YASKAWA

YASKAWA AC Drive 1000-Series Option

Motor PG Feedback Line Driver Interface

Installation Manual

Type: PG-X3

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

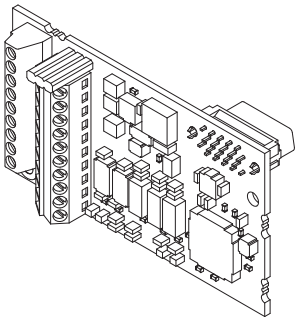
安川インバータ 1000シリーズオプション

ラインドライバタイプ PG インタフェース

取扱説明書

形　式 PG-X3

製品を安全にお使い頂くために，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。



MANUAL NO. TOBP C730600 37C

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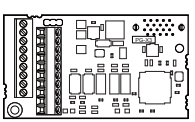
1 Preface and Safety

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.

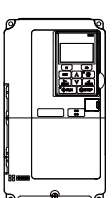
◆ Applicable Documentation

The following manuals are available for the option:

Option

	**YASKAWA AC Drive 1000-Series Option PG-X3 Installation Manual Manual No: TOBP C730600 37 (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 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 For questions, contact your local Yaskawa sales office or the nearest Yaskawa representative.
	YASKAWA AC Drive 1000-Series Technical Manual	

◆ Terms and Abbreviations

Note:	Indicates supplemental information that is not related to safety messages
Drive:	YASKAWA AC Drive 1000-Series
Option:	YASKAWA AC Drive 1000-Series Option Motor PG Feedback Line Driver Interface: Type PG-X3
PG:	Pulse Generator or Encoder mounted on the motor
V/f:	V/f Control
V/f w/PG:	V/f Control with PG
CLV:	Closed Loop Vector Control
AOLV/PM:	Advanced Open Loop Vector Control for PM
CLV/PM:	Closed Loop Vector Control for PM

◆ Registered Trademarks

Trademarks are the property of their respective owners.

◆ Supplemental Safety Information

Read and understand this manual before installing, operating, or servicing this option. Install the option according to this manual and local codes.

The following conventions indicate safety messages in this manual. Failure to heed these messages could cause fatal injury or damage products and 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 book may include options and drives without covers or safety shields to illustrate details. Be sure to reinstall covers or shields before operating any devices. Use the option 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 operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this 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

The PG-X3 Option allows the user to connect an incremental line driver encoder (PG) for motor speed feedback to the drive and take advantage of the V/f with PG, Closed Loop Vector, and Closed Loop Vector for PM Motors control modes. The option helps increase the control accuracy and performance.

This PG encoder signal allows the drive to compensate for subtle variations in the load, while providing the drive with the necessary data to control the output frequency and maintain an accurate constant speed.

The PG-X3 Option reads a maximum input frequency from the PG encoder of 300 kHz. Be sure to select a PG encoder with an output of maximum of 300 kHz when operating at maximum speed.

Note: This option cannot be used with an open collector encoder. Use option PG-B3 with open collector encoders.

◆ Applicable Models

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

Table 1 Applicable Models

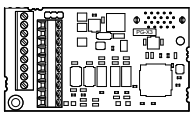
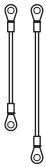
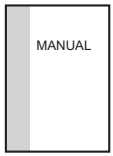
Drive Series	Drive Model Number
A1000	All models
L1000A	All models
U1000	All models
U1000L	All models

3 Receiving

Please perform the following tasks upon receiving 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 option nameplate (Refer to ***Figure 1*** on page ***10*** for more information).
- Contact your supplier if you have received the wrong model or the option does not function properly.

◆ Option Package Contents

Description:	Option	Ground Wires	Screws (M3)	Installation Manual
–				
Quantity:	1	2	3	1

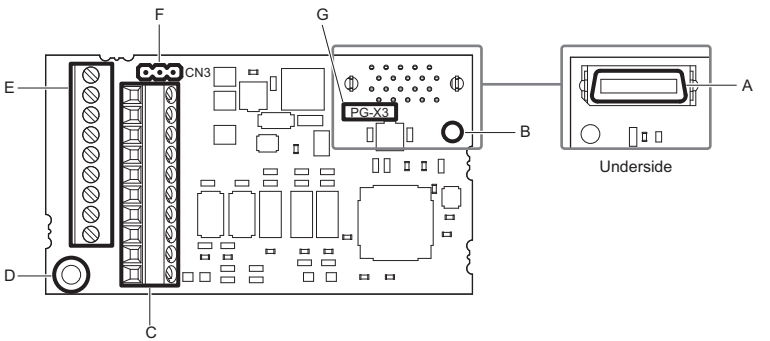
◆ Tools Required for Installation

- A Phillips screwdriver (M3 metric / #1, #2 U.S. standard size) is required to install the option.
- A flat-blade screwdriver (blade depth: 0.4 mm, width: 2.5 mm) is required to wire the option terminal block.
- A pair of diagonal cutting pliers.
- A small file or medium-grit sandpaper.

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

4 Option Components

◆ PG-X3 Option

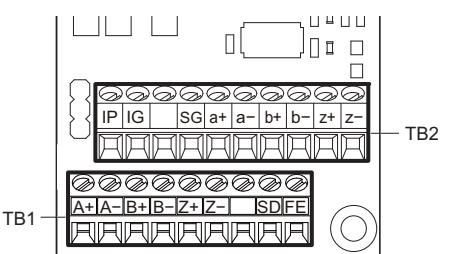


A – Connector (CN5)
B – Installation hole
C – Terminal block TB2
D – Ground terminal and installation hole <1>
E – Terminal block TB1
F – Jumper for PG encoder power supply voltage (CN3) <2>
G – Model number

<1> The ground wires provided in the option shipping package must be connected during installation.
<2> Refer to *Table 2* on page *21* for details.

Figure 1 PG-X3 Option Components

◆ Terminal Blocks TB1 and TB2



Refer to *Table 5* on page *26* for details on TB1 and TB2 terminal functions and signal levels.

5 Installation Procedure

◆ Section Safety

⚠ DANGER

Electric 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, 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. Use the option 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, stress the 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 running or outputting voltage.

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

Do not operate damaged equipment.

Failure to comply may cause further damage to the equipment.

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

Tighten all terminal screws to the specified tightening torque.

Failure to comply could result in damage to the terminal block.

Do not use unshielded cable for control wiring.

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

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

NOTICE

Properly connect all pins and connectors.

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

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

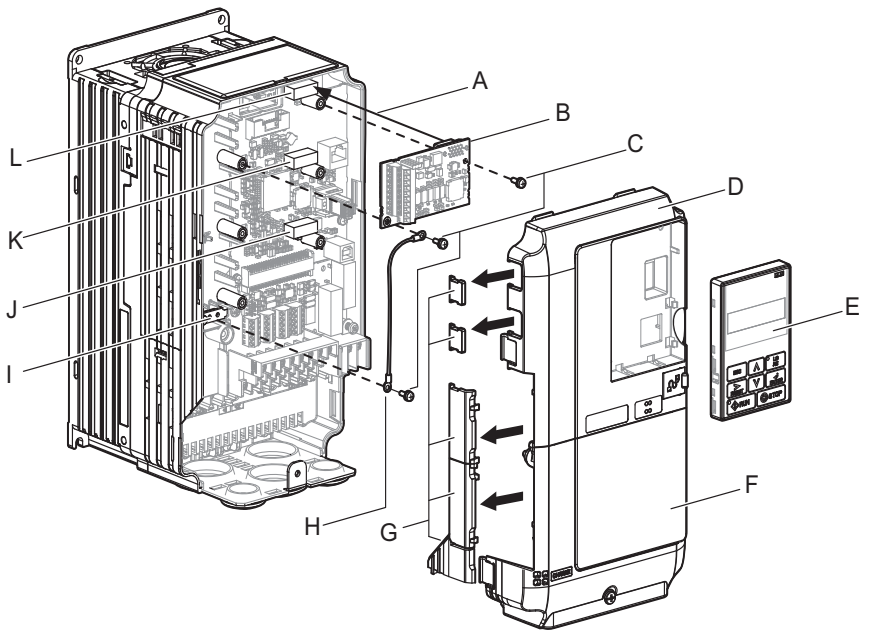
Failure to comply may result in damage to the option.

◆ Prior to Installing the Option

Note: Refer to the instruction manual of a specific drive for details.

Prior to installing the option, wire the drive, make the necessary connections to the drive terminals, and verify that the drive functions normally. Refer to the instruction manual 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
B – Option card
C – Included screws
D – Front cover
E – Digital operator
F – Terminal cover
G – Removable tabs for wire routing
H – Ground wire
I – Drive grounding terminal (FE)
J – Connector CN5-A
K – Connector CN5-B
L – Connector CN5-C

Figure 2 Drive Components with Option (CIMR-A□2A□)

◆ Installing the Option

Refer to the instructions below to install the option.

Note: Refer to the instruction manual of a specific drive for information on removing and installing the operators and the covers.

DANGER! *Electrical Shock Hazard. 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 to prevent electric shock. The internal capacitor remains charged even 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 (E), front cover (D), and terminal cover (F). Refer to the instruction manual packaged with the drive.

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.*

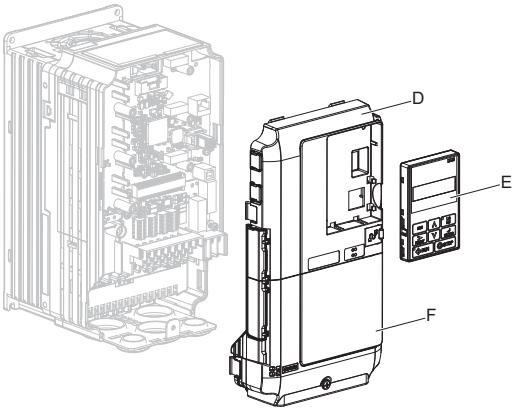


Figure 3 Remove the Front Cover, Terminal Cover, and Digital Operator

2. Insert the option card (B) into the CN5-B (K) or CN5-C (L) connectors located on the drive and fasten it into place using one of the included screws (C).
Use the CN5-C connector (L) when connecting only one option to the drive; use both CN5-B and CN5-C when connecting two options.

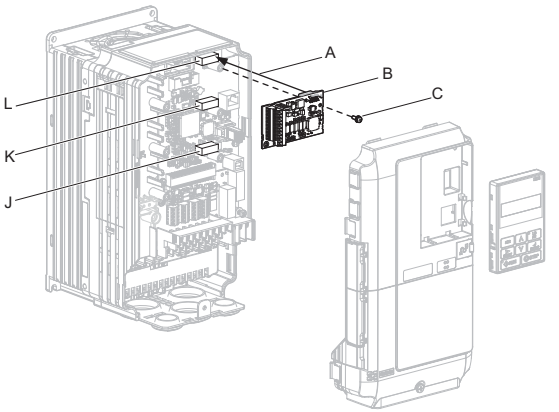


Figure 4 Insert the Option Card

3. Connect one end of the ground wire (H) to the ground terminal (I) using one of the remaining screws (C). Connect the other end of the ground wire (H) to the remaining ground terminal and installation hole on the option (B) using the last remaining provided screw (C).

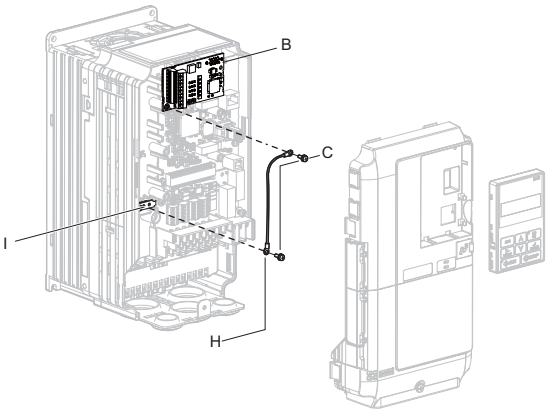


Figure 5 Connect the Ground Wire

Note: **1.** The option package includes two ground wires. Use the longer wire when plugging the option into connector CN5-C on the drive side. Use the shorter wire when plugging the option into connector CN5-B. *Refer to Option Package Contents on page 9* for more information.

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

4. Prepare and connect the wire ends as shown in ***Figure 6*** and ***Figure 7***. ***Refer to Wire Gauges and Tightening Torques on page 25*** to confirm that the proper tightening torque is applied to each terminal. Take particular precaution to ensure that each wire is properly connected and wire insulation is not accidentally pinched into electrical terminals.

WARNING! *Fire Hazard. Tighten all terminal screws according to the specified tightening torque. Loose electrical connections could result in death or serious injury by fire due to overheating electrical connections. Tightening screws beyond the specified tightening torque may result in erroneous operation, damage the terminal block, or cause a fire.*

NOTICE: *Heat shrink tubing or electrical tape may be required to ensure that cable shielding does not contact other wiring. Insufficient insulation may cause a short circuit and damage the option or drive.*

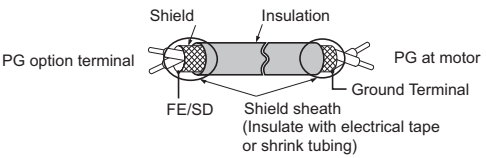


Figure 6 Preparing Ends of Shielded Cable

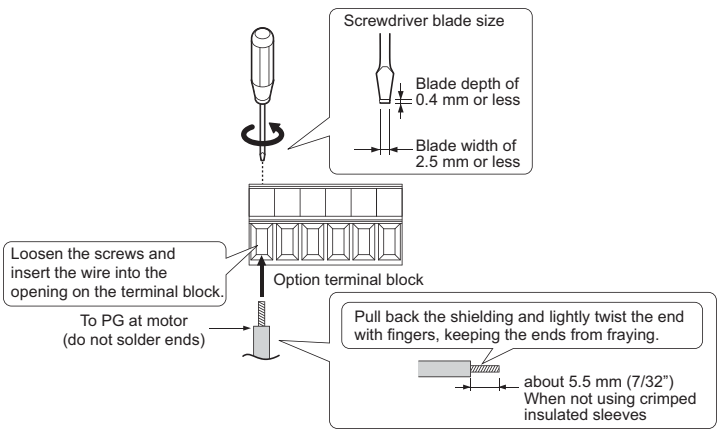


Figure 7 Preparing and Connecting Cable Wiring

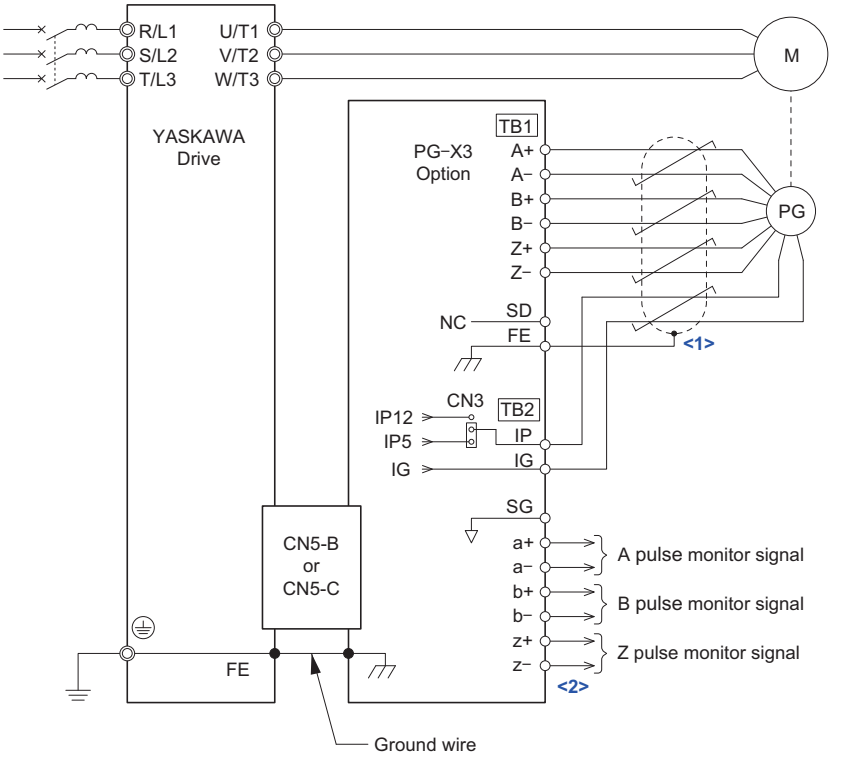
5. Wire the motor PG encoder to the terminal block on the option. Refer to ***Figure 6*** and ***Figure 7*** for wiring instructions. Refer to ***Figure 8*** for the connection diagram. Refer to ***Table 5*** for a detailed description of the option terminal functions.

Parameter Settings and Connections for Different PG Encoder Types

- Connecting a Single-Pulse PG Encoder
  When using a single-pulse PG encoder in V/f with PG control mode, connect the pulse output from the PG encoder to the option and set drive parameter F1-21 to 0.
- Connecting a Two-Pulse PG Encoder
  When using a two-pulse PG encoder, connect the A and B pulse outputs on the PG encoder to the option and set F1-21 to 1.
  When using a two-pulse PG encoder in Closed Loop Vector control mode, connect pulse outputs A and B from the PG encoder to the corresponding terminals on the option.
- Connecting a Two-Pulse PG Encoder with Z Marker Pulse
  When using a two-pulse PG encoder with Z marker pulse, connect the A, B, and Z pulse outputs to the corresponding terminals on the option.

Control Method	V/f with PG		Closed Loop Vector	
No. of PG Encoders	1 (CN5-C)	2 (CN5-B)	1 (CN5-C)	2 (CN5-B)
Single Pulse (A)	F1-21 = 0	F1-37 = 0	N/A	N/A
Two Pulse (AB Quadrature)	F1-21 = 1	F1-37 = 1	No setting required	No setting required
Two Pulse with Marker (ABZ)	F1-21 = 1	F1-37 = 1	No setting required	No setting required

Connection Diagram



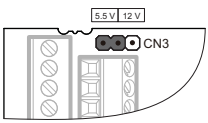
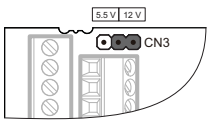
<1> Ground the shield on the PG encoder side and the drive side. If noise problems arise in the PG encoder signal, remove the shield ground from one end of the signal line or remove the shield ground connection on both ends.
<2> Yaskawa recommends using shielded lines or shielded twisted-pair lines.

Figure 8 PG-X3 Option and PG Encoder Connection Diagram

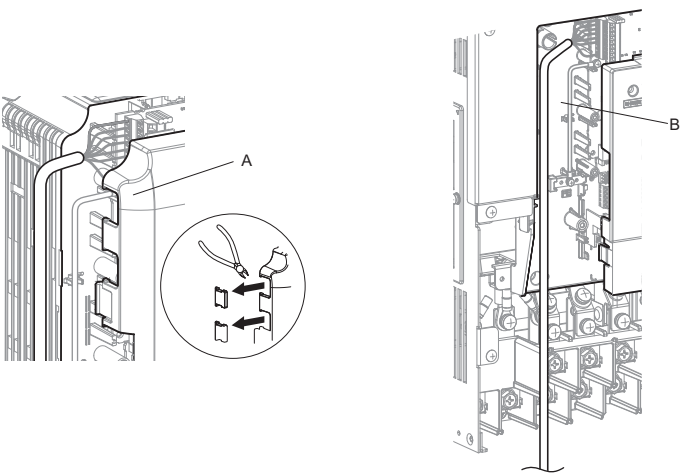
6. Set the voltage for the PG encoder power supply using jumper CN3 located on the option. Position the jumper as shown in ***Table 2*** to select the voltage level.

NOTICE: *The positioning of jumper CN3 selects the PG encoder power supply voltage (5.5 V or 12 V). Select the voltage level for the PG encoder connected to the option and motor. If the wrong voltage is selected, the PG encoder may not operate properly or may become damaged as a result.*

Table 2 Setting the PG Encoder Power Supply Voltage (IP) with Jumper CN3

Voltage Level	5.5 V ± 5% (default)	12.0 V ± 5%
Jumper CN3 Position		

7. 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. In these cases, cut out the perforated openings on the left side of the drive front cover as shown in ***Figure 9***-A and leave no sharp edges to damage wiring.
Route the wiring inside the enclosure as shown in ***Figure 9***-B for drives that do not require routing through the front cover.
Refer to the *Peripheral Devices & Options* section of the drive instruction manual for more information.



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

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

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

Figure 9 Wire Routing Examples

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

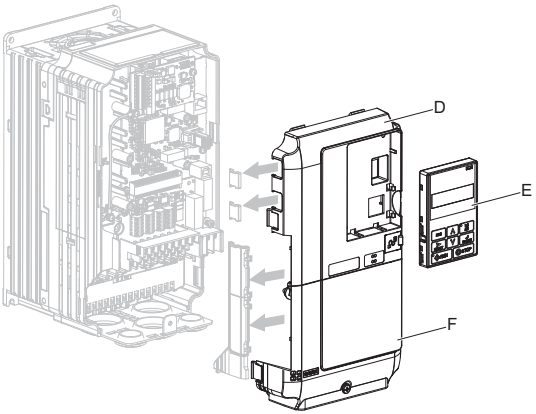


Figure 10 Replace the Front Covers and Digital Operator

Note: Take proper precautions when wiring the option so that the front covers will easily fit back onto the drive. Make sure cables are not pinched between the front covers and the drive when replacing the covers.

9. Set drive parameters in ***Table 6*** for proper motor rotation.

With a two-pulse or three-pulse PG encoder, the leading pulse determines the motor rotation direction. A PG encoder signal with leading A pulse is considered to be rotating forward (counter-clockwise when viewing rotation from motor load side).

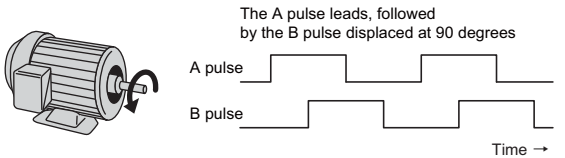


Figure 11 Displacement of A and B Pulses

After connecting the PG encoder outputs to the option, apply power to the drive and manually rotate the motor and check the rotation direction by viewing monitor U1-05 on the digital operator.

WARNING! *Ensure the drive RUN circuit is locked out and a RUN command is not possible before attempting to manually rotate the motor shaft with the drive powered on. Failure to comply may cause injury to personnel due to inadvertent equipment movement.*

Reverse motor rotation is indicated by a negative value for U1-05; forward motor rotation is indicated by a positive value.
If monitor U1-05 indicates that the forward direction is opposite of what is intended, reverse the two A channel wires with the two B channel wires on option terminal TB1 as shown in ***Figure 12***.

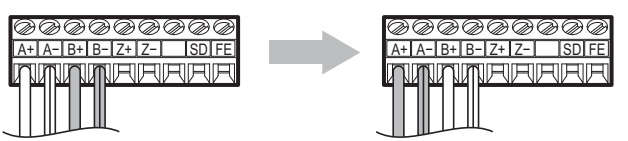


Figure 12 A Channel and B Channel Wire Switching

If switching the wires is inconvenient, set drive parameter F1-05/F1-32 to 1 to switch the direction of how the option reads pulses from the PG encoder output.

Note: If the drive is initialized using A1-03 =1110, 2220, or 3330, the value for F1-05/F1-32 will reset to factory default and the parameter will need to be adjusted again to switch the direction.

◆ Wire Gauges, Tightening Torque, and Crimp Terminals

■ Wire Gauges and Tightening Torques

Wire gauge and torque specifications are listed in ***Table 3***.

Table 3 Wire Gauges and Tightening Torques

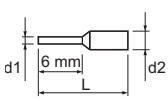
Terminal Signal	Screw Size	Tightening Torque N·m (in·lb)	Bare Cable		Crimp Terminals		Wire Type
			Recomm. Gauge mm^2	Applicable Gauges mm^2	Applicable Gauges mm^2	Recomm. Gauge mm^2	
A+, A–, B+, B–, Z+, Z–, SD, FE, IP, IG	M2	0.22 to 0.25 (1.95 to 2.21)	0.75 (18 AWG)	Stranded wire: 0.25 to 1.0 (24 to 17 AWG) Solid wire: 0.25 to 1.5 (24 to 16 AWG)	0.5 (20 AWG)	0.25 to 0.5 (24 to 20 AWG)	Shielded twisted pair, etc.
a+, a–, b+, b–, z+, z–, SG							Shielded cable, etc.

■ Crimp Terminals

Yaskawa recommends using CRIMPFOX 6 by Phoenix Contact or equivalent crimp terminals with the specifications listed in ***Table 4*** for wiring to ensure proper connections.

Note: Properly trim wire ends so loose wire ends do not extend from the crimp terminals.

Table 4 Crimp Terminal Sizes

	Wire Gauge mm^2	Phoenix Contact Model	L mm (in)	d1 mm (in)	d2 mm (in)
	0.25 (24 AWG)	AI 0.25 - 6YE	10.5 (13/32)	0.8 (1/32)	2 (5/64)
	0.34 (22 AWG)	AI 0.34 - 6TQ	10.5 (13/32)	0.8 (1/32)	2 (5/64)
	0.5 (20 AWG)	AI 0.5 - 6WH	14 (9/16)	1.1 (3/64)	2.5 (3/32)

◆ Terminal Functions

Table 5 Option Terminal Functions

Terminal Block	Terminal	Function	Description
TB1	A+	A pulse signal input	• Inputs for the A channel, B channel, and Z pulses from the PG encoder • Signal level matches RS-422
	A–	A inverse pulse signal input	
	B+	B pulse signal input	
	B–	B inverse pulse signal input	
	Z+	Z pulse signal input	
	Z–	Z inverse pulse signal input	
	SD	NC pin (open)	Open connection port for use when cable shields should not be grounded
	FE	Ground	Used as the shield ground termination point.
TB2	IP	PG encoder power supply	• Output voltage: 12.0 V ± 5% or 5.5 V ± 5% • Max. output current: 200 mA <1>
	IG	PG encoder power supply common	
	SG	Monitor signal common	• Output signal for monitoring A channel, B channel, and Z pulses from the PG encoder • Signal level matches RS-422
	a+	A pulse monitor signal	
	a–	A pulse inverse monitor signal	
	b+	B pulse monitor signal	
	b–	B pulse inverse monitor signal	
	z+	Z pulse monitor signal	
	z–	Z pulse inverse monitor signal	

<1> A separate UL-listed class 2 power supply is necessary when the PG requires more than 200 mA to operate.

6 Related Parameters

The following parameters set the drive for operation with the option. Set parameters as needed. Parameter setting methods can be found in the drive instruction manual.

Table 6 Related Parameters

No. (Addr. Hex)	Name	Description	Control Mode	Values
A1-02 (102)	Control Method Selection	0: V/f Control 1: V/f Control with PG 2: Open Loop Vector Control 3: Closed Loop Vector Control 5: Open Loop Vector Control for PM 6: Advanced Open Loop Vector Control for PM 7: Closed Loop Vector Control for PM	All Modes	Default: <1> Range: <1>
F1-01 (380) <2> <3>	PG 1 Pulses per Revolution	Sets the pulses to be read from the pulse generator.	V/f w/ PG CLV CLV/PM	Default: <1> Min: <1> Max: <1>
F1-02 (381)	PG Feedback Loss Operation Selection	Sets the stopping method after PG disconnect (PGo). 0: Ramp to stop (decelerates at time set to C1-02) 1: Coast to stop 2: Fast Stop (decelerates at the time set to C1-09) 3: Continue running 4: No alarm display **NOTICE**: Due to potential damage to the motor and machinery, only use settings 3 and 4 under special circumstances.	V/f w/ PG CLV CLV/PM	Default: 1 Range: <1>
F1-03 (382)	PG Overspeed Operation Selection	Sets the stopping method after detecting overspeed. 0: Ramp to stop (decelerates at time set to C1-02) 1: Coast to stop 2: Fast Stop (decelerates at the time set to C1-09) 3: Continue running **NOTICE**: Due to potential damage to the motor and machinery, do not use the "Continue running" setting except under special circumstances.	V/f w/ PG CLV CLV/PM	Default: 1 Range: 0 to 3
F1-04 (383)	PG Deviation Operation Selection	0: Ramp to stop (decelerates at time set to C1-02) 1: Coast to stop 2: Fast Stop (decelerates at the time set to C1-09) 3: Continue running **NOTICE:** Due to potential damage to the motor and machinery, do not use the "Continue running" setting except under special circumstances.	V/f w/ PG CLV CLV/PM AOLV/PM	Default: <1> Range: 0 to 3
F1-05 (384) <3>	PG 1 Rotation	0: Forward = A pulse leads 1: Forward = B pulse leads	V/f w/ PG CLV CLV/PM	Default: <1> Range: 0, 1

No. (Addr. Hex)	Name	Description	Control Mode	Values
F1-06 (385) <3>	PG 1 Ratio for PG Pulse Monitor	Sets the division ratio for PG encoder pulse output. Set as a three-digit number: x is the first digit, y is the second digit, and z is the third digit: $\text{Ratio} = \frac{(1 + x)}{yz}$ When only the A pulse is read, this ratio is disabled and pulses are set as 1/32 : 1.	V/f w/ PG CLV CLV/PM	Default: 1 Min: 1 Max: 132
F1-08 (387)	PG Overspeed Level	Sets the level for detecting overspeed as a percentage of the maximum output frequency.	V/f w/ PG CLV CLV/PM AOLV/PM	Default: 115 Min: 0 Max: 120
F1-09 (388)	Overspeed Det. Time	Sets the time required for the motor to exceed the level set in F1-08 to trigger a fault.	V/f w/ PG CLV CLV/PM AOLV/PM	Default: <4> Min: 0.0 Max: 2.0
F1-10 (389)	Excessive Speed Deviation Det. Level	Sets the degree of speed deviation to trigger a dEv fault. Set as a percentage of the maximum output frequency.	V/f w/ PG CLV CLV/PM AOLV/PM	Default: 10 Min: 0 Max: 50
F1-11 (38A)	Excessive Speed Deviation Det. Time	Sets the time required for a speed deviation situation to trigger a fault.	V/f w/ PG CLV CLV/PM AOLV/PM	Default: 0.5 Min: 0.0 Max: 10.0
F1-12 (38B) <3> <5>	PG 1 Gear Teeth 1	Number of gear teeth between the PG and motor. $\frac{\text{Pulses} \times 60}{\text{F1-01}} \times \frac{\text{F1-13 (load side)}}{\text{F1-12 (motor side)}}$ A gear ratio of 1 will be used if any of these parameters is set to 0.	V/f w/ PG	Default: 0 Min: 0 Max: 1000
F1-13 (38C) <3> <5>	PG 1 Gear Teeth 2			
F1-14 (38D)	PG Disconnect Det. Time	Sets the time in seconds for PG encoder disconnect to be detected.	V/f w/ PG CLV CLV/PM	Default: 2.0 Min: 0.0 Max: 10.0
F1-18 (3AD) <3>	Reverse Rotation Det. for PG 1	0: Disabled n: Number of times a dv3 situation must be detected to trigger a fault.	CLV/PM	Default: 10 Min: 0 Max: 10
F1-19 (3AE) <3>	Reverse Rotation Det. for PG 1	0: Disabled n: Number of times a dv4 situation must be detected to trigger a fault.	CLV/PM	Default: 128 Min: 0 Max: 5000
F1-20 (3B4) <3>	PG 1 Hardware Disconnect	0: Disabled. No fault if the connection is lost. 1: Enabled. Fault if connection is lost.	V/f w/ PG CLV CLV/PM	Default: 1 Range: 0, 1
F1-21 (3BC) <3>	PG 1 Option Function	0: A pulse detection 1: AB pulse detection	V/f w/ PG	Default: 0 Range: 0, 1

No. (Addr. Hex)	Name	Description	Control Mode	Values
F1-30 (3AA) <6>	Motor 2 PG Connector	Selects the PG option connector for motor 2. 0: CN5-C 1: CN5-B	V/f w/ PG CLV	Default: 1 Range: 0, 1
F1-31 (3B0) <2> <7>	PG 2 Pulse Setting	Sets the pulses to be read from the pulse generator.	V/f w/ PG CLV	Default: 1024 Min: 0 Max: 60000
F1-32 (3B1) <7>	PG 2 Rotation	0: Forward = A pulse leads 1: Forward = B pulse leads	V/f w/ PG CLV	Default: 0 Range: 0, 1
F1-33 (3B2) <5> <7>	PG 2 Gear Teeth 1	Number of gear teeth between the PG and motor. $\frac{\text{Pulses} \times 60}{\text{F1-31}} \times \frac{\text{F1-33 (load side)}}{\text{F1-34 (motor side)}}$ A gear ratio of 1 will be used if any of these parameters is set to 0.	V/f w/ PG	Default: 0 Min: 0 Max: 1000
F1-34 (3B3) <5> <7>	PG 2 Gear Teeth 2			
F1-35 (3BE) <7>	PG 2 Division Ratio for Pulse Monitor	Sets the division ratio for the PG encoder pulse output. Set as a three-digit number where x is the first digit, y is the second digit, and z is the third digit: $\text{Ratio} = \frac{(1 + x)}{yz}$ When only the A pulse is read, this ratio is disabled and pulses are set as 1/32 : 1.	V/f w/ PG CLV	Default: 1 Min: 1 Max: 132
F1-36 (3B5) <7>	PG 2 Hardware Disconnect	0: Disabled. No fault if the connection is lost. 1: Enabled. Fault if connection is lost.	V/f w/ PG CLV	Default: 1 Range: 0, 1
F1-37 (3BD) <7>	PG 2 Option Function	0: A pulse detection 1: AB pulse detection	V/f w/ PG	Default: 0 Range: 0, 1

<1> Varies by drive model.
<2> The number of output pulses for the PG encoder can be calculated with the following formula:

$$f_{PG}(\text{Hz}) = \frac{\text{Motor speed at maximum frequency output (min}^{-1}\text{)}}{60} \times \text{PG rating (p/rev)}$$

<3> The parameter is available only for the drive connector CN5-C.
<4> Value changes according to the control mode selection in A1-02.
<5> Enabled only when using the V/f with PG control mode.
<6> Depending on the drive series, a second PG encoder (PG 2) may not be possible. Refer to the drive Technical Manual for the drive in your application.
<7> The parameter is available only for the drive connector CN5-B.

7 Troubleshooting

◆ Drive-Side Error Codes

Table 7 lists the various fault codes related to the option and pulse generator. Refer to the drive Technical Manual for further details on fault codes.

Check the following items first when an error code occurs on the drive:

- Are the cables connected properly and securely?
- Is the option properly installed to the drive?
- Did a momentary power loss occur?

Table 7 Fault Displays, Causes, and Possible Solutions

Digital Operator Display		Fault Name
dEv	dEv	Speed Deviation (for Control Mode with PG)
		The deviation between the speed reference and speed feedback is greater than the setting in F1-10 for longer than the time set to F1-11.
Cause		**Possible Solution**
The load is too heavy.		Reduce the load.
The acceleration and deceleration times are set too short.		Increase the acceleration and deceleration times (C1-01 through C1-08).
The load is locked up.		Check the machine.
Parameters are set inappropriately.		Check the settings of parameters F1-10 and F1-11.
Motor brake is engaged.		Ensure the motor brake releases properly.
Digital Operator Display		**Fault Name**
dv1	dv1	Z Channel Pulse Fault Detection
		The motor turned one full rotation while failing to detect the Z channel pulse.
Cause		**Possible Solution**
The PG encoder is disconnected or is not wired properly, or the PG option or PG encoder are damaged.		• Rewire the PG encoder and make sure all wiring including shielded wiring is properly connected. • If the problem continues after cycling power, replace the PG option or the PG encoder.
Digital Operator Display		**Fault Name**
dv2	dv2	Z Channel Pulse Noise Fault Detection
		The Z channel pulse is out of phase by more than 5 degrees for the number of times specified in parameter F1-17.
Cause		**Possible Solution**
PG encoder cable noise interference.		Separate the PG encoder cable wiring from the source of the noise (e.g., drive output wiring).

The PG encoder is disconnected or is not wired properly, or the PG option or PG encoder are damaged.	• Rewire the PG encoder and make sure all wiring including shielded wiring is properly connected. • If the problem continues after cycling power, replace the PG option or the PG encoder.
Digital Operator Display	**Fault Name**
dv3	Inversion Detection
	• Torque reference and acceleration are in opposite directions. • The speed reference and actual motor speed differ by over 30% for the number of pulses set to parameter F1-18.
Cause	**Possible Solution**
The Z channel pulse offset is not set properly to E5-11.	Set the value for Δθ to E5-11 as specified on the motor nameplate. Replacing the PG encoder or changing the application so the motor rotates in reverse requires readjustment of the Z channel pulse offset.
An external force on the load side caused the motor to move.	• Make sure the motor is rotating in the proper direction. • Investigate problems on the load side causing motor rotation in the opposite direction.
Noise interference along the PG encoder cable is affecting the A channel or B channel.	• Check PG encoder wiring and make sure all wiring including shielded wiring is properly connected. • If the problem continues after cycling power, replace the PG option or the PG encoder.
The PG encoder is disconnected or is not wired properly, or the PG option or PG encoder is damaged.	
The PG encoder rotational direction set to F1-05 is in the opposite direction of the motor wiring.	Make sure motor wiring for each phase (U, V, W) is connected properly.
Digital Operator Display	**Fault Name**
dv4	Inversion Prevention Detection
	Pulses indicate that the motor is rotating in the opposite direction of the speed reference. Set the number of pulses to trigger inverse detection to F1-19. **Note:** To avoid nuisance faults, be sure to disable inverse detection in applications where the motor may rotate in the opposite direction of the speed reference. Set F1-19 to 0 to disable this feature.
Cause	**Possible Solution**
The Z channel pulse offset is not set properly to E5-11.	• Set the value for Δθ to E5-11 as specified on the motor nameplate. • If the problem continues after cycling power, replace the PG option or the PG encoder. Replacing the PG encoder or changing the application so the motor rotates in reverse requires readjustment of the Z channel pulse offset.
Noise interference along the PG encoder cable is affecting the A or B pulse.	• Make sure the motor is rotating in the proper direction. • Investigate problems on the load-side that may be causing the motor to rotate in the opposite direction.

PG encoder is disconnected or is not wired properly, or the PG option or PG encoder are damaged.	• Check PG encoder wiring and make sure all wiring including shielded wiring is properly connected. • If the problem continues after cycling power, replace the PG option or the PG encoder.
Digital Operator Display	**Fault Name**
oFA00	oFA00 — Non-compatible option is connected to drive port CN5-A.
Cause	**Possible Solution**
Non-compatible option is connected to drive port CN5-A.	Use only compatible options. Connect PG-X3 to CN5-B or CN5-C. For other options, refer to the Installation Manual for that option.
Digital Operator Display	**Fault Name**
oFb00	oFb00 — Non-compatible option is connected to drive port CN5-B.
Cause	**Possible Solution**
Non-compatible option is connected to drive port CN5-B.	Use only compatible options. For other options, refer to the Installation Manual for that option.
Digital Operator Display	**Fault Name**
oFb01	oFb01 — Option Connection Error at drive port CN5-B
Cause	**Possible Solution**
Option at drive port CN5-B was changed during run.	Switch the power off and reconnect the option.
Digital Operator Display	**Fault Name**
oFC01	oFC01 — Option Connection Error at drive port CN5-C
Cause	**Possible Solution**
Option at drive port CN5-C was changed during run.	Switch the power off and reconnect the option.
Digital Operator Display	**Fault Name**
oS	oS — Overspeed The motor speed feedback exceeded the F1-08 setting.
Cause	**Possible Solution**
Overshoot is occurring.	• Increase the settings for C5-01 (Speed Control Proportional Gain 1) and reduce C5-02 (Speed Control Integral Time 1). • Enable Feed Forward Control and perform Inertia Auto-Tuning in CLV.
Incorrect speed feedback scaling when terminal RP is used as speed feedback input in V/f control.	• Set H6-02 to the value of the speed feedback signal frequency when the motor runs at the maximum speed. • Adjust the input signal using parameters H6-03 through H6-05.
Incorrect PG encoder pulse number set.	Check and correct parameter F1-01.
Inappropriate parameter settings.	Check the setting for the overspeed detection level and the overspeed detection time (F1-08 and F1-09).

Digital Operator Display		Fault Name
PGo	PGo	PG Encoder Disconnected
		Detected when no PG encoder pulses have been received for a time longer than is set to F1-14.
Cause		**Possible Solution**
PG encoder cable is disconnected.		Reconnect the cable.
PG encoder wiring is incorrect.		Correct the wiring.
PG encoder does not have enough power.		Make sure the correct power supply is properly connected to the PG encoder.
Brake is holding the PG encoder.		Ensure the brake releases properly.
Digital Operator Display		**Fault Name**
PGoH	PGoH	PG Encoder Hardware Fault
		PG encoder cable is disconnected.
Cause		**Possible Solution**
PG encoder cable is disconnected.		Reconnect the cable.

Table 8 Operation Error Displays, Causes, and Possible Solutions

Digital Operator Display		Fault Name
oPE06	oPE06	Control Method Selection Error
		Correct the setting for the control method.
Cause		**Possible Solution**
Control mode requires installing a PG option, but no PG option is installed (A1-02 = 1, 3, or 7).		• Connect a PG option. • Correct the value set to A1-02.

◆ Preventing Noise Interference

Take the following steps to prevent erroneous operation caused by noise interference:

- Use shielded wire for the PG encoder signal lines.
- Limit the length of the PG encoder signal cables to less than 100 m.
- Use separate conduit or cable tray dividers to separate option control wiring, main circuit input power wiring, and motor output power cables.
- Ground the shield of the cable on the PG encoder side and the drive side. If noise problems arise in the PG encoder signal, verify that the shield is properly grounded and ground one end of the signal line or remove the ground connection on both ends.

■ Interface Circuit

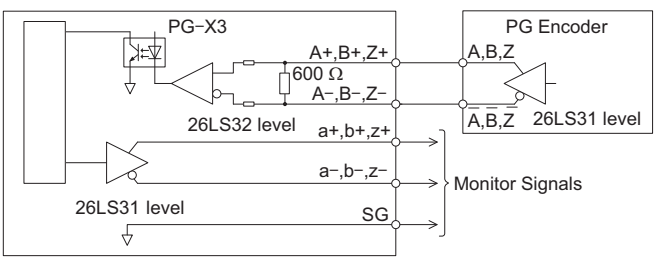


Figure 13 Interface Circuit

8 European Standards

Figure 14 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: 2004/108/EC

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. After setting up the device, verify that conditions meet European standards.

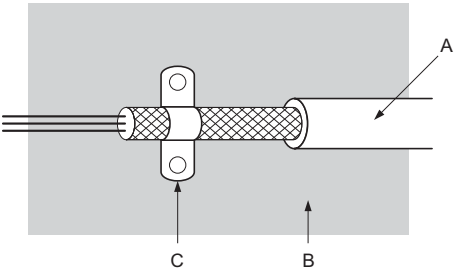
◆ EMC Guidelines Compliance

This option is tested according to European standards IEC/EN61800-3:2004 and complies with EMC guidelines. We declared the CE marking based on the harmonized standards.

■ Installation Method

Verify the following installation conditions to ensure that other devices and machinery used in combination with this option 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. Ground the shield according to ***Figure 16***.
3. Ground the largest possible surface area of the shield to the metal panel when using dedicated shield cable.



A – Braided shield cable
B – Metal panel
C – Cable clamp (conductive)

Figure 15 Ground Area

■ Option Installation for CE Compliance: Models PG-□□,DI-□□,DO-□□, AI-□□,AO-,SI-□□

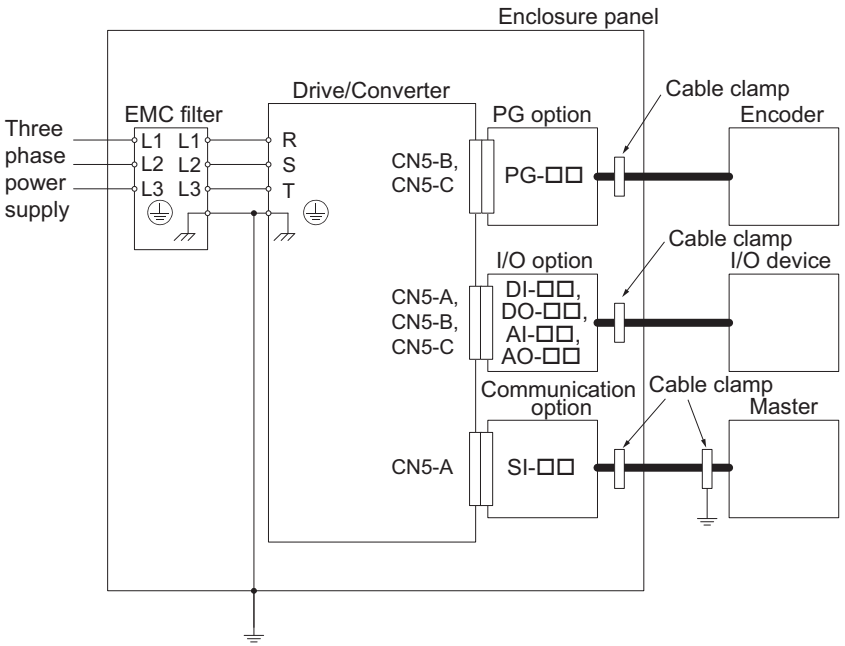


Figure 16 Option Installation for CE Compliance

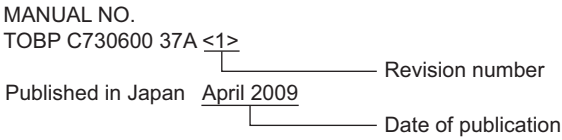
9 Specifications

Table 9 Option Specifications

Items	Specifications
Model	PG-X3
Compatible Pulse Generators	Line driver Single-pulse (A pulse), two-pulse (A, B pulse) or three-pulse (A, B, Z (R) pulse)
PG Encoder Wiring Length	100 m (328 ft.) maximum
PG Encoder Power Supply	Output voltage: 12 V ± 5% or 5.5 V ± 5% Max. Output Current: 200 mA
Compatible Control Modes	V/f with PG, Closed Loop Vector, Closed Loop Vector for PM motors
Maximum Input Frequency	300 kHz
Pulse Monitor Output	Monitor for A channel, B channel, and Z pulse output Matches RS-422 level
Pulse Monitor Wiring Length	100 m (328 ft.) maximum
PG Encoder Disconnect Detection	Software and hardware detection
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.



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		Chapter 2	Addition: Information on U1000 and U1000L
		Chapter 8	Addition: European Standards
February 2014	<9>	–	Japanese version only.
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YASKAWA AC Drive 1000-Series Option

Motor PG Feedback Line Driver Interface

Installation Manual

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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.

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