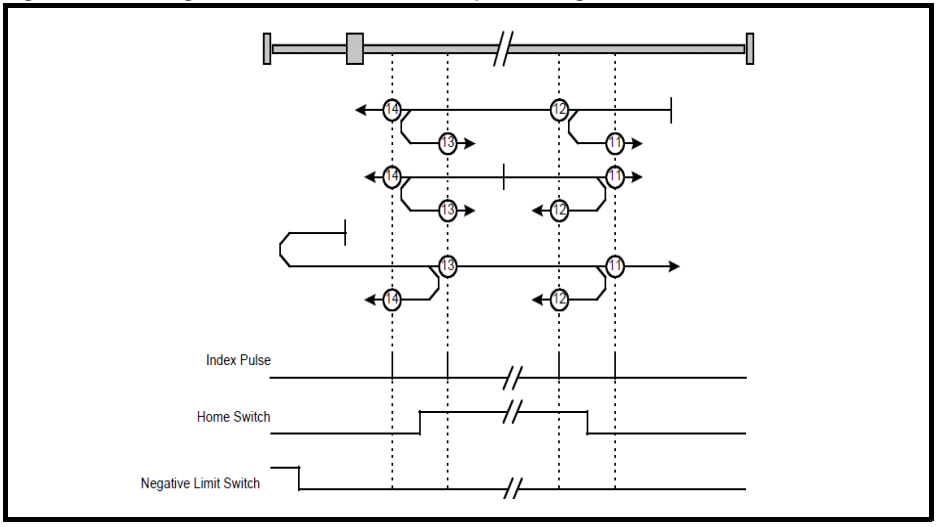


Figure 7-8 Homing on home switch and index pulse - negative initial motion



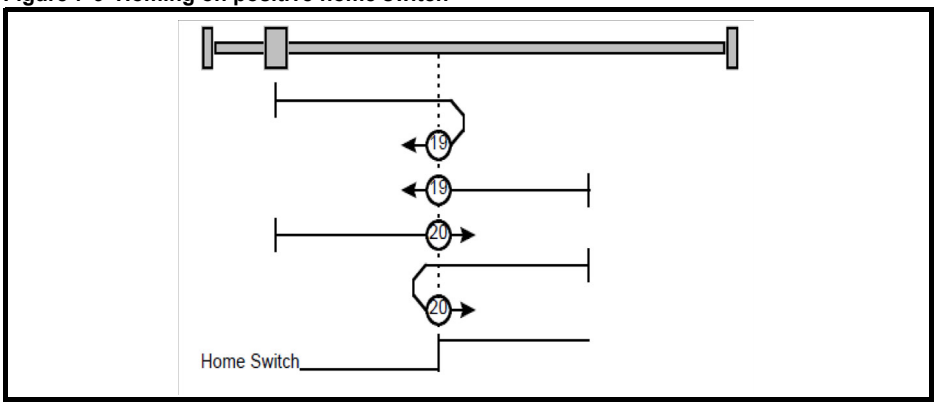
Method 15 and 16: Reserved

These methods are reserved.

Method 17 to 30: Homing without index pulse

These methods are similar to methods 3 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in Figure 7-9 *Homing on positive home switch* on page 95.

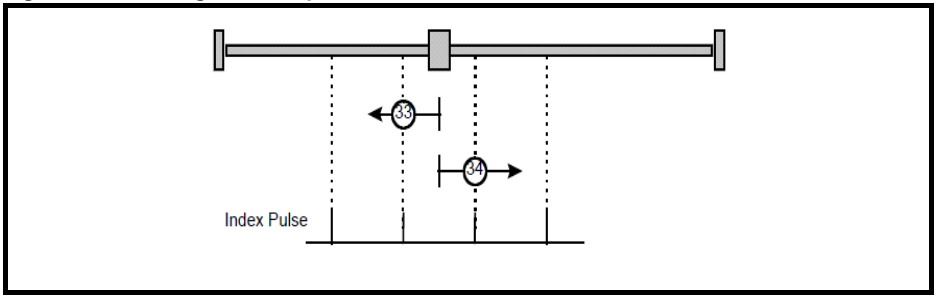
Figure 7-9 Homing on positive home switch



Method 31 and 32: Reserved
These methods are reserved.

Method 33 and 34: Homing on index pulse
Using these methods, the direction of homing is negative or positive respectively. The home position shall be at the index pulse found in the selected direction as shown in Figure 7-10 *Homing on index pulse* on page 95.

Figure 7-10 Homing on index pulse



Method 35 and 37: Homing on the current position
The homing methods 35 and 37 are equivalent, in these methods the current position is taken to be the home position; they do not require the drive to be in OPERATION ENABLED state.

Homing method 35 is a legacy mode.

Use of controlword and statusword
The homing mode uses some bits of the controlword and the statusword for mode-specific purposes. Table 7-65 *Definition of bits 4 and 8 of the controlword* on page 95 defines the values for bits 4 and 8 of the controlword.

Table 7-65 Definition of bits 4 and 8 of the controlword

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

Table 7-66 Definition of bit 10, 12 and 13 of statusword

Bit 13	Bit 12	Bit 10	Definition
0	0	0	Homing procedure is in progress.
0	0	1	Homing procedure is interrupted or not started.
0	1	0	Homing is attained, but target is not reached.
0	1	1	Homing procedure was completed successfully.
1	0	0	Homing error occurred, velocity is not 0.
1	0	1	Homing error occurred, velocity is 0.
1	1	X	Reserved.

7.6.2 Homing mode object definitions

0x3003 Homing source

This object indicates the configured source of the homing switch used during the homing procedure. The following table gives the object description.

Table 7-67 Homing source

0x3003	Homing source object		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 1 to 6	Size: 1 byte	Unit: N/A
Default: 5		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	The source of homing switch. This will specify the number of a drive digital input/output; the selected Digital I/O also needs to be configured as an input. If a value of 0 is selected. The homing switch source is taken from the menu and parameter defined in sub-indexes 3 & 4. There is no checking that the parameter selected in suitable as a marker input, the marker is considered activity when the parameter values is not zero. This value will be read when CiA402 homing operation mode is selected.		
Sub-index 2			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	Freeze or marker source for homing; this value will be read when CiA402 homing operation mode is selected. This will have a value as follows: 0 - Use the marker of the feedback source selected for position feedback (see object 0x3000) 1 - Use the F1 freeze of the selected feedback source (drive or numbered option module). 2 - Use the F2 freeze of the selected feedback source (drive or numbered option module).		
Sub-index 3			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	Menu to be used for the source of homing switch (0 = none). Also, sub-index 1 needs to be set to zero.		

0x3003	Homing source object		
Sub-index 4			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	Parameter to be used for the source of homing switch (0 = none). Also, sub-index 1 needs to be set to zero.		

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 97. 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

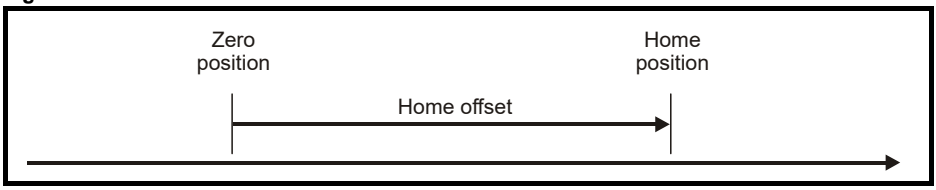


Table 7-68 Home offset

0x607C	Home offset		
Sub-index 0			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User-defined position units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When homing completed to add offset to homed position.	
Motion Profiles: HM			
Description:	Homing offset value.		

0x6098 Homing method

This object indicates the configured homing method that shall be used. The following two tables specify the object description and the value ranges for this object.

Table 7-69 Homing method

0x6098	**Homing method**		
Sub-index 0			
Access: RW	Range: 0 - 37	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: RxPDO		Update Rate: On CiA402 transition to SWITCH_ON	
Motion Profiles: HM			
Description: The homing method that shall be used.			

Table 7-70 Homing method values

Value	Definition
0	No homing method assigned
1	Homing on negative limit switch and index pulse
2	Homing on positive limit switch and index pulse
3..4	Homing on positive home switch and index pulse
5..6	Homing on negative home switch and index pulse
7..14	Homing on home switch and index pulse
15..16	Reserved
17..30	Homing without index pulse
31..32	Reserved
33..34	Homing on index pulse
35	Homing on current position (legacy)
36	Reserved
37	Homing on current position

0x6099 Homing speeds

This object indicates the configured speeds used during the homing procedure. The values shall be given in user-defined velocity units. The following table specifies the object description.

Table 7-71 Homing speeds

0x6099	Homing speeds		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A - Never Changes	
Motion Profiles: HM			
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: On CiA402 transition to SWITCH_ON	
Description: Speed during search for a switch.			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: On CiA402 transition to SWITCH_ON	
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 7-72 *Homing acceleration* on page 99 specifies the object description.

Table 7-72 Homing acceleration

0x609A	Homing acceleration		
Access: RW	Range: 0 to 2^{32}-1	Size: 4 bytes	Unit: User-defined acceleration units
Default: 65536		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: On CiA402 transition to SWITCH_ON	
Motion Profiles: HM			
Description: Indicates the configured acceleration and deceleration to be used during homing operation.			

7.7 Cyclic Synchronous Position Mode

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

Table 7-73 Cyclic synchronous position mode

Index	Name
0x607A	target_position
0x60C0	Interpolation sub-mode select
0x60C2	interpolation_time_period
0x6086	Motion profile type

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

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

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

7.7.1 0x607A Target_position

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

Table 7-74 Target position

0x607A	**Target position**		
Sub-index 0			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User-defined position units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: Every Network Cycle period	
Motion Profiles: CSP, IP, PP			
Description:	Indicates the command positions that the drive should move to in cyclic sync position mode.		

Table 7-75 Interpolation time period

0x60C2	**Interpolation time period**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: CSP, CSV, CST, IP			
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: (sub-index2)
Default: 250		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: On CiA402 transition to SWITCH_ON	
Description:	The number of time units between interpolator restarts. A time unit is defined by sub-index 2. The interpolator time period value will be checked to ensure that it is valid. Valid values are 250 µs, 500 µs or any multiple of 1 ms. Selecting other values will result in an error indication.		
Sub-index 2			
Access: RW	Range: -6 to 0	Size: 1 byte	Unit: N/A
Default: -6 (a time unit of 1 µs)		Type: Signed integer / SINT	
PDO Mappable: No		Update rate: On CiA402 transition to SWITCH_ON	
Description:	This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10 $^{(\text{sub-index 2})}$. The range of values allows for the shortest time unit to be 1 µs, and the longest to be 1s.		

The implementation of cyclic sync position mode will provide linear interpolation, which will always cause a delay of one operating mode cycle. The time specified must always be an integer multiple of the control loop cycle time; this will be checked. Every interpolator time period, a value will be read from the target position object, and the interpolator will generate a new position command to the control loops, every control loop cycle (between the current and new position).

7.7.2 0x6086 Motion Profile Type

This object is used to configure the type of motion to perform in motion profile modes.

Table 7-76 Motion Profile Type

0x6086	Motion Profile Type		
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0		Type: Signed integer / INT	
PDO Mappable: No		Update rate: Read when state changes to Switch On	
Motion Profiles: CSP, PP			
Description:	Motion profile to perform (values less than zero are manufacture specific) -1 = Linear interpolation followed by linear extrapolation on data loss (CSP only see notes) 0 = Linear interpolation terminated on data loss 3 = Jerk limited (PP only) Others - treat same as value 0		

In Cyclic Synchronous Position mode, the AMC always needs to be supplied with updated values every 250 µs, since PDOs may not always be exchanged at 250 µs, interpolation is used by the EtherCAT module to provide linear values calculated from the previous and currently supplied target value. The EtherCAT module can also use extrapolation, this is used when a target value hasn't been supplied in the defined cyclic period caused by a PDO loss. In this case, linear extrapolation of the target value is performed from the last two valid target values until a valid target value is supplied. Extrapolation is currently only supported for Cyclic Synchronous Position mode.

7.8 Cyclic Synchronous Velocity Mode

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

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

The following objects will be supported:

Table 7-77 CSV supported objects

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

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

7.8.1 Velocity actual value

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

Table 7-78 Velocity actual value

0x606C	Velocity actual value		
Access: RO	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: N/A
Default: 0		Type: Signed integer / DINT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: All (where no feedback device this will be an estimate)			
Description:	Indicates the actual velocity feedback value. Value is given User-defined position units per ms.		

7.8.2 Target velocity

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

Table 7-79 Target velocity

0x60FF	Target velocity		
Sub-index 0			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User-defined position per ms
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: Every Network Cycle period	
Motion Profiles: ALL			
Description:	Specifies the target velocity value in User-defined position units per ms.		

7.8.3 0x60B1 Velocity offset

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

Table 7-80 Velocity offset

0x60B1	**Velocity offset**		
Sub-index 0			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: N/A
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: Every Network Cycle Period	
Motion Profiles: CSV			
Description:	Specifies the velocity offset value per thousandths of RPM. (e.g. A value of 1000000 equates to a reference of 1000.0 rpm in drive parameter Pr **03.022**). The target velocity value is added to the velocity offset value to give the final velocity reference value		

7.9 Cyclic Synchronous Torque Mode

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

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

The following objects will be supported:

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

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

7.9.1 Target torque

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

Table 7-81 Target torque

0x6071	**Target torque**		
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: 0.1 %
Default: 0		Type: Signed integer / INT	
PDO Mappable: RxPDO		Update rate: Every Network Cycle period	
Motion Profiles: CST			
Description:	Specifies the target torque value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.00 % in Pr **04.008**)		

7.9.2 0x6073 Maximum current

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

Table 7-82 Maximum current

0x6073	Maximum current		
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: 0.1 %
Default: Derived from Pr 04.007		Type: Unsigned integer / UINT	
PDO Mappable: RxPDO		Update Rate: Background sync with Pr **04.007**	
Motion Profiles: ALL			
Description:	Specifies the maximum current value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr **04.007**) This value is also changed when Pr **04.007** is written to.		

7.9.3 0x6077 Torque actual value

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

Table 7-83 Torque actual value

0x6077	Torque actual value		
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Integer / INT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: ALL			
Description:	Indicates the actual instantaneous torque value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % of Pr **04.003**) *Before V01.06.02*: For open-loop drives, this value is taken from Pr **04.026**, on closed-loop drives this value is taken from Pr **04.003**. *After and including V01.06.02*: This value is taken from Pr **04.026**.		

7.9.4 0x6078 Current actual value

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

Table 7-84 Current actual value

0x6078	Current actual value		
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Integer / INT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: ALL			
Description:	Indicates the actual instantaneous current value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % of 0x6075) *Before V01.06.02*: For open-loop drives, this value is taken from Pr **04.020**, on closed-loop drives this value is taken from Pr **04.004**. *After and including V01.06.02*: This value is taken indirectly from Pr **04.001**		

7.9.5 0x60B2 Torque offset

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

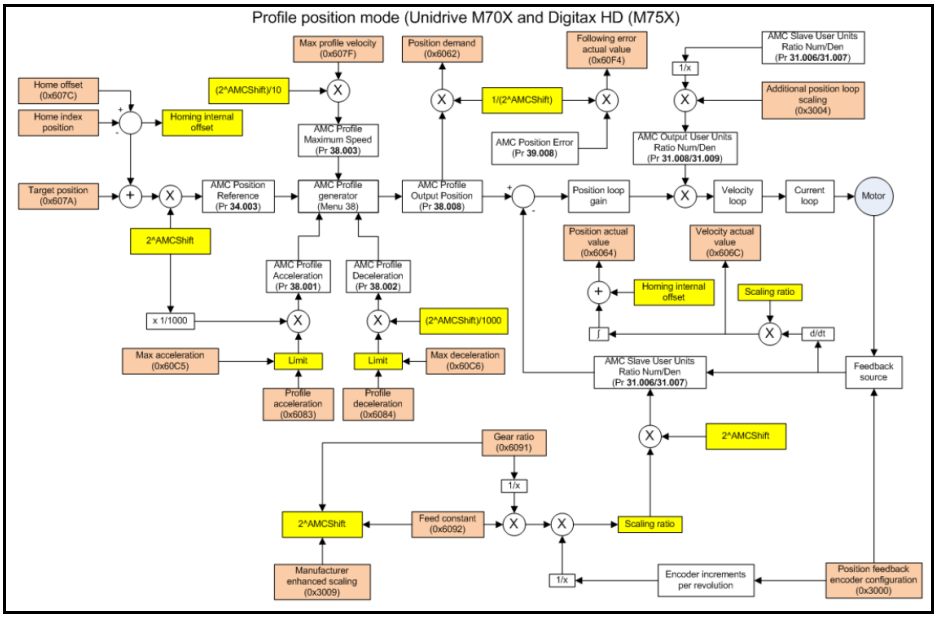
Table 7-85 Torque offset

0x60B2	**Torque offset**		
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: 1/10th of a percentage
Default: 0		Type: Signed integer / INT	
PDO Mappable: RxPDO		Update rate: Every Network Cycle Period	
Motion Profiles: CSP, CSV, CST, IP, PP			
Description:	Indicates the required torque value as a percentage of rated motor torque, Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 %). The value is written to drive parameter Pr **04.008**). The maximum and minimum is defined by parameter Pr **04.024** (which itself is limited by drive size and other parameters). It is therefore for this reason that range for 0x60B2 is set as the maximum range for a signed integer.		

7.10 Profile Position Mode

The profile position mode is only supported on Unidrive M70X and Digitax HD (M75X) drives in RFC-A or RFC-S modes.The profile position mode allows the user to execute point-to-point positioning using the drive position profile generator. The setting of setpoints is controlled by the timing of the *Control word* bits b4 (NEW SETPOINT) and b5 (CHANGE SETPOINT IMMEDIATELY). It is possible to request an absolute position or position relative to the previous absolute position.

The position profile mode allows the handling of a rotary axis setting the axis period in object 0x607B:02 (*Position range limits*).If either of the subindex values are zero, this will disable the function, otherwise the object 0x60F2 (*Positioning option code*) allows the user to configure the rotation direction; relative positioning is not allowed for all option settings. If a relative position is requested but is not allowed due to the setting of object 0x60F2, the setpoint will be discarded on the rising edge of the NEW SETPOINT bit (b4) and the *Status word* acknowledge bit (b12) will not be set.



Control word usage

The Control word for the profile position mode differs from the standard configuration as shown below.

Table 7-86 Profile Position Mode control word usage

Bits	b15-b10	b9	b8	b7	b6	b5	b4	b3-b0
Name		CHANGE ON SETPOINT	HALT		ABSOLUTE or RELATIVE	CHANGE SETPOINT IMMEDIATELY	NEW SET-POINT	

b9	b5	b4	Description
0	0		Process a new setpoint value. If the motor shaft is moving, the new position is buffered (unless the buffer is already busy), the buffered move- ment will start after the current movement completes.
x	1		Process a new setpoint value. The target position is immediately updated even if an existing movement is in progress.
1	0		Not supported. The new setpoint value is ignored.

Bit	Value	
b6	0	The target position in object 0x607A is absolute
	1	The target position is relative to the previous setpoint value
b8	0	The motor shaft can move, the *Control word* bit b4 is evaluated
	1	The motor decelerates according to the object 0x605D (*Halt option code*)

Status word usage

The Status word for the profile position mode differs from the standard configuration as shown below.

Table 7-87 Profile Position mode status word usage

Bits	b15-b14	b13	b12	b11	b10	b9-b0
Name		FOLLOWING ERROR	SETPOINT ACKNOWLEDGE		TARGET REACHED	

Process a new setpoint

The target position, profile velocity, acceleration, deceleration and jerk to be used for the movement are set in objects 0x607A, 0x6081, 0x6083, 0x6084 and 0x60A4 respectively, the CANopen master controller requests a new valid setpoint value by a rising edge on the *Control word* bit b4. The SI-CANopen V2 module then signals the setpoint has been accepted by setting the SETPOINT ACKNOWLEDGE bit b12 in the Status word. No new setpoint can be accepted until this bit is cleared, this bit is cleared when the CANopen master controller clears the *Control word* bit b4 unless the new setpoint is buffered and another movement is in progress, in this case the *Status word* bit b12 remains set until the previous movement completes.

If the new movement requires a change in velocity, acceleration, deceleration or jerk then a minimum delay of 4 ms after the *Control word* bit b4 is written and the *Status word* bit b12 being set will be seen, this delay will increase further if the jerk setting is changed depending on the background task rate. No delay is used if none of the values mentioned are changed.

The following diagram shows an example of the setpoint process when the CHANGE SETPOINT IMMEDIATELY bit (b5) is set.

Figure 7-12 Profile position setpoint example (CHANGE SETPOINT IMMEDIATELY = 1)

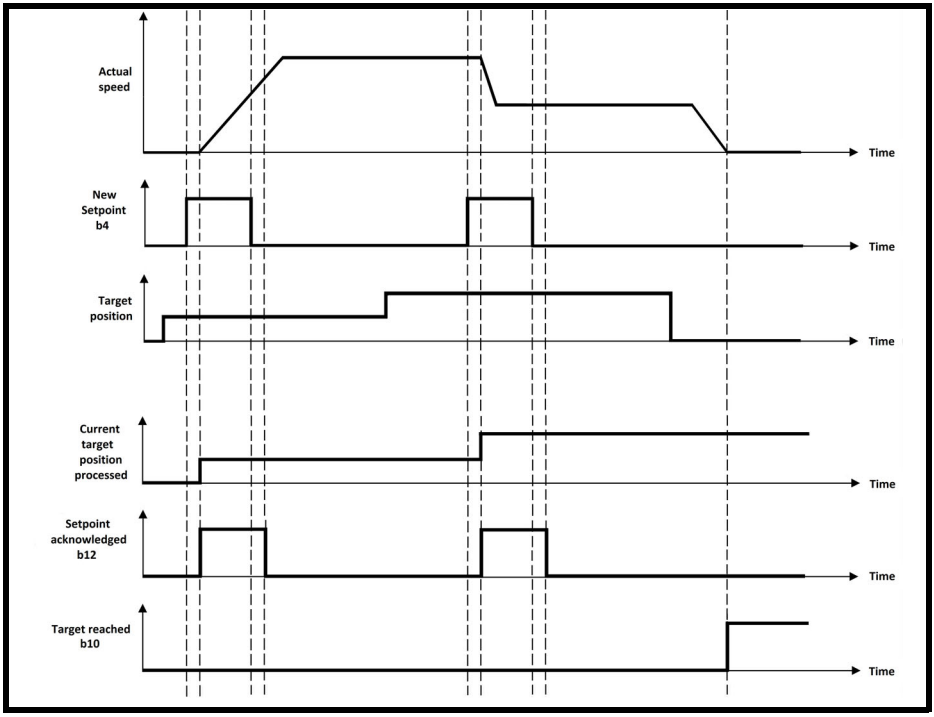
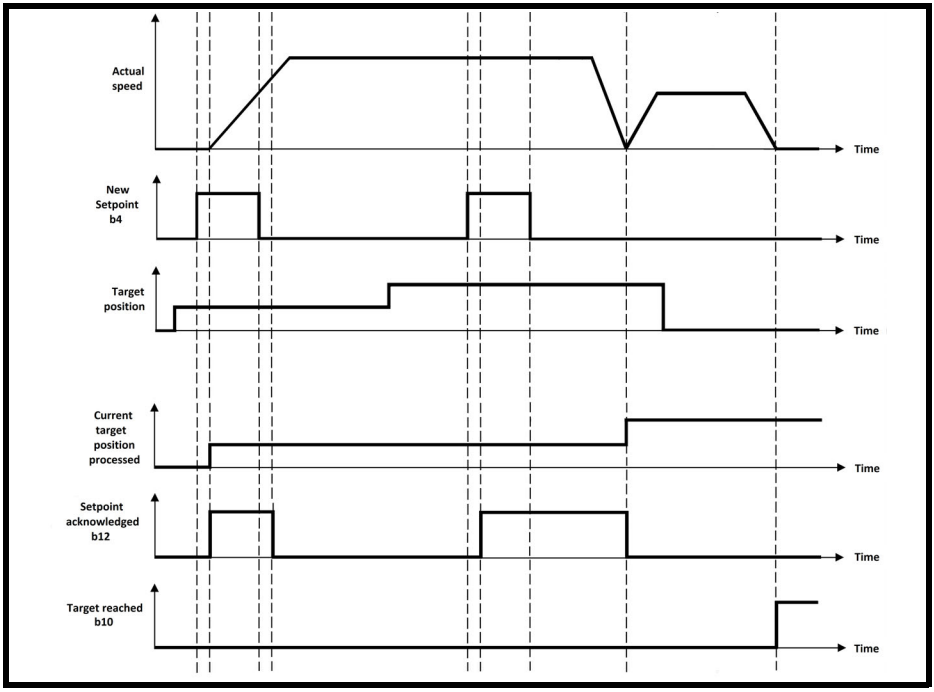


Figure 7-13 Profile position setpoint example (CHANGE SETPOINT IMMEDIATELY = 0)



In addition to the common supported objects, the following Profile Position mode specific objects are supported:

Table 7-88 Profile Position mode supported mode specific objects

Index	Name
0x6067	Position window
0x6068	Position window time
0x606B	Velocity demand value
0x606C	Velocity actual value
0x607B	Position range limit
0x607D	Software position limit
0x6081	Profile velocity
0x6083	Profile acceleration
0x60A4	Profile jerk
0x60C5	Max acceleration
0x60F2	Positioning option code
0x60FA	Control effort

The object descriptions are for those objects unique to this profile, all other objects are detailed elsewhere in this document.

7.10.1 0x606B Velocity Demand ValuePosition window time

The *Velocity Demand Value* object shows the velocity output of the trajectory generator in user units.

Table 7-89 Velocity Demand Value

0x606B	**Torque offset**		
Access: RO	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle period	
Motion Profiles: PP			
Description:	This object shall provide the output value of the trajectory generator. The value shall be given in the user-defined velocity units.		

7.10.2 0x607B Position range limit

This object allows the user to configure the numerical range limit of the position, on reaching or exceeding the limits, the target, actual and demand position values internally wrap to the other end of the range.

A value of 0 in both minimum and maximum range limits will disable the limit function.

The movement direction can be configured using object 0x60F2 (*Positioning option code*). This implementation is particularly targeted to rotary axes.

Table 7-90 Position Range Limit

0x607B	**Position Range Limit**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: PP			
Description:	This object shall indicate the configured maximal and minimal position range limits.		
Sub-index 1			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Description:	Min position range limit. Values other than 0 are not supported for this sub-index.		
Sub-index 2			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Description:	Max position range limit. Negative values are not supported.		

7.10.3 0x607D Software position limit

This object allows the user to configure a software position limits.

Table 7-91 Software Position Limit

0x607D	Software Position Limit		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: PP			
Description: This object shall indicate the configured maximal and minimal position range limits.			
Sub-index 1			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: -2^{31}		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Description: Min position limit.			
Sub-index 2			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: $-2^{31}-1$		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Description: Max position limit.			

7.10.4 0x6081 Profile velocity

This object is used to configure the profile velocity.

Table 7-92 Profile Velocity

0x6081	Profile Velocity		
Access: RW	Range: 0 to 2^{31}	Size: 4 bytes	Unit: User units
Default: 2147483647<		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: When new Setpoint set (PP)	
Motion Profiles: PP			
Description: This object indicates the configured velocity normally attained at the end of the acceleration ramp during a profiled motion and will be valid for both directions of motion. The value is given in user-defined velocity units.			

7.10.5 0x6083 Profile acceleration

This object is used to configure the profile acceleration

Table 7-93 Profile Acceleration

0x6083	Profile Acceleration		
Access: RW	Range: 0 to 2^{31}	Size: 4 bytes	Unit: User units
Default: 65536		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update Rate: When new Setpoint set (PP)	
Motion Profiles: PP			
Description: This object indicates the configured acceleration.			

7.10.6 0x60A4 Profile jerk

This object is supported in the profile position mode only and specifies the jerk rate to be applied.

Table 7-94 Profile Jerk

0x60A4	**Profile Jerk**		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 1		Type: Unsigned integer / USINT	
PDO Mappable: No		Update rate: N/A	
Motion Profiles: PP			
Description: This sub-index returns the last sub-index number for the object.			
Sub-index 1			
Access: RW	Range: -2^{31} to $2^{31}-1$	Size: 4 bytes	Unit: User units
Default: 0		Type: Signed integer / DINT	
PDO Mappable: RxPDO		Update rate: When new Setpoint set (PP)	
Description: This sub-index specifies the profile jerk rate to be applied. It is linked to Pr **38.011** (*AMC Profile Jerk 1*).			

7.10.7 0x60C5 Max Acceleration

This object defines the maximum acceleration in user units.

Table 7-95 Max Acceleration

0x60C5	**Max Acceleration**		
Access: RW	Range: 0 to $2^{32}-1$	Size: 4 bytes	Unit: User units
Default: 32768000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Motion Profiles: PP			
Description: Max Acceleration			

7.10.8 0x60C6 Max Deceleration

This object defines the maximum deceleration in user units.

Table 7-96 0x60C6 Max Deceleration

0x60C6	**Max Acceleration**		
Access: RW	Range: 0 to $2^{32}-1$	Size: 4 bytes	Unit: User units
Default: 32768000		Type: Unsigned integer / UDINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Motion Profiles: PP			
Description: Max deceleration			

7.10.9 0x60F2 Positioning option code

This object is supported in the profile position mode only, it allows the user to configure the behaviour of the positioning system and is evaluated when the profile position mode is selected and on a transition in state from READY TO SWITCH ON to SWITCHED ON.

Table 7-97 Positioning Option Code

0x60F2	**Positioning Option Code**		
Access: RW	Range: Bit mask	Size: 2 bytes	Unit: N/A
Default: 0		Type: Bit Mask / UINT	
PDO Mappable: RxPDO		Update rate: When state changes to Switch On	
Motion Profiles: PP			
Description:	This object shall indicate the configured positioning behaviour as described by the profile positioning mode. Only bits 6 & 7 are used. • Bit 6,7 = 1 Rotary negative only • Bit 6,7 = 2 Rotary positive only • Bit 6,7 = 3 Rotary shortest only		

The bits b6 and b7 configure the movement for rotary axes, the position range limit is enabled, setting object 0x607B:2 (*Maximum position range limit*) to a value other than 0.

This object is ignored if the value of 0x607B:2 (*Maximum position range limit*) is set to 0.

Table 7-98 describes the positioning action depending on the value of this object. Only bits b6 and b7 are supported, all other bits are ignored.

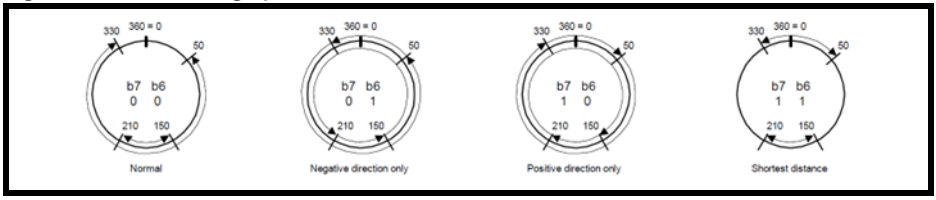
Table 7-98 Positioning option code actions

Bit	**Value**	**Description**
b7	b6	
0	0	Normal positioning. If reaching or exceeding the position range limits (0x607B) the input value wraps to the other end of the range. Positioning can be absolute or relative.
0	1	Positioning only in the negative (reverse) direction. If the requested target position exceeds the actual position, the motor will reverse direction to the requested target position.
1	0	Positioning only in the positive (forward) direction. If the requested target position is lower than the actual position, the motor will move forward using the maximum position limit (0x607B:2) to the requested target position
1	1	Positioning with the shortest distance to the target position. The motor will move either forward or backwards to attain the requested position in the shortest distance possible. If the distance between the actual and target positions are equal in both directions (the distance is half of the maximum position limit), the motor will move forward.

The following diagrams illustrate the movements depending on the selected configuration. In this example the maximum position range limit (0x607B:2) is set to 360º.

All units in the following examples are in degrees (º).

Figure 7-14 Positioning options



A movement greater than the limit (more than 1 revolution) is allowed only if both bits b6 and b7 are set to 0 (i.e. normal mode). If the target position is larger than the maximum position range limit, or it is negative, it is automatically converted to the equivalent modulo position.

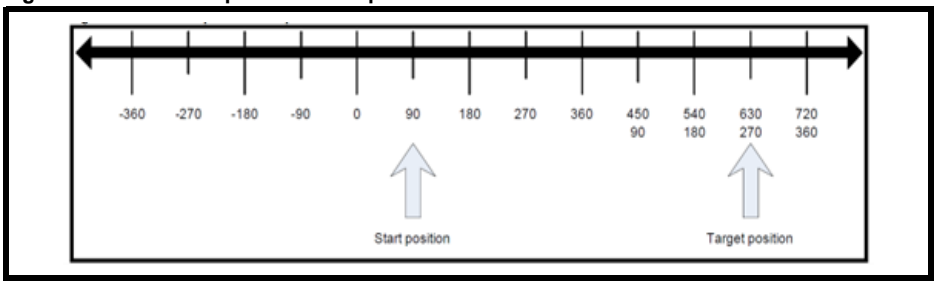
For example, referring to the Normal example above, if the target position requested was 450, then the converted target position would be:

$$\text{Converted target position} = \frac{\text{Requested target position}}{\text{Maximim position range limit}} = \text{mod}\ \frac{450}{360} = 90$$

Figure 7-15 shows an example for an absolute positioning system using the Normal mode and a target position larger than the limit (360 in this example). The actual position is 90 and absolute target position is 630.

The axis will move in the positive (forward) direction from 90, once through the maximum position range limit of 360 to finish at the converted target position of 270 (absolute 630).

Figure 7-15 Absolute position example



The relative positioning is allowed only if the Normal mode is selected (bits b6 and b7 are both 0).

If bits b6 and b7 are not 0 and *Control word* bit b6 (*Abs/Rel)* is set when a new setpoint is applied by *Control word* bit b4 (NEW SETPOINT), the new setpoint will not be processed.

7.10.10 0x60FA Control Effort

This object shows the control effort as the output of the position control loop.

Table 7-99 Control Effort

0x60FA	**Control Effort**		
Access: RO	Range: -2^{32} to $2^{32}-1$	Size: 4 bytes	Unit: N/A
Default: 0		Type: Integer / DINT	
PDO Mappable: TxPDO		Update rate: Every Network Cycle Period	
Motion Profiles: PP			
Description: This object shall provide the control effort as the output of the position control loop.			

8 Advanced features

8.1 Distributed clocks

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

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

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

8.1.1 Time synchronization support

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

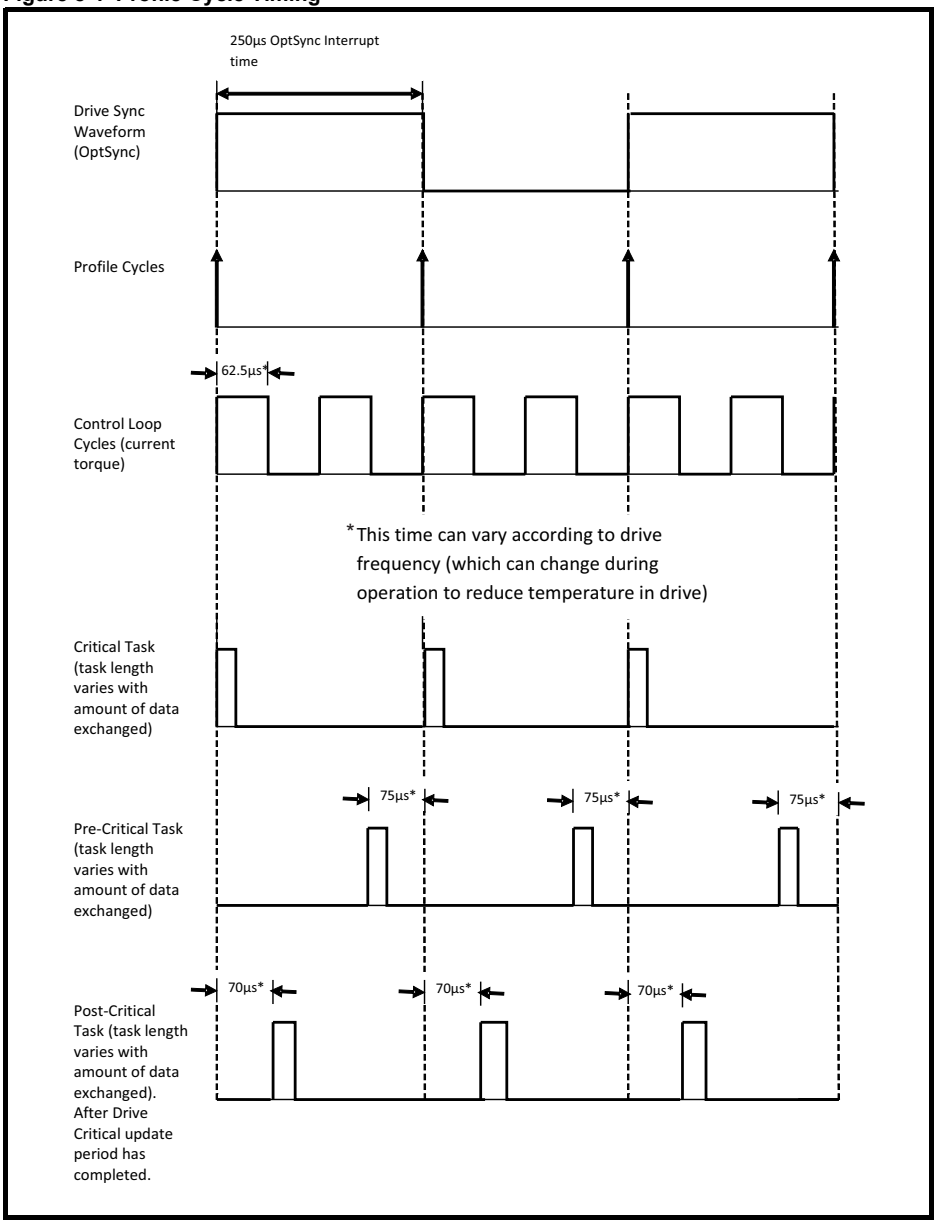
If possible, the option will provide a synchronization signal suitable for the longest interval drive cyclic task (this will also, of course, synchronize the higher rate tasks, if they are phase locked to the lowest rate task).

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

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

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

Figure 8-1 Profile Cycle Timing



8.2 SI-EtherCAT protocol support

The following are supported:

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

8.3 Advanced Cyclic Data Task Configuration

This configuration will allow the timing behaviour of the synchronous cyclic data handling to be modified; specifically, it will allow the tasks in which synchronous cyclic data is handled to be changed. It is recommended the objects are not changed from their default values.

On General Purpose drives, the cyclic data tasks are asynchronous (i.e. there is no OPT_SYNC signal, or equivalent) to the drive tasks; therefore the values of these objects will have no effect.

Table 8-1 Out cyclic data configuration

0x3006	**Out cyclic data configuration**		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on PreOp -> SafeOp transition	
Description:	High priority cyclic data task. Selects the task in which synchronous out (master to slave) cyclic data is copied to the mapped objects, parameters, etc, 0. Pre-Drive Critical update period (default). This is the task that starts execution 75 µs before the OPT_SYNC event. 1. Drive Critical update period. Occurs for the first 70 µs following an edge of the OPT_SYNC signal. 2. Post-Drive Critical update period. The task that occurs immediately after the critical update period.		
Sub-index 2			
Access: RW	Range: 0 to 3	Size: 1 byte	Unit: N/A
Default: 3		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A	
Description:	Reserved		

OPT_SYNC is an internal signal used for synchronisation purposes on drives that support synchronisation.

OPT_SYNC occurs every 250 µs and can be synchronised with the EtherCAT network event SYNC0 (which occurs at a rate dependent on network cycle time configured in the master). For example, if the network cycle time is 1 ms. Four OPT_SYNC events will occur per SYNC0 event. With one of the four OPT_SYNC events aligning with the SYNC0 event.

Data arriving from the Master causes the SM2 event to occur. The relationship of this event relative to SYNC0 is governed by the master, but there should only be one SM2 event per SYNC0 cycle period.

The copy of the data to ma OPT_SYNC is an internal signal used for synchronisation purposes on drives that support synchronisation.

OPT_SYNC occurs every 250 µs and can be synchronised with the EtherCAT network event SYNC0 (which occurs at a rate dependent on network cycle time configured in the master). For example, if the network cycle time is 1 ms. Four OPT_SYNC events will occur per SYNC0 event. With one of the four OPT_SYNC events aligning with the SYNC0 event.

Data arriving from the Master causes the SM2 event to occur. The relationship of this event relative to SYNC0 is governed by the master, but there should only be one SM2 event per SYNC0 cycle period.

The copy of the data to mapped objects, controlled by this object, therefore can only take place after the SM2 event. For example, in a 1 ms cycle with the SM2 occurring 30 % through the cycle, the copy can only take place in either the 2nd or 3rd OPT_SYNC cycle depending on which task is selected for the copy.

Typically, a value of '0' means the copy is scheduled to happen ~80 % through an OPT_SYNC period; a value of '1' means a copy is scheduled to happen ~10 % through an OPT_SYNC period and a value of '2' means a copy is scheduled to happen ~40 % through an OPT_SYNC period. Note: these are approximate figures which will vary based on load, etc.

It should be noted, objects listed below, will take effect on the current or next SYNC0 event. If 0x3006:01 is set to the value of 1 (critical task) and the copy occurs at the OPT_SYNC aligned with SYNC0 the copy takes place first and then the action applied based on this new value.

Although not recommended to change the default value unless necessary, the reasons for adjusting from the default are:

- Avoid skew issues with parameter that are read by applications modules such as the SI-Application family of modules and written by EtherCAT. SI-Applications module may be configured to read parameters in the POS task which overlaps with the EtherCAT post and pre-critical task.
- If the Master sends PDO data too late in the cycle for data to be handled in the pre-critical task (the default). Although the shift offset should be adjusted in the first instance.
- If the master sends PDO data close to the point at which the copy takes place causes data jitter issues. Although the shift offset should be adjusted in the first instance.

The data copy margin i.e. when a copy occurs related to SM2 event; can be observed by monitoring the different values seen for parameter **S.09.024**.

The default values have been carefully selected, so the advice is not to change the default values unless necessary.

Table 8-2 Objects that take effect in Pre-Critical event just before Sync0 event

Object / Subindex	Description
0x60B2	CiA402 Object Torque Offset - CSP, CSV, CST, and IP
0x6071	

Table 8-3 Objects that take effect on SYNC0 event

Object / Subindex	Description
0x60C1:01	CiA402 Interpolation Data Record - IP only
0x607A	CiA402 Target position - CSP only
0x60FF	CiA402 Target Velocity - CSV only
0x60B1	CiA402 Velocity Offset - CSV only

Table 8-4 In cyclic data configuration

0x3007	In cyclic data configuration		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on PreOp -> SafeOp transition	
Description:	High priority cyclic data task. Selects the task in which synchronous in (slave to master) cyclic data is "copied", i.e. made ready for sending to the master. 0. Pre-Drive Critical update period. This is the task that starts execution 75 µs before the OPT_SYNC event. 1. Drive Critical update period. Occurs for the first 70 µs following an edge of the OPT_SYNC signal. 2. Post-Drive Critical update period (default). The task that occurs immediately after the critical update period.		
Sub-index 2			
Access: RW	Range: 0 to 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on PreOp -> SafeOp transition	
Description:	DEPRECATED, Internal Intermediate buffer copy task. 0. Pre Drive Critical update period. 1. Drive Critical update period. 2. Post Drive Critical update period. In nearly all cases this should have the same value as subindex 1. The only reason to change this, is because there is a critical task over-run. This subindex can then be used to reduce the processor loading on the task that has over-run.		

OPT_SYNC is an internal signal used for synchronisation purposes on drives that support synchronisation.

OPT_SYNC occurs every 250 µs and can be synchronised with the EtherCAT network event SYNC0 (which occurs at a rate dependent on network cycle time configured in the master). For example, if the network cycle time is 1 ms. Four OPT_SYNC events will occur per SYNC0 event. With one of the four OPT_SYNC events aligning with the SYNC0 event.

Typically, a value of '0' means the copy is scheduled to happen ~80 % through an OPT_SYNC period; a value of '1' means a copy is scheduled to happen ~10 % through an OPT_SYNC period and a value of '2' means a copy is scheduled to happen ~40 % through an OPT_SYNC period.

NOTE These are approximate figures which will vary based on load, etc.

The copy of the data from mapped objects, takes place every OPT_SYNC period no matter the SYNC0 cycle.

Data to be sent to the Master happens on SM3 event. The relationship of this event relative to SYNC0 is governed by the master, but there should only be one SM3 event per SYNC0 cycle period.

Be-aware, the copy (make ready) of the data from mapped objects occurs every OPT_SYNC cycle, but the SM3 event that sends the data only occurs once every SYNC0 cycle.

Although not recommended to change the default value unless necessary, the reasons for adjusting from the default are:

- Avoid skew issues with parameter that are written by the SI-Applications modules and read by EtherCAT. SI-Applications modules may be configured to write parameters in the POS task which overlaps with the EtherCAT post and pre-critical tasks.
- If the master reads PDO data close to the point at which the copy takes place causes data jitter issues. Although the shift offset should be adjusted in the first instance.

The default values have been carefully selected, so the advice is not to change the default values unless necessary.

8.4 File over EtherCAT (FoE)

File over EtherCAT(FoE) is a simple protocol which allows the EtherCAT exchange files with an EtherCAT slave device.

The following functions are supported with our FoE implementation:

- Drive and option module parameter file upload and download.
- EtherCAT firmware update

NOTE

FoE requires the EtherCAT master support for it to work.

For detailed FoE instructions, refer to the controller's user guide.

8.4.1 Upload and download drive or option module parameter file

Both drive parameters and option module parameters can be backed up (uploaded) and restored (downloaded) using FoE.with the online file download and upload function provided by the controller.

When upload or download a parameter file, a file path is required to locate the parameter file.

The file Path for accessing the drive and option module parameter files is as follows:

/x/par/diff

where "x" becomes the slot number;

/0/par/diff - Drive parameters

/1/par/diff - Option Slot 1 parameters

/2/par/diff - Option Slot 2 parameters

/3/par/diff - Option Slot 3 parameters

/4/par/diff - Option Slot 4 (only available on Unidrive M70x)

Drive parameters or option module parameters are stored in a binary format file type called Parameter Difference File which is only readable by a Control Techniques drive or option module. They can be uploaded and saved as they are without file extensions.

The Parameter difference file generated by the uploading process can be used to restore the drive or option module of the same drive or another drive and option module of the same type.

NOTE

Some controllers set the default file type to.efw file which is a firmware file type When saving the file, make sure to set the file type to 'All Files', so that the parameter file can be saved as a binary file without file extension.

Similarly, when downloading the parameter file, the file type needs to be set to 'All files' for the file to be visible.

8.4.2 Update EtherCAT module firmware

The firmware of the EtherCAT option module itself can be updated via FoE function. Controllers support this function allow the EtherCAT firmware file being downloaded to the connected EtherCAT option module using the online firmware update function.

The EtherCAT firmware file is .img file provided by Control Techniques. Which can be downloaded to the following file path in the EtherCAT option module:

/fw/app

Follow the instructions of the controller's user guide to activate the firmware download. After a successful firmware download, the EtherCAT module will reboot to the new firmware version.

NOTE Some controllers set the default firmware file type to .efw. The file type needs to be set to 'All Files' for the EtherCAT firmware file to be visible.

Firmware of drive or option modules in other slots cannot be updated.

Only firmware download for the connected EtherCAT module is supported, firmware upload is not supported.

8.5 Functional Safety over EtherCAT (FSoE)

SI-EtherCAT module supports FSoE. It can be used to implement an FSoE network together with the MiS210 and MiS250 safety modules. The MiS210 and MiS250 (MiS2x0) safety modules are Certified Product and listed by TÜV Rheinland on certificate 01/205/5720.01/24.

NOTE For more details on implementing an FSoE network with the MiS210 and MiS250 safety modules, please refer to MiS210 and MiS250 Safety Modules Installation and Operating Manual (Part Number:0478-0665-03)

8.6 Drive Type and Mode Override

In order to provide Unidrive SP compatibility and drives of different type and mode to be able to replace each other, parameter Pr **S.00.049**, Drive Type/Mode Override, can be used to select the following override functions:

- Unidrive SP compatibility
- Mode agnostic
- M200/M300 agnostic

See also the parameter description in chapter 9 for details.

8.6.1 Unidrive SP compatibility

When Pr **S.00.049** is set to "Unidrive SP"(1),the drive will be identified as a Unidrive SP and simulate the SP parameters.

The following parameters accessed via the Object dictionary, are adjusted to simulate access as if the drive is a Unidrive SP.

Object 0x1018 Subindex 2
When in Unidrive SP override, the following product codes are returned depending on the Drive Mode.

Table 8-5 Product codes in Unidrive SP override

Drive Mode	Value
RFC-A	0x30003
RFC -S	0x40003
Open Loop	0x10003
Regen	Same as before, no over-ride of product code

Objects Mapped To Parameters That May Not Exist In A Unidrive M

When in Unidrive SP override, the following parameters will be available (via the CoE object mapping mechanism) that may or may not exist on the drive (depending on the model). If they do exist, reading and writing work as expected. If they do not exist, a write will succeed, and a read will return zero.

Table 8-6 Parameters may not exist in Unidrive M

Object / Subindex	Corresponding Unidrive SP parameter	Unidrive SP parameter name - for the corresponding menu/ parameter number
0x2005:17	Pr 5.17	Stator Resistance
0x2006:22	Pr 6.22	Run time years and days
0x2006:23	Pr 6.23	Run time hours and minutes
0x2006:24	Pr 6.24	Metered Power MWh
0x2006:25	Pr 6.25	Metered Power kWh
0x2007:19	Pr 7.19	Analogue Output Source
0x2007:20	Pr 7.20	Analogue Output Scaling
0x2007:21	Pr 7.21	Analogue Output Mode
0x2015:12	Pr 21.12	Stator Resistance

Objects Redirected To Other Parameters

When in Unidrive SP override, the following Unidrive SP parameters will be available (via the CoE object mapping mechanism) that map to different parameters on the drive. If they do exist, reading and writing work as expected. If they do not exist, a write will succeed, and a read will return zero.

Table 8-7 Objects redirected to other parameters

Object / Subindex	Unidrive SP parameter	Corresponding Unidrive M parameter	Unidrive SP Parameter Name
0x2006:22	Pr 6.22	Pr 06.016	Run time years and days
0x2006:23	Pr 6.23	Pr 06.017	Run time hours and minutes
0x2006:24	Pr 6.24	Pr 06.025	Metered Power MWh
0x2006:25	Pr 6.25	Pr 06.026	Metered Power kWh

Objects That Require Additional Configuration To Work As Expected For Unidrive SP

When in Unidrive SP override, the Run time (years/days/hours/minutes) will only return valid values if the Unidrive M Date/Time Selector (Pr **06.019** is set to Running (2)).

Objects Values That Are Correctly Scaled To Be Same As Unidrive SP

When in Unidrive SP override, the resolution and size of some on the objects are different to that for Unidrive M, so a conversion function is invoked when reading and writing to the corresponding objects.

It must be noted that there may be a loss of accuracy and possible rounding errors. The effected objects (if the corresponding parameter exists) are as follows:

Table 8-8 Objects that are scaled to be the same as Unidrive SP

Object / Subindex	Corresponding Unidrive SP parameter	Unidrive SP parameter name - for the corresponding menu/ parameter number
0x2003:10	Pr 3.10	Speed Controller proportional Gain Kp1
0x2003:34	Pr 3.34	Rotary Lines per Revolution
x02003:46	Pr 3.46	Drive encoder reference destination
0x2004:01	Pr 4.01	Current magnitude
0x2004:02	Pr 4.02	Active current
0x2005:3	Pr 5.03	Output Power
0x2005:7	Pr 5.07	Motor rated current
0x2005:17	Pr 5.17 (*)	Stator Resistance
0x2005:18	Pr 5.18	Maximum Switching Frequency
0x2005:29	Pr 5.29	Motor saturation breakpoint 1
0x2005:30	Pr 5.30	Motor saturation breakpoint 2
0x2006:22	Pr 6.22 (*)	Run time years and days
0x2006:23	Pr 6.23 (*)	Run time hours and minutes
0x2007:02	Pr 7.02	Analogue input Level
0x2007:03	Pr 7.03	Analogue input Level
0x2007:10	Pr 7.10	Analogue input Destination
0x2007:14	Pr 7.14	Analogue input Destination
0x2007:18	Pr 7.18	Analogue input Destination
0x2007:19	Pr 7.19 (*)	Analogue Output Source
0x2007:20	Pr 7.20 (*)	Analogue Output Scaling
0x2007:22	Pr 7.22	Analogue Output Source
0x2007:31	Pr 7.31	Analogue Input Offset
0x2007:32	Pr 7.32	Analogue Input Offset
0x2008:21	Pr 8.21	Digital I/O Source / Destination
0x2008:22	Pr 8.22	Digital I/O Source / Destination
0x2008:23	Pr 8.23	Digital I/O Source / Destination
0x2008:24	Pr 8.24	Digital I/O Source / Destination
0x2008:25	Pr 8.25	Digital I/O Destination
0x2008:26	Pr 8.26	Digital I/O Destination
0x2008:27	Pr 8.27	Relay Source
0x2008:28	Pr 8.28	24 V output source
0x2009:04	Pr 9.04	Logic Function Source
0x2009:06	Pr 9.06	Logic Function Source
0x2009:10	Pr 9.10	Logic Function Destination
0x2009:14	Pr 9.14	Logic Function Destination
0x2009:16	Pr 9.16	Logic Function Source
0x2009:20	Pr 9.20	Logic Function Destination
0x2009:25	Pr 9.25	Motorised pot destination
0x2009:33	Pr 9.33	Binary Sum destination
0x2009:41	Pr 9.41	Timer Destination
0x2009:53	Pr 9.53	Timer Destination
0x200B:22	Pr 11.22	Parameter displayed at power-up
0x200B:32	Pr 11.32	Maximum Heavy Duty current rating
0x200C:03	Pr 12.03	Threshold detector source

Object / Subindex	Corresponding Unidrive SP parameter	Unidrive SP parameter name - for the corresponding menu/ parameter number
0x200C:07	Pr 12.07	Threshold detector destination
0x200C:08	Pr 12.08	Variable Selector source
0x200C:09	Pr 12.09	Variable Selector source
0x200C:11	Pr 12.11	Variable Selector destination
0x200C:23	Pr 12.23	Variable Selector source
0x200C:27	Pr 12.27	Threshold detector destination
0x200C:28	Pr 12.28	Variable Selector source
0x200C:29	Pr 12.29	Variable Selector source
0x200C:31	Pr 12.31	Variable Selector destination
0x200E:02	Pr 14.02	PID main reference source
0x200E:03	Pr 14.03	PID reference source
0x200E:04	Pr 14.04	PID feedback source
0x200E:09	Pr 14.09	PID optional enable source
0x200E:27	Pr 14.27	PID optional enable source parameter
0x200E:33	Pr 14.33	PID reference source
0x200E:34	Pr 14.34	PID feedback source
0x200E:46	Pr 14.46	PID output destination
0x2015:07	Pr 21.07	Read Current
0x2015:12	Pr 21.12 (*)	Stator Resistance
0x2015:25	Pr 21.25	Motor saturation breakpoint 1
0x2015:26	Pr 21.26	Motor saturation breakpoint 2

(*) Objects that are always present, even if the Unidrive M parameter is not available, see earlier section on objects that are always available.

NOTE We strongly recommend the drive is configured to be what it is whenever a change of system configuration from PLC side is possible

The Undrive SP Compatibility mode cannot provide full compatibility to a Unidrive SP drive. It should only be considered when change the system configuration is not allowed.

We cannot guarantee the compatibility of the functions, users should evaluate the compatibility function according to the individual application themselves.

8.6.2 Mode agnostic

When Pr **S.00.049** is set to "Mode Agnostic" (2) override is selected, the Object 0x1018:02 reports a mode agnostic product code. i.e., the same product code for all modes. This allows an EtherCAT master to change the drive mode, without the slave product code changing and thereby avoiding the error that the slave seems to have changed.

The mode agnostic

The "Mode Agnostic" (2) override is used for high performance drives. For those drives support mode agnostic function, a mode agnostic device type has been integrated in the ESI file. If the mode agnostic function is used, the mode agnostic device type should be configured.

NOTE The mode agnostic drive uses the preconfigured PDO mappings (PDO6, defaults for vl velocity mode) in ESI file. It needs to select the appropriate preconfigured PDO or edit the mappings manually as the application requires.

To change drive mode, defaulting the slot parameters (specifically, parameter Pr S.00.049) should be avoided. This is done by using the special codes 1255 (50 Hz) /1256 (60 Hz) when writing to Pr MM.000 (where MM is any menu). First set Pr 11.031 to the new mode, then write 1255 to Pr MM.000 and finally press the reset button (which can also be done by writing 100 to Pr 10.038).

8.6.3 M200 and M300 agnostic

Pr **S.00.049** can also be set to "M200 Agnostic" (2) or "M300 Agnostic"(3). When the host drive is a general purpose drive, selecting "M200 Agnostic" (2) or "M300 Agnostic"(3), will make the drive appear to be Unidrive M200 or M300 respectively.The Object 0x1018:02 reports as if the drive was an M200 or M300. i.e. the same product code as that for M200 or M300. This allows a Commander C200/300 to be used in place of an M200/300, without the need to change the system configuration from PLC side.

8.6.4 Enhanced loop control

A manufacture specific object 0x3009, enhanced loop control, is added to fine control over the AMC loop control.

Table 8-9 Enhanced Loop Control

0x3009	**Enhanced Loop Control**		
Access: RW	Range: 0 to 1	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	This object can be used to change the behaviour of the closed loop control. 0. = default, standard behaviour 1. = where possible use Master AMC scaling as opposed to Slave AMC scaling so maximum encoder resolution is used in the AMC closed loop		

AMC Master scaling is only available when performing position control, so this only currently applies to Cyclic Synchronous Position Mode.

8.6.5 Window Filter

A window filter before interpolation can be enabled when the application requires. If the window filter is enabled, the target values are fed through a window filter, the output of that window filter is then the input to the interpolation.

Table 8-10 Window Filter Size

0x300A	**Window Filter Size**		
Access: RW	Range: 0 to 4	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: New value used on CiA402 transition to SWITCH_ON	
Description:	2. = Disable window filter 3. = Window filter size 2 x interpolation period 4. = Window Filter size 4 x interpolation period 5. = Window Filter size 8 x interpolation period 6. = Window Filter size 16 x interpolation period		

The Window filter follows the following equations:

$$Y(n) = Y(n-1) + \frac{X(n)}{s} - \frac{X(n-S)}{s} \quad \text{When } n>S$$

$$Y(n) = Y(n-1) + \frac{X(n)}{s} - \frac{X(0)}{s} \quad \text{When } n<=S$$

$Y(0) + X(0)$ when $n = 0$

Where:

- n is the iteration i.e. increments after each new target position arrives. n = 0 when entering CiA402 operational state.
- Y(n) is the window filter output at the nth iteration of the filter.
- Y(n-1) is the window filter output at the (n-1)th iteration (i.e. the previous iteration)
- X(n) is the window filter input at the nth iteration of the filter.
- S is a constant, the size of the filter
- X(n-S) is the window filter input at the (n-S) iteration.

The window filter is executed at the rate of the EtherCAT cycle time; hence it operates before the interpolator.

NOTE One of the side effects of the window filter is to add a delay in the feedback loop. Therefore, the following error, as seen by the PLC, will be increase by the length of the filter. The EtherCAT module does not hide this fact so it will impact on status word target reached flag which will no longer indicate target reached if the increase in following error exceeds the position window object setting (0x6067).

9 Parameter descriptions

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

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

9.1 Internal menus

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

Table 9-1 SI-EtherCAT internal menus

Menu	Name	Description
S.00	Setup	Provides module information such as firmware version and serial number
S.01	ECAT Status	Provides information on the EtherCAT network status
S.02	EoE Status	Provides information on the Ethernet over EtherCAT status and configuration
S.03	Motion Profile	Provides information on CiA402 Motion profile
S.09	Resources	Provides information on the module task resources and PCB temperature

9.2 Parameter type codes

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

Table 9-2 Parameter type codes

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

9.3 Single line parameter descriptions

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

Parameter		Range	Default	Access	Size (Bits)
S.00.000	Parameter mm.00	0 to 65535		RW	16
S.00.001	Module ID	0 to 65535		RO	16
S.00.002	Firmware version	00.00.00.00 to 99.99.99.99		RO	32
S.00.003	Hardware version	0 to 65535		RO	16
S.00.004	Serial number LS	0 to 99999999		RO	32
S.00.005	Serial number MS	0 to 99999999		RO	32
S.00.006	Module status	-2 to 3		RO	8
S.00.007	Module reset	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.008	Module default	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.010	EtherCAT RUN Status	1 to 8		RO	8
S.00.031	Slot indicator	1 to 8		RO	8
S.00.032	Slot menu number	0 to 255		RO	8
S.00.033	Drive has control	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.034	Allow EEPROM Upgrade	0 to 2	0 (Off)	RW	1
S.00.035	ECAT Device ID	0 to 65535	0	RW	16
S.00.036	Consistency trigger for synchronous outputs	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.037	Consistency trigger parameter for synchronous outputs	0.00.000 to 9.99.999	0.00.000	RW	32
S.00.038	Consistency trigger for synchronous inputs	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.039	Consistency trigger parameter for synchronous inputs	0.00.000 to 9.99.999	0.00.000	RW	32
S.00.040	Consistency trigger for non-synchronous outputs	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.041	Consistency trigger parameter for non-synchronous outputs	0.00.000 to 9.99.999	0.00.000	RW	32
S.00.042	Consistency trigger for non-synchronous inputs	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.043	Consistency trigger parameter for non-synchronous inputs	0.00.000 to 9.99.999	0.00.000	RW	32
S.00.045	Homing position save	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.046	Homing position parameter	51 to 54	51	RW	8
S.00.047	FSoE Black Channel	0 (Off) to 1 (On)	0 (Off)	RW	1
S.00.048	Compatibility	0 to 65535	0	RW	16
S.00.049	Drive Type/Mode Override	0 to 4	0	RW	8

Table 9-4 Menu 1 parameters (EtherCAT Status)

Parameter		Range	Default	Access	Size (Bits)
S.01.000	Parameter mm.00	0 to 65535		RW	16
S.01.001	EtherCAT RUN indicator	0 (Unknown State) to 8 (Op)		RO	8
S.01.002	PDO Accesses per second	0 to 65535		RO	16
S.01.004	Mapped parameter xx.000	0 to 65535		RW	16
S.01.005	FSoE Msgs per second	0 to 65535		RO	16
S.01.006	FSoE Black Channel State	-3 to 5		RO	8
S.01.007	Fast Watchdog	-1 to 1		RW	8

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

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

Table 9-6 Menu 3 parameters (CiA402 Motion Profile)

Parameter		Range	Default	Access	Size (Bits)
S.03.000	Parameter mm.00	0 to 65535		RW	16
S.03.002	CiA402 Home Status	0 to 1		RO	1
S.03.003	Stop on Digital Input Count	0 to 2^{32}-1		RO	16
S.03.010	Motion step Behaviour	0 (Default) to 1 (Controlled stop)	0	RW	8

Table 9-7 Menu 9 parameters (Resources)

Parameter		Range	Default	Access	Size (Bits)
S.09.000	Parameter mm.00	0 to 65535		RW	16
S.09.009	Background Task Period	0 to 65535		RO	16
S.09.010	Pre-critical task % free	0 to 100		RO	8
S.09.011	Critical task % free	0 to 100		RO	8
S.09.012	Post-critical task % free	0 to 100		RO	8
S.09.020	Pre-critical task worst % free	0 to 100		RO	8
S.09.021	Critical task worst % free	0 to 100		RO	8
S.09.022	Post-critical task worst % free	0 to 100		RO	8
S.09.023	Deprecated Parameter	0 to 100		RO	8
S.09.024	OutData Margin	-2147483648 to 2147483647		RO	32
S.09.030	PCB Temperature	-128 to 127		RO	8
S.09.039	Active Alarm Bits	0 to 65535		RO	16
S.09.040	Diagnostic Counter Selector	0 to 8	0	RW	8
S.09.041	Diagnostic Counter Value	0 to 2^{32}-1		RO	32
S.09.042	Deprecated Parameter	0 to 65535		RO	16
S.09.043	Worst drive to network sync time	0 to 65535		RO	16
S.09.050	Object index view selector 1	0 to 65535	0	RW	16
S.09.051	Object subindex view selector 1	0 to 255	0	RW	8
S.09.052	Object view value 1	-2147483648 to 2147483647		RO	32
S.09.053	Object index view selector 2	0 to 65535	0	RW	16
S.09.054	Object subindex view selector 2	0 to 255	0	RW	8
S.09.055	Object view value 2	-2147483648 to 2147483647		RO	32
S.09.056	Object index view selector 3	0 to 65535	0	RW	16
S.09.057	Object subindex view selector 3	0 to 255	0	RW	8
S.09.058	Object view value 3	-2147483648 to 2147483647		RO	32

9.4 Full parameter descriptions

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

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

Table 9-8 Module ID

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

The option module ID. SI-EtherCAT is 431. For Factory Fitted EtherCAT module, the option module ID is 435.

Table 9-9 Firmware version

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

Module firmware version in ww.xx.yy.zz format.

Table 9-10 Hardware version

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

Contains the modules hardware version information in the format xx.yy.

Table 9-11 Serial number LS

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

The module serial number is available as a pair of 32-bit values where Serial Number LS (**S.00.004**) provides the least significant 8 decimal digits and Serial Number MS (**S.00.005**) provides the most significant 8 decimal digits. The reconstructed serial number is ((**S.00.005*** 100000000) + **S.00.004**). For example serial number "0001234567898765" would be stored as **S.00.005** = 12345, **S.00.004** = 67898765.

Table 9-12 Serial number MS

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

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

Table 9-13 Status

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

Table 9-14 Values of module Status

Value	Text	Description
-3	Bootstrap	Master has requested boot strap mode
-2	Bootldr - Update	The bootloader is performing a flash update
-1	Bootldr - Idle	The bootloader is idle
0	Initializing	The firmware is currently Initializing.
1	OK	The firmware is initialised and no errors have been detected.
2	Config	A configuration error has been detected.
3	Error	An error has occurred preventing the firmware from running correctly.

Table 9-15 Reset

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

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

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

Table 9-16 Default

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

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

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

Table 9-17 EtherCAT RUN status

S.00.010	EtherCAT RUN status		
Minimum	1	Maximum	8
Default		Units	
Type	8 bit volatile	Update Rate	Background
Display Format	Standard	Decimal Places	0
Coding	RO, TE, ND, NC, PT, BU		

This parameter displays the EtherCAT Conformant run state. The text displayed conforms to ETG1300

Table 9-18 Values of EtherCAT RUN status

Value	Text	Description
1	NET RN Init	Initial
2	NET RN PreOp	Pre Operational
3	NET RN Boot	Boot
4	NET RN SafeOp	Safe Operational
5	Unknown State	Unknown State
6	Unknown State	Unknown State
7	Unknown State	Unknown State
8	NET RN Op	Operational

Table 9-19 Slot indicator

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

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

Table 9-20 Slot menu number

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

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

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

Slot 1 - Menu 15

Slot 2 - Menu 16

Slot 3 - Menu 17

Slot 4 - Menu 24

Table 9-21 Disable drive control

S.00.033	Drive has control		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0	Units	
Type	1 bit User Save	Update Rate	Read in background
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

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

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

Change to the parameter will take effect without a module reset, however the switch follows the switch of the control operates as the following:

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

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

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

Table 9-22 Allow EEPROM Upgrade

S.00.034	Allow EEPROM Upgrade		
Minimum	0 (Display: Off)	Maximum	2 (Display: Force Default)
Default	0	Units	
Type	1 bit User Save	Update Rate	Read in background
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

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

Table 9-23 Values of Allow EEPROM upgrade

Value	Text	Description
0	Off	This does not allow the user to update EEPROM.
1	User Update	This allows the user to update the EEPROM using ECMP.
2	Force Default	Default EEPROM back to original state. Effective after reset.

Table 9-24 EtherCAT device ID

S.00.035	EtherCAT device ID		
Minimum	0	Maximum	65535
Default	0	Units	
Type	16 bit User Save	Update Rate	Read on power up
Display Format	None	Decimal Places	0
Coding	RW, NC, PT, BU, US		

This parameter is used to configure an Explicit EtherCAT Device ID, which can be used to uniquely identify a particular slave. A value of 0 disables Explicit Device ID. If this value is changed, it is necessary to reset the option for the new value to take effect (e.g. by saving parameters and performing a power cycle). If this value is left at the default value of zero, any value stored in the EtherCAT EEPROM (SII) will take precedence. If the value in the EEPROM and value here are both non-zero a race condition is flagged as per ETG1020. On A M753 the rotary switch takes precedence over this value and this value will be updated with the value from the rotary switch (if rotary switch is non-zero).

Table 9-25 Consistency trigger for synchronous output

S.00.036	Consistency trigger for synchronous output		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0 (Display: Off)	Units	None
Type	1 bit User Save	Update Rate	EtherCAT state transition
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

See Consistency trigger parameter for synchronous outputs (**S.00.037**) for details.

Table 9-26 Sync OUT consistency trigger parameter

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

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

When the output consistency is enabled in Consistency trigger for synchronous outputs (**S.00.036**), this configured parameter is used to control the data exchange, ensuring skew does not occur; a user program, etc, must check the configured parameter is 1 before reading the data received over the EtherCAT network, and it should clear the parameter to 0 after all the data has been read.

The EtherCAT Module will check that the parameter is 0 before writing RxPDO destinations and will set the parameter to 1 after the RxPDO destinations have been written.

Table 9-27 Consistency trigger for synchronous inputs

S.00.038	Consistency trigger for synchronous inputs		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0 (Display: Off)	Units	None
Type	1 bit User Save	Update Rate	EtherCAT state transition
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

See Consistency trigger parameter for synchronous inputs (**S.00.039**) for details

Table 9-28 Consistency trigger parameter for synchronous inputs

S.00.039	Consistency trigger parameter for synchronous inputs		
Minimum	0 (Display: 0.00.000)	Maximum	1 (Display: 9.99.999)
Default	0 (Display: 0.00.000)	Units	None
Type	32 bit User Save	Update Rate	EtherCAT state transition
Display Format	SMP	Decimal Places	0
Coding	RW, DE		

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

When the input consistency is enabled in Consistency trigger for synchronous inputs (**S.00.038**), this configured parameter is used to control the data exchange, ensuring skew does not occur; a user program, etc, must check the configured parameter is 0 before writing the data to be transmitted over the EtherCAT network, and it should set the parameter to 1 after all the data has been written.

The EtherCAT Module will check that the parameter is 1 before reading TxPDO sources and will set the parameter to 0 after the TxPDO sources have been read.

Table 9-29 Consistency trigger for non-synchronous outputs

S.00.040	Consistency trigger for non-synchronous outputs		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0 (Display: Off)	Units	None
Type	1 bit User Save	Update Rate	EtherCAT state transition
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

See Consistency trigger for non-synchronous outputs (**S.00.041**) for details

Table 9-30 Consistency trigger parameter for non-synchronous outputs

S.00.041	Consistency trigger parameter for non-synchronous outputs		
Minimum	0 (Display: 0.00.000)	Maximum	1 (Display: 9.99.999)
Default	0 (Display: 0.00.000)	Units	None
Type	32 bit User Save	Update Rate	EtherCAT state transition
Display Format	SMP	Decimal Places	0
Coding	RW, DE		

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

When the output consistency is enabled in Consistency trigger for non-synchronous outputs (**S.00.040**), this configured parameter is used to control the data exchange, ensuring skew does not occur; a user program, etc, must check the configured parameter is 1 before reading the data received over the EtherCAT network, and it should clear the parameter to 0 after all the data has been read.

The EtherCAT Module will check that the parameter is 0 before writing RxPDO destinations and will set the parameter to 1 after the RxPDO destinations have been written

Table 9-31 Consistency trigger for non-synchronous inputs

S.00.042	Consistency trigger for non-synchronous inputs		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0 (Display: Off)	Units	None
Type	1 bit User Save	Update Rate	EtherCAT state transition
Display Format	Bit	Decimal Places	0
Coding	RW, Bit		

See Consistency trigger parameter for non-synchronous inputs(**S.00.043**) for details

Table 9-32 Consistency trigger parameter for non-synchronous inputs

S.00.043	Consistency trigger parameter for non-synchronous inputs		
Minimum	0 (Display: 0.00.000)	Maximum	1 (Display: 9.99.999)
Default	0 (Display: 0.00.000)	Units	None
Type	32 bit User Save	Update Rate	EtherCAT state transition
Display Format	SMP	Decimal Places	0
Coding	RW, DE		

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

When the input consistency is enabled in Consistency trigger for non-synchronous inputs (**S.00.042**), this configured parameter is used to control the data exchange, ensuring skew does not occur; a user program, etc, must check the configured parameter is 0 before writing the data to be transmitted over the EtherCAT network, and it should set the parameter to 1 after all the data has been written.

The EtherCAT Module will check that the parameter is 1 before reading TxPDO sources and will set the parameter to 0 after the TxPDO sources have been read.

Table 9-33 Home position save

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

Used to control if Homing Position is saved and used at start-up, see Homing Position Parameter (**S.00.046**) for details.

Table 9-34 Homing position parameter

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

The SI-EtherCAT module provides a method to save the absolute home position. This parameter is used to define the parameter in menu 18 that is used to save the homing position. This is limited to the 32 bit power-down save parameters. For example, a value of 51means the power-down save long integer parameter Pr 18.051 will be used to save the home position.

The defined parameter will be updated at the end of homing and then read on initialisation as the Homing Position if Homing Position Save (**S.00.045)** is set to true.

Table 9-35 FSoE Black Channel enable

S.00.047	FSoE Black Channel enable		
Minimum	0 (Display: Off)	Maximum	1 (Display: On)
Default	0 (Display: Off)	Units	None
Type	1 bit User Save	Update Rate	Read in reset
Display Format	Standard	Decimal Places	0
Coding	RW, PT		

The EtherCAT module evaluates this parameter during the reset: if it set to "On", the black channel is enabled, starting the handshake communication with the MiS2x0 safety module. If the parameter value is "Off" during reset, no FSoE functionalities are available and no related constraints apply.

NOTE The status of this parameter doesn't indicate if the exchange of the FSoE frames with the MiS2x0 module is active: the FSoE Black Channel State (**S.01.006**) shall be referred instead.
Any changes to this parameter have no effect if the module is not reset.
For more safety related information, refer to MiS2x0 safety module user guide.

Table 9-36 Compatibility

S.00.048	Compatibility		
Minimum	0 (Display 0000000000000000)	Maximum	1 (Display: 1111111111111111)
Default	0 (Display 0000000000000000)	Units	None
Type	16 bit User Save	Update Rate	Read in reset
Display Format	Binary	Decimal Places	0
Coding	RW, PT, BU		

This is a bit mask of 16 bits for legacy feature backward compatibility, each bit defines a legacy feature(s) to be enabled.

NOTE Enabling a Legacy feature means SI-EtherCAT is no longer fully Conformant.

It is not recommended to use this parameter (leave set to value 0), only use if it is really necessary for backwards compatibility purposes.

This parameter will be subject to change between releases, ask Control Techniques for further details if required.

Table 9-37 Drive Type/Mode Override

S.00.049	Drive Type/Mode Override		
Minimum	0	Maximum	4
Default	0	Units	None
Type	8 bit User Save	Update Rate	Read in reset
Display Format	Standard	Decimal Places	0
Coding	RW, Txt PT, BU		

The EtherCAT module evaluates this parameter during the reset. The parameter determines the product code reported to the PLC.

Value	Text	Description
0	None	Default
1	Unidrive SP	SP Compatibility mode
2	Mode Agnostic	Don't report drive mode in Product Code
3	M200 Override	Report as M200 in product code
4	M300 Override	Report as M300 in product code

9.4.2 Menu 1 (EtherCAT Status)

This menu provides status information on the EtherCAT network.

Table 9-38 EtherCAT RUN Indicator

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

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

Table 9-39 Values of EtherCAT RUN Indicator

Value	Text	Description
0	Unknown State	Unknown State Value
1	Init	Initial
2	PreOp	Pre Operational
3	Boot	Boot Strap State
4	SafeOp	Safe Oprerational
5	Unknown State	Unknown State Value
6	SafeOp to Op	SafeOp to Op
7	Unknown State	Unknown State Value
8	Op	Operational

Table 9-40 PDO Accesses per second

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

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

Table 9-41 Mapped Parameter xx.000

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

This parameter is mapped to parameter Pr 13.000, Pr 09.000, Pr 02.000, Pr 01.000, to allow this parameter to be accessed using a CoE object (mapped CoE object indices correspond to menu numbers, and sub-object indices correspond to parameter numbers; since sub-object index zero is already used for another CoE purpose, it cannot be used to access parameter zero of a menu).

Table 9-42 FSoE Msgs per Second

S.01.005	FSoE Msgs per Second		
Minimum	0	Maximum	65535
Default	0	Units	Messages/s
Type	8 bit volatile	Update Rate	Background
Display Format	None	Decimal Places	0
Coding	RW, ND, NC, PT, BU		

This parameter counts the number of FSoE frames per second, exchanged across the interface with the MiS2x0 module, in both directions

Table 9-43 FSoE Black Channel State

S.01.006	FSoE Black Channel State		
Minimum	-3	Maximum	5
Default	0	Units	Messages/s
Type	8 bit volatile	Update Rate	Background
Display Format	Standard	Decimal Places	0
Coding	RO, Txt, ND, NC, PT		

This parameter displays the current status of the FSoE black channel functionality.

Table 9-44 Values of FSoE Black Channel State

Value	Text	Description
-3	Not supported	Black Channel is unavailable
-2	Uninitialised	Black Channel is uninitialised
-1	Error	Black channel is not available because of an error
0	Disabled	Black channel is disabled
1	Detect	Detecting Safety Module
2	Resetting	Resetting communications with the Safety Module
3	Await init	Awaiting handshake with the Safety Module
4	Activating	Completing handshake with the Safety Module
5	Active	The exchange of FSoE frames with the Safety module in progress

Table 9-45 Fast Watchdog

S.01.007	Fast Watchdog		
Minimum	-1	Maximum	1
Default	0	Units	
Type	8 bit volatile	Update Rate	Read in background
Display Format	Standard	Decimal Places	0
Coding	RW		

This parameter enables or disables the Fast Watchdog. When enabled (set to On), if the SI-EtherCAT module should fail (e.g. the module is physically removed), the drive will trip up to 8 milliseconds after the failure event has been detected by the drive, with the trip "Slot x Watchdog".

This feature is only available if supported by the drive. If the drive does not support the fast watchdog feature, the parameter will be set to default value of "Not supported(-1)" and any attempt to set the parameter to On will fail.

Table 9-46 Values of Fast Watchdog

Value	Text	Description
-1	Not supported	Fast watchdog is not supported by the host drive
0	Disabled	Fast watchdog is disabled
1	Enabled	Fast watchdog is enabled

NOTE The feature should not be enabled when performing a module reset or firmware update, as this will cause a "SlotX Watchdog" trip..

9.4.3 Menu 2 (Ethernet over EtherCAT Status)

This menu provides information on the Ethernet over EtherCAT configuration.

Table 9-47 EoE Status

S.02.003	EoE Status		
Minimum	0	Maximum	6
Default	None	Units	None
Type	8 bit volatile	Update Rate	On EtherCAT Initialization
Display Format	Text	Decimal Places	N/A
Coding	RO, Txt, ND, NC, PT, BU		

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

Table 9-48 Values of EoE Status

Value	Text	Description
0	Initialising	The EoE interface is being initialised
1	Link Down	No EoE connection has been detected
2	Not Applicable	
3	Not Applicable	
4	Ready	The EoE interface has been successfully configured but no data is being received or transmitted
5	Active	The EoE interface is receiving or transmitting data
6	Active with Errs	The EoE interface is receiving or transmitting data but Receive errors have been detected

Table 9-49 EoE Network Message Count

S.02.004	EoE Network Message Count		
Minimum	0	Maximum	65536
Default	None	Units	
Type	16 bit volatile	Update Rate	On EtherCAT Initialization
Display Format	Decimal	Decimal Places	1
Coding	RO, ND, NC, PT, BU		

This is the average number of Ethernet frames received and transmitted via EoE.

Table 9-50 EoE IP Address

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

This parameter displays the IP address of the module, as set by Ethernet over EtherCAT (EoE).

Table 9-51 EoE Subnet Mask

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

This parameter displays the subnet mask of the module, as set by EoE.

Table 9-52 EoE Default Gateway

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

This parameter displays the default gateway of the module, as set by EoE.

Table 9-53 EoE Virtual MAC Address

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

This parameter displays the MAC address for the EoE virtual Ethernet interface as a 48 bit hexadecimal value. For example "0A1C0034AB0C" could be a virtual MAC address of the module, as set by EoE.

9.4.4 Menu 3 (CiA402 Motion Profiles)

This menu provides information on CiA402 motion profiles

Table 9-54 CiA402 Home status

S.03.002	CiA402 Home status		
Minimum	0	Maximum	1
Default	0	Units	
Type	1 bit volatile	Update Rate	Background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, BU		

A Status indicator. When "On" indicates that a successful CiA402 Homing has been performed and there has been no errors since that time. The Status only refers to the CiA402 motion profiles used by EtherCAT. On a feedback error where known position is lost, the status will be set to "Off".

Table 9-55 Stop on Digital Input Count

S.03.003	Stop on Digital Input Count		
Minimum	0	Maximum	2^{32}-1
Default	0	Units	
Type	32 bit volatile	Update Rate	Background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, BU		

A Count of number of times Controlled Stop on Digital Input has occurred whilst under the control of CiA402 motion profiles. This feature is only supported if Motion Stop Behaviour parameter is set to Controlled Stop.

Table 9-56 Motion Stop Behaviour

S.03.010	Motion Stop Behaviour		
Minimum	0	Maximum	1
Default	0	Units	
Type	8 bit volatile	Update Rate	Background
Display Format	Standard	Decimal Places	0
Coding	RW, TW, NC, PT		

Value	Text	Description
0	Default	All Stops are governed by CiA402 Option Codes
1	Controlled Stop	All Stops use the same ramp in menu 2

When set to "Controlled Stop", Drive operation will now always require 06.038 to be true for CiA402 motion to be possible, this can be mapped to a digital input to provide a local signal to cause a stop. All CiA402 state transitions will use the same Stopping Ramp. Any change to 06.038 will cause a controlled stop and then require to be true to allow motion again.

The slope of the controlled stop ramp can be configured in the drive parameter 02.028.

9.4.5 Menu 9 (Resources)

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

Table 9-57 Background Task Period

S.09.009	Background Task Period		
Minimum	0	Maximum	65535
Default	None	Units	ms
Type	16 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT, BU		

This parameter shows the current period of the background task.

Table 9-58 Pre-critical task % free

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

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

Table 9-59 Critical task % free

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

This parameter shows the current resource available for the critical task. In the SI-EtherCAT option, this is the Critical Task executed on OptSync, every 250 µs, executed synchronously with the drive control loops.

Table 9-60 Post-critical task % free

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

This parameter shows the current resource available for the post-critical task. In the SI-EtherCAT option, this is the PostCritical Task executed 75 µs after OptSync, the 250 µs task executed synchronously with the drive control loops.

Table 9-61 Pre-critical task worst % free

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

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

Table 9-62 Critical task worst % free

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

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

Table 9-63 Post-critical task worst % free

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

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

Table 9-64 Deprecated Parameter

S.09.023	Deprecated Parameter		
Minimum	0	Maximum	100
Default	None	Units	%
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT, BU		

This parameter shows Deprecated parameter.

Table 9-65 OutData Margin

S.09.024	OutData Margin		
Minimum	-2147483648	Maximum	2147483647
Default	None	Units	µs
Type	32 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter shows the margin in microseconds between when the TxPDO data has been received from the network and when the values have been applied to the hardware. A negative value indicates data is too late (and hence used in the next cycle).

Table 9-66 PCB Temperature

S.09.030	PCB Temperature		
Minimum	-128	Maximum	127
Default	None	Units	°C
Type	8 bit volatile	Update Rate	Written in background
Display Format	None	Decimal Places	0
Coding	RO, ND, NC		

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

Table 9-67 Active Alarm Bits

S.09.039	Active Alarm Bits		
Minimum	0	Maximum	65535
Default	(Display:0000000000000000)	Units	(Display:1111111111111111)
Type	16 bit volatile	Update Rate	Written in background
Display Format	Binary	Decimal Places	0
Coding	RO, ND, NC, PT, PU		

This parameter shows the SI-EtherCAT option module active alarm bits. The definition of each alarm bit is as the following:

Table 9-68 Definitions of Active Alarm Bits

Bit	Alarm
0	Reserved for future use
1	Reserved for future use
2	Temperature too Hot
3	PDOs lost
4	Home position save/restore failed
5	Synchronisation between drive and network failed
6	PDO exchange stopped

Table 9-69 Diagnostic Counter Selector

S.09.040	Diagnostic Counter Selector		
Minimum	0	Maximum	8
Default	0	Units	
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, Txt, NC, PT		

This parameter selects the Diagnostic counter to be viewed in Diagnostic Counter Value (**S.09.041**).It has the following values:

Table 9-70 Values of Diagnostic Counter Selector

Value	Text	Description
0	Off	No Counter Selected to be displayed
1	Port A Inv Errs	Port A Invalid Frame Receive Error Counter
2	Port B Inv Errs	Port B Invalid Frame Receive Error Counter
3	Port A Rx Errs	Port A Receive Error Counter
4	Port B Rx Errs	Port B Receive Error Counter
5	Port A Fwd Errs	Port A Forwarded Error Counter
6	Port B Fwd Errs	Port B Forwarded Error Counter
7	Port A LL Count	Port A Link loss Counter
8	Port B LL Count	Port B Link loss Counter

Table 9-71 Diagnostic Counter Value

S.09.041	Diagnostic Counter Value		
Minimum	-2147483648	Maximum	2147483647
Default	0	Units	
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter shows the value of the Diagnostic Counter selected to be viewed by Diagnostic Counter Selector (**S.09.040**).

Table 9-72 Deprecated Parameter

S.09.042	Deprecated Parameter		
Minimum	0	Maximum	65535
Default	0	Units	
Type	16 bit volatile	Update Rate	No Update
Display Format	Standard	Decimal Places	0
Coding	RO		

The parameter is deprecated.

Table 9-73 Worst Drive to Network Sync time

S.09.043	Worst Drive to Network Sync time		
Minimum	0	Maximum	65535
Default		Units	ms
Type	16 bit volatile	Update Rate	After SafeOp to Op transition
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter shows the worst drive to EtherCAT network sync time in ms.

Table 9-74 Object Index view Selector 1

S.09.050	Object Index view Selector 1		
Minimum	0	Maximum	65535
Default	0	Units	
Type	16 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter selects a CAN Object Index to view in *Object View Value 1* (**S.09.052**). The CAN Object Subindex also need to be configured in *Object Subindex View Selector 1*(**S.09.051**).

Setting a value of zero will freeze the value in S.09.052, to that for the previous object selected.

Table 9-75 Object Subindex view Selector 1

S.09.051	Object Subindex view Selector 1		
Minimum	0	Maximum	255
Default	0	Units	
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, NC, PT		

This parameter selects a CAN Object Subindex to view in *Object View Value 1* (**S.09.052**).

Table 9-76 Object View Value 1

S.09.052	Object View Value 1		
Minimum	-2147483648	Maximum	2147483647
Default		Units	
Type	32 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter shows the value of object view selector 1.

Table 9-77 Object Index view Selector 2

S.09.053	Object Index view Selector 2		
Minimum	0	Maximum	65535
Default	0	Units	
Type	16 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, NC, PT		

This parameter selects a CAN Object Index to view in *Object View Value 2* (**S.09.055**). The CAN Object Subindex also need to be configured in *Object Subindex View Selector 2* (**S.09.054**).

Setting a value of zero will freeze the value in S.09.055, to that for the previous object selected.

Table 9-78 Object Subindex view Selector 2

S.09.054	Object Subindex view Selector 2		
Minimum	0	Maximum	255
Default	0	Units	
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, NC, PT		

This parameter selects a CAN Object Subindex to view in *Object View Value 2* (**S.09.055**).

Table 9-79 Object View Value 2

S.09.055	Object View Value 2		
Minimum	-2147483648	Maximum	2147483647
Default		Units	
Type	32 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, ND, NC, PT		

This parameter shows the value of object view selector 2.

Table 9-80 Object Index view Selector 3

S.09.056	Object Index view Selector 3		
Minimum	0	Maximum	65535
Default	0	Units	
Type	16 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, NC, PT		

This parameter selects a CAN Object Index to view in *Object View Value 3* (**S.09.058**). The CAN Object Subindex also need to be configured in *Object Subindex View Selector 3* (**S.09.057**).

Setting a value of zero will freeze the value in S.09.058, to that for the previous object selected.

Table 9-81 Object Subindex view Selector 3

S.09.057	Object Subindex view Selector 3		
Minimum	0	Maximum	255
Default	0	Units	
Type	8 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RW, NC, PT		

This parameter selects a CAN Object Subindex to view in *Object View Value 3* (**S.09.058**).

Table 9-82 Object View Value 3

S.09.058	Object View Value 3		
Minimum	-2147483648	Maximum	2147483647
Default		Units	
Type	32 bit volatile	Update Rate	Written in background
Display Format	Standard	Decimal Places	0
Coding	RO, NC, NC, PT		

This parameter shows the value of object view selector 3.

10 Diagnostics

10.1 Module identification parameters

10.1.1 SI-EtherCAT module ID code

Table 10-1 SI-EtherCAT module ID code

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

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

10.1.2 SI-EtherCAT firmware version

Table 10-2 SI-EtherCAT firmware version

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

10.2 SI-EtherCAT module temperature

Table 10-3 SI-EtherCAT module temperature

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

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

10.3 Error handling

The following objects are provided to indicate an error condition

Table 10-4 Error handling objects

Index	Name
1001	error_register
603F	error_code
1003	Error history
10F1	Error settings

Table 10-5 Error Register

0x1001	Error Register		
Access: RO	Range: N/A - Bit Mask	Size: 1 byte	Unit: N/A
Default: 0		Type: Bit Mask / USINT	
PDO Mappable: No		Update Rate: On error	
Description:	A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits will be supported: Bit 0: Generic error Bit 1: Current Bit 2: Voltage Bit 3: Temperature Bit 4: Communications		

When a CiA402 related error is indicated in this object, the error code will be contained in object 0x603F (Error code). A history of errors is available in object 0x1003.

Table 10-6 Error code

0x603F	Error Code		
Access: RO	Range: 0 to 0xFFF	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: TxPDO		Update rate: On error	
Motion Profiles: All			
Description:	A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in the Error code tables below.		

The Error can be the result of three things:

- A Drive trip, the first table shows error codes and associated drive trip.
- An EtherCAT Module trip, the second tables shows error codes and associated module trip.
- An EtherCAT network error, the third table shows error codes and associated network event

Table 10-7 Error code for drive trips

Value	Text	Description
0x0000	Error reset / No error	0 - None
0xFF01	Generic trip related error	(Any trip code not elsewhere in table)
0xFF02	Generic non-trip error	Any error not elsewhere in this table or following tables that caused the CiA402 state machine into a FAULT state.
0x2340	Current, device output side	3 - OI ac 98.1- Out Phase Loss.1 (U phase) 98.2- Out Phase Loss.2 (V phase) 98.3- Out Phase Loss.3 (W phase)
0x3130	Phase failure	32 - Phase Loss 98 - Out Phase Loss
0x2230	Short circuit/earth leakage (device internal)	5 - PSU 9 - PSU 24V
0x3210	DC link over-voltage	2 - Over Volts
0x3230	Load error	38 - Low Load
0x4310	Excess temperature drive	21 - OHt inverter 101 - OHt Brake
0x4311	Excess temperature drive	22 - OHt Power

Value	Text	Description
0x4312	Excess temperature drive	23 - OHt Control
0x4313	Excess temperature drive	24 - Thermistor
0x4314	Excess temperature drive	27 - OHt dc bus
0x4315	Excess temperature drive	101 - OHt Brake
0x5112	"Supply low voltage" and "U2 = supply +24 V"	91 - User 24 V
0x5200	Control device hardware	200 - Slot1 HF
0x5201	Control device hardware	203 - Slot1 Not Fitted
0x5202	Control device hardware	204 - Slot1 Different
0x5203	Control device hardware	205 - Slot2 HF
0x5204	Control device hardware	208 - Slot2 Not Fitted
0x5205	Control device hardware	209 - Slot2 Different
0x5206	Control device hardware	210 - Slot3 HF
0x5207	Control device hardware	213 - Slot3 Not Fitted
0x5208	Control device hardware	214 - Slot3 Different
0x5209	Control device hardware	250 - Slot4 HF
0x520A	Control device hardware	253 - Slot4 Not Fitted
0x520B	Control device hardware	254 - Slot5 Different
0x520C	Control device hardware	NO_POWER_BOARD
0x5400	Power section	111 - Configuration 220 - Power Data 223 - Rating Mismatch
0x5510	RAM	227 - Sub Array RAM Allocation
0x5530	Data Storage (Non-volatile data memory)	31 - EEPROM Fail 36 - User Save 37 - Power Down Save
0x5430	Input stages	94 - Rectifier Set-up
0x5440	Contacts	226 - Soft Start
0x6010	Software reset (watchdog)	30 - Watchdog
0x6320	Parameter Error	199 - Destination 216 - Slot App Menu Crash 217 - App Menu Changed
0x7112	Brake Chopper (Over current brake chopper)	4 - OI Brake 19 - Brake R Too Hot HOT_RECT_BRAKE
0x7113	Protective circuit break chopper	10 - Th Brake Res
0x7120	Motor	11 - Autotune 1 12 - Autotune 2 13 - Autotune 3
0x7122	Motor error or commutation malfunction	14 - Autotune 4 15 - Autotune 5 16 - Autotune 6 20 - Motor Too Hot 25 - Th Short Circuit 33 - Resistance
0x7300	Sensor	17 - Autotune 7 189 to 197 - Encoder 1 to Encoder 9 162 to 164 - Encoder 12 to Encoder 14 176 - Name Plate 218 - Temp Feedback
0x7310	Speed	7 - Over Speed
0x7500	Communication	90 - Power Comms 103 - Interconnect

Value	Text	Description
0x7600	Data storage (external)	174 - Card Slot
0x7601	Data storage (external)	175 - Card Product
0x7603	Data storage (external)	177 - Card User Prog
0x7604	Data storage (external)	178 - Card Busy
0x7605	Data storage (external)	179 - Card Data Exists
0x7606	Data storage (external)	180 - Card Option
0x7607	Data storage (external)	181 - Card Read Only
0x7608	Data storage (external)	182 - Card Error
0x7609	Data storage (external)	183 - Card No Data
0x760A	Data storage (external)	184 - Card Full
0x760B	Data storage (external)	185 - Card File Error
0x760C	Data storage (external)	186 - Card Rating
0x760D	Data storage (external)	187 - Card File Data
0x760E	Data storage (external)	188 - Card Derivative

Each drive trip will correspond to only one error code (although one error code can represent multiple trip codes). The error code will be generated when a drive trip occurs.

Table 10-8 Error Codes for EtherCAT module comms

Error Code	Meaning	Corresponding EtherCAT Comms Trip Name
0x0000	Error reset / No error	0 - None
0xFF01	Generic trip related error	*(Any trip code not elsewhere in table)*
0x431F	Excess temperature drive	OVER_TEMPERATURE
0x8101	Communications error	TO_ECAT_PDO
0x8102	Communications error	SYNC_TASK_ORUN
0x8103	Communications error	SYNC_PDO_STOP
0x8104	Communications error	PRECRIT_TASK_ORUN

The following table shows the error codes for EtherCAT network error.

Table 10-9 Error codes for EtherCAT errors

Error Code	Meaning	Corresponding EtherCAT Comms Trip Name
0x0000	Error reset / No error	0 - None
0xFF02	Generic non-trip error	*Any error not elsewhere in this table or following tables that caused the CiA402 state machine into a FAULT state.*
0x8606	Communications error	SM 2 loss count exceeds loss threshold causing CiA402 state machine entering the FAULT state
0x8607	Communications error	Network SM timeout causes state to change into SafeOp resulting in CiA402 state machine entering the Fault state
0x8608	Communications error	User disabled profiles whilst profiles running

Table 10-10 Error code

0x1003	Error History		
Sub-index 0			
Access: RW	Range: 0 to 10	Size: 1 byte	Unit: N/A
Default: 0		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: On error	
Description:	The number of the last sub-index in this object. A value of zero can be written to sub-index 0 to clear the array of last errors		
Sub-index 1 to N			
Access: RO	Range: N/A - Bit Mask	Size: 4 bytes	Unit: See notes
Default: N/A		Type: Bit Mask / UDINT	
PDO Mappable: No		Update Rate: On error	
Description:	This will contain an element of the error history. Index 1 is the latest error and index n is the oldest. A maximum of 10 error codes are kept with the oldest deleted when a new error occurs.		

Each entry is a 32-bit value where the most significant 16 bits is the age of the error and the least 16 bits is the error code as defined in 0x603F.

The Age is expressed in seconds so the maximum age shown will be 0xFFFF i.e. approx. 18 hours. Due to the internal clock only having a resolution of approx. 49 days, after 49 days the age value will become invalid. It is suggested that the error list is downloaded regularly and cleared by writing a zero to subindex 0.

The history is volatile and therefore is cleared after a power outage event or a reset.

Table 10-11 Error Settings

0x10F1	Error Settings		
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2		Type: Unsigned integer / USINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The number of the last sub-index in this object.		
Sub-index 1: Local Error Reaction			
Access: RO	Range: 2	Size: 4 bytes	Unit: N/A
Default: 2		Type: Unsigned integer / UDINT	
PDO Mappable: No		Update Rate: N/A - Never changes	
Description:	The Local Error Reaction. This is always value '2' i.e. Manufacturer specific.		
Sub-index 2: Sync Error Counter limit			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer / UINT	
PDO Mappable: No		Update Rate: New value used on next sync0 event	
Description:	This is the Sync Error Counter limit. It is compared against the weighted "internal" SM missed counter as defined in ETG1020. A value of zero disables this check. When the threshold is reached the Slave state is changed from Op to SafeOP and an AL status code raised to indicate the error. **NOTE** When using one of the CiA402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the SI-EtherCAT module going into the SAFE-OPERATIONAL state.		

10.4 Drive trip display codes

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

Table 10-12 Trip display codes

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

10.5 Option module trips

Table 10-13 Option module trips

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

10.6 Option module warnings

Table 10-14 Option module warning

Value	Display Text	Description
1	Reserved	This value is reserved for future use.
2	Too Hot	Option module temperature is too high.
3	PDOs Lost	Process data has not been received within the specified time.
4	Parameter Error	Home position save/restore failed.
5	Drive Sync Lost	Synchronisation with drive lost.
6	PDOs Stop	PDO exchange stopped.

10.7 Updating SI-EtherCAT firmware

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

10.8 Sync Task Orun trips

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

10.9 EtherCAT AL status codes

Table 10-15 shows the possible AL (Application Layer) status codes returned to the EtherCAT master controller during configuration or operational mode.

Table 10-15 Application Layer status codes

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

Code (0x)	Meaning	Description	Comment
001E	Invalid input configuration	Sync Manager for input process data is invalid	Use correct Sync Manager
001F	Invalid watchdog configuration	The watchdog configuration is invalid	Check watchdog setting
0020	Slave needs cold restart	Slave device requires a cold restart or power cycle	Restart the slave device
0021	Slave needs INIT	Slave application requests INIT state	Re-initialise the slave device
0022	Slave needs PREOP	Slave application requests, PREOP state	Instruct slave device to enter PREOP state
0023	Slave needs SAFEOP	Slave application requests SAFEOP state	Instruct slave device to enter SAFEOP state
0024	Invalid input mapping	Invalid input mapping object	Check slave input mapping
0025	Invalid output mapping	Invalid output mapping object	Check slave output mapping
0026	Inconsistent settings	General settings mismatch	Check configuration settings
0027	Freerun not supported	Freerun not supported on slave	
0028	Synchronization not supported	Synchronization not supported on slave	
0029	Freerun needs 3 Buffer Mode	Sync Manager requires 3 Buffer Mode to run	
002A	Background Watchdog	Background task watchdog activated	
002B	No valid inputs and outputs	Slave device does not provide valid inputs and outputs	
002C	Fatal Sync error	The hardware synchronization signal has stopped	Set master to INIT and back to OP so that the DCs are initialized again.
002D	No Sync error	Hardware synchronization signal not detected	
0030	Invalid DC SYNC configuration	Distributed Clocks configuration is invalid	Check DC configuration
0031	Invalid DC Latch configuration	Distributed Clocks Latch configuration is invalid	Check DC configuration
0032	PLL error	Master not synchronized, at least one DC event received	Check wiring and synchronization settings
0033	DC Sync IO error	Multiple sync errors: At least one sync signal was received but the slave is no longer synchronized	Check network jitter Increase cycle time Use Distributed Clocks scheme
0034	DC Sync timeout error	Multiple sync errors: Excessive Sync Manager events missed	Check DC configuration
0035	DC invalid sync cycle time	DC sync cycle time is invalid	Check DC configuration
0036	DC Sync0 cycle time	DC Sync0 cycle time invalid for application	Check DC configuration
0037	DC Sync1 cycle time	DC Sync1 cycle time invalid for application	Check DC configuration

10.10 SDO abort codes

SDO messages use a request-response mechanism and the EtherCAT master will always expect a response from the slave device. If an error occurs with an SDO transfer SI-EtherCAT will return an SDO abort code to indicate the reason for the failure, the SDO abort codes are listed in Table 10-16.

Table 10-16 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

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.

CoE: CANopen over EtherCAT.

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.

EoE: Ethernet over EtherCAT

FoE: File transfer over EtherCAT

FSoE: Functional Safety over EtherCAT.

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

LED: Light emitting diode.

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

LSB: Least significant bit/byte.

MSB: Most significant bit/byte.

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

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

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

PC: Personal computer.

PLC: Programmable logic controller.

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

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

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

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

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

Word: A collection of sixteen binary digits.

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