YASKAWA

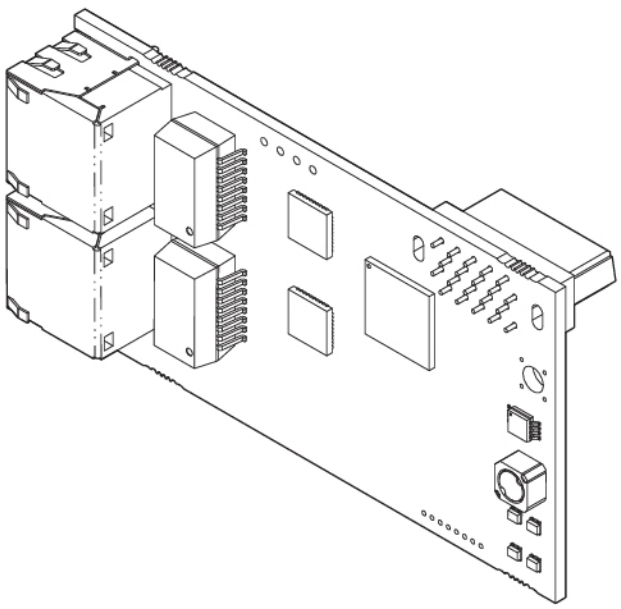
YASKAWA AC Drive 1000-Series Option

EtherCAT

Technical Manual

Type: SI-ES3

To properly use the product, read this manual thoroughly and retain for easy reference, inspection, and maintenance. Ensure the end user receives this manual.



MANUAL NO. SIEP C730600 64A

Table of Contents

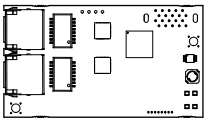
1 Preface and Safety

Yaskawa manufactures products used as components in a wide variety of industrial systems and equipment. The selection and application of Yaskawa products remain the responsibility of the equipment manufacturer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any Yaskawa product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All systems or equipment designed to incorporate a product manufactured by Yaskawa must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by Yaskawa must be promptly provided to the end user. Yaskawa offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the Yaskawa manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. Yaskawa assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

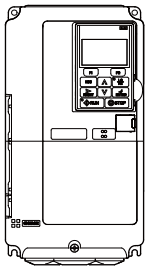
◆ Applicable Documentation

The following manuals are available for the option:

Option

	**Yaskawa AC Drive 1000-Series Option SI-ES3 EtherCAT Installation Manual Manual No: TOBP C730600 64**	Read this manual first. The installation manual is packaged with the option and contains information required to install the option and set up related drive parameters.
	Yaskawa AC Drive 1000-Series Option SI-ES3 EtherCAT Technical Manual Manual No: SIEP C730600 64 (This book)	The technical manual contains detailed information about the option. Access the following sites to obtain the technical manual: U.S.: http://www.yaskawa.com Europe: http://www.yaskawa.eu.com Japan: http://www.e-mechatronics.com For questions, contact your local Yaskawa sales office or the nearest Yaskawa representative.

Yaskawa Drive

	**Yaskawa AC Drive 1000-Series Quick Start Guide**	The drive manuals cover basic installation, wiring, operation procedures, functions, troubleshooting, and maintenance information. The manuals also include important information about parameter settings and drive tuning. Access these sites to obtain Yaskawa instruction manuals: U.S.: http://www.yaskawa.com Europe: http://www.yaskawa.eu.com Japan: http://www.e-mechatronics.com Other areas: contact a Yaskawa representative.
	Yaskawa AC Drive 1000-Series Technical Manual	

◆ Terms

Note:	Indicates supplemental information that is not related to safety messages.
Drive:	Yaskawa AC Drive 1000-Series
Option:	Yaskawa AC Drive 1000-Series Option SI-ES3 EtherCAT
NOID:	Network Option Interface Driver (Yaskawa Interface driver)
Online-DRV:	NOID processing mode, process (ctrl/resp) data is active
Online-PRG:	NOID processing mode, NO process (ctrl/resp) data is active

◆ Registered Trademarks

- EtherCAT is a trademark of Beckhoff Automation GmbH, Germany.
- All trademarks are the property of their respective owners.

◆ Supplemental Safety Information

Read and understand this manual before installing, operating, or servicing this option. The option must be installed according to this manual and local codes.

The following conventions are used to indicate safety messages in this manual. Failure to heed these messages could result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

⚠ DANGER

Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates an equipment damage message.

■ General Safety

General Precautions

- The diagrams in this section may include options and drives without covers or safety shields to illustrate details. Reinstall covers or shields before operating any devices. The option should be used according to the instructions described in this manual.
- Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.
- The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.
- When ordering new copies of the manual, contact a Yaskawa representative or the nearest Yaskawa sales office and provide the manual number shown on the front cover.

⚠ DANGER

Heed the safety messages in this manual.

Failure to comply will result in death or serious injury.

The operator is responsible for injuries or equipment damage caused from failure to heed the warnings in the manual.

NOTICE

Do not modify the drive or option circuitry.

Failure to comply could result in damage to the drive or option and will void warranty.

Yaskawa is not responsible for any modification of the product made by the user. This product must not be modified.

Do not expose the drive or option to halogen group disinfectants.

Failure to comply may cause damage to the electrical components in the option.

Do not pack the drive in wooden materials that have been fumigated or sterilized.

Do not sterilize the entire package after the product is packed.

2 Product Overview

◆ About This Product

This option provides a communications connection between the drive and an EtherCAT network. The option connects the drive to an EtherCAT network and facilitates the exchange of data.

This manual explains the handling, installation and specifications of this product.

EtherCAT is a communications link to connect industrial devices (such as smart motor controllers, operator interfaces, and variable frequency drives) as well as control devices (such as programmable controllers and computers) to a network. EtherCAT is a simple, networking solution that reduces the cost and time to wire and install factory automation devices, while providing interchangeability of like components from multiple vendors.

By installing the option to a drive, it is possible to do the following from an EtherCAT master device:

- drive operation
- drive operation status monitoring
- changing parameter settings.

The option provides instant connectivity to an EtherCAT network for the Yaskawa A1000 drive. The option supports the Velocity mode according the CANopen Device Profile and Motion Control (DSP402) profile. It also contains Yaskawa vendor specific CANopen objects based on the present CANopen option board specification.

The EtherCAT Option supports the following communication profiles:

- DS 301 Ver. 4.02
- DSP 402 Ver. 3.0 Velocity Mode

Figure 1 EtherCAT Conformance Tested

◆ Applicable Models

The option can be used with the drive models in *Table 1*.

Table 1 Applicable Models

Drive Series	Drive Model Number	Software Version <1>
A1000	CIMR-A□2A□□□□	≥1017
	CIMR-A□4A□□□□	

<1> See “PRG” on the drive nameplate for the software version number.

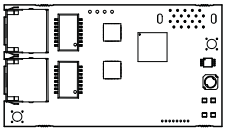
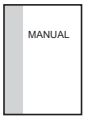
3 Receiving

Please perform the following tasks upon receipt of the option:

- Inspect the option for damage. Contact the shipper immediately if the option appears damaged upon receipt.
- Verify receipt of the correct model by checking the model number printed on the name plate of the option package.
- Contact your supplier if you have received the wrong model or the option does not function properly.

◆ Option Package Components

Table 2 Option Package Contents

Description:	Option	Ground Wire	Screws (M3)	LED Label	Installation Manual
–					
Quantity:	1	1	3	1	1

◆ Tools Required for Installation

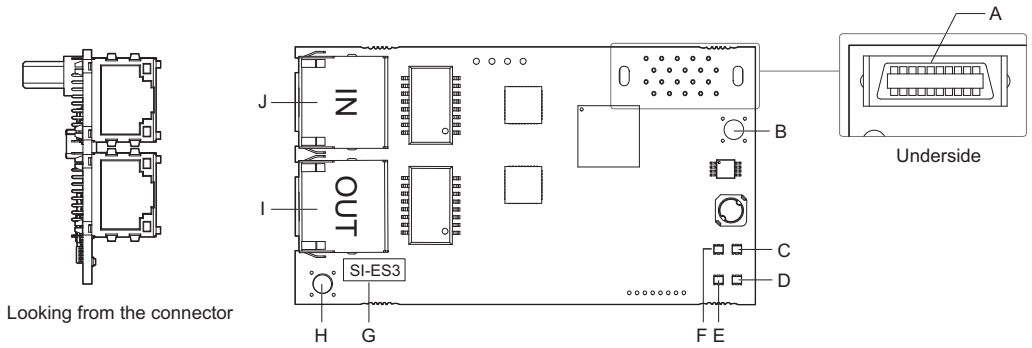
- A Phillips screwdriver (M3 metric/#1, #2 U.S. standard size <1>) is required to install the option and remove drive front covers.
- Diagonal cutting pliers. (required for some drive models)
- A small file or medium grit sandpaper. (required for some drive models)

<1> Screw sizes vary by drive capacity. Select a screwdriver appropriate for the drive capacity.

Note: Tools required to prepare option networking cables for wiring are not listed in this manual.

4 Option Components

◆ SI-ES3 Option



A – Connector (CN5)
B – Installation hole
C – LED (RUN) *<1>*
D – LED (ERR) *<1>*
E – LED (L/A OUT) *<1>*
F – LED (L/A IN) *<1>*
G – Model number
H – Ground terminal and installation hole *<2>*
I – Communication connector CN1 (RJ45)
J – Communication connector CN2 (RJ45)

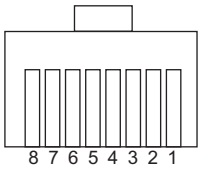
<1> *Refer to Option LED Display on page 9* for details on the LEDs.
<2> The ground wire provided in the option shipping package must be connected during installation.

Figure 2 SI-ES3 Option Components

◆ Communication Connector

The EtherCAT Option is connected to the network using a RJ45 connector. The pin assignment is explained in *Table 3*.

Table 3 Communication Connector (RJ45)

EtherCAT Connector	Pin	Signal	Description
	1	TD+	Send data
	2	TD-	
	3	RD+	Receive data
	4	–	N.C. (Pins denoted as N.C. do not connect to any signal)
	5	–	N.C. (Pins denoted as N.C. do not connect to any signal)
	6	RD-	Receive data
	7	–	N.C. (Pins denoted as N.C. do not connect to any signal)
	8	–	N.C. (Pins denoted as N.C. do not connect to any signal)
	Housing	–	Shield

◆ Option LED Display

The EtherCAT Option has four LED displays that indicate the communication status. The indications conform with DS303, Part 3: Indicator Specification.

■ L/A IN, L/A OUT

The Link/Activity indicators show the status of the physical link and show activity on the link period

■ RUN

A green lit EtherCAT RUN LED indicates the status of the EtherCAT network state machine.

A red lit EtherCAT RUN LED is only used by the NOID firmware loader (refer to ***Table 4***).

■ ERR

The red EtherCAT error LED indicates the presence of any errors.

Table 4 Option LED States

Name	Indication		Meaning
	Color	Status	
L/A IN L/A OUT	–	Continuously off	No link. The communication cable is not physically connected or the EtherCAT controller is not started up.
	Green	Continuously on	The option is connected to Ethernet. A communication cable is physically connected, but data is not being exchanged.
		Flickering	There is traffic on Ethernet. Data is being exchanged.
RUN	–	Continuously off	The device is in INIT state.
	Green	Blinking	The device is in Pre-Operational state (flashing rate about 400 ms).
		Single flash	The device is in Safe-Operational state. Single flash is one short flash (approximately 200 ms), followed by a long off phase (approximately 1000 ms).
		Continuously on	The device is in Operational state.
	Red	Blinking (1 Hz or 6 Hz)	The Option BOOT or APP firmware is executing the NOID firmware loader. 1 Hz: Firmware loader protocol is in IDLE state (waiting for commands from the drive). 6 Hz: Firmware loader protocol is processing commands.
ERR	Red	Continuously off	No fault. The EtherCAT communication is operating normally.
		Blinking	General configuration error
		Single flash	The slave device application has changed the EtherCAT state autonomously. The parameter “Change” in the AL status register is set to 0x01: change/error. Single flash is one short flash (approximately 200 ms), followed by a long off phase (approximately 1000 ms).
		Double flash	The sync manager watchdog time out has occurred. Double flash is two short flashes (approximately 200 ms each), separated by an off condition (approximately 200 ms), and then a long off phase (approximately 1000 ms).
		Continuously on	Possible causes: • An EtherCAT PDI (Process Data Interface) error has occurred or the NOID application interface has failed. • An option card FATAL event has occurred (System has stalled execution; see manufacturer specific profile object 0x4000 for cause).
		Blinking (1 Hz or 6 Hz)	The option BOOT or APP firmware is executing the NOID firmware loader. 1 Hz: Firmware loader protocol is in IDLE state (waiting for commands from drive). 6 Hz: Firmware loader protocol is processing commands.

Figure 3 explains the indicator flash rates.

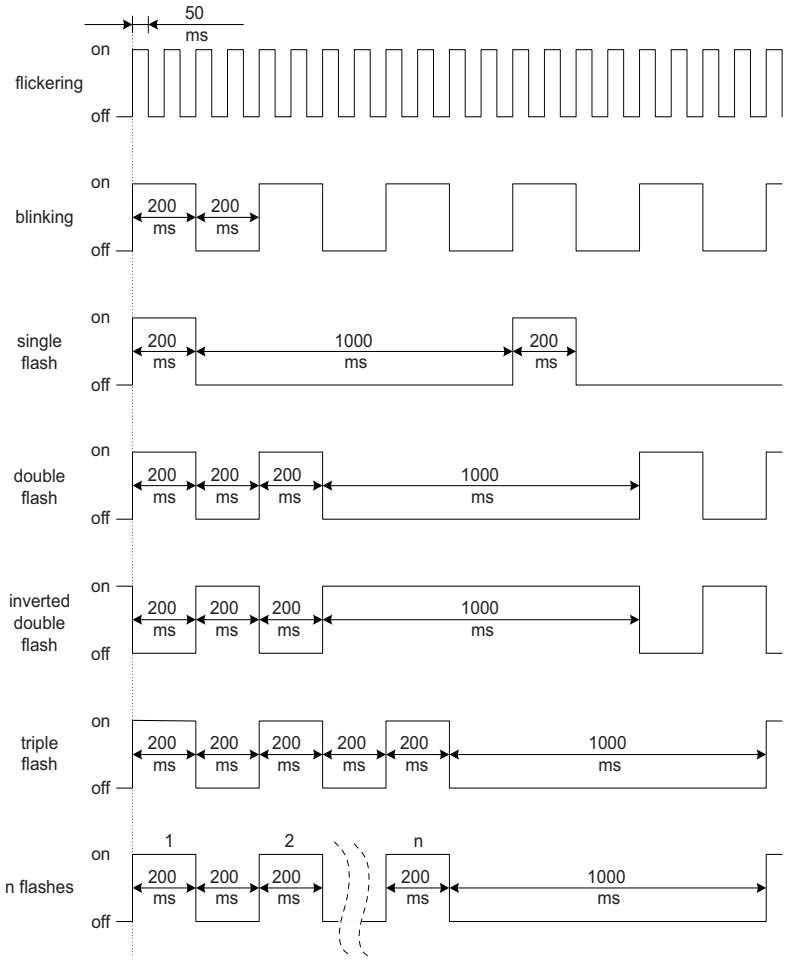


Figure 3 LED Flash Rates

◆ DSP402 Functionality

This function manages the DSP402 drive profile functionality in the option and converts the control/status data into drive specific control/status data.

◆ Vendor Specific CANopen Objects

The vendor specific CANopen object model is integrated into EtherCAT.

◆ Error Management

EtherCAT processes drive and EtherCAT specific errors and assures that all faults process and propagate properly to the drive/EtherCAT network.

5 Installation Procedure

◆ Section Safety

⚠ DANGER

Electrical Shock Hazard

Do not connect or disconnect wiring while the power is on.

Failure to comply will result in death or serious injury.

Disconnect all power to the drive and wait at least the amount of time specified on the drive front cover safety label. After all indicators are off, measure the DC bus voltage to confirm safe level, and check for unsafe voltages before servicing. The internal capacitor remains charged after the power supply is turned off.

⚠ WARNING

Electrical Shock Hazard

Do not remove the front covers of the drive while the power is on.

Failure to comply could result in death or serious injury.

The diagrams in this section may include options and drives without covers or safety shields to show details. Be sure to reinstall covers or shields before operating any devices. The option should be used according to the instructions described in this manual.

Do not allow unqualified personnel to use equipment.

Failure to comply could result in death or serious injury.

Maintenance, inspection, and replacement of parts must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of this product.

Do not touch circuit boards while the power to the drive is on.

Failure to comply could result in death or serious injury.

Do not use damaged wires, place excessive stress on wiring, or damage the wire insulation.

Failure to comply could result in death or serious injury.

NOTICE

Damage to Equipment

Observe proper electrostatic discharge (ESD) procedures when handling the option, drive, and circuit boards.

Failure to comply may result in ESD damage to circuitry.

Never shut the power off while the drive is outputting voltage.

Failure to comply may cause the application to operate incorrectly or damage the drive.

Do not operate damaged equipment.

Failure to comply may cause further damage to the equipment.

Do not connect or operate any equipment with visible damage or missing parts.

Do not use unshielded cable for control wiring.

Failure to comply may cause electrical interference resulting in poor system performance.

Use shielded twisted-pair wires and ground the shield to the ground terminal of the drive.

NOTICE

Properly connect all pins and connectors.

Failure to comply may prevent proper operation and possibly damage equipment.

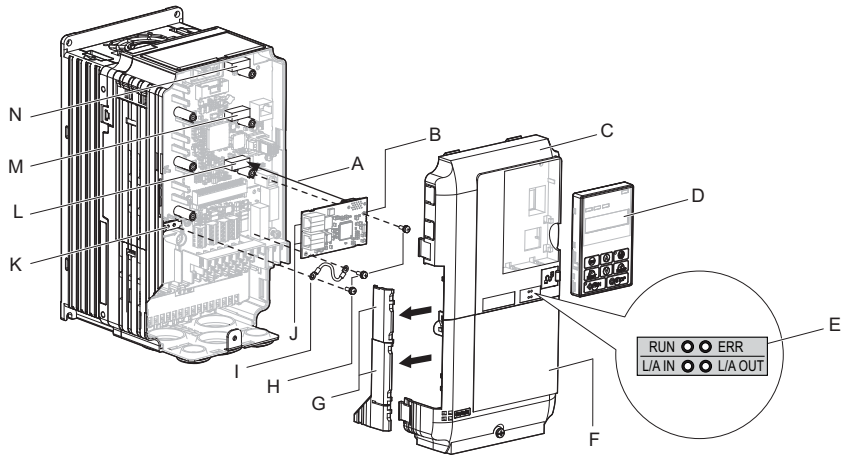
Check wiring to ensure that all connections are correct after installing the option and connecting any other devices.

Failure to comply may result in damage to the option.

◆ Prior to Installing the Option

Prior to installing the option, wire the drive, make necessary connections to the drive terminals, and verify that the drive functions normally without the option installed. Refer to the Quick Start Guide packaged with the drive for information on wiring and connecting the drive.

Figure 4 shows an exploded view of the drive with the option and related components for reference.



A – Insertion point for CN5 connector
B – SI-ES3 option
C – Drive front cover
D – Digital operator
E – LED label
F – Drive terminal cover
G – Removable tabs for wire routing
H – Included screws
I – Ground wire
J – Option modular connector CN1, CN2
K – Drive grounding terminal (FE)
L – Connector CN5-A
M – Connector CN5-B
N – Connector CN5-C

Figure 4 Drive Components with Option

◆ Installing the Option

Remove the front covers of the drive before installing the option. Refer to the drive Quick Start Guide for directions on removing the front covers. Cover removal varies depending on drive size. This option can be inserted only into the **CN5-A** connector located on the drive control board.

WARNING! *Electrical Shock Hazard. Do not connect or disconnect wiring while the power is on. Failure to comply could result in death or serious injury. Before installing the option, disconnect all power to the drive and wait at least the amount of time specified on the drive front cover safety label. After all indicators are off, measure the DC bus voltage to confirm safe level, and check for unsafe voltages before servicing. The internal capacitor remains charged after the power supply is turned off.*

1. Shut off power to the drive, wait the appropriate amount of time for voltage to dissipate, then remove the digital operator (D) and front covers (C, F). Refer to the Quick Start Guide packaged with the drive for directions on removing the front covers. Cover removal varies depending on drive size.

NOTICE: *Damage to Equipment. Observe proper electrostatic discharge procedures (ESD) when handling the option, drive, and circuit boards. Failure to comply may result in ESD damage to circuitry.*

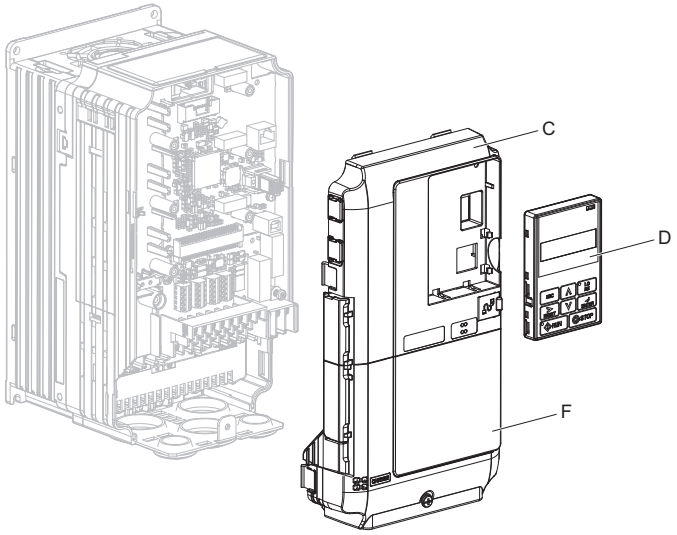


Figure 5 Remove the Front Covers and Digital Operator

2. With the front covers and digital operator removed, apply the LED label (E) in the appropriate position on the drive top front cover (C).

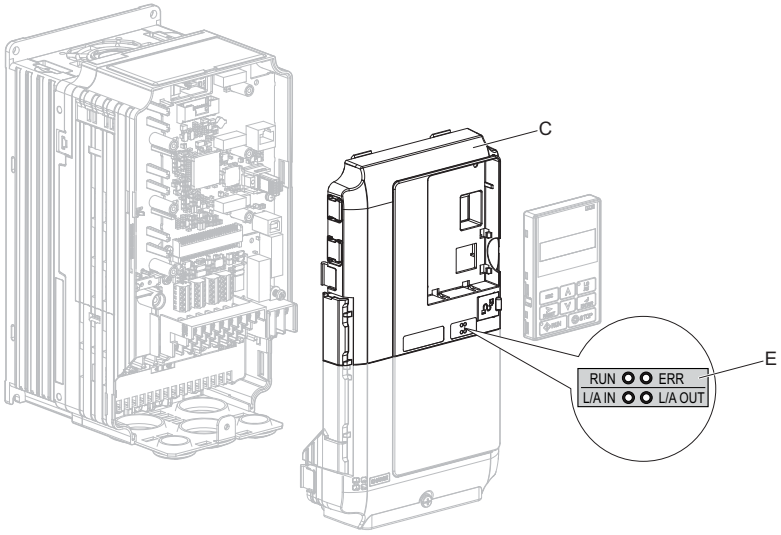


Figure 6 Apply the LED Label

3. Insert the option (B) into the CN5-A connector (L) located on the drive and fasten it using one of the included screws (H).

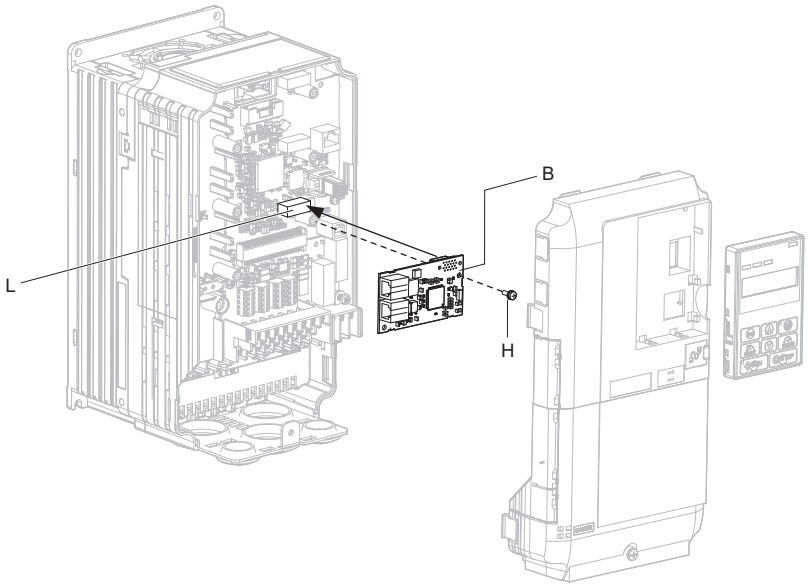


Figure 7 Insert the Option

4. Connect the ground wire (I) to the ground terminal (K) using one of the remaining provided screws (H). Connect the other end of the ground wire (I) to the remaining ground terminal and installation hole on the option (B) using the last remaining provided screw (H) and tighten both screws to 0.5 to 0.6 N·m (4.4 to 5.3 in lbs).

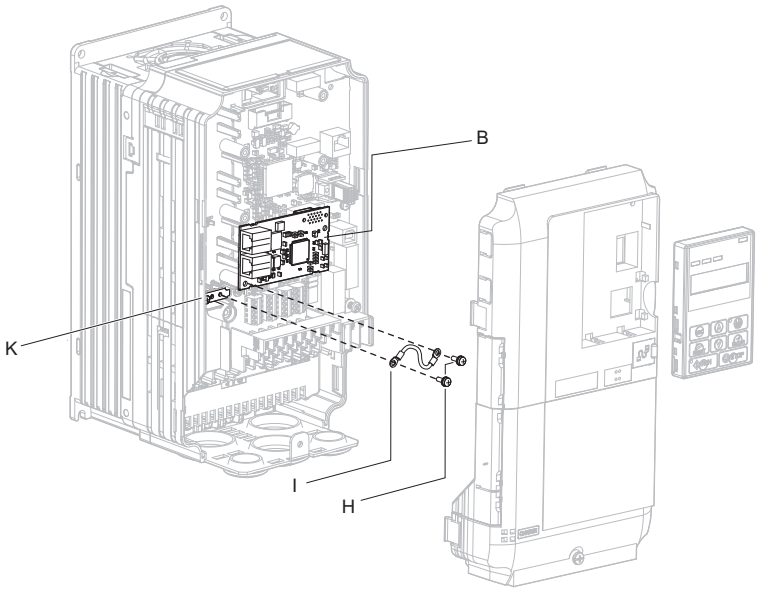


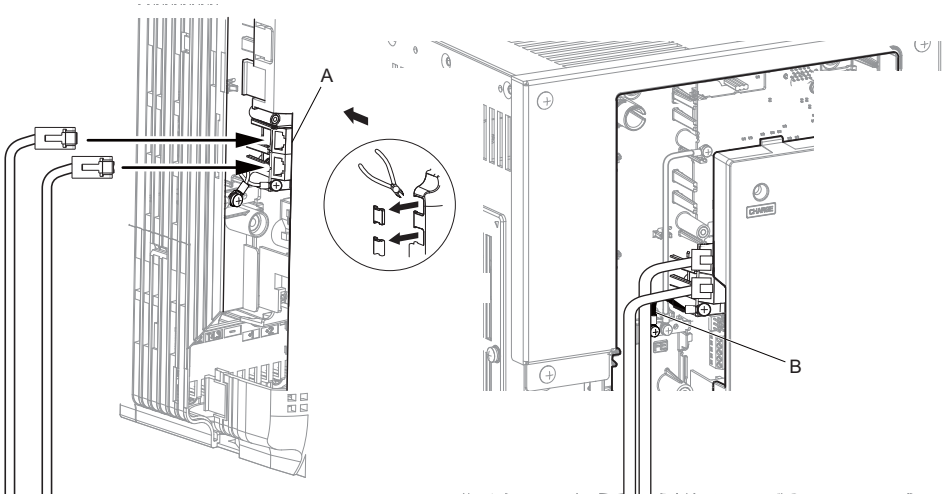
Figure 8 Connect the Ground Wire

Note: There are two screw holes on the drive for use as ground terminals (K). When connecting three options, two ground wires will need to share the same drive ground terminal.

5. Route the option wiring.
Depending on the drive model, some drives may require routing the wiring through the side of the front cover to the outside to provide adequate space for the wiring. Refer to the Peripheral Devices & Options section of the drive Quick Start Guide or Technical Manual for more information on wire routing of specific models.

Route the wiring through the side of the front cover to the outside. In these cases, using diagonal cutting pliers, cut out the perforated openings on the left side of the drive front cover as shown in ***Figure 9***-A. Sharp edges along the cut out should be smoothed down with a file or sand paper to prevent any damage to the wires. Route the wiring inside the enclosure as shown in ***Figure 9***-B for drives that do not require routing through the front cover.

Note: Separate communication cables from main circuit wiring and other electrical lines.



A – Route wires through the openings provided on the left side of the front cover. <1>

B – Use the open space provided inside the drive to route option wiring.

<1> The drive will not meet NEMA Type 1 requirements if wiring is exposed outside the enclosure.

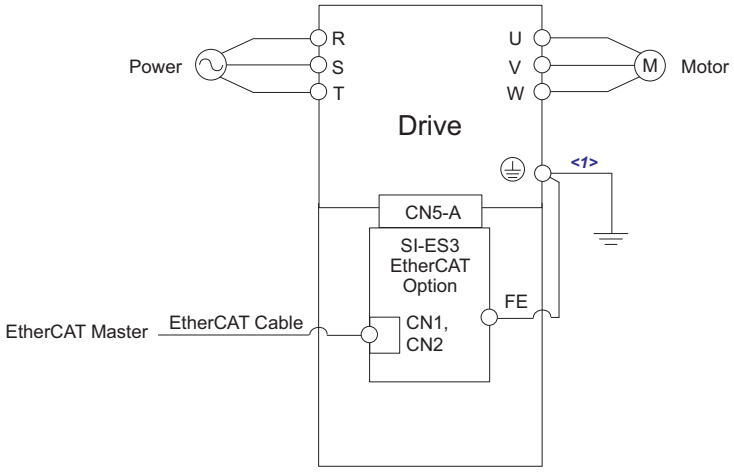
Figure 9 Wire Routing Examples

6. Connect the EtherCAT communication cable to the option modular connector CN1 and CN2.
To connect the option to a network, insert the RJ45 communication connector of the Cat5e patch cable into the option modular female connector CN1 and CN2. Ensure the cable end is firmly connected (see ***Figure 9***).

Communication Cable Specifications

Only use cable recommended for EtherCAT. Using a cable not specifically recommended may cause the option or drive to malfunction.

Connection Diagram



<1> The ground wire provided in the option shipping package must be connected during installation.

Figure 10 Option Connection Diagram

7. Replace and secure the front covers of the drive (C, F) and replace the digital operator (D).

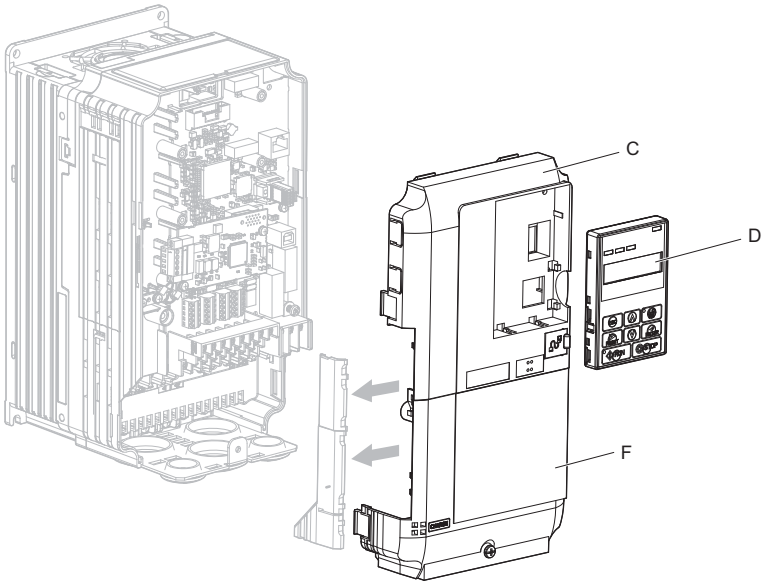


Figure 11 Replace the Front Covers and Digital Operator

Note: Take proper precautions when wiring the option so that the front covers will easily fit back onto the drive. Make sure no cables are pinched between the front covers and the drive when replacing the covers.

8. Set drive parameters in ***Table 13*** for proper option performance.

◆ Network Termination

The EtherCAT network does not require a termination resistor if the drive is the last node in the network. The network is terminated by the ASIC of the EtherCAT option card.

◆ ESI File

For easy network implementation of drives equipped with an EtherCAT option, the ESI file can be obtained from:

U.S.: http://www.yaskawa.com

Europe: http://www.yaskawa.eu.com

Japan: http://www.e-mechatronics.com

Other areas: Contact a Yaskawa representative

6 DSP301 and DSP402 Specifications

Network communication on EtherCAT is based on the DSP301 communication profile and the CANopen DSP402 device profile for drives and motion control. This profile specifies mandatory objects that will be implemented as well as manufacturer specific and optional objects.

Process Data Objects (PDOs) are used for I/O exchange and Service Data Objects (SDO) for explicit messaging. The time for transmitting PDOs is significantly lower than the time for transmitting SDOs, therefore, communication objects like command/reference are mapped onto PDOs as standard.

All CANopen communication objects can be accessed via SDOs. The SDOs allow acknowledged access to communication objects, i.e., the communication adapter confirms the intended access.

◆ Modes

The A1000 series EtherCAT option will support two operating modes:

- DSP402 Velocity mode
  DSP402 object 0x6061 (Modes of operation display) = 2
- Automatic vendor specific mode
  It is also possible to run the drive by mapping the vendor specific command and status to control the drive. Any access to the DSP402 Controlword will be rejected.
  DSP402 object 0x6061 (Modes of operation display) = -2

Profile/vendor mode is automatically activated by the option within the following constraints:

- If an RxPDO mapping has been assigned to DSP402 Controlword 0x6040 and EtherCAT is in the Safe-Operational (SAFEOP) or Operational (OP) state, the DSP402 profile will be processed.
- If the EtherCAT state machine is NOT in the SAFEOP or OP state and an SDO write request is performed on the DSP402 0x6040 Controlword, the DSP402 profile will be processed.
- If the EtherCAT state machine is NOT in the SAFEOP or OP state and an SDO read request is performed on the DSP402 0x6041 Statusword, the DSP402 profile will be processed.
- Otherwise, the vendor specific Controlword will be accessed normally.

■ DSP402 Velocity Mode

Many AC drives use this simple mode to control the velocity of the drive with limits and ramp functions.

■ Vendor Specific Mode (DSP402 profile bypass)

In this mode, the DSP402 state machine processor in the option is bypassed and the drive native control commands and status are used.

◆ Implemented CANopen Objects/Components

Communication and parameters on CANopen are built around objects using the following message types.

- SDO (Service Data Object)
  The SDO object uses asynchronous data transmission and is used to access objects without mapping them to an I/O (PDO) connection. With SDO communication, the user will have access to all CANopen objects in the option.
- Process Data Object (PDO)
  The PDO object is used for I/O communication.
- Emergency Object (EMCY)
  Emergency object is used for error reporting when a fault has occurred in the drive or option.

■ Services

Supported SDO Requests

- SDO Download Expedited
  Writes up to four octets to the slave
- SDO Download Normal
  Writes up to a negotiated number of octets to the slave
- Download SDO segment
  Writes additional data if the object size is greater than the negotiated number of octets
- SDO Upload Expedited
  Reads up to four octets from the slave
- SDO Upload Normal
  Reads up to a negotiated number of octets from the slave
- Upload SDO segment
  Reads additional data if the object size is greater than the negotiated number of octets
- Abort SDO Transfer
  Server abort of service when error is detected

Emergency Service

- Emergency (Does not support incoming requests)
  Report of unexpected conditions

◆ EtherCAT State Machine

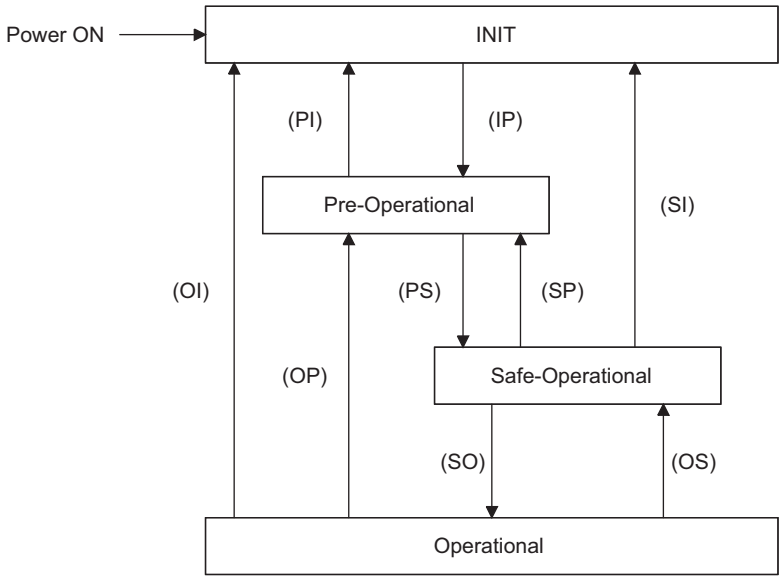


Figure 12 EtherCAT State Machine

The option enters the INIT state directly after start-up. After this, the option can be switched to the Pre-Operation (PREOP) state. In the PREOP state, drive parameters can be accessed by CoE SDO.

After the master has configured the slave, the option can be switched to Safe-Operation (SAFEOP) state. In the SAFEOP state, Input I/O data (PDOs) will be sent from the option to the EtherCAT master, but there may be no void Output I/O data from the master to the option.

When the transition from PREOP to SAFEOP occurs, the option will process the configured PDO assignments and re-map the relevant drive registers. After this, the option will enter the SAFEOP state.

In order to communicate Output I/O data, the master must switch the option to Operation (OP) state.

■ EtherCAT Operation Mode Relations

Table 5 EtherCAT Operation Mode Relations

EtherCAT state	Event	Description
INIT	State	SDO access possible against the drive.
PREOP	State	• SDO access possible against the drive. • No ctrl data is mapped against the drive. • Only drive status is mapped on resp registers to service the DSP emergency services.
SAFEOP	State	• SDO access possible against the drive. • Input PDO data from “Drive → Option” valid. • Master output data “Option → Drive” not valid.
OP	State	• SDO access possible against the drive. • Input PDO data from “Drive → Option” valid. • Master output data “Option → Drive” valid.
PREOP → SAFEOP	Trans	• Option will re-map required drive registers in NOID. • Option will trigger INIT request to re-map ctrl/resp registers exchanged in Online-DRV.
SAFEOP → PREOP SAFEOP → INIT OP → PREOP OP → INIT	Trans	• If drive is operating, option will trip drive with bUS error. • Option will trigger NOID to switch operation mode to Online-PRG. • Option will remap and clear all ctrl/resp data.
SAFEOP → OP	Trans	NOID will SET “ctrl data valid bit”
OP → SAFEOP	Trans	No processing done, only bUS error is set against the drive.

Note: If the requested drive state cannot be entered due to transition from lower to higher state (the drive might be controlled locally and reject an application IF state switch), an error will be generated on EtherCAT. The state transition time out wait time is 3 seconds.

◆ DSP402 State Machine

The CANopen DSP402 specification indicates the state machine of the drive. Since the DSP402 adapter is external to the inverter, the whole state machine must be implemented in the option card itself.

■ CANopen DSP402 Controlword/Statusword

This section describes how to control the drive via Controlword/Statusword and how to access drive parameters.

Table 6 Controlword

Bit Number	Controlword	Application Reference/CPI Function Calls
0	Switch on	This bit controls the DS402 state machine - See ***Table 10***
1	Enable voltage	This bit controls the DS402 state machine - See ***Table 10***
2	Quick stop	This bit controls the DS402 state machine - See ***Table 10***
3	Enable operation	This bit controls the DS402 state machine - See ***Table 10***
4	Operation mode specific	Please see ***Table 8*** for more details
5	Operation mode specific	Please see ***Table 8*** for more details
6	Operation mode specific	Please see ***Table 8*** for more details
7	Fault reset	This bit controls the DS402 state machine - See ***Table 10***
8	Halt	Not implemented
9	Operation mode specific	Please see ***Table 8*** for more details
10	Manufacturer specific	NA
11	Manufacturer specific	NA
12	Manufacturer specific	NA
13	Manufacturer specific	NA
14	Manufacturer specific	NA
15	Manufacturer specific	NA

Table 7 Statusword

Bit Number	Statusword	Drive Reference
0	Ready to switch on	This bit controls the DS402 state machine - See ***Table 11***
1	Switched on	This bit controls the DS402 state machine - See ***Table 11***
2	Operation enabled	This bit controls the DS402 state machine - See ***Table 11***
3	Fault	This bit controls the DS402 state machine - See ***Table 11***
4	Voltage enabled	1: High voltage is applied to the drive
5	Quick stop	This bit controls the DS402 state machine - See ***Table 11***
6	Switch on disabled	This bit controls the DS402 state machine - See ***Table 11***
7	Warning	1: During alarm condition
8	Manufacturer specific	NA
9	Remote	1: Controls the frequency reference or the run command from the option 0: Does not control the frequency reference or the run command from the option
10	Target reached (Op mode spec)	See ***Table 9***
11	Internal limit active	0: Always, not implemented
12	Operation mode specific	Refer to ***Table 9*** for more details
13	Operation mode specific	Refer to ***Table 9*** for more details
14	Manufacturer specific	NA
15	Manufacturer specific	NA

Controlword Operation Mode Specific Bits in Velocity Mode

Table 8 Controlword Operation Mode Specific Bits in Velocity Mode

Bit Number	Controlword	Drive Reference
4	rfg enable	0: Does not control the frequency reference from the option 1: Controls the frequency reference from the option
5	rfg unlock	0: Discards any new NET set-point 1: Uses new NET set-point
6	rfg use ref	0: Forces NET set-point to zero 1: Uses NET set-point
9	Not implemented	Not implemented

Statusword Operation Mode Specific Bits in Velocity Mode

Table 9 Statusword Operation Mode Specific Bits in Velocity Mode

Bit Number	Statusword	Drive Reference
10	Target reached	1: Speed agree
12	Reserved	0: Always, not applicable in velocity mode
13	Reserved	0: Always, not applicable in velocity mode

CANopen DSP402 Controlword State Transition Bits

Table 10 Controlword State Transitions

DSP402 Command	Controlword Bits					Transitions <1>	Drive Command Orders
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0		
0: Shutdown	0	0 or 1	1	1	0	2, 6, 8	Turns off run command
1: Switch on	0	0	1	1	1	3	Turns off run command
2: Switch on + enable operation	0	1	1	1	1	3 + 4 <2> <3>	If velocity mode index 0x6042 (vl target velocity) < 0 : runs in reverse If velocity mode index 0x6042 (vl target velocity) ≥ 0 : runs forward
3: Disable voltage	0	0 or 1	0 or 1	0	0 or 1	7, 9, 10, 12	Turns off run command
4: Quick stop	0	0 or 1	0	1	0 or 1	7, 10, 11	Quick stop (using time set in C1-09)
5: Disable operation	0	0	1	1	1	5	Turns off run command
6: Enable operation	0	1	1	1	1	4, 16	If velocity mode index 0x6042 (vl target velocity) < 0 : runs in reverse If velocity mode index 0x6042 (vl target velocity) ≥ 0 : runs forward
7: Fault reset	0 → 1	0 or 1	0 or 1	0 or 1	0 or 1	15	Resets fault

<1> Refer to ***Figure 13***.
<2> Automatic transition to Enable operation state after executing SWITCHED ON state functionality.
<3> If the option does not have the NetCtrl command, it will not process any command orders against the drive.

CANopen DSP402 Statusword State Transition Bits

After a change in the Controlword (remote control) according to ***Table 10***, the node state will change and the state result will be indicated in the Statusword according to ***Table 11***.

Table 11 Statusword State Transitions

DSP402 State	Statusword Bits						Drive Status + Option Cmd Evaluation
	Bit 6 SOD	Bit 5 QS	Bit 3 F	Bit 2 OE	Bit 1 SO	Bit 0 RTSO	
1: Not ready to switch on	0	0 or 1	0	0	0	0	Drive is not ready
2: Switch on disabled	1	0 or 1	0	0	0	0	Drive is stopped
3: Ready to switch on	0	1	0	0	0	1	Drive is stopped Ready to switch on
4: Switched on	0	1	0	0	1	1	Drive is stopped Switched on
5: Operation enabled	0	1	0	1	1	1	Drive is running
6: Quick stop active	0	0	0	1	1	1	Drive is stopped Quick stop
7: Fault reaction active	0	0 or 1	1	1	1	1	Drive is running and fatal fault occurred
8: Fault	0	0 or 1	1	0	0	0	Drive is stopped and fatal fault occurred

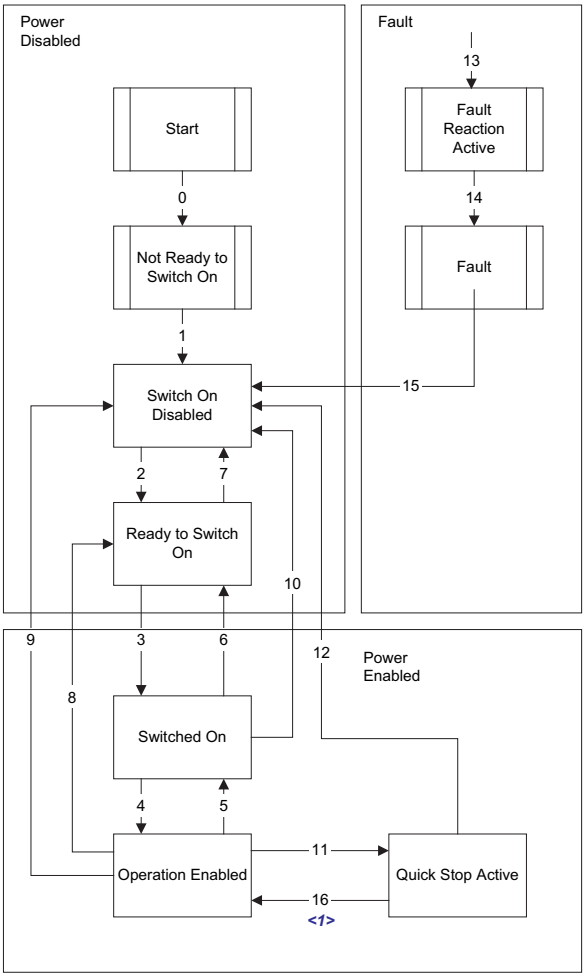
CANopen DS402 State Transition Definition

The Yaskawa EtherCAT option has the state transitions and states shown in ***Figure 13***. The option must be in the Operation Enable state in order to accept frequency and operation commands. In ***Table 12***, the events needed to change between different states are described. Some events are internally triggered, but most of the events are triggered from the Controlword received from the bus.

CANopen DSP402 State Diagram

At any time, the EtherCAT option card will be in one of the states in ***Figure 13***. The state specified in each square indicates the DSP402 state, and the numbered arrows indicate the state transition number.

The events that are able to trigger a transition between the states are either sent with the Controlword or triggered by an internal action. All the possible events and the corresponding transition numbers are listed in ***Table 12***.



<1> Transition 16 is only available while the drive is performing the quick stop action. When completed, transition will automatically be processed.

Figure 13 DSP402 State Diagram

CANopen DSP402 Event Description

The following state transitions are available in the CANopen DSP402 drive profile. Transition 0 and 1 are triggered at start-up and when all start-up tests are performed, the option will be in state 3. Some commands like fault reset can be triggered from more then one place. For example, the reset command can be triggered both from the bus with the Controlword or from the application drive.

Table 12 Event description table

State Transition Number	Transition Name	DSP402 Event
0	Startup → Not Ready To Switch On	Reset
1	Not ready to switch on → Switch on disabled	Self test and INIT successful
2	Switch on disabled → Ready to switch on	Shutdown command received
3	Ready to switch on → Switched on	Switch on command received
4	Switched on → Operation enabled	Enable operation command received
5	Operation enabled → Switched on	Disable operation command received
6	Switched on → Ready to switch on	Shutdown command received
7	Ready to switch on → Switch on disabled	Quick stop command received
8	Operation enabled → Ready to switch on	Shutdown command received
9	Operation enabled → Switch on disabled	Disable voltage command received
10	Switched on → Switch on disabled	Disable voltage or quick stop command received
11	Operation enabled → Quick stop active	Quick stop command received
12	Quick stop active → Switch on disabled	Quick stop completed or Disable voltage command received
13	All states → Fault reaction active	Fatal fault has occurred in the drive
14	Fault reaction active → Fault	Fault action is completed
15	Fault → Switch on disabled	Fault reset command received
16	Quick stop active → Operation enabled	Enable operation command received

7 Related Drive Parameters

The following parameters are used to set up the drive for operation with the option. Parameter setting instructions can be found in the drive Quick Start Guide or Technical Manual.

Confirm proper setting of all the parameters in ***Table 13*** using the digital operator, before starting network communications.

Table 13 Related Parameter Settings

No. (Addr. H)	Name	Description	Values
b1-01 (180) <1>	Frequency Reference Selection	Selects the frequency reference input source. 0: Operator - Digital preset speed d1-01 to d1-17 1: Terminals - Analog input terminal A1 or A2 2: MEMOBUS/Modbus communications 3: Option 4: Pulse Input (Terminal RP)	Default: 1 Range: 0 to 4 (Set to 3)
b1-02 (181) <1>	Run Command Selection	Selects the run command input source. 0: Digital Operator - RUN and STOP keys 1: Digital input terminals S1 to S8 2: MEMOBUS/Modbus communications 3: Option	Default: 1 Range: 0 to 3 (Set to 3)
E2-04 (311) <2>	Number of Motor Poles	Set the number of motor poles described on the motor nameplate.	Default: 4 Min: 2 Max: 48
F6-01 (3A2)	Operation Selection after Communications Error	Determines drive response when a bUS error is detected during communications with the option. 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <3>	Default: 1 Range: 0 to 3
F6-02 (3A3)	External Fault Detection Conditions (EF0)	Sets the condition for external fault detection (EF0). 0: Always detected 1: Detected only during operation	Default: 0 Range: 0, 1
F6-03 (3A4)	Stopping Method for External Fault from the Communication Option	Determines drive response for external fault input (EF0) detection during option communications. 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <3>	Default: 1 Range: 0 to 3
F6-06 (3A7) <6>	Torque Reference/Torque Limit Selection from the Communication Option	0: Torque Reference/Torque Limit via network communications are disabled 1: Torque Reference/Torque Limit via network communications are enabled <7>	Default: 0 Range: 0, 1
F6-07 (3A8)	NetRef/ComRef Selection Function	0: Multi-step speed reference disabled, (F7 functionality) 1: Multi-step speed reference allowed, (V7 functionality)	Default: 0 Range: 0, 1
F6-08 (36A)	Reset Communication Related Parameters	Determines if communication-related parameters F6-☐☐ and F7-☐☐ are set back to original default values when the drive is initialized using parameter A1-03. 0: Do not reset parameters 1: Reset parameters	Default: 0 Range: 0, 1
o1-03 (502) <4>	Digital Operator Display Selection	Sets the units to display the frequency reference and output frequency. 0: 0.01 Hz 1: 0.01% (100% = E1-04) 2: r/min (enter the number of motor poles to E2-04/E4-04/E5-04) 3: User defined by parameters o1-10 and o1-11	Default: <5> Range: 0 to 3

<1> To start and stop the drive with the option master device using serial communications, set b1-02 to 3. To control the drive frequency reference via the master device, set b1-01 to 3.
<2> E2-04 must be set up when the Drive Profile DSP402 objects are used.
<3> If F6-01 or F6-03 is set to 3, the drive will continue to operate when a fault is detected. Take safety measures, such as installing an emergency stop switch.
<4> Changing o1-03 changes the units for input object 2010 (Hex) (frequency reference), output object 2110 (Hex) (output frequency) and 2200 (Hex) (motor speed). In order to use the Drive Profile DSP402, o1-03 must be set to 2 and E2-04 must be set to the correct value.
<5> Default setting is determined by the control mode (A1-02).
<6> Enabled in CLV, AOLV/PM, and CLV/PM control modes (A1-02 = 3, 6, or 7). When enabled, d5-01 determines whether the value is read as the Torque Limit value (d5-01 = 0) or read as the Torque Reference value (d5-01 = 1). In CLV/PM, this value is read as the Torque Limit.

<7> The setting specifies that the Torque Reference or Torque Limit is to be provided via network communications (F6-06 = 1). The motor may rotate if no torque reference or Torque Limit is supplied from the PLC.

8 Object Dictionary

◆ Object Dictionary Overview

The Object Dictionary consists of three sections:

- Communication Profile Objects
- Manufacturer Specific Profile Objects
- Drive and Motion Profile Objects

The tables below give an overview of the communication objects available in the option. Refer to the page references given for further details on each object.

■ Communication Profile Objects (DSP 301)

Index (Hex)	Name	Page
1000	Device Type	*27*
1001	Error Register	*28*
1003	Pre-defined Error Field	*28*
1008	Manufacturer Device Name	*28*
1009	Manufacturer Hardware Version	*28*
100A	Manufacturer Software Version	*28*
1010	Store Parameters	*29*
1011	Restore Default Parameters	*29*
1018	Identity Object	*29*
1600 - 1628	Receive PDO Mapping	*30*
1A00 - 1A28	Transmit PDO Mapping	*30*
1C00	Sync Manager Communication Type	*30*
1C12	Sync Manager RxPDO Assign	*31*
1C13	Sync Manager TxPDO Assign	*31*

■ Manufacturer Specific Profile Objects (DS 301)

Index (Hex)		Content	Page
Input	2000	Operation Command	*31*
	2010	Speed Reference/Speed Limit	*32*
	2020	Torque Reference/Torque Limit	*32*
	2030	Torque Compensation	*32*
	2040	MEMOBUS/Modbus Read Request	*32*
	2050	MEMOBUS/Modbus Write Request	*33*
	2060	MEMOBUS/Modbus Unlimited ENTER Command	*33*
	2070	MEMOBUS/Modbus Limited ENTER Command	*33*
	2080	Selectable (default: none)	*34*
	2090	Selectable (default: none)	*34*
	20A0	Selectable (default: none)	*34*
	20B0	Selectable (default: none)	*34*
	20C0	Selectable (default: none)	*34*
	20D0	Analog Output Terminal FM Setting	*34*
	20E0	AM Analog Output	*34*
	20F0	Multi-function DO Output	*34*
	3000	Selectable (default: none)	*34*
	3100	Selectable (default: none)	*34*

Index (Hex)		Content	Page
Output	2100	Drive Status	35
	2110	Output Frequency	35
	2120	Output Current	36
	2130	Output Torque Reference	36
	2140	MEMOBUS/Modbus Read Response	36
	2150	MEMOBUS/Modbus Write Response	36
	2155	PDO Parameter Write Response	36
	2160	MEMOBUS/Modbus Not Limited ENTER Command Response	37
	2180	Selectable (default: Input terminal status)	37
	2190	Selectable (default: Analog input 1 monitor)	37
	21A0	Selectable (default: none)	37
	21B0	Selectable (default: none)	37
	21C0	Selectable (default: none)	37
	21D0	Selectable (default: none)	37
	21E0	Selectable (default: none)	37
	21F0	Selectable (default: none)	37
	2200	Motor Speed	38
	2210	DC Bus Voltage	38
	2220	Analog Input Monitor A1	38
	2240	Analog Input Monitor A2	38
	2260	Analog Input Monitor A3	39
	2270	Drive DI Input	39
	4000	Option NVS FATAL Record	39
	4001	Option Info + Status Record	39

■ Drives and Motion Profile Objects (DSP 402)

Object Type	Index (Hex)	Name	Page
Common Entries	60FD	Digital Inputs	44
	60FE	Digital Outputs	44
Device Control	6040	Controlword	40
	6041	Statusword	40
	6060	Modes of Operation	43
	6061	Modes of Operation Display	43
Velocity Mode	6042	vl Target Velocity	40
	6043	vl Velocity Demand	40
	6044	vl Velocity Actual Value	40
	6046	vl Velocity Min Max Amount	41
	6048	vl Velocity Acceleration	41
	6049	vl Velocity Deceleration	42
	604A	vl Velocity Quick Stop	42
	604C	vl Dimension Factor	43
	604D	vl Pole Number	43

◆ Communication Profile Objects (DS 301)

■ 1000 (Hex) - Device Type

This object describes the type of the device and its functionality. It is composed of a 16-bit field that describes the device profile used and a second 16-bit field that gives additional information about optional functionality.

Bit 0-15: Device Profile Number = 0x0192 (402)

Bit 16-23: Type = 0x01

Bit 24-31: Mode Bits (Vendor specific) = 0x00

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1000	–	Device type	Read Only	No	Unsigned 32

■ 1001 (Hex) - Error Register

This register shows the fault status of the device. If any errors occurs in the device, bit 0 (generic error) is set to one.

0x00 = No error

0x01 = 1: During fault condition

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1001	–	Error register	Read Only	Tx	Unsigned 8

■ 1003 (Hex) - Pre-defined Error Field

This register provides a history of errors that occurred in the drive and have been signalized via the Emergency object. Subindex 0 contains the number of errors. Subindexes 1 to FF contain a rolling list of error codes where subindex 1 always contains the last occurring error. *Refer to EtherCAT Option Card Error Codes on page 54* for a list of possible error codes. The number of valid logged errors in sub index is 0x01-0xFE.

Writing a 0 to subindex 0 resets the error field.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1003	0	Number of errors	Read/Write	No	Unsigned 8
	1	Standard error field	Read Only		Unsigned 32

■ 1008 (Hex) - Manufacturer Device Name

This object contains the manufacturer device name. String: EtherCAT for 1000 series.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1008	–	Manufacturer device name	Read Only	No	Visible string

■ 1009 (Hex) - Manufacturer Hardware Version

This object contains the manufacturer hardware version.

Value: 1.x

x = HW revision assigned during production

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1009	–	Manufacturer hardware version	Read Only	No	Visible string

■ 100A (Hex) - Manufacturer Software Version

This object contains the Manufacturer software version.

Value: VST9242xx

Yaskawa Def: VST9242xx

VST9 = A1000 option card

2 = European product

42 = Product code

xx = Minor revision

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
100A	–	Manufacturer software version	Read Only	No	Visible string

■ 1010 (Hex) - Store Parameters

By writing “save” (s = 73H, a = 61H, v = 76H, e = 65H) to this object, the EtherCAT Option settings are saved in the non-volatile memory. The EtherCAT Option will operate using these settings when a Reset Node or Reset Communications command is performed or when the power supply is cycled.

Default read value: 0x01 (Save on command)

Behavior: Write of value 0x0000 to MEMOBUS/Modbus register: 0x0900. Issue EEPROM ENTER command to the drive.

Note: Write access is only allowed in the EtherCAT Pre-Operational state.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1010	1	Store parameters	Read/Write	No	Unsigned 32

■ 1011 (Hex) - Restore Default Parameters

Writing “load” (l = 6CH, o = 6FH, a = 61H, d = 64H) to subindex 1 restores the EtherCAT Option default settings.

Default read value: 0x01 (Restore on command)

Behavior: Option will write value = 2220 to MEMOBUS/Modbus register: 0x0103 (A1-03) together with an EEPROM ENTER command

Note: Write access is only allowed in the EtherCAT Pre-Operational state.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1011	1	Restore default parameters	Read/Write	No	Unsigned 32

■ 1018 (Hex) - Identity Object

This object contains general information about the drive.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1018	–	Identity object	Read/Write	–	Unsigned 32
	0	Number of entries	Read Only	No	Unsigned 8
		Value: 4			
	1	Vendor ID	Read Only	No	Unsigned 32
		Yaskawa ETG Member Vendor ID Value: 0x00000539 (Yaskawa Electric Corporation, Japan)			
	2	Product Code	Read Only	No	Unsigned 32
		EtherCAT option product code Value: 0x53455333 (ASCII: SES3)			
	3	Revision number	Read Only	No	Unsigned 32
		Yaskawa EtherCAT option software revision number. Definition: xxxxxYYYY ' (xxxx = Major, YYYY = Minor) Value: 9242.xx00 9 = A1000 option card 2 = European product 42 = Product code xx = Minor revision			
	4	Serial number	Read Only	No	Unsigned 32
		EtherCAT option serial number			

■ 1600 (Hex) to 1628 (Hex) - Receive PDO Mapping

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1600 to 1628	–	Receive PDO mapping	–	–	–
	0	Number of mapped application objects (0-8(2))	Read/Write	No	Unsigned 8
		Value: 0-8 (Depends on RxPDO) For default configurations per RxPDO please refer to *Table 16*. Max Sub-index: 0x1600: 8 0x1601-0x1628: 2 **Note:** Write access to those objects are only allowed in the EtherCAT Pre-Operational state.			
	1	Mapped Object #1	Read/Write	No	Unsigned 32
	2	Mapped Object #2	Read/Write	No	Unsigned 32
	3	Mapped Object #3	Read/Write	No	Unsigned 32
	n	Mapped Object #n	Read/Write	No	Unsigned 32

■ 1A00 (Hex) to 1A28 (Hex) - Transmit PDO Mapping

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1A00 to 1A28	–	Transmit PDO mapping	–	–	–
	0	Number of mapped application objects (0-8(2))	Read/Write	No	Unsigned 8
		Value: 0-8 (Depends on TxPDO) For default configurations per TxPDO please refer to *Table 15*. Max Sub-index: 0x1A00: 8 0x1A01-0x1A28: 2 **Note:** Write access to those objects are only allowed in the EtherCAT Pre-Operational state.			
	1	Mapped Object #1	Read/Write	No	Unsigned 32
	2	Mapped Object #2	Read/Write	No	Unsigned 32
	3	Mapped Object #3	Read/Write	No	Unsigned 32
	n	Mapped Object #n	Read/Write	No	Unsigned 32

■ 1C00 (Hex) - Sync Manager Communication Type

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1C00	–	Transmit PDO mapping	–	–	–
	0	Number of entries	Read Only	No	Unsigned 8
		Value: 4			
	1	Mailbox wr	Read Only	No	Unsigned 8
		Value: 1			
	2	Mailbox rd	Read Only	No	Unsigned 8
		Value: 2			
	3	Process data out	Read Only	No	Unsigned 8
		Value: 3			
	4	Process data in	Read Only	No	Unsigned 8
		Value: 4			

■ 1C12 (Hex) - Sync Manager RxPDO Assign

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1C12	–	Sync Manager RxPDO assign	–	–	–
		Sync Manager RxPDO assignment object. **Note:** Write access to this object is only allowed in the EtherCAT Pre-Operational state.			
	0	Number of entries	Read Write	No	Unsigned 8
		Value: (0-4) Default: 1			
	1	Assigned RxPDO #1	Read Write	No	Unsigned 16
		Default: 0x1600			
	2	Assigned RxPDO #2	Read Write	No	Unsigned 16
	3	Assigned RxPDO #3	Read Write	No	Unsigned 16
	4	Assigned RxPDO #4	Read Write	No	Unsigned 16

■ 1C13 (Hex) - Sync Manager TxPDO Assign

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
1C13	–	Sync Manager TxPDO assign	–	–	–
		Sync Manager TxPDO assignment object. **Note:** Write access to this object is only allowed in the EtherCAT Pre-Operational state.			
	0	Number of entries	Read Write	No	Unsigned 8
		Value: (0-4) Default: 1			
	1	Assigned TxPDO #1	Read Write	No	Unsigned 16
		Default: 0x1A00			
	2	Assigned TxPDO #2	Read Write	No	Unsigned 16
	3	Assigned TxPDO #3	Read Write	No	Unsigned 16
	4	Assigned TxPDO #4	Read Write	No	Unsigned 16

◆ Manufacturer Specific Profile Objects (DS 301)

The option offers the manufacturer specific objects listed below. These objects are specific to Yaskawa products and are therefore not available on other EtherCAT products.

The manufacturer specific objects list consists of objects that have predefined, non-changeable content and objects that are configurable. The content of configurable objects can be determined by linking these objects to drive parameters, monitors or MEMOBUS/Modbus registers (refer to *Selectable Object Content on page 45*).

Input objects are processed in a cycle of 2 ms. Output objects are, depending on the object, updated in a cycle of either 2 ms or 8 ms. The update cycle cannot be changed.

■ 2000 (Hex) - Operation Command

This object is used for starting and stopping the drive, for controlling the multi-function digital input terminals, and for triggering and resetting faults.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2000	0	Operation command	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx/Tx	
	2	MEMOBUS/Modbus register address	Read Only	No	
		Value (MEMOBUS/Modbus register): 0x0001 (Run operation signal)			

Bit No. (Hex)	Description	Function
0	Forward Run	1: Forward run 0: Stop (Enabled when b1-02 = 3)
1	Reverse Run	1: Reverse run 0: Stop (Enabled when b1-02 = 3)
2	External Fault (EF0)	1: External Fault Input (EF0)
3	Fault Reset	1: Fault Reset
4	Terminal S1 Function	Multi-Function Input: H1-01

Bit No. (Hex)	Description	Function
5	Terminal S2 Function	Multi-Function Input: H1-02
6	Terminal S3 Function	Multi-Function Input: H1-03
7	Terminal S4 Function	Multi-Function Input: H1-04
8	Terminal S5 Function	Multi-Function Input: H1-05
9	Terminal S6 Function	Multi-Function Input: H1-06
A	Terminal S7 Function	Multi-Function Input: H1-07
B	Terminal S8 Function	Multi-Function Input: H1-08
C to F	Not used	–

■ 2010 (Hex) - Speed Reference/Speed Limit

Sets the speed reference or speed limit. The unit of this value depends on the setting of the drive parameter o1-03.

The value will be used as the speed reference for speed control (d5-01 = 0) or as the speed limit in torque control (d5-01 = 1).

Note: The availability of the torque control function depends on the drive and the selected control mode. For details, refer to the technical manual for the drive.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2010	0	Speed reference/Speed limit	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx/Tx	–
		Speed reference/Speed limit The unit of this value depends on the setting of the drive parameter o1-03. o1-03: 0: Hz 1: % (100% = E1-04) 2: rev/min (enter the number of motor poles into E2-04/E4-04/E5-04) 3: User defined by parameters o1-10 and o1-11			
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0002 (Frequency reference)			

■ 2020 (Hex) - Torque Reference/Torque Limit

This object sets the torque reference or the torque limit in units of 0.1%.
To use this object, set drive parameter F6-06 to 1. The value will be used as the torque reference for torque control (d5-01 = 1) or as the torque limit in speed control (d5-01 = 0).

Note: The availability of the torque control and torque limit function depends on the drive and the selected control mode. For details, refer to the technical manual for the drive.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2020	0	Torque reference/Torque limit	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx/Tx	–
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0004 (Torque ref/limit)			

■ 2030 (Hex) - Torque Compensation

This object sets the torque compensation in units of 0.1%.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2030	0	Torque compensation	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx/Tx	–
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0005 (Torque compensation)			

■ 2040 (Hex) - MEMOBUS/Modbus Read Request

This object can be used to read out the content of drive MEMOBUS/Modbus registers. The address of the MEMOBUS/Modbus must be written in byte 3 and 4 of Subindex 1, and bytes 1 and 2 must be set to 0. After sending a MEMOBUS/Modbus Read Request to the drive, the MEMOBUS/Modbus register content can be read out from object 2140H.

For more details on MEMOBUS/Modbus address and data, refer to the MEMOBUS/Modbus/Modbus Data Table in Appendix C of the technical manual for the drive.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2040	0	Number of entries	Read Only	Possible	1 byte
	1	MEMOBUS/Modbus read request	Read/Write		2 + 2 byte MEMOBUS/Modbus 0000H + Address
		Value: 0xAAAABBBB → 0xAAAA = drive register, 0xBBBB = 0x0000			

■ 2050 (Hex) - MEMOBUS/Modbus Write Request

Drive MEMOBUS/Modbus registers can be written using this object. The data must be written in byte 1 and 2 of Subindex 1, and the MEMOBUS/Modbus address must be written in bytes 3 and 4. After sending a MEMOBUS/Modbus Write Request to the drive, the response can be read from object 2150H.

For more details on MEMOBUS/Modbus address and data, refer to the MEMOBUS/Modbus Data Table in Appendix C of the technical manual for the drive.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2050	0	Number of entries	Read Only	Possible	1 byte
	1	MEMOBUS/Modbus write request	Read/Write		2 + 2 byte MEMOBUS/Modbus Data + Address
		Value: 0xAAAABBBB → 0xAAAA = drive register, 0xBBBB = Data			

■ 2060 (Hex) - MEMOBUS/Modbus Unlimited ENTER Command

Depending on the drive parameter H5-11 setting, an ENTER command must be used to activate drive parameters changed via MEMOBUS/Modbus Write Commands. The Unlimited ENTER command activates parameters in the drive RAM only. If the drive power is cycled, parameter changes are lost. If more than one parameter has been changed, only one ENTER command must be sent after the last parameter change. This will activate all changed parameters. This ENTER command can be used without limitations.

To execute this ENTER command, “save” (73H + 61H + 76H + 65H) must be written in object 2060H, subindex 0.

Read value: 0x00000001 (Execute on command)

MEMOBUS/Modbus register: 0x0910 (Un-Memorized ENTER command)

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2060	0	Unlimited ENTER command	Read/Write	Possible	4 byte

■ 2070 (Hex) - MEMOBUS/Modbus Limited ENTER Command

Depending on the drive parameter H5-11 setting, an ENTER command must be used to activate drive parameters changed via MEMOBUS/Modbus Write Commands. The limited ENTER command activates parameters in the drive’s RAM and saves them to the EEPROM. When power supply loss occurs or the power supply is cycled, the drive will operate using the saved parameters. If more than one parameter has been changed, only one ENTER command must be sent after the last parameter change. This will activate all changed parameters. This ENTER command can be applied approximately 100,000 times and should be used only when necessary.

To execute this ENTER command, “save” (73H + 61H + 76H + 65H) must be written in object 2070H, subindex 0.

Read value: 0x00000001 (Execute on command)

MEMOBUS/Modbus register: 0x0900 (Memorized ENTER command)

Note: Write access to this object is only allowed in the EtherCAT Pre-Operational state.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2070	0	Limited ENTER command	Read/Write	Possible	4 byte

■ 2080 to 3100 (Hex) - Freely Configurable Input Objects

The content of these objects can be freely selected by linking them to drive MEMOBUS/Modbus registers. Refer to *Selecting the Object Content on page 45* for details.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Data Length
2080	0	Number of entries	2	Read Only	No	1 byte
	1	Value	–	Read/Write	Possible	4 byte
		Value of mapped MEMOBUS/Modbus register. Value: 0xAAAABBBB AAAA = MEMOBUS/Modbus register 1 value BBBB = MEMOBUS/Modbus register 2 value				
	2	MEMOBUS/Modbus register address of content 1 and 2	FFFF (Hex)/FFFF (Hex)	Read/ Write <1>	No	4 byte
		MEMOBUS/Modbus register addresses for content 1 and 2 Value: 0xAAAABBBB AAAA = MEMOBUS/Modbus register 1 address BBBB = MEMOBUS/Modbus register 2 address Reg. value = 0xFFFF ' Mapping disabled. **Note:** Those values can only be changed in EtherCAT Pre-Operational state. Refer to *Table 4* for the state relations.				
2090 to 20C0, 3000, and 3100	0	Number of entries	2	Read Only	No	1 byte
	1	Value	–	Read/Write	Possible	2 byte
		Value of mapped MEMOBUS/Modbus register. Value: 0xAAAA AAAA = MEMOBUS/Modbus register value				
	2	MEMOBUS/Modbus register address of content	FFFF (Hex)	Read/ Write <1>	No	2 byte
		MEMOBUS/Modbus register addresses Value: 0xAAAA AAAA = MEMOBUS/Modbus register address. **Note:** Those values can only be changed in EtherCAT Pre-Operational state. Refer to *Table 4* for the state relations.				

<1> Read/Write access when the option is in the Pre-Operational state. Read only access if the option is in the Operational state or if the drive is running.

■ 20D0 (Hex) - Analog Output Terminal FM Setting

This object controls the analog output terminal FM setting value.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
20D0	1	Value	Read/Write	Rx/Tx	–
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0007 (Analog output terminal FM setting)			

■ 20E0 (Hex) - AM Analog Output

This object controls the AM analog output value.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
20E0	1	Value	Read/Write	Rx/Tx	–
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0008 (AM analog output)			

■ 20F0 (Hex) - Multi-function DO Output

This object controls the multi-function DO outputs.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
20F0	1	Value	Read/Write	Rx/Tx	–
	2	MEMOBUS/Modbus register address	Read Only	No	–
		Value (MEMOBUS/Modbus register): 0x0009 (Multi-function DO output)			

■ 2100 (Hex)/2101 (Hex) - Drive Status

These objects can be used to monitor the drive status. The value in object 2100 (Hex) is not filtered.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Data Length	Update Cycle
2100	0	Drive status	–	Read Only	Possible	2 byte	2 ms
	1	Value	–	Read Only	Tx	2 byte	2 ms
	2	MEMOBUS/Modbus register address	–	Read Only	No	2 byte	–
		Value (Drive status): Refer to *Table 14*					

Table 14 Drive Status

Bit No. (Hex)	Function	Description
0	During Run	1: During Run 0: During Stop
1	During Zero Speed	1: During Zero Speed
2	Reverse Running	1: During Reverse Running 0: During Forward Running
3	During Fault Reset Signal Input	1: During Fault Reset Signal Input
4	During Speed Agree	1: During Speed Agree
5	During Drive Ready	1: During Drive Ready 0: Not Ready
6	During Alarm	1: During Alarm
7	During Fault	1: During Fault
8	During Operation Error	1: During Operation Error
9	During Momentary Power Loss	1: During Momentary Power Loss 0: During Power Loss
A	NetCtrl Status	1: NetCtrl
B	Digital Output 1 Status (function set in drive parameter H2-01)	1: ON 0: OFF
C	Digital Output 2 Status (function set in drive parameter H2-02)	1: ON 0: OFF
D	Digital Output 3 Status (function set in drive parameter H2-03)	1: ON 0: OFF
E	Motor 2 Selected	1: Motor 2 Selected
F	Zero-Servo End	1: Zero-Servo End

■ 2110 (Hex) - Output Frequency

This object can be used to monitor the drive output frequency. The unit of the monitor value is determined by drive parameter o1-03.

0: Hz

1: % (100% = E1-04)

2: r/min (enter the number of motor poles into E2-04/E4-04/E5-04)

3: User defined by parameters o1-10 and o1-11

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2110	–	Output frequency	–	Read Only	–	–
	1	Value	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address	0041 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0041, U1-02 (Output frequency)				

■ 2120 (Hex) - Output Current

This object can be used to monitor the drive output current in units of Ampere. The current value resolution is the same as in drive monitor U1-03 (for details refer to the technical manual of the drive).

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2120	–	Output current	–	Read Only	–	–
	1	Value	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address	00FB (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x00FB (Output current)				

■ 2130 (Hex) - Output Torque Reference

This object can be used to monitor the output torque reference.

The availability of this object content depends on the drive control mode. If the selected control mode does not support this monitor (equal to drive monitor U1-09), the torque reference monitor value will be 0. Refer to the drive technical manual for details.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2130	–	Output torque reference	–	Read Only	–	–
	1	Value	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address	0048 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0048 (Output torque reference)				

■ 2140 (Hex) - MEMOBUS/Modbus Read Response

This object contains the data of the drive MEMOBUS/Modbus register specified in object 2040 (Hex). Bytes 1 and 2 of subindex 1 will contain the data, and bytes 3 and 4 will contain the MEMOBUS/Modbus Address read.

Value: 0xAAAABBBB

0xAAAA = Drive register

0xBBBB = Data

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
2140	0	Number of entries	Read Only	No	Unsigned 8
		Value: 0x01			
	1	MEMOBUS/Modbus read response	Read Only	Tx	Unsigned 32

■ 2150 (Hex) - MEMOBUS/Modbus Write Response

This object contains the response from the drive when writing a drive parameter using a MEMOBUS/Modbus write command (object 2050 (Hex)). Bytes 1 and 2 of subindex 1 will contain the data that were written, and bytes 3 and 4 will contain the MEMOBUS/Modbus Address that was written to.

Value: 0xAAAABBBB

0xAAAA = Drive register

0xBBBB = Data

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
2150	0	Number of entries	Read Only	No	Unsigned 8
		Value: 0x01			
	1	MEMOBUS/Modbus write response	Read Only	Tx	Unsigned 32

■ 2155 (Hex) - PDO Parameter Write Response

Note: Object only available in EtherCAT SAFEOP or Operational state. Object data is always cleared when a transition from PREOP to SAFEOP is done.

This object contains the response from the drive when writing a drive parameter directly using a RxPDO. Byte 1 and 2 contain the last RxPDO number that caused the error. Byte 3 contains the number of errors. This object can only be read if the option is in Operational state.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2155	0	PDO parameter write response	Read Only	Tx	3 byte

■ 2160 (Hex) - MEMOBUS/Modbus Not Limited ENTER Command Response

This object contains the response from the drive when writing an ENTER command using object 2060 (Hex).

Response values:

OK: 0x65766173

ERR: MEMOBUS/Modbus error code or SDO abort code if SDO request.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Data Length
2160	0	MEMOBUS/Modbus not limited ENTER command response	Read Only	Tx	4 byte

■ 2180 (Hex) to 21E0 (Hex) - Configurable Output Objects

Note: This value can only be changed in EtherCAT Pre-Operational state.

The content of these objects can be selected by linking them to drive MEMOBUS/Modbus registers.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2180 to 21E0	0	Number of entries	–	Read Only	No	Unsigned 8
	1	Value	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	Defaults: 0x2180: 0x0049 (Input Terminal Status) 0x2190: 0x004E (Analog Input A1 Monitor) 0x21A0-0x21E0: Default: 0xFFFF (No mapping)	Read/Write	No	Unsigned 16

■ 21F0 (Hex) - Configurable Output Object

Note: This value can only be changed in EtherCAT Pre-Operational state.

The content of this object can be selected by linking them to drive MEMOBUS/Modbus registers.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
21F0	0	Number of entries	–	Read Only	No	Unsigned 8
	1	Value	–	Read Only	Tx	Unsigned 32
		Value: 0xAAAABBBB AAAA = MEMOBUS/Modbus register 1 value BBBB = MEMOBUS/Modbus register 2 value				
	2	MEMOBUS/Modbus register address of content 1 and 2	Value: 0xAAAABBBB ' AAAA = MEMOBUS/Modbus register 1 address BBBB = MEMOBUS/Modbus register 2 address Reg. value = 0xFFFF ' Mapping disabled. Default: 0xFFFFFFFF	Read/Write	No	Unsigned 32

■ 2200 (Hex) - Motor Speed

This object can be used to monitor the motor speed. The value in object 2200 (Hex) is not filtered. Setting units are determined by o1-03.

The availability of the object content depends on the drive control mode. If the selected control mode does not support this monitor (equal to drive monitor U1-05), the object value will be 0. Refer to the drive technical manual for details.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2200	–	Motor speed	–	Read Only	–	–
	0	Number of entries	–	Read Only	No	Unsigned 8
	1	Motor speed	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	0044 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0044 (Motor speed)				

■ 2210 (Hex) - DC Bus Voltage

This object can be used to monitor the DC bus voltage.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2210	–	DC bus voltage	–	Read Only	–	–
	1	Value	1 V	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	0046 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0046 (DC Bus voltage)				

■ 2220 (Hex) - Analog Input Monitor A1

This object can be used to display the analog input A1 level; 100% when input is 10 V.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2220	–	Analog input monitor A1	–	Read Only	–	–
	1	Value	0.1%	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	004E (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x004E (Terminal A1 Input Level)				

■ 2240 (Hex) - Analog Input Monitor A2

This object can be used to display the analog input A2 level; 100% when input is 10 V.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2240	–	Analog input monitor A2	–	Read Only	–	–
	1	Value	0.1%	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	004F (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x004F (Terminal A2 Input Level)				

■ 2260 (Hex) - Analog Input Monitor A3

This object can be used to display the analog input A3 level; 100% when input is 10 V.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2260	–	Analog input monitor A3	–	Read Only	–	–
	1	Value	0.1%	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	0050 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0050 (Terminal A3 Input Level)				

■ 2270 (Hex) - Drive DI Input

This object can be used to display the input terminal status.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
2270	–	Drive DI input	–	Read Only	–	–
	1	Value	–	Read Only	Tx	Unsigned 16
	2	MEMOBUS/Modbus register address of content	0049 (Hex)	Read Only	No	Unsigned 16
		Value (MEMOBUS/Modbus register): 0x0049 (Input Terminal Status)				

■ 4000 (Hex) - Option NVS FATAL Record

Internal FATAL NVS record for debugging purposes.

Note: Writing 0xFB to sub-index 0 will clear the record in NVS memory.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
4000	–	Option NVS FATAL record	–	Read/Write	No	Unsigned 8
		Information regarding a system failure/crash is stored in this object and can be read out for on-site troubleshooting.				
	1	Number of FATALs	–	Read Only	No	Unsigned 16
		Total number of FATAL events logged since entry was cleared.				

■ 4001 (Hex) - Option Info + Status Record

Provides general information of option system firmware parts and internal system states.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Value Range
4001	–	Option Info+Status Record	–	Read Only	No	Unsigned 8
		Provides general information of option system firmware parts and internal system states.				
	1	OptBootFwRev	–	Read Only	No	Unsigned 32
		Boot firmware revision in flash. Value: 0x00AABBCC AA = Major revision BB = Minor revision CC = Build				
	2	OptAppFwRev	–	Read Only	No	Unsigned 32
		Application firmware revision in flash. Value: 0x00AABBCC AA = Major revision BB = Minor revision CC = Build				
	3	OptRunTimeMS	–	Read Only	No	Unsigned 32
		Total running time in milliseconds of option system since power-up.				
	4	NOISystem: iSysErrorBits	–	Read Only	No	Unsigned 16
		NOI System active error bits.				
	5	NOISystem: iSysErrorBitsLatched	–	Read Only	No	Unsigned 16
		All errors that have occurred since NOI System start-up.				

◆ Drives and Motion Profile Objects (DSP 402)

The drive supports the Drive and Motion Profile DSP 402 Velocity Mode. Before using the Velocity Mode, objects the following parameters have to be set up in the drive:

- The number of motor poles must be set to E2-04.
- The frequency reference and output frequency display unit must be set to r/min by setting parameter o1-03 = 2.

If these settings are not done properly, the Velocity Mode objects can not be used or the drive will not operate as expected.

Note: Drive and Motion Control (DSP 402) cannot be set or referenced unless o1-03 = 2.

■ 6040 (Hex) - Controlword

This object sets the device to different states. Refer to *Table 6* for details.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
6040	0	Controlword	Read/Write	Rx/Tx	0...65535

■ 6041 (Hex) - Statusword

This object shows different states of the device. Refer to *Table 7* for details.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
6041	0	Statusword	Read Only	Tx	0...65535

■ 6042 (Hex) - vl Target Velocity

This object sets the speed reference and the run command. It is internally multiplied with the vl dimension factor (604C) and can be set when the status in Controlword 6040 (Hex) is “Operation Enable.”

If vl target velocity is < 0, the value will be converted to positive before writing it to the frequency reference. The 0x6040 Enable operation command will also be processed as RUN REV order.

If target velocity ≥ 0, the value will be used natively in the frequency reference. The 0x6040 Enable operation command will also be processed as RUN FWD order.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6042	0	vl target velocity	Read/Write	Rx /Tx	-32768...0...32767	r/min

■ 6043 (Hex) - vl Velocity Demand

The vl velocity demand is the output frequency of the drive to the motor.

MEMOBUS/Modbus register: 0x003E (Output frequency in r/min)

When in reverse run, the value in MEMOBUS/Modbus register: 0x003E will be converted to negative to indicate REV operation mode.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6043	0	vl velocity demand	Read Only	Tx	-32768...0...32767	r/min

■ 6044 (Hex) - vl Velocity Actual Value

The vl velocity actual value is the motor speed.

MEMOBUS/Modbus register: 0x00AC (Motor speed in r/min)

When in reverse run, the value in MEMOBUS/Modbus register: 0x00AC will be converted to negative to indicate REV operation mode.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6044	0	vl velocity actual value	Read Only	Tx	-32768...0...32767	r/min

■ 6046 (Hex) - vl Velocity Min Max Amount

This object provides two subindexes to set the minimum and maximum speed reference in r/min.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6046	1	vl velocity min amount	Read/Write	Rx/Tx	0...(2^{32}-1)	r/min
		Minimum speed reference allowed MEMOBUS/Modbus register: 0x028A, d2-02 (Frequency reference lower limit) **Note:** The parameter specifies the % rate of E1-04 maximum output frequency. Internal parameter calculations are needed.				
	2	vl velocity max amount	Read/Write	Rx/Tx	0...(2^{32}-1)	r/min
		Maximum speed reference allowed MEMOBUS/Modbus register: 0x0289, d2-01 (Frequency reference upper limit) **Note:** The parameter specifies the % rate of E1-04 maximum output frequency. Internal parameter calculations are needed.				

■ 6048 (Hex) - vl Velocity Acceleration

The vl velocity acceleration specifies the acceleration time. The quotient of the subindexes delta speed and delta time determines the acceleration time. The object values correspond to the acceleration time setting in the drive.

Behavior: At power-up, the option will sync the E1-04 (Max output frequency) against the delta speed (sub-index 1) and calculate the delta time (sub-index 2) accordingly. If the E1-04 (Max output frequency) changes during runtime, the option will adapt the internal delta speed attribute according the change of E1-04 linearly to provide the proper delta-speed.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6048	1	Acceleration delta speed	Read/Write	Rx/Tx	0...(2^{23} -1)	r/min
		T = MEMOBUS/Modbus register: 0x0200, C1-01 (Unit: 0.1/0.01 s) (Acceleration time 1) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P dt = Delta time, sub-index 2 Delta speed (ds) = Mrpm (At power-up) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				
	2	Acceleration delta time	Read/Write	Rx/Tx	0...65535	s
		T = MEMOBUS/Modbus register: 0x0200, C1-01 (Unit: 0.1/0.01 s) (Acceleration time 1) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P ds = Delta speed, sub-index 1 Delta time (dt) = (ds*T)/Mrpm (dt) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				

■ 6049 (Hex) - vl Velocity Deceleration

The vl velocity min max amount specifies the deceleration time. The quotient of the subindexes delta speed and delta time determines the deceleration time. The object values correspond to the deceleration time setting in the drive.

Behavior: At power-up, the option will sync the E1-04 (Max output frequency) against the delta speed (sub-index 1) and calculate the delta time (sub-index 2) accordingly. If the E1-04 (Max output frequency) changes during runtime, the option will adapt the internal delta speed attribute according the change of E1-04 linearly to provide the proper delta-speed.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6049	1	Deceleration delta speed	Read/Write	Rx/Tx	0...(2^{23} -1)	r/min
		T = MEMOBUS/Modbus register: 0x0201, C1-02 (Unit: 0.1/0.01 s) (Deceleration time 1) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P dt = Delta time, sub-index 2 Delta speed (ds) = Mrpm (At power-up) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				
	2	Deceleration delta time	Read/Write	Rx/Tx	0...65535	s
		T = MEMOBUS/Modbus register: 0x0201, C1-02 (Unit: 0.1/0.01 s) (Deceleration time 1) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P ds = Delta speed, sub-index 1 Delta time (dt) = (ds*T)/Mrpm (dt) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				

■ 604A (Hex) - vl Velocity Quick Stop

The vl velocity quick stop specifies the quick stop ramp. The quotient of the subindexes delta speed and delta time determines the quick stop ramp time. The object values correspond to the fast stop time setting in the drive.

Behavior: At power-up, the option will sync the E1-04 (Max output frequency) against the delta speed (sub-index 1) and calculate the delta time (sub-index 2) accordingly. If the E1-04 (Max output frequency) changes during runtime, the option will adapt the internal delta speed attribute according the change of E1-04 linearly to provide the proper delta-speed.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
604A	1	Quick stop delta speed	Read/Write	Rx/Tx	0...(2^{23} -1)	r/min
		T = MEMOBUS/Modbus register: 0x0208, C1-09 (Unit: 0.1/0.01 s) (Fast stop time) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P dt = Delta time, sub-index 2 Delta speed (ds) = Mrpm (At power-up) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				
	2	Quick stop delta time	Read/Write	Rx/Tx	0...65535	s
		T = MEMOBUS/Modbus register: 0x0208, C1-09 (Unit: 0.1/0.01 s) (Fast stop time) M = MEMOBUS/Modbus register: 0x0303, E1-04 (Unit: 0.1 Hz) (Max output frequency) P = MEMOBUS/Modbus register: 0x0211, E2-04 (Motor pole count) Mrpm = (120*M)/P ds = Delta speed, sub-index 1 Delta time (dt) = (ds*T)/Mrpm (dt) T = (dt*M)/ds **Note:** Unit of T (C1-01) is linked to C1-10.				

■ 604C (Hex) - vl Dimension Factor

The vl dimension factor is multiplied with the target velocity. The quotient of the subindexes vl dimension factor numerator and vl dimension factor denominator determines the vl dimension factor.

Default Value = 1

This parameter affects other objects such as:

- 0x6042 vl_target_velocity
- 0x6043 vl_velocity_demand
- 0x6044 vl_velocity_actual_value
- 0x6046 vl_velocity_min_max_amount
- 0x6048 vl_velocity_acceleration
- 0x6049 vl_velocity_deceleration
- 0x604A vl_velocity_quick_stop

and is always used in a product.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
604C	1	vl dimension factor numerator	Read/Write	Rx/Tx	$-2^{31}...(2^{31}-1)$
		Internal in EtherCAT option card, save in NVS memory. Default Value = 1			
	2	vl dimension factor denominator	Read/Write	Rx/Tx	$-2^{31}...(2^{31}-1)$
		Internal in EtherCAT option card, save in NVS memory. Default Value = 1			

■ 604D (Hex) - vl Pole Number

The vl pole number sets the number of motor poles and is used to calculate all speed related values in r/min. This value corresponds to the number of motor poles setting in the drive.

MEMOBUS/Modbus register: 0x0311, E2-04 (Number of motor poles)

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
604D	0	vl pole number	Read/Write	Tx	0...255

■ 6060 (Hex) - Modes of Operation

This object sets the mode of the device. The object supports 2 (Velocity Mode) only.

Value: 2: Velocity mode

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
6060	0	Modes of operation	Read/Write	Rx/Tx	-128...127

■ 6061 (Hex) - Modes of Operation Display

This object shows the mode of the device. The object supports 2 (Velocity Mode) only.

Value: 2: Velocity mode

Value: -2: Vendor specific mode

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
6061	0	Modes of operation display	Read Only	Tx	-128...127

■ 60FD (Hex) - Digital Inputs

This object contains the drive digital output status (seen as input to the network).

The content of this object is equal to drive MEMOBUS/Modbus register 004A (Hex) (drive output terminal status monitor U1-11) and depends on the drive the option is used with. For details on the content of this register, refer to the technical manual for the drive.

Bit definitions:

0-15 = Reserved (Set to zero)

16-31 = MEMOBUS/Modbus register: 0x004A, U1-11 (Output terminal status)

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
60FD	0	Drive digital input status	Read Only	Tx	0...(2^{32}-1)

Bit No. (Hex)	Function	Description
0 to F	Reserved	–
10 to 1F	Bit 0 to F of drive register 004A (Hex) (drive output terminal status monitor U1-11)	1: ON 0: OFF

■ 60FE (Hex) - Digital Outputs

This object is used to set drive digital inputs (seen as output from the network).

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range
60FE	–	Drive digital input command	Read/Write	–	–
	0	Number of elements	Read Only	–	0...255
	1	Physical outputs	Read/Write	Rx/Tx	0...(2^{32}-1)

Bit No. (Hex)	Function	Description
0 to 17	Reserved (Set to zero)	–
18	Terminal S3 Function	MEMOBUS/Modbus register: 0x0001#0x0040 (1 = set, 0 = clear)
19	Terminal S4 Function	MEMOBUS/Modbus register: 0x0001#0x0080 (1 = set, 0 = clear)
20	Terminal S5 Function	MEMOBUS/Modbus register: 0x0001#0x0100 (1 = set, 0 = clear)
21	Terminal S6 Function	MEMOBUS/Modbus register: 0x0001#0x0200 (1 = set, 0 = clear)
22	Terminal S7 Function	MEMOBUS/Modbus register: 0x0001#0x0400 (1 = set, 0 = clear)
23	Terminal S8 Function	MEMOBUS/Modbus register: 0x0001#0x0800 (1 = set, 0 = clear)
24	External Fault (EF0)	MEMOBUS/Modbus register: 0x0001#0x0004 (1 = set, 0 = clear)
25	Fault Reset	MEMOBUS/Modbus register: 0x0001#0x0008 (1 = set, 0 = clear)
26 to 31	Reserved (Set to zero)	–

9 Configuring Manufacturer Specific CANopen Objects

This section describes the configuration of manufacturer specific objects that support content selection.

◆ Selectable Object Content

All parameters, monitors and other control registers in the drive are represented by their MEMOBUS/Modbus register. The EtherCAT option card allows the user to select the content of some manufacturer specific objects by mapping them to any of the drives MEMOBUS/Modbus registers, so that those objects can be set up to contain the value of drive parameters, monitors, and other MEMOBUS/Modbus registers (e.g. alarm and fault status, etc.). Refer to the drive Technical Manual for details on available MEMOBUS/Modbus registers.

■ Selecting the Object Content

Objects with selectable content have the following structure.

Object Type	Subindex	Content	Access	PDO Mapping	Data Length
2 byte	0	Number of entries	Read Only	No	1 byte
	1	Data	Depends on object	Possible	2 byte
	2	MEMOBUS/Modbus register address of content	Read/Write <1>	No	2 byte
4 byte	0	Number of entries	Read Only	No	1 byte
	1	Data	Depends on object	Possible	4 byte
	2	MEMOBUS/Modbus register address of content 1 and 2	Read/Write <1>	No	4 byte

<1> Read/Write access when the option is in the Pre-Operational state. Read only access if the option is in the Operational state or if the drive is running.

To map the content of a specific MEMOBUS/Modbus register of the drive to subindex 1 of an object, the MEMOBUS/Modbus register address must be written to subindex 2 of the object.

Examples

- In order to map the drive output power monitor (U1-08, 0047 (Hex)) to output object 21A0 (Hex), write 0047 (Hex) to subindex 2 of object 21A0 (Hex).
- In order to map the frequency reference 1 (d1-01, 0280 (Hex)) to input object 2090 (Hex), write 0280 (Hex) to subindex 2 of object 2090 (Hex).
- In order to map the input terminal status (U1-10, 0049 (Hex)) and output terminal status (U1-11, 004A (Hex)) to output object 21F0 (Hex) (4 byte), write 0049 (Hex) to the higher, and 004A (Hex) to the lower word of object 2090 (Hex), subindex 2.

■ Limitations of Object Content Selection

The following limitations have to be considered when setting the content of an object.

- The object content can only be changed when the option is in Pre-Operational state and the drive is stopped (Run command is not active).
- The option can not be switched to the Operational state until the content selection process is complete. Otherwise, an emergency message (code 6301 (Hex)) will be sent.
- When object content selection is ongoing, no other request or command, including Run, should be sent to the drive. Otherwise, an error message or an emergency message (code 6301 (Hex)) will be sent.
- For 4 byte input objects, MEMOBUS/Modbus register numbers below 0100 (Hex) can be linked in any combination. If MEMOBUS/Modbus register numbers above 00FF (Hex) are linked to a 4 byte object, the MEMOBUS/Modbus register numbers must be consecutive.

Mapped Register 1	Mapped Register 2	Combination
0007 (Hex)	0009 (Hex)	Possible
0201 (Hex)	0202 (Hex)	Possible
0202 (Hex)	0201 (Hex)	Not possible
0201 (Hex)	0203 (Hex)	Not possible
0202 (Hex)	0202 (Hex)	Not possible
0200 (Hex)	FFFF (Hex) (Disable)	Possible
FFFF (Hex) (Disable)	0200 (Hex)	Possible

- Register numbers must not be consecutive for 4 byte output objects.
- A MEMOBUS/Modbus register cannot be mapped to two or more objects at the same time.
- MEMOBUS/Modbus registers 0001 (Hex), 0002 (Hex), 0004 (Hex), 0005 (Hex), 0007 (Hex), 0008 (Hex), and 0009 (Hex) are already linked to unchangeable input objects and can not be linked to any object with selectable content. Trying to map one of those registers to an input object will result in an error message.

10 Process Data Objects (PDO)

PDOs (Process Data Object) will be used for I/O exchange. PDOs are mapped to objects during configuration (Pre-Operational state).

TxPDOs are used to transfer data from the option card and RxPDOs are used to transfer data to the option card.

The option supports at least 8 parameters mapped to RxPDO and 8 parameters mapped to TxPDO.

◆ PDOs and Default PDO Setup

The drive supports 15 Receive and 16 Transmit PDOs. The tables below show available PDOs, their default settings and the objects required to set up when changing the PDO configuration or the PDO mapping.

■ Transmit PDOs (TxPDO)

The Transmit PDOs have a default mapping according to ***Table 15***. The transmit PDOs can be re-mapped by the end user by writing to map objects 0x1A00-0x1A28. Refer to ***Communication Profile Objects (DSP 301) on page 26***.

Table 15 Transmit PDOs

PDO Number	Transmit PDO Mapping	
	Mapped Objects (Hex)	Index (Hex)
1	Sub-index 1: 0x6041#0, 2-bytes (DSP402 statusword)	0x1A00
2	Sub-index 1: 0x6041#0, 2-bytes (DSP402 statusword) Sub-index 2: 0x6061#0, 2-bytes (DSP402 modes of operation display)	0x1A01
6	Sub-index 1: 0x6041#0, 2-bytes (DSP402 statusword) Sub-index 2: 0x6044#0, 2-bytes (vl velocity actual value)	0x1A05
7	Sub-index 1: 0x6041#0, 2-bytes (DSP402 statusword) Sub-index 2: 0x60FD#0, 4-bytes (Digital inputs)	0x1A06
21	Sub-index 1: 0x6042#0, 2-bytes (vl target velocity)	0x1A14
22	Sub-index 1: 0x6043#0, 2-bytes (vl velocity demand)	0x1A15
23	Sub-index 1: 0x6048#1, 4-bytes (vl accel delta speed) Sub-index 2: 0x6048#2, 2-bytes (vl accel delta time)	0x1A16
24	Sub-index 1: 0x6049#1, 4-bytes (vl decel delta speed) Sub-index 2: 0x6049#2, 2-bytes (vl decel delta time)	0x1A17
25	Sub-index 1: 0x604A#1, 4-bytes (vl quick stop delta speed) Sub-index 2: 0x604A#2, 2-bytes (vl quick stop delta time)	0x1A18
26	Sub-index 1: 0x604C#1, 4-bytes (vl dimension factor numerator) Sub-index 2: 0x604C#2, 4-bytes (vl dimension factor denominator)	0x1A19
36	Sub-index 1: 0x2100#1, 2-bytes (Drive status)	0x1A23
37	Sub-index 1: 0x2110#1, 2-bytes (Output frequency)	0x1A24
38	Sub-index 1: 0x2120#1, 2-bytes (Output current)	0x1A25
39	Sub-index 1: 0x2130#1, 2-bytes (Output torque reference)	0x1A26
40	Sub-index 1: 0x2140#1, 2-bytes (MEMOBUS/Modbus read response)	0x1A27
41	Sub-index 1: 0x2150#1, 2-bytes (MEMOBUS/Modbus write response)	0x1A28

■ Receive PDOs (RxPDO)

The Receive PDOs have a default mapping according to *Table 16*. The end user can re-map Receive PDOs by writing to the map objects 0x1600-1628. Refer to *Communication Profile Objects (DSP 301) on page 26*.

Table 16 Receive PDO

PDO Number	Receive PDO Mapping	
	Mapped Objects (Hex)	Index (Hex)
1	Sub-index 1: 0x6040#0, 2-bytes (DSP402 controlword)	0x1600
2	Sub-index 1: 0x6040#0, 2-bytes (DSP402 controlword) Sub-index 2: 0x6060#0, 1-bytes (DSP402 modes of operation)	0x1601
6	Sub-index 1: 0x6040#0, 2-bytes (DSP402 controlword) Sub-index 2: 0x6042#0, 2-bytes (vl target velocity)	0x1605
7	Sub-index 1: 0x6040#0, 2-bytes (DSP402 controlword) Sub-index 2: 0x60FE#1, 4-bytes (Physical digital outputs)	0x1606
8	Sub-index 1: 0x6040#0, 2-bytes (DSP402 controlword) Sub-index 2: 0x6060#0, 1-bytes (DSP402 modes of operation)	0x1607
21	Sub-index 1: 0x6048#1, 4-bytes (vl accel delta speed) Sub-index 2: 0x6048#2, 2-bytes (vl accel delta time)	0x1614
22	Sub-index 1: 0x6049#1, 4-bytes (vl decel delta speed) Sub-index 2: 0x6049#2, 2-bytes (vl decel delta time)	0x1615
23	Sub-index 1: 0x604A#1, 4-bytes (vl quick stop delta speed) Sub-index 2: 0x604A#2, 2-bytes (vl quick stop delta time)	0x1616
24	Sub-index 1: 0x604C#1, 4-bytes (vl dimension factor numerator) Sub-index 2: 0x604C#2, 4-bytes (vl dimension factor denominator)	0x1617
36	Sub-index 1: 0x2000#1, 2-bytes (Operation command)	0x1623
37	Sub-index 1: 0x2010#1, 2-bytes (Speed reference/Speed limit)	0x1624
38	Sub-index 1: 0x2020#1, 2-bytes (Torque reference/Torque limit)	0x1625
39	Sub-index 1: 0x2030#1, 2-bytes (Torque compensation)	0x1626
40	Sub-index 1: 0x2040#1, 4-bytes (MEMOBUS/Modbus read request)	0x1627
41	Sub-index 1: 0x2050#1, 4-bytes (MEMOBUS/Modbus write request)	0x1628

■ RxPDO Mapped Drive Registers Above 0x0100 Range

Drive registers above 0x0100 cannot be configured as process data exchanged on each I/F scan cycle. To be able to RxPDO map those objects on EtherCAT, a “slow” IO channel must be realized inside the option system firmware. This slow IO channel uses the overlaid MEMOBUS/Modbus channel in I/F to write the drive registers required.

When the RxPDO mapping is performed on any drive register and the address is larger than 0x0100, it will be added to the slow IO control set.

ENTER command management for slow IO channel control sets:

- New value only written against drive if it changes from the previously written value.
- If a value update is detected, the write will be scheduled directly after the RxPDO EtherCAT process data cycle is complete.
- If the written value via MEMOBUS/Modbus fails, i.e. parameter cannot be written when the drive is running, a new retry will be triggered after 8 ms.
- If a RAM ENTER command is required for the written value to be used by the drive, the ENTER command will be written when the last register that should be updated in an slow IO data scan set update is triggered.
- Mapped drive registers: A: 0x0200, B: 0x0201, C: 0x0203
  - All three registers change at the same time: RAM ENTER command executed with C.
  - Only register 0x0200 changes: RAM ENTER command executed with A.

■ Objects Managed in Option Slow IO Channel

Table 17 describes which EtherCAT CoE objects are managed in the slow IO channel.

Table 17 Objects Managed in the Slow IO Channel

CoE Object	Linked Drive Register	Information
0x2080 0x2090 0x20A0 0x20B0 0x20C0 0x3000 0x3100	If sub-index #2 (MEMOBUS/Modbus register address is > 0x0100 that address is linked.	Configurable input objects
0x2040/0x2140	Register address in MEMOBUS/Modbus read payload	Overlaid MEMOBUS/Modbus read channel, request and response CoE objects
0x2050/0x2150	Register address in MEMOBUS/Modbus write payload	Overlaid MEMOBUS/Modbus write channel, request and response CoE objects **Note:** No ENTER command is executed for this request. It has to be manually managed with object 0x2060.
0x2060/0x2160	0x0910 (RAM Enter)	MEMOBUS/Modbus RAM (un-memorized) ENTER command
0x6046#1	0x028A (d2-02)	Drive frequency reference lower limit
0x6046#2	0x0289 (d2-01)	Drive frequency reference upper limit
0x6048#1/0x6048#2	0x0200 (C1-01)	vl velocity acceleration #1 = delta speed #2 = delta time
0x6049#1/0x6049#2	0x0201 (C1-02)	vl velocity deceleration #1 = delta speed #2 = delta time
0x604A#1/0x604A#2	0x0208 (C1-09)	vl velocity quick stop #1 = delta speed #2 = delta time

■ Option NVS Parameters

This section describes the option NVS parameter stored in option EEPROM and how it is managed.

Parameter behavior:

- On first power-up, the option will initialize the EEPROM with the default values for each parameter.
- The option will load the EEPROM stored values on each power-up in runtime after the NOID driver has completed the I/F power-up sequence and entered the online processing state.
- When DSP301 CANopen object 0x1010 (Store parameters) receives the 0x65766173 (“save”) command in the EtherCAT Pre-Operational state, the option card will store the present values in EEPROM.
- When DSP301 CANopen object 0x1011 (Restore default parameters) receives the 0x64616f6c (“load”) command, the option will load the NVS parameter default values and store them to EEPROM.

Table 18 Option NVS Parameters

CANopen Object	Default Value	Consumed EEPROM Size
0x2080#2	0xFFFFFFFF	32-bits
0x2090#2	0xFFFF	16-bits
0x20A0#2	0xFFFF	16-bits
0x20B0#2	0xFFFF	16-bits
0x20C0#2	0xFFFF	16-bits
0x3000#2	0xFFFF	16-bits
0x3100#2	0xFFFF	16-bits
0x2180#2	0x0049	16-bits
0x2190#2	0x004E	16-bits
0x21A0#2	0xFFFF	16-bits
0x21B0#2	0xFFFF	16-bits
0x21C0#2	0xFFFF	16-bits
0x21E0#2	0xFFFF	16-bits
0x21F0#2	0xFFFF	32-bits

CANopen Object	Default Value	Consumed EEPROM Size
0x604C#1	0x00000001	32-bits
0x604C#2	0x00000001	32-bits

■ Accessed Drive Registers

Table 19 describes the accessed drive registers.

Table 19 Accessed Drive Registers

Reg. Address	Internal Name/Short	Used in Context Evaluation	Description	Option Access (RO/RW/WO)
0x003E	INVR_U102_OUTFREQ_RPM	CoE: 0x6043 (vl velocity demand)	Output freq [Unit: 1.0 r/min]	RO
0x00AC	INVR_U105_MSPEED_RPM	CoE: 0x6044 (vl velocity actual value)	Motor speed (U1-05) [Unit: 1.0 r/min]	RO
0x0041	INVR_U102_OUTFREQ	CoE: 0x2110 (Output frequency)	Output freq (U1-02) [Unit: o1-03]	RO
0x00FB	INVR_U103_OUTCUR2	CoE: 0x2120 (Output current)	Output current (U1-03)	RO
0x0048	INVR_U109_OUTTRQREF	CoE: 0x2130 (Output torque reference)	Torque reference (U1-09) [Unit: 0.1%]	RO
0x0049	INVR_U110_TER_DIN	• CoE: 0x2180 (Free output default) • CoE: 0x2270 (Drive DI input)	Input terminal status (U1-10)	RO
0x0044	INVR_U105_MSPEED	CoE: 0x2200 (Motor speed)	Motor speed (U1-05) [Unit: o1-03]	RO
0x0046	INVR_U107_DCBUSVOLT	CoE: 0x2210 (DC bus voltage)	Bus voltage [Unit: 1.0 V]	RO
0x004A	INVR_U111_TER_OUT	CoE: 0x60FD (Digital inputs)	Output terminal status (U1-11)	RO
0x004E	INVR_U113_TER_A1IN	• CoE: 0x2190 (Free output default) • CoE: 0x2220 (Analog input monitor A1)	A1 terminal level voltage (U1-13)	RO
0x004F	INVR_U114_TER_A2IN	CoE: 0x2240 (Analog input monitor A2)	A2 terminal level voltage (U1-14)	RO
0x0050	INVR_U114_TER_A3IN	CoE: 0x2260 (Analog input monitor A3)	A3 terminal level voltage (U1-15)	RO
0x0080	INVR_U201_FAULTCUR	EtherCAT CoE Emergency services	Current fault (U2-01)	RO
0x0001	INVR_INVCTRL1	• CoE: 0x6040 (DSP402 controlword) • CoE: 0x60FE (Digital outputs) • CoE: 0x2000 (Operation command)	Run operation signal (option)	RW
0x0002	INVR_OPT_FREQ_REF	CoE: 0x2010 (Speed reference/Speed limit)	Frequency reference	RW
0x0004	INVR_OPT_TORQUE_REF	CoE: 0x2020 (Torque reference/Torque limit)	Torque reference/limit [Unit: 0.1%]	RW
0x0005	INVR_OPT_TORQUE_COMP	CoE: 0x2030 (Torque compensation)	Torque compensation [Unit: 0.1%]	RW
0x0007	INVR_OPT_FM_AOUT1	CoE: 0x20D0 (Analog output terminal FM setting)	Analog output terminal FM setting	RW
0x0008	INVR_OPT_AM_AOUT2	CoE: 0x20E0 (AM analog output)	AM analog output	RW
0x0009	INVR_OPT_MFUNC_DO	CoE: 0x20F0 (Multi-function DO output)	Multi function DO	RW
0x0200	INVR_C101_ACC1	CoE: 0x6048 (vl velocity acceleration)	Acceleration time 1 (C1-01) [Unit: C1-10]	RW
0x0201	INVR_C102_DEC1	CoE: 0x6049 (vl velocity deceleration)	Deceleration time 1 (C1-02) [Unit: C1-10]	RW
0x0208	INVR_C109_FASTSTOP	CoE: 0x604A (vl velocity quick stop)	Fast Stop time (C1-09) [Unit: C1-10]	RW
0x0209	INVR_C110_ADTUNIT	• CoE: 0x6048 (vl velocity acceleration) • CoE: 0x6049 (vl velocity deceleration) • CoE: 0x604A (vl velocity quick stop)	Accel/Decel Time Setting Units (C1-10)	RO
0x0289	INVR_D201_FREQUL	CoE: 0x6046#2 (vl velocity max amount)	Frequency Reference Upper Limit (d2-01)	RW
0x028A	INVR_D202_FREQLL	CoE: 0x6046#1 (vl velocity min amount)	Frequency Reference Lower Limit (d2-02)	RW

Reg. Address	Internal Name/Short	Used in Context Evaluation	Description	Option Access (RO/RW/WO)
0x0303	INVR_E104_MAXOUTFREQ	• INIT runtime data sequence • CoE: 0x6046 (vl velocity min max amount) • CoE: 0x6048 (vl velocity acceleration) • CoE: 0x6049 (vl velocity deceleration) • CoE: 0x604A (vl velocity quick stop)	Max output frequency (E1-04)	RO
0x0311	INVR_E204_MPOLES	• CoE: 0x6046 (vl velocity min max amount) • CoE: 0x6048 (vl velocity acceleration) • CoE: 0x6049 (vl velocity deceleration) • CoE: 0x604A (vl velocity quick stop) • CoE: 0x604D (vl pole number)	Number of motor poles (E2-04)	RW
0x0910	INVR_ENTER_RAM	CoE: 0x2060 (MEMOBUS/Modbus unlimited ENTER command)	Drive RAM ENTER command	WO
0x0900	INVR_ENTER_EEP	• CoE: 0x1010 (Store parameters) • CoE: 0x2070 (MEMOBUS/Modbus limited ENTER command)	Drive EEPROM ENTER command	WO
0x0103	INVR_A103_INITPRM	CoE: 0x1011 (Restore default parameters)	Initialize parameters Value = 2220 (2-wire initialize)	WO

11 Drive Parameter, Monitor and Control Register Access

All drive parameters, monitors, and other control registers are represented by their MEMOBUS/Modbus register. The registers can be read or written by accessing these registers through the option.

MEMOBUS/Modbus registers can be directly read or written using MEMOBUS/Modbus read/write commands. The registers can also be mapped to the content of a manufacturer specific object and then be accessed by reading from or writing to this object. Refer to *Selecting the Object Content on page 45* for details on object content selection.

When writing drive parameters, certain precautions concerning message timing must be taken into account.

- The drive requires a certain time to activate changes to parameter values. When changing multiple parameters, make sure to add a wait time between write requests.
- If an ENTER command is issued, make sure to add a wait time between the ENTER command and the next message.

Refer to the drive technical manual for information about MEMOBUS/Modbus addresses available in the drive and the wait times required between parameter write requests and ENTER commands.

◆ Drive Parameter and Monitor Access by MEMOBUS/Modbus Read/Write Commands

■ Reading a Drive Register, Parameter or Monitor

Reading a drive parameter, monitor or control register using a MEMOBUS/Modbus read command requires the following steps:

- Write the address of the drive MEMOBUS/Modbus register to be read to subindex 1 of object 2040 (Hex).
- Read the value of the drive MEMOBUS/Modbus register from the MEMOBUS/Modbus read response in subindex 1 of object 2140 (Hex).

Objects 2040 (Hex) and 2140 (Hex) can both be mapped to PDOs.

■ Writing a Drive Parameter or Drive Control Register

Writing a drive parameter or drive control register can be performed by following the steps below:

- Write the value and the MEMOBUS/Modbus address of the drive parameter or control register to subindex 1 of object 2050 (Hex).
- Read the MEMOBUS/Modbus write response from subindex 1 of object 2150 (Hex) in order to verify that the item is written correctly.

If drive parameters are written and parameter H5-11 in the drive is set to 0, a RAM ENTER command (object 2060 (Hex)) must also be issued in order let the change take effect. To store the parameter change in the non-volatile memory of the drive, a ROM ENTER command (object 2070 (Hex)) must be issued instead. An ENTER command can be issued by performing the steps below.

- Write “save” (73H + 61H + 76H + 65H) to subindex 1 of object 2060 (Hex) for a RAM ENTER command, or to subindex 1 of object 2070 (Hex) for a ROM ENTER command.
- When using a RAM ENTER command, read the ENTER command response from object 2160 (Hex) in order to verify the ENTER command is performed successfully.

Note: When multiple drive parameters are changed, only one ENTER command is required after the last parameter value to activate all parameter changes.

Objects 2050/01 (Hex), 2060 (Hex), 2070 (Hex), 2150/01 (Hex) and 2160 (Hex) can be mapped to PDOs.

◆ Initializing the Drive

The drive can be initialized by writing the corresponding initialization code to MEMOBUS/Modbus register 0103 (object 1011 Hex) (drive parameter A1-03; refer to the technical manual of the drive for details on initialization codes). The initialization is performed only if drive parameter H5-11 is set to “0” and if an Unlimited ENTER Command is sent after setting register 0103 (object 1011 Hex).

In order to initialize a drive via EtherCAT communications follow the instructions below:

1. Read out the value of drive parameter H5-11 using a MEMOBUS/Modbus Read Request (Obj. 2040 (Hex)) on drive register 04C3 (Hex) (H5-11).
2. If the content of register 04C3 (Hex) is “1” then change it to “0” using a MEMEOBUS/Modbus Write Request (Obj. 2050 (Hex)).
3. Set drive parameter A1-03 to the desired initialization mode. For example, in order to perform a “2-Wire Initialization”, write “08AC” (Hex) (2220) to MEMOBUS/Modbus register 0103 (object 1011 Hex).
4. Finish the initialization by sending an Unlimited ENTER Command (Obj. 2070 (Hex)).

12 Fault Diagnosis and Possible Solutions

◆ EtherCAT Option Card Error Codes

The following error codes will be shown in object 1003, subindex 01 if the correspondent error occurred on the drive.

■ Drive and CANopen/EtherCAT Faults

Emergency Object (EMCY)

The emergency object is used for sending fault information from the option to the CANopen/EtherCAT network.

The emergency object is triggered by a fault event from the drive or the option card itself. An emergency object is transmitted only once per fault event.

Emergency error codes are specified for a number of events.

Table 20 Emergency Word Specification

Byte	0	1	2	3	4	5	6	7
Content	Emergency error code	Error register object 0x1001	Manufacturer specific error info. Not used. Set to zero.					

Emergency Messages, DSP301 & DSP402

The error codes specified in the list below can be read from CANopen object 0x1003 (Pre-defined error field).

Table 21 Error Codes

Error Code (Hex)	Meaning	Drive Display	MEMOBUS/Modbus Register: 0x0080 Enum Value
0000	No error	No error	0x00
3220	DC bus undervoltage	Uv1	0x02
5200	Control power supply voltage fault	Uv2	0x03
3221	Undervoltage 3 (soft-charge bypass circuit fault)	Uv3	0x04
2330	Ground fault	GF	0x06
2220	Overcurrent	oC	0x07
3210	Overvoltage	ov	0x08
4280	Heatsink overheat	oH	0x09
4210	Overheat 1 (heatsink overheat)	oH1	0x0A
2310	Motor overload	oL1	0x0B
2221	Drive overload	oL2	0x0C
2311	Overtorque detection 1	oL3	0x0D
2312	Overtorque detection 2	oL4	0x0E
5420	Dynamic braking transistor	rr	0x0F
4410	Braking resistor overheat	rH	0x10
5441	External fault (input terminal S3)	EF3	0x11
5442	External fault (input terminal S4)	EF4	0x12
5443	External fault (input terminal S5)	EF5	0x13
5444	External fault (input terminal S6)	EF6	0x14
5445	External fault (input terminal S7)	EF7	0x15
5480	External fault (input terminal S8)	EF8	0x16
FF17	Internal FAN fault	FAn	0x17
7180	Overspeed	oS	0x18
8321	Speed deviation (control mode with PG and PM Open Loop Vector control mode without PG)	dEv	0x19
7305	PG disconnect (control mode with PG)	PGo	0x1A
3130	Input phase loss	PF	0x1B
3300	Output phase loss	LF	0x1C
FF01	Motor overheat alarm (PTC input)	oH3	0x1D
5300	External digital operator connection fault	oPr	0x1E
5530	EEPROM write error	Err	0x1F

Error Code (Hex)	Meaning	Drive Display	MEMOBUS/Modbus Register: 0x0080 Enum Value
4310	Motor overheat fault (PTC input)	oH4	0x20
FF08	MEMOBUS/Modbus communication error	CE	0x21
FF07	Option communication error	bUS	0x22
FF06	Control fault	CF	0x25
8313	Zero servo fault	SvE	0x26
5481	Option card external fault	EF0	0x27
FF02	PID feedback loss	FbL	0x28
FF03	Undertorque detection 1	UL3	0x29
FF04	Undertorque detection 2	UL4	0x2A
FF05	High slip braking oL	oL7	0x2B
6000	Hardware or communication error of drive or option	oF□/CPF□	0x30
FF32	Z pulse fault (Closed Loop Vector for PM motors)	dv1	0x32
FF33	Z pulse noise fault detection (Closed Loop Vector for PM motors)	dv2	0x33
FF34	Inversion detection (Closed Loop Vector for PM motors)	dv3	0x34
FF35	Inversion prevention detection (Closed Loop Vector for PM motors)	dv4	0x35
FF36	Output current imbalance	LF2	0x36
FF37	Pull-out detection	STo	0x37
FF38	PG disconnect (control mode with PG)	PGoH	0x38
FF3B	Too many speed search restarts	SEr	0x3B
FF41	PID feedback loss	FbH	0x41
FF0D	External fault (input terminal S1)	EF1	0x42
FF0E	External fault (input terminal S2)	EF2	0x43
FF44	Mechanical weakening detection 1	oL5	0x44
FF45	Mechanical weakening detection 2	UL5	0x45
FF46	Current offset fault	CoF	0x46
FF47	PLC detection error 1	PE1	0x47
FF49	DriveWorksEZ fault	dWFL	0x49
6301	Error during object content selection	–	–

◆ SDO Abort Codes

SDO abort codes are supported as specified in DS301. Additionally the abort codes listed below are implemented.

Table 22 SDO Abort Codes

SDO Abort Code	Description
0602 0010 (Hex)	Consecutive MEMOBUS/Modbus Read/Write/ENTER commands are send but the wait time between messages is too short.
	A MEMOBUS/Modbus Read or Write Response (2140 (Hex) and 2150 (Hex)) was attempted but no or an incorrect MEMOBUS/Modbus address has been written to object 2040 (Hex) or 2050 (Hex) before.
	A MEMOBUS/Modbus write request has been sent during DC bus under voltage.
0602 0022 (Hex)	Drive Profile DSP402 is used and a value is written to object 6042 (Hex) (vl Target Velocity) while the drive status is not “Operation Enable”.
	Object 2155 (Hex) is tried to be read while the option is not in Operational state.
	A MEMOBUS/Modbus Read or Write command (2040 (Hex) and 2050 (Hex)) was performed with an invalid MEMOBUS/Modbus address.

◆ Drive-Side Error Codes

Drive-side error codes appear on the drive digital operator. Causes of the errors and corrective actions are listed in *Table 23*, *Table 24*, *Table 25*. For additional error codes that may appear on the drive digital operator, refer to the drive Technical Manual.

■ Faults

Both bUS (option communication error) and EF0 (External fault input from the option) can appear as an alarm or as a fault. When a fault occurs, the digital operator ALM LED remains lit. When an alarm occurs, the ALM LED flashes.

If communication stops while the drive is running, use the following questions as a guide to help remedy the fault:

- Is the option properly installed?
- Is the communication line properly connected to the option? Is it loose?
- Is the controller program working? Has the controller/PLC CPU stopped?
- Did a momentary power loss interrupt communications?

Table 23 Detailed Fault Displays, Causes, and Possible Solutions

LED Operator Display		Fault Name
bUS	bUS	Option Communication Error
		• After establishing initial communication, the connection was lost. • Only detected when the run command or frequency reference is assigned to the option (b1-01 = 3 or b1-02 = 3).
Cause		**Possible Solution**
Master controller (PLC) has stopped communicating.		• Check that power is supplied to the PLC. • Check that PLC is not in program mode.
Communication cable is not connected properly.		• Check for faulty wiring. • Correct any wiring problems.
A data error occurred due to noise.		• Inspect items that can minimize the effects of electrical noise. • Counteract noise in the control circuit, main circuit, and ground wiring. • If a magnetic contactor is identified as a source of noise, install a surge absorber to the contactor coil. • Make sure the cable used meets the EtherCAT requirements. • Make sure the option ground wire is connected between option FE terminal and the drive ground terminal connected to earth ground.
Option is damaged.		If there are no problems with the wiring and the error continues to occur, replace the option.
Connection Time-out		• The option Requested Packet Interval (RPI) timer timed out. • Make sure that RPI time is set properly.

LED Operator Display		Fault Name
EF0	EF0	Option Card External Fault
		The alarm function for an external device has been triggered.
Cause		**Corrective Action**
An external fault is being sent from the upper controller (PLC).		• Remove the cause of the external fault. • Reset the external fault input from the PLC device.
Problem with the PLC program		Check the program used by the PLC and make the appropriate corrections.
PLC is in the Idle Mode.		• Set the PLC to the Run Mode. • Set the drive parameter F6-54 to 0 (Enabled) not to detect errors while the PLC is in the Idle Mode.

LED Operator Display		Fault Name
oFA00	oFA00	Option Card Connection Error (CN5-A)
		Option is not properly connected.
Cause		**Possible Solution**
Non-compatible option connected to the drive.		Connect an option that is compatible with the drive.

LED Operator Display		Fault Name
oFA01	oFA01	Option Card Fault (CN5-A)
		Option is not properly connected.
Cause		**Possible Solution**
Problem with the connectors between the drive and option		Turn the power off and check the connectors between the drive and option.

LED Operator Display		Fault Name
oFA30 to oFA43	oFA30 to oFA43	Option Card Connection Error (CN5-A)
		Communication ID error
Cause		**Possible Solution**
Option hardware fault		Replace the option.

LED Operator Display		Fault Name
oFb00	oFb00	Option Fault (CN5-B)
		Non-compatible option is connected.
Cause		**Possible Solution**
Non-compatible option connected to the drive.		Connect the correct option to CN5-A.

LED Operator Display		Fault Name
oFb02	oFb02	Option Fault (CN5-B)
		Two identical options are connected at the same time.
Cause		**Possible Solution**
Options AI-A3 or DI-A3 are connected to the CN5-B port with an option connected to CN5-A.		• Only one type of AI-A3, DI-A3 or SI-☐☐ option can be connected to the drive. • The SI-ES3 option can only be connected to CN5-A.

LED Operator Display		Fault Name
oFC00	oFC00	Option Fault (CN5-C)
		Non-compatible option is connected.
Cause		**Possible Solution**
Non-compatible option connected to the drive.		Connect the correct option to CN5-A.

LED Operator Display		Fault Name
oFC02	oFC02	Option Fault
		Option Flash write mode
Cause		**Possible Solution**
Options AI-A3 or DI-A3 are connected to the CN5-B port while an option connected to CN5-A.		• Only one type of AI-A3, DI-A3 or SI-☐☐ option can be connected to the drive. • The SI-ES3 option can only be connected to CN5-A.

■ Option Error Management

This section describes the errors managed by the option and the linked actions taken.

Table 24 Option Error Management

Option Error	Description	Error Indication	Possible Solution
OP→SAFEOP/PREOP when drive running	When an EtherCAT state transition from OP→SAFEOP/PREOP was made when the drive was in OPERATION enabled.	bUS Error is triggered in drive. **Note:** Error against drive will be cleared when the next lower to higher EtherCAT state transition is made.	Check and correct state machine transitions in Controlword.
OP→SAFEOP EtherCAT WD time out	If the EtherCAT watchdog time out is enabled (Default in ESI file) and output data from PLC to the drive is not updated in time, an error will be triggered.	bUS Error is triggered in drive. **Note:** Error against drive will be cleared when the next lower to higher EtherCAT state transition is made.	• Check network connection (e.g. if cables plugged in at each node). • Check telegram timing. Are telegrams sent to the slave the error occurred on?
OP→SAFEOP 1. Drive frame check sequence error 2. Drive COMID error	1. Drive has detected a Sum check error. 2. Drive has detected a Communication Option ID error. Possible cause: 1. Option card is overloaded. 2. Option is not properly processing the state.	1. Drive fault: oF☐32 2. Drive fault: oF☐30	• Disable process data OUT sync manager channel. • Force EtherCAT state change to SAFEOP.
OP→SAFEOP 1. Option card frame check sequence error 2. Option card COMID error	1. Option card has detected a Sum check error. 2. Option card has detected a Communication Option card ID error. Possible cause: 1. Drive system is overloaded. 2. Drive is not properly processing the state.	1. Drive fault: oF☐32 2. Drive fault: oF☐30	• Disable process data IN sync manager channel. • Force EtherCAT state change to SAFEOP.
Initial power-up sequence not completed within 10 seconds.	Possible cause: Drive is not processing the internal interface protocol. Drive does not support EtherCAT option card.	Drive fault: oF☐00 Option will log FATAL event record in NVS memory and set ERR LED: solid RED, see *Table 4*.	• Check drive firmware version. • If drive firmware version is correct, replace option card. • Replace the drive.
I/F proc time out	Option card has not processed any drive system frames in 1000 ms. Possible cause: Drive has stopped serving the internal interface to option card or HW failure.	Option will log FATAL event record in NVS memory, and set ERR LED: solid RED, see *Table 4*.	Force EtherCAT state to INIT.
Option ID Error: Power-up sequence copyright string mismatch.	Drive reported invalid copyright string in power-up process.	Option will log FATAL event record in NVS memory, and set ERR LED: solid RED, see *Table 4*.	Replace option card.

■ Minor Faults and Alarms

Table 25 Alarm Codes, Causes, and Possible Solutions

LED Operator Display		Minor Fault Name	
CALL	CALL	Serial communication transmission error	
		Communication is not established.	
Cause		**Possible Solution**	**Minor Fault (H2-☐☐ = 10)**
Communication wiring is faulty, there is a short circuit, or improper connection.		Check for wiring errors: • Correct the wiring. • Remove ground shorts and reconnect loose wires.	YES
Programming error on the master side.		Check communications at start-up and correct programming errors.	
Communication circuitry is damaged.		• Perform a self-diagnostics check. • Replace the drive if the fault continues to occur.	

Digital Operator Display		Minor Fault Name	
EEP	EEP	EEPROM Error	
		EEPROM checksum error	
Cause		**Possible Solution**	**Minor Fault (H2-☐☐ = 10)**
Communication wiring is faulty, there is a short circuit, or something is not connected properly.		Check for wiring errors. • Correct the wiring. • Remove and ground shorts and reconnect loose wires.	YES
EEPROM checksum error		If these errors occur, the object dictionary will be reset to its default values. • After the object dictionary has been changed and object dictionary contents are then changed, execute a Store Parameter command (Index = 1010 (Hex)). • If the object dictionary has not been changed, execute a Restore Parameter command (Index = 1011 (Hex)).	

◆ Prior to Installing the Option

Prior to installing the option, wire the drive, make the necessary connections to the drive terminals, and verify that the drive functions normally. Refer to the ***Table 26*** for information on wiring and connecting the drive.

Table 26 below lists the number of option cards that can be connected to the drive and the drive connectors for connecting those option cards.

Table 26 Option Card Installation

Option Card	Connector	Number of Cards Possible
PG-B3, PG-X3	CN5-C	2 *<1>*
PG-RT3 *<2>* *<3>*, PG-F3 *<2>* *<3>*	CN5-C	1
DO-A3, AO-A3	CN5-A, B, C	1
SI-C3, SI-N3, SI-P3, SI-S3, SI-T3, SI-ET3, AI-A3, DI-A3, SI-ES3, SI-B3, SI-M3, SI-W3, SI-EM3, SI-EN3, SI-EP3, SI-ES3 *<4>*	CN5-A	1

<1> If two PG option cards are connected, use both CN5-B and CN5-C. If only one PG option card is connected to the drive, use the CN5-C connector.
<2> These option cards are not available for the application with Motor 2 Selection.
<3> These option cards are not available with models CIMR-A☐4A0930 and 4A1200.
<4> When AI-A3 and DI-A3 are to be used as monitors, the card can be connected to any of CN5-A, CN5-B or CN5-C. The input status of AI-A3 can then be viewed using U1-21, U1-22, and U1-23, and the input status of DI-A3 can then be viewed using U1-17.

13 Specifications

◆ Specifications

Table 27 Option Card Specifications

Items	Specifications
Model	SI-ES3
Communication Profile	DS 301 Ver. 4.02 DSP 402 Ver. 1.1 Velocity Mode
Connector	RJ45 connector
Communications Speed	10/100 Mbps
Ambient Temperature	-10°C to +50°C (14°F to 122°F)
Humidity	Up to 95% RH (no condensation)
Storage Temperature	-20°C to +60°C (-4°F to +104°F) (allowed for short-term transport of the product)
Area of Use	Indoor (free of corrosive gas, airborne particles, etc.)
Altitude	1000 m (3280 ft.) or lower

◆ Internal Scan Cycle

A1000: 1 ms

◆ Revision History

Revision dates and manual numbers appear on the bottom of the back cover.

MANUAL NO. SIEP C730600 64A
Published in Japan October 2013 13-10
Date of original publication
Date of publication

Date of Publication	Revision Number	Section	Revised Content
October 2013	–	–	First edition

YASKAWA AC Drive 1000-Series Option

EtherCAT

Technical Manual

DRIVE CENTER (INVERTER PLANT)
2-13-1, Nishimiyaichi, Yukuhashi, Fukuoka, 824-8511, Japan
Phone: 81-930-25-3844 Fax: 81-930-25-4369
http://www.yaskawa.co.jp

YASKAWA ELECTRIC CORPORATION
New Pier Takeshiba South Tower, 1-16-1, Kaigan, Minatoku, Tokyo, 105-6891, Japan
Phone: 81-3-5402-4502 Fax: 81-3-5402-4580
http://www.yaskawa.co.jp

YASKAWA AMERICA, INC.
2121 Norman Drive South, Waukegan, IL 60085, U.S.A.
Phone: 1-800-YASKAWA (927-5292) or 1-847-887-7000 Fax: 1-847-887-7310
http://www.yaskawa.com

YASKAWA ELÉTRICO DO BRASIL LTDA.
Avenida Piraporinha 777, Diadema, São Paulo, 09950-000, Brasil
Phone: 55-11-3585-1100 Fax: 55-11-3585-1187
http://www.yaskawa.com.br

YASKAWA EUROPE GmbH
Hauptstrasse 185, 65760 Eschborn, Germany
Phone: 49-6196-569-300 Fax: 49-6196-569-398
http://www.yaskawa.eu.com

YASKAWA ELECTRIC KOREA CORPORATION
9F, Kyobo Securities Bldg., 26-4, Yeouido-dong, Yeongdeungpo-gu, Seoul, 150-737, Korea
Phone: 82-2-784-7844 Fax: 82-2-784-8495
http://www.yaskawa.co.kr

YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
151 Lorong Chuan, #04-02A, New Tech Park, 556741, Singapore
Phone: 65-6282-3003 Fax: 65-6289-3003
http://www.yaskawa.com.sg

YASKAWA ELECTRIC (CHINA) CO., LTD.
12F, Carlton Bld., No.21 HuangHe Road, HuangPu District, Shanghai 200003, China
Phone: 86-21-5385-2200 Fax: 86-21-5385-3299
http://www.yaskawa.com.cn

YASKAWA ELECTRIC (CHINA) CO., LTD. BEIJING OFFICE
Room 1011, Tower W3 Oriental Plaza, No. 1 East Chang An Ave.,
Dong Cheng District, Beijing, 100738, China
Phone: 86-10-8518-4086 Fax: 86-10-8518-4082

YASKAWA ELECTRIC TAIWAN CORPORATION
9F, 16, Nanking E. Rd., Sec. 3, Taipei, 104, Taiwan
Phone: 886-2-2502-5003 Fax: 886-2-2505-1280

YASKAWA INDIA PRIVATE LIMITED
#17/A Electronics City, Hosur Road Bangalore 560 100 (Karnataka), India
Phone: 91-80-4244-1900 Fax: 91-80-4244-1901
http://www.yaskawaindia.in

YASKAWA ELECTRIC CORPORATION

In the event that the end user of this product is to be the military and said product is to be employed in any weapons systems or the manufacture thereof, the export will fall under the relevant regulations as stipulated in the Foreign Exchange and Foreign Trade Regulations. Therefore, be sure to follow all procedures and submit all relevant documentation according to any and all rules, regulations and laws that may apply.

Specifications are subject to change without notice for ongoing product modifications and improvements.

MANUAL NO. SIEP C730600 64A

Published in Japan October 2013 13-10
13-7-11