YASKAWA

YASKAWA AC Drive 1000-Series Option

Modbus TCP/IP

Installation Manual

Type: SI-EM3

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

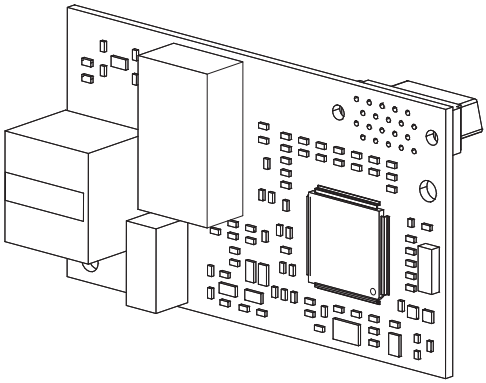
安川インバータ 1000シリーズオプション

Modbus TCP/IP通信

取扱説明書

形　式 SI-EM3

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MANUAL NO. TOBP C730600 57B

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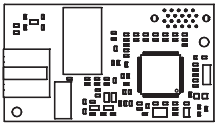
1 Preface and Safety

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

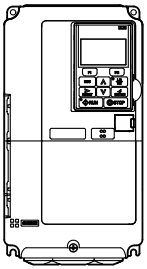
◆ Applicable Documentation

The following manuals are available for the SI-EM3 Option:

SI-EM3 Option

	**Yaskawa AC Drive 1000-Series Option SI-EM3 Modbus TCP/IP Installation Manual Manual No: TOBP C730600 57 (This book)**	Read this manual first. The installation manual is packaged with the option and contains information required to install the option and set up related drive parameters.
	Yaskawa AC Drive 1000-Series Option SI-EM3 Modbus TCP/IP Technical Manual Manual No: SIEP C730600 57	The technical manual contains detailed information about the option. Access the following sites to obtain the technical manual: U.S.: http://www.yaskawa.com Europe: http://www.yaskawa.eu.com Japan: http://www.e-mechatronics.com For questions, contact your local Yaskawa sales office or the nearest Yaskawa representative.

Yaskawa Drive

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

◆ Terms

Note: Indicates supplemental information that is not related to safety messages.

Drive: Yaskawa AC Drive 1000-Series

Option: Yaskawa AC Drive 1000-Series Option SI-EM3 Modbus TCP/IP

◆ Registered Trademarks

- Modbus TCP/IP is a trademark of Modbus-IDA.
- All trademarks are the property of their respective owners.

◆ Supplemental Safety Information

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

Indicates an equipment damage message.

■ General Safety

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

⚠ DANGER

Heed the safety messages in this manual.

Failure to comply will result in death or serious injury.

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

NOTICE

Do not modify the drive or option circuitry.

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

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

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

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

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

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

2 Product Overview

◆ About This Product

This option provides a communications connection between the drive and a Modbus TCP/IP network. The option connects the drive to a Modbus TCP/IP network and facilitates the exchange of data.

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

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

By installing the option to a drive, it is possible to do the following from a Modbus TCP/IP master device:

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

◆ Applicable Models

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

Table 1 Applicable Models

Drive Series	Drive Model Number	Software Version <1>
A1000	CIMR-A□2A□□□□	≥ 1010
	CIMR-A□4A0002 to 4A0675	≥ 1010
	CIMR-A□4A0930 and 4A1200	301□
	CIMR-A□5A□□□□	504□
Z1000	CIMR-Z□□A□□□□	≥ 1014

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

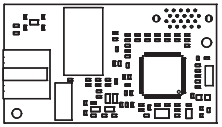
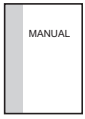
3 Receiving

Please perform the following tasks upon receipt of the option:

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

◆ Option Package Contents

Table 2 Option Package Contents

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

◆ Tools Required for Installation

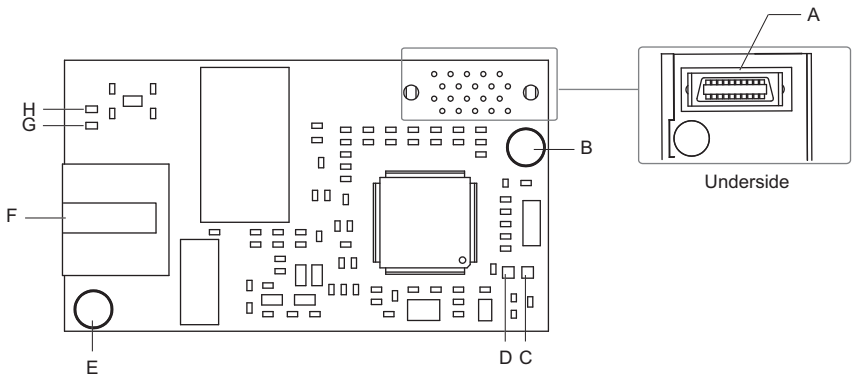
- A Phillips screwdriver (M3 metric/#1, #2 U.S. standard size <1>) is required to install the option and remove drive front covers.
- Diagonal cutting pliers. (required for some drive models)
- A small file or medium grit sandpaper. (required for some drive models)

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

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

4 Option Components

◆ SI-EM3 Option



A – Connector (CN5)
B – Installation hole
C – LED (MS) *<1>*
D – LED (NS) *<1>*
E – Ground terminal and installation hole *<2>*
F – Communication connector CN1 (RJ45)
G – LED (LINK/ACT) *<1>*
H – LED (10/100) *<1>*

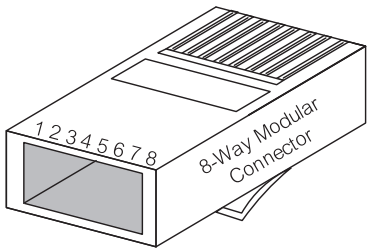
<1> ***Refer to Option LED Display on page 12*** for details on the LEDs
<2> The ground wire provided in the option shipping package must be connected during installation

Figure 1 SI-EM3 Option Components

◆ Communication Connector CN1

The communication connector on the option is a modular RJ45 female connector designated CN1.
CN1 is the connection point for a customer supplied male Modbus network communication cable.

Table 3 Male, 8-way Ethernet Modular Connector (Customer Supplied)

Male Ethernet 8-Way Modular Connector	Pin	Description
	1 (Pair 2)	Transmit data (TXD) +
	2 (Pair 2)	Transmit data (TXD) -
	3 (Pair 3)	Receive data (RXD) +
	4 (Pair 1)	Not used <1>
	5 (Pair 1)	Not used <1>
	6 (Pair 3)	Receive data (RXD) -
	7 (Pair 4)	Not used <1>
	8 (Pair 4)	Not used <1>

<1> Not used for 10 Mbps and 100 Mbps networks.

◆ Option LED Display

The option has four LEDs:

Bi-color Status LEDs:

- Module status (MS) red/green
- Network status (NS) red/green

Green Ethernet LEDs:

- Network speed-10/100 (MS) green
- Link status and network activity-Link/Act (NS) red/green

The operational states of the option LEDs after the power-up diagnostic LED sequence is completed are described in *Table 4*. Wait at least 2 seconds for the power-up diagnostic process to complete before verifying the states of the LEDs.

Table 4 Option LED States

Name	Indication		Operating Status	Remarks
	Color	Status		
MS	–	OFF	Power supply OFF	Power is not being supplied to the drive
	Green	ON	Option operating	The option is operating normally
	Green	Flashing	Option initializing	The option is configuring an IP address
	Red	ON	Fatal error occurred	The option has detected a fatal (unrecoverable) error
	Red	Flashing	Non-fatal error occurred	The option has detected a non-fatal (recoverable) error
NS	–	OFF	Offline or power supply OFF	–
	Green	ON	Online communications established	The option is online and has established connections
	Green	Flashing	Control connection active	The option is online and has an established and active control connection.
	Red	ON	Communications error (fatal)	The option detected a duplicate IP address
10/100 <1>	Green	OFF	10 Mbps is established	–
	Green	ON	100 Mbps is established	
LINK/ACT <1>	Green	OFF	Link is not established	
	Green	ON	Link is established	
	Green	Flashing	Link is established and there is network activity	

<1> Remove the drive front cover to check the status of the LED. Be careful not to touch the main circuit terminals or the control board in the drive.

5 Installation Procedure

◆ Section Safety

⚠ DANGER

Electrical Shock Hazard

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

Failure to comply will result in death or serious injury.

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

⚠ WARNING

Electrical Shock Hazard

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

Failure to comply could result in death or serious injury.

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

Do not allow unqualified personnel to use equipment.

Failure to comply could result in death or serious injury.

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

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

Failure to comply could result in death or serious injury.

⚠ WARNING

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.

Fire Hazard

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.

NOTICE

Damage to Equipment

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

Failure to comply may result in ESD damage to circuitry.

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

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

Do not operate damaged equipment.

Failure to comply may cause further damage to the equipment.

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

Do not use unshielded cable for control wiring.

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

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

NOTICE

Properly connect all pins and connectors.

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

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

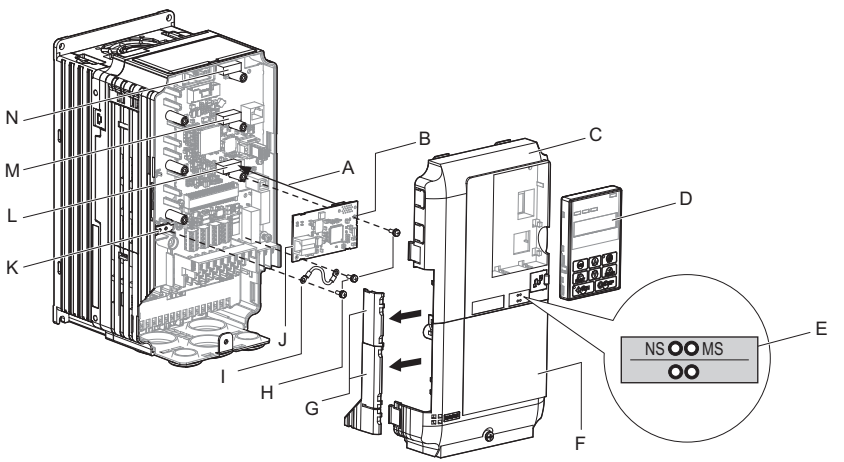
Failure to comply may result in damage to the option.

◆ Installing the Option to A1000 Drive

■ Prior to Installing the Option

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

Figure 2 shows an exploded view of the drive with the option and related components for reference.



A – Insertion point for CN5 connector
B – SI-EM3 option
C – Drive front cover
D – Digital operator
E – LED label
F – Drive terminal cover
G – Removable tabs for wire routing
H – Included screws
I – Ground wire
J – Option modular connector CN1
K – Drive grounding terminal (FE)
L – Connector CN5-A
M – Connector CN5-B
N – Connector CN5-C

Figure 2 Drive Components with Option

■ Installing the Option

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

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

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

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

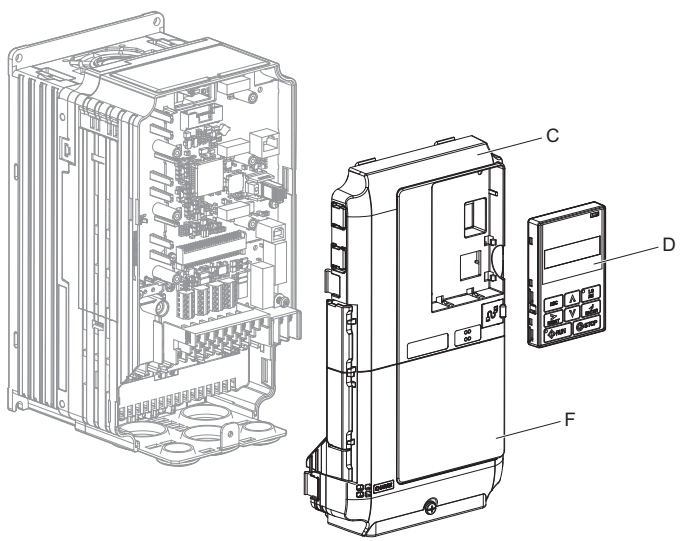


Figure 3 Remove the Front Covers and Digital Operator

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

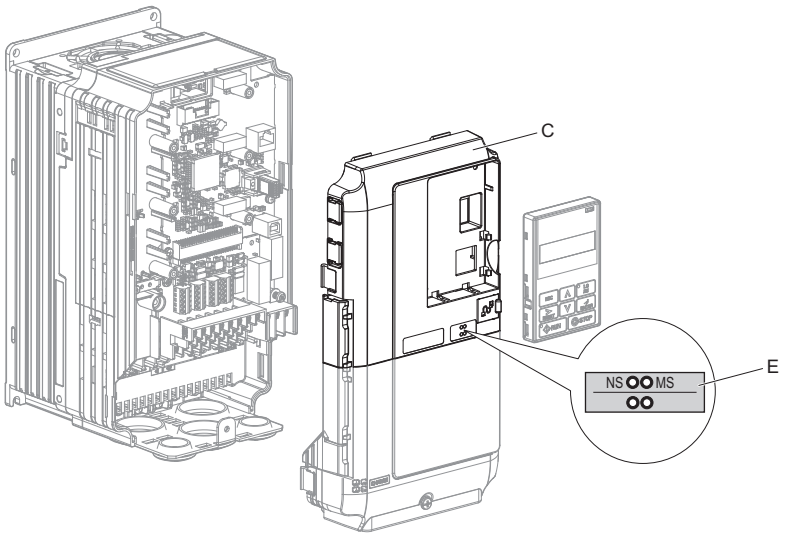


Figure 4 Apply the LED Label

3. Make sure the screws on the left and right sides of the option terminal block (J) are tightened with a tightening torque of 0.5 to 0.6 N·m (4.4 to 5.3 in lbs), then insert the option (B) into the CN5-A connector (L) located on the drive and fasten it using one of the included screws (H).

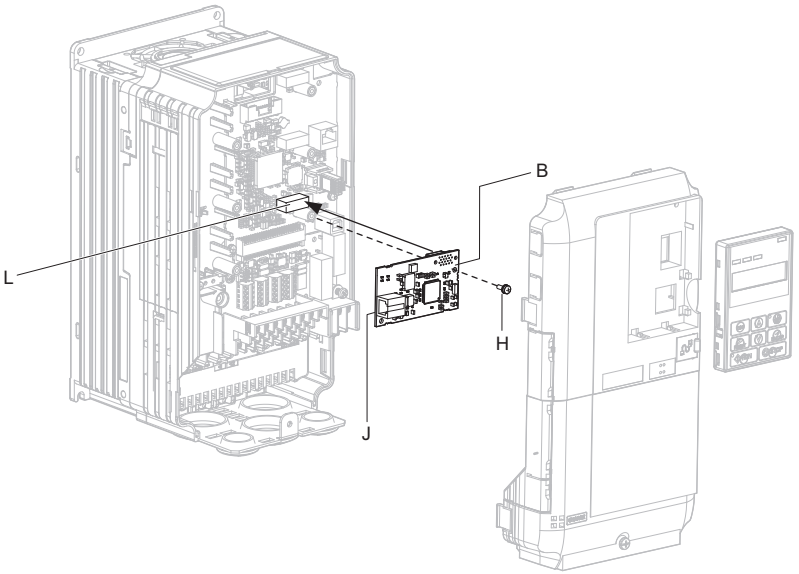


Figure 5 Insert the Option

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

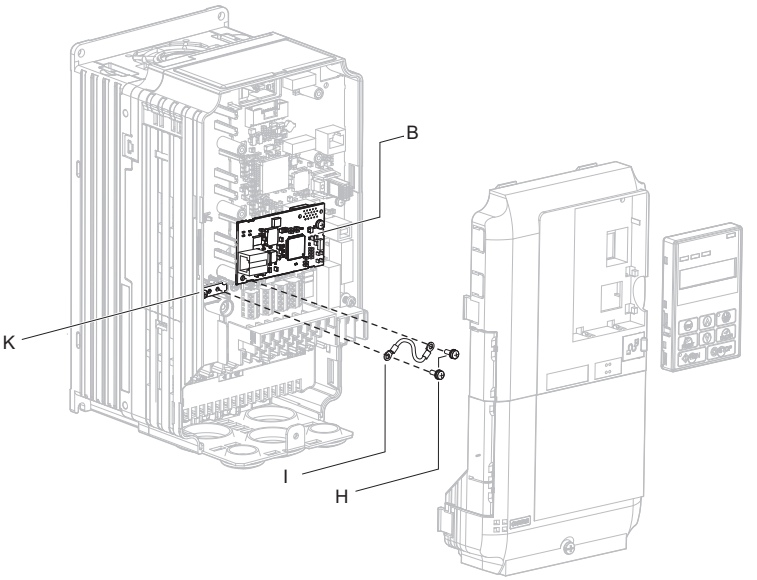


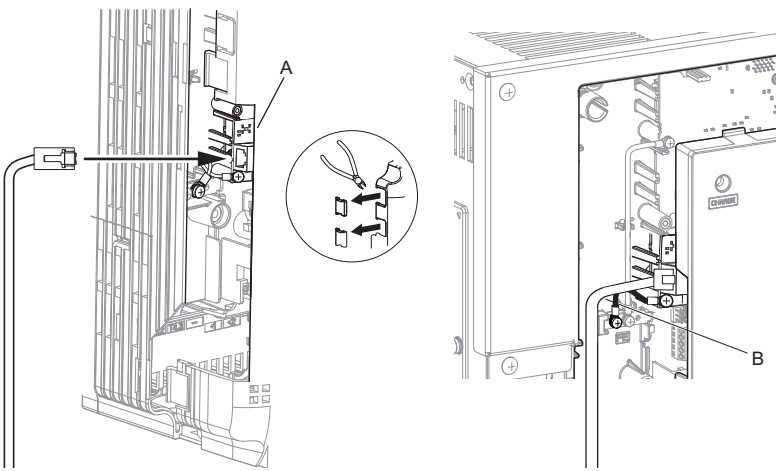
Figure 6 Connect the Ground Wire

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

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

Route the wiring through the side of the front cover to the outside. In these cases, using diagonal cutting pliers, cut out the perforated openings on the left side of the drive front cover as shown in ***Figure 7***-A. Sharp edges along the cut out should be smoothed down with a file or sand paper to prevent any damage to the wires. Route the wiring inside the enclosure as shown in ***Figure 7***-B for drives that do not require routing through the front cover.

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



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

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

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

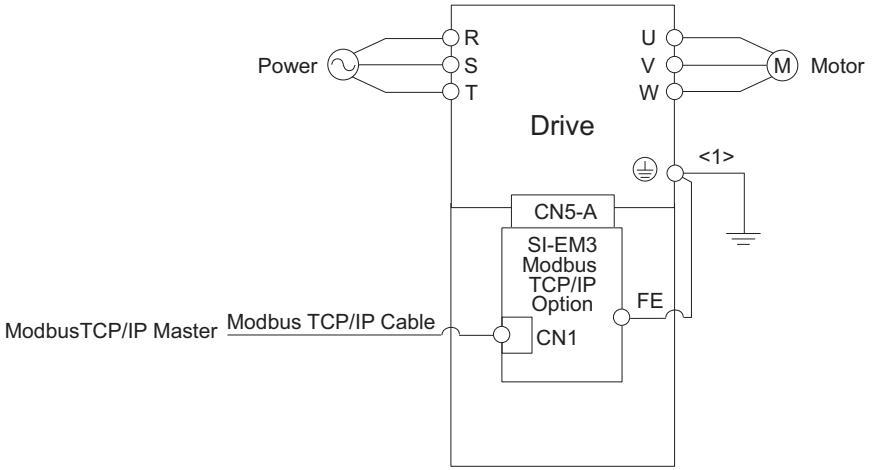
Figure 7 Wire Routing Examples

6. Connect the Ethernet communication cable to the option modular connector (CN1).

To connect the option to a network, insert the RJ45 communication connector of the Cat 5e patch cable into the option modular female connector (CN1). Ensure the cable end is firmly connected (see ***Figure 7***).

Communication Cable Specifications
Only use cable recommended for Modbus TCP/IP™. Using a cable not specifically recommended may cause the option or drive to malfunction.

Connection Diagram



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

Figure 8 Option Connection Diagram

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

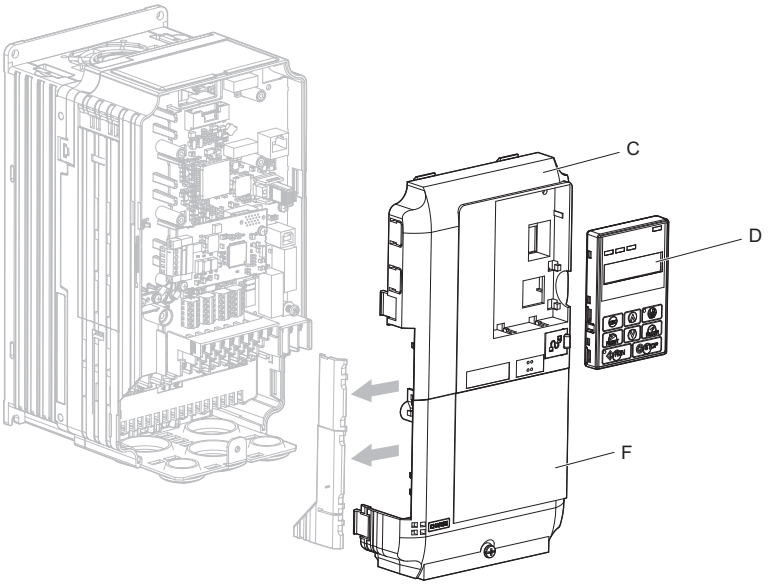


Figure 9 Replace the Front Covers and Digital Operator

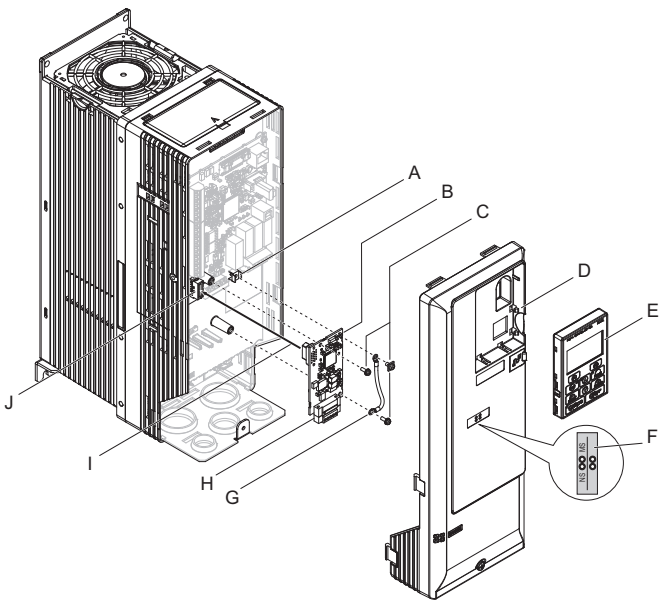
Note: Take proper precautions when wiring the option so that the front covers will easily fit back onto the drive. Make sure no cables are pinched between the front covers and the drive when replacing the covers.

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

◆ Installing the Option to Z1000 Drive

■ Prior to Installing the Option

Prior to installing the option, wire the drive, make necessary connections to the drive terminals, and verify that the drive functions normally without the option installed. Refer to the User Manual packaged with the drive for information on wiring and connecting the drive.
Figure 10 shows an exploded view of the drive with the option and related components for reference.



A – Drive grounding terminal (FE)
B – Option card
C – Mounting screw
D – Drive front cover
E – HOA keypad
F – LED label
G – Ground wire
H – Terminal block CN1
I – Insert connector CN5 here
J – Connector CN5

Figure 10 Drive Components with Option

■ Installing the Option

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

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

1. Shut off power to the drive, wait the appropriate amount of time for voltage to dissipate, then remove the HOA keypad (E) and front cover (D).

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

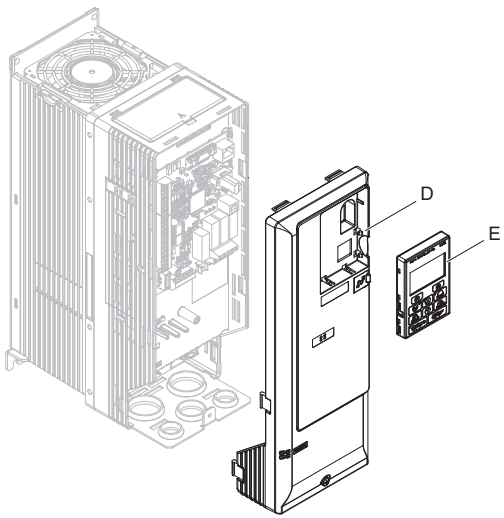


Figure 11 Remove the Front Cover and HOA Keypad

2. With the front cover and HOA keypad removed, apply the LED label (F) in the appropriate position on the drive front cover (D).

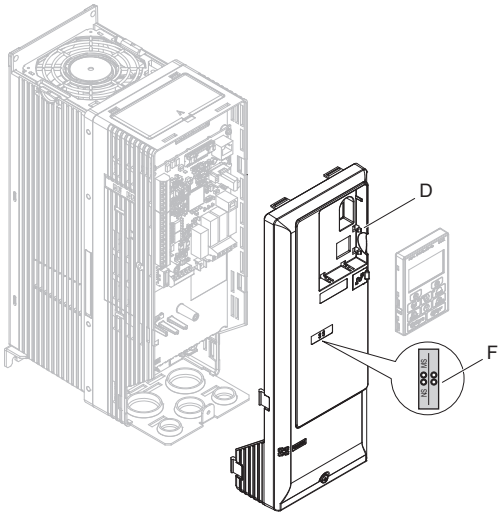


Figure 12 Apply the LED Label

3. Make sure the screws on the left and right sides of the option terminal block (H) are tightened with a tightening torque of 0.5 to 0.6 N·m (4.4 to 5.3 in lbs), then insert the option (B) into the CN5 connector (J) located on the drive and fasten it using one of the included screws (C).

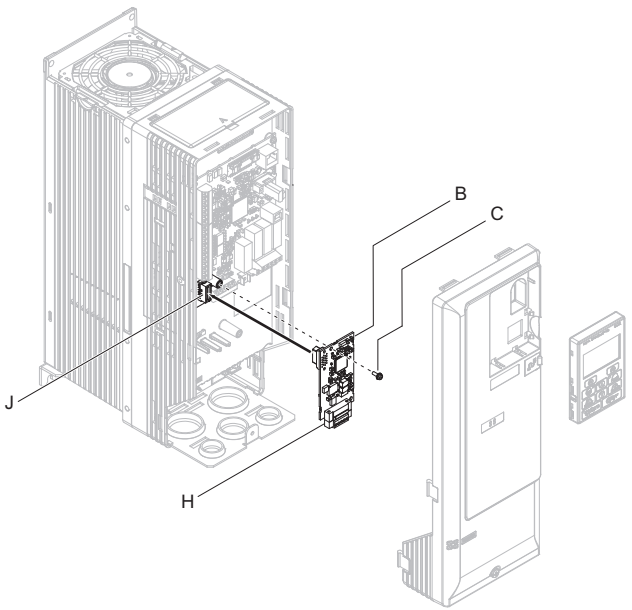


Figure 13 Insert the Option

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

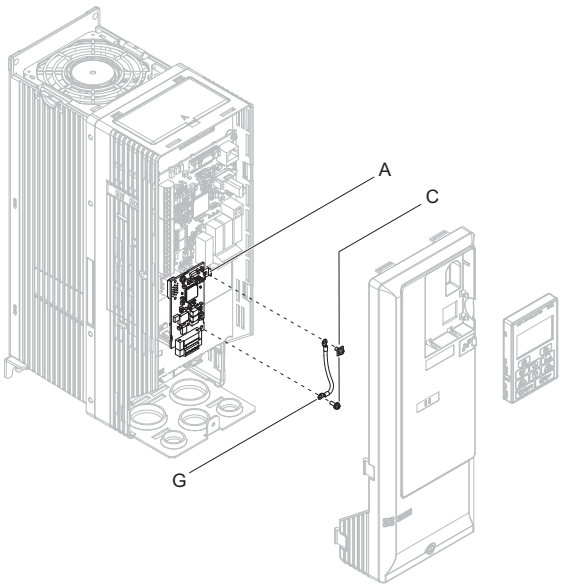


Figure 14 Connecting the Ground Wire

5. Wire the communication cables.

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

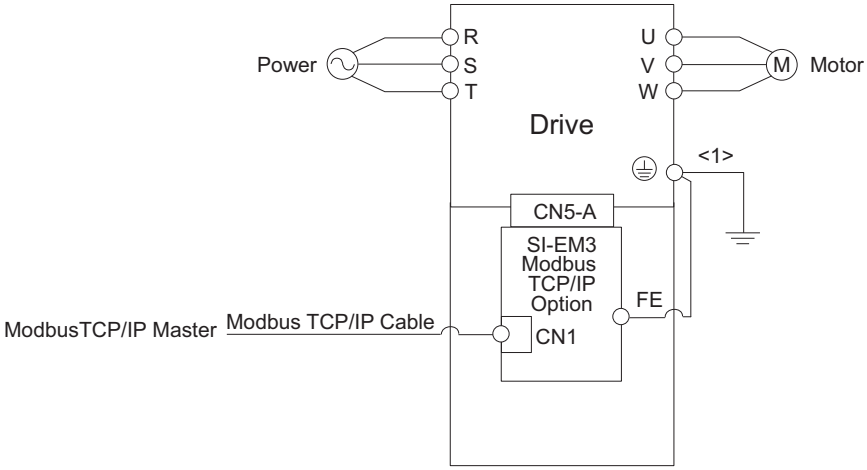
6. Connect the Ethernet communication cable to the option modular connector (CN1).

To connect the option to a network, insert the RJ45 communication connector of the Cat 5e patch cable into the option modular female connector (CN1). Ensure the cable end is firmly connected (see ***Figure 15***).

Communication Cable Specifications

Only use cable recommended for Modbus TCP/IP™. Using a cable not specifically recommended may cause the option or drive to malfunction.

Connection Diagram



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

Figure 15 Option Connection Diagram

7. Replace and secure the front cover of the drive (D) and replace the HOA Keypad (E).

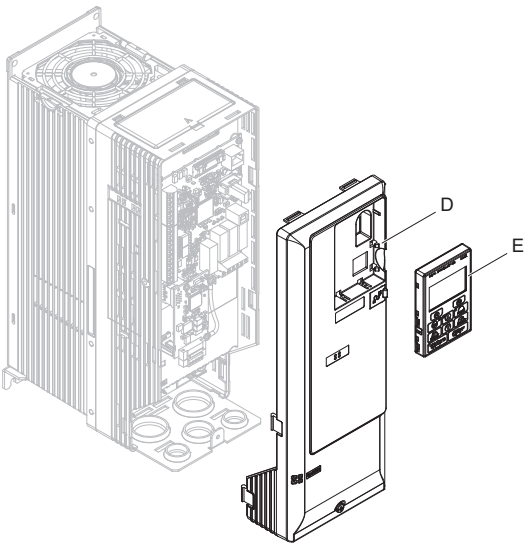


Figure 16 Replace the Front Cover and HOA Keypad

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

8. Set drive parameters in ***Table 6*** for proper option performance.

6 Related Drive Parameters

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

Confirm proper setting of all the parameters in ***Table 5*** using the digital operator, before starting network communications.

Table 5 Related Parameter Settings

No. (Addr. H)	Name	Description	Values
b1-01 (180) <1>	Frequency Reference Selection	Selects the frequency reference input source. 0: Operator - Digital preset speed d1-01 to d1-17 1: Terminals - Analog input terminal A1 or A2 2: MEMOBUS/Modbus communications 3: Option 4: Pulse Input (Terminal RP)	Default: 1 Range: 0 to 4 (Set to 3)
b1-02 (181) <1>	Run Command Selection	Selects the run command input source. 0: Digital Operator - RUN and STOP keys 1: Digital input terminals S1 to S8 2: MEMOBUS/Modbus communications 3: Option	Default: 1 Range: 0 to 3 (Set to 3)
F6-01 (3A2)	Operation Selection after Communications Error	Determines drive response when a bUS error is detected during communications with the option. 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <2>	Default: 1 Range: 0 to 3
F6-02 (3A3)	External Fault Detection Conditions (EF0)	Sets the condition for external fault detection (EF0). 0: Always detected 1: Detected only during operation	Default: 0 Range: 0, 1
F6-03 (3A4)	Stopping Method for External Fault from the Communication Option	Determines drive response for external fault input (EF0) detection during option communications. 0: Ramp to Stop 1: Coast to Stop 2: Fast-Stop 3: Alarm Only <2>	Default: 1 Range: 0 to 3
F6-06 (3A7) <3>	Torque Reference/ Torque Limit Selection from the Communication Option	0: Torque Reference/Torque Limit via network communications are disabled 1: Torque Reference/Torque Limit via network communications are enabled <4>	Default: 0 Range: 0, 1

No. (Addr. H)	Name	Description	Values
F6-07 (3A8)	NetRef/ComRef Selection Function	0: Multi-step speed reference disabled, (F7 functionality) 1: Multi-step speed reference allowed, (V7 functionality)	Default: 0 Range: 0, 1
F6-08 (36A)	Reset Communication Related Parameters	Determines if communication-related parameters F6-☐☐ and F7-☐☐ are set back to original default values when the drive is initialized using parameter A1-03. 0: Do not reset parameters 1: Reset parameters	Default: 0 <7> Range: 0, 1
F7-01 (3E5) <5> <6> <7>	IP Address 1	Sets the static/fixed IP address. Parameter F7-01 sets the most significant octet.	Default: 192 Range: 0 to 255
F7-02 (3E6) <5> <6> <7>	IP Address 2	Sets the static/fixed IP address. Parameter F7-02 sets the second most significant octet.	Default: 168 Range: 0 to 255
F7-03 (3E7) <5> <6> <7>	IP Address 3	Sets the static/fixed IP address. Parameter F7-03 sets the third most significant octet.	Default: 1 Range: 0 to 255
F7-04 (3E8) <5> <6> <7>	IP Address 4	Sets the static/fixed IP address. Parameter F7-04 sets the fourth most significant octet.	Default: 20 Range: 0 to 255
F7-05 (3E9) <7>	Subnet Mask 1	Sets the static/fixed Subnet Mask. Parameter F7-05 sets the most significant octet.	Default: 255 Range: 0 to 255
F7-06 (3EA) <7>	Subnet Mask 2	Sets the static/fixed Subnet Mask. Parameter F7-06 sets the second most significant octet.	Default: 255 Range: 0 to 255
F7-07 (3EB) <7>	Subnet Mask 3	Sets the static/fixed Subnet Mask. Parameter F7-07 sets the third most significant octet.	Default: 255 Range: 0 to 255
F7-08 (3EC) <7>	Subnet Mask 4	Sets the static/fixed Subnet Mask. Parameter F7-08 sets the fourth most significant octet.	Default: 0 Range: 0 to 255
F7-09 (3ED) <7>	Gateway Address 1	Sets the static/fixed Gateway address. Parameter F7-09 sets the most significant octet.	Default: 192 Range: 0 to 255
F7-10 (3EE) <7>	Gateway Address 2	Sets the static/fixed Gateway address. Parameter F7-10 sets the second most significant octet.	Default: 168 Range: 0 to 255

No. (Addr. H)	Name	Description	Values
F7-11 (3EF) <7>	Gateway Address 3	Sets the static/fixed Gateway address. Parameter F7-11 sets the third most significant octet.	Default: 1 Range: 0 to 255
F7-12 (3E0) <7>	Gateway Address 4	Sets the static/fixed Gateway address. Parameter F7-12 sets the fourth most significant octet.	Default: 1 Range: 0 to 255
F7-13 (3F1)	Address Mode at Startup	Selects how the option address is set. 0: Static <6> 1: BOOTP 2: DHCP	Default: 2 Range: 0 to 2
F7-14 (3F2)	Duplex Mode Selection	Selects duplex mode setting. 0: Half duplex forced 1: Auto-negotiate duplex mode and communication speed 2: Full duplex forced	Default: 1 Range: 0 to 2
F7-15 (3F3) <8>	Communication Speed Selection	Sets the communication speed. 10: 10 Mbps 100: 100 Mbps	Default: 10 Range: 10, 100
F7-16 (3F4)	Communication Loss Time-out	Sets the time-out value for communication loss detection in tenths of a second. A value of 0 disables the connection time-out. Example: An entered value of 100 represents 10.0 seconds.	Default: 0 Min.: 0 Max.: 300
H5-11 (43C)	Communications ENTER Function Selection	Select the function for the ENTER command that saves parameter data to the drive. 0: Parameter changes are activated when ENTER command is written 1: Parameter changes are activated immediately without use of ENTER command	Default: 1 Range: 0, 1

<1> To start and stop the drive with the option master device using serial communications, set b1-02 to 3. To control the drive frequency reference via the master device, set b1-01 to 3.
<2> If F6-01 is set to 3, the drive will continue to operate when a fault is detected. Take safety measures, such as installing an emergency stop switch.
<3> A1000: Enabled in CLV, AOLV/PM, and CLV/PM control modes (A1-02 = 3, 6, or 7). When enabled, d5-01 determines whether the value is read as the Torque Limit value (d5-01 = 0) or read as the Torque Reference value (d5-01 = 1). In CLV/PM, this value is read as the Torque Limit.
Z1000: Enabled in OLV/PM control modes (A1-02 = 5). When enabled, d5-01 determines whether the value is read as the Torque Limit value (d5-01 = 0) or read as the Torque Reference value (d5-01 = 1). In V/f, this value is read as the Torque Limit.
<4> The setting specifies that the Torque Reference or Torque Limit is to be provided via network communications (F6-06 = 1). The motor may rotate if no torque reference or Torque Limit is supplied from the PLC.
<5> Cycle power for setting changes to take effect.
<6> If F7-13 is set to 0, then all IP Addresses (F7-01 to F7-04) must be unique.
<7> Set F7-01 to F7-12 when F7-13 is set to 0.
<8> Set F7-15 when F7-14 is set to 0 or 2.

Table 6 Option Monitors

No.	Name	Description	Value Range
U6-80 to U6-83	Online IP Address	IP Address currently available; U6-80 is the most significant octet	0 to 255
U6-84 to U6-87	Online Subnet	Subnet currently available; U6-84 is the most significant octet	0 to 255
U6-88 to U6-91	Online Gateway	Gateway currently available; U6-88 is the most significant octet	0 to 255
U6-92	Online Speed	Link Speed	10: 10 Mbps 100: 100 Mbps
U6-93	Online Duplex	Duplex Setting	0: Half, 1: Full
U6-98	First Fault	First Option Fault	–
U6-99	Current Fault	Current Option Fault	–

7 Modbus TCP/IP Messaging

◆ Modbus TCP/IP Overview

The Modbus TCP/IP protocol is essentially the Modbus protocol over an Modbus TCP/IP network. A master controller (typically a PLC) sends commands to slave devices, which then perform the specified functions and send a response to the master. The drive using the option has slave functionality.

■ Supported Modbus TCP/IP Commands

Table 7 Supported Modbus TCP/IP Commands

Function Code	Function Name
03H	Read Multiple Registers
06H	Write Single Register
10H	Write Multiple Registers
17H	Read/Write Multiple Registers

■ Drive Modbus TCP/IP Option Registers

All of the command registers, monitor registers, and parameters documented in the drive Technical Manual are accessible via the option.

■ High Speed Access Drive Modbus TCP/IP Option Registers

Many of the registers required for control have been specially mapped to provide higher speed access to increase network performance. Use these registers for the best response times.

All of the drive command registers have been mapped to this high speed access area (Modbus TCP/IP registers 01H to 01FH). In addition, the monitors shown in ***Table 8*** are mapped for high speed access.

Table 8 Drive Registers

Address (hex)	Drive Register (hex)	Description	Bit	Description
2000	4B	Status Word (U1-12)	0	During Run
			1	During Zero Speed
			2	During Reverse Direction
			3	During Fault Reset Signal Input
			4	During Speed Agree
			5	Drive Ready
			6	Alarm
			7	Fault
			8	During Operation Error (oPE□□)
			9	During Momentary Power Loss
			A	Motor 2 Selected
			B	Reserved
			C	Reserved
			D	Reserved
			E	ComRef Status, NetRef Status
			F	ComCtrl Status, NetCtrl Status
2001	44	Motor Speed Monitor (U1-05)		
2002	48	Torque Reference Monitor (U1-09)		
2003	F0	PG Count Channel 1		
2004	40	Frequency Reference Monitor (U1-01)		
2005	41	Output Frequency Monitor (U1-02)		
2006	26	Output Current (0.01 A units for drives set to 11 kW in Heavy or Normal Duty and 0.1 A units for drives set to 15 kW and above.)		
2007	4F	Terminal A2 Input Level Monitor (U1-14)		
2008	46	DC Bus Voltage Monitor (U1-07)		

Address (hex)	Drive Register (hex)	Description	Bit	Description
2009	C0	Error Signal 1	0	Reserved
			1	Undervoltage (Uv1)
			2	Control Power Supply Undervoltage (Uv2)
			3	Soft Charge Circuit Fault (Uv3)
			4	Reserved
			5	Ground Fault (GF)
			6	Overcurrent (oC)
			7	Overvoltage (ov)
			8	Heatsink Overheat (oH)
			9	Heatsink Overheat (oH1)
			A	Motor Overload (oL1)
			B	Drive Overload (oL2)
			C	Overtorque Detection 1 (oL3)
			D	Overtorque Detection 2 (oL4)
			E	Dynamic Braking Transistor Fault (rr)
			F	Braking Resister Overheat (rH)
200A	C1	Error Signal 2	0	External Fault at input terminal S3 (EF3)
			1	External Fault at input terminal S4 (EF4)
			2	External Fault at input terminal S5 (EF5)
			3	External Fault at input terminal S6 (EF6)
			4	External Fault at input terminal S7 (EF7)
			5	External Fault at input terminal S8 (EF8)
			6	Cooling fan Error (FAn)
			7	Overspeed (os)
			8	Excessive Speed Deviation (dEv)
			9	PG Disconnected (PGo)
			A	Input Phase Loss (PF)
			B	Output Phase Loss (LF)
			C	Motor Overheat (PTC input) (oH3)
			D	Digital Operator Connection Fault (oPr)
			E	EEPROM Write Error (Err)
			F	Motor Overheat Fault (PTC input) (oH4)

Address (hex)	Drive Register (hex)	Description	Bit	Description
200B	C2	Error Signal 3	0	MEMOBUS/Modbus Communication Error (CE)
			1	Option Communication Error (bUS)
			2	Reserved
			3	Reserved
			4	Control Fault (CF)
			5	Zero Servo Fault (SvE)
			6	Option External Fault (EF0)
			7	PID Feedback Loss (FbL)
			8	Undertorque Detection 1 (UL3)
			9	UL4 Undertorque Detection 2 (UL4)
			A	High Slip Braking Overload (oL7)
			B	Reserved
			C	Reserved
			D	Reserved
			E	Reserved
			F	Hardware Fault (includes oF□)
200C	4E	Terminal A1 Input Level Monitor (U1-13)		
200D	49	Digital Input Terminal Status (U1-10)		
200E	50	Terminal A3 Input Level Monitor (U1-15)		
200F	F1	PG Count Channel 2		
2010	4D	Drive Software Number (Flash) (U1-25)		

◆ Enter Command Types

The drive supports two types of Enter Commands as shown in the table below. An Enter Command is enabled by writing 0 to register number 0900H or 0910H.

■ Enter Commands

Table 9 Enter Command Types

Register Number	Description
0900H	Writes data into the EEPROM (non-volatile memory) of the drive and enables the data to RAM at the same time. Parameter changes remain even if the power supply is cycled.
0910H	Writes data in the RAM only. Parameter changes are lost when the drive is shut off.

Note: Because the EEPROM can be written to a maximum of 100,000 times, refrain from frequently writing to the EEPROM. An Enter Command is not required if reference or broadcast data are sent to the drive.

◆ Enter Command Settings

When replacing earlier Yaskawa drive models with a 1000 Series drive and keeping the MEMOBUS/Modbus communications settings, parameter H5-11 needs to be set in accordance with how the Enter Command functions in the older drive. H5-11 determines if an Enter Command is needed or not in order to activate parameter changes in the drive.

- If upgrading from a G7 or F7 series drive to 1000 Series, set parameter H5-11 to 0.
- If upgrading from a V7 series drive to 1000 Series, set parameter H5-11 to 1.

■ H5-11 and the Enter Commands

Table 10 Enter Command Types

H5-11 Settings	H5-11 = 0	H5-11 = 1
Drive being replaced.	G7, F7	V7
How parameter settings are enabled.	When the Enter Command is received from the master.	As soon as the value is changed.
Upper/lower limit check.	Upper/lower limit check is performed taking the settings of related parameters into account.	The upper/lower limit of the changed parameter is checked only.
Default value of related parameters.	Not affected. The settings of related parameters remain unchanged. Parameters must be changed manually if needed.	The default settings of related parameters are changed automatically.
Error handling when setting multiple parameters.	Data is accepted even if one setting is invalid. The invalid setting will be discarded. No error message occurs.	Error occurs if only one setting is invalid. All data sent is discarded.

8 Web Interface

The web server interface to the drive option allows management of diagnostic information through a standard web browser. The embedded web pages include:

- Main page (Information)
- Drive Status page (Status, Monitor and Fault History)
- Network Monitor page (Network Monitor)

◆ Main Page (Information)

The embedded main page shows basic option information such as IP address, MAC address, and firmware version. This page also shows the status of the option and provides links to the other embedded web pages.

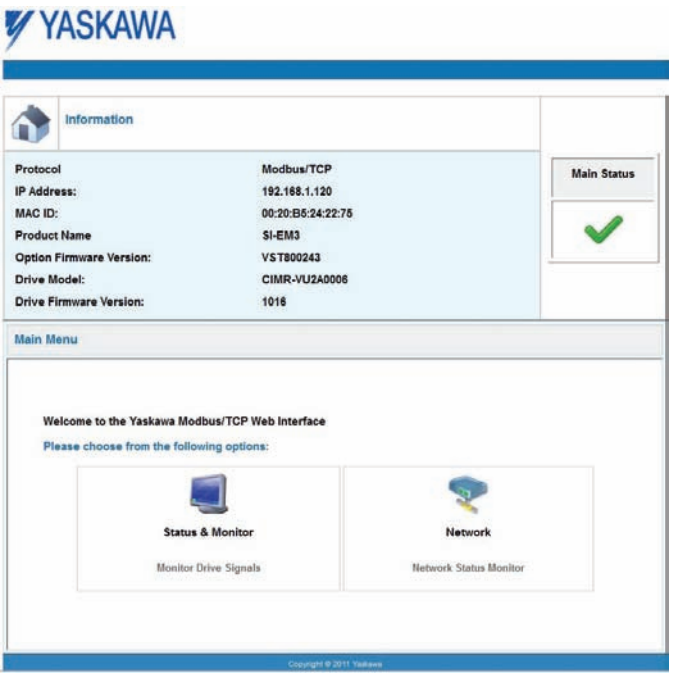


Figure 17 Main Page View

◆ Drive Status Page (Status, Monitor and Fault History)

The embedded drive status page shows basic I/O information and drive state information.

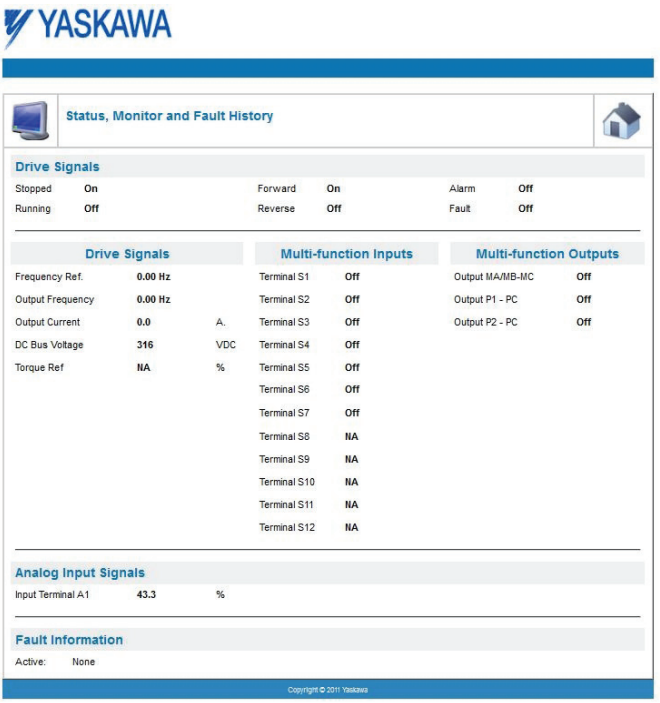


Figure 18 Drive Status Page View

◆ Network Monitor Page (Network Monitor)

The embedded network monitor page shows the status of the option network traffic and open I/O connections.

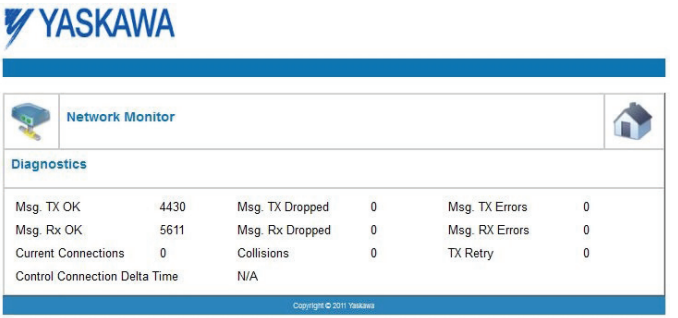


Figure 19 Network Monitor Page View

Table 11 Network Monitor Explanations

Network Monitor	Explanation
Msg Tx OK	Cumulative number of messages transmit successfully from the option.
Msg Rx OK	Cumulative number of messages received successfully to the option.
Current Connections	Current number of open connections.
Control Connection Delta Time	The time between the last two writes to the Control register, MEMOBUS/Modbus address 0001H.
Msg Tx Dropped	Cumulative number of messages dropped due to output network buffer being full and unable to hold the new message.
Msg Rx Dropped	Cumulative number of messages dropped due to input network buffer being full and unable to hold the new message.
Collisions	Cumulative number of collisions (half duplex only) reported by the MAC/PHY (Media Access Control/Physical Connection).
Msg Tx Errors	Cumulative number of transmit underruns and transmit stops reported by the MAC/PHY.
Msg Rx Errors	Cumulative number of receive overruns, receive stops, and receive error frames reported by the MAC/PHY.
Tx Retry	Cumulative number of transmits in which the 1st attempt was delayed due to busy medium reported by the MAC/PHY.

Note: Cumulative counters are reset when the power supply is cycled.

9 Troubleshooting

◆ Drive-Side Error Codes

Drive-side error codes appear on the drive digital operator. Causes of the errors and corrective actions are listed in *Table 12*. For additional error codes that may appear on the drive digital operator, refer to the drive Technical Manual.

■ Faults

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

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

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

Table 12 Fault Displays, Causes, and Possible Solutions

LED Operator Display		Fault Name
bUS	bUS	Option Communication Error. • After establishing initial communication, the connection was lost • Only detected when the run command or frequency reference is assigned to the option (b1-01 = 3 or b1-02 = 3)
Cause		**Possible Solution**
Master controller (PLC) has stopped communicating		• Check that power is supplied to the PLC • Check that PLC is not in program mode
Communication cable is not connected properly		• Check for faulty wiring • Correct any wiring problems
A data error occurred due to noise		• Check the various options available to minimize the effects of noise • Counteract noise in the control circuit, main circuit, and ground wiring • If a magnetic contactor is identified as a source of noise, install a surge absorber to the contactor coil • Make sure the cable used meets the Modbus TCP/IP requirements • Make sure the option ground wire is connected between option FE terminal and the drive ground terminal connected to earth ground
Option is damaged		If there are no problems with the wiring and the error continues to occur, replace the option.
Control Connection Timeout		The control connection timer value set in F7-16 has timed out.

Duplicate IP Address	The option shares IP Address with at least one other node. Check the setting value of F7-03 and F7-04.

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

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

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

LED Operator Display		Fault Name
oFA03	oFA03	Option Card Error (CN5-A)
		Option self-diagnostics error.
Cause		**Possible Solution**
Option hardware fault		Replace the option.

LED Operator Display		Fault Name
oFA04	oFA04	Option Card Error (CN5-A)
		Option flash write mode.
Cause		**Possible Solution**
Option hardware fault		Replace the option.

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

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

LED Operator Display		Fault Name
oFb02	oFb02	Option Card Fault (CN5-B)
		Two of the same options are connected at the same time.
Cause		**Possible Solution**
Options AI-A3 or DI-A3 were connected to the CN5-B port while an option was already connected to CN5-A.		• Only one type of AI-A3, DI-A3 or SI-☐☐ option can be connected to the drive. • The SI-EM3 option can only be connected to CN5-A.

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

LED Operator Display		Fault Name
oFC02	oFC02	Option Card Fault (CN5-C)
		Option flash write mode.
Cause		**Possible Solution**
Options AI-A3 or DI-A3 are connected to the CN5-B port with an option connected to CN5-A.		• Only one type of AI-A3, DI-A3 or SI-☐☐ option can be connected to the drive. • The SI-EM3 option can only be connected to CN5-A

■ Minor Faults and Alarms

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

■ Option Fault Monitors U6-98 and U6-99

The option can declare error/warning conditions via drive monitor parameters on the drive digital operator as shown in *Table 13*.

Table 13 Option Fault Monitor Descriptions

Fault Condition	Fault Declared	Status Value (U6-98/U6-99)	Description
No Fault	n/a	0	No faults
Force Fault	EF0	3	Network sent a message to force this node to the fault state
Network Link Down	BUS ERROR	1200	No network link to the option
Connection Time-out	BUS ERROR	1201	The control connection timer (F7-16) timed out
Duplicate IP Address	BUS ERROR	1202	This node and at least one other node have the same IP address
Default MAC Address	None	1203	Factory default MAC Address programmed into the option. Contact a Yaskawa representative or the nearest Yaskawa sales office for details.

Two drive monitor parameters, U6-98 and U6-99, assist the user in network troubleshooting.

- U6-98 displays the first declared fault since the last power cycle. U6-98 is only cleared upon drive power-up.
- U6-99 displays the present option status. U6-99 is cleared upon a network-issued fault reset and upon power-up.

If another fault occurs while the original fault is still active, parameter U6-98 retains the original fault value and U6-99 stores the new fault status value.

◆ Option Compatibility with A1000

A limited number of options may be simultaneously connected to the A1000 depending on the type of option. Refer to *Table 14* for more information. More details can be found in the Options and Peripheral Devices chapter of the drive Technical Manual.

Table 14 Option Installation Compatibility

Option	Connector	Number of Possible Options
SI-C3, SI-EM3, SI-EN3, SI-N3, SI-P3, SI-S3, SI-W3, etc.	CN5-A	1
PG-B3, PG-X3, etc.	CN5-B, C	2 <2>
AI-A3 <1>, AO-A3, DI-A3 <1>, DO-A3, etc.	CN5-A, B, C	1

<1> When installed in CN5-A, the AI-A3 and DI-A3 options can be used to set the frequency reference or replace the drive analog inputs with higher resolution. When installed in CN5-B or CN5-C, these options can only be used for monitoring; their input levels will be displayed in U1-17 or U1-21 to U1-23.
<2> Use the CN5-C connector when connecting only one option to the drive; use both CN5-B and CN5-C when connecting two options.

10 Specifications

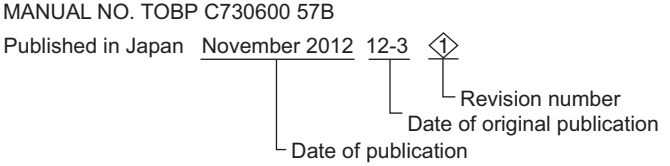
◆ Specifications

Table 15 Option Specifications

Item	Specification
Model	SI-EM3
Supported Messages	• Read Multiple Registers (03H) • Write Single Register (06H) • Write Multiple Registers (10H) • Read and Write Registers (17H) Commands that support multiple registers have a maximum Read and Write size of 16 registers.
Option Conformance	Modbus-IDA Passed
Connector Type	RJ45 8-pin Shielded Twisted Pair Cat 5e cable
Physical Layer Type	Isolated Physical Layer
IP Address Setting	Programmable from drive keypad or network
Communication Speed	Programmable from drive keypad or network: 10/100 Mbps, auto-negotiate.
Number of Connections	Modbus TCP/IP: 10 Web Page Access: 2
Duplex Mode	Half-forced, Auto-negotiate, Full-forced
Address Startup Mode	Static, BOOTP, DHCP
Ambient Temperature	-10 °C to +50 °C (14 °F to 122 °F)
Humidity	95% RH or lower with no condensation
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	1000 m (3280 ft.) or lower

◆ Revision History

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



Date of Publication	Revision Number	Section	Revised Content
November 2012	◇1	All	Revision: Reviewed and corrected entire documentation.
		Chapter 2, 3, and 5	Addition: Z1000 drive added along with corresponding data.
March 2012	–	–	First edition

YASKAWA AC Drive 1000-Series Option

Modbus TCP/IP

Installation Manual

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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.

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