YASKAWA

YASKAWA AC Drive Option
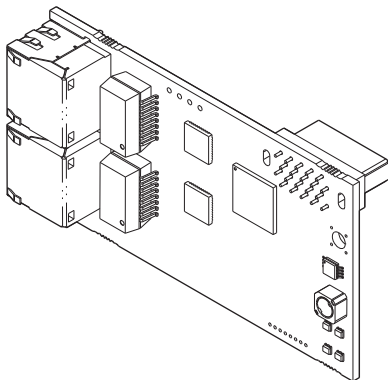# EtherCAT
Installation Manual

Type: SI-ES3

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

安川インバータ オプション
EtherCAT通信
取扱説明書

形式 SI-ES3

製品を安全にお使いいただくために，本書を必ずお読みください。
また，本書をお手元に保管していただくとともに，最終的に本製品をご使用になる
ユーザー様のお手元に確実に届けられるよう，お取り計らい願います。

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Table of Contents

1   Preface and General Precautions

This chapter describes important safety precautions regarding the use of this product. Failure to follow these precautions may result in serious injury or death, and may lead to damage to this product or related devices and systems. Yaskawa shall not be held responsible for any injury or equipment damage as a result of failure to observe the precautions and instructions contained in this manual.

◆ Receiving

This instruction manual contains the information necessary to use the product correctly. Thoroughly read this manual before installing, wiring, operating, or performing maintenance and inspections. Make sure to read and understand the safety information and precautions before using the product.

■ About Terms and Abbreviations in This Document

Representations Used in This Manual	Description
Option	YASKAWA AC Drive Option EtherCAT
Drive	• YASKAWA AC Drive 1000-Series (A1000) • YASKAWA AC Drive GA700 • YASKAWA AC Drive GA800
Keypad	• LCD Operator for YASKAWA AC Drive 1000-Series • LED Operator for YASKAWA AC Drive 1000-Series • LCD Keypad for YASKAWA AC Drive GA700 and GA800 • LED Keypad for YASKAWA AC Drive GA700 and GA800
EtherCAT	Ethernet for Control Automation Technology, an open Ethernet-based network
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 inverter drive
LED	Light Emitting Diode
OPT, Option	The unit described in this document
INV, Inverter	Inverter drive
PCB	Printed Circuit Board
FCS	Frame Check Sequence
INVR	MEMOBUS register number
ESI	EtherCAT Slave Information file

■ **About Registered Trademarks**

• EtherCAT is a registered trademark of Beckhoff Automation GmbH.
• Other company names and product names that appear in this document are trademarks or registered trademarks of the respective companies.

◆ **Supplemental Safety Information**

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

Indicates an equipment damage message.

1 Preface and General Precautions

■ **General Safety**

General Precautions
• The diagrams in this section may include options and drives without covers or safety shields to illustrate details. Be sure to reinstall covers or shields before operating any devices. The option should be used according to the instructions described in this manual. • The diagrams in this manual are provided as examples only and may not pertain to all products covered by this manual. • 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. • Contact Yaskawa or a Yaskawa representative and provide the manual number shown on the front cover to order new copies of the manual.

⚠ DANGER

Heed the safety messages in this manual.

Failure to comply will cause 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.

⚠ WARNING

Electrical Shock Hazard

Do not attempt to modify or alter the drive or drive circuitry in any way not explained in this manual.

Failure to comply could cause death or serious injury and will void warranty. Yaskawa is not responsible for any modification of the product made by the user. Do not modify this product.

NOTICE

Do not modify the drive or option circuitry.

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

Yaskawa is not responsible for any modification of the product made by the user.

Do not expose the drive or the option to halogen group disinfectants. Do not pack the drive or the option in fumigated or sterilized wooden materials. Do not sterilize the entire package after packing the product.

Failure to comply could damage electrical components in the option.

2   Overview

The EtherCAT Communication Option (Model: SI-ES3) is an option card designed to connect the YASKAWA inverter drives to an EtherCAT network. Using this option card and an EtherCAT master you can:

• Operate the inverter drive
• Monitor the inverter drive operation status
• Read or modify inverter drive parameters.

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

◆   **Compatible Products**

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

Table 1 Compatible Products

Product Series	Model(s)	Software Version *<1>*
A1000	CIMR-A□2A□□□□	≥1017
	CIMR-A□4A0002 to 4A0675	≥1017
	CIMR-A□4A0930 and 4A1200	≥3015
	CIMR-A□5A□□□□	≥5045 ≥1017
GA700 *<2>*	CIPR-GA70□□□□□	≥1010
GA800 *<2>*	CIPR-GA80□□□□□	≥9010

<1> Refer to "PRG" on the drive nameplate for the software version number.
<2> Before you install the option on a YASKAWA AC Drive GA700 or GA800, make sure that the option software version is PRG: 2.01 or later.

   Note: Refer to the option package labeling in the field designated "PRG" (four digit number)" or the option nameplate designated "V: option software version" to identify the option software version.

3   Receiving

This instruction manual contains the information necessary to use the product correctly. Thoroughly read this manual before installing, wiring, operating, or performing maintenance and inspections. Make sure to read and understand the safety information and precautions before using the product.
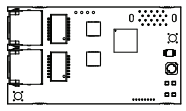
◆ Receiving the Option Card

Please perform the following tasks after receiving the Communication Option card:

- Inspect the Communication Option card for damage. If the Communication Option card appears damaged upon receipt, contact the shipper immediately.
- Verify receipt of the correct model by checking the information:
  Find the model number on the nameplate on the PCB.
- If you have received the wrong option card model or the Communication Option card does not function properly, contact Yaskawa or a Yaskawa representative.

◆ Content and Packaging

Table 2 Option Package Contents for Inverter Drives

Description	Option Card	Ground Cables <1>	Screws (M3)	LED Labels		Installation Manual
				1000-Series	GA700 and GA800	
Illustration				L/A IN ⚪⚪ RUN L/A OUT ⚪⚪ ERR	RUN ERR ⚪⚪ ⚪⚪ L/A IN L/A OUT	MANUAL
Quantity	1	1	3 <2>	1	1	1

<1> GA700 and GA800 drives does not use the ground wire.
<2> GA700 and GA800 drives uses two screws only.

◆ Tools Required

A Phillips screwdriver PH1 (#1) or PH2 (#2) is required to install the Communication Option card.

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

4   EtherCAT Option Components

◆ EtherCAT Option
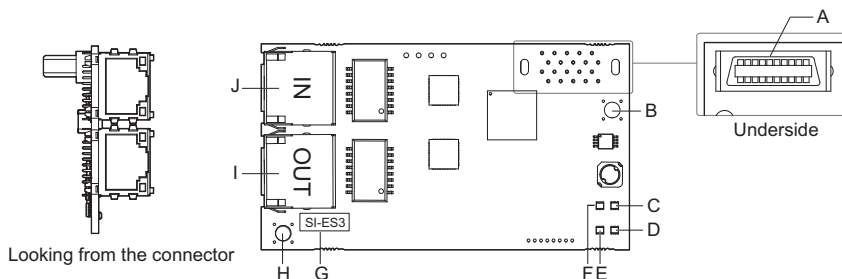
A – Connector (CN5)

B – Installation hole

C – LED (RUN) *<1>*

D – LED (ERR)

E – LED (L/A OUT) *<1>*

F – LED (L/A IN) *<1>*

G – Model number

H – Ground terminal
(installation hole) *<2>*

I – Communication cable
connector OUT (JP3)

J – Communication cable
connector IN (JP2)

<1> *Refer to EtherCAT Option Status LEDs on page 11* for details on the LEDs.
<2> Connect the provided ground wire during installation. Installation on GA700 and GA800 drives does not require the ground wire.

Figure 2 Option Card

◆ EtherCAT Option Status LEDs

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

■ LED Location

1000-Series Label   GA700 and GA800 Label

Figure 3 LED Location

■ 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.

LED	Color	Display	Meaning
L/A OUT, L/A IN	–	Off	No link. The communication cable is not physically connected. The communication controller is not started up.
	Green	On	The module is connected to Ethernet. A communication cable is physically connected, but no data is being exchanged.
	Green	Flickering	There is traffic on Ethernet, data is being exchanged.

■ RUN LED

A green lit RUN LED indicates the status of the communication network state machine.
A red lit RUN LED is only used by the NOID firmware loader.

LED	Color	Display	Meaning
RUN	–	Off	The device is in Init state.
	Green	Blinking	The device is in Pre-Operational State.
	Green	Single Flash	The device is in Safe-Operational State.
	Green	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 LED

The red error LED indicates the presence of any errors.

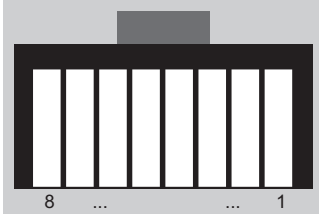| LED	Color	Display	Meaning
ERR	–	Off	No link. The communication option card is in working condition.
	Red	Blinking	General configuration error.
	Red	Single Flash	The slave device application has changed the communication state autonomously: The parameter "Change" in the AL status register is set to 01 (Hex): change/error.
	Red	Double Flash	The sync manager watchdog time out has occurred.
	Red	On	Possible causes: 1: A 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 the technical manual for this option. for the cause).
	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 drive) 6 Hz: Firmware loader protocol is processing commands

◼ **Indicator Flash Rates**
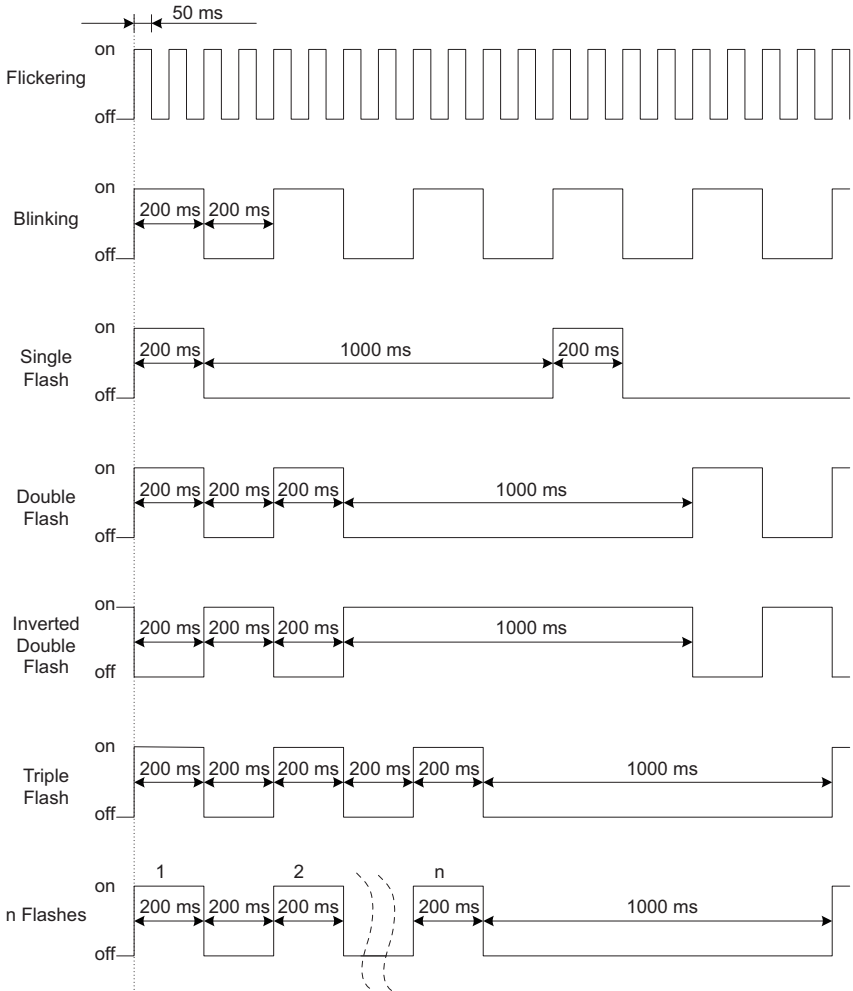
Figure 4 Meaning of LED Flash Rates

◆ Communication Connector

The Communication Option card is connected to the network using a RJ45 connector.

Table 3 Pin Assignment of RJ45 Communication Connector

EtherCAT Connector	Pin	Signal	Description
	1	TD+	Send data
	2	TD-	Send data
	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

■ Communication Cable

YASKAWA recommends using EtherCAT dedicated Cat5e or better communication cables.

■ Network Termination

If the drive is the last node in the network, network termination is automatically realized by the ASIC of the Communication Option card.

5   Mechanical & Electrical Installation

◆ Safety Precautions

⚠ **DANGER**

Electrical Shock Hazard

Do not inspect, connect, or disconnect any wiring while the drive is energized.

Failure to comply will cause death or serious injury.

Before servicing, disconnect all power to the equipment and wait for at least the time specified on the warning label. The internal capacitor remains charged even after the drive is de-energized. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. When all indicators are OFF, measure for unsafe voltages to confirm the drive is safe.

⚠ **WARNING**

Electrical Shock Hazard

Do not operate equipment with covers removed.

Failure to comply could cause death or serious injury.

The diagrams in this section may include options and drives without covers or safety shields to illustrate details. Reinstall covers and shields before operating the drive and run the drive according to the instructions described in this manual.

Do not allow unqualified personnel to perform work on the drive or option.

Failure to comply could cause death or serious injury.

Only authorized personnel familiar with installation, adjustment, and maintenance of AC drives and options may perform work.

Do not remove covers or touch circuit boards while the drive is energized.

Failure to comply could cause death or serious injury.

⚠ WARNING

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

Failure to comply could cause death or serious injury.

Fire Hazard

Tighten all terminal screws to the specified tightening torque.

Loose or overtightened connections could cause erroneous operation and damage to the terminal block or start a fire and cause death or serious injury.

NOTICE

Damage to Equipment

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

Failure to comply could cause ESD damage to circuitry.

Never connect or disconnect the motor from the drive while the drive is outputting voltage.

Improper equipment sequencing could damage the drive.

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

Failure to comply could further damage the equipment.

Do not use unshielded wire 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 on the option and drive.

Failure to comply could prevent proper operation and damage equipment.

Confirm that all connections are correct after installing the option and connecting peripheral devices.

Failure to comply could damage the option.

◆ Procedures for Installing and Wiring Options on a Drive

Procedures for installing and wiring options differ depending on the drive model.

Refer to *Table 4* to check the procedures for installing and wiring options on a drive.

Table 4 Procedures for Installing and Wiring Options on a Drive

Product Series	Procedures for Installing and Wiring Options on a Drive	Page
A1000	Procedure A	*18*
GA700	Procedure B	*24*
GA800	Procedure B	*24*

■ Procedure A

This section shows the procedure to install and wire the option on a 1000-series drive.

Prepare the Drive for the Option
1. Correctly wire the drive as specified by the manual packaged with the drive.
2. Make sure that the drive functions correctly.
   Refer to *Figure 5* for an exploded view of the drive with the option and related components for reference in the installation procedure.
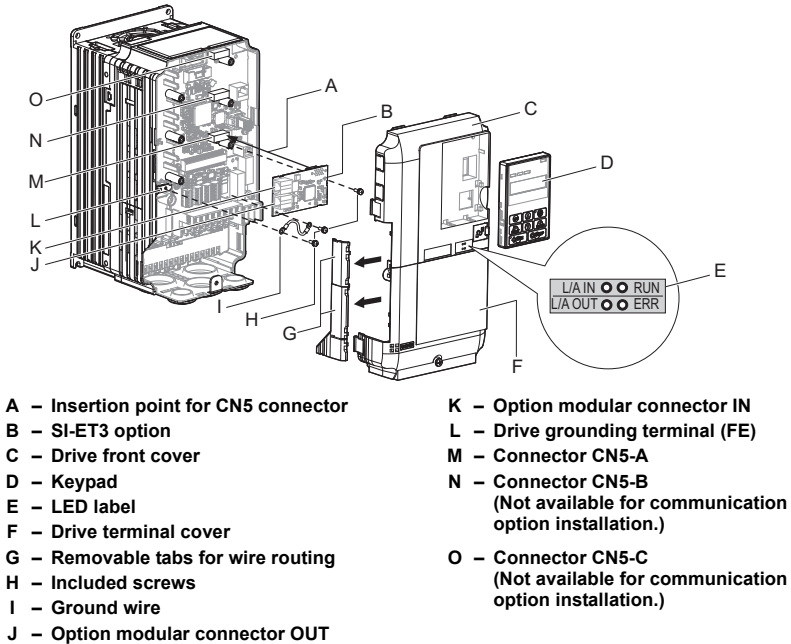

A	– **Insertion point for CN5 connector**	**K**	– **Option modular connector IN**
B	– **SI-ET3 option**	**L**	– **Drive grounding terminal (FE)**
C	– **Drive front cover**	**M**	– **Connector CN5-A**
D	– **Keypad**	**N**	– **Connector CN5-B**
E	– **LED label**		**(Not available for communication option installation.)**
F	– **Drive terminal cover**		
G	– **Removable tabs for wire routing**	**O**	– **Connector CN5-C**
H	– **Included screws**		**(Not available for communication option installation.)**
I	– **Ground wire**		
J	– **Option modular connector OUT**		

Figure 5 Drive Components with Option

Install the Option

Remove the front covers of the drive before you install the option.
Refer to the drive manual for information about how to remove the front covers. Different drive sizes have different cover removal procedures.
You can only install this option into the **CN5-A** connector on the drive control board.

DANGER! *Electrical Shock Hazard. Do not inspect, connect, or disconnect any wiring while the drive is energized. Failure to comply will cause death or serious injury. Before servicing, disconnect all power to the equipment and wait for at least the time specified on the warning label. The internal capacitor remains charged even after the drive is de-energized. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. When all indicators are OFF, measure for unsafe voltages to confirm the drive is safe.*

1. Shut off power to the drive, wait the appropriate amount of time for voltage to dissipate, then remove the keypad (D) and front covers (C, F).
Refer to the manual packaged with the drive for details on keypad and cover removal.

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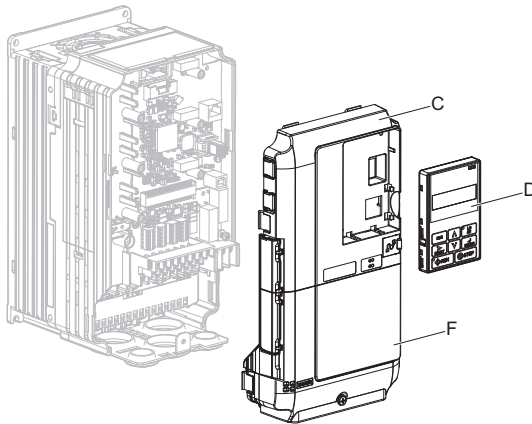

Figure 6 Remove the keypad, Front Cover, and Terminal Cover

2. Affix the LED label (E) in the appropriate position on the drive front cover (C).

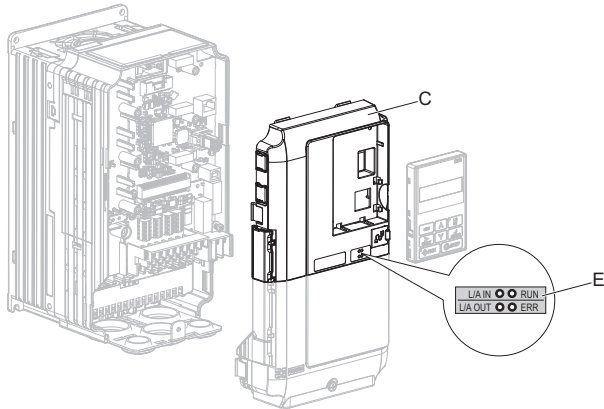L/A IN ◯◯ RUN
L/A OUT ◯◯ ERR

Figure 7 Affix the LED Label

3. Insert the option card (B) into the CN5-A (M) connector on the drive and fasten it into place using one of the included screws (H). Tighten the screw to 0.5 to 0.6 N·m (4.4 to 5.3 in·lb).
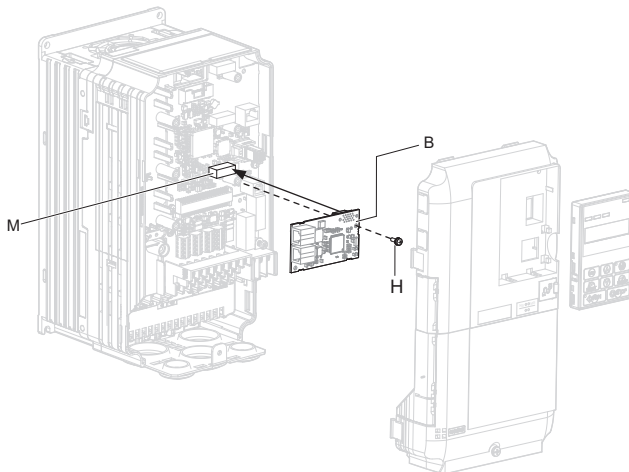

Figure 8 Insert the Option

4. Connect one end of the ground wire (I) to the ground terminal (L) using one of the remaining provided screws (H). Connect the other end of the ground wire (I) to the remaining ground terminal and installation hole on the option (B) using the last remaining provided screw (H). Tighten both screws to 0.5 to 0.6 N·m (4.4 to 5.3 in·lb).
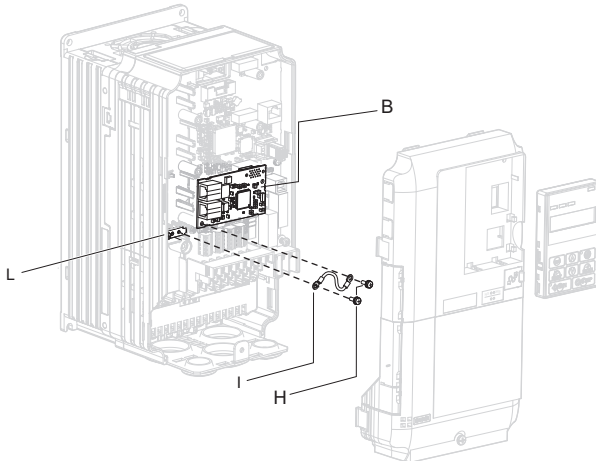
Figure 9 Connect the Ground Wire

Note: The drive has only two ground terminal screw holes (I). Two ground wires should share the same ground terminal when connecting three options.

5. Select the proper EtherCAT dedicated communication cable.

Route the option wiring inside the enclosure as shown in *Figure 10*-B. Take proper precautions so that the front covers will easily fit back onto the drive.
Users may also choose to route the option wiring through openings on the front cover of some models. Remove the perforated tabs on the left side of the front cover as shown in *Figure 10*-A to create the necessary openings on these models.
Refer to the Peripheral Devices & Options section of the drive instruction manual for more information.

Note: Separate communication cables from main circuit wiring and other electrical lines to avoid potential sources of electrical interference.
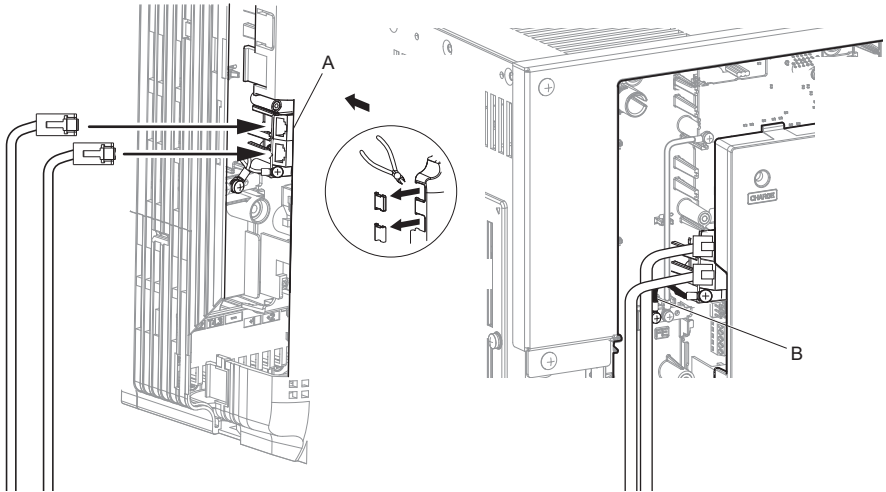
A – Route wires through the openings provided on the left side of the front cover. *<1>*	B – Use the open space provided inside the drive to route option wiring.

<1> The drive will not meet Enclosed wall-mounted type (IP20/UL Type 1) requirements if wiring is exposed outside the enclosure.

Figure 10 Wire Routing Examples

6. Firmly connect the EtherCAT communication cable to option communication connector IN and OUT.
Install EtherCAT communications cables apart from main-circuit wiring and other electrical and power lines. Ensure the cable end is firmly connected (see *Figure 18*).

7. Reattach the drive front covers (C, F) and the keypad (D).

NOTICE: *Do not pinch cables between the front covers and the drive. Failure to comply could cause erroneous operation.*
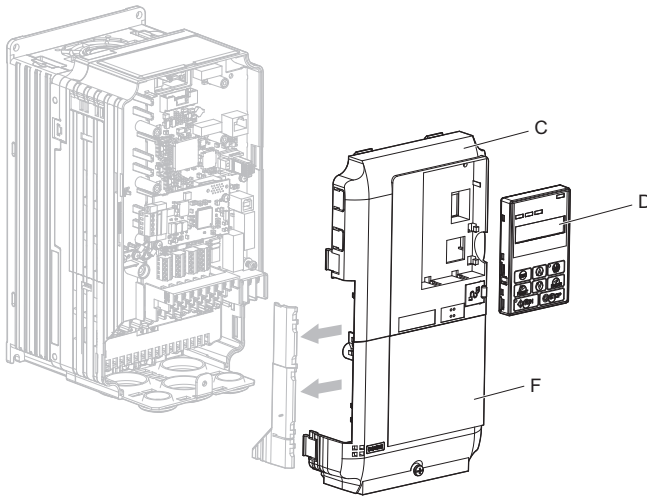

Figure 11 Replace the Front Covers and Keypad

8. Set drive parameters in *Table 5* for correct option performance.

■ Procedure B

This section shows the procedure to install and wire the option on a GA700 or GA800 drive.

Prepare the Drive for the Option

Before you install the option on a YASKAWA AC Drive GA700 or GA800, make sure that the option software version is PRG: 2.01 or later.

1. Correctly wire the drive as specified by the manual packaged with the drive.
2. Make sure that the drive functions correctly.
   Refer to *Figure 12* for an exploded view of the drive with the option and related components for reference in the installation procedure.
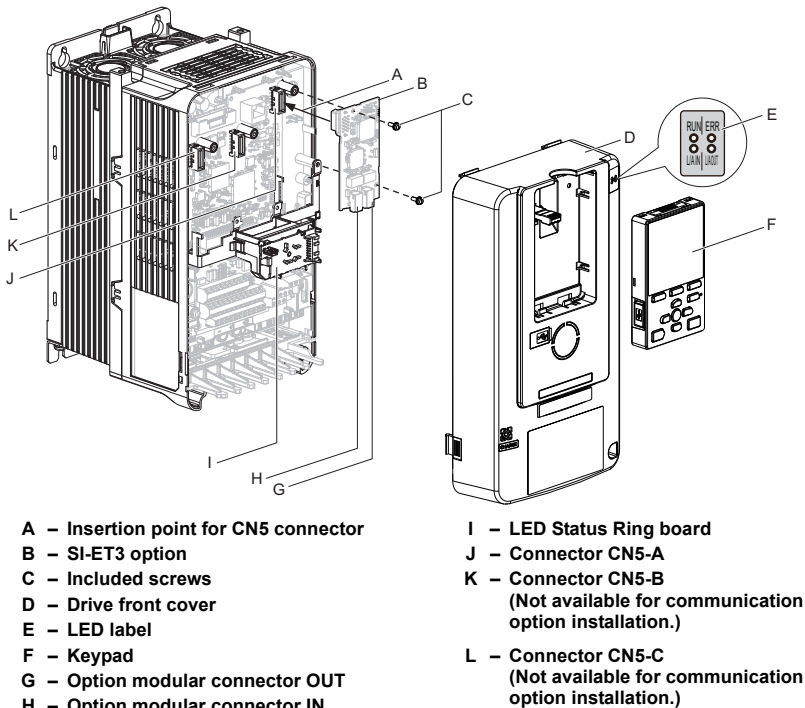

A – Insertion point for CN5 connector		**I** – LED Status Ring board	
B – SI-ET3 option		**J** – Connector CN5-A	
C – Included screws		**K** – Connector CN5-B	
D – Drive front cover		(Not available for communication option installation.)	
E – LED label		**L** – Connector CN5-C	
F – Keypad		(Not available for communication option installation.)	
G – Option modular connector OUT			
H – Option modular connector IN			

Figure 12 Drive Components with Option

Install the Option

Remove the front cover of the drive before you install the option.
Refer to the drive manual for information about how to remove the front cover. Different drive sizes have different cover removal procedures.
You can only install this option into the CN5-A connector on the drive control board.

DANGER! *Electrical Shock Hazard. Do not inspect, connect, or disconnect any wiring while the drive is energized. Failure to comply will cause death or serious injury. Before servicing, disconnect all power to the equipment and wait for at least the time specified on the warning label. The internal capacitor remains charged even after the drive is de-energized. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. When all indicators are OFF, measure for unsafe voltages to confirm the drive is safe.*

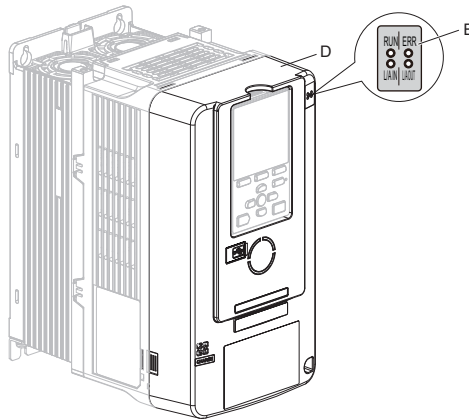**1.** Affix the LED label (E) in the appropriate position on the drive front cover (D).

Figure 13 Affix the LED Label

2. Shut off power to the drive, wait the appropriate amount of time for voltage to dissipate, then remove the front cover (D).
Refer to the manual packaged with the drive for details on cover removal.

NOTICE: *Damage to Equipment. Observe proper electrostatic discharge (ESD) procedures when handling the option, drive, and circuit boards. Failure to comply could cause ESD damage to circuitry.*
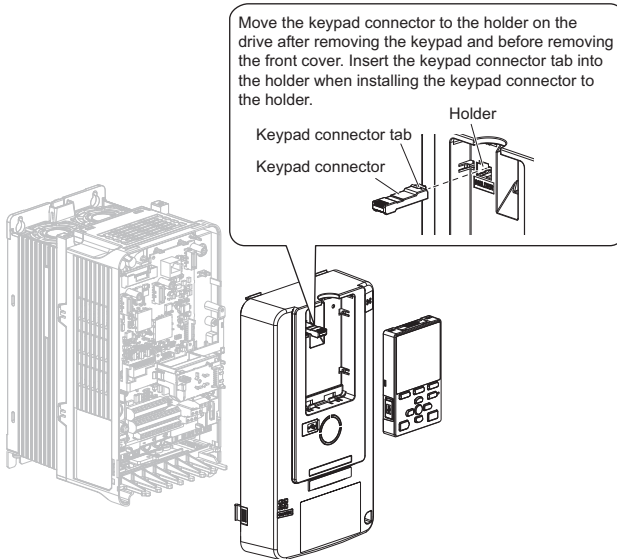
Move the keypad connector to the holder on the drive after removing the keypad and before removing the front cover. Insert the keypad connector tab into the holder when installing the keypad connector to the holder.

Holder

Keypad connector tab

Keypad connector

Figure 14 Remove the Front Cover and Keypad

3. Carefully remove the LED Status Ring board (I) and place it on the right side of the drive using the temporary placement holes.
Refer to the manual packaged with the drive for details on removing the LED Status Ring board.

NOTICE: *Do not remove the LED Status Ring board cable connector. Failure to comply could cause erroneous operation and damage the drive.*
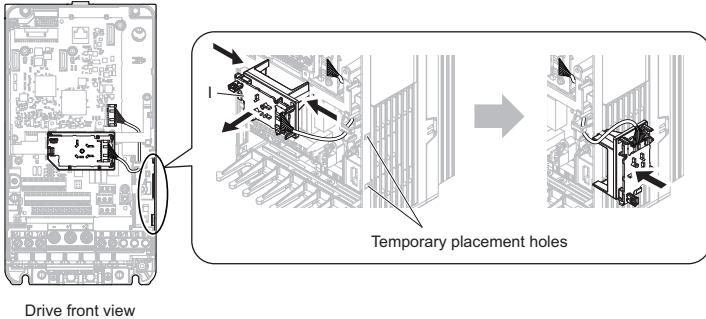
Drive front view

Figure 15 Remove the LED Status Ring Board

4. Insert the option card (B) into the CN5-A connector (J) on the drive and fasten it into place using the included screws (C). Tighten both screws to 0.5 to 0.6 N·m (4.4 to 5.3 in·lb).

Note: Installing the option card on GA700 and GA800 drives requires only two screws and does not require a ground wire. The option package ships with three screws and a ground wire for installation on other product series.
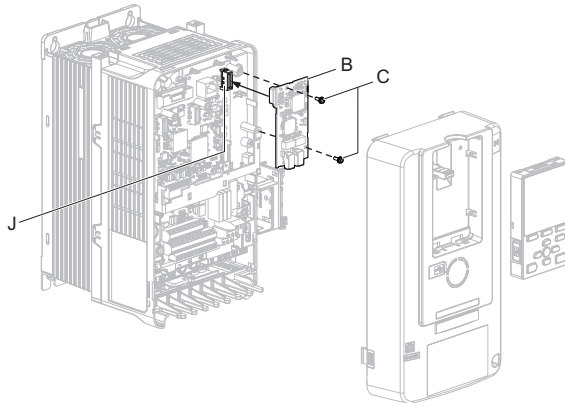

Figure 16 Insert the Option Card

5. Select the proper EtherCAT dedicated communication cable.
Firmly connect the EtherCAT communication cable to option communication connector IN and OUT.
Install EtherCAT communications cables apart from main-circuit wiring and other electrical and power lines. Ensure the cable end is firmly connected (see *Figure 18*).

6. Reattach the LED Status Ring board (I).
Use the open space provided inside the LED Status Ring board to route option wiring.

NOTICE: *Do not pinch cables between the front cover or the LED Status Ring board and the drive. Failure to comply could cause erroneous operation.*

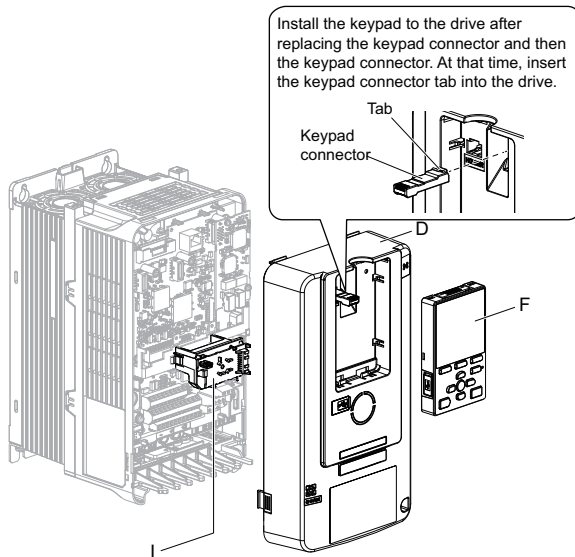**7.** Reattach the drive front cover (D) and the keypad (F).

Install the keypad to the drive after replacing the keypad connector and then the keypad connector. At that time, insert the keypad connector tab into the drive.

Tab

Keypad connector

Figure 17 Replace the Front Cover and Keypad
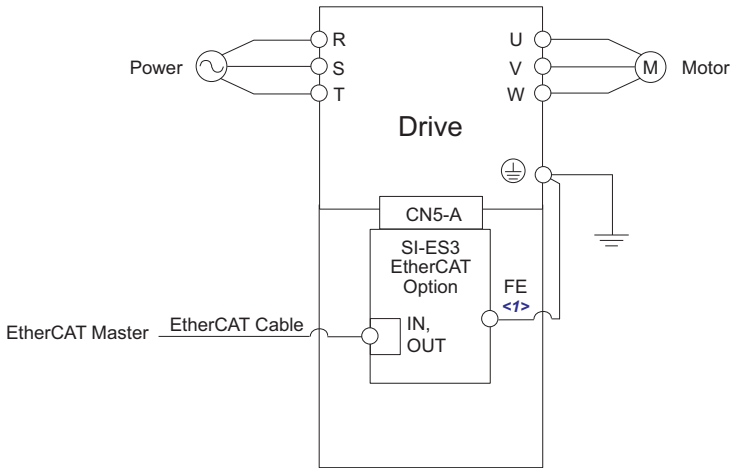
8. Set drive parameters in *Table 5* for correct option performance.

◆ EtherCAT Communications Cables

Connect the EtherCAT communication cable to option communication connector IN and OUT.

YASKAWA recommends using EtherCAT dedicated Cat5e or better communication cables.

■ Option Connection Diagram

<1> Connect the provided ground wire for installations on 1000-series drives.
The ground wire is not necessary for installation on GA700 or GA800 drives.

Figure 18 Option Connection Diagram

◆ ESI File

For easy network implementation of drives equipped with a Communication Option card, the ESI file can be obtained from these sources:

U.S.: http://www.yaskawa.com
Europe: http://www.yaskawa.eu.com
Japan: http://www.e-mechatronics.com
Other areas: Check the back cover of these manuals.
For questions, contact Yaskawa or a Yaskawa representative.

6 EtherCAT Option Related Drive Parameters

The drive parameters listed in page *Table 5* have influence on some functions of the communication option card. Check these parameters before starting network communications.

Table 5 Parameter Settings

No.	Name	Description	Default
b1-01 *<1>*	Frequency Reference Selection	Selects the frequency reference input source. 0: Keypad - 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)	*<2>*
b1-02 *<1>*	Run Command Selection	Selects the run command input source. 0: Keypad - RUN and STOP keys 1: Digital input terminals Sx 2: MEMOBUS/Modbus communications 3: Option card	1
E2-04 *<3>*	Motor 1 Motor Poles	Set the number of motor poles described on the motor nameplate. Relevant for DSP402. YASKAWA AC Drive 1000-Series: 2 to 48 YASKAWA AC Drive GA700, GA800: 2 to 120	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 *<4>* 4: Alarm-Run at d1-04 *<4> <5>* 5: Alarm-Ramp to Stop *<5>*	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 *<4>*	1
F6-06 *<6> <7>*	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. *<8>*	0

No.	Name	Description	Default
F6-07	NetRef/ComRef Selection Function	0: Multi-step speed reference disabled 1: Multi-step speed reference allowed	Default: 0 Range: 0, 1
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-xx and F7-xx parameters when the drive is initialized using parameter A1-03. 1: Reset F6-xx and F7-xx 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-xx and F7-xx) are also reset when A1-03 is used to initialize the drive.	0
o1-03 *<9>*	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). Relevant for DSP402. 3: User defined by parameters o1-10 and o1-11	*<2>*

<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> The default value depends on the drive used and/or the drive software version. For details refer to the technical manual for the drive.

<3> E2-04 is necessary to set up when the Drive Profile DSP402 objects are used. Also refer to *<9>*.

<4> If set to 3 or 4, then the drive will continue to operate when an EF0 fault is detected. Take proper safety measures, such as installing an emergency stop switch.

<5> Refer to the drive manual to know if settings 4 and 5 are available. Settings 4 and 5 are available in A1000 software versions PRG: 1021 and later.

<6> 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.

<7> Control method availability of this parameter depends on product series.
•1000-Series Drives: Parameter is available in CLV, AOLV/PM, and CLV/PM.
In AOLV/PM, this value is read as the Torque Limit.
•GA700, GA800 Drives: Parameter is available in OLV, CLV, AOLV, AOLV/PM, CLV/PM, and EZOLV.
In OLV and EZOLV, this value is read as the Torque Limit.

<8> 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.

<9> 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.

7   Supported Modes of Operation

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

To reset a mode, a power cycle is necessary.

> **Note:**   If an object of the range 6xxx is used, the DSP402 mode is used.

8   Object Dictionary

◆ Object Dictionary Overview

The Object Dictionary consists of the following sections:

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

■ Communication Profile Objects (DS301)

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

■ Manufacturer Specific Profile Object (DS301)
Table 6 Input Objects

Index (Hex)	Name
2000	Operation Command
2010	Speed Reference/Speed Limit
2020	Torque Reference/Torque Limit
2030	Torque Compensation
2040	MEMOBUS/Modbus Read Request
2050	MEMOBUS/Modbus Write Request
2051	Advanced MEMOBUS/Modbus Write Request
2060	MEMOBUS/Modbus Unlimited Enter Command

Index (Hex)	Name
2061	MEMOBUS/Modbus Unlimited ENTER Command 2
2070	MEMOBUS/Modbus Limited Enter Command
2071	MEMOBUS/Modbus Limited Enter Command 2
2080	Selectable (default: none)
2090	Selectable (default: none)
20A0	Selectable (default: none)
20B0	Selectable (default: none)
20C0	Selectable (default: none)
20D0	FM analog output 1
20E0	AM analog output 2
20F0	Multi-function DO output
3000	Selectable (default: none)
3100	Selectable (default: none)

Table 7 Output Objects

Index (Hex)	Name
2100	Drive Status
2110	Output Frequency
2120	Output Current
2130	Output Torque Reference
2140	MEMOBUS/Modbus Read Response
2150	MEMOBUS/Modbus Write Response
2151	Advanced MEMOBUS/Modbus Write Response
2155	PDO Parameter Write Response
2160	MEMOBUS/Modbus Not Limited Enter Command Response
2180	Selectable (default: Input terminal status)
2190	Selectable (default: Analog input 1 monitor)
21A0	Selectable (default: none)
21B0	Selectable (default: none)
21C0	Selectable (default: none)
21E0	Selectable (default: none)
21F0	Selectable (default: none)
2200	Motor Speed
2210	DC Bus Voltage
2220	Analog input monitor A1
2240	Analog input monitor A2

Index (Hex)	Name
2260	Analog input monitor A3
2270	Inverter DI Input
2301	Error Register
2318	Drive Information
4000	Option NVS FATAL Record
4001	Option Info + Status Record
4010	Store Parameters
4011	Restore Default Parameters

■ Drives and Motion Specific Profile Object (DS402)

Table 8 Common Entries

Index (Hex)	Name
60FD	Digital Inputs
60FE	Digital Outputs
6502	Supported Drive Modes

Table 9 Device Control

Index (Hex)	Name
6040	Control Word
6041	Status Word
6060	Modes of Operation
6061	Modes of Operation Display

Table 10 Velocity Mode

Index (Hex)	Name
6042	vl target velocity
6043	vl velocity demand
6044	vl control effort
6046	vl velocity min max amount
6048	vl velocity acceleration
6049	vl velocity deceleration
604A	vl velocity quick stop
604C	vl dimension factor
604D	vl pole number

9   Process Data Objects (PDO)

◆ PDOs and Default PDO Setup

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 Communication Option card supports at least 8 parameters mapped to RxPDO and 8 parameters mapped to TxPDO.

The drive supports 15 Receive and 16 Transmit PDOs. The following tables 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 1A00 (Hex) - 1A28 (Hex). *Refer to Communication Profile Objects (DS301) on page 33*.

Table 11 Transmit PDO Mapping

PDO Number	Mapped Objects (Hex)	Index (Hex)
1	Sub-index 1: 6041:0, 2-bytes (DSP402 status word)	1A00
2	Sub-index 1: 6041:0, 2-bytes (DSP402 status word) Sub-index 2: 6061:0, 2-bytes (DSP402 Modes of operation display)	1A01
6	Sub-index 1: 6041:0, 2-bytes (DSP402 status word) Sub-index 2: 6044:0, 2-bytes (vl control effort)	1A05
7	Sub-index 1: 6041:0, 2-bytes (DSP402 status word) Sub-index 2: 60FD:0, 4-bytes (Digital inputs)	1A06
21	Sub-index 1: 6042:0, 2-bytes (vl target velocity)	1A14
22	Sub-index 1: 6043:0, 2-bytes (vl velocity demand)	1A15
23	Sub-index 1: 6048:1, 4-bytes (vl Accel delta speed) Sub-index 2: 6048:2, 2-bytes (vl Accel delta time)	1A16
24	Sub-index 1: 6049:1, 4-bytes (vl Decel delta speed) Sub-index 2: 6049:2, 2-bytes (vl Decel delta time)	1A17
25	Sub-index 1: 604A:1, 4-bytes (vl quick-stop delta speed) Sub-index 2: 604A:2, 2-bytes (vl quick-stop delta time)	1A18
26	Sub-index 1: 604C:1, 4-bytes (vl Dimension factor) Sub-index 2: 604C:2, 4-bytes (vl Dimension factor)	1A19
36	Sub-index 1: 2100:1, 2-bytes (Drive status)	1A23
37	Sub-index 1: 2110:1, 2-bytes (Output frequency)	1A24
38	Sub-index 1: 2120:1, 2-bytes (Output current)	1A25
39	Sub-index 1: 2130:1, 2-bytes (Output torque reference)	1A26
40	Sub-index 1: 2140:1, 2-bytes (MEMOBUS/Modbus read response)	1A27
41	Sub-index 1: 2150:1, 2-bytes (MEMOBUS/Modbus write response)	1A28
42	Sub-index 1: 6041:0, 2-bytes (DSP402 status word) Sub-index 2: 6061:0, 1-byte (DSP402 Modes of operation display) Sub-index 3: 6044:0, 2-bytes (DSP402 vl velocity actual value) Sub-index 4: 60FD:0, 4-bytes (DSP402 Digital inputs) Sub-index 5: 6042:0, 2-bytes (DSP402 vl target velocity) Sub-index 6: 6043:0, 2-bytes (DSP402 vl velocity demand)	1A29
81	Sub-index 1: 2100:1, 2-bytes (Drive status) Sub-index 2: 5001:0, 2-bytes (Input voltage) Sub-index 3: 5003:0, 2-bytes (AC power) Sub-index 4: 2210:1, 2-bytes (DC bus voltage)	1A50

◆ 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 1600 (Hex) - 1628 (Hex). *Refer to Communication Profile Objects (DS301) on page 33*.

Table 12 Receive PDO Mapping

PDO Number	Mapped Objects (Hex)	Index (Hex)
1	Sub-index 1: 6040:0, 2-bytes (DSP402 control word)	1600
2	Sub-index 1: 6040:0, 2-bytes (DSP402 control word) Sub-index 2: 6060:0, 1-bytes, (DSP402 Modes of operation)	1601
6	Sub-index 1: 6040:0, 2-bytes (DSP402 control word) Sub-index 2: 6042:0, 2-bytes, (Vl target velocity)	1605
7	Sub-index 1: 6040:0, 2-bytes (DSP402 control word) Sub-index 2: 60FE:1, 4-bytes, (Physical digital outputs)	1606
8	Sub-index 1: 6040:0, 2-bytes (DSP402 control word) Sub-index 2: 6060:0, 1-bytes, (DSP402 Modes of operation)	1607
21	Sub-index 1: 6048:1, 4-bytes (Vl Accel delta speed) Sub-index 2: 6048:2, 2-bytes, (Vl Accel delta time)	1614
22	Sub-index 1: 6049:1, 4-bytes (Vl Decel delta speed) Sub-index 2: 6049:2, 2-bytes, (Vl Decel delta time)	1615
23	Sub-index 1: 604A:1, 4-bytes (Vl quick-stop delta speed) Sub-index 2: 604A:2, 2-bytes, (Vl quick-stop delta time)	1616
24	Sub-index 1: 604C:1, 4-bytes (Vl Dimension factor) Sub-index 2: 604C:2, 4-bytes, (Vl Dimension factor)	1617
36	Sub-index 1: 2000:1, 2-bytes (Operation command)	1623
37	Sub-index 1: 2010:1, 2-bytes (Speed reference/limit)	1624
38	Sub-index 1: 2020:1, 2-bytes (Torque reference/limit)	1625
39	Sub-index 1: 2030:1, 2-bytes (Torque compensation)	1626
40	Sub-index 1: 2040:1, 4-bytes (MEMOBUS read request)	1627
41	Sub-index 1: 2050:1, 4-bytes (MEMOBUS write request)	1628

10 Examples

## ◆ Example Project with SPEED7 Studio

The following example shows how to make the YASKAWA EtherCAT communication option card available in a SPEED7 Studio project.

> **Note:** The graphics were created using SPEED7 Studio version 2016 [clarify]. In other versions, the software user interface may vary.

■ Procedure

1. Click **Extra > Install device description file (EtherCAT ESI)** to import the device description file for the communication option card.
2. In the projecting view, right-click the **EC-Mastersystem (100)** and select **Add new device...**.
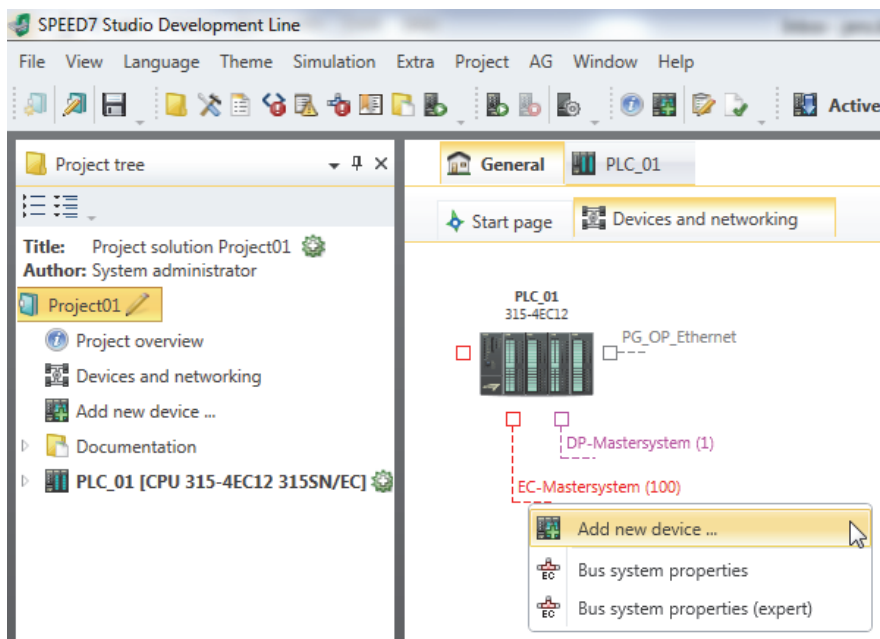
3. In the dialog box, select **ESI** on the left pane.
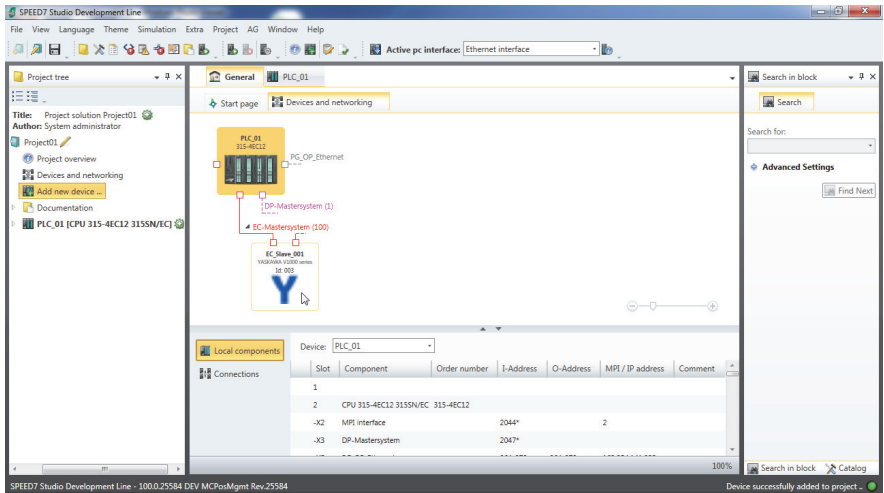
4. Navigate to **Vendor > Yaskawa Electric Corporation > Drives** and select your inverter drive.
Confirm with **OK**.

■ **Result**

After following the procedure, the YASKAWA inverter drive is ready for further use.

◆ Example Project with TwinCAT System Manager

The following example shows how to make the YASKAWA EtherCAT communication option card available in a Beckhoff TwinCAT System Manager.

Note: The graphics were created using TwinCAT System Manager version 2.11. In other versions, the software user interface may vary.

■ Procedure

1. Click **Action > Import XML Description...** to import the device description file for the communication option card.
2. In the project tree, right-click **I/O Devices** in the **I/O - Configuration** node and select **Scan Devices....**
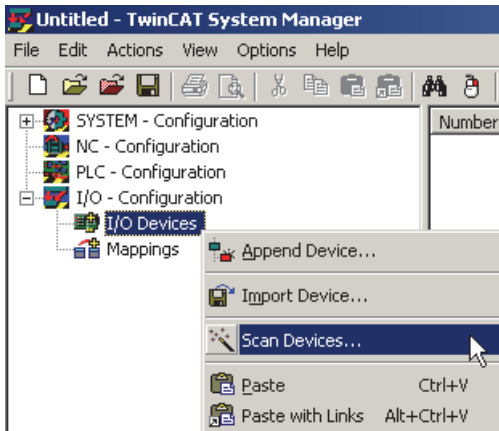
3. Make sure the EtherCAT device (line two in the graphic) is selected and confirm with **OK**.
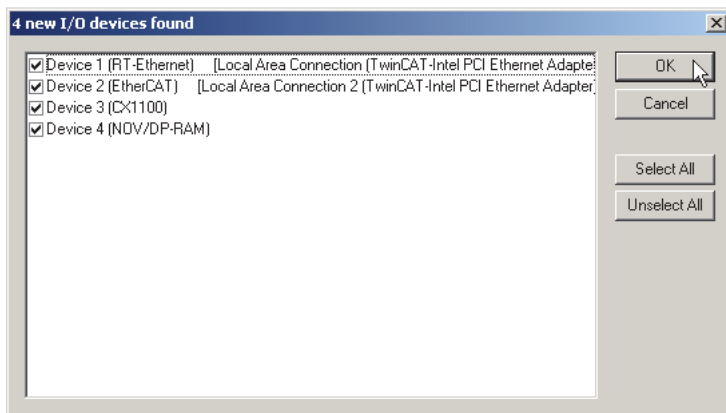
4. TwinCAT System Manager will ask you to scan for boxes. Select Yes.

■ **Result**

After following the procedure, the YASKAWA inverter drive is ready for further use.

11   Troubleshooting

◆ Fault

This section explains the causes and possible solutions when a fault occurs. The drive will remain inoperable until the fault is cleared using the Fault Reset operation. Remove the cause of the fault referring to the following table.

Code	Name	Causes	Possible Solutions
bUS	Option Communication Error	No signal was received from the controller.	Correct any wiring errors.
		The communications cable wiring is incorrect.	
		There is a short circuit or disconnection in the communications cable.	• Repair disconnected cables and short circuits for proper wiring. • Replace a faulty communications cable with a normal one.
		Communication data error occurred due to noise.	• Check the control circuit lines, main circuit lines, and ground wiring, and minimize the effects of noise. • Check whether an electromagnetic contactor is the noise source, and use Surge Protective Device if necessary. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate all communication wiring from drive power lines, and install a noise filter to the input side of the power supply for communication. • Minimize the effects of controller noise.
		The option card is not properly connected to the drive.	Mount the option card to the drive correctly.
		The option card is damaged.	Replace the option card if the error continues to occur even though the wiring is correct.
EF0	Option Card External Fault	The communication option card received an external fault from the controller.	1. Identify the device that triggered the external faults and remove the cause. 2. Clear the external fault input from the controller.
		Programming error occurred on the controller side.	Check the operation of the controller program.
oFA00	Not supported	An option card that is not compatible with the CN5-A connector was connected.	Connect the option card to the correct connector. **Note:** The PG option card could not be connected to the CN5-A connector.

11 Troubleshooting

Code	Name	Causes	Possible Solutions
oFA01	Connection Error	The option card connected to the CN5- A connector was changed during operation.	1. De-energize the drive. 2. Properly connect the option card to the connector on the drive, referring to the manual for the option card.
oFA03, oFA04	Option Card Error (CN5-A)	A fault occurred in the option.	1. De-energize the drive. 2. Make sure that the option is correctly connected to the connector. 3. If the problem continues, replace the option.
oFA30 to oFA43	Communication Option Card Connection Error (CN5-A)	A fault occurred in the option card.	1. De-energize the drive. 2. Check whether the option card is connected securely to the connector. 3. If the problem continues, replace the option card.
oFb00	Not supported	An option card that is not compatible with the CN5-B connector was connected.	Connect the option card to the correct connector. **Note:** The option cards that can be connected to the CN5-B connector are the DO-A3, AO-A3, PG- B3, and PG-X3. Use the CN5-C connector when mounting only one PG option card.
oFb02	DuplicateOptions	The same option card or the same type of option card has been connected to the CN5-A, B, and C connectors.	Connect the option card to the correct connector.
oFC00	Not supported	An option card that is not compatible with the CN5-C connector was connected.	Connect the option card to the correct connector. **Note:** AI-A3, DI-D3, and communication option cards cannot be connected to the CN5-C connector.
oFC02	DuplicateOptions	The same option card or the same type of option card has been connected to the CN5-A, B, and C connectors.	Connect the option card to the correct connector.

◆ **Option Board Error Management**

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

Option Error	Description	Error Indication	Possible Solution
OP > SAFEOP/ PREOP when Drive running	When an EtherCAT state transition from OP > SAFEOP/PREOP was made when the drive was in OPERATION enabled.	BUS Error is triggered in drive. 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.

Option Error	Description	Error Indication	Possible Solution
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. 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?

Option Error	Description	Error Indication	Possible Solution
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 system is overloaded. 2. Option card is not properly processing the state.	1. Drive fault: OFx32 2. Drive fault: OFx30	1+2 actions: • Disable process data OUT sync manager channel. • Force EtherCAT state change to SAFE_OP.

Option Error	Description	Error Indication	Possible Solution
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 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: • Disable process data IN sync manager channel. • Force EtherCAT state change to SAFE_OP.

Option Error	Description	Error Indication	Possible Solution
Initial power-up sequence not completed within 10 seconds.	Possible cause: 1. Drive is not processing the internal interface protocol. 2. Drive does not support this communication option card.	Drive fault: OFx00 Option will log FATAL event record in NVS memory and set ERR LED: solid RED.	Actions: • Check drive firmware version. • If drive firmware version is correct, replace option card. • Replace the drive.

Option Error	Description	Error Indication	Possible Solution
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.	Drive fault: OFx00 Option will log FATAL event record in NVS memory and set ERR LED: solid RED.	Force communication state to INIT.

Option Error	Description	Error Indication	Possible Solution
Option ID Error: Power-up sequence copyright string mismatch.	Drive reported invalid copyright string in power-up process.	Drive fault: OFx00 Option will log FATAL event record in NVS memory and set ERR LED: solid RED.	Replace option card.

◆ Minor Faults/Alarms

This section explains the causes and possible solutions when a minor fault or alarm occurs. Remove the cause of the fault referring to the following table.

Code	Name	Causes	Possible Solutions
CALL	Serial Comm Transmission Error	The communications cable wiring is incorrect.	Correct any wiring errors.
		There is a short circuit or disconnection in the communications cable.	• Repair disconnected cables and short circuits for proper wiring. • Replace a faulty communications cable with a normal one.
		Programming error occurred on the controller side.	Check communications at start-up and correct programming errors.
		Communications circuitry is damaged.	• Perform a self-diagnostics check. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.
		Termination resistor setting for MEMOBUS/Modbus communications is incorrect.	Enable the termination resistor in the last drive in a MEMOBUS/Modbus network by setting DIP switch S2 to the ON position.

Code	Name	Causes	Possible Solutions
EEP	EEPROM Checksum Error	Communication wiring is faulty, there is a short circuit, or something is not connected properly.	Correct any wiring errors.
		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)).
		Programming error occurred on the controller side.	Check communications at start-up and correct programming errors.
		Communications circuitry is damaged.	• Perform a self-diagnostics check. • If the problem continues, replace either the control board or the entire drive. For instructions on replacing the control board, contact Yaskawa or a Yaskawa representative.
		Termination resistor setting for MEMOBUS/Modbus communications is incorrect.	Enable the termination resistor in the last drive in a MEMOBUS/Modbus network by setting DIP switch S2 to the ON position.
CyPo	Cycle Power to Active Parameters	Although F6-15 = 1 [Comm. Option Parameters Reload = Reload Now], the drive does not update the communication option parameters.	Re-energize the drive to update the communication option parameters. Note: If the option software version is not compatible or if you install an incorrect option to the drive, it will trigger an alarm.

12   European Standards

Figure 19 CE Mark

The CE mark indicates compliance with European safety and environmental regulations. It is required for engaging in business and commerce in Europe.

European standards include the Machinery Directive for machine manufacturers, the Low Voltage Directive for electronics manufacturers, and the EMC guidelines for controlling noise.

This option displays the CE mark based on the EMC guidelines.

EMC Guidelines: 2014/30/EU

Drives used in combination with this option and devices used in combination with the drive must also be CE certified and display the CE mark. When using drives displaying the CE mark in combination with other devices, it is ultimately the responsibility of the user to ensure compliance with CE standards. Verify that conditions meet European standards after setting up the device.

◆ EMC Guidelines Compliance

This option is tested according to European standards EN 61800-3:2004/A1:2012 and complies with EMC guidelines. The CE marking is declared based on the harmonized standards.

■ EMC Guidelines Installation Conditions

Verify the following installation conditions to ensure that other devices and machinery used in combination with this option and drives also comply with EMC guidelines:

1. Use dedicated shield cable for the option and external device (encoder, I/O device, master), or run the wiring through a metal conduit.
2. Keep wiring as short as possible and ground the largest possible surface area of the shield to the metal panel according to *Figure 21*.
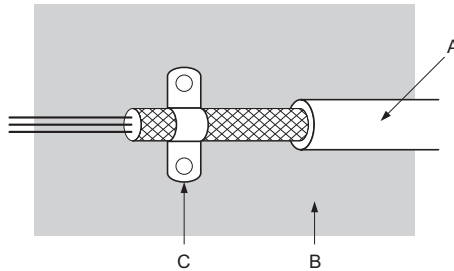
A – Braided shield cable   C – Cable clamp (conductive)
B – Metal panel

Figure 20 Ground Area

■ **Option Installation for CE Compliance: Models PG-□□, DI-□□, DO-□□, AI-□□, AO-□□, SI-□□**
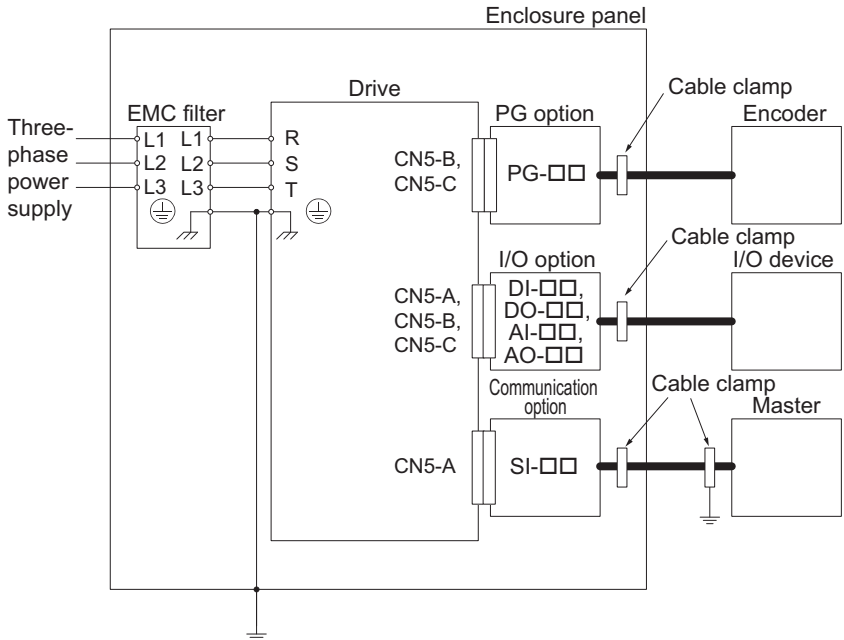
Figure 21 Option Installation for CE Compliance (PG-□□, DI-□□, DO-□□, AI-□□, AO-□□, SI-□□)

13 Specifications

Item	Specification
Model	SI-ES3
Communication Profile	DSP 301 Ver. 4.02 DSP 402 Ver. 1.1 Velocity Mode
Connector	RJ45 connector
Communication Speed	10/100 Mbps
Ambient Temperature	-10°C to +50°C (14°F to 122°F)
Humidity	up to 95% RH (non-condensing)
Storage Temperature	-20°C to +60°C (-4°F to 140°F) (allowed for short-term transport of the product)
Area of Use	Indoor (free of corrosive gas, airborne particles, etc.)
Altitude	Up to 1000 m (3280 ft)

◆ Revision History

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

MANUAL NO. TOBP C730600 96B <u><1></u>

└──────── Revision number

Published in Japan   <u>June 2018</u>

└──────────────── Date of publication

Date of Publication	Revision Number	Section	Revised Content
November 2018	<2>	All	Addition: Applicable product series Revision: Reviewed and corrected entire documentation.
		Back cover	Revision: Address
June 2018	<1>	All	Revision: Reviewed and corrected entire documentation.
February 2018	–	–	First Edition

YASKAWA AC Drive Option
EtherCAT
Installation Manual

YASKAWA
YASKAWA ELECTRIC CORPORATION

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

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