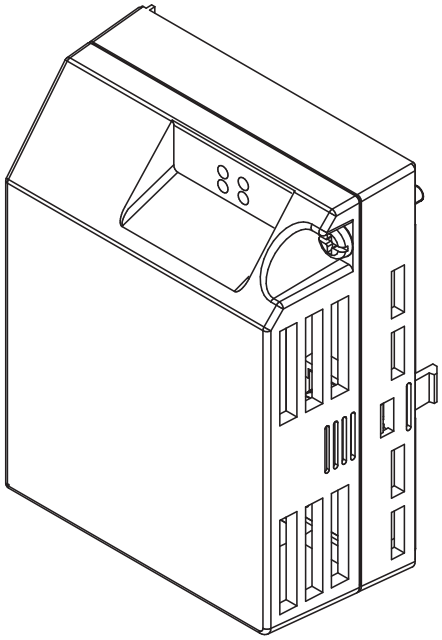
YASKAWA

YASKAWA AC Drive V1000 Option

EtherCAT®
Technical Manual

Type: SI-ES3 for V1000 Series

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



ATTENTION!
This product can only be used on V1000 drives with firmware version VSV901020 to VSV901099 installed.

MANUAL NO. YEU SIEP C710606 98A

Table of Contents

1 PREFACE AND SAFETY 4
2 PRODUCT OVERVIEW. 6
3 SOFTWARE PARTS 7
4 RECEIVING 8
5 ETHERCAT® OPTION COMPONENTS 9
6 INSTALLATION PROCEDURE 12
7 DSP301 AND DSP402 SPECIFICATIONS 16
8 ETHERCAT® OPTION RELATED DRIVE PARAMETERS 21
9 OBJECT DICTIONARY 22
10 CONFIGURING MANUFACTURER SPECIFIC CANOPEN OBJECTS 37
11 PROCESS DATA OBJECTS (PDO) 38
12 DRIVE PARAMETER, MONITOR AND CONTROL REGISTER ACCESS 42
13 FAULT DIAGNOSIS AND POSSIBLE SOLUTIONS 43
14 SPECIFICATIONS. 47

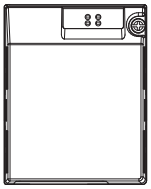
1 Preface and Safety

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 SI-ES3 EtherCAT® Option card:

Option Card

	**YASKAWA AC Drive V1000 Option EtherCAT® Installation Manual** **Manual No.: YEU TOEP C710606 98A**
	Read this manual first. The installation manual is packaged with the EtherCAT® Option and contains a basic overview of wiring, settings, functions, and fault diagnoses.
	YASKAWA AC Drive V1000 Option EtherCAT® Technical Manual (this book) **Manual No.: YEU SIEP C710606 98A**
	The technical manual contains detailed information. To obtain the technical manual access these sites: Europe: http://www.yaskawa.eu.com Japan: http://www.e-mechatronics.com USA: http://www.yaskawa.com Other areas: contact a YASKAWA representative.

For the drive setup, refer to one of the documentation listed below.

YASKAWA Drive

	Refer to the manual of the drive this option card is being used with. The instruction manual for the drive covers basic installation, wiring, operation procedures, functions, troubleshooting, and maintenance information. It also includes important information on parameter settings and how to tune the drive. A Quick Start Guide is included with the drive. For the more detailed technical manual, visit YASKAWA's home page. Europe: http://www.yaskawa.eu.com Japan: http://www.e-mechatronics.com USA: http://www.yaskawa.com Other areas: contact a YASKAWA representative

◆ Terms

Note: Indicates supplemental information that YASKAWA highly recommends be followed. Content identified by Note: is not related to personnel safety or equipment damage safety messages.

EtherCAT® Option:	YASKAWA AC Drive SI-ES3 EtherCAT® option card
EtherCAT®:	Ethernet for Control Automation Technology, an open Ethernet-based network
NOID:	Network Option Interface Driver (YASKAWA Interface driver)
Online-DRV:	NOID processing mode, process (ctrl/resp) data is active
Online-DRVMB:	NOID processing mode, process resp data is active, ctrl data is on hold (Until MEMOBUS process is complete)
Online-PRG:	NOID processing mode, NO process (ctrl/resp) data is active
Host:	YASKAWA drive 1000 series
JTAG:	Joint Test Action Group, an IEEE standard interface test port for test and programming purposes
LED:	Light Emitting Diode
OPT, Option:	The unit described in this document
INV, Inverter:	Host application to OPT
PCB:	Printed Circuit Board
SPI:	Serial Peripheral Interface Bus
FCS:	Frame Check Sequence
INVR:	Drive register number
ESI:	EtherCAT Slave Information

◆ Registered Trademarks

- EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
- Other company names and product names listed in this manual are registered trademarks of those companies.

◆ Supplemental Safety Information

Read and understand this manual before installing, operating, or servicing this option card. The option card 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 drives without covers or safety shields to illustrate details. Be sure to reinstall covers or shields before operating any devices. The option board 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 a new copy of the manual due to damage or loss, contact your 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 operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.

NOTICE

Do not expose the drive to halogen group disinfectants.

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

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.

Do not modify the drive circuitry.

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

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

2 Product Overview

◆ About This Product

The EtherCAT® Option (Model: SI-ES3) is an option card designed to connect the YASKAWA AC drive to an EtherCAT® network. Using this option card and an EtherCAT® master can;

- operate the drive
- monitor the drive operation status
- read or modify drive parameters.

The SI-ES3 option provides instant connectivity to an EtherCAT® network for the YASKAWA V1000 drive. The option contains support for 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>
V1000	CIMR-V□2□□□□□	VSV901020 to VSV901099
	CIMR-V□4□□□□□	

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

3 Software Parts

◆ NOID - Network Option Interface Driver

This section explains communication sequences provided by the SI-ES3 option to startup and control the drive.

Functionality provided:

- Startup/initialization of option with the drive.
- Option and drive compatibility/acceptance management.
- Process data parameter (register) mapping.
- Drive <--> Option re-initialization management (remap of process data).
- MEMOBUS channel.
- Error management.
- Drive <- -> Option basic control response data in Online-DRV mode.
- Drive <- -> Option operation mode.

■ Drive/Option Identification Information

This section specifies the option/drive specific identification information exchanged during power-up state of the application driver.

Table 2 Drive/Option Identification Information

Setting	Value	Description
Option model code	0x53455333	Option mode code, 4-digit ASCII string. Value: SES3=0x53455333 Used by drive to identify what kind of option that is mounted.
Option software version	DEC: 24201	Last 5 decimal digits of decimal option firmware revision. Def: VST9242zz VST9 = V1000 option card 2 = European product 42 = Product code zz = Minor revision
Drive model codes	ALL	Drive model codes accepted by option NOID driver. If the provided drive model code does not match the list the option will raise the OFx31 drive error. Option will accept any drive model code.

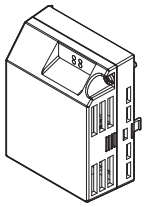
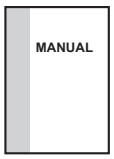
4 Receiving

Please perform the following tasks after receiving the EtherCAT® Option:

- Inspect the EtherCAT® Option for damage.
  If the EtherCAT® Option appears damaged upon receipt, contact the shipper immediately.
- Verify receipt of the correct model by checking the information on the PCB (see ***Figure 2***).
- If you have received the wrong model or the EtherCAT® Option does not function properly, contact your supplier.

◆ Contents and Packaging

Table 3 Option Package Contents

Description:	Option Card	Ground Cable	Installation Manual
			
Quantity:	1	1	1

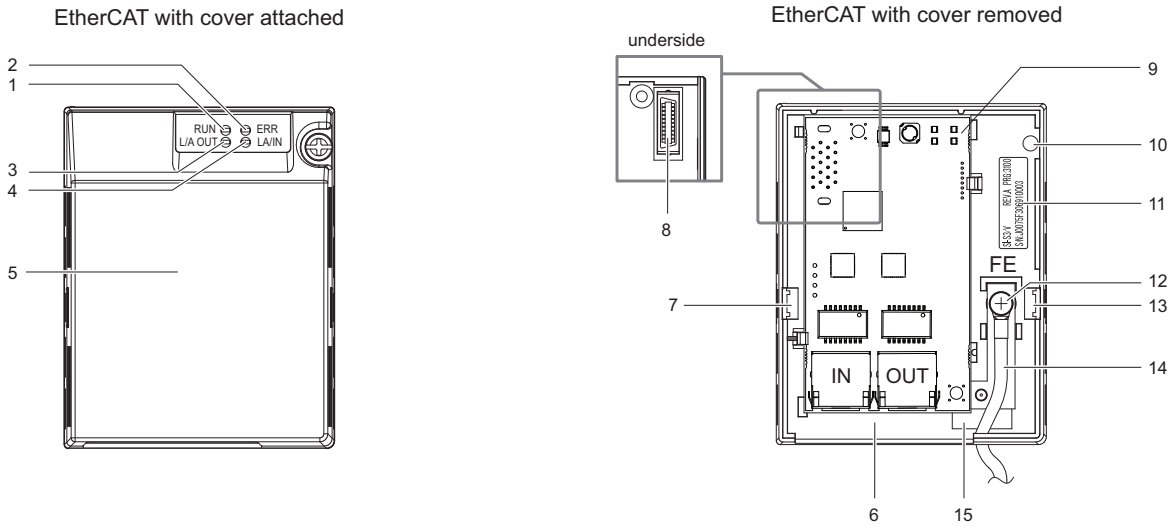
◆ Tool Requirements

A Phillips screwdriver PH1(#1) or PH2(#2) is required to install the EtherCAT® option.

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

5 EtherCAT® Option Components

◆ EtherCAT® Option



1 - LED (RUN)
2 - LED (ERR)
3 - LED (L/A OUT)
4 - LED (L/A IN)
5 - Option Cover
6 - Communication cable connector (RJ45)
7 - Mounting clip
8 - Option board connector
9 - EtherCAT PCB
10 - Attachment screw hole for option cover
11 - Nameplate
12 - Function Earth wire connection (FE)
13 - Mounting clip
14 - Wire
15 - Through-hole for wire

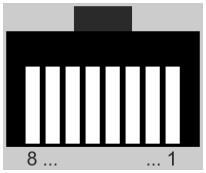
Figure 2 Option Card

For details on the LEDs, refer to *EtherCAT® Option Status LEDs on page 9*.

◆ Communication connector

The EtherCAT® Option is connected to the network using a RJ45 connector. The pin assignment is explained in *Table 4*.

Table 4 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

◆ EtherCAT® Option Status LEDs

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

■ LEDs L/A OUT and L/A IN: Ethernet Link/Activity 1 and 2

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

■ RUN LED

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 5*.

■ EtherCAT® ERROR indicator

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

Table 5 UNDERSTANDING THE STATUS LEDS

LED	Color	Display	Meaning
Link Activity 1/2	-	Continuously Off	No link. The communication cable is not physically connected. The EtherCAT® controller is not started up.
	Green	Continuously On	The module is connected to Ethernet. A communication cable is physically connected, but no data are being exchanged.
		Flickering	There is traffic on Ethernet, data are being exchanged
RUN	-	Continuously Off	The device is in Init state
	Green	Blinking	The device is in Pre-Operational State (flashing rate about 2.5 Hz)
		Single flash	The device is in Safe-Operational State (one short flash (approximately 200 ms) followed by a long off condition (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 in IDLE state (waiting for commands from the drive) 6 Hz: Firmware loader protocol is processing commands.
ERR	Red	Continuously Off	No link. The EtherCAT® communication is in working condition.
		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: 1. An EtherCAT® PDI (Process Data Interface) error has occurred, the NOID application interface has failed. 2. An option card FATAL event has occurred (system has stalled execution, see EtherCAT® vendor object 0x4000 for the cause).
		Blinking (1 Hz or 6 Hz)	The option BOOT or APP firmware is executing the NOID firmware loader. 1Hz: Firmware loader protocol in IDLE state (waiting for commands from drive) 6Hz: Firmware loader protocol is processing commands.

Figure 3 explains the indicator flash rates.

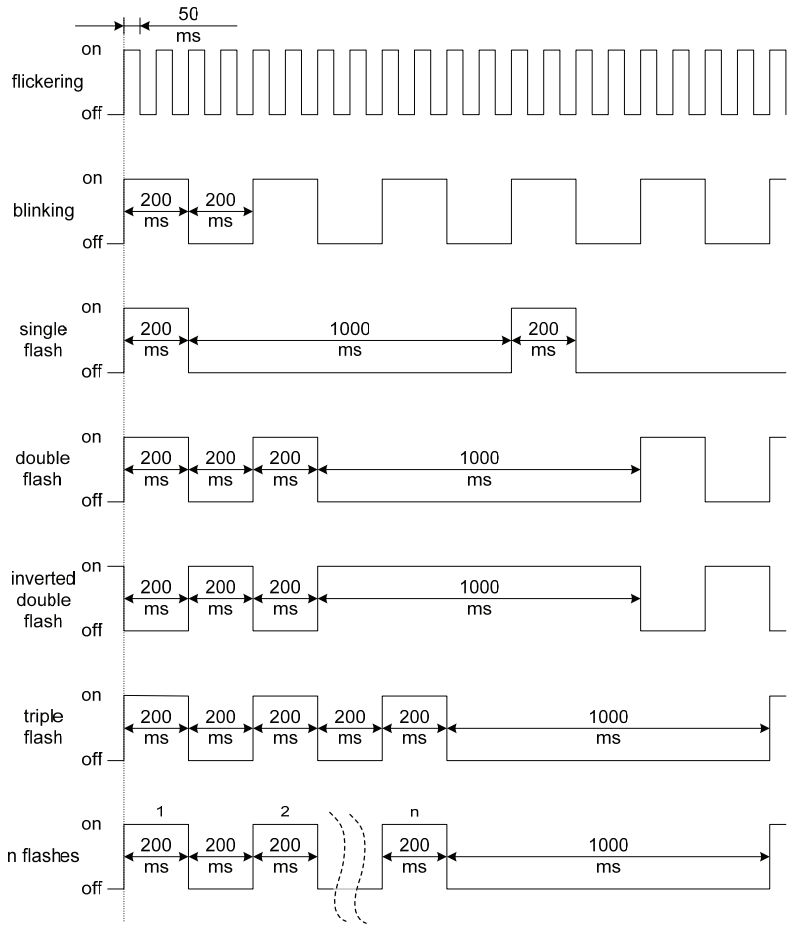


Figure 3 LED Flash Rates and Meaning

◆ DSP402 functionality

This part 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

This part integrates the vendor specific CANopen object model into EtherCAT®.

◆ Error management

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

◆ EtherCAT® processing stack

The "EtherCAT® Slave example code" from the EtherCAT® technology group (ETG) is used as a main base in this project. It is internally adopted to fit the product.

6 Installation Procedure

◆ Section Safety

⚠ DANGER

Electric Shock Hazard

Power to the drive must be shut off when installing this option card.

Even though the power has been shut off, voltage still remains in the drive's DC bus. Wait before removing the front cover once the drive has been turned off.

The CHARGE light on the drive will go out after voltage in the DC bus drops below 50 V, at which point it is safe to remove the front cover.

Due to the risk of electric shock, be sure that all LEDs have gone out and that the DC bus voltage has reached a safe level prior to performing any work on the drive.

⚠ WARNING

Electrical Shock Hazard

Do not remove the front cover 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 drives without covers or safety shields to show details. Be sure to reinstall covers or shields before operating any devices. The option board 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 the option card while the power supply to the drive is switched 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 procedures (ESD) when handling the option card, 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.

Tighten all terminal screws to the specified tightening torque.

Loose electrical connections could result in death or serious injury by fire due to overheating of electrical connections.

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.

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 card and connecting any other devices.

Failure to comply may result in damage to the option card.

◆ Prior to Installing the Option Card

Prior to installing the EtherCAT® Option, wire the drive and make necessary connections to the drive terminals. For more information on wiring and connecting the drive, refer to the manual packaged with the drive. Verify that the drive runs normally without the option installed.

◆ Installing the Option Unit

Remove the front cover of the drive before installing the EtherCAT® Option. Follow the directions below for proper installation.

1. Switch off the power supply to the drive.

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. Before installing the EtherCAT® Option, disconnect all power to the drive. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 VDC. To prevent electric shock, wait at least five minutes after all indicators are off and measure the DC bus voltage level to confirm safe level.*

2. Remove the front cover. The original drive front cover may be discarded because it will be replaced by the EtherCAT® Option cover in step 8.

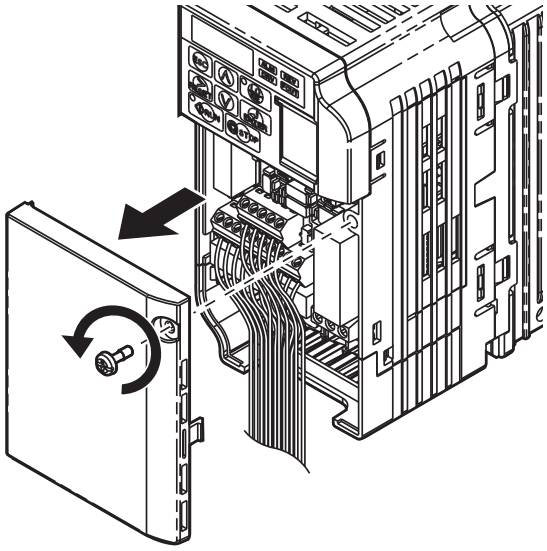


Figure 4 Remove Front Cover

3. Remove the bottom cover and connect the EtherCAT® Option ground wire to the ground terminal.

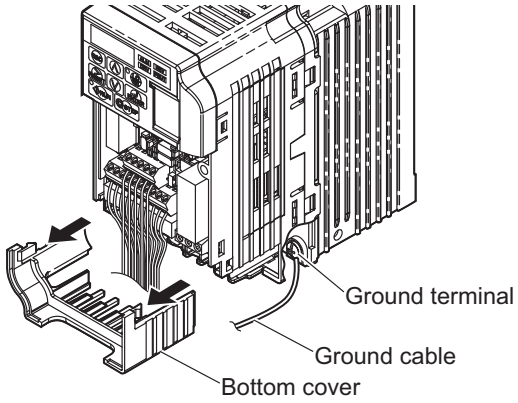
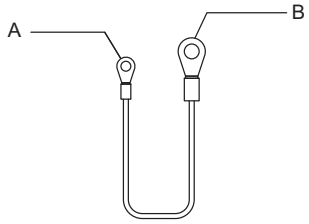


Figure 5 Connect Ground Wire

Note: The four different ground wires packaged with the EtherCAT® Option connect the unit to different drive models. Select the proper ground wire from the EtherCAT® Option kit depending on drive size. *Refer to Ground Wire Selection on page 14*.



A – Option unit connection: screw size = M3
B – Drive-side connection: screw size = M3.5 to M6

Figure 6 Ground Wire

Table 6 Ground Wire Selection

Ground Wire Length (mm/in)	Drive Model CIMR-VU		
	Single-Phase 200 V Class	Three-Phase 200 V Class	Three-Phase 400 V Class
150/5.9	BA0001 BA0002 BA0003	2A0001 2A0002 2A0004 2A0006	-
200/7.9	BA0006 BA0010 BA0012 BA0018	2A0010 2A0012 2A0020	4A0001 4A0002 4A0004 4A0005 4A0007 4A0009 4A0011
250/9.8	-	2A0030 2A0040	4A0018 4A0023
400/15.7	-	2A0056 2A0069	4A0031 4A0038

Note: Cover removal steps for certain larger models of V1000 with a Terminal Cover:
-Single-Phase 200 V Class: CIMR-VUBA0006 to BA0018
-Three-Phase 200 V Class: CIMR-VU2A0008 to 2A0069
-Three-Phase 400 V Class: All models
Remove the terminal cover before removing the bottom cover to install the EtherCAT® Option. Replace the terminal cover after wiring the EtherCAT® Option.

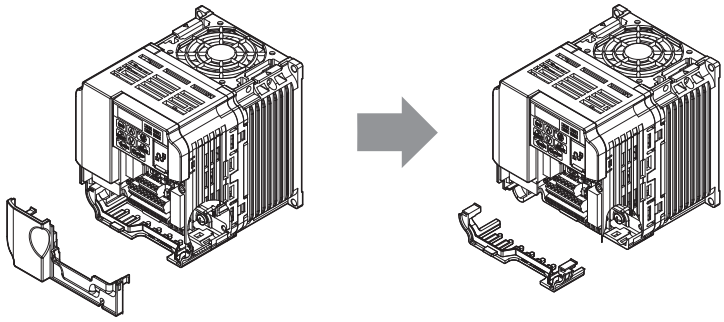


Figure 7 Models with Terminal Cover

4. Reattach the bottom cover.
5. Connect the EtherCAT® Option to the drive. Properly secure the tabs on the left and right sides of the EtherCAT® Option to the drive case.

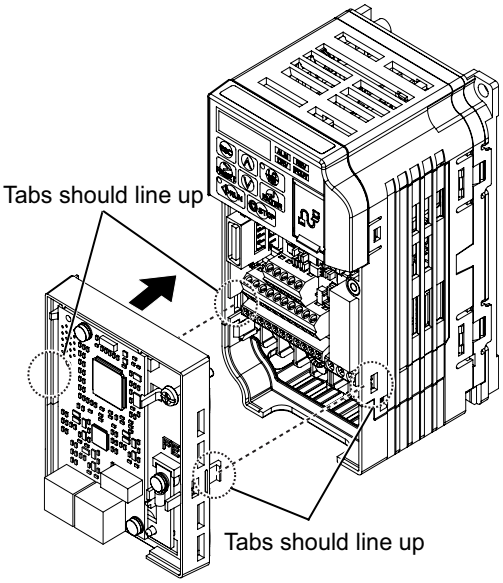


Figure 8 Attach EtherCAT® Option

6. Connect the ground wire between the drive ground terminal and the EtherCAT® Option ground. When wiring the EtherCAT® Option, pass the ground wire through the inside of the drive bottom cover, then pass the ground wire into the through-hole for the ground wire at the front of the EtherCAT® Option.

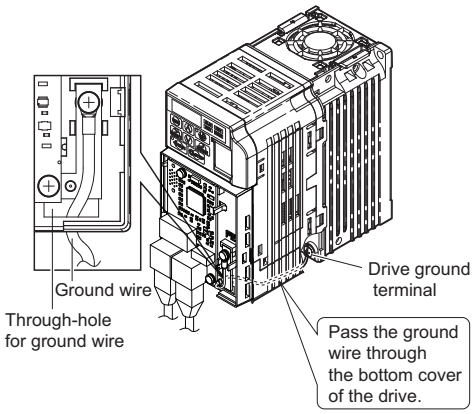


Figure 9 Ground Wire Connection

7. Connect the communication wire to the EtherCAT® Option modular connector.
8. Attach the EtherCAT® Option cover to the front of the EtherCAT® Option.

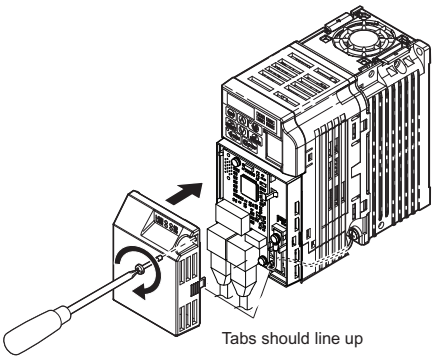


Figure 10 Attach Cover

◆ Communication Cable Specifications

To ensure proper performance, Yaskawa recommends using EtherCAT® dedicated Cat5e communication cables.

◆ Network Termination

The EtherCAT® network does not require a termination resistor if the drive is the last node in the network. Network termination is realized 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:
Europe: http://www.yaskawa.eu.com
Japan: http://www.e-mechatronics.com
USA: http://www.yaskawa.com
Other areas: contact a Yaskawa representative

◆ Identification of Drive Firmware Version

1. Read out firmware version from drive digital operator.

Check monitor parameter U1-25 when the drive is switched ON. The display shows the last four digits of the firmware version and the value should be in the range of 1020 ~ 1099.

2. Verifying firmware version on drive nameplate

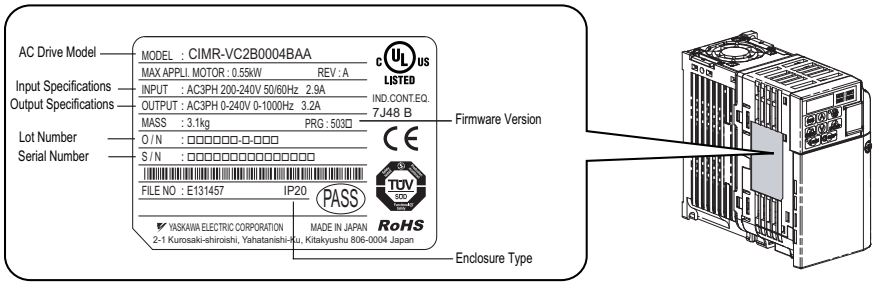


Figure 11 Verifying firmware version on drive nameplate

7 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 Object (SDO) for explicit messaging. The time for transmitting PDOs is significantly lower than the time for transmitting SDO, therefore, communication objects like command/reference are mapped onto PDOs as standard.

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

7.1 Modes

The V1000 series EtherCAT® option will support two operating modes:

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

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

1. If an RxPDO mapping has been assigned to DSP402 control word 0x6040 and EtherCAT® is in the SAFEOP or OP state the DSP402 profile will be processed.
2. If the EtherCAT® state machine is NOT in the SAFEOP or OP state and an SDO write request is performed on the DSP402 0x6040 control word the DSP402 profile will be processed.
3. If the EtherCAT® state machine is NOT in the SAFEOP or OP state and an SDO read request is performed on the DSP402 0x6041 status word the DSP402 profile will be processed.
4. Otherwise the vendor specific control word will be accessed normally.

7.1.1 DSP402 Velocity mode

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

7.1.2 Vendor specific mode (DSP402 profile bypass)

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

7.2 Implemented CANopen Objects/Components

Communication and parameters on CANopen are built around objects.

The following message types are implemented:

- SDO (Service Data 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 module.
- 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 application or communication adapter.

■ 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 in case of an erroneous condition

Emergency Service

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

◆ EtherCAT® State Machine

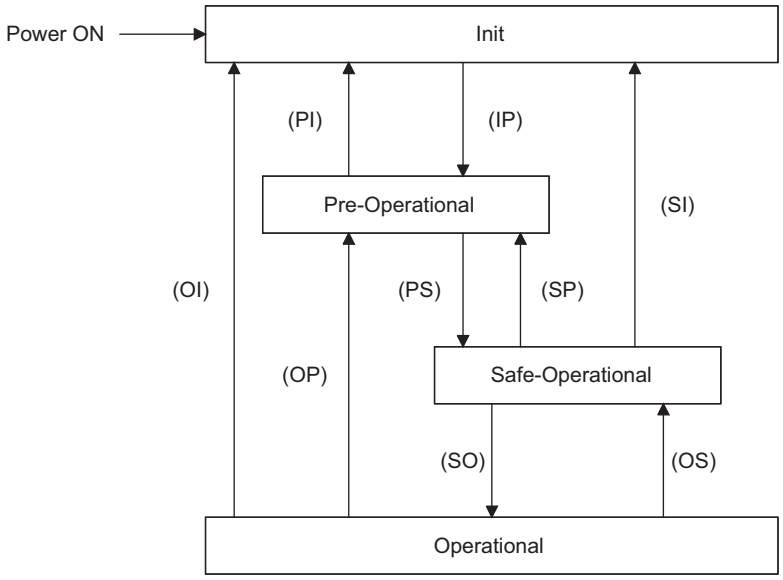


Figure 12 EtherCAT® State Machine

The EtherCAT® module enters the INIT state directly after start-up. After this, the module can be switched to the PRE-OP state. In the PRE-OP state EtherCAT® mailbox communication is allowed, and drive parameters can be accessed by CoE SDO.

After the master has configured the slave, it can switch the module to state SAFE-OP. In the SAFE-OP state Input I/O data (PDOs) will be sent from the module to the EtherCAT® master, but there may be no void Output I/O data from the master to the option.

When the transition from PRE-OP to SAFE-OP occurs, the option will process the configured PDO assignments and re-map the relevant drive registers. After this SAFE-OP state is entered.

In order to communicate Output I/O data the master must switch the module to OP state.

■ EtherCAT® Operation Mode Relations

Table 7 EtherCAT® Operation Mode Relations

EtherCAT® state	Event	Description
INIT	State	SDO access possible against the drive.
PRE-OP	State	1. SDO access possible against the drive. 2. No ctrl data is mapped against INV. 3. Only INV status word is mapped on resp registers to service the DSP emergency services.
SAFE-OP	State	1. SDO access possible against the drive. 2. Input PDO data from INV->OPT valid. 3. Master output data OPT->INV NOT valid.
OP	State	1. SDO access possible against the drive. 2. Input PDO data from INV->OPT valid. 3. Master output data OPT->INV valid.
PRE-OP -> SAFE-OP	Trans	1. Option will re-map required drive registers in NOID. 2. OPT will trigger INIT request to enter Power-up state and re-map ctrl/resp registers exchanged in Online-DRV.
SAFE-OP -> PRE-OP SAFE-OP -> INIT OP -> PRE-OP OP -> INIT	Trans	1. If INV is operating OPT will trip drive with BUS error. 2. OPT will trigger NOID to switch operation mode to Online-PRG. 3. OPT will remap and clear all ctrl/resp data.
SAFE-OP -> OP	Trans	1. NOID will SET "ctrl data valid bit"
OP -> SAFE-OP	Trans	No processing done, only BUS error is set against INV.

Note: If the requested drive state cannot be entered in case of a lower->higher state transition (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 specifies the state machine of the inverter. Since the DSP402 adapter is external to the inverter, the whole state machine has to be implemented in the option card itself.

■ CANopen DSP402 Control Word/Status Word

This section describes how to control the drive via control word/status word and how to access drive parameters.

Table 8 Control Word

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

Table 9 Status Word

Bit Number	Status Word	Inverter Reference
0	Ready to switch on	This bit controls the DS402 state machine - See *Table 13*
1	Switched on	This bit controls the DS402 state machine - See *Table 13*
2	Operation Enabled	This bit controls the DS402 state machine - See *Table 13*
3	Fault	This bit controls the DS402 state machine - See *Table 13*
4	Voltage enabled	This bit controls the DS402 state machine - See *Table 13*
5	Quick stop	This bit controls the DS402 state machine - See *Table 13*
6	Switch on disabled	This bit controls the DS402 state machine - See *Table 13*
7	Warning	1: INVR:0x00FC & 0x0040 0: !(INVR:0x00FC & 0x0040)
8	Manufacturer specific	NA
9	Remote	1: Online-DRV:INVSTS2 & 0x0003 != 0 (INV uses NET cmd or ref) 0: Online-DRV:INVSTS2 & 0x0003 = 0 (INV does not use NET cmd or ref)
10	Target reached (Op mode spec)	See *Table 10*
11	Internal limit active	0: Always, not implemented
12	Operation mode specific	Refer to *Table 10* for more details
13	Operation mode specific	Refer to *Table 10* for more details
14	Manufacturer specific	NA
15	Manufacturer specific	NA

Control Word Operation Mode Specific Bits in Velocity Mode

Table 10 Control Word Operation Mode Specific Bits in Velocity Mode

Bit Number	Control Word	Drive Reference
4	rfg enable	0: Online-DRV:OPTSTS2#0x0002 = 0 (Clear NetRef bit) 1: Online-DRV:OPTSTS2#0x0002 = 1 (Set NetRef bit)
5	rfg unlock	0: Discard any new NET set-point 1: Use new NET set-point
6	rfg use ref	0: Force NET set-point to zero. 1: Use NET set-point
9	Not implemented	Not implemented

Status Word Operation Mode Specific Bits in Velocity Mode

Table 11 Status Word Operation Mode Specific Bits in Velocity Mode

Bit Number	Status Word	Drive Reference
(10)	Target reached	1: INVR:0x00FC & 0x0010 0: !(INVR:0x00FC & 0x0010)
12	Reserved	0: Always, not applicable in velocity mode.
13	Reserved	0: Always, not applicable in velocity mode.

CANopen DSP402 Control Word State Transition Bits

Table 12 Control Word State Transitions

DSP402 Command	Bits of the Control Word					Transitions	INV Command Orders
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0		
0: Shutdown	0	X	1	1	0	2,6,8	INVR:0x0014#0x0004 = 0 (No Quick STOP) INVR:0x0001#0x0003 = 0 (STOP order)
1: Switch on	0	0	1	1	1	3	INVR:0x0014#0x0004 = 0 (No Quick STOP) INVR:0x0001#0x0003 = 0 (STOP order)

2: Switch on + enable operation	0	1	1	1	1	3 + 4
						(NOTE 1)
							IF(0x6042 vl target velocity < 0)
							INVR:0x0001#0x0003 = 2 (RUN REV order)
							ELSE
							INVR:0x0001#0x0003 = 1 (RUN FWD order)

3: Disable voltage	0	X	X	0	X	7,9,10,12	INVR:0x0014#0x0004 = 0 (No Quick STOP) INVR:0x0001#0x0003 = 0 (STOP order)
4: Quick stop	0	X	0	1	X	7,10,11	INVR:0x0014#0x0004 = 1 (Quick STOP select) INVR:0x0001#0x0003 = 0 (STOP order)
5: Disable operation	0	0	1	1	1	5	INVR:0x0014#0x0004 = 0 (No Quick STOP) INVR:0x0001#0x0003 = 0 (STOP order)

6: Enable operation	0	1	1	1	1	4,16	IF(0x6042 vl target velocity < 0)
							INVR:0x0001#0x0003 = 2 (RUN REV order)
							ELSE

7: Fault reset	0 -> 1	X	X	X	X	15	INVR:0x0001#0x0003 = 0 (STOP order) INVR:0x0001#0x0008 = 0->1 (FAULT reset order)

Notes:
1. Automatic transition to Enable operation state after executing SWITCHED ON state functionality.
2. If the option does not have the NetCtrl command (Online-DRV#INVSTS2&0x0002) it will not process any command orders against the drive.

CANopen DSP402 Status Word State Transition Bits

After a change in the control word (remote control) according to ***Table 11*** the node state will change and the state result will be indicated in the status word according to ***Table 12***.

Table 13 Status Word State Transitions

DSP402 State	Bits of the status word						INV Status + OPT 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	X	0	0	0	0	INVR:0x00FC#0x0080 = 0 (No FAULT) AND INVR:0x00FC#0x0020 = 0 (Not READY)
2: Switch on disabled	1	X	0	0	0	0	INVR:0x00FC&0x0005= 0 (INV Not RUN) AND INVR:0x00FC&0x0002 = 0 (Zero speed)
3: Ready to switch on	0	1	0	0	0	1	OPT CMD = 0 AND DSP402 state= (2,4,5) AND INVR:0x00FC&0x0005= 0 (INV Not RUN) AND INVR:0x00FC&0x0002 = 0 (Zero speed)
4: Switched on	0	1	0	0	1	1	OPT CMD= (1, 5) AND DSP402 state= (3,5) AND INVR:0x00FC&0x0005= 0 (INV Not RUN) AND INVR:0x00FC&0x0002 = 0 (Zero speed)
5: Operation enabled	0	1	0	1	1	1	INVR:0x00FC&0x0005!= 0 (INV RUN) AND INVR:0x00FC&0x0002 != 0 (Not Zero speed) AND DSP402 state != (6,7,8)
6: Quick stop active	0	0	0	1	1	1	(OPT CMD = 4 OR DSP402 state=6) AND INVR:0x00FC&0x0005!= 0 (INV RUN) AND INVR:0x00FC&0x0002 != 0 (Not Zero speed)
7: Fault reaction active	0	X	1	1	1	1	INVR:0x00FC#0x0080 = 1 (FAULT) AND INVR:0x00FC&0x0005!= 0 (INV RUN) AND INVR:0x00FC&0x0002 != 0 (Not Zero speed)
8: Fault	0	X	1	0	0	0	INVR:0x00FC#0x0080 = 1 (FAULT) AND INVR:0x00FC&0x0005= 0 (INV Not RUN) AND INVR:0x00FC&0x0002 = 0 (Zero speed)

CANopen DS402 State Transition Definition

The YASKAWA EtherCAT® option has the following state transitions and states. The module must be in the state Operation Enable in order to accept frequency and operation commands. In ***Table 13*** the events needed to change between different states are described. Some events are internally triggered, but most of the events are triggered from the control word received from the bus.

CANopen DSP402 State Diagram

At any time the EtherCAT® option card will be in one of the following states. The events that are able to trigger a transition between the states are either sent with the control word or triggered by an internal action. All the possible events and the corresponding transition number are listed in *Table 14*.

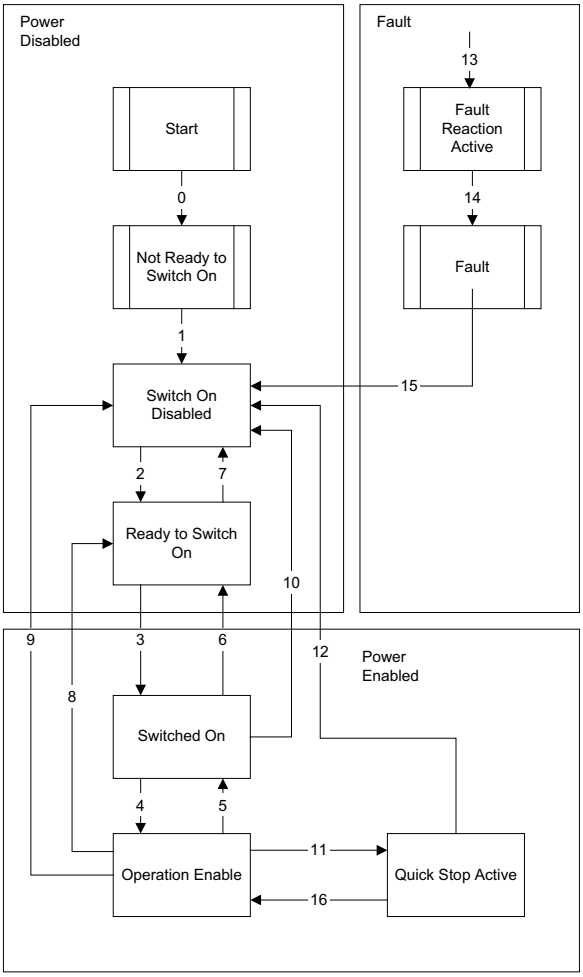


Figure 13 DSP402 State Diagram

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

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 module 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 control word, or from the application drive.

Table 14 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 disabled	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	Quickstop 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 disable	Disable voltage or quickstop command received
11	Operation enabled => Quick stop active	Quickstop command received
12	Quick stop active => Switch on disabled	Quickstop completed or Disable voltage command received
13	All states => Fault reaction active	Fatal fault has occurred in the drive
14	Fault reaction active => Fault	The fault action is completed
15	Fault => Switch on disabled	Fault reset command received
16	Quick stop active => Operation enabled	Enable operation command received

8 EtherCAT® Option Related Drive Parameters

The drive parameters listed in *Table 15* have influence on some functions of the SI-ES3 option card. Check these parameters before starting network communications.

Table 15 Parameter Settings

No.	Name	Description	Default
b1-01 <1>	Frequency Reference Selection	Selects the frequency reference input source 0: Operator - Digital preset speed d1-01 to d1-17 1: Terminals - Analog input terminals 2: MEMOBUS/Modbus communications 3: Option card 4: Pulse Input (Terminal RP)	<6>
b1-02 <1>	Run Command Selection	Selects the run command input source 0: Digital Operator - RUN and STOP keys 1: Digital input terminals S☐ 2: MEMOBUS/Modbus communications 3: Option card	1
E2-04 <2>	Motor 1 Motor Poles	Set the number of motor poles described on the motor nameplate. 2 to 48	4
F6-01	Operation Selection after Communications Error	Determines drive response when a bUS error is detected during communications with the EtherCAT® Option 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <3>	1
F6-02	External Fault Detection Conditions (EF0)	Sets the condition for external fault detection (EF0) 0: Always detected 1: Detected only during operation	0
F6-03	Stopping Method for External Fault from Communication Option Board	Determines drive response for external fault input (EF0) detection during EtherCAT® communication 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <3>	1
F6-06 <4>	Torque Reference/Torque Limit selection from Communications Option	0: Torque reference/torque limit via network communications are disabled. 1: Torque reference/torque limit via network communications are enabled. <5>	0
F6-07	NetRef/ComRef Selection Function	0: Multi-step speed reference disabled (F7 mode) 1: Multi-step speed reference allowed (V7 mode)	0
F6-08	Reset Communication Related Parameters	Determines if communication-related parameters are set back to their original default values when the drive is initialized. 0: Do not reset F6-☐☐ and F7-☐☐ parameters when the drive is initialized using parameter A1-03. 1: Rest F6-☐☐ and F7-☐☐ parameters when the drive is initialized using parameter A1-03. **Note:** Setting this parameter does not affect communication-related parameters. Setting this parameter only determines if communication-related parameters (F6-☐☐ and F7-☐☐) are also reset when A1-03 is used to initialize the drive.	0
o1-03 <7>	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	<6>

<1> To start and stop the drive from an EtherCAT® master device using serial communications, set b1-02 to 3. To control the frequency reference of the drive via the master device, set b1-01 to 3.
<2> E2-04 is necessary to set up when the Drive Profile DSP402 objects are used.
<3> If set to 3, then the drive will continue to operate when an EF0 fault is detected. Take proper safety measures, such as installing an emergency stop switch.
<4> This parameter might not appear in certain drives. Furthermore its availability is limited to depending on the control mode selection. For details refer to the technical manual for the drive the option card is used with.
<5> If the drive is set to receive the torque reference/limit from the network (F6-06 = 1) make sure the value is set appropriately by the controller. If no torque reference/limit value is entered the motor will not produce torque.
<6> The default value depends on the drive used and/or the drive software version. For details refer to the technical manual for the drive.
<7> Changing o1-03 changes the units for input object 2010 (Hex) (frequency reference), output object 2110 (Hex) (output frequency) and 2200 (Hex) (motor speed). Furthermore o1-03 must be set to 2 and E2-04 must be set to the correct value in order to use the Drive Profile DSP402.

9 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 SI-ES3 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	*23*
1001	Error Register	*23*
1003	Pre-defined Error Field	*24*
1008	Manufacturer Device Name	*24*
1009	Manufacturer Hardware Version	*24*
100A	Manufacturer Software Version	*24*
1010	Store Parameters	*24*
1011	Restore Default Parameters	*24*
1018	Identity Object	*25*
1600 - 1628	Receive PDO Mapping	*25*
1A00 - 1A28	Transmit PDO mapping	*25*
1C00	Sync Manager Communication Type	*25*
1C12	Sync Manager RxPDO assign	*26*
1C13	Sync Manager TxPDO assign	*26*

■ Manufacturer Specific Profile Objects (DS 301)

Index (Hex)		Content	Page
Input	2000	Operation Command	*26*
	2010	Speed Command	*27*
	2020	Torque Limit	*27*
	2030	Torque Compensation	*27*
	2040	MEMOBUS/Modbus Read Command	*27*
	2050	MEMOBUS/Modbus Write Command	*27*
	2060	MEMOBUS/Modbus Unlimited Enter Command	*28*
	2070	MEMOBUS/Modbus Limited Enter Command	*28*
	2080	Selectable (default: none)	*28*
	2090	Selectable (default: none)	*28*
	20A0	Selectable (default: none)	*28*
	20B0	Selectable (default: none)	*28*
	20C0	Selectable (default: none)	*28*
	20D0	FM analog output 1	*28*
	20E0	AM analog output 2	*29*
	20F0	Multi-function DO output	*29*
	3000	Selectable (default: none)	*28*
	3100	Selectable (default: none)	*28*

Index (Hex)		Content	Page
Output	2100	Drive Status	29
	2110	Output Frequency	29
	2120	Output Current	29
	2130	Output Torque	30
	2140	MEMOBUS/Modbus Read Command Response	30
	2150	MEMOBUS/Modbus Write Command Response	30
	2155	PDO Parameter Write Response	30
	2160	MEMOBUS/Modbus Not Limited Enter Command Response	30
	2180	Selectable (default: Input terminal status)	31
	2190	Selectable (default: Analog input 1 monitor)	31
	21A0	Selectable (default: none)	31
	21B0	Selectable (default: none)	31
	21C0	Selectable (default: none)	31
	21E0	Selectable (default: none)	31
	21D0	Selectable (default: none)	31
	21F0	Selectable (default: none)	31
	2200	Motor Speed	31
	2210	DC Bus Voltage	31
	2220	Analog input monitor A1	31
	2240	Analog input monitor A2	32
	2260	Analog input monitor A3	32
	2270	Inverter DI Input	32
	4000	Option NVS FATAL Record	32
	4001	Option Info + Status Record	32

■ Drives and Motion Profile Objects (DSP 402)

Object Type	Index (Hex)	Name	Page
Common Entries	60FD	Digital Inputs	36
	60FE	Digital Outputs	36
Device Control	6040	Controlword	33
	6041	Statusword	33
	6060	Modes of operation	35
	6061	Modes of operation display	36
Velocity Mode	6042	vl target velocity	33
	6043	vl velocity demand	33
	6044	vl control effort	33
	6046	vl velocity min max amount	33
	6048	vl velocity acceleration	34
	6049	vl velocity deceleration	34
	604A	vl velocity quick stop	35
	604C	vl dimension factor	35
	604D	vl pole number	35

◆ 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) (static)

Bit 16-23: Type = x01 (static)

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 = Generic error (INVR:0x00FE & 0x0080)

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 43* 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: VST92x101

YASKAWA Def: VST92x1zz

VST9 = V1000 option card

2 = European product

42 = Product code

zz = 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)

Actions: Write of value 0x0000 to INVR:0x0900; Will issue INV EEPROM enter command.

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 this object restores the EtherCAT® Option default settings.

Default read value: 0x01 (Restore on command)

Actions: Option will write value=2220 to INVR: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: 92x1.zz00 9 = V1000 option card 2 = European product 42= Product code zz= 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	-	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 section 3.9.1. 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	-	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 section 3.9.2. 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
1A00	-	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
IC12	-	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
IC12	-	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 SI-ES3 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 37*).

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, as well 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: INVR: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	Terminal S3 Function	Multi-Function Input: H1-03
3	Terminal S4 Function	Multi-Function Input: H1-04
4	Terminal S5 Function	Multi-Function Input: H1-05
5	Terminal S6 Function	Multi-Function Input: H1-06
6	Terminal S7 Function	Multi-Function Input: H1-07
7	Terminal S8 Function	Multi-Function Input: H1-08
8	External Fault (EF0)	1: External Fault Input (EF0)
9	Fault Reset	1: Fault Reset
10 to 15	Not used	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 command	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx/Tx	-
		Speed command 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: INVR:0x0002 (Frequency reference)					

■ 2020 (Hex) - Torque Reference/Torque Limit

This object sets the torque reference or the torque limit in units of 0.1%.
In order 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/Limit	Read/Write	Possible	2 byte
	1	Value	Read/Write	Rx Tx	-
	2	MEMOBUS/Modbus register address	Read Only	No	-
Value: INVR: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: INVR: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, bytes 1 and 2 have to 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

Using this object, drive MEMOBUS/Modbus registers can be written. The data must be written in byte 1 and 2 of Subindex 1, 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 = 0x0000					

■ 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, it is enough to send only one ENTER command after the last parameter change. Doing so will activate all changed parameters. This ENTER command can be used without limitations.

To execute this type of ENTER command, "save" (73H + 61H + 76H + 65H) has to be written in object 2060H, subindex 0.

Read value: 0x00000001 (Execute on command)

INVR: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, it is sufficient to send only one ENTER command after the last parameter change. Doing so will activate all changed parameters. This type of ENTER command can be applied approximately 100,000 times and should be used only when necessary.

To execute this type of ENTER command, "save" (73H + 61H + 76H + 65H) has to be written in object 2070H, subindex 0.

Read value: 0x00000001 (Execute on command)

INVR: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 37*** for details.

Index (Hex)	Subindex	Content	Default	Access	PDO Mapping	Data Length
2080 <1>	0	Number of entries	2	Read Only	No	1 Byte
	1	Value	-	Read/Write	Possible	4 byte
		Value of mapped MEMOBUS register. Value: 0xAAAABBBB AAAA = MEMOBUS register 1 value BBBB = MEMOBUS register 2 value				
	2	MEMOBUS/Modbus register address of content 1 and 2	FFFF (Hex)/FFFF (Hex)	Read/Write <1>	No	4 Byte
		MEMOBUS register addresses for content 1 and 2 Value: 0xAAAABBBB AAAA = MEMOBUS register 1 address BBBB = MEMOBUS register 2 address Reg. value=0xFFFF ' Mapping disabled. Note: Those values can only be changed in EtherCAT® pre-operational state. Refer to ***Table 5*** 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 register. Value: 0xAAAA AAAA = MEMOBUS register value				
	2	MEMOBUS/Modbus register address of content	FFFF (Hex)	Read/Write <1>	No	2 Byte
		MEMOBUS register addresses Value: 0xAAAA AAAA = MEMOBUS register address. Note: Those values can only be changed in EtherCAT® pre-operational state. Refer to ***Table 5*** for the state relations.				

<1> Read/Write access when SI-ES3 is in the Pre-Operational state, Read only access if the SI-ES3 is in the Operational state or if the drive is running.

■ 20D0 (Hex) - FM analog output 1

This object controls the FM analog output 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: INVR:0x0007 (FM analog output 1)					

■ 20E0 (Hex) - AM analog output 2

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: INVR:0x0008 (AM analog output 2)					

■ 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: INVR:0x0009 (Multi-function DO)					

■ 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	00FC (Hex)	Read Only	No	2 byte	-
	Value: INVR:0x00FC (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	Data Length	Update Cycle
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: INVR: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: INVR: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: INVR: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, bytes 3 and 4 will contain the MEMOBUS/Modbus Address read.

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, 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 write response		Tx	Unsigned 32

■ 2155 (Hex) - PDO Parameter Write Response

Note: Object only available in EtherCAT® SAFE_OP or OPERATIONAL state. Object data is always cleared when a transition from PRE_OP ' SAFE_ OP 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. The error counter is increased when an NOID Online-DRV control data write is flagged as invalid by the drive (INVSTS2: Bit6, Control command error or local option RxPDO error). This object can only be read if the SI-ES3 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 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	Data Length
2180 to 21E0	0	Number of entries	-	Read Only	No	Unsigned 8
	1	Value of mapped drive register	-	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	Data Length
21F0	0	Number of entries	-	Read Only	No	Unsigned 8
	1	Value of mapped drive register 1 and 2	-	Read Only	Tx	Unsigned 32
	Value: 0xAAAABBBB -> AAAA = MEMOBUS register 1 value BBBB = MEMOBUS register 2 value					
	2	MEMOBUS register address of content 1 and 2	Value: 0xAAAABBBB ' AAAA = MEMOBUS register 1 address BBBB = MEMOBUS 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	Data Length
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: INVR: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	Data Length
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: INVR: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	Data Length
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: INVR: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	Data Length
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: INVR: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	Data Length
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: INVR: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	Data Length
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: INVR: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	Data Length
4001	-	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	Data Length
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
	NOI System latched (All errors that have occurred since start-up) error bits.					

◆ 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 might 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.

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.

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). Can be set when the status in Control word 6040 (Hex) is “Operation Enable”.

INVR:0x0010 (Reference frequency in rpm)

If vl target velocity is < 0 value will be converted to positive before writing it to INVR:0x0010. Also 0x6040 ENABLE_OP command will be processed as RUN REV order.

If target velocity >= 0 value will be used natively in INVR:0x0010 and 0x6040 ENABLE_OP command will 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 effort is the output frequency of the drive to the motor.

INVR:0x003E (Output frequency in rpm)

If (INVR:0x00FC#0x0004 = 1) value in INVR:0x003E will be turned 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 Control Effort/Actual Value

The V1 control effort is the motor speed.

INVR:0x00AC (Motor speed in rpm)

If (INVR:0x00FC#0x0004 = 1) value in INVR:0x00AC will be turned to negative to indicate REV operation mode.

Index (Hex)	Subindex	Content	Access	PDO Mapping	Value Range	Unit
6044	0	vl control effort	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 INVR:0x028A, d2-02 (Frequency reference lower limit) Note: The parameter specifies the % rate of E1-04 maximum output frequency. Internal parameter calculations needed.					
	2	vl velocity max amount	Read/Write	Rx/Tx	0...(2^{32}-1)	r/min
	Maximum speed reference allowed INVR:0x0289, d2-01 (Frequency reference upper limit) Note: The parameter specifies the % rate of E1-04 maximum output frequency. Internal parameter calculations 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 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 = INVR:0x0200, C1-01(Unit: 0.1/0.01s) (Acceleration time 1) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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	sec
		T = INVR:0x0200, C1-01(Unit: 0.1/0.01s) (Acceleration time 1) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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 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 = INVR:0x0201, C1-02(Unit: 0.1/0.01s) (Deceleration time 1) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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	sec
		T = INVR:0x0201, C1-02(Unit: 0.1/0.01s) (Deceleration time 1) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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 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 = INVR:0x0208, C1-09(Unit: 0.1/0.01s) (Fast stop time) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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	sec
	T = INVR:0x0208, C1-09(Unit: 0.1/0.01s) (Fast stop time) M = INVR:0x0303, E1-04 (Unit:0.1Hz) (Max output frequency) P = INVR: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_control_effort

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 (multiplication).

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.

INVR: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 control 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 SI-ES3 option card is used with. For details on the content of this register refer to the technical manual for the drive.

Bit defines:

0-15 = reserved (Set to zero)

16-31 = INVR: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	INVR:0x0001#0x0040 (1=set, 0=clear)
19	Terminal S4 Function	INVR:0x0001#0x0080 (1=set, 0=clear)
20	Terminal S5 Function	INVR:0x0001#0x0100 (1=set, 0=clear)
21	Terminal S6 Function	INVR:0x0001#0x0200 (1=set, 0=clear)
22	Terminal S7 Function	INVR:0x0001#0x0400 (1=set, 0=clear)
23	Terminal S8 Function	INVR:0x0001#0x0800 (1=set, 0=clear)
24	External Fault (EF0)	INVR:0x0001#0x0004 (1=set, 0=clear)
25	Fault Reset	INVR:0x0001#0x0008 (1=set, 0=clear)
26 to 31	Reserved (Set to zero)	

10 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 registers, so that those objects can be set up to contain the value of drive parameters, monitors as well as 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	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 1 and 2	Read/Write <1>	No	4 byte

<1> Read/Write access when SI-ES3 is in the Pre-Operational state, Read only access if the SI-ES3 is in the Operational state or if the drive is running.

To map the content of a certain 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 speed 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 SI-ES3 option card is in Pre-Operational state and drive is stopped (Run command not active).
- The SI-ES3 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	
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 can no 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), 0009 (Hex), and 0014 (Hex) are already linked to not changeable 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.

11 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 module 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 the table below. The transmit PDOs can be re-mapped by the end user by writing to map objects 0x1A00-0x1A28, please see *Communication Profile Objects (DSP 301) on page 22*.

PDO number	Transmit PDO Mapping	
	Mapped objects (Hex)	Index (Hex)
1	Sub-index 1: 0x6041#0, 2-bytes (DSP402 status word)	0x1A00
2	Sub-index 1: 0x6041#0, 2-bytes (DSP402 status word) Sub-index 2: 0x6061#0, 2-bytes, (DSP402 Modes of operation display)	0x1A01
6	Sub-index 1: 0x6041#0, 2-bytes (DSP402 status word) Sub-index 2: 0x6044#0, 2-bytes, (vl control effort)	0x1A05
7	Sub-index 1: 0x6041#0, 2-bytes (DSP402 status word) 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) Sub-index 2: 0x604C#2, 4-bytes, (vl Dimension factor)	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 the table below. 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 22*.

PDO number	Receive PDO Mapping	
	Mapped objects (Hex)	Index (Hex)
1	Sub-index 1: 0x6040#0, 2-bytes (DSP402 control word)	0x1600
2	Sub-index 1: 0x6040#0, 2-bytes (DSP402 control word) Sub-index 2: 0x6060#0, 1-bytes, (DSP402 Modes of operation)	0x1601
6	Sub-index 1: 0x6040#0, 2-bytes (DSP402 control word) Sub-index 2: 0x6042#0, 2-bytes, (vl target velocity)	0x1605
7	Sub-index 1: 0x6040#0, 2-bytes (DSP402 control word) Sub-index 2: 0x60FE#1, 4-bytes, (Physical digital outputs)	0x1606
8	Sub-index 1: 0x6040#0, 2-bytes (DSP402 control word) 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) Sub-index 2: 0x604C#2, 4-bytes, (vl Dimension factor)	0x1617
36	Sub-index 1: 0x2000#1, 2-bytes (Operation command)	0x1623
37	Sub-index 1: 0x2010#1, 2-bytes (Speed reference/limit)	0x1624
38	Sub-index 1: 0x2020#1, 2-bytes (Torque reference/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 has been realized inside the option system firmware. This slow IO channel is using 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 failed for some reason, 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.
- I.e 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

The *Table 16* describes which EtherCAT CoE objects are managed in the slow IO channel.

Table 16 Objects Managed in the Slow IO Channel

CoE Object	Linked INV Register	Information
0x2080 0x2090 0x20A0 0x20B0 0x20C0 0x3000 0x3100	If sub-index #2 (MEMOBUS register address is > 0x0100 that address is linked.	Configurable input objects
0x2040/0x2140	Register address in MEMOBUS read payload	Overlaid MEMOBUS read channel, request and response CoE objects
0x2050/0x2150	Register address in MEMOBUS write payload	Overlaid MEMOBUS 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 RAM (un-memorized) Enter command
0x6046#1	0x028A (d2-02)	Inverter frequency reference lower limit
0x6046#2	0x0289 (d2-01)	Inverter 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 chapter describes the option NVS parameter stored in option EEPROM and how it is managed.

Parameter behavior:

1. On first power-up, the option will initialize the EEPROM with the default values for each parameter.
2. 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.
3. When DSP301 CANopen object 0x1010 (Store parameters) receives the 0x65766173 ("save") command in EtherCAT® pre-operational state the option card will store the present values in EEPROM.
4. When DSP301 CANopen object 0x1011 (Restore parameters) receives the 0x64616f6c ("load") command, the option will load the NVS parameter default values and store them to EEPROM.

Table 17 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

CANopen Object	Default Value	Consumed EEPROM Size
0x21B0#2	0xFFFF	16-bits
0x21C0#2	0xFFFF	16-bits
0x21E0#2	0xFFFF	16-bits
0x21F0#2	0xFFFF	32-bits
0x604C#1	0x00000001	32-bits
0x604C#2	0x00000001	32-bits

■ Accessed Drive Registers

The following table describes the accessed drive registers.

Table 18 Accessed Drive Registers

Reg. Address	Internal Name/Short	Used in Context Evaluation	Description	Option Access (RO/RW/WO)
0x00FC	INVR_INVSTS1	1. EtherCAT CoE Emergency services 2. CoE: 0x2100 (Inverter native status) 3. CoE: 0x6041 (DSP402 status word) 4. OPT->INV BUS error management	Inverter native status	RO
0x003E	INVR_U102_OUTFREQ_RPM	1. CoE: 0x6043 (vl velocity demand)	Output freq [Unit: 1.0 RPM]	RO
0x00AC	INVR_U105_MSPEED_RPM	1. CoE: 0x6044 (vl velocity control effort)	Motor speed (u1-05) [Unit: 1.0 RPM]	RO
0x0041	INVR_U102_OUTFREQ	1. CoE: 0x2110 (Output frequency)	Output freq (u1-02) [Unit: o1-03]	RO
0x00FB	INVR_U103_OUTCUR2	1. CoE: 0x2120 (Output current)	Output current (u1-03)	RO
0x0048	INVR_U109_OUTTRQREF	1. CoE: 0x2130 (Output torque ref.)	Torque monitor (u1-09) [Unit: 0.1%]	RO
0x0049	INVR_U110_TER_DIN	1. CoE: 0x2180 (Free output default) 2. CoE: 0x2270 (Inverter DI input)	Input terminal status (u1-10)	RO
0x0044	INVR_U105_MSPEED	1. CoE: 0x2200 (Motor speed)	Motor speed (u1-05) [Unit: o1-03)	RO
0x0046	INVR_U107_DCBUSVOLT	1. CoE: 0x2210 (DC bus voltage)	Bus voltage [Unit: 1.0 V]	RO
0x004A	INVR_U111_TER_OUT	1. CoE: 0x60FD (Digital inputs)	Output terminal status (u1-11)	RO
0x004E	INVR_U113_TER_A1IN	1. CoE: 0x2190 (Free output default) 2. CoE: 0x2220 (Analog input monitor A1)	A1 terminal input voltage (u1-13)	RO
0x004F	INVR_U114_TER_A2IN	1. CoE: 0x2240 (Analog input monitor A2)	A2 terminal input voltage (u1-14)	RO
0x0050	INVR_U114_TER_A3IN	1. CoE: 0x2250 (Analog input monitor A3)	A2 terminal input voltage (u1-15)	RO
0x0080	INVR_U201_FAULTCUR	1. EtherCAT CoE Emergency services	Inverter Current fault (u2-01)	RO
0x0001	INVR_INVCTRL1	1. CoE: 0x6040 (DSP402 control word) 2. CoE: 0x60FE (Digital outputs) 3. CoE: 0x2000 (Operation command)	Run operation signal (option)	RW
0x0014	INVR_INVOPTCTRL1	1. CoE: 0x6040 (DSP402 control word)	Option auxiliary command 1	RW
0x0002	INVR_OPT_FREQ_REF	1. CoE: 0x2010 (Speed reference/limit)	Frequency reference	RW
0x0010	INVR_OPT_SPEEDREF_RPM	1. CoE: 0x6042 (vl target velocity)	Frequency reference [Unit: 1.0 RPM]	RW
0x0007	INVR_OPT_FM_AOUT1	1. CoE: 0x20D0 (FM analog output 1)	FM analog output 1	RW
0x0008	INVR_OPT_AM_AOUT2	1. CoE: 0x20E0 (AM analog output 2)	AM analog output 2	RW
0x0009	INVR_OPT_MFUNC_DO	1. CoE: 0x20F0 (Multi function DO output)	Multi function DO	RW
0x0200	INVR_C101_ACC1	1. CoE: 0x6048 (vl velocity acceleration)	Acceleration time 1 (c1-01) [Unit: c1-10]	RW
0x0201	INVR_C102_DEC1	1. CoE: 0x6049 (vl velocity deceleration)	Deceleration time 1 (c1-02) [Unit: c1-10]	RW
0x0208	INVR_C109_FASTSTOP	1. CoE: 0x604A (vl velocity quick-stop)	Fast-Stop time (c1-10) [Unit: c1-10]	RW
0x0209	INVR_C110_ADTUNIT	1. CoE: 0x6048 (vl velocity acceleration) 2. CoE: 0x6049 (vl velocity deceleration) 3. CoE: 0x604A (vl velocity quick-stop)	Accel/Decel Time Setting Units (c1-10)	RO
0x0289	INVR_D201_FREQUL	1. CoE: 0x6046#2 (vl velocity max amount)	Frequency Reference Upper Limit (d2-01)	RW
0x028A	INVR_D202_FREQLL	1. CoE: 0x6046#1 (vl velocity min amount)	Frequency Reference Lower Limit (d2-02)	RW
0x0303	INVR_E104_MAXOUTFREQ	1. Init runtime data sequence 2. CoE: 0x6046 (vl velocity min/max amount) 3. CoE: 0x6048 (vl velocity acceleration) 4. CoE: 0x6049 (vl velocity deceleration) 5. CoE: 0x604A (vl velocity quick-stop)	Max output frequency (e1-04)	RO
0x0311	INVR_E204_MPOLES	1. CoE: 0x6046 (vl velocity min/max amount) 2. CoE: 0x6048 (vl velocity acceleration) 3. CoE: 0x6049 (vl velocity deceleration) 4. CoE: 0x604A (vl velocity quick-stop) 5. CoE: 0x604D (vl pole number)	Number of motor poles (e2-04)	RW

Reg. Address	Internal Name/Short	Used in Context Evaluation	Description	Option Access (RO/RW/WO)
0x0910	INVR_ENTER_RAM	1. CoE: 0x2060 (MEMOBUS RAM Enter)	Inverter RAM Enter command	WO
0x0900	INVR_ENTER_EEP	1. CoE: 0x1010 (Store parameters) 2. CoE: 0x2070 (MEMOBUS ROM Enter)	Inverter EEPROM Enter command	WO
0x0103	INVR_A103_INITPRM	1. CoE: 0x1011 (Restore default parameters)	Initialize parameters Value=2220 (2-wire initialize)	WO

12 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 SI-ES3 option card.

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 37* 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 0 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 Parameter or Drive Control Register

Writing to drive parameters or control registers can be performed 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, additionally a RAM Enter command (object 2060 (hex)) must 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 Modbus/MEMOBUS 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 Modbus/MEMOBUS 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 Modbus/MEMEOBUS 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 Modbus/MEMOBUS register 0103 (object 1011 hex).
4. Finish the initialization by sending an Unlimited Enter Command (Obj. 2070 (Hex)).

13 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.

■ Inverter and CANopen/EtherCAT® Faults

■ Emergency Object (EMCY)

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

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

Emergency error codes are specified for a number of events. Emergency word specification:

Table 19 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 20 Error Codes

Error Code (Hex)	Meaning	Drive Display	INVR:0x0080 Enum Value
0000	No error	No error	0x00
3220	DC bus undervoltage	Uv1	0x02
5200	Control power supply undervoltage	Uv2	0x03
3221	DC bus charging circuit fault	Uv3	0x04
2330	Ground fault	GF	0x06
2220	Over current	oC	0x07
3210	DC bus overvoltage	ov	0x08
4280	Heatsink overheat	oH	0x09
4210	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	Braking transistor fault	rr	0x0F
4410	Internal braking resistor overheat	rH	0x10
5441	External fault 3	EF3	0x11
5442	External fault 4	EF4	0x12
5443	External fault 5	EF5	0x13
5444	External fault 6	EF6	0x14
FF17	Cooling FAN fault	FAn	0x17
7180	Motor over speed (control mode using PG)	oS	0x18
8321	Speed deviation (control mode using PG)	dEv	0x19
7305	PG fault (control mode using PG)	PGo	0x1A
3130	Input phase loss	PF	0x1B
3300	Output phase loss	LF	0x1C
FF01	Motor overheat alarm	oH3	0x1D
5300	Digital operator disconnected	oPr	0x1E
5530	EEPROM error	Err	0x1F
FF08	MEMOBUS/Modbus Error	CE	0x21
FF07	BUS error	bUS	0x22
FF06	Control fault	CF	0x25
5481	Fault input from option card	EF0	0x27
FF02	PID feedback lost	FbL	0x28
FF03	Undertorque detected 1	UL3	0x29
FF04	Undertorque detected 2	UL4	0x2A
FF05	High slip braking OL	oL7	0x2B
FF31	Intermediary voltage fault	VCF	0x31
FF36	Output current imbalance	LF2	0x36
FF3B	Too many speed search restarts	SEr	0x3B
FF41	PID feedback loss	FbH	0x41
FF0D	External fault at input terminal S1	EF1	0x42
FF0E	External fault at input terminal S2	EF2	0x43
FF44	Mechanical weakening detection 1	oL5	0x44
FF45	Mechanical weakening detection 2	UL5	0x45

Error Code (Hex)	Meaning	Drive Display	INVR:0x0080 Enum Value
FF46	Current offset fault	CoF	0x46
FF47	Programming Error 1	PE1	0x47
FF49	Current offset 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 21 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 SI-ES3 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’s digital operator. Causes of the errors and corrective actions are listed in *Table 22* and *Table 8*. For additional error codes, refer to the technical manual for the drive.

The bUS (EtherCAT® Option Communication Error) and EF0 (External Fault Input from the EtherCAT® Option) may appear as an alarm or a fault. If they occur as an alarm, the "ALM" LED on the drive digital operator will blink and the alarm code will flash in the display. When these occur as a fault, the “ALM” LED will light and the display will show the fault code.

If communication stops while the drive is running, check the following items:

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

■ Faults

Table 22 lists possible faults when using a communication option. The drive's fault contact will close if one of these faults occur.

Table 22 Fault Display and Possible Solutions

Digital Operator Display		Fault Name
bUS	bUS	EtherCAT® 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 for faulty wiring. ⇒ Correct any wiring problems.
Communication cable is not connected properly.		
A data error occurred due to noise.		Check the various options available to minimize the effects of noise. ⇒ Take steps to counteract noise in the control circuit wiring, main circuit lines, 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 fulfills the EtherCAT® requirements. Ground the shield on the controller side and on the EtherCAT® Option side.
EtherCAT® Option is damaged.		⇒ If there are no problems with the wiring and the error continues to occur, replace the EtherCAT® Option.

Digital Operator Display		Fault Name
EF0	EF0	External Fault Input from EtherCAT® Option
		The alarm function for an external device has been triggered.
Cause		**Possible Solution**
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 upper controller (PLC) device.
Problem with the upper controller (PLC) program.		⇒ Check the program used by the upper controller (PLC) and make the appropriate corrections.

Digital Operator Display		Fault Name
oFA00	oFA00	EtherCAT® Option Card Fault
		The drive does not support the option board plugged in.
Cause		**Possible Solution**
Non-compatible option connected to the drive.		⇒ Check the drive option board compatibility. Replace the option card if the fault persists even though the drive should support it.

Digital Operator Display		Fault Name
oFA01	oFA01	EtherCAT® Option Card Fault
		Option card is not properly connected.
Cause		**Possible Solution**
Problem with the connectors between the drive and EtherCAT® Option.		⇒ Turn the power off and check the connectors between the drive and EtherCAT® Option.

Digital Operator Display		Fault Name
oFA30 to oFA43	oFA30 to oFA43	EtherCAT® Option Card Fault at Connector CN5-A
		Communication ID error
Cause		**Possible Solution**
Option card hardware fault		⇒ Replace the EtherCAT® Option. Contact Yaskawa for assistance.

■ Option board error management

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

Table 23 Option Board Error Management

OPT Error	Description	INV Error Link	OPT Indication
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 control word.
OP→SAFEOP 1. EtherCAT WD time out	If the EtherCAT watchdog time out is enabled (Default in native XML description file) and output data from PLC to the drive isn't 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 FCS 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: OFx32 2. Drive fault: OFx30	1+2 Actions: a. Disable process data OUT sync manager channel b. Force EtherCAT state change to SAFE_OP

OPT Error	Description	INV Error Link	OPT Indication
OP→SAFEOP 1. Option card FCS 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: OFx32 2. Drive fault: OFx30	1+2 Actions: a. Disable process data IN sync manager channel b. Force EtherCAT state change to SAFE_OP
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: OFx00 Option will log FATAL event record in NVS memory and set ERR LED: solid RED, see *Table 5*	Actions: 1. Check drive firmware version as described in *Figure 6* 2. If drive firmware version is correct, replace option card. 3. 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 5*	• 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 5*	• Replace option card

■ Minor Faults and Alarms

Table 6 lists up alarms that might occur during operation using a communication option board. If a multi function digital output of the drive is programmed for H2-☐☐ = 10, the output will close if these alarms occur.

Digital Operator Display		Minor Fault Name
CALL	CALL	Serial Communication Transmission Error
		Communication has not yet been established.
Cause		**Possible Solution**
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.
Programming error on the master side		⇒ Check communications at start-up and correct programming errors.
Communication circuitry is damaged.		⇒ 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**
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.
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)).

14 Specifications

◆ Specifications

Table 24 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
Humidity	up to 95% RH (no condensation)
Storage Temperature	–20 °C to +60 °C (allowed for short-term transport of the product)
Area of Use	Indoor (free of corrosive gas, airborne particles, etc.)
Altitude	up to 1000 m

◆ Internal Scan Cycle

V1000: 2 ms

◆ Revision History

The revision dates and the numbers of the revised manuals appear on the bottom of the back cover.

MANUAL NO. YEU SIEP C710606 98A

Published in Germany September 2011 11-9

Date of publication

Date of original publication

Date of Publication	Revision Number	Section	Revised Content
September 2011	–	–	First Edition

YASKAWA AC Drive V1000 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: (800) YASKAWA (927-5292) or 1-847-887-7000 Fax: 1-847-887-7310
http://www.yaskawa.com

YASKAWA ELÉTRICO DO BRASIL LTDA.
Avenda Fagundes Filho, 620 Bairro Saude, São Paulo, SP04304-000, Brasil
Phone: 55-11-3585-1100 Fax: 55-11-5581-8795
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 UK LTD.
1 Hunt Hill Orchardton Woods, Cumbernauld, G68 9LF, United Kingdom
Phone: 44-1236-735000 Fax: 44-1236-458182
http://www.yaskawa.co.uk

YASKAWA ELECTRIC KOREA CORPORATION
7F, Doore Bldg. 24, Yeoido-dong, Yeoungdungpo-gu, Seoul, 150-877, Korea
Phone: 82-2-784-7844 Fax: 82-2-784-8495
http://www.yaskawa.co.kr

YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
151 Lorong Chuan, #04-01, New Tech Park, 556741, Singapore
Phone: 65-6282-3003 Fax: 65-6289-3003
http://www.yaskawa.com.sg

YASKAWA ELECTRIC (SHANGHAI) CO., LTD.
No. 18 Xizang Zhong Road, 17F, Harbour Ring Plaza, Shanghai, 200001, China
Phone: 86-21-5385-2200 Fax: 86-21-5385-3299
http://www.yaskawa.com.cn

YASKAWA ELECTRIC (SHANGHAI) 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

YASKAWA EUROPE GMBH

MANUAL NO. YEU SIEP C710606 98A
Published in Germany September 2011 11-9