Fuji Electric

Innovating Energy Technology

User's Manual

USER'S MANUAL

FRENIC-VG Series

Option Edition

High Performance, Vector Control Inverter

FRENIC-VG

User's Manual

(Option Edition)

Preface

This manual describes the functions of various option cards and RS-485 interface available for the FRENIC-VG series (Unit type/Stack type).

For the operating procedure, drive modes and selection of peripheral equipment, refer to the FRENIC-VG User's Manuals (Unit Type / Function Codes Edition and Stack Type Edition).

Carefully read this manual in conjunction with the Unit type / Function Codes Edition and Stack Type Edition for proper use. Incorrect handling of the inverter may prevent the inverter or related equipment from operating correctly, shorten their lives, or cause problems.

The table below lists the materials related to the use of the FRENIC-VG. Read them in conjunction with this manual as necessary.

Name		Manual No.	Description
Catalog		24A1-□-0002* (Old No. MH659)	Product scope, features, specifications, external drawings, and options of the product
User's Manuals	Unit Type / Function Codes Edition (this manual)	24A7-□-0019* (Old No. MHT286)	1) Function codes, keypad operation, etc. for the FRENIC-VG series (Unit type/Stack type) 2) Outline, features, specifications, replacement data, etc. of the FRENIC-VG Unit type
	Option Edition (this manual)	24A7-□-0045* (Old No. MHT286)	Functions of various option cards, RS-485 interface, etc. available for the FRENIC-VG series * For the optional functional safety card (OPC-VG1-SAFE), refer to the option card instruction manual. Other options are described in this manual.
	Stack Type Edition	24A7-□-0018*	Features, specifications, cabinet design materials, etc. of the FRENIC-VG Stack type and the converter
	UPAC Option Edition	24A7-□-0044*	UPAC option card specifications, INV⇔UPAC interface, application package software (orientation and dancer type of winders), etc.
Instruction Manual (FRENIC-VG Unit Type)		INR-SI47-1580*-□	Acceptance inspection, mounting & wiring of the inverter, operation using the keypad, troubleshooting, and maintenance and inspection, specifications, etc.
FRENIC-VG Loader Instruction Manual	WPS-VG1-STR	INR-SI47-1617*-□	Instructions for inverter support software FRENIC-VG Loader (free version)
	WPS-VG1-PCL	INR-SI47-1589*-□	Instructions for FRENIC-VG Loader (paid-for version) including the tracing function not supported by the WPS-VG1-STR (free version)

Note 1: A box (□) in the above table replaces an alphabet letter: J (Japanese), E (English), or C (Chinese). An asterisk (*) replaces a revision code (a, b, c,…).

Note 2: The materials are subject to change without notice. Be sure to obtain the latest editions for use.

How this manual is organized

This manual contains Chapters 5 and 6.

Chapter 5 USING STANDARD RS-485

This chapter describes the use of standard RS-485 communications ports and provides an overview of the FRENIC-VG Loader.

Chapter 6 CONTROL OPTIONS

This chapter describes the FRENIC-VG's control options.

For other information, refer to the FRENIC-VG User's Manuals (Unit Type / Function Codes Edition and Stack Type Edition).

CONTENTS

Safety precautions

Read this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Safety precautions are classified into the following two categories in this manual.

⚠WARNING	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries.
⚠CAUTION	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage.

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

Application

⚠WARNING

- The FRENIC-VG is designed to drive a three-phase induction motor. Do not use it for single-phase motors or for other purposes.

  Fire or an accident could occur.

- The FRENIC-VG may not be used for a life-support system or other purposes directly related to the human safety.
- Though the FRENIC-VG is manufactured under strict quality control, install safety devices for applications where serious accidents or property damages are foreseen in relation to the failure of it.

  An accident could occur.

Installation

⚠WARNING

- Install the inverter on a base made of metal or other non-flammable material.

  Otherwise, a fire could occur.

- Do not place flammable object nearby.

  Doing so could cause fire.

- Inverters with a capacity of 30 kW or above, whose protective structure is IP00, involve a possibility that a human body may touch the live conductors of the main circuit terminal block. Inverters to which an optional DC reactor is connected also involve the same. Install such inverters in an inaccessible place.

  Otherwise, electric shock or injuries could occur.

⚠CAUTION

- Do not support the inverter by its front cover during transportation.

  Doing so could cause a drop of the inverter and injuries.

- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.
- When changing the positions of the top and bottom mounting bases, use only the specified screws.

  Otherwise, a fire or an accident might result.

- Do not install or operate an inverter that is damaged or lacking parts.

  Doing so could cause fire, an accident or injuries.

Wiring

⚠WARNING

- If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only.

  Otherwise, a fire could occur.

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the recommended devices within the recommended current capacity.

- Use wires in the specified size.
- Tighten terminals with specified torque.

  Otherwise, a fire could occur.

- When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

  Doing so could cause a fire.

- Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity.

  Otherwise, a fire could occur.

- Ground the inverter in compliance with the national or local electric code.
- Be sure to ground the inverter's grounding terminals ⏚G.

  Otherwise, an electric shock or a fire could occur.

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after turning the power OFF.

  Otherwise, an electric shock could occur.

- Be sure to perform wiring after installing the inverter unit.

  Otherwise, an electric shock or injuries could occur.

- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

  Otherwise, a fire or an accident could occur.

- Do not connect the power supply wires to output terminals (U, V, and W).
- When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals P(+) and DB.

  Doing so could cause fire or an accident.

- In general, sheaths of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of the sheath might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal wires will not come into contact with live conductors of the main circuit.

  Doing so could cause an accident or an electric shock.

⚠WARNING⚠

- Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.

⚠CAUTION

- The inverter, motor and wiring generate electric noise. Be careful about malfunction of the nearby sensors and devices. To prevent them from malfunctioning, implement noise control measures.

  Otherwise an accident could occur.

Operation

⚠WARNING

- Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON.
  Otherwise, an electric shock could occur.

- Do not operate switches with wet hands.
  Doing so could cause electric shock.

- If the auto-reset function has been selected, the inverter may automatically restart and drive the motor depending on the cause of tripping. Design the machinery or equipment so that human safety is ensured at the time of restarting.
  Otherwise, an accident could occur.

- If the stall prevention function (torque limiter) has been selected, the inverter may operate with acceleration/deceleration or speed different from the commanded ones. Design the machine so that safety is ensured even in such cases.

- The ⊙ key on the keypad is effective only when the keypad operation is enabled with function code F02 (= 0, 2 or 3). When the keypad operation is disabled, prepare an emergency stop switch separately for safe operations. Switching the run command source from keypad (local) to external equipment (remote) by turning ON the "Enable communications link" command **LE** disables the ⊙ key.
  To enable the ⊙ key for an emergency stop, select the STOP key priority with function code H96 (= 1 or 3).

- If any of the protective functions have been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.
  Otherwise, an accident could occur.

- If you enable the "Restart mode after momentary power failure" (Function code F14 = 3 to 5), then the inverter automatically restarts running the motor when the power is recovered.
  Design the machinery or equipment so that human safety is ensured after restarting.

- If the user configures the function codes wrongly without completely understanding this Instruction Manual and the FRENIC-VG User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.
  An accident or injuries could occur.

- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.

- Even if the run command is set to OFF, voltage is output to inverter output terminals U, V, and W if the servo-lock command is ON.

- Even if the motor is stopped due to DC braking or preliminary excitation, voltage is output to inverter output terminals U, V, and W.
  An electric shock may occur.

- The inverter can easily accept high-speed operation. When changing the speed setting, carefully check the specifications of motors or equipment beforehand.
  Otherwise, injuries could occur.

⚠CAUTION

- Do not touch the heat sink and braking resistor because they become very hot.
  Doing so could cause burns.

- The DC brake function of the inverter does not provide any holding mechanism.
  Injuries could occur.

- Ensure safety before modifying the function code settings.
  Run commands (e.g., "Run forward" **FWD**), stop commands (e.g., "Coast to a stop" **BX**), and speed change commands can be assigned to digital input terminals. Depending upon the assignment states of those terminals, modifying the function code setting may cause a sudden motor start or an abrupt change in speed.

- When the inverter is controlled with the digital input signals, switching run or speed command sources with the related terminal commands (e.g., **SS1**, **SS2**, **SS4**, **SS8**, **N2/N1**, **KP/PID**, **IVS**, and **LE**) may cause a sudden motor start or an abrupt change in speed.
  An accident or injuries could occur.

Maintenance and inspection, and parts replacement

⚠ WARNING ⚠

- Before proceeding to the maintenance/inspection jobs, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.

- Maintenance, inspection, and parts replacement should be made only by qualified persons.

- Take off the watch, rings and other metallic objects before starting work.

- Use insulated tools.

  Otherwise, an electric shock or injuries could occur.

- Never modify the inverter.

  Doing so could cause an electric shock or injuries.

Disposal

⚠ CAUTION

- Treat the inverter as an industrial waste when disposing of it.

  Otherwise injuries could occur.

Speed control mode

⚠ CAUTION

- If the control parameters of the automatic speed regulator (ASR) are not appropriately configured under speed control, even turning the run command OFF may not decelerate the motor due to hunting caused by high gain setting. Accordingly, the inverter may not reach the stop conditions so that it may continue running.

  Even if the inverter starts deceleration, the detected speed deviates from the zero speed area before the zero speed control duration (F39) elapses due to hunting caused by high response in low speed operation. Accordingly, the inverter will not reach the stop conditions so that it enters the deceleration mode again and continues running.

  If any of the above problems occurs, adjust the ASR control parameters to appropriate values and use the speed mismatch alarm function in order to alarm-trip the inverter, switch the control parameters by speed, or judge the detection of a stop speed by commanded values when the actual speed deviates from the commanded one.

  An accident or injuries could occur.

Torque control mode

⚠ CAUTION

- When the motor is rotated by load-side torque exceeding the torque command under torque control, turning the run command OFF may not bring the stop conditions so that the inverter may continue running.

  To shut down the inverter output, switch from torque control to speed control and apply a decelerate-to-stop or coast-to-stop command.

  An accident or injuries could occur.

GENERAL PRECAUTIONS

Drawings in this manual may be illustrated without covers or safety shields for explanation of detail parts. Restore the covers and shields in the original state and observe the description in the manual before starting operation.

Icons

The following icons are used throughout this manual.

Note   This icon indicates information which, if not heeded, can result in the inverter not operating to full efficiency, as well as information concerning incorrect operations and settings which can result in accidents.

Tip   This icon indicates information that can prove handy when performing certain settings or operations.

This icon indicates a reference to more detailed information.

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Chapter 5
USING STANDARD RS-485

This chapter describes the use of standard RS-485 communications ports and provides an overview of FRENIC-VG Loader.

Contents

5.1 Standard RS-485 Communications Ports

The FRENIC-VG has standard 1-channel RS-485 communications ports. The RS-485 communications ports are assigned in the control terminal block, enabling easy multi-drop connection.

RS-485 enables the following communications functions.

(1) Communication through Modbus RTU / Fuji general-purpose inverter protocol

The FRENIC-VG can be connected to a host (master) device such as a PC, PLC, or display/operation device. Through the interface, you can execute run/stop commands, monitor the running status, and change the function code data.

(2) Connection to FRENIC-VG Loader

FRENIC-VG Loader can be installed on a PC to enable connection between FRENIC-VG and RS-485. Through the interface, you can use the various functions of FRENIC-VG Loader such as editing the function code data, tracing the running data in real time, and tracing back the running data from the time when an alarm occurs. Multi-drop connection through RS-485 enables you to access up to 31 FRENIC-VG inverters with one FRENIC-VG Loader.

FRENIC-VG Loader can also be connected to the built-in USB port of the FRENIC-VG. However, in this case it would be a one-to-one connection.

> Note
> • The RJ-45 connector for the keypad is intended solely for communication using the keypad, and cannot be used for RS-485 communication.
> • Do not connect the inverter to a PC LAN port, Ethernet hub, or telephone line. Doing so may result in damage to the inverter or connected device.

The application can be used when a run command is executed and a break in communication is detected or an alarm occurs. If a communication error occurs during operation, it is possible to issue an $Er\text{-}5$ alarm (RS-485 alarm) after the application starts up. At this time, the inverter output cuts off and the motor idles.

Chap. 5

USING STANDARD RS-485

5.1.1　RS-485 common specifications

Items	Specifications		
Protocol	SX protocol (For FRENIC-VG Loader)	Modbus RTU	Fuji general-purpose inverter protocol
Compliance	Loader dedicated protocol (Not disclosed)	Modicon Modbus RTU-compliant	Fuji general-purpose inverter protocol
Protocol selection	Function code H40 = "1"	Function code H40 = "2"	Function code H40 = "0"
Messaging system	Command message	RTU (Remote Terminal Unit) mode only ASCII mode not yet supported Query/Broadcast message	Polling/Selecting/Broadcast
Electrical specifications, Transmission speed	EIA RS-485		
	2,400 4,800 9,600 19,200 38,400 bps		
Synchronization	Asynchronous start-stop system (UART)		
Transmission mode	Half-duplex		
Transmission type	Direct link to inverter 1:N ($1 \leq N \leq 31$)		
Transmission character format	HEX		ASCII 7 bits or 8 bits
Data length	8 bits (fixed) (Note 3)	8 bits (fixed) (Note 2)	H35 data length setting 7 or 8 bits selectable
Stop bit	1 bit (fixed) (Note 3)	2 bits (Note 2) / 1 bit (Note 2)	H37 stop bit setting 1 or 2 bits selectable
Parity	Even (fixed) (Note 3)	None / Even / Odd	H36 parity setting None, Even, or Odd selectable
Error checking	Sum-check (1 byte BCC)	CRC-16 Generator polynomial: $X^{16} + X^{15} + X^2 + 1$	Sum-check (2 byte BCC)
Logical station selection	1-255; logical station	0; Broadcast 1-247; logical station	99; Broadcast (Note 1) 1-31; logical station
Frame length	Variable length	Variable length	Normal transmission: 16 bytes (fixed) High-speed transmission: 8 or 12 bytes (fixed)
Max. transfer data (1 message)	Write: 16 words Read: 99 words	Write: 16 words Read: 99 words	1 word
Disconnection detection time	Communication disconnection time (Timeout) can be set with function code H38. Operates only during operation through 485.		
Cable length	Non-isolated: Max. 10 m Isolated: Max. 500 m *　For isolation, use a commercially-available 485/485 isolating device (repeater), and a 485/232C isolated converter. *　Inverters generate noise. Use a converter with superior noise resistance. Recommended converters: KS-485PTI, KS-10PTI, USB-485I RJ45-T4P (System Sacom Sales Corporation)		

(Note 1) For Broadcast, only communications command codes (S codes) are enabled. Other function codes are disabled.

(Note 2) With RTU protocol, H37 stop bit setting is not required because the stop bit is selected automatically in accordance with the parity selection status (H36 parity setting).

(Note 3) With SX protocol, it is not necessary to change the H35-H37 settings because the data length, stop bit, and parity are fixed.

5.1.2   Terminal specifications for RS-485 communications

The FRENIC-VG has terminals for RS-485 communications on the control circuit terminal block.

Signal name	Function	Remarks
DX -	RS-485 data (-)	Built-in terminating resistor: 112Ω
DX +	RS-485 data (+)	Open/close by SW4*

*For details about SW4, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

As there is no earth terminal for the shield, the shield wire must be earthed on the host device side.

A02	A03	13	Ai2	TH1	PLC	X6	X7	X8	X9	Y2	Y3	Y4	FB	Y5C	Y5A	30B
A01	M	12	Ai1	THC	X1	X2	X3	X4	X5	CMY		Y1	FA	30C	30A
DX+	DX-	11	M	CM	EN1	PS	EN2	CM	FWD	REV	CM	PGM	PGP	PA	PB

Contact output

Reinforced isolation
(Max. 250 V AC overvoltage category II, contamination level 2)
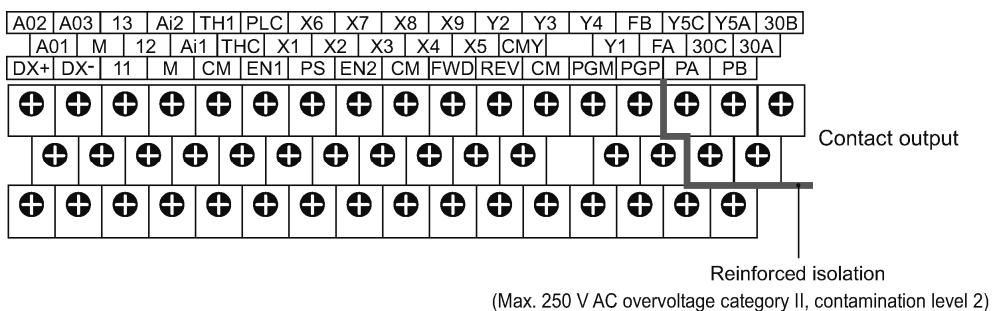
5.1.3　Connection method

(1) Multi-drop connection using the RS-485 communications port
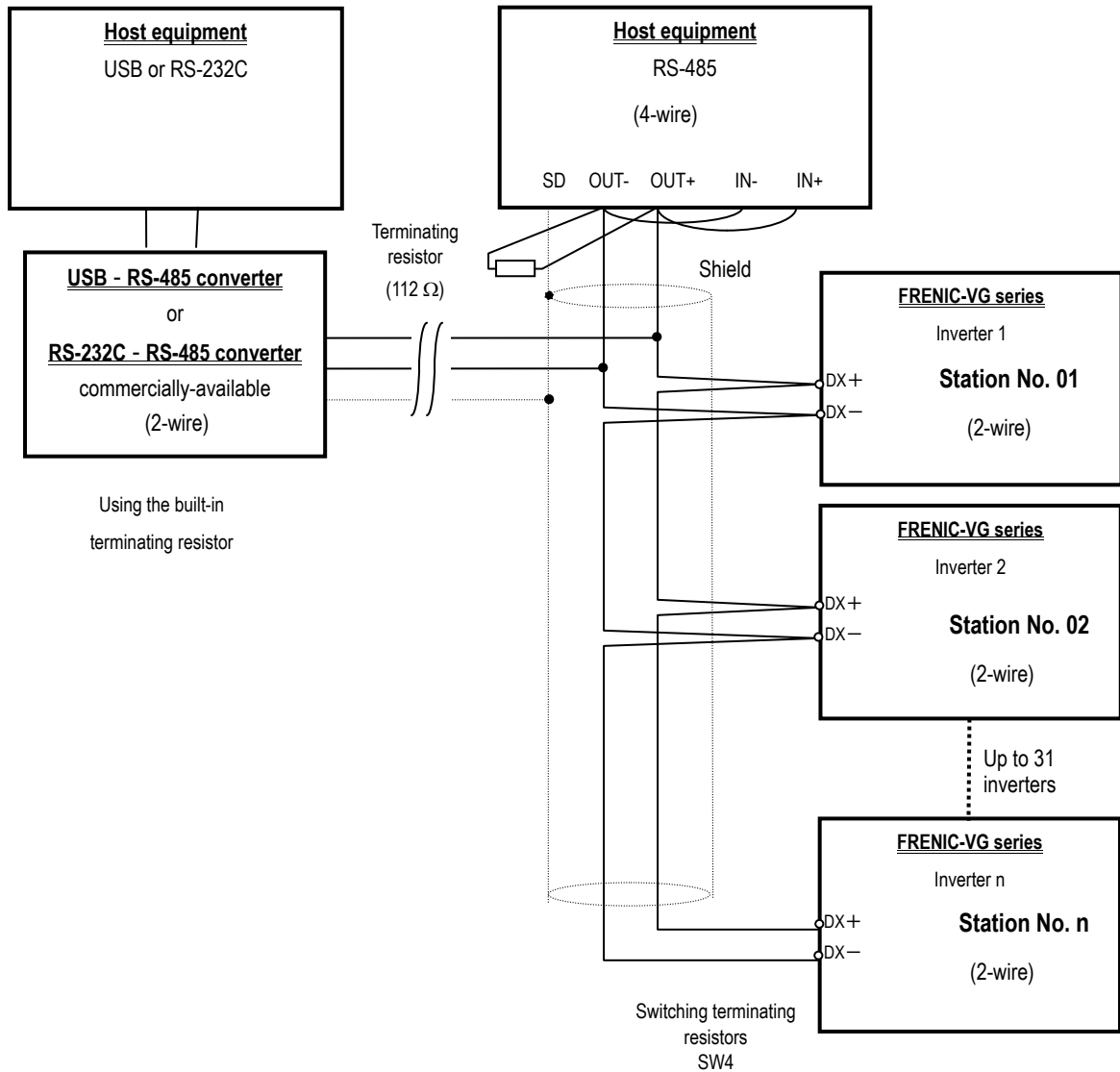
Figure 5.1　Multi-drop Connection Diagram (Connecting to the Terminal Block)

Note　Use cables and converters meeting the specifications for proper connection to the RS-485 port. (Refer to Section 5.1.4 "Communications support devices.")

The shield must be earthed on the host device side.

(2) Connection with a 4-wire type host device

Although the cables used with the converter are 2-wire types, some host devices use 4-wire type cables. When connecting to such a host device, it is necessary to change to a 2-wire type connection by connecting the driver output on the host device side with the receiver input using transition wiring.
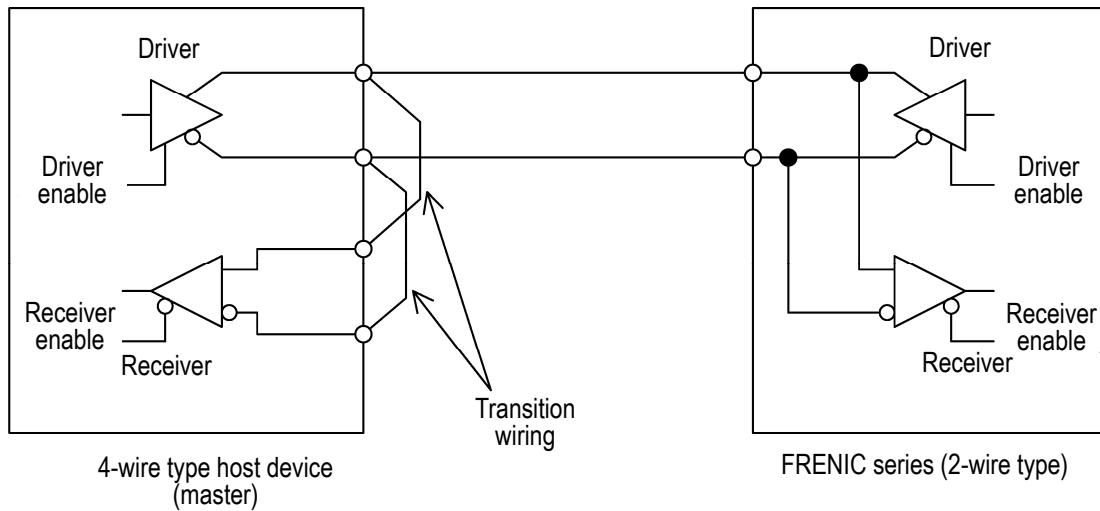
Fig 5.2 Connection with a 4-wire type host device

Note
- The driver circuit on the host device side requires a function to change the output to high impedance (driver enable: OFF). Always check that products using the RS-485 protocol have this function.
- The output of the driver circuit on the host device side should be changed to high impedance (driver enable: OFF), except during transmission.
- During host device transmission, disable the host device receiver circuit (receiver enable: OFF) so that you don't receive back the data that you sent. If it is not possible to disable the host device receiver circuit, program the system to discard the data you sent.

5.1.4 Communications support devices

This section describes the devices required for connecting the inverter to a PC having no RS-485 interface or for connecting two or more inverters in multi-drop network.

5.1.4.1 Converters

Usually PCs are not equipped with an RS-485 communications port. Therefore, it is necessary to use an RS-232C–RS-485 converter or a USB–RS-485 converter. To run the loader correctly, use a converter satisfying the recommended specifications given below. If you use a converter other than a recommended one, the loader may not operate properly.

Recommended converter specifications

Send/receive switching:	Auto-switching by monitoring of send/receive data status at the PC (RS-232C)
Electric isolation:	Electrically isolated from the RS-485 port
Fail-safe:	Fail-safe facility*
Other requirements:	Superior noise immunity

* The fail-safe facility refers to a feature that ensures the RS-485 receiver's output at "High" logic even if the RS-485 receiver's input is opened or short-circuited or all the RS-485 drivers are inactive. Refer to Figure 5.3 Communications Level Conversion.

Recommended converter

System Sacom Sales Corporation: KS-485PTI (RS-232C - RS-485 converter)
: USB-485I RJ45-T4P (USB - RS-485 converter)

Send/receive switching system

The RS-485 communications system of the inverter acts in half-duplex mode (2-wire) so the converter must feature a send/receive switching circuit. Generally, the switching system may be either one of the following.

(1) Auto-switching by monitoring of send/receive data

(2) Switching by RS-232C control signal of RTS or DTR (hardware flow control system)
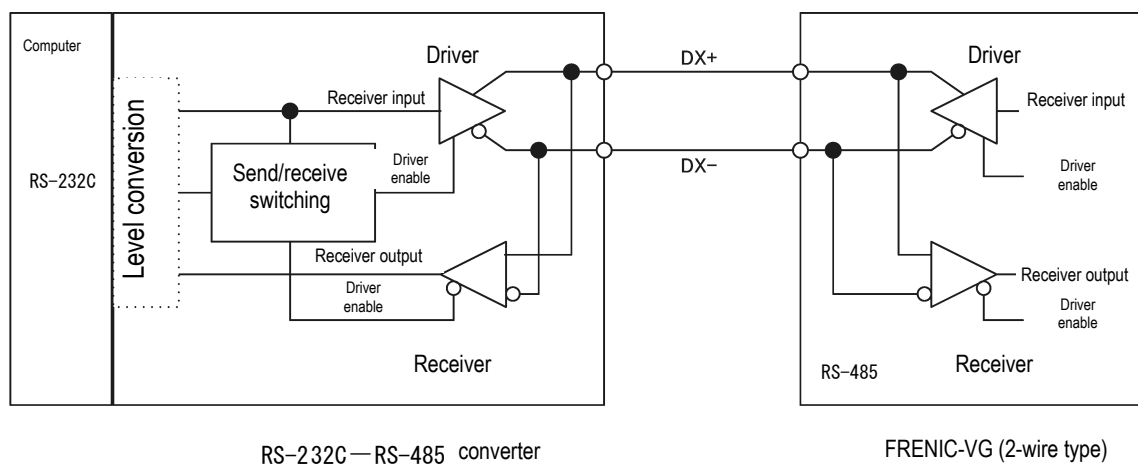
Figure 5.3   Communications Level Conversion

5.1.4.2 Cables

To ensure the reliability of connection, use twisted pair shield cables for long distance transmission AWG 16 to 26.

Recommended cable manufacturer: FURUKAWA Electric Co., LTD

AWM2789 Cable for long distance connection

Type (Product code): DC23225-2PB

5.1.5 Link functions

Communications functions such as RS-485 are called link functions. Command data (S range) is used to access the inverter from the host via a link function to issue start, stop, and speed/torque setting commands. Function code H30 and the "24: Link run selection signal [LE]" X function are used to switch between (REM/LOC/COM) enabling the command data (S range) and enabling commands issued from the actual terminal block and keypad. Refer to Chapter 4, Section 4.1 "Block Diagrams for Control Logic" for more details.

Function code H29 and the "23: Allow link edit command [WE-LK]" X function are used to control writing to function codes (F, E, C, P, H, A, o, L, U) via the link function. Refer to Chapter 4, Section 4.1 "Block Diagrams for Control Logic" for more details.

5.1.5.1 Link command permission selection

<u>Link switching</u>

You can switch modes as shown below by assigning "24: Link run selection signal [LE]" to the X function input terminal.

Link run selection signal [LE] assignment	Input terminal	Status
Not assigned	-	Link command allowed mode
Assigned	ON	
	OFF	Link command disallowed mode

In link command disallowed mode, writing command data and run operation data via the link function is enabled, <u>but the data is not reflected in the actual run operation</u>. It is possible to set up the data in advance in link command disallowed mode, and then switch to link command allowed mode to reflect the data in the actual run operation.

Note
• The run operation may start when the [LE] terminal is switched from OFF to ON.

Link commands

In link command allowed mode, you can use function code H30 (link function) to link (COM) the command data and the run operation command, and switch between Remote and Local. At this time, REM (Remote: run operation via terminal block) or LOC (Local: run operation via keypad) is displayed.

H30 data	Link command allowed mode		Link command disallowed mode
	Command data (S01-S05, S10-S12)	Run operation command (FWD, REV)	
0	Disallow link (REM/LOC)	Disallow link (REM/LOC)	Disallow link (REM/LOC)
1	Allow link (COM)	Disallow link (REM/LOC)	
2	Disallow link (REM/LOC)	Allow link (COM)	
3	Allow link (COM)	Allow link (COM)	

These functions enable a flexible system structure, with run commands issued via the terminal block and speed commands issued via RS-485.

5.1.5.2   Link edit permission selection

Link edit switching

You can write protect the function codes (F, E, C, P, H, A, o, L, U) as shown below by assigning "23: Allow link edit command [WE-LK]" to the X function input terminal.

Allow link edit command assignment	Input terminal	Status
Assigned	-	Link edit allowed mode (Function code write enabled)
Not assigned	ON	
	OFF	Link edit disallowed mode (Function code write protected)

Link edit

You can use function code H29 (allow link edit command) to control writing to function codes (F, E, C, P, H, A, o, L, U) in the link edit allowed mode.

H29 data	Link edit allowed mode	Link edit disallowed mode
0	Function code (F, E, C, P, H, A, o, L, U) write enabled	Function code (F, E, C, P, H, A, o, L, U) write protected
1	Function code (F, E, C, P, H, A, o, L, U) write protected	

5.1.5.3   S range option priority

If the system has field options (T link, field bus, SX, SI (UPAC), etc.), writing to the S range (run operation command, command data) via RS-485 is disabled and the options are given priority. However, reading and writing function code data via RS-485 is constantly enabled.

5.1.6 Referencing and changing data

If the system does not have field options, writing to the S range (run operation command, command data) via RS-485 constantly enabled.

Additionally, refer to the communications address, 485 No. in Chapter 4, Section 4.2 "Function Code Tables" for details on referencing and changing function codes. Take note of restrictions such as data ranges and disabled changes during operation.

5.1.6.1 Write restrictions for function codes

Writing to (selecting) function codes (F, E, C, P, H, A, o, L, U) is subject to the following restrictions.

(1) Writing to volatile memory

In order to enable a high-speed writing response when writing via RS-485, the system uses volatile memory (RAM: Random Access Memory, memory that is discarded when the system is switched OFF). If you need to keep the data after the system is switched OFF, issue the H02 [Save All] function code to write the data to non-volatile memory.

Writing using function code H02 takes about 2 seconds. Do not attempt to perform another write operation while the system is writing data to the memory.

(2) Writing via RS-485 disabled mode

You will receive a negative response if you attempt to write to any of the following function codes.

Code	Name	Reason
P02	M1 mode selection	Other codes are automatically updated when P02 is changed. Updates are generally written to non-volatile memory. For P02 only, however, updates are written to volatile memory (discarded when system switched OFF), resulting in inconsistent codes when the system is switched OFF and ON again. Only change P02 via the keypad. However, writing is enabled when using FRENIC-VG Loader software (SX protocol).
H31	Station address	If changed, communications operations are disabled
H34 to H37	(UART setting)	RS-485 hardware settings
H40	Protocol selection	If changed, communications operations are disabled

(3) Continuous writing disabled mode

When using ModBus RTU, you can continuously write 16 pieces of data. When doing so, do not include the following codes in the continuous write group. If you attempt to write with these codes in the group, the system will return a negative response. Fuji general-purpose inverter protocol and ModBus RTU can be written individually.

Code	Name	Reason
H02	Save all function	Internal data is updated at the same time as operation is performed. This updated data is overwritten by continuously written data.
H03	Data initialization	
H68	Alarm data deletion	
H79	Cooling fan cumulative run time default setting	
H80	Main circuit condenser capacity default setting	
H81	Main circuit condenser cumulative lifetime default setting	

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(4) Data protection

Writing via RS-485 is not restricted by function code F00 [Protect Data]. This code only protects data in the case of keypad operation.

Writing via RS-485 is restricted by function code H29 [Protect Link Function] and the [WE-LK] X function (Refer to section 5.1.5.2).

However, writing to H29 is enabled even in link edit disallowed mode.

5.1.6.2 Negative response and error response

If you attempt to perform the write operation when the communication data contains an error or the inverter is not ready, the system will return a negative response and the write operation will not be performed. You can check the error details with function code M26 or the keypad maintenance screen. For details, refer to the section on type [34] communication error codes in Chapter 4, Section 4.2 "Function Code Tables."

Additionally, Modbus RTU protocol uses special codes (subcodes) for error responses. For details, refer to the section on Modbus RTU.

5.1.6.3 No response

If the hardware on the inverter side detects a parity error or framing error, or the software detects a sum-check error or CRC error because the communication data is physically damaged, the system will return no response. You can check the reason for no response with function code M26 or the keypad I/O check.

If the character interval of the data on the host side is greater than 20 ms due to a host hardware error, the inverter will return no response. At this time, the communication data will be reset.

5.1.7   RS-485 function codes

	Function code	Data setting	Remarks
H31	RS-485 setting (station address)	0 to 255 1 to 247: RTU 1 to 31: Fuji general-purpose	Specify station number when connecting to inverter No response returned when Broadcast is selected 0: Broadcast when RTU selected 99: Broadcast when Fuji general-purpose selected
H32	RS-485 setting (error measure selection)	0; Forced stop 1; Stop after fixed time 2; Stop after error continues longer than operation time 3; Continue operation	RAS
H33	RS-485 setting (timer time)	0.01 to 20.00 s	
H34	RS-485 setting (transmission rate)	0; 38,400 bps 1; 19,200 bps 2; 9,600 bps 3; 4,800 bps 4; 2,400 bps	Default communications setting
H35	RS-485 setting (data length selection)	0; 8 bit 1; 7 bit	
H36	RS-485 setting (parity bit selection)	0; None 1; Even 2; Odd	
H37	RS-485 setting (stop bit selection)	0; 2 bit 1; 1 bit	
H38	RS-485 communication downtime	0.1 to 60.0 s 0.0; disabled	
H39	Response interval time	0.00 to 1.00 s	
H40	RS-485 protocol selection	0; Fuji general-purpose 1; SX protocol (loader protocol) 2; Modbus RTU	Protocol switching

5.1.7.1   Response interval time (H39)

Set the time until the inverter returns a response when a request is received from an upper level device such as a computer. This function enables you to match the timing by setting the response interval time, even if the computer processes slowly.
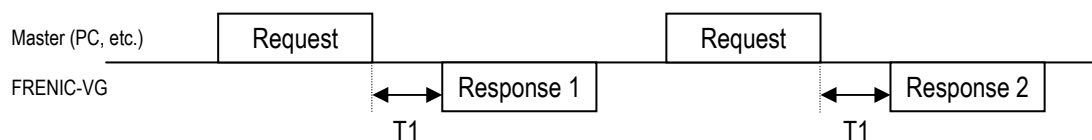
$T1$ = response interval time + Td (inverter operation delay time; 0-30 ms).

Use the H39 code to set the time within the range of 0.00-1.00 s.

5.1.7.2 Disconnection detection time (H38)

If communication from the master (PLC, PC) during RS-485 linked operation (S06: operation command FWD, REV) exceeds the specified time, an RS-485 communication error (Er-5) is immediately generated. When performing non-fixed cycle communications, disable this function (setting: "0"). When performing fixed cycle communications, set H38 to a longer time than the cycle time before using the disconnection detection function.

5.1.7.3 Character timeouts

The receiving interval of transmissions is monitored with a fixed timer. If the character interval of the data sent from the master exceeds the timer time, this function determines that the operation is not fixed or that there has been a disconnection. The function operates with a **fixed timer of 20 ms** based on the slowest communication speed of 2400 bps, allowing for a character interval of 5 ms to 4.6 ms (12-11 bit/2400). Be aware that, if the character interval exceeds this time, communications on the inverter side will be reset.
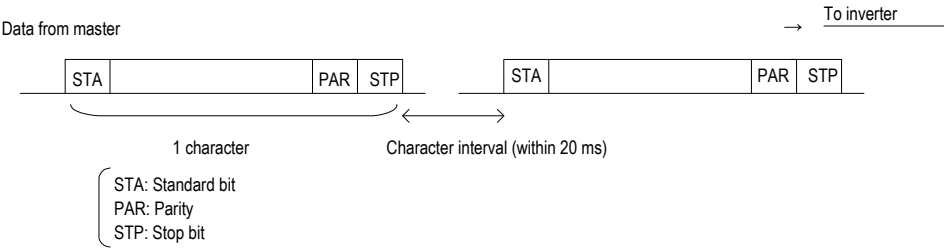
5.1.7.4 Timeouts on the master side

Specify the time allowed before determining that the master side (PLC, PC) will timeout if the response from the inverter is interrupted. The specified time common to Fuji inverters (G, C, E, VG) is **500 ms or more**. Always set the timout for the master device to this time or longer. The response is normally returned within the internal process time (about 1 ms) + the interval timer time (H39 setting). Therefore, the timeout for the master device can be set to a little longer than the interval timer time. However, the actual timeout time should be set to 500 ms or more to allow for multiple connections to other types of devices (G/E series).

5.1.8 Host side procedures

Please follow the flow chart for each frame transmission procedure.

For both reading and writing, always confirm the response before sending the next frame. If there is no response from the inverter after a certain time, execute a timeout and retry. (If you attempt to start a retry before a timeout, the request frame will not be received properly.)

Retry

When executing a retry, either use a standard frame to resend the data that was sent before no response was received or execute polling (M26) to enable the error details to be read, and then check that the response was normal. (When checking the response, you will need to determine whether a further timeout is necessary.)

If the response is normal, this indicates that some kind of temporary transmission error such as noise occurred, and normal communications should be possible thereafter. (If there is frequent reoccurrence of this phenomenon, it is necessary to investigate further to determine whether there is an error.)

If there is again no response, execute further retries. If the number of retries exceeds the preset value (normally about 3 times), there may be a problem with the hardware or the software of an upper level device. As there is no response from the specified station, it will be necessary to abort and investigate further.

5.1.8.1 Read procedure

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5.1.8.2   Write procedure

```
                    ┌──────────────┐
                    │    Start     │
                    └──────┬───────┘
                           │
                    ┌──────▼───────┐
                    │ Request frame│◄──────────┌─────────────────────────┐
                    │     sent     │           │ Transmission error      │
                    └──────┬───────┘           │ detected                │
                           │                   └────────────▲────────────┘
                     ◄─────▼─────►                           │
                    < Response frame >──────────────────────┘
                    < received?      >  No
                     ◄─────┬─────►
                        Yes│
                     ◄─────▼─────►  No
                    < Normal (ACK)   >─────────────┐
                    < response?      >             │
                     ◄─────┬─────►                 │
                        Yes│                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Format error? >─────►│ Change to correct format │
                           │                  ◄────┬────►          │ and resend.              │
                           │                    No │               └──────────────────────────┘
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Command error?>─────►│ Change to correct command│
                           │                  ◄────┬────►          │ and resend.              │
                           │                    No │               └──────────────────────────┘
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Link priority?>─────►│ Operation via this       │
                           │                  ◄────┬────►          │ communication is disabled│
                           │                    No │               │ during link option       │
                           │                       │               │ connection.              │
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Function code >─────►│ Change to correct        │
                           │                 < error?        >     │ function code and resend.│
                           │                  ◄────┬────►          └──────────────────────────┘
                           │                    No │
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Write disabled?>────►│ Written to write-disabled│
                           │                  ◄────┬────►          │ function code (cannot be │
                           │                    No │               │ changed during operation,│
                           │                       │               │ etc.)                    │
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Data error?   >─────►│ Change to correct data   │
                           │                  ◄────┬────►          │ range and resend.        │
                           │                    No │               └──────────────────────────┘
                           │                  ◄────▼────►  Yes  ┌──────────────────────────┐
                           │                 < Error during  >─────►│ Resend after writing     │
                           │                 < writing?      >     │ completes.               │
                           │                  ◄────┬────►          └──────────────────────────┘
                           │                    No │
                    ┌──────▼───────┐        ┌──────▼───────┐
                    │Normal finish │        │    Abort     │
                    └──────────────┘        └──────────────┘
```

5.1.9 RAS

5.1.9.1 Communication errors

Depending on the usage environment, noise generated by the inverter may prevent normal communications or cause equipment such as instrumentation on the master and converters to malfunction. The following measures may be effective in such cases. Please also refer to the appendix on electrical noise.

(1) Measures on side receiving noise

Isolated converter: Deletes common mode noise exceeding the specified operating voltage range of the receiver, such as with long wiring layouts. However, the isolated converter itself may malfunction as a result of noise so it is necessary to use a converter with strong noise immunity.

Twisted pair shield wire: The shield protects against static induction noise. Make sure to earth one side.

The twisting protects against electromagnetic induction noise. Where possible, use wires with a short twist pitch. When using long wiring layouts where crosstalk could be a problem, consider using separate shields for sending and receiving.

Effect of shield

The shield acts as an antenna, picking up noise. If the circiut is looped between the shield and the ground and the earth is not close, the electrical potential may differ, resulting in noise from the flow of current through the loop. Additionally, noise may be caused by variations in the magnetic flux in the loop.

In section X in the diagram, the effect of static induction can be completely eradicated.

Effect of twist

If there is a uniform magnetic flux downwards as you look at the page and it changes (augmentation), electromotive forces are generated in the direction of the arrows in the diagram.The strength of electromotive forces (A) to (D) is the same, and the directions are as shown. On line Tx+, (B) and (C) move in opposite directions and therefore cancel each other out. This is the same for (A) and (D) and, therefore, normal mode noise due to electromagnetic inductance does not occur. However, it may not be possible to completely suppress noise due to conditions such as a non-uniform twist pitch. If the lines are parallel, normal mode noise will occur.

Terminating resistor: To suppress ringing due to signal reverberation, position terminating resistors with resistance equivalent to the cable impedance (100 Ω) at both ends of the wiring.

Separate wiring: Do not bundle power wires (input: R, S, T; output: U, V, W) with RS-485 communication wires. Separating the wiring can help to suppress inductance noise.

Change earth:	Do not use a common earth for instrumentation and the inverter. Noise may propagate from the earth wire. Additionally, use thick earth wires.
Isolated power supply:	Noise may propagate from the power supply of instrumentation. To isolate the wiring from the power supply of the inverter, it is recommended to change the power wiring, or use an isolated transformer (TRAFY) for the power supply or a noise-suppressing transformer.
Filtering:	To cut ringing and high-frequency noise, create a (low pass filter) LPF by connecting a condenser in parallel at the signal input/output terminal.

Effect of filtering

This method separates ringing due to signal reverberation and normal mode noise from the normal signal. Generally, the former is a higher frequency than the signal and so can be separated with a LPF.

C: Condenser
(about 0.01-0.001 μF)
R: Terminating resistor (100 Ω)
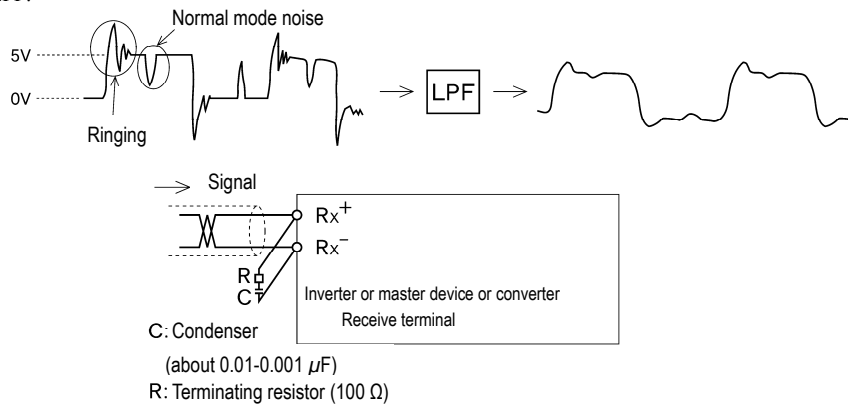
Add inductance components:	Insert inductance components such as choke coils in series in the signal circuit, or pass the cable through a ferrite core ring. This will help to keep the impedance of the signal lines high to counteract high frequency noise.

Adding inductance components

Pass through or wind 2-3 times
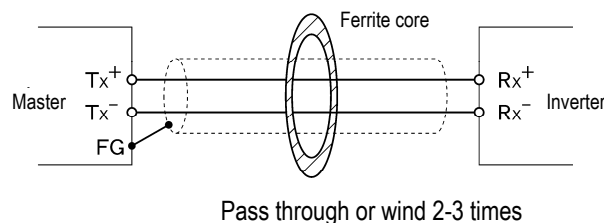
⚠CAUTION

When filtering and adding inductance components, with fast communication speeds the signal waveform may become irregular, causing transmission errors. If this happens, use function code H34 to slow down the communication speed.

Normal signal   Irregular waveform
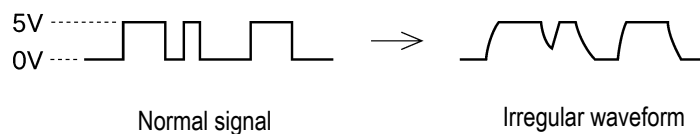
(2) Measures on side generating noise

Carrier frequency:	It is possible to lower the noise level by lowering the setting of function code F26 [Motor operation noise (carrier frequency)]. However, be aware that lowering the carrier frequency can result in higher levels of noise from other sources.
Equipment:	It is possible to contain noise (radiation/inductance) by passing the power wires through a metal duct or using a metal control panel.
Isolated power supply:	It is possible to curb the propagation of noise (conductance) by using an isolated transformer for the inverter power supply.

(3) Measures to lower noise level

Consider using a zero-phase reactor (9.6.5) and an EMC filter (9.6.2). Normally, you should consider measure (3) if measures (1) and (2) do not lower the noise to the allowable level for the equipment.

5.1.10　Communication error measures

When executing run commands or applying command data via RS-485, it is possible to continue running the inverter without tripping the alarm, even if there is a transmission error, by implementing the following measures. The following examples show communication alarms (keypad displays *er5*) generated when operating the inverter from the master side.

(a)　H32 = 0; Forced stop (Forced stop: idling stop during alarm)
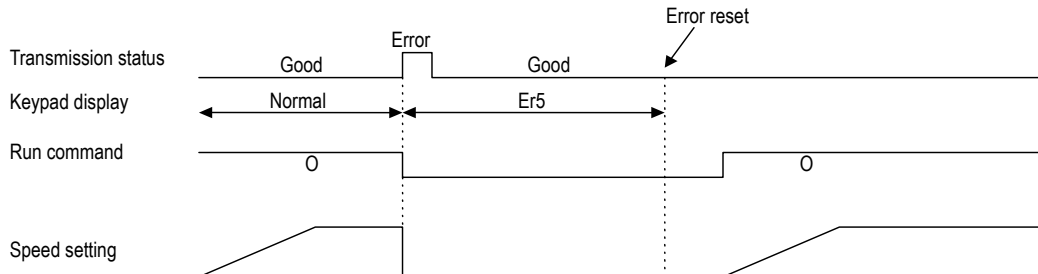
(b)　H32 = 1; Idling stop after set time elapses following transmission error
　　(Operation stops after continuing for timer set time, H33: timer time = 5.00 s)
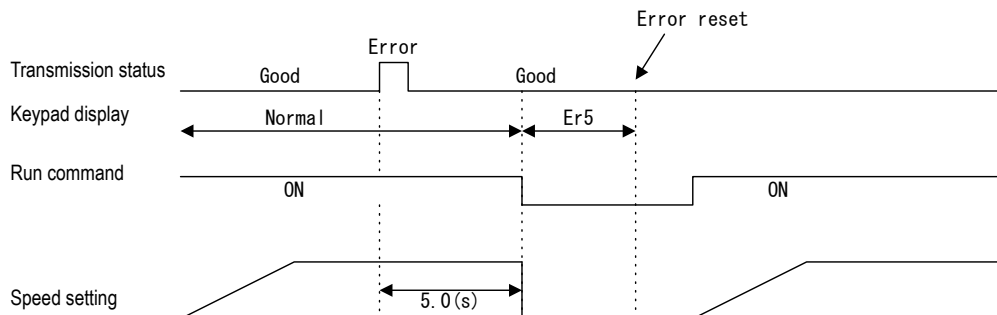
(c)　H32 = 2; Operation continues if cause of transmission error is resolved within timer time set in (b) above.
　　(Operation stops after error continues beyond timer set time, H33: timer time = 5.00 s)
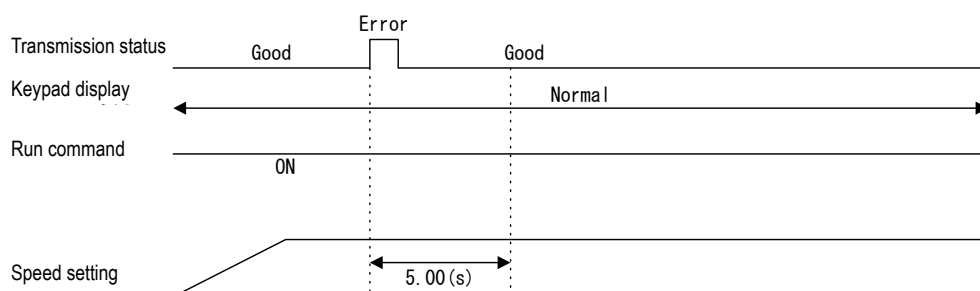
(d)　H32 = 3; Operation continues even after transmission error occurs (continued operation).
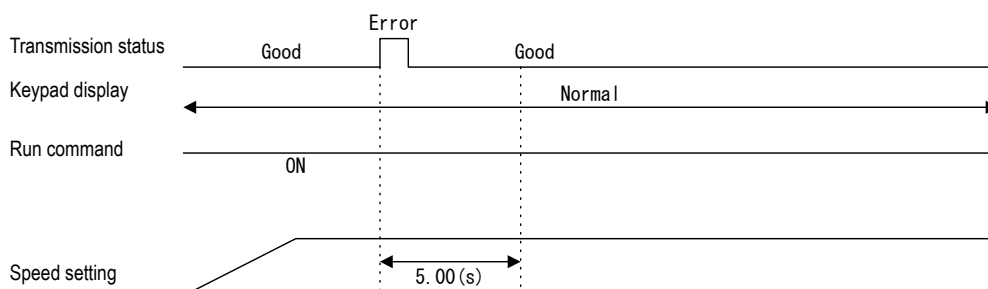
5.2   Fuji General-purpose Communications

5.2.1   Message format

Polling/selecting is used for the response message format. The inverter is in a constant standby state, waiting for either selecting (write request) or polling (read request) from the host (PC, PLC).

The inverter receives a request frame with the same station address from the host while in the standby state. If the frame is received normally, the request is processed and a positive response frame (in the case of polling, the data is returned with the response) is returned. If the frame is not received normally, a negative response frame is returned. In the case of a broadcast (all-station selecting), no response is returned.
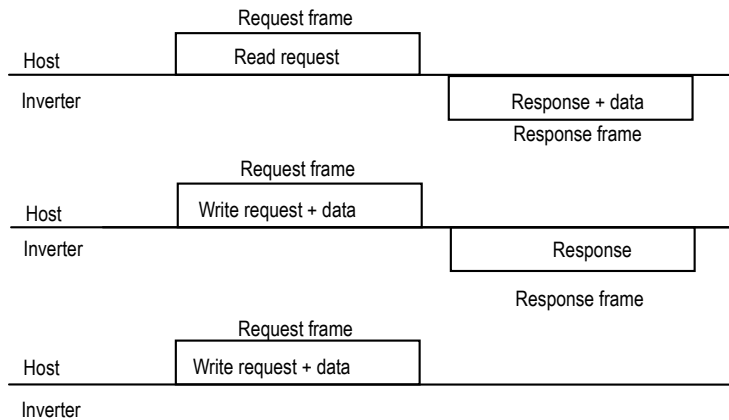
Explanation: Broadcast (all-station selecting)

If the station number (station address) of a frame is set to "99", it is processed by all inverters as a broadcast. By using a broadcast, you can execute run commands and frequency commands for all inverters simultaneously. (This is enabled only for S codes with standard frames, and a to f and m commands with W, E, and option frames.)

5.2.2   Transmission frame

There are two types of transmission frame: a standard frame which allows you to use all communications functions, and an option frame which allows you to perform high speed communications but is restricted to monitoring and sending commands to the inverter.

With both the standard frame and option frame, all constituent characters (including BCC) of the frame are displayed as ASCII characters. The table below shows the transmission frame length for each of these frame types.

Frame type			Frame length
Standard frame	Selecting	Request	16 byte
		Response	16 byte
	Polling	Request	16 byte
		Response	16 byte
Option frame	Selecting	Request	12 byte
		Response	8 byte
	Polling	Request	8 byte
		Response	12 byte

5.2.3 Standard frame

Request frame   [Host → Inverter]

0	1	2	3	4	5	6	7	8	9	12	13	14	15	
SOH	Station No.		ENQ	Command	Type	Function code No.		SP		Data		ETX	BCC	
1	2		1	1	1	2		1		4		1	2	(byte)

BCC target

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05_H	Transmission frame
4	Command			Request command
		'R'	52_H	Polling (read)
		'W'	57_H	Selecting (write)
		'A'	41_H	High speed response selecting (write) - Note 1
		'E'	45_H	Alarm reset
5	Type			Function code type
		'F'	46_H	Basic function
		'E'	45_H	Terminal function
		'C'	43_H	Control function
		'P'	50_H	Motor 1
		'H'	48_H	High level function
		'A'	41_H	Motor 2, 3
		'L'	$4C_H$	Elevator data
		'U'	55_H	User function
		'o'	$6F_H$	Option
		'S'	53_H	Command data
		'M'	$4D_H$	Monitor data
6	Function code No.	'0' - '9'	30_H - 39_H	Function code No. (Decimal: tens place)
7		'0' - '9'	30_H - 39_H	Function code No. (Decimal: ones place)
8	SP	' '	20_H	Unused (fixed space)
9	Data	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	1st character (Hexadecimal: thousands place)
10		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	2nd character (Hexadecimal: hundreds place)
11		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	3rd character (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	4th character (Hexadecimal: ones place)
13	ETX	ETX	03_H	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Note 1:   FRENIC-VG returns a response when the request is received, regardless of the write type.

        With FRENIC-VG, both normal selecting (W) and high speed response selecting (A) are the same operation.

ACK response frame   [Inverter → Host]

0	1	2	3	4	5	6	7	8	9		12	13	14	15
SOH	Station No.		ACK	Command	Type	Function code No.		SP	Data			ETX	BCC	
1	2		1	1	1	2		1	4			1	2	(byte)

← BCC target →

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01H	Transmission begins
1	Station No.	'0' - '3', '9'	30H - 33H, 39H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30H - 39H	Inverter station address (Decimal: ones place)
3	ACK	ACK	06H	Transmission frame. Positive response: No receiving error or request logic error
4	Command			Request command answer back
		'R'	52H	Polling (read)
		'W'	57H	Selecting (write)
		'A'	41H	High speed response selecting (write)
		'E'	45H	Alarm reset
5	Type			Function code type
		'F'	46H	Basic function
		'E'	45H	Terminal function
		'C'	43H	Control function
		'P'	50H	Motor 1
		'H'	48H	High level function
		'A'	41H	Motor 2, 3
		'L'	4CH	Elevator data
		'U'	55H	User function
		'o'	6FH	Option
		'S'	53H	Command data
		'M'	4DH	Monitor data
6	Function code No.	'0' - '9'	30H - 39H	Function code No. (Decimal: tens place)
7		'0' - '9'	30H - 39H	Function code No. (Decimal: ones place)
8	SP			Unused
9	Data	'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	1st character (Hexadecimal: thousands place)
10		'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	2nd character (Hexadecimal: hundreds place)
11		'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	3rd character (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	4th character (Hexadecimal: ones place)
13	ETX	ETX	03H	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30H - 39H, 41H - 46H	Sum-check 2 (Hexadecimal: ones place)

NAK response frame [Inverter → Host]

0	1	2	3	4	5	6	7	8	9	12	13	14	15
SOH	Station No.		NAK	Command	Type	Function code No.		SP	Data		ETX	BCC	
1	2		1	1	1	2		1	4		1	2	(byte)

← BCC target →

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01$_H$	Transmission begins
1	Station No.	'0' - '3', '9'	30$_H$ - 33$_H$, 39$_H$	Inverter station address (Decimal: tens place)
2		'0' - '9'	30$_H$ - 39$_H$	Inverter station address (Decimal: ones place)
3	NAK	NAK	15$_H$	Transmission frame Negative response: Request logic error
4	Command - Note 1			Request command answer back
		'R'	52$_H$	Polling (read)
		'W'	57$_H$	Selecting (write)
		'A'	41$_H$	High speed response selecting (write)
		'E'	45$_H$	Alarm reset
5	Type - Note 1			Function code type
		'F'	46$_H$	Basic function
		'E'	45$_H$	Terminal function
		'C'	43$_H$	Control function
		'P'	50$_H$	Motor 1
		'H'	48$_H$	High level function
		'A'	41$_H$	Motor 2, 3
		'L'	4C$_H$	Elevator data
		'U'	55$_H$	User function
		'o'	6F$_H$	Option
		'S'	53$_H$	Command data
		'M'	4D$_H$	Monitor data
6	Function code No. - Note 1	'0' - '9'	30$_H$ - 39$_H$	Function code No. (Decimal: tens place)
7		'0' - '9'	30$_H$ - 39$_H$	Function code No. (Decimal: ones place)
8	SP	' '	20$_H$	Unused (fixed space)
9	Data	' '	20$_H$	Unused (fixed space)
10		' '	20$_H$	Unused (fixed space)
11		'4', '5'	34$_H$, 35$_H$	Communication error code 1 (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Communication error code 2 (Hexadecimal: ones place)
13	ETX	ETX	03$_H$	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 2 (Hexadecimal: ones place)

Note 1: Space (' ' = 20H) is specified for transmission format errors and transmission command errors.

5.2.4 Option frame

Selecting request frame   [Host → Inverter]

0	1	2	3	4	5			8	9	10	11
SOH	Station No.		ENQ	Command	Data				ETX	BCC	
1	2		1	1	4				1	2	(byte)

← BCC target →

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01$_H$	Transmission begins
1	Station No.	'0' - '3', '9'	30$_H$ - 33$_H$, 39$_H$	Inverter station address (Decimal: tens place)
2		'0' - '9'	30$_H$ - 39$_H$	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05$_H$	Transmission request
4	Command			Request command
		'a'	61$_H$	Speed setting 1 (S01)
		'b'	62$_H$	Torque command (S02)
		'c'	63$_H$	Torque current command (S03)
		'd'	64$_H$	Magnetic flux command (S04)
		'e'	65$_H$	Orientation position command (S05)
		'f'	66$_H$	Run command (S06)
		'm'	6D$_H$	Reset command: All "0"
5	Data	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	1st character (Hexadecimal: thousands place)
6		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	2nd character (Hexadecimal: hundreds place)
7		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	3rd character (Hexadecimal: tens place)
8		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	4th character (Hexadecimal: ones place)
9	ETX	ETX	03$_H$	Transmission ends
10	BCC	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 1 (Hexadecimal: tens place)
11		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 2 (Hexadecimal: ones place)

Selecting response frame [Inverter → Host]

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ACK/NAK			Transmission response
		ACK	06_H	Positive response: No receiving error or request logic error
		NAK	15_H	Negative response: Request logic error
4	Command			Request command
		'a'	61_H	Speed setting 1 (S01)
		'b'	62_H	Torque command (S02)
		'c'	63_H	Torque current command (S03)
		'd'	64_H	Magnetic flux command (S04)
		'e'	65_H	Orientation position command (S05)
		'f'	66_H	Run command (S06)
		'm'	$6D_H$	Reset command: All "0"
5	ETX	ETX	03_H	Transmission ends
6	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
7		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Polling request frame   [Host → Inverter]

0	1	2	3	4	5	6	7

SOH	Station No.	ENQ	Command	ETX	BCC
1	2	1	1	1	2 (byte)

BCC target

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01$_H$	Transmission begins
1	Station No.	'0' - '3', '9'	30$_H$ - 33$_H$, 39$_H$	Inverter station address (Decimal: tens place)
2		'0' - '9'	30$_H$ - 39$_H$	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05$_H$	Transmission request
4	Command			Request command
		'g'	67$_H$	Speed detection value (M06)
		'h'	68$_H$	Torque command monitor (M07)
		'i'	69$_H$	Torque current monitor (M08)
		'j'	6A$_H$	Output frequency monitor (M09)
		'k'	6B$_H$	Run status monitor (M14)
5	ETX	ETX	03$_H$	Transmission ends
6	BCC	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 1 (Hexadecimal: tens place)
7		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 2 (Hexadecimal: ones place)

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Polling response frame   [Inverter → Host]

0	1	2	3	4	5	8	9	10	11
SOH	Station No.		ACK/NAK	Command	Data		ETX	BCC	
1	2		1	1	4		1	2	(byte)

← BCC target →

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01$_H$	Transmission begins
1	Station No.	'0' - '3', '9'	30$_H$ - 33$_H$, 39$_H$	Inverter station address (Decimal: tens place)
2		'0' - '9'	30$_H$ - 39$_H$	Inverter station address (Decimal: ones place)
3	ACK/NAK			Transmission response
		ACK	06$_H$	Positive response: No receiving error or request logic error
		NAK	15$_H$	Negative response: Request logic error
4	Command			Request command
		'g'	67$_H$	Speed detection value (M06)
		'h'	68$_H$	Torque command monitor (M07)
		'i'	69$_H$	Torque current monitor (M08)
		'j'	6A$_H$	Output frequency monitor (M09)
		'k'	6B$_H$	Run status monitor (M14)
5	Data	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	1st character (Hexadecimal: thousands place)
6		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	2nd character (Hexadecimal: hundreds place)
7		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	3rd character (Hexadecimal: tens place)
8		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	4th character (Hexadecimal: ones place)
9	ETX	ETX	03$_H$	Transmission ends
10	BCC	'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 1 (Hexadecimal: tens place)
11		'0' - '9', 'A' - 'F'	30$_H$ - 39$_H$, 41$_H$ - 46$_H$	Sum-check 2 (Hexadecimal: ones place)

5.2.5 Negative response frame

In cases where the length of the response frame varies according to the command type, if the command type character is determined properly, the frame length designated for that command is generally used for the response.

No.	Frame/command type	Cause of error	Negative response frame	Error code (M26)
1	Standard frame Option frame	ENQ not detected in designated position	Standard frame (Length: 16 bytes)	Format error: 74 (4AH)
2	Non-designated command	Non-designated command (not R, W, A, E, a-k, m) detected	Standard frame (Length: 16 bytes)	Command error: 75 (4BH)
3	Selecting command (a-f, m)	ETX not detected in designated position	Option frame (Length: 8 bytes)	Format error: 74 (4AH)
4	Polling command (g-k)	ETX not detected in designated position	Option frame (Length: 12 bytes)	Format error: 74 (4AH)

Note: If a negative response such as a format error or command error is returned with a standard frame as in No. 1 & 2, the contents of the command type, function code type, and function code number fields are not specified.

5.2.6 Field descriptions

5.2.6.1 Data field

Standard frame

8	9	10	11	12
SP additional data	1st character	2nd character	3rd character	4th character

Option frame

5	6	7	8
1st character	2nd character	3rd character	4th character
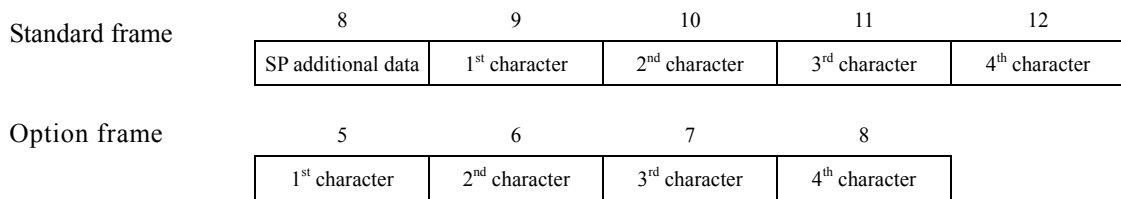
Except for some special cases, the length of all data is 16 bits. In the data field of a transmission frame, the data format is hexadecimal (0000H-FFFFH), and each digit is expressed as an ASCII code. Additionally, for negative integer data (signed data), two's complement is used to represent the negative data.

Notes: ・Use alphabetical capitals for hexadecimal A-F.

・For polling, set all request frame data fields to zero ('0') before sending.

・For selecting, ACK response frame data field contents are not specified.

Example: Function code S01 (speed setting 1): 500 r/min (Max. speed: 1500 r/min)

1) Calculate the default in accordance with the S01 data format (±20,000/max. speed).

Data = 500r/min × ±20,000/1500r/min (CW: +, CCW: -)
= ±6666.6
≈ ±6667

2) Convert the data to hexadecimal. (negative data: two's complement)
Data = 6667   (CW)
= 1A0BH
Data = -6667   (CCW)

= 0 - 6667 = 65536 - 6667 = 58869
= E5F5H

3) Set the data.

Position	Default (CW)		Default (CCW)	
1st character	ASCII	'1'	ASCII	'E'
2nd character	ASCII	'A'	ASCII	'5'
3rd character	ASCII	'0'	ASCII	'F'
4th character	ASCII	'B'	ASCII	'5'

5.2.6.2   Sum-check field

This field contains data used to check for errors in the transmission frame when sending data. The data is calculated by adding all fields except for the S0H and sum-check fields in 1 byte increments. The lowest 1 byte of data is expressed as an ASCII code.

Example: Sum result = 0123H

Position	Default	
Sum-check 1	ASCII	'2'
Sum-check 2	ASCII	'3'

5.2.7   Communication examples

This section illustrates representative communication examples. (In all cases, the station number is 12.)

5.2.7.1   Standard frame

(1) S01: Selecting speed setting 1 (write)
300r/min command × 20000 / max. speed: 1500 = 4000d = 0FA0H

Request frame (Host → Inverter)

SOH	1	2	ENQ	W	S	0	1	SP	0	F	A	0	ETX	7	D

ACK response frame (Inverter → Host)

SOH	1	2	ACK	W	S	0	1	SP	0	F	A	0	ETX	7	E

NAK response frame (Inverter → Host) .... Link priority error

SOH	1	2	NAK	W	S	0	1	SP	0	0	4	C	ETX	7	D

(2) M09: Polling output frequency (read)

Request frame (Host → Inverter)

SOH	1	2	ENQ	R	M	0	9	SP	0	0	0	0	ETX	5	3

ACK response frame (Inverter → Host)..................... 30.00 Hz (0BB8$_H$ → 3000d → 30.00)

SOH	1	2	ACK	R	M	0	9	SP	0	B	B	8	ETX	8	0

5.2.7.2 Option frame

(1) Selecting run command (write)

Request frame (Host → Inverter) .... FWD command

SOH	1	2	ENQ	f	0	0	0	1	ETX	9	2

ACK response frame (Inverter → Host)

SOH	1	2	ACK	f	ETX	D	2

NAK response frame (Inverter → Host) .... Cause of error confirmed to be "M26: Send error process code"

SOH	1	2	NAK	f	ETX	E	1

(2) Polling torque command value (read)

Request frame (Host → Inverter)

SOH	1	2	ENQ	h	ETX	D	3

ACK response frame (Inverter → Host)...................... 85.00% (2134_H → 8500d → 85.00)

SOH	1	2	ACK	h	2	1	3	4	ETX	9	E

(3) Selecting run command with broadcast (write)

Request frame (Host → Inverter) .... REV command

SOH	9	9	ENQ	f	0	0	0	2	ETX	A	2

Broadcast returns no response.

5.2.7.3   ASCII code table

10$_H$ place / 01$_H$ place	00$_H$	10$_H$	20$_H$	30$_H$	40$_H$	50$_H$	60$_H$	70$_H$	80$_H$ Note 1
0$_H$	NUL	DLE	SP	0	@	P	'	p	E1
1$_H$	SOH	DC1	!	1	A	Q	a	q	H1
2$_H$	STX	DC2	"	2	B	R	b	r	H2
3$_H$	ETX	DC3	#	3	C	S	c	s	H3
4$_H$	EOT	DC4	$	4	D	T	d	t	H4
5$_H$	ENQ	NAK	%	5	E	U	e	u	H5
6$_H$	ACK	SYN	&	6	F	V	f	v	A1
7$_H$	BEL	ETB	'	7	G	W	g	w	o1
8$_H$	BS	CAN	(	8	H	X	h	x	o2
9$_H$	HT	EM	)	9	I	Y	i	y	U1
A$_H$	LF	SUB	*	:	J	Z	j	z	SF
B$_H$	VT	ESC	+	;	K	[	k	{	-
C$_H$	FF	FS	,	<	L	\	l	|	-
D$_H$	CR	GS	-	=	M	]	m	}	-
E$_H$	SO	RS	.	>	N	^	n	~	-
F$_H$	SI	US	/	?	O	_	o	DEL	-

⎡Shaded⎤ codes are used with this communication.

Example: For "0," ASCII code is "30$_H$." For "1," ASCII code is "31$_H$."

Note 1: Codes after "80$_H$" are unique codes specified by Fuji Electric.
For settings, use binary.

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5.2.7.4 Program example

This program is written in Microsoft QuickBASIC (MS-DOS QBasic), and runs in accordance with Fuji general-purpose inverter protocol.

```
100    'FGI-Bus Sample Program(MS-DOS QBasic)
110    '
120    OPEN "COM1:38400,E,8,1" FOR RANDOM AS #1          'ComPort:BaudRate,Parity,DataBits,StopBits
130    soh$ = CHR$(1)              'FunctionCode H34,    H36,      H35,      H37
140    etx$ = CHR$(3)
150    enq$ = CHR$(5)
160    ack$ = CHR$(6)
170    nak$ = CHR$(&H15)
180    esc$ = CHR$(&H1B)
190    CLS
200    '
1000   PRINT "Select Operation 1:Read,2:Write"
1010   key$ = INKEY$
1020   IF key$ = "1" THEN 2000
1030   IF key$ = "2" THEN 3000
1040   GOTO 1010
1050   '
2000   '==== Read(F03) ====        'Reference User's Manual 6-19
2010   cmd$ = soh$                'SOH
2020   cmd$ = cmd$ + "01"         'Address(01 - 31) FunctionCode: H31
2030   cmd$ = cmd$ + enq$         'ENQ
2040   cmd$ = cmd$ + "R"          'Command(R,W,A,E)
2050   cmd$ = cmd$ + "F03"        'Code(F00...)
2060   cmd$ = cmd$ + " 0000"      'Data(0000 - FFFF)
2070   cmd$ = cmd$ + etx$         'ETX
2080   GOTO 4000
2090   '
3000   '==== Write(F03:1500r/m) ====          'Reference User's Manual 6-19
3010   cmd$ = soh$                'SOH
3020   cmd$ = cmd$ + "01"         'Address(01 - 31) FunctionCode: H31
3030   cmd$ = cmd$ + enq$         'ENQ
3040   cmd$ = cmd$ + "W"          'Command(R,W,A,E)
3050   cmd$ = cmd$ + "F03"        'Code(F00...)
3060   cmd$ = cmd$ + " 05DC"      'Data(0000 - FFFF)
3070   cmd$ = cmd$ + etx$         'ETX
3080   '
4000   '==== Send ====
4010   buf$ = cmd$
4020   GOSUB calcbcc
4030   cmd$ = cmd$ + bcc$         'Add BCC
4040   '
4050   PRINT #1, cmd$             'Send
4060   '
5000   '==== Receive ====
5010   recv$ = INPUT$(1, #1)      'Receive
5020   IF recv$ = soh$ THEN answer$ = ""
5030   answer$ = answer$ + recv$
5040   IF recv$ <> etx$ THEN 5010
5050   answer$ = answer$ + INPUT$(2, #1)
5060   PRINT "Received Data:"; answer$
5070   '
5080   PRINT "Hit any key (ESC -> End)"
5090   key$ = INKEY$
5100   IF key$ = "" THEN 5090
5110   IF key$ <> esc$ THEN 1000
5120   CLOSE #1
5130   END
5140   '
6000   calcbcc:
6010   b = 0
6020   c = 2
6030   char$ = MID$(buf$, c, 1)
6040   b = b + ASC(char$)         'Add
6050   c = c + 1
6060   IF char$ <> etx$ THEN 6030
6070   b = b AND &HFF
6080   bin = INT(b / 16)
6090   GOSUB bintoasc             'BCC1(8bit High)Character
6100   bcc$ = ascii$
6110   bin = b MOD 16
6120   GOSUB bintoasc             'BCC2(8bit Low)Character
6130   bcc$ = bcc$ + ascii$       'BCC1+2(Character)
6140   RETURN
6150   '
7000   bintoasc: 'Digit"0 - 15" to Character"0 - F"
7010   IF bin < 10 THEN ascii$ = CHR$(ASC("0") + bin) ELSE ascii$ = CHR$(ASC("A") + bin - 10)
7020   RETURN
```

5.3   Modbus RTU

This communications protocol was created overseas. Where possible, English text is used alongside the Japanese.

5.3.1   Message format

The normal format for sending RTU messages is as follows.

1. Query

Host	Query message	
Inverter		Response

2. Broadcast

Host	Broadcast message	
Inverter		(No response)
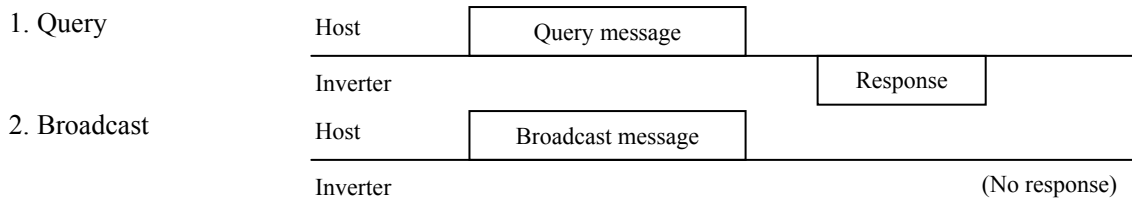
The inverter receives a message with the same station address from the host while in the standby state. If the message is received normally, the request is processed and a normal response is returned. If the message is not received normally, an error response is returned. In the case of a broadcast, no response is returned. There are four types of message: Query, Normal response, Error response, and Broadcast.

Query

The host sends a message to a single inverter.

Normal response

After the query from the host is received, the request is processed and a normal response is returned.

Error response

An error response is returned if the inverter receives the query but the requested function cannot be activated. A message indicating the reason why the requested function cannot be activated is sent with the error response. However, in the case of a CRC error or physical sending error, no response is returned.

Broadcast

The master uses a "0" address to send a message to all slaves. All slaves that receive the broadcast message activate the requested function. This process ends with the time out on the master side.

5.3.2　Transmission frame

The transmission frame is as follows.

1 byte	1 byte	max. 203 bytes	2 bytes
Station address	FC (function code)	Information	Error check

(1) Station address (station number)

Station addresses **0 to 247** are selectable with a 1 byte length.

Selecting a "0" address selects all slave stations and, therefore, the message will be a broadcast message.

(2) FC (function code)

Function codes are defined with values of 0 to 255 with a length of 1 byte, as shown below. The shaded sections indicate codes used with FRENIC-VG. Do not use "unused" function codes. Doing so will result in an error response being returned.

FC	Description
0 to 2	Unused
3	Read function code　Data size: max. 99
4 to 5	Unused
6	Write function code　Data: 1
7	Unused
8	Maintenance code
9 to 15	Unused
16	Continuously write function code　Data size: max. 16
17 to 127	Unused
128 to 255	Reserved for Exception Response

(3) Information

Information fields contain all information items (function code, byte count, data size, data, etc.). For details on information fields for each message type (broadcast, query, normal response, error response), refer to Section 5.3.2.1 "Reading function codes", Section 5.3.2.2 "Writing single function codes", and Section 5.3.2.3 "Writing multiple function codes".

(4) Error check

Error check fields contain data 2 bytes in length for the CRC-16 check method.

Because information fields vary in length, it is necessary to calculate the frame length required to calculate the CRC-16 code from the FC and byte count data.

5.3.2.1   Reading function codes

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	03	Function code	Read data size (max. 99)	Error check

Normal response

1 byte	1 byte	1 byte	2 to 198 bytes	2 bytes
Station No.	03	Byte count	Read data size (max. 198)	Error check

Hi, Lo, Hi, Lo, Hi, Lo,…

Setting "Query"

This request cannot be used with broadcasts. Station number "0" cannot be used.

FC = 03

Function codes are 2 bytes in length and composed of an identification code and a number (Ex. "F40" = F + 40). The Hi side corresponds to identification codes F, E-, L. The Lo side corresponds to the number. The setting data range is 0-9, 11 (F-L, U) on the Hi side, and 0-99 on the Lo side. For example, the setting data for F20 is "0014h".

Setting	Identification code	Name	Setting	Identification code	Name
0	F	Basic function	30	E1	Terminal function 1
1	E	Terminal function	31	H1	High level function 1
2	C	Control function	32	H2	High level function 2
3	P	Motor 1 function	33	H3	High level function 3
4	H	High level function	34	H4	High level function 4
5	A	Motor 2 function	35	H5	High level function 5
6	o	Option function	36	A1	Motor 3 function
7	S	Command/function data	37	o1	Option function 1
8	M	Monitor data	38	o2	Option function 2
9	L	Elevator function	39	U1	User function 1
11	U	User function		SF	
			41	M1	Monitor data function 1
			42	M2	Monitor data function 2

The length of read data is 2 bytes. The setting range is 1-99 (words). Make sure to set read data so that it does not exceed the upper limit offset 99 of the function code. Otherwise, an error response will be returned.

Interpreting "Normal response"

The byte count data range is 2-198. A byte count is twice the size of read data (1-99) for a query.

In the response, read data is listed in the order of Hi bytes and then Lo bytes for each word of data, and each word of data is listed in the order of the function code (address) requested with the query, and then the address +1, +2, etc. Missing function codes (F09, etc.) will be returned as "0000".

5.3.2.2 Writing single function codes
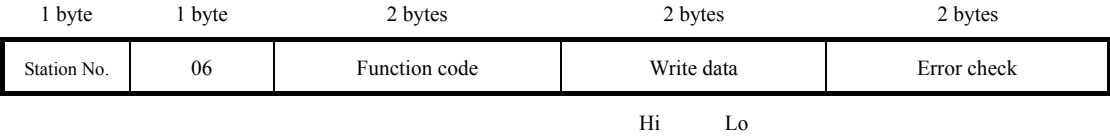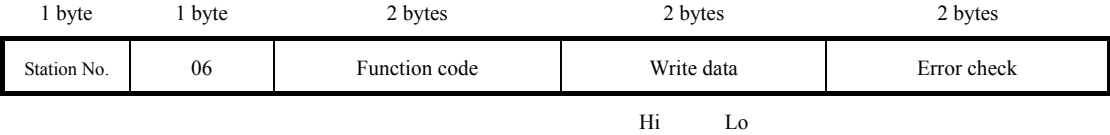
<u>Query</u>

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	06	Function code	Write data	Error check

Hi   Lo

<u>Normal response</u>

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	06	Function code	Write data	Error check

Hi   Lo

<u>Setting "Query"</u>

Broadcasts can be used if the address is "0". In this case, the broadcast request is processed by all inverters and no response is returned.

FC = 06

Function codes are 2 bytes in length and composed of an identification code and a number.

For details on identification codes, refer to the table in Section 5.3.2.1. The length of read data fields is fixed at 2 bytes.

<u>Interpreting "Normal response"</u>

A normal response uses the same frame as a query.

5.3.2.3 **Writing multiple function codes**

<u>Query</u>

1 byte	1 byte	2 bytes	2 bytes	1 byte	2 to 32 bytes	2 bytes
Station No.	16	Function code	Write data size	Byte count	Write data	Error check

Hi, Lo, Hi, Lo,…

<u>Normal response</u>

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	16	Function code	Write data size	Error check

<u>Setting "Query"</u>

Broadcasts can be used if the address is "0". In this case, the broadcast request is processed by all inverters and no response is returned.

FC = 16

Function codes are 2 bytes in length and composed of an identification code and a number.

For details on identification codes, refer to the table in Section 5.3.2.1. The length of read data fields is fixed at 2 bytes.

The setting range is 1-16. If you set a value of 17 or more, an error response will be returned. The byte count is 1 byte in length. The setting range is 2-32. Set the byte count to twice the size of the write data. The first 2 bytes of write data should be set to a Lo code (function code requested by the query), and subsequent data should be Hi codes set in ascending order (address +1, address +2, etc).

<u>Interpreting "Normal response"</u>

The returned function code and write data size values are the same as for the query.

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5.3.2.4　Maintenance code

This function is used to check communication line connections (hardware).

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	08	Diagnosis code 00 00	Data	Error check

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	08	Diagnosis code 00 00	Data	Error check

Setting "Query"

Broadcasts cannot be used for this query.

FC = 08

Diagnosis codes should be 2 bytes in length and fixed as 0x0000. If you set the data to a value other than 0x0000, an error response will be returned. The data should be 2 bytes in length. The content of the data can be set arbitrarily.

Interpreting "Normal response"

A normal response is the same as a query.

5.3.2.5 Error response

If an incorrect query is received, the query is not processed and an error response is returned.

Error response

1 byte	1 byte	1 byte	2 bytes
Station No.	Exception function	Sub code	Error check

Interpreting "Error response"

This is the same as for a station number request. The exception function adds 128 to the FC of the query message.

For example, if FC = 3, then exception function = 3 + 128 = 131 (83_H). The subcode indicates the reason for the exception, as shown in the table below.

Sub code	Item		Details	M26 (HEX.)	Keypad
1	Incorrect FC		FC other than 3, 6, 8, 16 received	75 (4BH)	01
2	Incorrect address	Incorrect function code	Range exceeded or non-existent code (F81, etc.) received	78 (4EH)	02
		Incorrect data size	Attempted to write more than 16W of data		
		Diagnosis code error (maintenance code)	Diagnosis code setting is not "0"		
3	Incorrect data	Data range error	Write data range exceeds writable range	80 (50H)	03
7	NAK	Link priority	Attempted to write command data or run command data with field option (T link, SX, etc.) applied	76 (4CH)	07
		Write disabled	(1) Change during operation disabled (2) Write disabled (Read only, M range) (3) Link function edit allowed mode (4) Write via RS-485 disabled (H31, H34-37, H40, P02) (5) F04, F05, P03-P27 (M1 motor parameters protected)	79 (4FH)	

5.3.3　Error checking

5.3.3.1　CRC-16

When sending data, CRC data is used to check for errors in the transmission frame.

CRC is the most effective system for error checking. At the sending side, the CRC value is calculated and added to the last level of the frame. Then, at the receiving side, the CRC value is calculated again in the same way based on the received data. The two CRC values are then cross-checked.

Simplified steps for calculating CRC

- Convert the data to a polynomial (Ex. 1100 0000 0010 0001 → X15 + X14 + X5 + 1) and then divide this polynomial by a generating polynomial (17 bit; X16 + X15 + X2 + 1). The remainder (16 bit) is the CRC value.

- Add the "remainder" to the last level of the data, disregarding the quotient, and send the message.

- The recipient divides the received message (with the CRC value added) by the generating polynomial. If the "remainder" is zero, the message has been received without errors.

CRC-16

A generating polynomial is expressed as factors of X such as "$X^3 + X^2 + X$", rather than binary codes such as "1110".

Although any kind of generating polynomial can be used, some standard types are defined and proposed for optimal error detection.

For RTU, the "$\mathbf{X^{16} + X^{15} + X^2 + 1}$" generating polynomial, which corresponds to "1 1000 0000 0000 0101" in binary code, is used. The CRC that is generated with this polynomial is known as "**CRC-16**".

5.3.3.2   CRC-16 algorithm

The following diagram shows the CRC-16 calculation algorithm. Please also refer to the calculation example in Section 5.3.3.3.

```
                          ┌─────────────┐
                          │    START    │
                          └──────┬──────┘
                                 ▼
                    ┌──────────────────────────┐
                    │         Default          │
                    │  Remainder R ← "FFFF"    │
                    │ Generating polynomial     │
                    │        P ← "A001"         │
                    │ Data length counter n ← 0 │
                    └────────────┬─────────────┘
                                 ▼
                    ┌──────────────────────────┐
                    │ Data length calc. N ←    │
                    │        Data length        │
                    └────────────┬─────────────┘
                                 ▼
                          ◇ n == N? ◇ ──── Yes ──┐
                                 │ No             │
                                 ▼                │
                            [ n++ ]               │
                                 ▼                │
                    ┌──────────────────────────┐ │
                    │ Specify last byte of word │ │
                    │ data as:                  │ │
                    │   A = nth sent byte       │ │
                    │   Top byte is "00"        │ │
                    └────────────┬─────────────┘ │
                                 ▼                │
                       [ Shift Count ← 0 ]        │
                                 ▼                │
                   No ── ◇ Shift Count == 0? ◇    │
                                 │ Yes            │
                                 ▼                │
                          ◇ n == 1? ◇ ── Yes ──┐  │
                                 │ No          │  │
  [CRC DATA ← CRC DATA XOR P]    ▼             │  │
            (Yes)    [CRC DATA ← CRC DATA XOR A]│  │
                                 │    [CRC DATA ← A XOR R]
                                 ▼             │
                          ◇ Shift Count == 8? ◇
                                 │ No
                                 ▼
                        [ Shift Count++ ]
                                 ▼
                     [ CRC DATA >> 1 bit shift ] ── No
                                 ▼
                        ◇ Bit shift Carry? ◇ ── Yes
                                 ▼
                    ┌──────────────────────────┐
                    │ Add CRC DATA to last level │
                    │     of sent frame          │
                    └────────────┬─────────────┘
                                 ▼
                          ┌─────────────┐
                          │     END     │
                          └─────────────┘
```

CRC DATA is 1 word of memory. It is updated in the calculation process and finally added to the sent frame as a check code.

When the message is received, the same algorithm is used. The CRC calculated at the receiving side must then be cross-checked with the CRC that was sent.

5.3.3.3 CRC-16 calculation example

The following is an example of read data that is sent:

Station number: 1, FC = 03, function code P49 (P = code 03, 49 = 31 Hex), read data size: 20 items, G.P (generating polynomial): 1010 0000 0000 0001.

Address	FC	Function code		Read data size	
O1	O3	O3	31	OO	14

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
1	Initial data R="FFFF"	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	1st data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	CRC = No.1 X or No.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
4	Shift >> 2 (up to flag=1)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CRC = No.4 X or G.P	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
6	Shift >> 2	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7	CRC = No.6 X or G.P	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
8	Shift >> 2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
9	CRC = No.8 X or G.P	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift >> 2 (8 shift end)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC = No.10 X or G.P	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
12	2nd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13	CRC = No.11 X or No.12	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
14	Shift >> 1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
15	CRC = No.14 X or G.P	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
16	Shift >> 1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
17	CRC = No.16 X or G.P	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
18	Shift >> 2	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
19	CRC = No.18 X or G.P	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
20	Shift >> 2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1
21	CRC = No.20 X or G.P	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift >> 2 (8 shift end)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
23	3rd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
24	CRC = No.22 X or No.23	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	
25	Shift >> 1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
26	CRC = No.25 X or G.P	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	
27	Shift >> 6	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
28	CRC = No.27 X or G.P	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	
29	Shift >> 1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1
30	CRC = No.29 X or G.P	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	
31	4th data byte	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	
32	CRC = No.30 X or No.31	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1	
33	Shift >> 1	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1
34	CRC = No.33 X or G.P	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1	

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
35	Shift >> 1	0	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1
36	CRC = No.35 X or G.P	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1	
37	Shift >> 1	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1
38	CRC = No.37 X or G.P	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	
39	Shift >> 1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1
40	CRC = No.37 X or G.P	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	
41	Shift >> 3	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1
42	CRC = No.41 X or G.P	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1	
43	Shift >> 1	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1
44	CRC = No.43 X or G.P	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
45	5th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	CRC = No.44 X or No.45	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
47	Shift >> 5	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1
48	CRC = No.47 X or G.P	1	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	
49	Shift >> 3	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	0
50	6th data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
51	CRC = No.49 X or No.50	0	0	0	1	0	1	0	0	1	1	1	0	1	0	0	0	
52	Shift >> 4	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1
53	CRC = No.52 X or G.P	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	
54	Shift >> 1	0	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1
55	CRC = No.54 X or G.P	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	0	
56	Shift >> 2	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1
57	CRC = No.56 X or G.P	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	
58	Shift >> 1	0	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0
	Send CRC		4				E				1				4			

Following the above calculation, the sent data is as follows.

Address	FC	Function code		Read data size		CRC check	
01	03	03	31	00	14	14	4E

5.3.3.4   Calculating frame length

In order to calculate CRC-16, it is necessary to know the message length, which is variable. The lengths of all message types can be determined from the table below.

FC	Name	Length of query broadcast message excluding CRC code	Length of response message excluding CRC code
3	Read function code	6 bytes	3 + 3rd byte
6	Write single function code	6 bytes	6 bytes
8	Maintenance code	6 bytes	6 bytes
16	Write multiple function codes	7 + 7th byte	6 bytes
128-255	Exception function	Unused	3 bytes

Note: 7th and 3rd denote the byte count value for the information field.

5.3.4   Communication examples

This section illustrates representative communication examples. (In all cases, the station number is 5.)

5.3.4.1   Reading

(1) M06: Read speed detection value.

<u>Query</u> (Host → Inverter)

05	03	08	06	00	01	67	EF

<u>Normal response</u> (Inverter → Host)

05	03	02	27	10	53	B8

Speed detection value: 2710_H → 10000d

$$10000d \ \text{x} \ \frac{\text{Max. speed}}{20000} = 750 \ (\text{r/min})$$
(Max. speed: 1500 r/min)

(2) S01: Write 400 r/min to speed setting 1. (Max. speed: 1500 r/min)

$$400 \ (\text{r/min}) \ \text{x} \ \frac{20000d}{1500 \ (\text{r/min})} = 5333d = 14D5_H$$

<u>Query</u> (Host → Inverter)

05	06	07	01	14	D5	16	65

<u>Normal response</u> (Inverter → Host)

05	06	07	01	14	D5	16	65

5.4   FRENIC-VG Loader

Inverter support software FRENIC-VG Loader runs on a computer to provide the following.

• Configuring and managing function codes: Reading/writing function code data from/to the inverter

• Monitoring the running status of the FRENIC-VG:

　　　　　Operation monitor (I/O monitor and system monitor)
　　　　　Trace functions (Real-time trace and historical trace)

• Analyzing failures that have happened in the FRENIC-VG:

　　　　　Operation monitor (Alarm monitor)
　　　　　Trace functions (Traceback)

Using the above functions of FRENIC-VG Loader enables you to easily start FRENIC-VG, manage function codes, and analyze failures without setting up a data logger tool.

FRENIC-VG Loader is available in two versions: Free version (WPS-VG1-STR) included in the CD-ROM that comes with the FRENIC-VG inverter and Optional paid-for version (WPS-VG1-PCL).

   For details, refer to the FRENIC-VG Loader Instruction Manual.

FRENIC-VG Loader functions supported by free version and paid-for version

Reading/writing function code data		Supported by free version WPS-VG1-STR (Instruction Manual INR-SI47-1617*-□)	Supported by optional paid-for version WPS-VG1-PCL (Instruction Manual INR-SI47-1589*-□)
Trace functions	Traceback		
	Historical trace	--	
	Real-time trace		
Operation monitor	I/O monitor		
	System monitor		
	Alarm monitor		

Note: On non-standard series of inverters such as special order-made inverters, FRENIC-VG Loader may not display some function codes normally.

5.4.1   Specifications

Item		Specifications	Remarks
Supported inverter series		FRENIC-VG (Unit and stack types) FRENIC5000VG7	
Connection	Direct connection with the inverter	USB connection: 1 inverter only RS-485 connection: Max. 31 inverters	Direct connection between Loader and inverter via the USB or RS-485 interface.
	Via-PLC communication *1	Via USB Via RS-485 Via communications board (Ethernet interface)	Connection between Loader and PLC (MICREX-SX).
Recommended cables		USB: USB cable (Mini B connector) RS-485: Shielded twisted pair for long-distance transmission	

*1 In the system configuration in which the FRENIC-VG (or FRENIC5000VG7) inverter is connected with the MICREX-SX via the SX bus (or E-SX bus), connecting FRENIC-VG Loader to the MICREX-SX enables access to the inverter.

	Item	Specifications	Remarks
Operating environment	OS *2	Microsoft Windows XP (SP3 or later) Microsoft Windows Vista Microsoft Windows 7 (32-bit, 64-bit)	
	Memory	512 MB or more RAM	2 GB or more recommended
	Hard disk space	Free space of 8.5 MB or more	
	Serial ports	USB port RS-232C port (Requires an RS-485−RS-232C converter)	The FRENIC5000VG7 requires a dedicated cable.
	Monitor resolution	800 x 600 or higher	Color XGA (1024 x 768) 32-bit or higher monitor recommended.
Transmission specifications *3	Communications ports	**COM1** to COM255	Port used by Loader on computers
	Transmission rate	USB connection: 12 Mbps fixed RS-485 connection: **38400**, 19200, 9600, 4800, 2400 bps	38400 bps or more recommended
	Character length	8 bits	Fixed
	Stop bit length	1 bit	Fixed
	Parity	Even	Fixed
	No. of retries	None, 1 to **3** to 10	No. of retries before detection of communication timeout error
	Timeout setting	100 ms, 300 ms, 500 ms, **1.0** to 1.9 s, 2.0 to 9.0 s, 10.0 to 60.0 s	Time longer than the response interval (H39) should be specified.

*2 It is *not* recommended that FRENIC-VG Loader be used on computers downgraded from Windows 7 or Vista to Windows XP.

*3 Underlined values are factory defaults.

5.4.2   Connection

5.4.2.1   USB connection

The FRENIC-VG is equipped with a USB port, enabling direct connection to a computer which is also equipped with a USB port. FRENIC-VG Loader can be used in the connection configuration of "Computer : FRENIC-VG = 1 : 1."

Note that the FRENIC5000VG7 has no USB port.

USB MiniB connector

Computer

USB A connector

USB cable

5 m or less
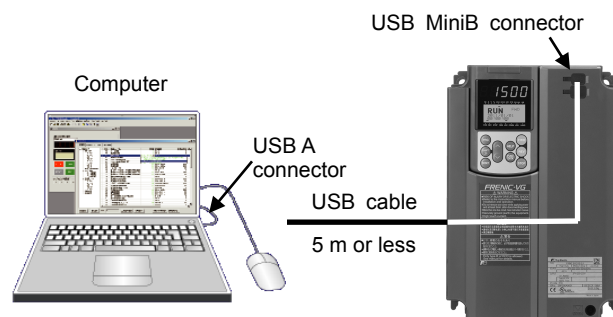
Figure 5.4.2-1   Connection Configuration (USB)

5.4.2.2 RS-485 connection

The FRENIC-VG or FRENIC5000VG7 has an RS-485 communications interface as standard, enabling access from FRENIC-VG Loader in RS-485 communication.

Connecting the inverter to a computer requires an RS-485 converter. In the maximum configuration, up to 31 inverters can be connected to a single computer running FRENIC-VG Loader. When two or more inverters are connected, it is necessary to register each inverter (station address, etc.) for access from FRENIC-VG Loader.

Connection with FRENIC-VG

The FRENIC-VG has an RS-485 terminal on the control terminal block. Connect the communications cable to that terminal.

📖 For details on connection, refer to Section 5.1.3 "Connection method."

📖 For details on RS-485 converters, refer to Section 5.1.4 "RS-485 Communications support devices."

Connection with FRENIC5000VG7

Use the VG7 loader cable for connection.

📖 For details, refer to the FRENIC5000VG7 related documents.

5.4.2.3 Communication via MICREX-SX

In the system configuration in which the FRENIC-VG or FRENIC5000VG7 inverters are connected with the MICREX-SX via the SX bus (or E-SX bus), FRENIC-VG Loader can access to those inverters through the MICREX-SX. (Transparent communication)
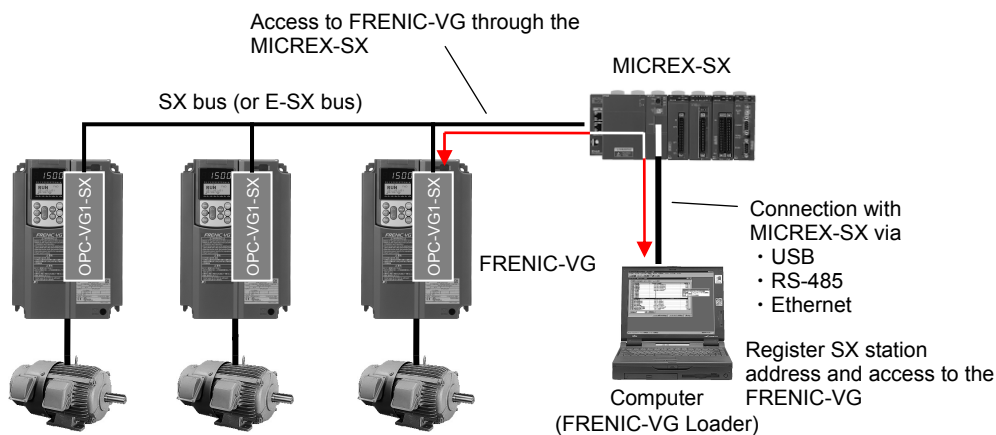
Figure 5.4.2-2   Access to Inverters in Transparent Communication

In transparent communication, the MICREX-SX runs software in the preset task cycle in RUN mode. FRENIC-VG Loader uses unoccupied time in the task cycle to access the inverter without interrupt; therefore, it does not disturb the operation of the machinery.

Note Reading or writing data from/to the inverter sometimes takes time.

5.4.3 Function overview

This section overviews the functions of FRENIC-VG Loader.

📖 For details, refer to the FRENIC-VG Loader Instruction Manual.

5.4.3.1 Configuring function codes

FRENIC-VG Loader allows you to edit, set, and check (comparison between data saved in the inverter and that in the connected computer) the function codes of the FRENIC-VG or FRENIC5000VG7. Function code numbers, names, setting values, setting ranges, factory defaults, etc. are listed on the screen.

It is also possible to save those data in CSV format so that it can be pasted to Microsoft Excel sheet for convenience in data management.
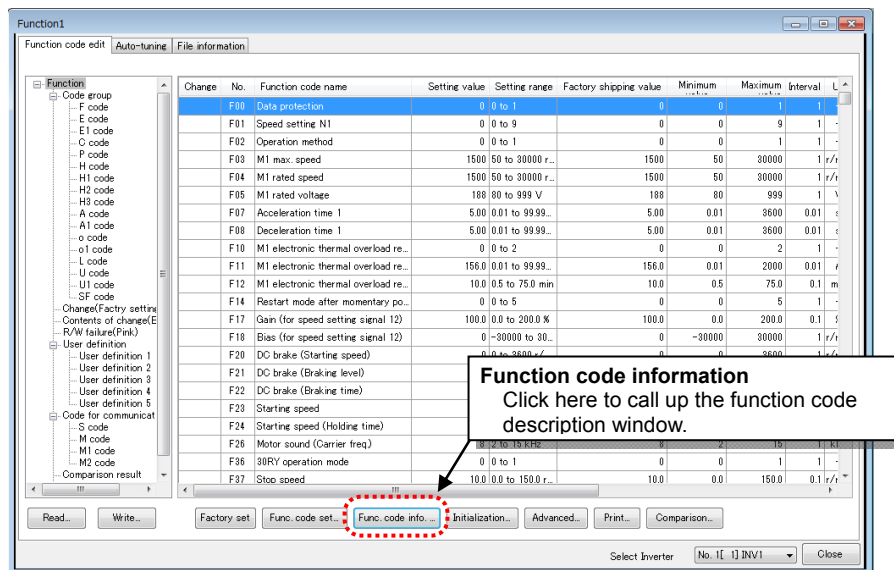
Figure 5.4.3-1　Function Codes Screen

5.4.3.2 Trace functions

The trace functions allow you to monitor the inverter running status in sequential waveforms.

The following three types of trace functions are available. Make use of each type according to its feature. The trace data can be saved in a computer so that it is possible to analyze failures not only at the site but also at offices.

① Traceback:　　　If the inverter causes an alarm, it automatically saves the running states in waveforms into its memory. FRENIC-VG Loader reads out the waveform data and displays it in graph form.

This function is suitable for failure analysis.

The inverter stores waveform data of the latest alarm and the last three alarms. It discards waveform data of the older alarms.

② Real-time trace:　This function reads out the current waveform data from the running inverter and shows it in graph form in real-time.

This is suitable for long-duration monitoring.

③ Historical trace:　According to the preset arbitrary triggers, this function reads out the waveform data of the inverter running states held in the inverter memory and displays it in graph form.

This is suitable for monitoring short-duration samples.

Trace specifications

Item	Traceback	Real-time trace	Historical trace
Sampling time	Detected current value, angle of current flow 50 μs to 83.36 μs 100 μs to 166.72 μs Other than those above 400 μs to 666.88 μs 1 ms to 1s	1 ms to 1s	Detected current value, angle of current flow 50 μs to 83.36 μs 100 μs to 166.72 μs Other than those above 400 μs to 666.88 μs 1 ms to 1 s
Number of sampling points	1100 point/Ch Before trigger: 1000 points/Ch After trigger: 100 points/Ch	15000 points/Ch (Number of points that can be displayed sequentially)	5456 to 24549 points/Ch (This number increases or decreases depending on the number of channels.)
Display data size	Analog: 8 channels Digital: 16 channels	Analog: 8 channels Digital: 16 channels	Analog: 8 channels Digital: 16 channels
Selected data size	Analog: 26 items Digital IN: 16 items OUT: 16 items x 8 blocks	Analog: 26 items Digital IN: 16 items x 6 blocks OUT: 16 items x 6 blocks	Analog: 26 items Digital IN: 16 items x 6 blocks OUT: 16 items x 6 blocks
Other	Built-in battery required *1 Inverters of 30 kW or above: Battery included as standard		

*1 For the battery loading procedure, refer to Chapter 8, Section 8.6 "Battery" in the FRENIC-VG User's Manual (Unit Type / Function Codes Edition).
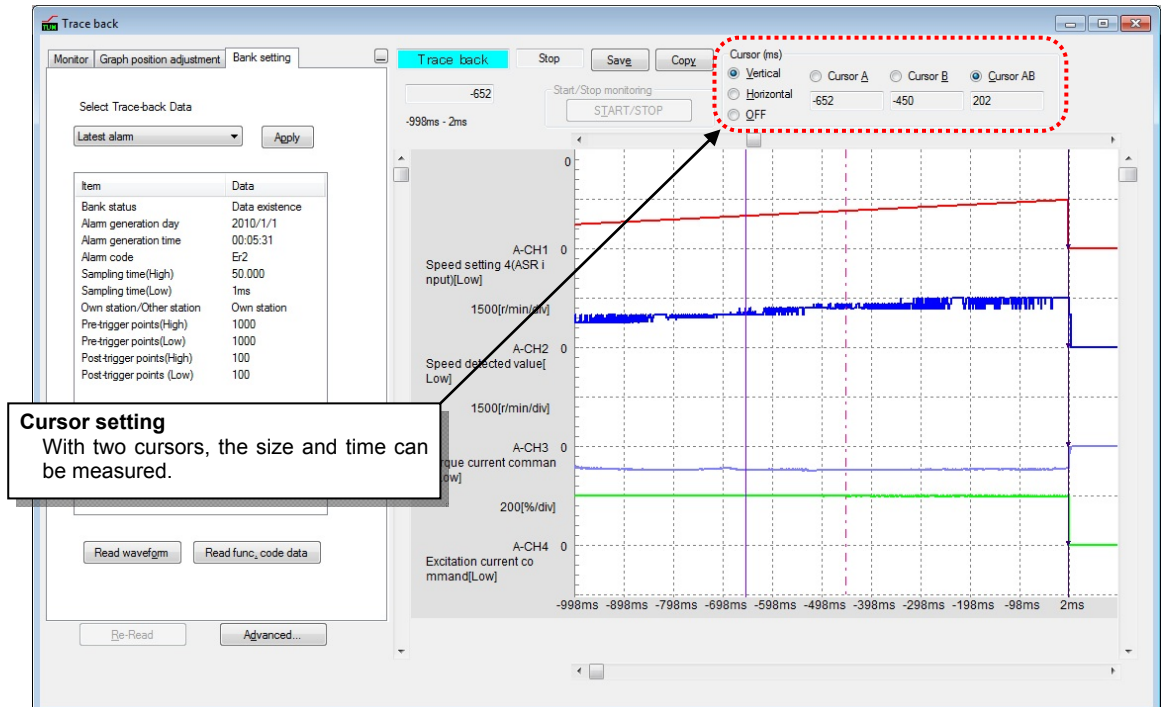
Figure 5.4.3-2   Traceback Screen

5.4.3.3　Operation monitor

FRENIC-VG Loader can monitor the following and save the monitored data in CSV format.

① I/O monitor:　　　This monitors the ON/OFF states of the input and output terminals of the inverter.

② System monitor:　This shows the inverter ROM version, inverter type, current setup information, and maintenance information of the inverter.

③ Alarm monitor:　　This shows the alarm status of the inverter--the current alarm content and the various running information applied when an alarm has occurred.

　　　　　　　　　　This also shows a list of alarm data selected from four alarms (latest and last three alarms).

　　　　　　　　　　This requires a backup battery. (Inverters of 30 kW or above: Battery included as standard)

　　　　　　　　　　📖　Refer to Chapter 8, Section 8.6 "Battery" in the FRENIC-VG User's Manual (Unit Type / Function Codes Edition).
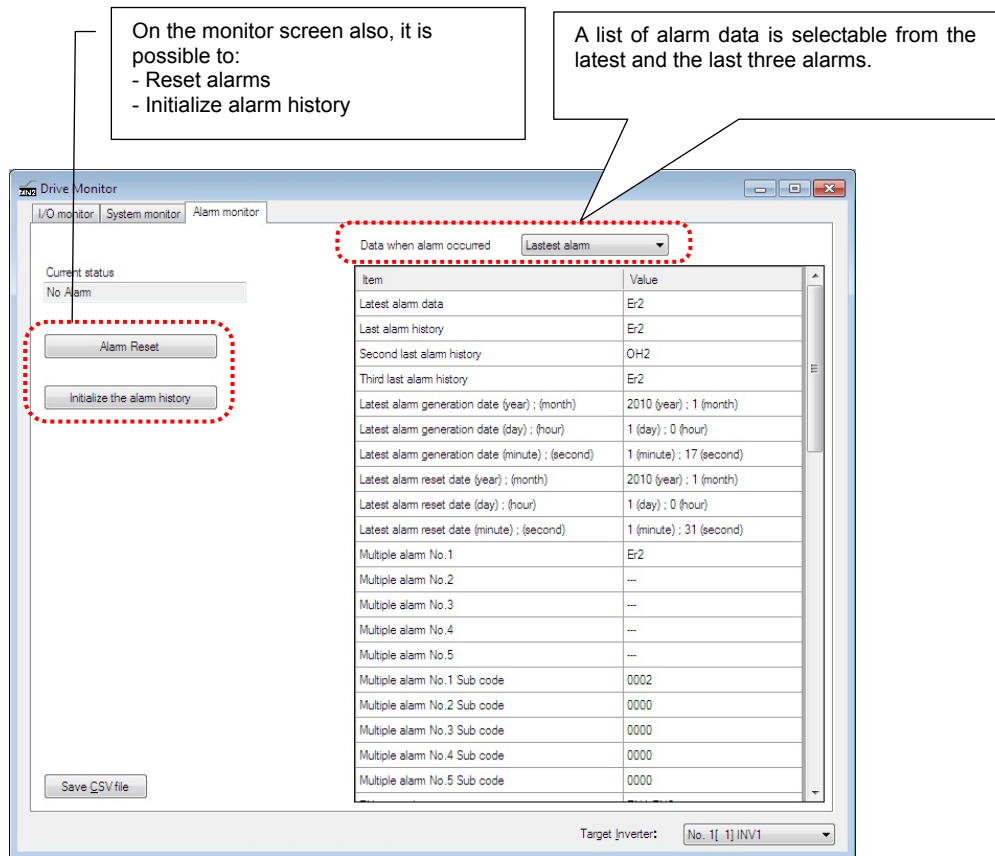
Figure 5.4.3-3　Operation Monitor (Alarm monitor)

FRENIC- VG 6

Chapter 6
CONTROL OPTIONS

This chapter describes the FRENIC-VG's control options.

Contents

6.1 Common Specifications

6.1.1 Specifications table

Table 6.1.1

Category	Name	Model	Switch-accessible functions	Specifications	See Section
Analog cards	F/V converter	OPC-VG1-FV (*1)		F/V converter	6.9
	Synchro interface	OPC-VG1-SN		Dancer control synchro interface circuit	6.10
	Aio expansion card	OPC-VG1-AIO		2 [Ai] + 2 [Ao] expansion card	6.13
Digital 8-bit (A and B ports only)	Di interface card	OPC-VG1-DI	OPC-VG1-DIA	16-bit Di binary or BCD 4-digit + sign speed command, torque command, and torque current command configuration (Configuration switching is required at the mounting port.)	6.11
			OPC-VG1-DIB		
	Dio expansion card	OPC-VG1-DIO	OPC-VG1-DIOA	Function selection Di × 4-bit + function selection Do × 8-bit expansion	6.12
			OPC-VG1-DIOB	UPAC I/O expansion Di × 16-bit + Do × 10-bit	
	T-link interface card	OPC-VG1-TL		T-link interface card	6.4
	CC-Link interface card	OPC-VG1-CCL		CC-Link-compliant card	6.7
	PG interface card	OPC-VG1-PG	OPC-VG1-PG(SD)	+5 V line driver type encoder interface (A, B, Z signals) (500 kHz) Motor speed, line speed, position command, position detection	6.2
			OPC-VG1-PG(LD)		
			OPC-VG1-PG(PR)		
			OPC-VG1-PG(PD)		
		OPC-VG1-PGo	OPC-VG1-PGo(SD)	Open collector type encoder interface (A, B, Z signals) (100 kHz) Motor speed, line speed, position command, position detection	
			OPC-VG1-PGo(LD)		
			OPC-VG1-PGo(PR)		
			OPC-VG1-PGo(PD)		
		OPC-VG1-SPGT		17-bit high-resolution ABS encoder interface	6.8
	Synchronous motor drive PMPG interface card	OPC-VG1-PMPG		+5 V line driver output — A, B, magnetic pole positions (max. 4-bit)	6.3
		OPC-VG1-PMPGo		Open collector output — A, B, magnetic pole positions (max. 4-bit)	
	UPAC communication high-speed serial card	OPC-VG1-SIU (*1)		Used for driving two or more inverters with a single inverter equipped with a UPAC via the communications link	Separately issued manual
Field bus interface card (C port only)	PROFIBUS-DP interface card	OPC-VG1-PDP (*2)		PROFIBUS-DP interface card	-
	DeviceNet interface card	OPC-VG1-DEV (*1)		DeviceNet interface card	-
Digital 16-bit (D port only)	SX bus interface card	OPC-VG1-SX		SX bus interface card	6.5
	E-SX bus interface card	OPC-VG1-ESX		E-SX bus interface card	6.15
	User Programmable Application Card (UPAC)	OPC-VG1-UPAC (*2)		Used for making customizable software at the user site for inverter control	Separately issued manual
Safety card (E port only)	Functional safety card	OPC-VG1-SAFE (*2)		Safety standard-compliant card	Separately issued manual
Control circuit terminal (F port only)	High-speed serial communications-compatible terminal block	OPC-VG1-TBSI (*2)		Used for multiplex systems such as multi-winding motor drive system and direct parallel system	6.6
Standalone options (*1)	F/V converter	MCA-VG1-FV		F/V converter	6.9
	Synchro interface	MCA-VG1-SN		Dancer control synchro interface circuit	6.10
	PG signal switch	MCA-VG1-CPG		PG/NTC signal switch (2-signal switch)	6.14
Loaders	Inverter support loader	WPS-VG1-STR		Windows CD-ROM (free version)	Separately issued manual
		WPS-VG1-PCL		Windows CD-ROM (paid-for version)	Separately issued manual

(*1)   Available soon
(*2)   Available in the ROM version H1/2 0020 or later and product serial number version BC or later.

Chap. 6

CONTROL OPTIONS

For options whose manuals are separately issued as shown in the above table, refer to the documents listed below.

Model	Name	Material No.	Remarks
OPC-VG1-SIU	UPAC communication high-speed serial card	24A7-□-0044*	
OPC-VG1-UPAC	User Programmable Application Card (UPAC)		
OPC-VG1-SAFE	Functional safety card	INR-SI47-1541*-□	
WPS-VG1-STR	FRENIC-VG Loader (free version)	INR-SI47-1588*-□	
WPS-VG1-PCL	FRENIC-VG Loader (paid-for version)	INR-SI47-1616*-□	

Note 1: A box (□) replaces an alphabetic letter: J (Japanese), E (English), or C (Chinese).
An asterisk (*) replaces an edition number (a, b, c, …).

Note 2: The materials are subject to change without notice. Be sure to obtain the latest editions for use.

Mounting ports for control options
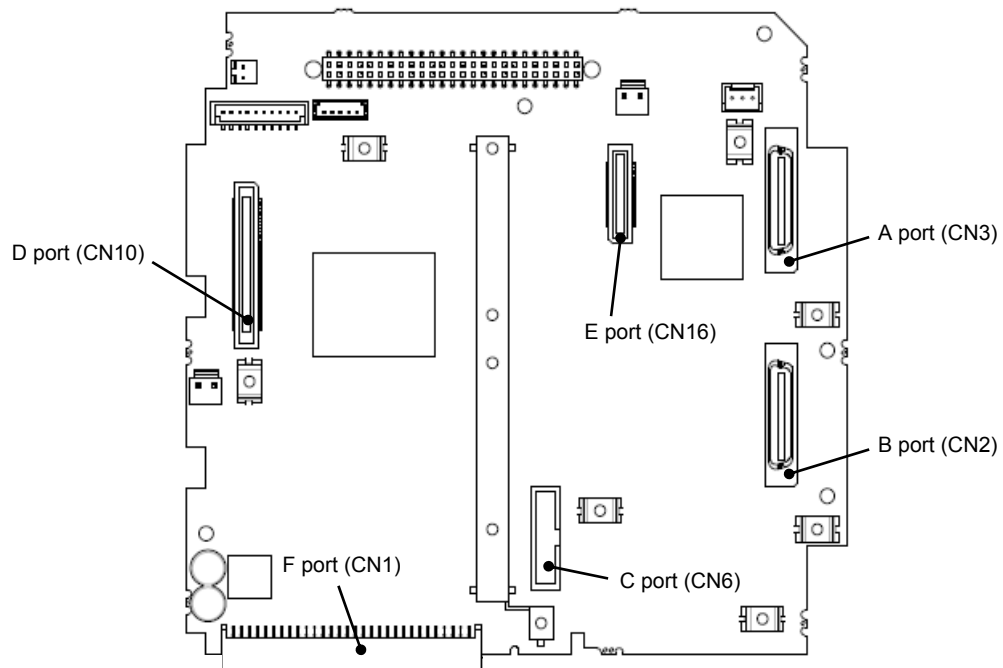
Figure 6.1.1   Control Option Mounting Ports on the Control Printed Circuit Board

Note: To use the control circuit terminal option (F port), replace the standard control circuit terminal printed circuit board.

The following table indicates which control options can be used in combination (number of options mountable):

Table 6.1.2

CN	Port	Category	Pattern 1	Pattern 2	Pattern 3
3	A	Digital 8-bit, analog card	1	1	1
2	B	Digital 8-bit	1	0	0
6	C	Filed bus interface card	0	0	1
10	D	Digital 16-bit	1	1	0
16	E	Safety cards	0	1	1
1	F	Control circuit terminals	1	1	1

Constraints when an OPC control option is installed

Table 6.1.3 indicates which options can be used simultaneously.

OK : Can be used simultaneously.   NG : Cannot be used simultaneously.

Table 6.1.3

Model OPC-VG1-＿＿＿＿	SN	FV	AIO	DI	DIO	TL	CCL	PG	PMPG	SPGT	SIU	SX	ESX	UPAC	PNET	PDP	DEV	SAFE	TBSI
SN	NG																		
FV	NG	NG																	
AIO	NG	NG	NG																
DI	OK	OK	OK	OK															
DIO	OK	OK	OK	OK	OK														
TL	OK	OK	OK	OK	OK	NG													
CCL	OK	OK	OK	OK	OK	NG	NG												
PG/PGo	OK	OK	OK	OK	OK	OK	OK	*2											
PMPG/PMPGo	OK	OK	OK	OK	OK	OK	OK	*2	NG										
SPGT	*1	*1	*1	OK	OK	OK	OK	NG	NG	NG									
SIU	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	NG								
SX	OK	OK	OK	OK	OK	OK	NG	OK	OK	OK	NG	NG							
ESX	OK	OK	OK	OK	OK	NG	NG	OK	OK	OK	NG	NG	NG						
UPAC	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	NG	NG	NG					
PNET	OK	OK	OK	OK	OK	NG	NG	OK	OK	OK	NG	NG	NG	NG	NG				
PDP	OK	OK	OK	OK	OK	NG	NG	OK	OK	OK	NG	NG	NG	NG	NG	NG			
DEV	OK	OK	OK	OK	OK	NG	NG	OK	OK	OK	NG	NG	NG	NG	NG	NG	NG		
SAFE	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	NG	
TBSI	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	NG	OK	OK	OK	OK	OK	OK	OK	NG

*1 Contact your Fuji sales representative if you need to use this combination of options.

*2 When the PG interface card (OPC-VG1-PG/PGo) and PMPG interface card (OPC-VG1-PMPG/PMPGo) are mounted concurrently, the following constraints apply.

	VG1-PG/PGo(SD)	VG1-PG/PGo(LD)	VG1-PG/PGo(PR)	VG1-PG/PGo(PD)
VG1-PG/PGo(SD) VG1-PMPG/PMPGo	NG			
VG1-PG/PGo(LD)	OK	NG		
VG1-PG/PGo(PR)	OK	NG	NG	
VG1-PG/PGo(PD)	OK	NG	NG	NG

Chap. 6

CONTROL OPTIONS

6.1.2　Inspecting options after delivery

6.1.2.1　Inspecting options

⚠CAUTION
• Do not use products with damaged or missing parts. 　Doing so may result in bodily injury or damage.

Once you receive the product you ordered, check the following items:

(1)　Verify that the product you received is in fact the product you ordered. Check the type/model printed on the option.

Example type/model: OPC-VG1-TL

Option name　　　　TL → T-link interface
Host inverter name　VG1 → FRENIC-VG
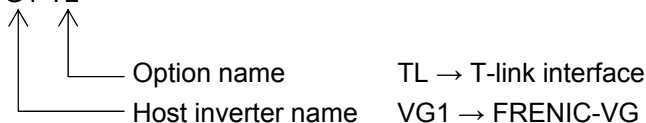
(2)　Check the product for damage sustained during shipment.

(3)　Verify that all accessories are included in the packaging.

Table 6.1.4　Accessories

Option model	Screws/spacers	Other (power supply harnesses, optical cables, plugs and housings)
OPC-VG1-FV, SN, AIO	Screws (M3): 3 Spacers: 3	±15 V use (CN12 connections)
OPC-VG1-DI		±24 V use (CN24 and CN25 connections) Sumitomo 3M Limited Plug: 10120-3000PE, Housing: 10320-52A0-008
OPC-VG1-DIO		±24 V use (CN24 and CN25 connections) Sumitomo 3M Limited Plug: 10136-3000PE, Housing: 10336-52A0-008
OPC-VG1-TL, CCL		
OPC-VG1-PG/PGo		
OPC-VG1-PMPG/ PMPGo		Sumitomo 3M Limited Plug: 10120-3000PE, Housing: 10320-52A0-008
OPC-VG1-SPGT		
OPC-VG1-SIU		Plastic optical cable (5 m, 1 per card)
OPC-VG1-SX, ESX, UPAC	Screws (M3): 2 Spacers: 4	
OPC-VG1-PDP, DEV	Screws (M3): 3 Spacers: 1	
OPC-VG1-SAFE	Screws (M3): 3	Keypad connection cable (5 m, 1 per card)
OPC-VG1-TBSI		Plastic optical cable (5 m, 1 per card)
MCA-VG1-FV, SN, CPG		
WPS-VG1-STR, PCL		

6.1.2.2 Operating environment

Options are designed for use in the same operating environment as the FRENIC-VG.

Table 6.1.5 Operating Environment

Item	Specifications	
Installation location	Shall be free from corrosive gases, flammable gases, oil mist, dusts, and direct sunlight. (Pollution degree 2 (IEC60664-1)). Indoor use only.	
Ambient temperature	-10 to +50°C (-10 to +40°C when installed side-by-side without clearance (22 kW or below))	
Relative humidity	5 to 95% RH (without condensation)	
Altitude	3,000 m or below 1001 to 3000 m: Current derating is required for use. 📖 Refer to the Chapter 3, 3.3 "Mounting and Wiring the Inverter."	
Vibration	200 V 55 kW, 400 V 75 kW or below 3 mm: 2 to less than 9 Hz, 9.8 m/s²: 9 to less than 20 Hz 2 m/s²: 20 to less than 55 Hz 1 m/s²: 55 to less than 200 Hz	200V 75 kW, 400 V 90 kW or above 3 mm: 2 to less than 9 Hz 2 m/s²: 9 to less than 55 Hz 1 m/s²: 55 to less than 200 Hz

Note: Use of options in an operating environment that does not satisfy these conditions may result in decreased performance and service life or equipment failure.

Chap. 6

CONTROL OPTIONS

6.1.3   Storing options

6.1.3.1   Temporary storage

Options should be stored in an environment that satisfies the conditions listed in Table 6.1.6.

Table 6.1.6   Storage Environment

Item	Specifications	
Ambient temperature	-10 to +50°C	Avoid use in environments where abrupt changes in temperature may cause condensation or freezing.
Storage temperature (Note 1)	-25 to +70°C	
Relative humidity	5 to 95% (Note 2)	
Atmosphere	Avoid exposure to dust, direct sunlight, corrosive gases, flammable gas, oil mist, steam, water droplets and oscillation. Avoid exposure to excessive salt content.	

(Note 1): Storage temperatures assume short-term exposure as during shipment.

(Note 2): Condensation or freezing may occur in locations where there are significant changes in temperature, even if the humidity satisfies the specifications. Avoid storage in such locations.

(1)   Do not place options directly on the floor. Instead, store on a table or shelf.

(2)   If the storage environment does not satisfy the conditions listed in Table 6.1.6, wrap the option in a vinyl sheet, polyethylene film designed for packaging use, or other material.

(3)   If exposure to humidity is a concern, place a desiccant (silica gel, etc.) inside the packaging and then wrap as described in (2) above.

6.1.3.2   Long-term storage

The method used to store options for an extended period of no use after purchase varies greatly with the storage environment. If the device must be stored under precisely controlled conditions, consult the company from which you purchased the product or your nearest Fuji sales office with information about the specific specifications.

Generally speaking, the following storage practices should be observed:

(1)   Options should be stored in an environment that meets the temporary storage conditions.

(2)   Options should be packaged carefully to prevent the incursion of humidity and foreign matter. Enclose a desiccant (silica gel, etc.) in the packaging. See JIS Z 0301 (damp-proof packaging methods) for the quantity of desiccant to use. Aim for a relative humidity of 70% or less inside the packaging.

When the option is to be installed in the FRENIC-VG and then left unused in a device or control panel for a period of time, particularly at a location where construction work is being carried out, the device is likely to be exposed to humidity and dust. In such situations, remove the entire FRENIC-VG inverter and store it in an environment that satisfies the conditions listed in Table 6.1.6.

6.1.4 Installing internal options (OPC-VG1-□□)

6.1.4.1 Removing the front cover

<div style="border:1px solid">

⚠CAUTION

- Inappropriate installation or removal of the product may cause damage to the product.

- Shut off the inverter's input power supply and verify that the charge lamp (CHARGE) has gone out before installing or removing options. When external control circuits are powered by separate power supplies, the inverter's 30A, 30B, 30C, Y5A, and Y5C control terminals may be energized, even when all inverter main circuits, control, and auxiliary power supplies are off (open). To avoid electric shock, ensure that all external power supplies are off (open).

</div>

Remove the inverter's front cover as shown in the following figures. Note that the method for removing the cover depends on which inverter model (capacity) you are using.

<table>
<tr><td>FRN22VG1S-2J/4J (22 kW) or lower</td><td>FRN30VG1S-2J/4J (30 kW) or greater</td></tr>
</table>

As shown in Figure 6.1.2, loosen the one mounting screw on the front cover at location (a) and grip the top of the cover to remove it.

(1) As shown in Figure 6.1.3, remove the mounting screws on the front cover at location (b) (the number of screws varies with the inverter's capacity) and remove the front cover.

(2) Open the keypad case.

Keypad case

Control printed circuit board

a

b
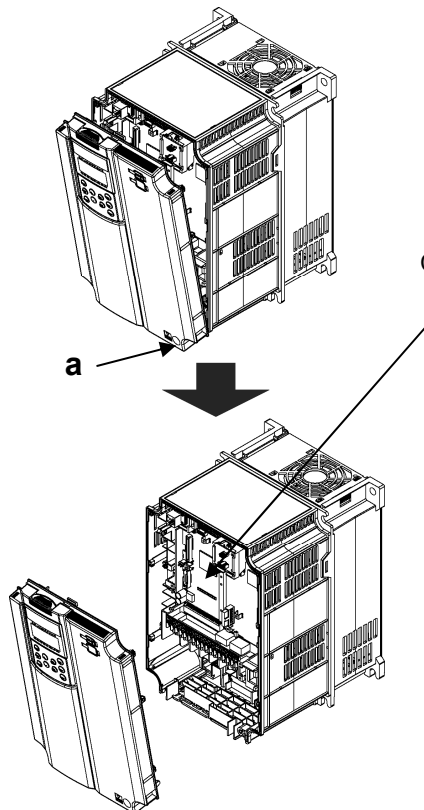
Figure 6.1.2 Removing the Front Cover FRN22VG1S-2J/4J (22 kW) or lower
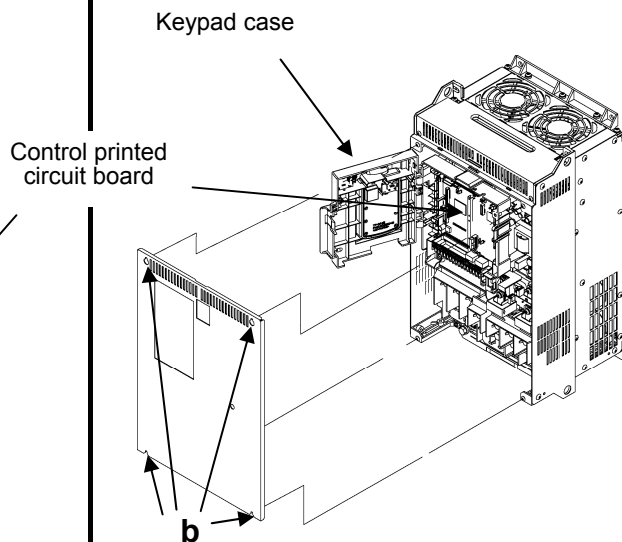
Figure 6.1.3 Removing the Front Cover FRN30VG1S-2J/4J (30 kW) or greater

Chap. 6

CONTROL OPTIONS

6.1.4.2 Installing a digital 8-bit communications option card

The following options ("communications option cards") are connected to either A port (CN3) or B port (CN2) on the control printed circuit board.

<table>
<tr>
<td>
Options
OPC-VG1-TL
OPC-VG1-CCL
OPC-VG1-SIU
</td>
<td>
• <u>When not using the communications option card at the same time</u> as a digital 16-bit option (OPC-VG1-SX, etc.), follow "Installation method 1" below.

• <u>When using the communications option card at the same time</u> as a digital 16-bit option (OPC-VG1-SX, etc.), follow "Installation method 2" below.
</td>
</tr>
</table>

■ **Installation method 1** (<u>when not using the option at the same time</u> as a digital 16-bit option card)

(When connecting the card to A port)

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector A port (CN3) on the control printed circuit board.

(3) Tighten the three included screws (e) to secure the communications option card in place.

(4) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.
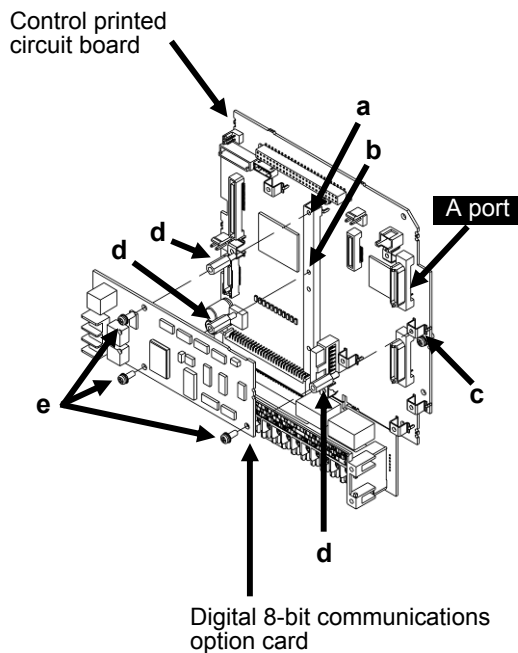
Figure 6.1.4   Installing a Communications Option Card (Connected to A port)

(When connecting the card to B port)

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector B port (CN2) on the control printed circuit board.

(3) Tighten the three included screws (e) to secure the communications option card in place.

(4) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.
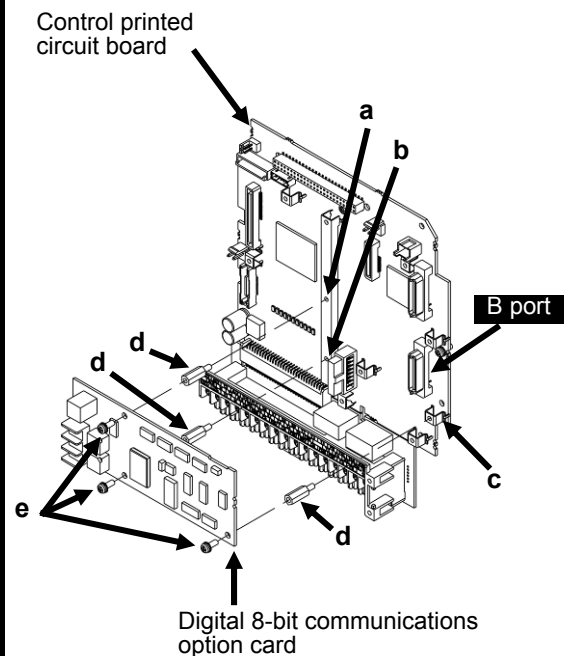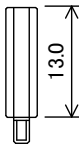
Figure 6.1.5   Installing a Communications Option Card (Connected to B port)
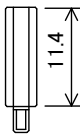
■ Installation method 2 (when using the option at the same time as a digital 16-bit option card)

⚠CAUTION

The dimensions of the spacers included with communications option cards and those included with digital 16-bit option cards differ slightly. See the following diagram when determining which spacers to use. Use of the wrong spacers may damage the product.

13.0 Spacers included with communications option cards

11.4 Spacers included with digital 16-bit option cards

(Unit: mm)

(When connecting to A port)

(1) Install the digital 16-bit option, connecting it to the D port (CN10) connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the communications option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to A port (CN3) on the control printed circuit board.

(5) Tighten the three included screws (e) to secure the communications option card in place.

(6) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.

Figure 6.1.6 Installing a Communications Option Card (Connected to A port)

(When connecting to B port)

(1) Install the digital 16-bit option, connecting it to the D port (CN10) connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the communications option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to B port (CN2) on the control printed circuit board.

(5) Tighten the three included screws (e) to secure the communications option card in place.

(6) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.

Figure 6.1.7 Installing a Communications Option Card (Connected to B port)

Chap. 6 CONTROL OPTIONS

6.1.4.3　Installing a digital 8-bit option card

The following options ("digital option card") can be connected to either A port (CN3) or B port (CN2) on the control printed circuit board. However, the OPC-VG1-SPGT must be connected to B port (CN2).

Options
OPC-VG1-PG/PGo
OPC-VG1-PMPG/PMPGo
OPC-VG1-SPGT
OPC-VG1-DI/DIO

- When not using the digital option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 1**" below.

- When using the digital option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 2**" below.

■ **Installation method 1　(when not using the option at the same time as a digital 16-bit option card)**

(When connecting to A port)

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to A port (CN3) on the control printed circuit board.

(3) Connect the power supply harness running from the top of the digital option card to CN25 on the control printed circuit board.

(4) Tighten the three included screws (e) to secure the digital option card in place.

(5) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.

(When connecting to B port)

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to B port (CN2) on the control printed circuit board.

(3) Connect the power supply harness running from the top of the digital option card to CN24 on the control printed circuit board. For OPC-VG1-SPGT, connect the harness to CN12.

(4) Tighten the three included screws (e) to secure the digital option card in place.

(5) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.
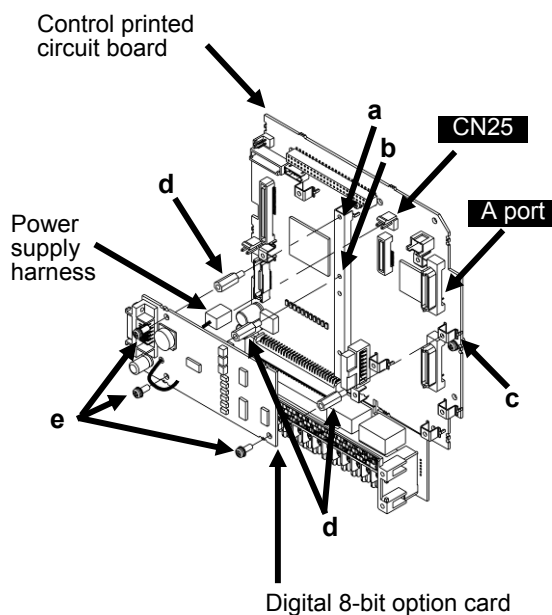
Figure 6.1.8　Installing a Digital Option Card (Connected to A port)
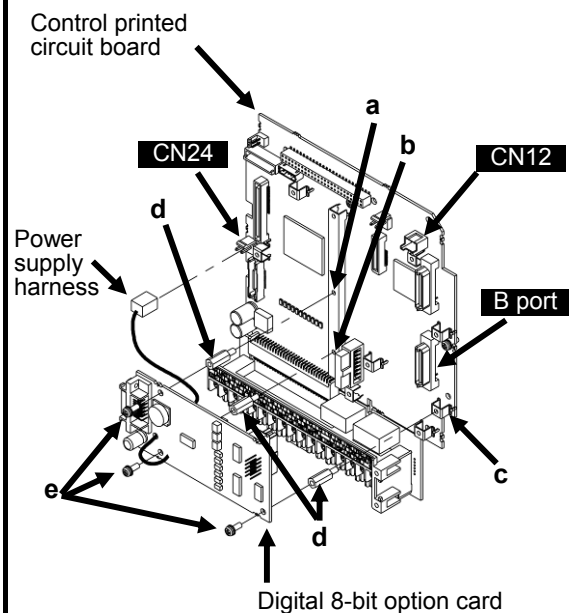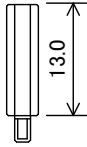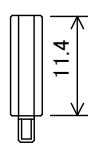
Figure 6.1.9　Installing a Digital Option Card (Connected to B port)

■ **Installation method 2** (<u>when using the option at the same time</u> **as a digital 16-bit option card)**

⚠**CAUTION**

The dimensions of the spacers included with digital option cards and those included with digital 16-bit option cards differ slightly. See the following diagram when determining which spacers to use. Use of the wrong spacers may damage the product.

13.0 — Spacers included with digital option cards

11.4 — Spacers included with digital 16-bit option cards

(Unit: mm)

(When connecting to A port)

(1) Install the digital 16-bit option, connecting it to the D port (CN10) connector on the control printed circuit board.

(2) Attach <u>the two screws (a) included with the digital 16-bit option</u> to mounting holes ① and ② on the digital 16-bit option, and attach <u>four spacers (b)</u> to holes ③ through ⑥.

(3) Attach <u>one spacer (d) included with the digital option card</u> to the option mounting fixture (c) on the control printed circuit board.

(4) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to A port (CN3) on the control printed circuit board.

(5) Connect the power supply harness running from the top of the digital option card to CN25 on the control printed circuit board.

(6) Tighten the three included screws (e) to secure the digital option card in place.

(7) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.

(When connecting to B port)

(1) Install the digital 16-bit option, connecting it to the D port (CN10) connector on the control printed circuit board.

(2) Attach <u>the two screws (a) included with the digital 16-bit option</u> to mounting holes ① and ② on the digital 16-bit option, and attach <u>four spacers (b)</u> to holes ③ through ⑥.

(3) Attach <u>one spacer (d) included with the digital option card</u> to the option mounting fixture (c) on the control printed circuit board.

(4) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to B port (CN2) on the control printed circuit board.

(5) Connect the power supply harness running from the top of the digital option card to CN24 on the control printed circuit board. For OPC-VG1-SPGT, connect the harness to CN12.

(6) Tighten the three included screws (e) to secure the digital option card in place.

(7) Referring to Figures 6.1.2 and 6.1.3, "Removing the Front Cover," reverse the procedure to reattach the front cover.

Chap. 6 CONTROL OPTIONS
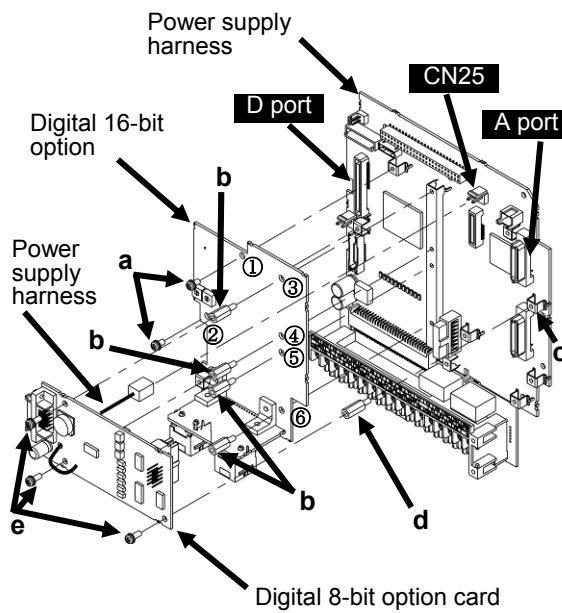
Figure 6.1.10 Installing a Digital Option Card (Connected to A port)
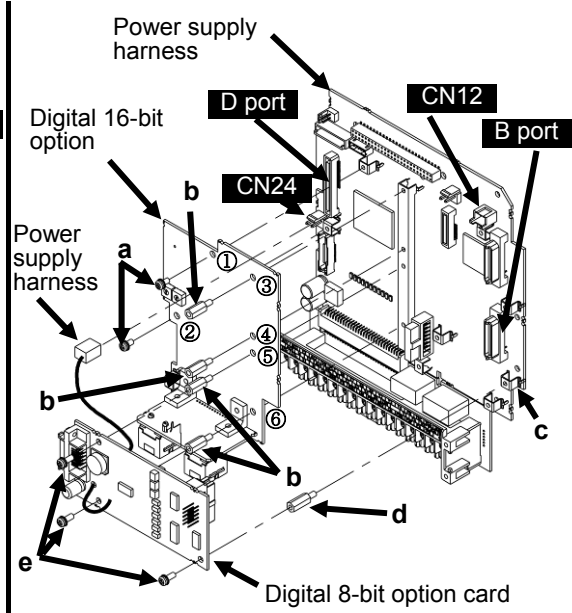
Figure 6.1.11 Installing a Digital Option Card (Connected to B port)

6.1.4.4   Installing a digital 16-bit option card

Install the digital 16-bit option card by following steps (1) and (2) in "Installation method 2 (<u>when using the option at the same time</u> as a digital 16-bit option card)" in "6.1.4.2 Installing a digital 8-bit communications option card."

Options
OPC-VG1-SX
OPC-VG1-ESX
OPC-VG1-UPAC

6.1.4.5   Installing an analog option card

The following options ("analog option card") can be connected to A port (CN3) connector on the control printed circuit board.

Options
OPC-VG1-FV
OPC-VG1-SN
OPC-VG1-AIO

- When *not* using the analog option card together with a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation procedure 1**" below.
- When using the analog option card together with a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation procedure 2**" below.

■ Installation procedure 1   (when *not* using the option together with a digital 16-bit option card)

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the analog option card so that connector CN1 (on the back of the analog option card) connects to A port (CN3) on the control printed circuit board.

(3) Connect the power supply harness running from the top of the analog option card to CN12 on the control printed circuit board.

(4) Tighten the three included screws (e) to secure the analog option card in place.

(5) Referring to Figures 6.1.2 and 6.1.3 "Removing the Front Cover," reverse the removal procedure to mount the front cover.
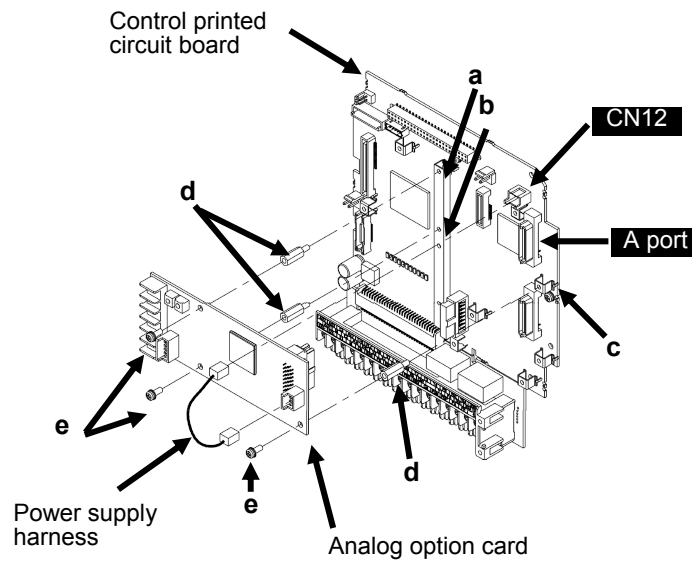
Figure 6.1.12   Installing an Analog Option Card

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■ Installation procedure 2 (when using the option together with a digital 16-bit option card)

⚠CAUTION

The dimensions of the spacers included with analog option cards and those included with digital 16-bit option cards differ slightly. See the following diagram when determining which spacers to use. Use of the wrong spacers may damage the product.

13.0 — Spacers included with analog option cards

11.4 — Spacers included with digital 16-bit option cards

(Unit: mm)
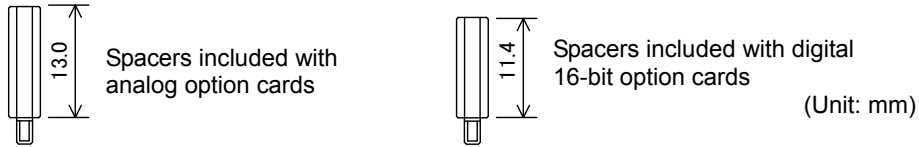
(1) Install the digital 16-bit option, connecting it to D port (CN10) on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the analog option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the analog option card so that connector CN1 (on the back of the analog option card) connects to A port (CN3) on the control printed circuit board.

(5) Connect the power supply harness running from the top of the analog option card to CN12 on the control printed circuit board.

(6) Tighten the three included screws (e) to secure the analog option card in place.

(7) Referring to Figures 6.1.2 and 6.1.3 "Removing the Front Cover," reverse the removal procedure to mount the front cover.
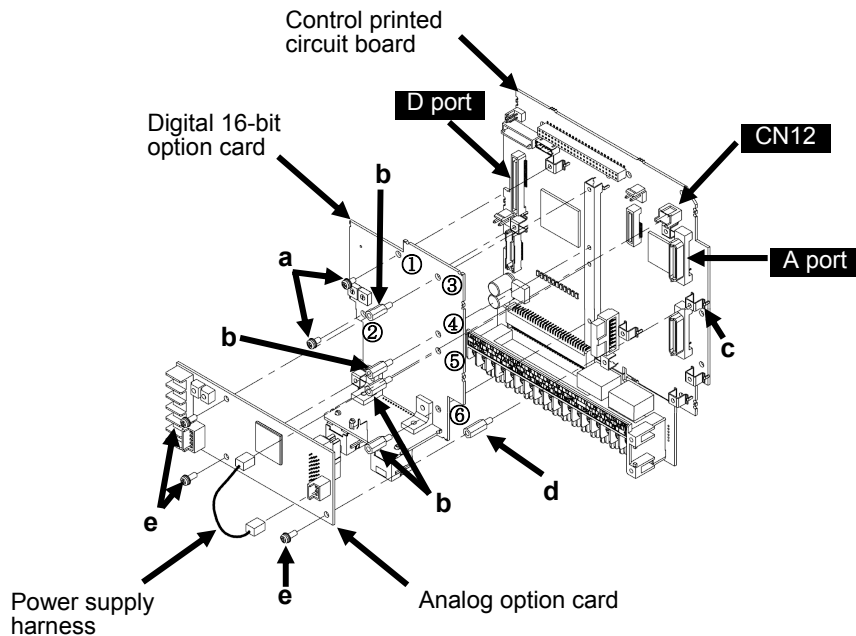
Figure 6.1.13   Installing an Analog Option Card

6.1.4.6   Installing a field bus interface card

The following options ("interface card") can be connected to C port (CN6) on the control printed circuit board.

Options
OPC-VG1-PVP
OPC-VG1-DEV

■ Installation procedure

(1) Attach one spacer (b) included with the interface card to the option mounting fixture (a) on the control printed circuit board.

(2) Install the interface card so that connector CN1 (on the back of the interface card) connects to C port (CN6) on the control printed circuit board.

(3) Tighten the two included screws (c) to secure the interface card in place.

(4) Referring to Figures 6.1.2 and 6.1.3 "Removing the Front Cover," reverse the removal procedure to mount the front cover.
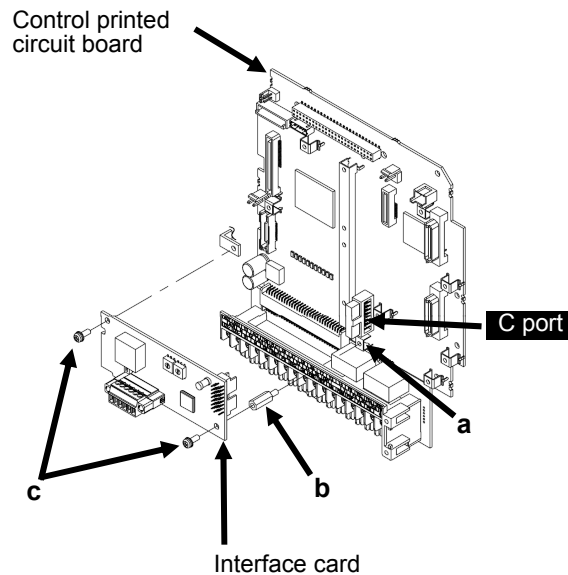
Figure 6.1.14   Installing an Interface Card

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6.1.4.7 Installing a functional safety card

The following options can be connected to E port (CN16) on the control printed circuit board.

Options
OPC-VG1-SAFE

■ **Installation procedure**

(1) Install the functional safety card so that connector CN6 (on the back of the functional safety card) connects to E port (CN16) on the control printed circuit board.

(2) Tighten the three included screws (a) to secure the functional safety card in place.

(3) Referring to Figures 6.1.2 and 6.1.3 "Removing the Front Cover," reverse the removal procedure to mount the front cover.
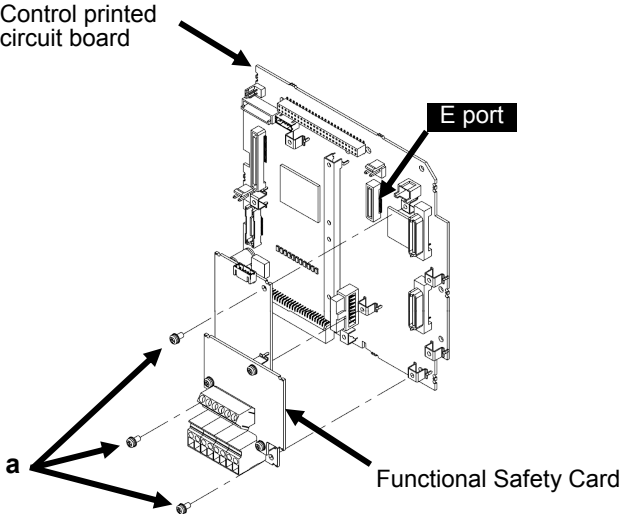
Figure 6.1.15   Installing a Functional Safety Card

6.1.4.8 Installing a control circuit terminal option

The following options can be connected to F port (CN1) on the control printed circuit board.

Options
OPC-VG1-TBSI

■ **Installation procedure**

(1) Loosen two screws (a) on the standard control circuit terminal printed circuit board and remove the board from F port (CN1) on the control printed circuit board.

(2) Mount the control circuit terminal option.

(3) Tighten two screws (b) to secure the control circuit terminal option in place.

(4) Referring to Figures 6.1.2 and 6.1.3 "Removing the Front Cover," reverse the removal procedure to mount the front cover.
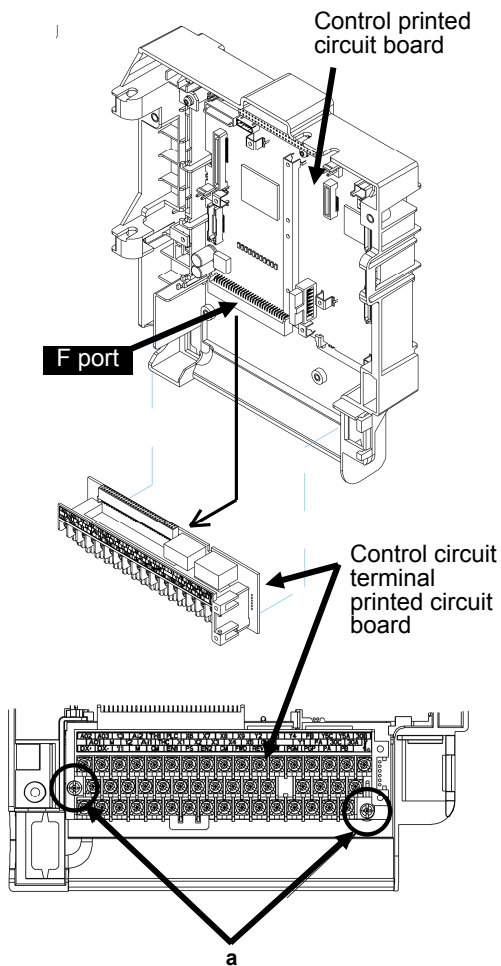
Figure 6.1.16 Removing the Control Circuit Terminal Printed Circuit Board
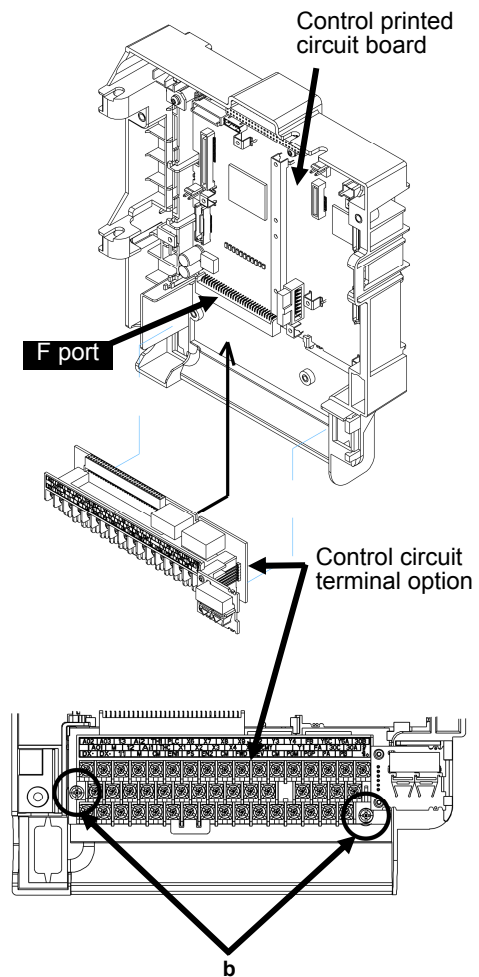
Figure 6.1.17 Mounting the Control Circuit Terminal Option

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6.2 PG Interface Expansion Card OPC-VG1-PG/PGo

6.2.1 Product overview

The PG interface expansion card is used for speed control using a line driver output type of encoders, synchronous operation of two or more motors, and rotational positioning (orientation).

Since the FRENIC-VG's built-in PG interface generates 15 V and 12 V complementary (totem pole, push-pull) output, the built-in PG interface function is used when performing speed control with PG feedback using a normal FRENIC-VG standard motor.
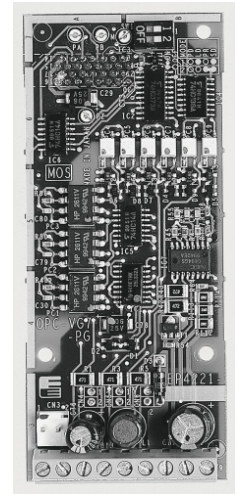
(1) Principal applications

- When interfacing with a PG that is not supported by the built-in PG interface, for example a 5 V line driver output type PG interface

- When you wish to detect the line speed using a PG installed on the line

- When you wish to drive the motor using pulse train commands or perform synchronized operation

- When you wish to perform orientation (rotational positioning) (requires a separate UPAC option)

To support applications above individually, the PG interface expansion card has SW1. Switching SW1 selects Speed detection (SD), Line speed detection (LD), Pulse reference (PR) or Pulse detection (PD) function.

(2) Hardware

Since the interface uses photocoupler insulation, PG wiring may be up to 50 m long with line driver signals and a small wiring voltage drop.

(3) Broken wire detection function

The broken wire detection function can be used when using SD motor speed detection. When a broken wire is detected, the inverter will display alarm $P9$, and the interruption of inverter output will cause the motor to perform a free-run stop. However, this function is not available when using the open collector/voltage output model (OPC-VG1-PGo). The FRENIC-VG ships with PG broken wire detection cancelation functionality in its standard configuration.

(4) PG interface expansion card function codes

PG interface expansion card codes (o05 to 08 and o12 to 19) are used for pulse compensation and other functionality when performing position and line control.

(5) PG frequency division output

As with the built-in PG, when performing speed control with the optional PG set to SD, the FA and FB built-in terminal blocks can be used to generate open collector output and complementary output by dividing the pulse signal frequency.

(6) Input format selection

When using the PG interface expansion card to perform speed detection (SD, LD), input signals are fixed to two signals (A- and B-phase) with a 90° phase difference. When receiving a pulse train (PR), you can select from three signal types using function codes (o13: pulse train input format selection).

(7) UPAC function

Cumulative values of PG signal input can be read out from programs running in the UPAC option. Therefore, the combination of the UPAC option and the PG interface expansion card can build applications including winding diameter calculation for winders and orientation.

6.2.2   Model and specifications

6.2.2.1   Model

<table>
<tr><td colspan="2" align="center">⚠CAUTION</td></tr>
<tr><td>

• There are two models for the PG interface expansion card, reflecting differences in the external equipment output interface:

OPC-VG1-PG: Line driver signals
OPC-VG1-PGo: Open collector/voltage output

<u>Take care not to specify the wrong model when placing an order for cards.</u>

</td></tr>
</table>

The available models of FRENIC-VG's PG options differ according to the external equipment output interface (line driver output, open collector output/voltage output).

After purchase, the target application can be selected with SW1 on the option.

Model format:
OPC-VG1-PG☐ (☐☐)

PD (pulse detection): For pulse detection
LD (line speed detection): For line speed detection
PR (pulse reference): For input of pulse train commands (pulse train synchronous operation)
SD (speed detection): For motor speed detection

None: Line driver output model (provides PG broken wire detection function when SD is selected)
o: Open collector output and voltage output model (no PG broken wire detection function)

PG: Pulse generator interface expansion card
VG1 → FRENIC-VG inverter

<u>Accessories</u>

Spacers: 3
Screws (M3): 3

<u>SW1 setting</u>

For example, to perform speed control for a motor that includes a line driver output type encoder, you would order the OPC-VG1-PG and select SD with the switches as the speed control application. To perform synchronized operation based on received pulse trains, set the switches to PR.

Table 6.2.1   Configuration of Switches on the Option

Function	SW1-1	SW1-2	
PD	OFF	OFF	
LD	ON	OFF	
PR	OFF	ON	(Factory default)
SD	ON	ON	

6.2.2.2   Specifications

⚠**CAUTION**

- Failure to set the switches (SW1) on the PG interface expansion card correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly.

- When performing rotational positioning, set the switches to PG (PD). Use of the card in this configuration requires the separate UPAC option.

Table 6.2.2   Hardware specifications

Item	Specifications	
Model	OPC-VG1-PG	OPC-VG1-PGo
Signal type	Line driver output (26C31, 26LS31 or equivalent recommended)	Open collector output Voltage output
Mode switching	SW-1 and SW1-2 on the PG interface expansion card are used to switch modes as follows: (SW1-1, SW1-2) = (OFF, OFF) : (ON, OFF) : (OFF, ON) : (ON, ON) = **PD : LD : PR : SD**	
Applications	Motor speed detection (SD), Line speed detection (LD), Pulse detection (PD), Pulse command input (PR)	
PG power supply	**The PG interface expansion card uses a 5 V power supply.** [PGP] terminal: +5 V ±5%, 250 mA [PGM] terminal: Common Includes an overcurrent protection function. Internal photocoupler insulation (connected to [PGM] and [CM] on the inverter's control Pt board; isolated from [M])	
Signal pins	[PA], [*PA], [PB], [*PB], [PZ], [*PZ] Photocoupler insulation	[PA], [PB], [PZ] Photocoupler insulation ([*PA], [*PB], and [*PZ] are not used.)
Connections (see basic connection diagram)	Line driver output type Connect a 5 V power supply to [PGP] and [PGM]. Other 5 V power supplies cannot be used. Since a balanced circuit is used, it is necessary to use twisted-pair shielded cable for wiring.	Open collector output type Built-in 5 V pull-up, sink current: 8 mA max./circuit (Can be used when connected to the FRENIC-VG's [FA] and [FB] terminals.) Voltage output type L level voltage detection: 0 V to 2 V or less H level voltage detection: 4 V to 15 V
Input format	Can select from 3 types using the o13 function code (pulse train input format selection). 2 signals (A- and B-phase) with 90° phase difference A-phase: Command pulse; B-phase: Command code A-phase: Run forward pulse; B-phase: Run reverse pulse	
Pulse output	Open collector output or complementary output can be generated by dividing the frequency of the input pulse with the inverter's built-in [FA], [FB], and [CM] terminals. Max. output frequency: 100 kHz; 15 mA max., 1.5 mA min., 27 V max./circuit	
Max. input pulse frequency	500 kHz, duty: 50 ±10%	100 kHz, duty: 50 ±10%
Allowable wiring length	Approx. 50 m Shorter wiring lengths are required when there is a high voltage drop. For wiring runs of 50 m or greater, use an insulation converter as described in "6.2.4.2 Wiring."	10 m or less Keep wiring runs as short as possible to avoid the effects of noise.
Power supply	24 V Supplied from the inverter's printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.	

Input signal format (run reverse signals * omitted)

2 signals with a 90° phase difference

Command pulse, command code

Run forward pulse, run reverse pulse

Figure 6.2.1

OPC-VG1-PG

SW1

Terminal block

Power supply harness
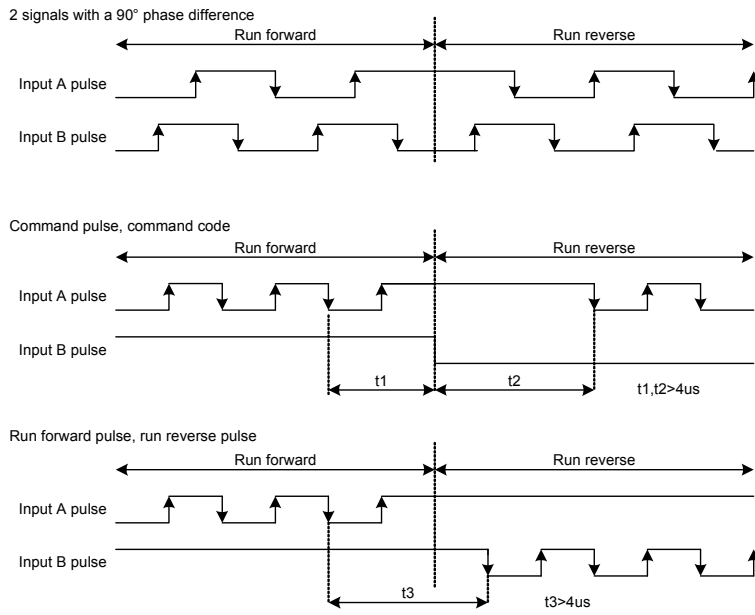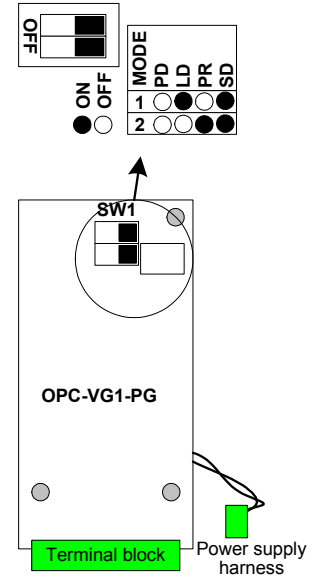
Figure 6.2.2

Software specifications

(1) Speed control specifications: OPC-VG1-PG□ (SD)
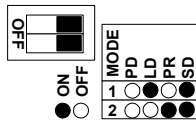
Figure 6.2.3

Specifications are the same as when the built-in PG interface is used.

Table 6.2.3

Item		Speed control specifications
Card type (setting)		OPC-VG1-PG□ (SD)
Motor control method		Vector control for IM with speed sensor
Speed control Vector control with speed sensor	Control range	1 : 1500 (min. speed: base speed, 1.0 to 1,500 r/min. with 4P conversion, using 1024 P/R) 1 : 6 (constant torque region : constant output region)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% max. speed
PG interface functionality		When the PG interface expansion option is installed and set to SD, the built-in PG function is disabled, and the PG option takes priority.
Broken wire detection function		Yes
Frequency division output		Output can be generated by dividing the frequency of PG interface expansion card pulses input from the standard [FA] and [FB] terminals.

(2) Line speed control specifications: OPC-VG1-PG□ (LD)
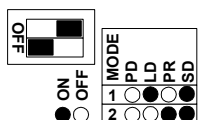
This configuration is used when controlling the line speed of a winding device using a PG installed on the line, rather than motor speed control.

Figure 6.2.4

Table 6.2.4

Item		Line speed control specifications
Card type (setting)		OPC-VG1-PG□ (LD)
Control method		Vector control with speed sensor (induction motor, line speed control) Line speed control is built into the standard configuration.
Line speed Vector control with speed sensor	Control range	1 : 1500 (min. speed: base speed, 1.0 to 1,500 r/min. with 4P conversion, using 1024P/R) 1 : 6 (constant torque region : constant output region)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% max. speed
PG interface functionality		With the PG interface expansion card installed and the LD setting active: Function code H53 = 2: Line speed detection enabled Function code H53 = 3: High selector (line speed detection, motor speed detection using built-in PG) The encoder pulse count can be set using the o06 function code.
Pulse compensation		Compensation can be performed using the o07 and 08 function codes.
Broken wire detection function		None
Application functionality		The speed can be set for 15 speed stages in m/min. (function codes C05 to C21). Line speed detection (±max. speed/±10 V) output can be generated for AO output.
Frequency division output		Output can be generated by dividing the frequency of standard built-in PG interface input (line PG is not output).

(3) Pulse train command and pulse train synchronous operation specifications: OPC-VG1-PG□ (PR)
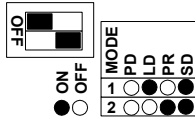
Operation conforms to pulse train command input.

Master/slave pulse train synchronous operation is possible.

Figure 6.2.5

Table 6.2.5

Item		Pulse train command and pulse train synchronous operation specifications
Card format (setting)		OPC-VG1-PG□ (PR)
Broken wire detection function		None
Synchronous drive	Function	Synchronous operation function, built-in as standard
	No. of synchronous units connectable	Supports cascading connections (see Figure 6.2.6). When using open collector output from a pulse oscillator or insulated pulse amp and connecting the devices in parallel, the number of units connectable depends on the requirement of 8 mA of sink current per circuit. For example, if the output maximum rating for the devices is 25 mA, up to 3 can be connected (24 mA = 3 × 8 mA).
Speed control	Valid setting range	0 to ±30,000 r/min. However, the input pulse frequency cannot exceed 500 kHz (OPC-VG1-PG) or 100 kHz (OPC-VG1-PGo).
	Speed control accuracy	±0.005% of maximum speed (Accuracy relative to steady-state deviation due to temperature fluctuations or load.)
Position control	Position response	10 Hz Response is adjusted using the APR gain and ASR gain.
	Synchronous accuracy (see following figure)	Within ±2 pulses (F/F gain is set to 1.0 during steady-state or transient operation) When F/F gain ≠ 1.0, steady-state or transient deviations may occur.
	Lock accuracy	Within ±1 pulse Opposing torque can be 150%.
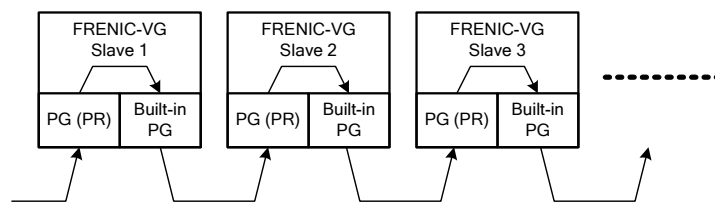
Figure 6.2.6

(4) Orientation specifications: OPC-VG1-PG□ (PD)
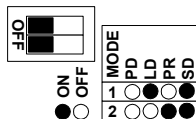
This configuration enables rotational positioning control using a UPAC.
For details, refer to the UPAC User's Manual.

Figure 6.2.7

Table 6.2.6

Item		Orientation specifications
Card format (setting)		Two cards required OPC-VG1-PG□ (PD) UPC-VG1-UPAC
Inverter ROM version		H10020 or later, H20020 or later The above ROM version should be used. (The ROM version can be checked with I/O Check on the keypad.
Orientation function		UPAC package software, orientation (WPS-VG1-POS) to be used
Wire break detection function		Not supported.
Stop position		Stop position setting = External stop position setting + Internal stop position setting
	External stop position setting	Can be set with any of the following. (1) OPC-VG1-TL (T-link card) + Fuji MICREX (2) OPC-VG1-DIOB (16-bit input, 10-bit output card) (3) Standard RS-485
	Internal stop position setting	Four points can be specified with the UNO function codes. The combination of general-purpose input terminals switches between the four points.
Positioning repeatability		Within ±1 pulse. (±0.088° when a pulse encoder of 1024 P/R is used) The repeatability is dependent on the encoder pulse resolution and calculated with 360°/4/encoder resolution. When the encoder power is turned ON, the Z-phase detection operation (initial operation) takes place.
Pulse encoder specifications		See Figure 6.2.8. The encoder pulse resolution is selectable from: 128, 256, 512, 1024, 2048, 4096, 8192 P/R.
Opposing torque		Up to the maximum motor value is possible (under ASR PI control). The displacement becomes large transiently relative to the momentary load torque. The speed control gain and orientation gain adjust the response of the opposing torque.
Mechanical conditions		The number of speed gear shifts is 4, which is changed with *RT1* and *RT2*.

Table 6.2.7

Item		Orientation specifications
Software package	Orientation package (WPS-VG1-POS)	
	Number of speed change gear shifts	4 (switchable with contact inputs *RT1* and *RT2*.
	Operation selection	Gradual stop function for stop operation Stop direction selectable such as shortcut Function selection, e.g., Speed-up and shortest stopping distance, or stop without speed-up
	Control input	Orientation command Position change command (latch function to apply when the stop position is changed) Slow direction command (Switching of stop direction)
	Control output	During orientation Orientation completed Off-delay and on-delay of each output signal are possible. Completion width specified.
	Monitor function	Positioning deviation amount (Stop position command - Current position) External stop position command Z-phase reference position
	Keypad	U code: Configuring parameters Option monitor (displaying position)

Figure 6.2.8

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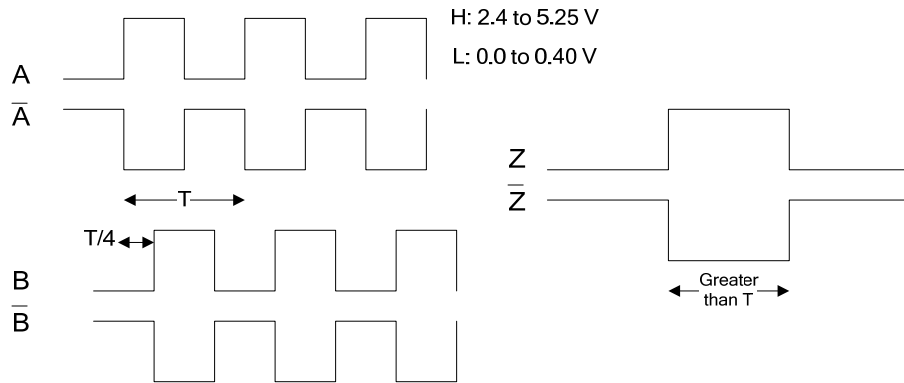
6.2.3 External dimension diagram
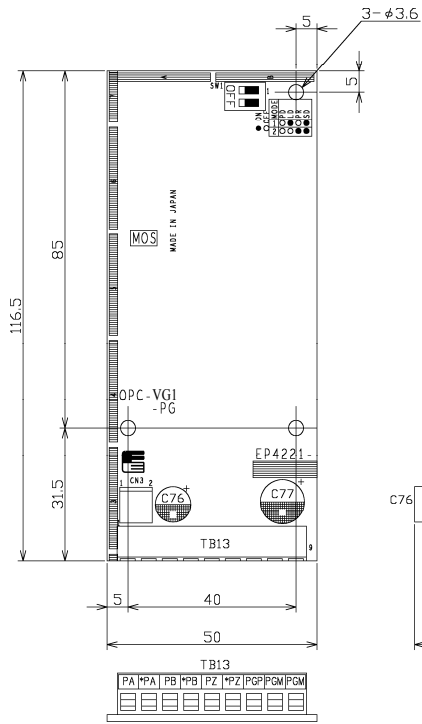
(Unit: mm)

Figure 6.2.9   OPC-VG1-PG Outline Drawing   **Figure 6.2.10   OPC-VG1-PGo Outline Drawing**
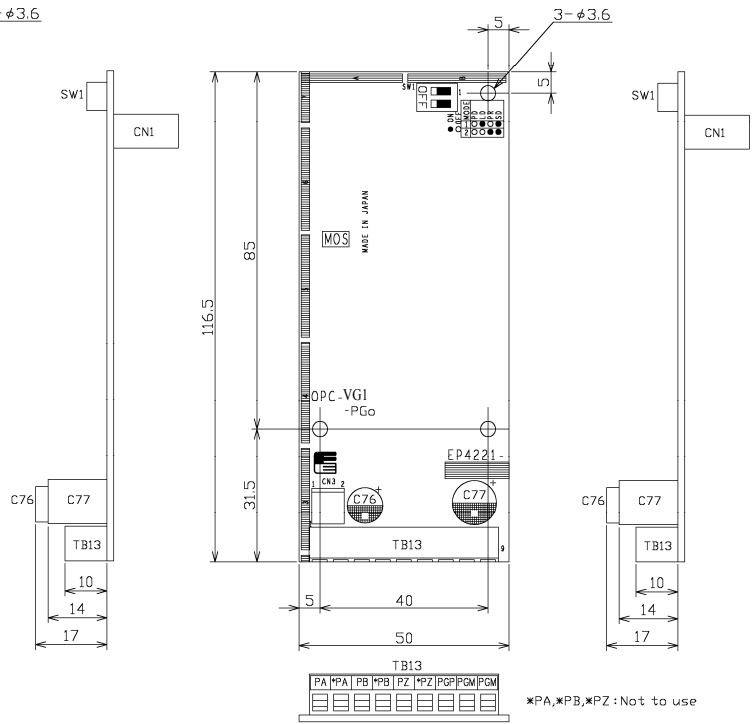
6.2.4 Basic connection diagram

Refer to "6.1.4 Installing Built-in Options (OPC-VG1-☐☐)" before performing wiring or connection work.

⚠WARNING
• Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.
• The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠CAUTION
• Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.
• Inappropriate installation or removal of the product may cause damage to the product.
• Failure to set the switches on the PG interface expansion card (SW1, SW2) correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly.

6.2.4.1 Terminal connections

The PG interface expansion card's connection terminals use a wire size of 16 to 26 AWG. When using the connection terminals with stripped wires, strip to a length of 6 mm. When using crimp contacts, use a rod-shaped terminal with vinyl insulation. Insert the wire so that it is held in place on the top of the terminal block's fixture and tighten the screw to hold it in place.

Wiring AWG: 16-26

6(mm)
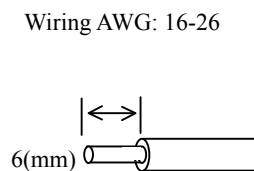
Figure 6.2.11 End of Wire at the PG Interface Expansion Card's Connection Terminal

Tightening torque
0.22 to 0.25N•m
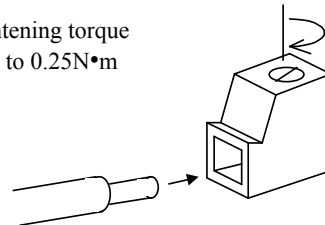
Figure 6.2.12 Connecting a Wire to the PG Interface Expansion Card's Terminal

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6.2.4.2   Wiring

Wiring between the PG interface expansion card and a pulse generator, PG, or other device

- Use shielded wire for PG interface expansion card wiring. Wiring length is subject to constraints depending on the interface type (see table below).

- Connect the shielded wire's housing to the external device or the motor's earth terminal and leave open at the inverter.

- To prevent malfunctions due to noise on PG interface expansion card wiring, leave as much distance as possible between wiring and the inverter's main circuit wiring and other power lines (10 cm or more) and never place wiring in the same conduit as power lines.

Table 6.2.8

External interface	Wiring length guideline	Application
Line driver type	Within 50 m	Use when connecting a line driver output type encoder. The 50 m figure for wiring length is a guideline based on the assumption that measures have been taken to limit the voltage drop, for example by using thicker signal wires for power lines (PGP, PGM).
Open collector output type	Within 10 m	Can be used when connecting the master device's [FA] and [FB] open collector outputs to [PA] and [PB] on the slave PGo (PR).
Voltage output type		Use when connecting a voltage output device or a device that uses an external power supply. It is necessary to exercise caution concerning the maximum voltage of 15 V and threshold values. (L level voltage detection: 0 V to 2 V; H level voltage detection: 4 V to 15 V)

Recommended insulation converters (insulated amps)

- When the wiring length will be 50 m or greater with a line driver type device (combination of motor PG and FRENIC-VG), use an insulation converter. The insulated amp type and manufacturer are as follows:

  SHC-205P05D (HEIDENHAIN Corporation): 200 V power supply input
  SHC-105P05D (HEIDENHAIN Corporation): 100 V power supply input

- When connecting multiple FRENIC-VG units in parallel to the slave device using open collector type signaling, the maximum number of slave devices is one. When connecting two or more devices, use an insulated amp. The insulated amp type and manufacturer are as follows:

  SHC-205C24C (HEIDENHAIN Corporation): 200 V power supply input
  SHC-105C24C (HEIDENHAIN Corporation): 100 V power supply input

6.2.4.3 Speed control

This connection example illustrates how to drive a motor (a Fuji servomotor, etc.) to which a line driver output type encoder or open collector or complementary type encoder.

Since the speed is detected and calculated based on received pulses, the PG interface expansion card must be set to SD. Since frequency division output can be generated using FA and FB, this approach can be used with a digital speedometer or other instrument.

When using a complementary output type encoder that supports 15 V and 12 V output, use the inverter's PGP and PGM terminals. In this configuration, the common line is connected to the PG interface expansion card.
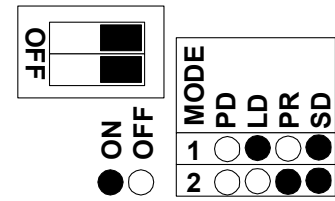
Figure 6.2.13
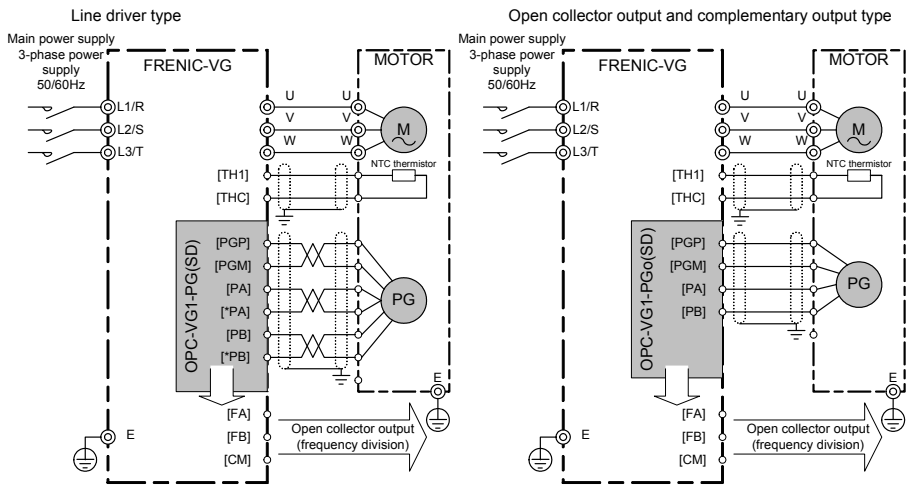
Figure 6.2.14

Figure 6.2.15

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

Chap. 6

CONTROL OPTIONS

6.2.4.4　Line speed control

This connection example illustrates how to perform speed control after installing a line driver output type encoder on a system's winding line. Since motor speed feedback and line speed feedback can be detected simultaneously, it is possible to prevent a runaway operation scenario resulting from a cause such as a paper tear on the line. When using the PG interface expansion card in an application such as this one, it must be set to LD.
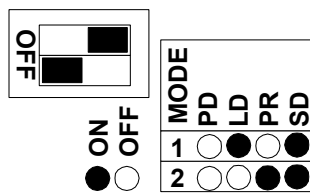
Figure 6.2.16
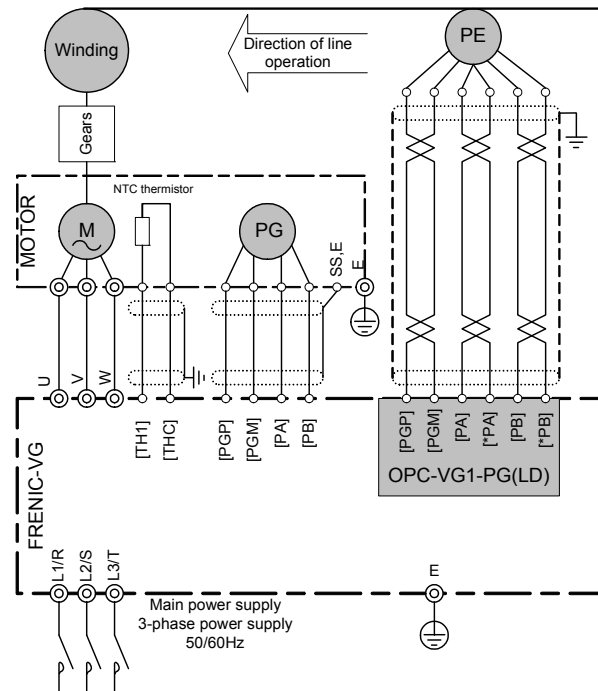
Figure 6.2.17

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.4.5　Pulse train operation and synchronized operation

> ⚠**CAUTION**
>
> • When using the FRENIC-VG's [FA] and [FB] open collector outputs to perform master/slave synchronized operation, separate open collector wiring from power lines and keep wiring runs as short as possible. When using long-distance wiring, it is recommended to provide a separate converter to convert the signals into line driver signals.

When using the PG interface expansion card in this application, set switch SW1 to PR.
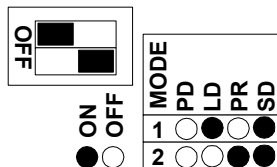
Figure 6.2.18

(1) Line driver output

The PG interface expansion card operates by receiving pulse commands from an external pulse generator or PG.

Since the FRENIC-VG receiving these signals can generate open collector output ([FA] and [FB]), the pulse signals can be passed to the next FRENIC-VG. In this way, multiple FRENIC-VG units can be driven synchronously.
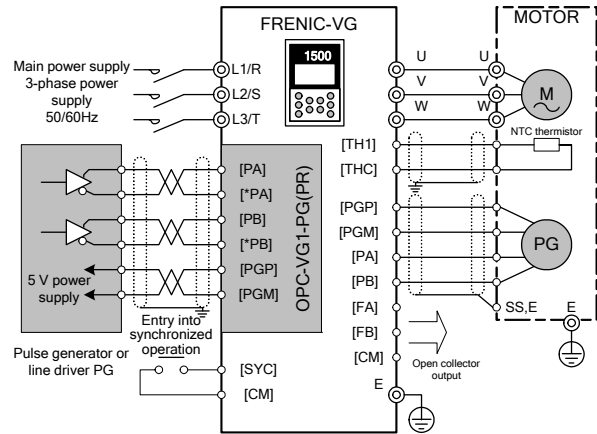
Figure 6.2.19

(2) Open collector output

Open collector output can be used when driving multiple FRENIC-VG units synchronously. The open collector output ([FA] and [FB]) generated by the master FRENIC-VG is connected to the slave FRENIC-VG's PG interface expansion card. The slave operates by receiving these pulse commands.
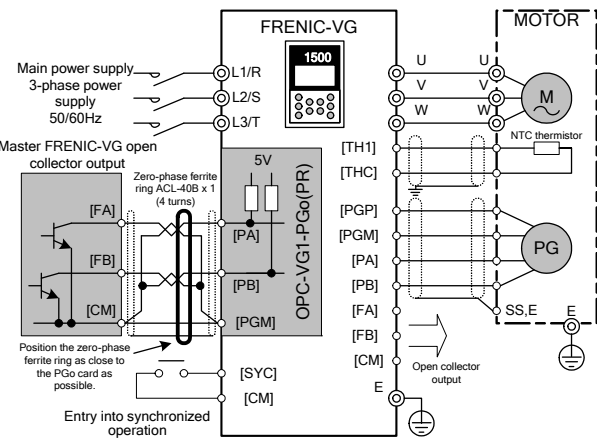
Since the FRENIC-VG receiving these signals can generate open collector output ([FA] and [FB]), the pulse signals can be passed to the next FRENIC-VG. In this way, multiple FRENIC-VG units can be driven synchronously.

It is recommended to install a zero-phase ferrite ring (ACL-40B) as shown in the figure to the right in order to ensure a noise margin, among other benefits.

Figure 6.2.20

Precautions

The OPC-VG1-PGo (open collector type) is not suited to use in applications characterized by a challenging noise environment in which signals are routed alongside motor power lines or where wiring is run over long distances, reducing the noise margin.
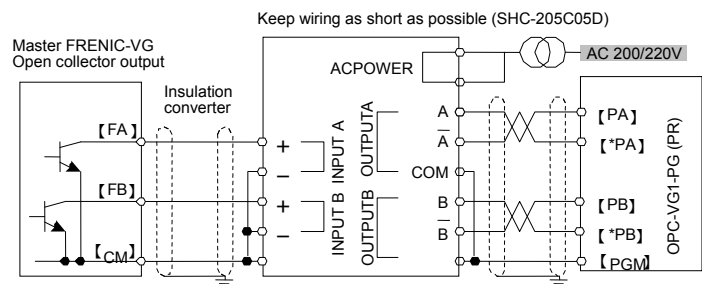
Figure 6.2.21

In such applications, it is recommended to use the architecture shown in the figure to the right, which utilizes the OPC-VG1-PG (line driver type).

Recommended insulation converter: SHC-205C05D (HEIDENHAIN Corporation)

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.4.6 Orientation

This section gives a connection example to perform rotation positioning using an encoder mounted on the machine axis. The option detects pulses including Z-phase, so "PD" should be selected. The Z-phase is for detecting an absolute position of the machine.

The stop position and orientation commands can be entered through the T-link, DI card, built-in RS-485, field bus, etc.
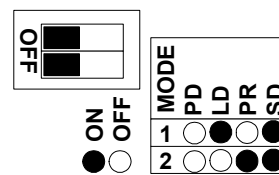
Figure 6.2.22

(1) Connection example using T-link
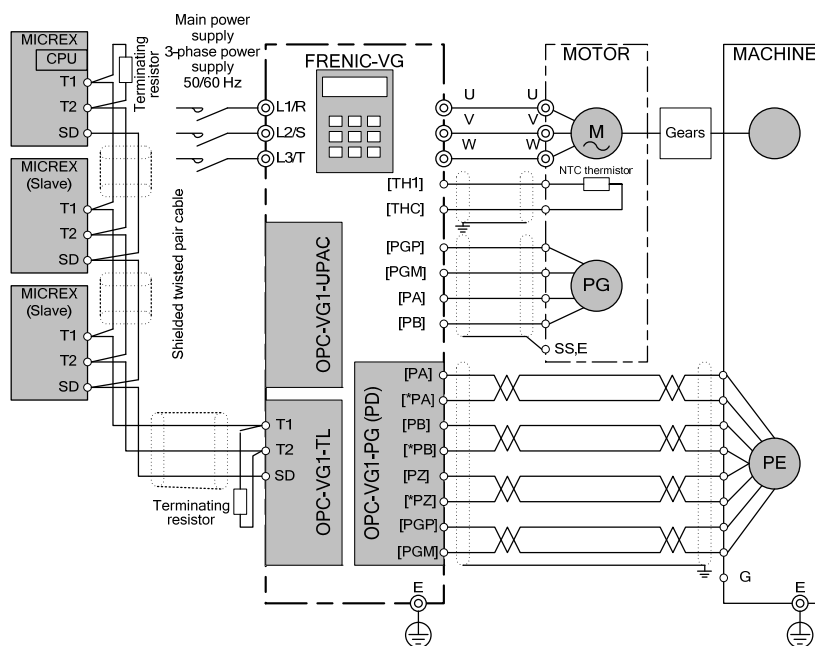
Figure 6.2.23

(2) Connection example using DIO (B)
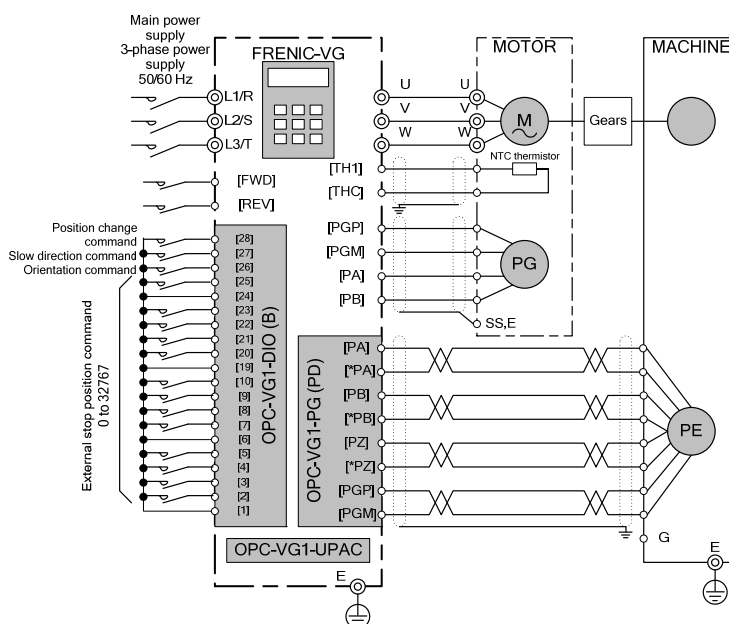
Figure 6.2.24

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.5 Synchronized operation

6.2.5.1 Synchronized operation system architecture

Systems for synchronously operating motors with a FRENIC-VG utilize master/slave connections, cascading connections, or pulse train commands from a PLC or other external transmitter.

(1) Master/slave connections

<table>
<tr><td colspan="1" align="center">⚠ CAUTION</td></tr>
<tr><td>
• When using a master/slave connection, up to one FRENIC-VG can be connected in parallel to the slave side of the system (8 mA sink current/1 circuit). Use a cascading connection if you need to connect two or more FRENIC-VG units as slaves.

• When the direction of rotation for slave motors will be opposite that of the master, use the IVS contact instead of the REV contact.
</td></tr>
</table>

This technique allows open collector pulse output from one FRENIC-VG (the master) to be passed to PG card input of another FRENIC-VG (the slave) that you wish to operate synchronously.

Up to one FRENIC-VG can be connected in this way, as shown below.

Table 6.2.9

Master open collector output [FA], [FB], and [CM] terminals	Slave OPC-VG1-PGo [PA], [PB], and [CM] terminals
15 mA max. per circuit	8 mA max. per circuit

When using master/slave synchronized operation, the slave's synchronized operation speed is obtained by multiplying the master's speed by the pulse compensation factor (function codes o14 and o15).

Change the slave motor's direction of rotation with each slave unit's [IVS] contact (forward operation/reverse operation). The [REV] contact cannot be used in this configuration.

Table 6.2.10

Master's direction of rotation	Slave [IVS]	Slave's direction of rotation
Forward	OFF	Same as master
Forward	ON	Opposite of master
Reverse	OFF	Same as master
Reverse	ON	Opposite of master

Figure 6.2.25

(2) Cascading connections

<table>
<tr><td align="center">⚠ CAUTION</td></tr>
<tr><td>
• When using a cascading connection, set function code E29 (PG pulse output selection) to 9 for slave units (slave 1, 2, etc., but not the master) in order to avoid a delay between the master and the final slave unit.
</td></tr>
</table>
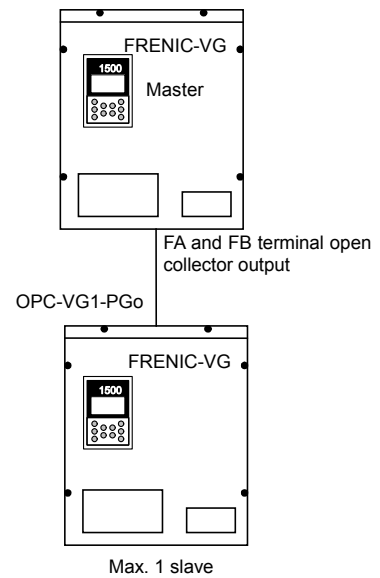
This connection method is used when connecting two or more slave units in a master/slave connection.

The description in (1) above applies between the master and the first slave unit, but function code E29 must be set between the first and second slave units.

This setting is needed so that pulse train commands from the master are passed as pulse train signals to slave 2 without being subject to software processing by slave 1.
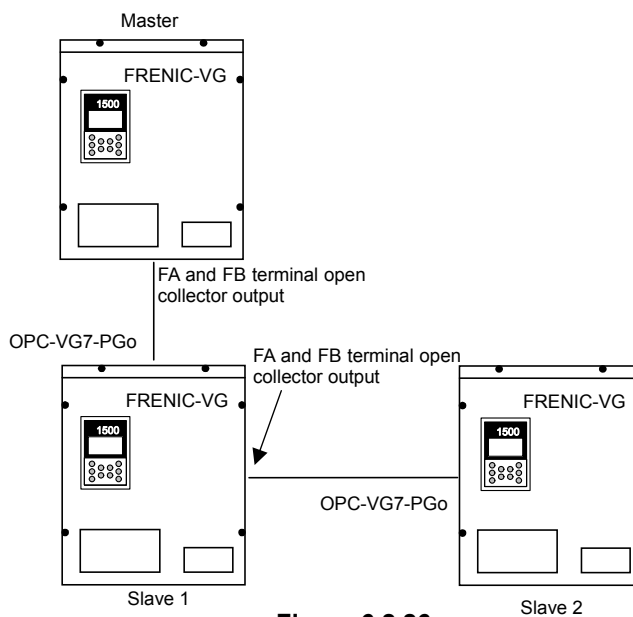
Table 6.2.11

Function code	Name	Setting
E29	PG pulse output selection	9: PG (PR) Generates open collector output for position command pulse input without other modification.

Figure 6.2.26

(3) Pulse transmitter

⚠CAUTION

- In pulse train operation using a pulse transmitter, the number of slave units that can be connected is determined by the transmitter's current capacity (8 mA sink current/circuit).

- When the direction of rotation for slave motors will be opposite that of the master, the direction is determined by the [IVS] contact and the pulse input format. Set function code o13 (pulse train input format selection) according to the pulse format.

This technique drives the master FRENIC-VG with pulse commands using a PLC or other pulse transmitter.

As illustrated below, the maximum number of units connectable is determined by the current capacity of the master pulse transmitter.

Table 6.2.12

Master pulse transmitter	Slave OPC-VG1-PGo [PA], [PB], and [CM] terminals
Current capacity per circuit	8 mA max. per circuit
16 mA or greater	2 units
24 mA or greater	3 units
x mA or greater	Whole number of units given by (x / 8)
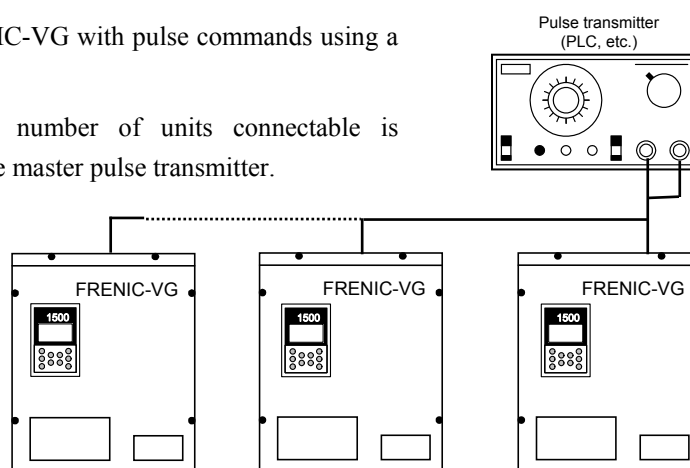
The number of slave units depends on the transmitter's drive current capacity.

Figure 6.2.27

The direction of rotation for slave motors is determined by [IVS] and the pulse input format.

Table 6.2.13

(1)	(2)	(3)	IVS	Slave direction of operation
B-phase high	A-phase input	B-phase, 90° advance	OFF	Forward
B-phase high	A-phase input	B-phase, 90° advance	ON	Reverse
B-phase low	B-phase input	B-phase, 90° delay	OFF	Reverse
B-phase low	B-phase input	B-phase, 90° delay	ON	Forward

Pulse input format

(1)   Command pulse/command code

(2)   Forward run pulse/reverse run pulse

(3)   Two signals with a 90° phase difference

Select the pulse input format with function code o13.

6.2.5.2   Synchronized operation method

⚠ **WARNING**

- Manipulate the [FWD] terminal and [SYC] (the contact input terminal) simultaneously during pulse train operation.
- When [FWD] turns on with a delay after [SYC] turns on while a pulse train continues to be input, the motor may accelerate to its maximum speed in order to eliminate the accumulated deviations.

Risk of bodily injury

⚠ **CAUTION**

- Operating the motor with an incorrect allocation of the function selection input function code's data may result in bodily injury or equipment damage. Re-check allocation prior to operation.

Risk of equipment damage

Synchronized operation signal [SYC]

During pulse train operation, allocate one of the contacts X1 to X14 to 27 (SYC) for the slave motor and manipulate [SYC] together with the [FWD] signal.

Table 6.2.14

Function code	Function name	Pulse train function
E01 to E13	X1 to X14 function selection	In order to perform position control operation, allocate the synchronized operation instruction ([SYC]: 27) to one of the contact input terminals listed to the left.

(1)　Master/slave synchronized operation

<table>
<tr><td>⚠️CAUTION</td></tr>
<tr><td>• When performing master/slave operation, use of an F/F gain other than 1.0 will cause a steady-state deviation to remain between the master and slave. Steady-state deviations can be reduced with the APR gain and F/F gain, but adjustments made using the F/F gain may cause overshoot.</td></tr>
</table>

In order to perform synchronized operation with a master/slave connection, maintain the [FWD] terminal and contact input signal [SYC] in the "on" state at all times. Doing so will cause the slave unit to operate in synchronization with the master unit, allowing the slave unit to be stopped in the servo-lock state by stopping the master.

• Change the slave motor's direction of rotation with [IVS]. Do not use the [REV] terminal.
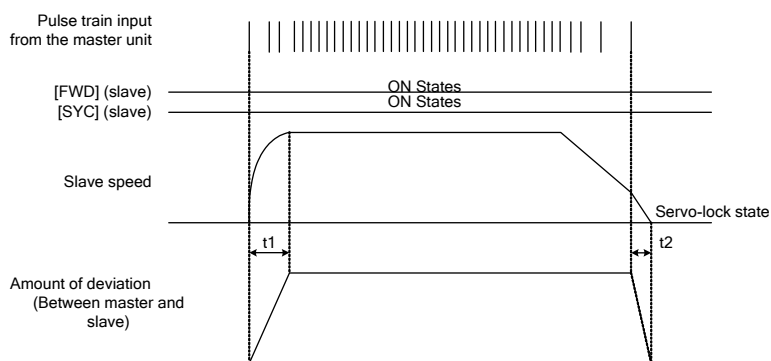
Figure 6.2.28

Slave acceleration and deceleration times

The slave motor's acceleration (t1) and deceleration (t2) times will lag slightly behind the master. As illustrated in the above figure, the slave will operate while maintaining a pulse deviation (steady-state deviation) relative to the master.

Steady-state deviation

The slave motor will operate while maintaining a steady deviation relative to the master. This deviation will be eliminated when the motor stops, and the motor will enter the servo-lock state when a deviation of zero is reached.

This steady-state deviation is the difference between the number of command pulses from the master during constant-speed operation and the number of position detection pulses for the slave.

The steady-state deviation can be adjusted with the APR gain and F/F gain. For more information, see the section on PG interface expansion card function codes.
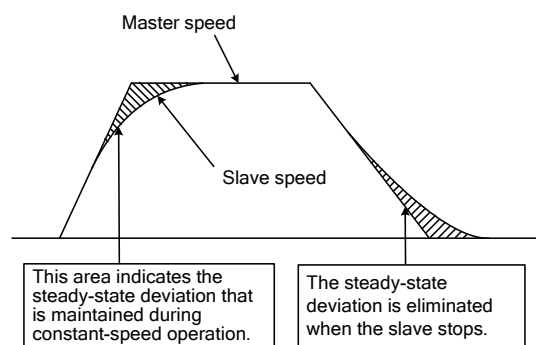
Figure 6.2.29

(2) Pulse train operation using a pulse transmitter

⚠CAUTION

- During pulse train operation, function code acceleration and deceleration time settings are disabled. Perform frequency control with the pulse transmitter. Starting operation while a high-frequency pulse train command has been given may cause the motor to accelerate rapidly.

Risk of bodily injury

Start and stop operation by simultaneously manipulating the [FWD] terminal and the contact input [SYC]. Turning [FWD] on alone will trigger operation with another speed command.

The acceleration and deceleration times cannot be controlled by the FRENIC-VG. Instead, perform frequency control with the pulse transmitter.

Times t1 (S) and t2 (S) in Figure 6.2.30 cannot be controlled by the inverter.
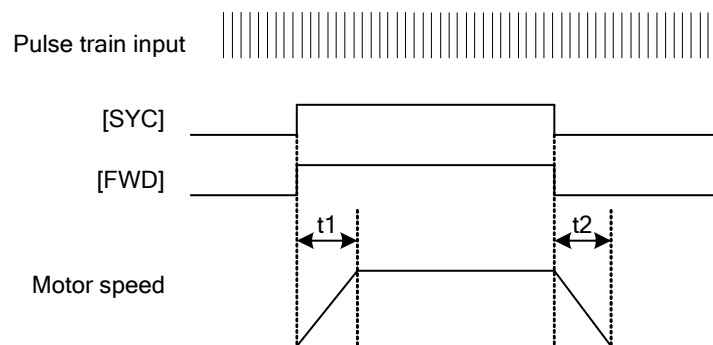
Figure 6.2.30

6.2.5.3 Function codes

⚠WARNING

- Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data.

Risk of accident

⚠CAUTION

- Suddenly setting a high gain value with ASR (gain and integration time) function codes or otherwise failing to write appropriate data may cause the motor to exhibit hunting behavior, causing damage to the motor and device as well as bodily injury.

- Risk of bodily injury

- Changing data for function code o17 (F/F gain 1) may cause an overshoot if the speed changes abruptly. When connecting the PG interface expansion card to devices that do not deal well with an overshoot, set this function code to 0.0.

Risk of equipment damage

Table 6.2.15 lists function codes related to pulse train operation. See the control block diagrams in Chapter 4 for more information.

Table 6.2.15

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o12	Command pulse selection	PLS REF SL	0, 1	0: PG (PR) option 1: Internal speed command
o13	Pulse train input format selection	PLS STATE SL	0 to 2	0: Two signals with a 90° phase difference between the A- and B-phases 1: A-phase command pulse, B-phase command code 2: A-phase run forward pulse, B-phase run reverse pulse
o14	Command pulse compensation 1	PLS CORR 1	1 to 9999	Allows the command pulse count ratio to be changed.
o15	Command pulse compensation 2	PLS CORR 2	1 to 9999	
o16	APR gain 1	APR-P-GAIN	0.1 to 999.9[times]	Position controller gain
o17	F/F gain 1	F/F GAIN	0.0 to 1.5[times]	Feed forward gain
o18	Deviation overrun width	DEV OVER W	1 to 65535[pulse]	Allows 10 to 655,350 pulses to be set (10 x the setting).
o19	Deviation zero width	DEV XERO W	1 to 1000[pulse]	Sets 1 to 1,000 pulses.
F64	ASR1 input filter	ASR1-IN	0.000 to 5.000[s]	Sets the time constant for the primary delay filter relative to the speed setting.

(1) Command pulse selection (o12)

Set to 0 when performing position control using pulses input to the PG (PR) option. Normally, the slave setting is 0.

By contrast, set to 1 at the master when you wish to send the same pulse to the slave while triggering pulse oscillation with an internal speed command and using pulse train operation for the master based on that signal.

[About o12 = 1 operation]

Internal speed commands ([12] input and multi-stage speed commands, etc.) are converted into pulse signals (oscillations), and those pulse signals are converted back into speed commands as part of position control and enabled with [SYC]. To synchronize operation with other inverters, converted pulse signals are output as-is and received by the PGo (PR) option.
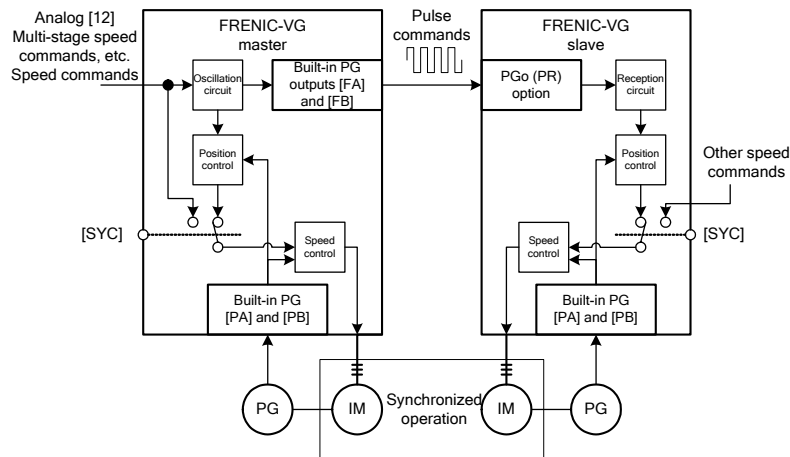
Figure 6.2.31

Precautions

When internal speed commands are used to generate oscillation with a pulse train using the o12 = 1 technique, processing is performed to correct the remainder portion of each pulse. For example, when using a 1024p/r encoder, conversion of a 1,500 r/min. command into a pulse generates 25.6 kHz pulse output without any problem. However, a speed command of 1,000 r/min. yields a pulse of 17.06666… kHz due to the remainder in the division operation. Remainders are corrected one by one. This correction processing causes a slight amount of speed fluctuation, but smoothing by the speed command filter prevents it from becoming a problem. Additionally, since synchronization accuracy is maintained by means of remainder correction processing, the problem of missing pulses (positional shifts) does not occur.

(2)   Pulse train input format selection (o13)

Set to reflect the pulse format that will be input to the A- and B-phases. Set to 0 when using a master/slave connection.

(3)   Command pulse compensation 1, 2 (o14, o15)

Position command data being input to the pulse train card can be changed with command pulse compensation 1 and 2. This functionality can be used to change the ratio of the speeds of the master motor and slave motor during synchronized operation.

$$\text{Position command pulse} = (\text{Command pulse input from external source}) \times \frac{\text{Command pulse compensation 1}}{\text{Command pulse compensation 2}} \times \frac{\alpha}{4}$$

α: Input format constant   Command pulse/command code or run forward/run reverse pulse: $\alpha = 1$
Two signals with a 90° phase difference: $\alpha = 4$

[Example]

In synchronized operation with a master/slave connection with a slave that uses gears, assume that the gear ratio is a:b and that the input pulse is transformed into b:a by command pulse compensation (b = command pulse compensation 1; a = command pulse compensation 2).

$$\text{Position command pulse} = (\text{Command pulse input from external source}) \times \frac{b}{a} \times \frac{\alpha}{4}$$

If the gear ratio is 1:3, the actual settings would be as follows:

Table 6.2.16

Command pulse compensation 1	900	300	· · ·	30	3
Command pulse compensation 2	300	100	· · ·	10	1
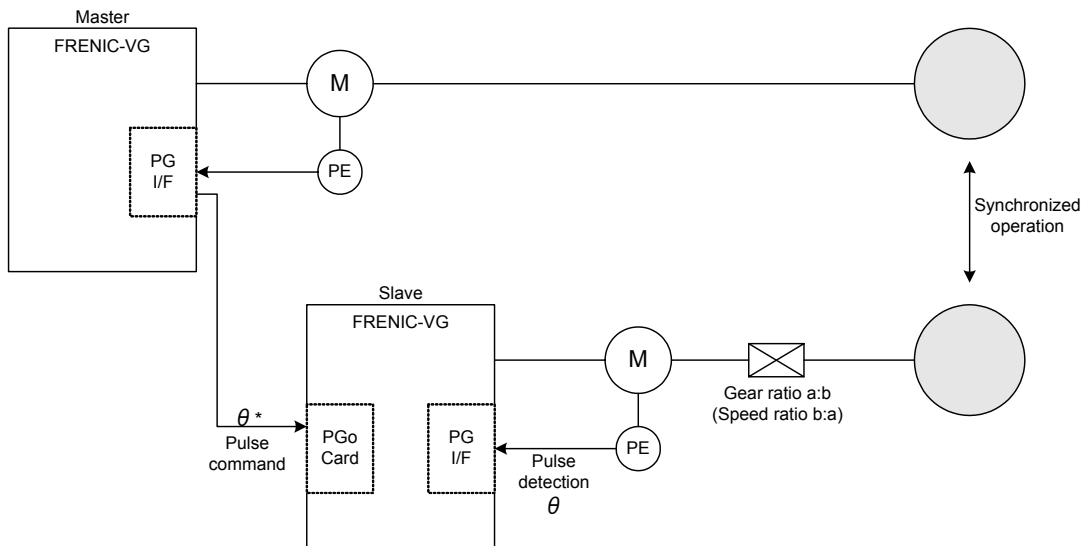
Figure 6.2.32

(4) APR gain 1 (o16)

By adjusting the APR gain, it is possible to improve speed response during pulse train operation. Additionally, it is possible to reduce the steady-state speed deviation during constant-speed operation. However, since use of an excessively large APR gain setting carries the risk of causing the motor to exhibit hunting behavior, it is recommended to start the adjustment process with a small value and then gradually increase it.

(a) APR = Low to optimal value (b) APR = Somewhat high (c) APR = High
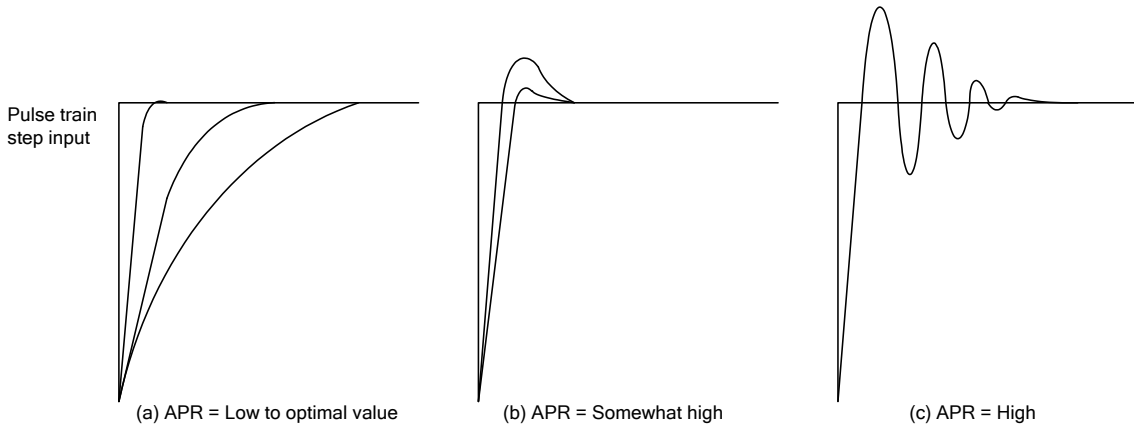
Figure 6.2.33

To improve the ASR response during pulse train operation, write 0 (s) to the ASR input filters. Setting the filters to large values may cause the motor to hunt.

(5) F/F gain 1 (o17)

The steady-state deviation can be reduced with the F/F gain value. The deviation is minimized with a setting of 1.0, but the F/F gain should be set to 0.0 when used in combination with machinery that does not do well with an overshoot.

The following figure illustrates the speed response when using step input consisting of position command pulses. With an F/F gain of 0.0 and an optimal APR gain setting, no overshoot occurs (a). However, a steady-state deviation is maintained during machinery operation.

By contrast, the steady-state deviation decreases to almost zero when the F/F gain is 1.0. However, an overshoot occurs (b) in order to eliminate the deviation that has accumulated by the time the target speed is reached. Additionally, the motor may accelerate to its maximum speed at this time. Consequently, a setting of 0.0 should be used in order to avoid overshoot.

(a) When F/F = 0.0 (b) When F/F = 1.0
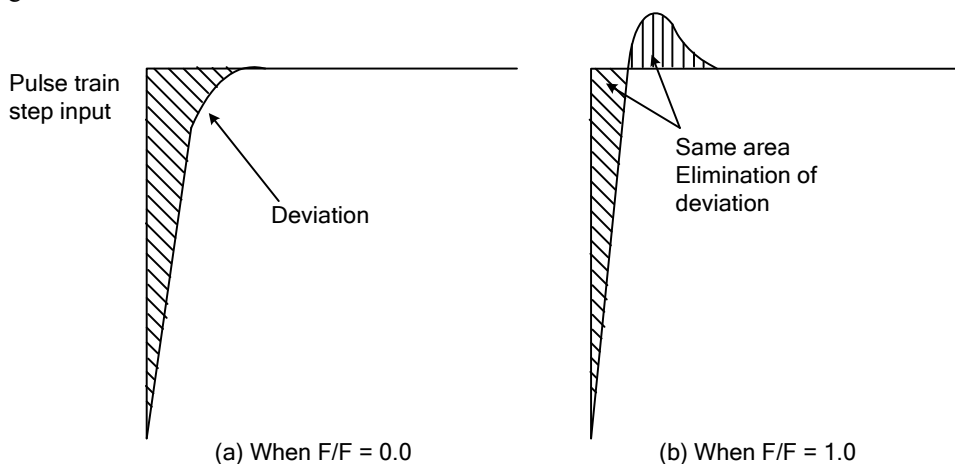
Figure 6.2.34

The following equation describes the relationship between the F/F gain and the APR gain:

$$|\text{Steady - state deviation}| = \frac{|1 - G_{FF}|}{G_{APR}} \times \alpha \times (\text{input frequency})$$

GFF: F/F gain, GAPR: APR gain,
α: Input format constant (α = 4 if 90° phase difference; otherwise, α = 1)

(6)   Deviation overrun alarm width (o18)

A deviation overrun occurs when the difference between the internal command position and the actual amount of motor rotation (i.e., the deviation) is equal to or greater than this setting, causing the motor to perform a free-run stop. The keypad LED will display "$d\bar{l}7$," and the LCD will display alarm information related to the deviation overrun.
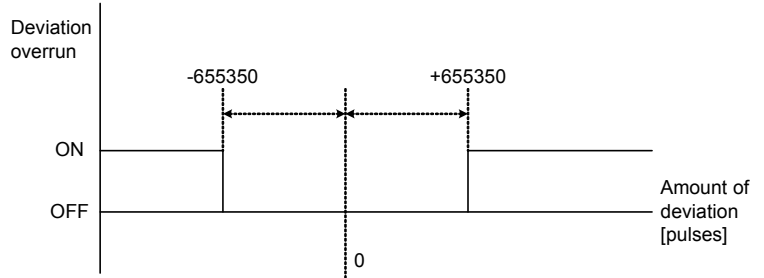
Figure 6.2.35

Deviation overrun alarms can be canceled by turning off the position control [SYC] and inputting the [RST] signal (see Figure 6.2.36).

Deviation overruns occur when the motor fails to track position commands. Although the initial value (factory setting) is 65,535 pulses (internally the setting is multiplied by 10), it should be set to about 2 times the position deviation that occurs during normal operation. If the function code APR gain and F/F gain settings have not been configured with optimal values, the motor may exhibit hunting behavior.
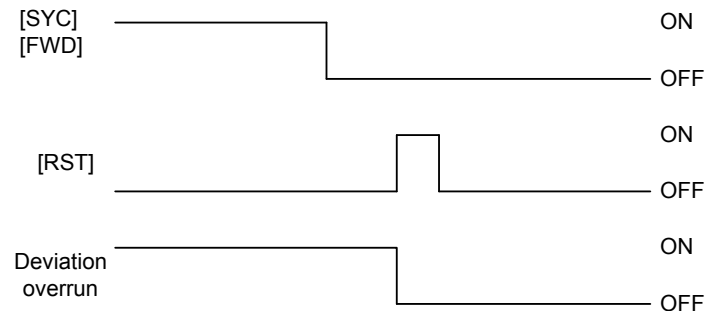
Figure 6.2.36

If that occurs, this value must be set again so that a deviation overrun alarm occurs immediately and the motor performs a free-run stop. Note that using a setting that is too low may cause the alarm to be triggered during acceleration and deceleration.

(7)   Deviation zero width (o19)

The synchronization control complete signal is output when the motor's current position falls within the range defined by this setting from the target position. This functionality allows detection of the fact that the motor has almost reached the target position. The magnitude of this setting does not affect the positioning system. The synchronization control complete signal is assigned by allocating 27 [SY-C] to an output selected with the Y1 to Y5 functions.
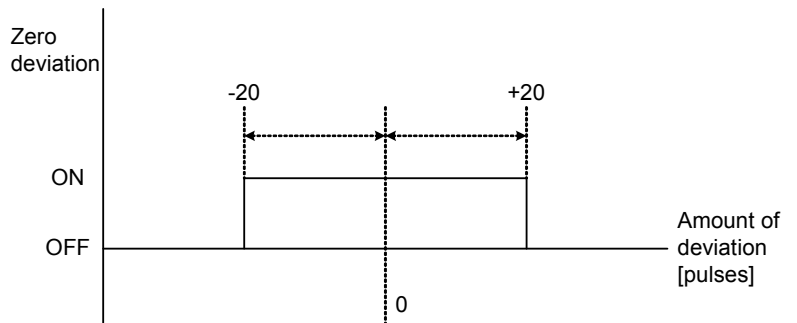
Figure 6.2.37

Figure 6.2.37 illustrates the [SY-C] output state when the value 20 is allocated to the deviation zero width.

Chap. 6

CONTROL OPTIONS

6.2.6 Check functions

6.2.6.1 Optional equipment check

You can check on the keypad whether the PG interface expansion card is set to SD, LD, PR, or PD.

From the Operating Mode screen, go to the Program Menu screen and select "4. I/O check." Use the ⌃ and ⌄ keys to switch screens and check the setting on screen 9 as shown in the figure to the right.

```
OPTION
OPA:VG1-PG (SD)
OPB:VG1-PG (PD)
OPC:
 ∧∨→PAGE SHIFT  9
```

For more information, see the section on keypad operation.

The figure to the right illustrates the screen that would be displayed when two PG interface expansion cards are installed and set to PG (PD) and PG (SD).

6.2.6.2 I/O check

You can check the PG interface expansion card's digital input status on the inverter's keypad.

From the Operating Mode screen, go to the Program Menu screen and select "4. I/O check." Use the ⌃ and ⌄ keys to switch screens and check the setting on screen 15 as shown in the figure below.

For more information, see the section on keypad operation.

```
SD =±×××××P/s    ←── Inverter and PG (SD) signal input information
LD =±×××××P/s    ←── PG (LD) signal input information
PR =±×××××P/s    ←── PG (PR) signal input information
PD =±×××××P/s    ←── PG (PD) signal input information
 ∧∨→PAGE SHIFT 15
```

6.2.7 Protective functionality

When the inverter's protective functionality operates, the inverter immediately displays an alarm, displays the alarm name on the keypad's LED, and allows the motor to free-run. When this functionality operates, resume operation after clearing the cause of the malfunction. Avoid automatically resetting the alarm, for example with an external sequence. Table 6.2.17 lists alarms related to the PG interface expansion card. For more information about other alarms, see "Protective Operation" in the inverter's operating manual.

Table 6.2.17 List of Alarm Protective Functions

Alarm display	30X	Alarm cause
$d0$	Operation	This position deviation overrun error occurs when the load causes the motor startup to lag relative to the pulse train command, creating a position deviation that exceeds a previously set value. The threshold is set with function code o18 (deviation overrun width).
Pg	Operation	A broken wire was detected due to an interruption in a PG signal when line driver operation (OPC-VG1-PG) was selected while using the SD setting.

6.3   Synchronous Motor Drive PG Interface Card OPC-VG1-PMPG/PMPGo

6.3.1   Product overview

Using this option allows the FRENIC-VG to drive a synchronous motor. When detecting magnetic pole positions using only the Z-phase, use the OPC-VG1-PG (SD) option. Synchronous motors offer advantages over induction motors in the form of their smaller size and lower energy consumption. Used in combination with this option, the FRENIC-VG can drive not only Fuji motors (GNF2 series motors, ES motors, and AC servomotors), but any synchronous motor with a compatible encoder interface. However, it cannot be used with motors that utilize serial encoders such as Fuji's FALDIC α dedicated motor. Choose the OPC-VG1-PMPG for line driver output or the OPC-VG1-PMPGo for open collector output.
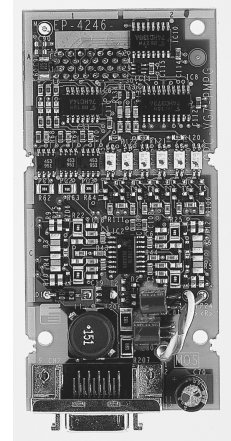
(1)   Maximum rotational speed of 30,000 r/min.
The synchronous motor drive PG interface card can generate output at up to 800 Hz when using a carrier frequency of 10 kHz, allowing it to drive a motor at up to 30,000 rpm with a 2P motor conversion. However, in fact the encoder's input frequency is limited to 100 kHz. For example, using a 256P/R encoder, the card can drive a motor at up to 100 kHz / 256 × 60 = 23,438 r/min.

(2)   Magnetic pole position interface
The card can drive a motor with an encoder interface that satisfies the following specifications:

1) Synchronous motors that output magnetic pole positions using 4-bit Gray codes
2) Synchronous motors that output magnetic pole positions using 3-bit codes (U-, V-, and W-phase)

(3)   Broken wire detection function
The card can use the broken wire detection function. When a broken wire is detected, the inverter will display alarm $P5$ and shut off its output, causing the motor to perform a free-run stop. However, this function cannot be used with the open collector output model (OPC-VG1-PMPGo). The FRENIC-VG's PG broken wire detection cancelation function can be used in the standard configuration.

(4)   Synchronous motor, ES motor, and AC servomotor drive
The synchronous motor drive PG interface card can drive Fuji synchronous motors (GNF2), ES motors (GRK2), and AC servomotors (GRH). The user need only set several motor parameters.

When driving GRK series motors, choose the PMPGo card, since the included encoder generates open collector output. In this application, be sure to attach a zero-phase ferrite ring to counteract line noise.

(5)   Small-capacity motor drive
The FRENIC-VG line starts with inverters rated for 0.75 kW in a 200 V circuit. However, these inverters can also drive 0.2 kW and 0.4 kW synchronous motors. The user need only set several motor parameters.

(6)   IPM and SPM motor drive
Synchronous motors are classified as either internal permanent magnet (IPM) or surface permanent magnet (SPM) devices, depending on the method with which the magnetic poles are incorporated into the motor. The FRENIC-VG can drive both types. In particular, it is possible to set the salient pole ratio using function codes. This capability allows the motor's reluctance torque (torque that takes advantage of differences in magnetic resistance) to be used, increasing efficiency.

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6.3.2 Model and specifications

6.3.2.1 Model

⚠CAUTION
• There are two models for the synchronous motor drive PG interface card, reflecting differences in the external equipment output interface: OPC-VG1-PMPG: Line driver signals OPC-VG1-PMPGo: Open collector/voltage output Exercise care that you do not specify the wrong model when purchasing one of the cards.

The model for the FRENIC-VG's PG option reflects differences in the external equipment output interface (line driver output versus open collector output/voltage output). Since the interface type cannot be selected with switches, it is necessary to determine which interface you require before purchase (OPC-VG1-PMPG or OPC-VG1-PMPGo).

Model format:

OPC-VG1-PMPG□

None: Line driver model
o: Open collector model

Option name: PMPG → Permanent magnet synchronous motor drive with PG synchronized drive option

VG1 → FRENIC-VG inverter
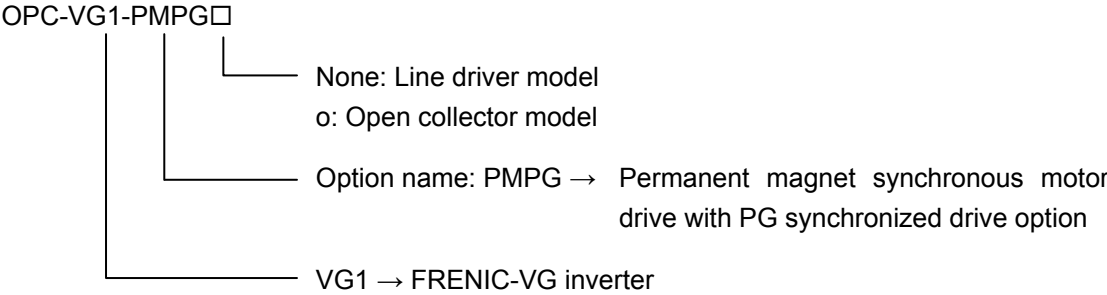
Accessories

Plug (Model: 20-pin 10120-3000PE by Sumitomo 3M Limited)
Housing (cover) (Model: 20-pin 10320-52A0-008 by Sumitomo 3M Limited)
Spacers: 3
Screws (M3): 3

6.3.2.2 Specifications

Table 6.3.1 Hardware Specifications

Item	Specifications	
Model	OPC-VG1-PMPG	OPC-VG1-PMPGo
Signal type	Line driver output (recommended 26C31, 26LS31 or equivalent)	Open collector output
PG power supply	The synchronous motor drive PG interface card uses a 5 V power supply. [PGP] pin: +5 V ±5%, 250 mA, [PGM] pin: Common, Includes an overcurrent protection function. Internal photocoupler insulation (connected to [PGM] and [CM] on the inverter's control Pt board; isolated from [M])	The inverter's PG power supply (+15 V, +12 V) can also be used to power the motor encoder. Connect after checking the motor encoder's specifications.
Input signal terminals	Speed detection incremental signals: [PA], [*PA], [PB], [*PB] Magnetic pole position detection absolute signals: [F0], [*F0], [F1], [*F1], [F2], [*F2], [F3], [*F3] Photocoupler insulation	Speed detection incremental signals: [PA], [PB] Magnetic pole position detection absolute signals: [F0], [F1], [F2], [F3] Photocoupler insulation
Broken wire detection function	Yes	No
Connections	Supply the 5 V power supply from [PGP] and [PGM]. Since a balanced circuit is used, it is necessary to use twisted-pair shielded cable for wiring.	Built-in 5 V pull-up; sink current: approx. 11 mA/circuit
Maximum input pulse frequency	100 kHz; duty: 50 ±10%	
Allowable wiring length	Approx. 50 m Shorter wiring lengths are required when there is a high voltage drop.	10 m or less Keep wiring runs as short as possible to avoid the effects of noise. Be sure to connect a zero-phase ferrite ring.
Power supply	24V Supplied from the inverter's printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.	

Table 6.3.2 Software Specifications

Item		Specifications
Motor control method		Vector control for PMSM with speed sensor When function code P01 (M1 control method selection), A01 (M2 control method selection), or A101 (M3 control method selection) = 3
Speed control Vector control with speed sensor	Control range	1:1500 (min. speed: base speed, 1.5 to 1,500 r/min. with 4P conversion, using 1024P/R)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% of max. speed
PG interface functionality		When the PMPG option is installed and function code P01 (M1 control method selection), A01 (M2 control method selection), or A101 (M3 control method selection) = 3, the built-in PG interface is disabled, and the PMPG option takes priority.
Broken wire detection function		Yes
Frequency division output		No
Magnetic pole position detection function		Configured with function code o09 (ABS signal input definition). o09 = 1: 3-bit detection; [F0] [F1] [F2] : U-/V-/W-phase detection o09 = 2: 4-bit detection; [F0] [F1] [F2] [F3]: Gray code detection

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6.3.2.3 Using the card in combination with a Fuji motor

Table 6.3.3 GRK-type ES Motors

Motor type	GRK2200M	GRK2400M	GRK2750M	GRK2151A	GRK2221A	GRK2301A	GRK2371A
FRENIC-VG model	FRN0.75VG1S-2J		FRN1.5VG1S-2J	FRN2.2VG1S-2J	FRN3.7VG1S-2J		
Rated output (kW)	0.2	0.4	0.75	1.5	2.2	3.0	3.7
Rated torque (N・m)	0.955	1.91	3.58	7.16	10.5	14.3	17.7
Rated rotational speed (r/min.)	2000						
Max. rotational speed (r/min.)	2500						
Max. torque (N・m)	1.43	2.87	5.38	10.8	15.8	21.5	26.5
Rated current (A)	1.2	2.3	4.0	8.6	13.0	17.2	21.0
Max. current (A)	2.0	3.6	6.0	13.0	19.5	25.8	31.5

* Contact Fuji if you wish to use the card with a motor with a rating of less than 0.2 kW.

* Contact Fuji for more information about how to configure the FRENIC-VG with motor parameters.

* Choose the OPC-VG1-PMPGo since these motors use 1000P/R pulse encoders and open collector output.

* The encoder interface provides A-, B-, Z-, 1- (U-), 2- (V-), and 3- (W-)phase terminals, which should be connected for U, V, and W 3-bit magnetic pole position detection. The Z-phase need not be connected.

Table 6.3.4 GRH-type ES Motors

Motor type	GRH.30BG	GRH.50BG	GRH1.1BG	GRH1.5BG	GRH1.8BG	GRH2.7BG
FRENIC-VG model	FRN0.75VG1S-2J	FRN1.5VG1S-2J	FRN2.2VG1S-2J	FRN3.7VG1S-2J		FRN5.5VG1S-2J
Rated output (kW)	0.3	0.5	1.1	1.5	1.8	2.7
Rated torque (N・m)	0.955	1.59	3.50	4.77	6.88	10.3
Rated rotational speed (r/min.)	3000				2500	
Max. rotational speed (r/min.)	3000				2500	
Max. torque (N・m)	2.86	5.73	11.5	15.7	18.0	26.3
Rated current (A)	1.9	2.7	5.4	7.0	8.3	13
Max. current (A)	5.7	8.1	16.2	21.0	21.7	33.2

* Contact Fuji for more information about how to configure the FRENIC-VG with motor parameters.

* Choose the OPC-VG1-PMPG since these motors use 2000P/R pulse encoders and line driver output.

* The encoder interface provides A-, B-, Z-, 1- (U-), 2- (V-), and 3- (W-)phase terminals, which should be connected for U, V, and W 3-bit magnetic pole position detection. The Z-phase need not be connected.

6.3.3   External dimension diagram
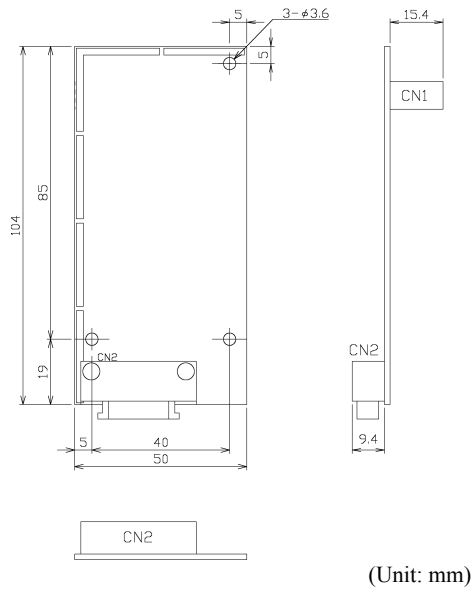
(Unit: mm)

Figure 6.3.1   OPC-VG1-PMPG/PMPGo Outline Diagram

Accessories
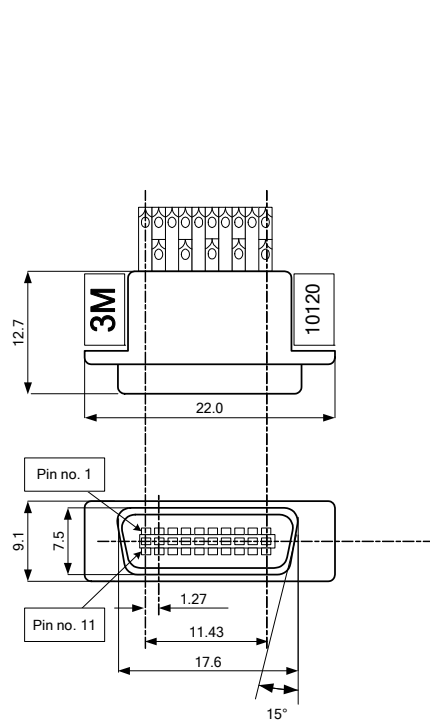
Model: 10120-3000PE
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.3.2   Plug
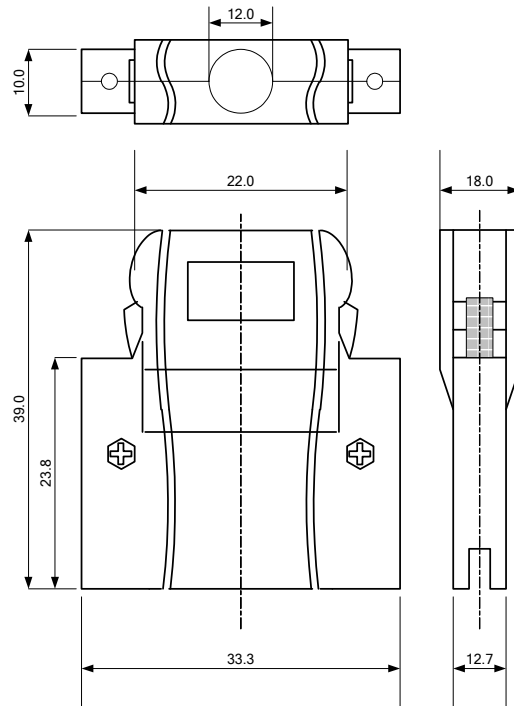
Model: 10320-52A0-008
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.3.3   Housing

*Plug and housing are included with the product.

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6.3.4   Basic connection diagram

Refer to "6.1.4 Installing Built-in Options (OPC-VG1-□□)" before performing wiring or connection work.

<table>
<tr><td colspan="2">⚠ WARNING</td></tr>
<tr><td>•</td><td>Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.</td></tr>
<tr><td>•</td><td>The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.</td></tr>
</table>

<table>
<tr><td colspan="2">⚠ CAUTION</td></tr>
<tr><td>•</td><td>Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.</td></tr>
<tr><td>•</td><td>Inappropriate installation or removal of the product may cause damage to the product.</td></tr>
</table>

Table 6.3.5   Terminal Function Descriptions

Pin no.	Name	Function	Pin no.	Name	Function
1	-		11	-	
2	*PA	A-phase reverse	12	*F1	Magnetic pole position *F1
3	PA	A-phase	13	F1	Magnetic pole position F1
4	*PB	B-phase reverse	14	*F2	Magnetic pole position *F2
5	PB	B-phase	15	F2	Magnetic pole position F2
6	-		16	-	
7	*F0	Magnetic pole position *F0	17	*F3	Magnetic pole position *F3
8	F0	Magnetic pole position F0	18	F3	Magnetic pole position F3
9	PGP	5 V PG power supply	19	PGM	0 V PG common
10	PGM	0 V PG common	20	PGP	5 V PG power supply

```
┌─────────────────────────────┐
│  11 │ 13 │ 15 │ 17 │ 19      │
│    12 │ 14 │ 16 │ 18 │ 20    │
│  1 │ 3 │ 5 │ 7 │ 9           │
│    2 │ 4 │ 6 │ 8 │ 10        │
└─────────────────────────────┘
```
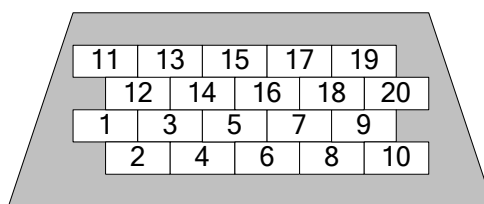
Viewed from the plug's soldered terminal

Figure 6.3.4

6.3.4.1 Line driver type

Choose the OPC-VG1-PMPG when using a line driver output type motor encoder. The following figure illustrates wiring connections used when detecting magnetic pole positions using 4-bit Gray codes and 3-phase U, V, and W signals (GNF2 series and GRH series motors).

Additionally, the OPC-VG1-PG (SD) option can also be used when detecting magnetic pole positions with the Z-phase alone (available soon).
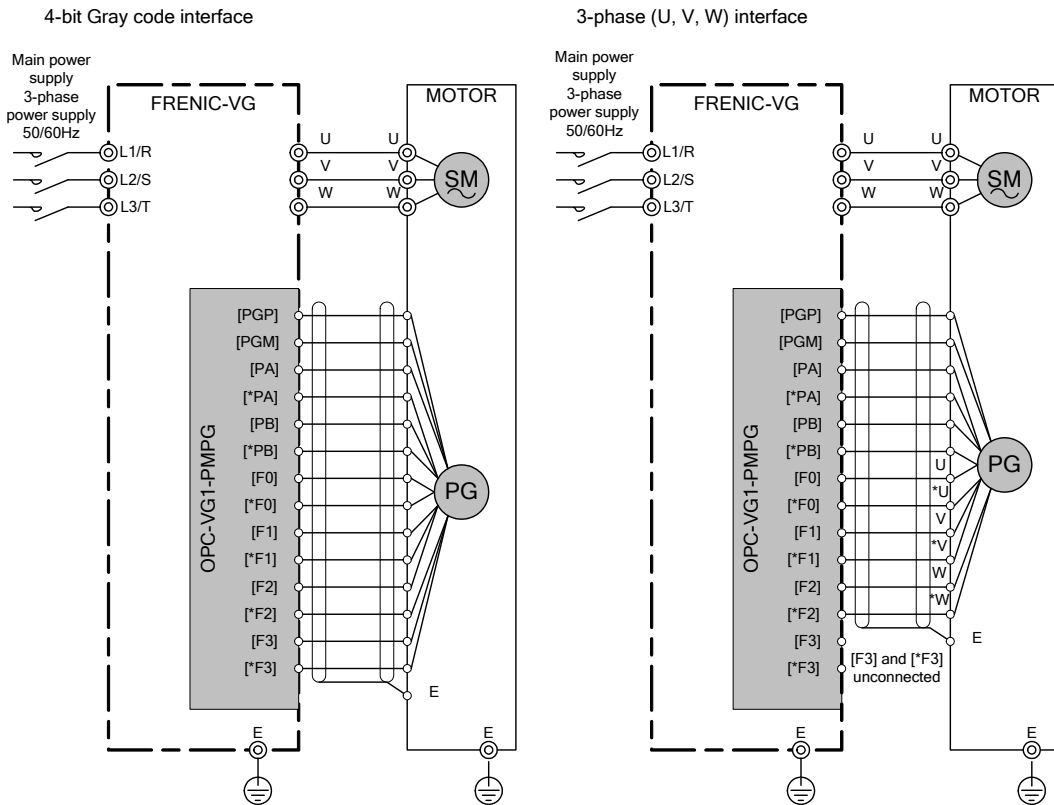
Figure 6.3.5

6.3.4.2   Open collector output type

Choose the OPC-VG1-PMPGo when using an open collector output type motor encoder. The following figure illustrates wiring connections used when detecting magnetic pole positions using 3-phase U, V, and W signals (GRK-type ES motors).

Since open collector connections offer low resistance to noise, use as short a wiring run as possible and connect zero-phase ferrite rings on the primary and secondary sides of the inverter.

3-phase (U, V, W) interface
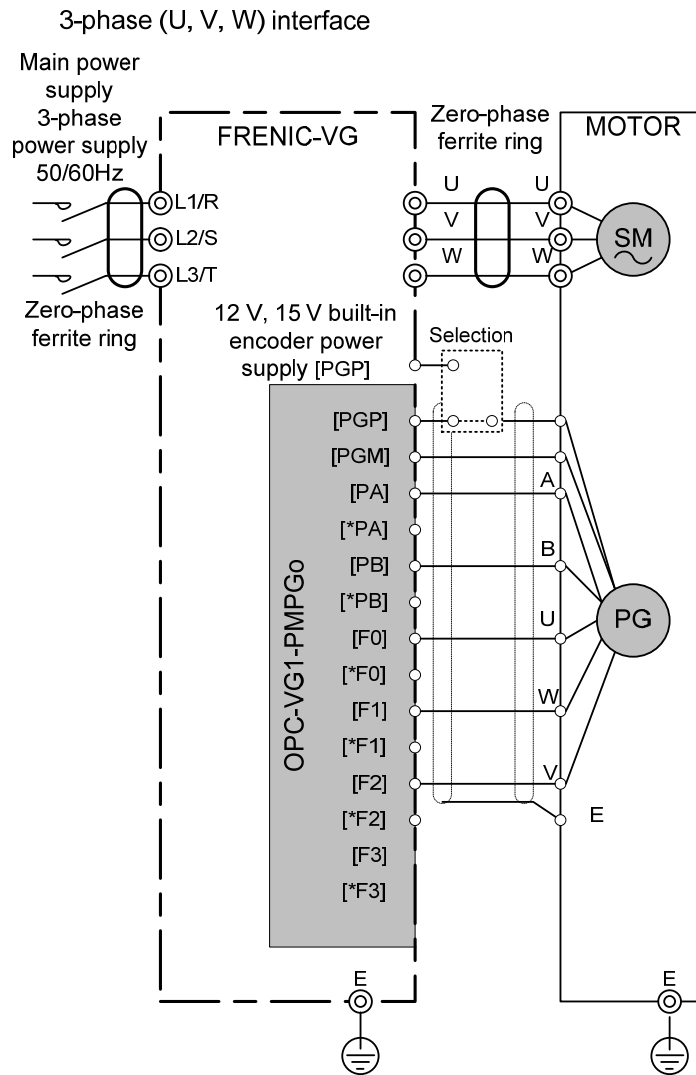
Figure 6.3.6

Precautions

(1)   Read over the motor specifications carefully before connecting the power supply to the motor encoder.

(2)   The synchronous motor drive PG interface card provides a 5 V power supply. The inverter's encoder power supply can also be used to provide a 15 V or 12 V power source.

(3)   The OPC-VG1-PGo option can also be used when detecting magnetic pole positions with the Z-phase alone (available soon).

(4)   As shown above, when connecting a GRK-type ES motor to the FRENIC-VG, connect the W-phase wire to [F1] and the V-phase wire, to [F2]. Be careful with the wiring.

6.3.4.3   Connection Diagram for Fuji servos

Change the shielding connection used for PG wiring from the motor's E terminal to the inverter's PGM terminal in order to secure a noise margin to protect against improper operation of encoder signals. Additionally, connecting shielding to the motor's E terminal is an effective way to reduce radiated noise.
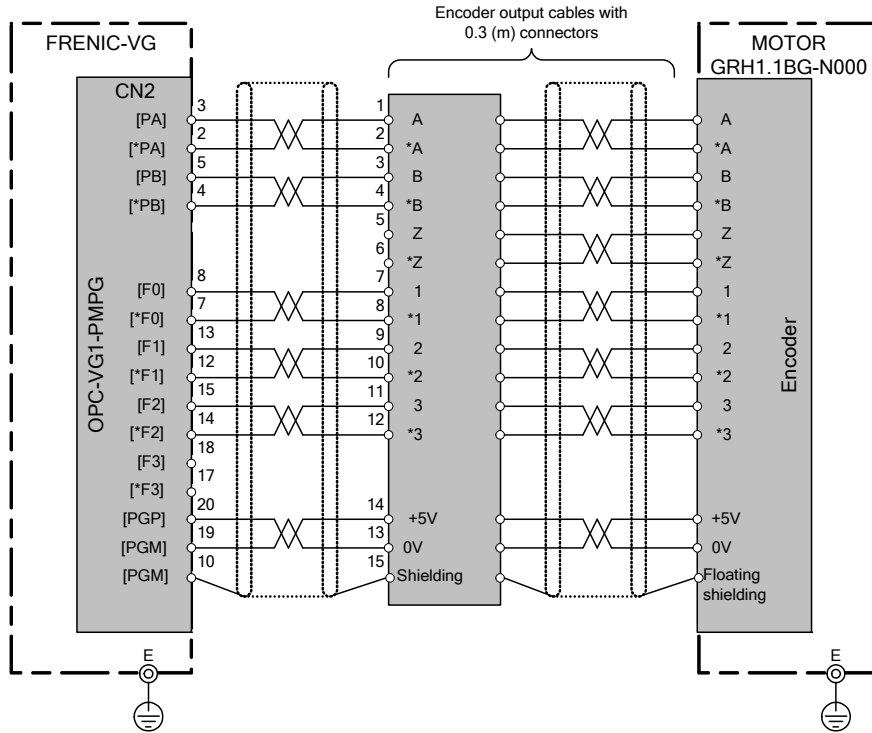
Figure 6.3.7

Precautions

- The encoder's shielding (15-pin) is not connected to the motor's earth (E) terminal.

6.3.5 Function codes

> ## ⚠ WARNING
>
> - Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data.
>
> **Risk of accident**

6.3.5.1 Synchronous motor drive PG interface card function codes

The following function codes can be used when the PMPG option or PMPGo option is installed:

Table 6.3.6

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o09	M1 ABS Signal input definition	ABS DEF	0 to 16	Set according to the motor encoder's specifications. Defines the operating interface for detecting magnetic pole positions. 0: 1-bit (terminal: F0) Z-phase interface (available soon) 1: 3-bit (terminals: F0, F1, F2) U-/V-/W-phase interface 2: 4-bit (terminals: F0, F1, F2, F3) Gray code interface 3 to 5: Reserved 6: SPGT 17-bit serial interface 7 to 16: Reserved
A59	M2 ABS Signal input definition			
A159	M3 ABS Signal input definition			
o10	M1 Magnetic pole position detection offset	SM-OFS	0.0 to 359.9	Set when you wish to compensate for divergence from the true value after aligning magnetic pole positions. 0.0 to 359.9 (0.0° to 359.9° moving counterclockwise)
A60	M2 Magnetic pole position detection offset			
A160	M3 Magnetic pole position detection offset			
o11	M1 Salient pole ratio (%Xq/%Xd)	Xq/Xd	1.000 to 5.000	Set when driving an IPM motor. This setting is used to control the IPM motor's reluctance torque. Set to 1.000 when driving an SPM motor.
A61	M2 Salient pole ratio (%Xq/%Xd)			
A161	M3 Salient pole ratio (%Xq/%Xd)			

6.3.5.2 Motor parameters

Motor parameters must be set to reflect the motors being used (M1 to M3). For more information, see the description of P codes and A codes in Chapter 4.

6.3.6   Check functions

6.3.6.1   Optional equipment check

You can check on the keypad whether the PMPG/PMPGo option is installed.

From the Operating Mode screen, go to the Program Menu screen and select "4. I/O check." Use the $\wedge$ and $\vee$ keys to switch screens and check the setting on screen 9 as shown in the figure to the right.

```
OPTION
A : VG1-PMPG
B :
C :
 ∧V→PAGE SHIFT  9
```

For more information, see the section on keypad operation.

The figure to the right illustrates the screen that would be displayed when the PMPG/PMPGo card is installed.
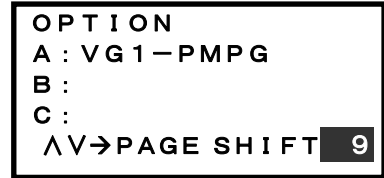
6.3.7   Protective functionality

When the inverter's protective functionality operates, the inverter immediately displays an alarm, displays the alarm name on the keypad's LED, and allows the motor to free-run. When this functionality operates, resume operation after clearing the cause of the malfunction. Avoid automatically resetting the alarm, for example with an external sequence. Table 6.3.7 lists alarms related to the synchronous motor drive PG interface card. For more information about other alarms, see "Protective Operation" in the inverter's operating manual.

Table 6.3.7   List of Alarm Protective Functions

Alarm display	30X	Alarm cause
PG	Operation	When the PMPG card is installed and the PG signal is interrupted, or when wiring has been corrected erroneously

6.4　T-Link Interface Card OPC-VG1-TL

6.4.1　Product overview

Use this option to control FRENIC-VG using the Fuji programmable logic controller MICREX-SX (T-Link module).

<u>Main Usage</u>

Using this option, you can:

- Input signals to start or stop operation, etc.: FWD, REV, X1 - X9, X11 - X14, RST

- Set the speed commands: 16-bit binary data

- Monitor the operation status (bit data)
  Running forward, running reverse, during DC braking or pre-exciting, inverter shutdown, braking, DC link bus voltage established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay output, remote/local, write error from T-link, and data writing in progress

- Monitor motor speed; 16-bit binary data

- Monitor the operation status (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)

- Reference and change function codes
  Function code which can be changed during operation using the touch panel $\Rightarrow$ Can be changed (and checked) during operation
  Function code which cannot be changed during operation using the touch panel $\Rightarrow$ Cannot be changed (but can be checked) during operation

- Monitor that the upper-level device and inverter are interoperating normally using the toggle monitor control.
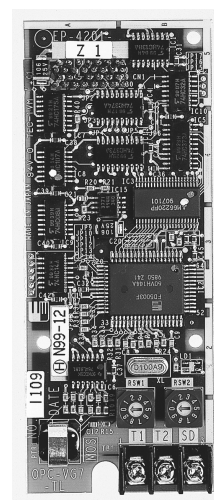
Function codes which can be accessed using this option are limited. For details, refer to "4.2 Function Code List" in Chapter 4.

6.4.2   Model and specifications

6.4.2.1   Inverter type

Model elements: OPC-<u>VG1</u>-<u>TL</u>

```
                      └──────── Name of equipped inverter VG1 → FRENIC-VG
                    └────────── Option name: TL → T-Link interface card
```
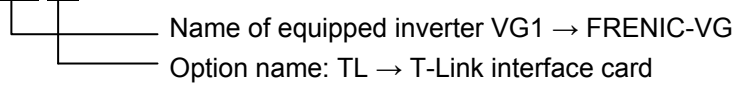
<u>Accessories</u>

Spacer x 3
M3 screw x 3

6.4.2.2   Specifications

⚠CAUTION
• The system will not operate correctly if the switches (RSW1 and RSW2) on this option are not set properly. Read the instruction below and set them accordingly.
• Be sure to power off the inverter before setting the switches (RSW1 and RSW2) on this option.

Table 6.4.1   Hardware Specifications

Item	Specifications
Name	T-Link Interface Card
Transmission specifications	T-Link slave, I/O transmission
Transmission speed	500 kbps
Number of words occupied in transmission	Selected by the function code o32 "Transmission format selection"
	Total of 16 words (8 words + 8 words): 8 words for MICREX → FRENIC-VG and 8 words for FRENIC-VG → MICREX
	Total of 8 words (4 words + 4 words): 4 words for MICREX → FRENIC-VG and 4 words for FRENIC-VG → MICREX
Terminal	TX+, TX-, SD
Rotary switches RSW1 and RSW2	Address setting, 99W space
	4W+4W: Up to 12 cards can be connected.
	8W+8W: Up to 6 cards can be connected.

Rotary switches   <u>RSW1, 2</u>

Set the station address using the rotary switches RSW1 and RSW2 on the option board.

RSW1   RSW2

Figure 6.4.1

RSW1: Upper (x10)

RSW2: Lower (x1)

* When two or more cards are used, do not allocate the same station address to multiple stations.
* The factory default is RSW1=0 and RSW2=0 (address = 00).

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Table 6.4.2   Software Specifications

Item		Specifications
Data update interval		4 ms
Oper ation	Run command	Running forward/reverse alarm reset, X1-X14 commands
	Speed command	16-bit binary data, setting resolution 0.005% (against the highest speed)
	Operation state output	Operating, braking, torque limiting, alarm relay output signals, etc.
		Motor speed, torque current command, etc.
Function code		You can reference and change the 255 functions assigned to the link numbers in the function code list.
Optional function code		o30 - o32 (Displayed on the touch panel when this option is installed)
Protective Function		Er-4: Network failure (T-Link error) * Light alarm: o30 and o31 can be used to control the Er-4 alarm. * Heavy alarm: Momentary alarm

* Light alarm: E.g., Signal noise. If the noise is not frequent, the Er-4 alarm can be controlled by o30 and o31 to continue operation.

* Heavy alarm: Fatal failure such as power down on MICREX, disconnection of communication, and hardware failure.

6.4.3 External dimensions

Tightening torque
0.49N•m

(Unit: mm)
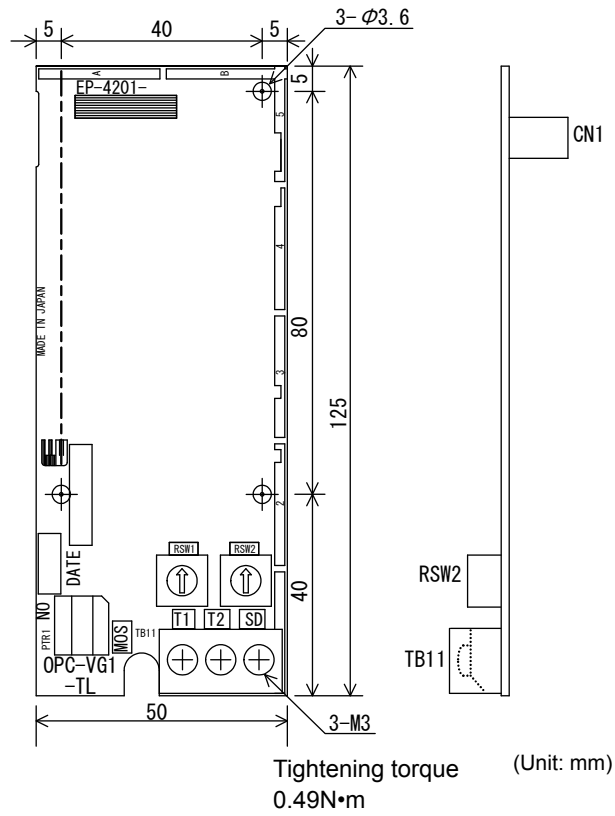
Figure 6.4.2

6.4.3.1 Terminal function

(1) Terminal arrangement

Terminal TB11 | T1 | T2 | SD
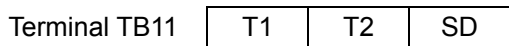
(2) Terminal description

Table 6.4.3

Terminal symbol	Name	Description
T1 T2 SD (shielded)	T-Link cable connection terminal	For T-Link cable connection

* All terminals are open upon shipment.

6.4.4 Basic connection diagram

Refer to "6.1.4 Installing Internal Options (OPC-VG1-□□)" before connecting the cables.

⚠WARNING
• Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock.
• Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠CAUTION
• Do not use the product that is damaged or lacking parts to prevent an injury or damage.
• Incorrect handling in installation/removal jobs could result in a broken product.

The basic connection diagram is shown on the next page. When connecting the cables, observe the following precautions.

[Notes on connection]

(1) Use either of the following cables as a T-Link communications cable.

• Furukawa Electric twisted pair cable
CPEV-SB 0.9 dia. x 1 pair

• Furukawa Electric twisted pair cable
KPEV-SB 0.5 mm^2 x 1 pair

Refer to the document of MICREX for the cable specifications.

(2) Connect the terminal resistor 100 Ω supplied with the T-Link master to the both ends of the T-Link.

(3) Bes sure to connect the T-Link cable without going over the same line twice as shown in the basic connection diagram (Figure 6.4.3).

Correct transmission cannot be performed if the cable branches.

(4) To prevent an error due to noises, keep the T-Link cable apart from the main circuit cables of the inverter and other power cables as apart as possible (30 cm or more) and never put it in the same duct.

Basic Connection Diagram
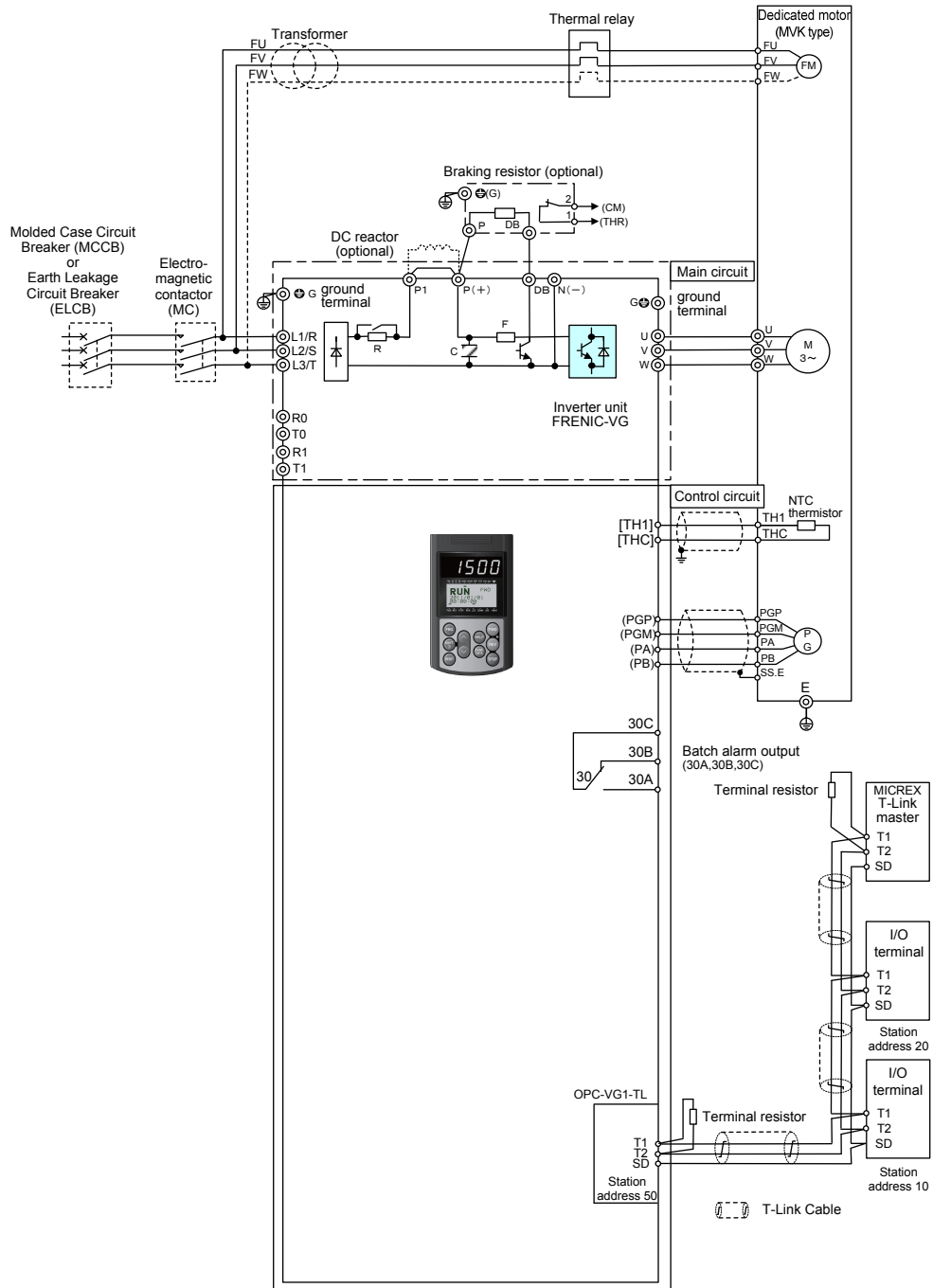
Figure 6.4.3

6.4.5 Function code

<div style="border:1px solid black">

⚠ WARNING

- Incorrect function code data may result in a dangerous situation. After setting and writing the data, check it again.

  An accident could occur.

</div>

By installing the T-Link interface card, the dedicated function codes of o29 to o32 will be available.

Table 6.4.4

No.	Function code name		Available scope	Description
	Name	Touch panel display		
o29	Operation continuation signal operation upon alarm	LK-D OPE	0	Invalid
			1	Available soon
			2	
o30	Error processing after detection of transmission failure	MODE ON ER	0	Immediately force operation to stop upon communication error (light alarm) occurrence (Er-4 alarm: coast to stop).
			1	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop after the timer time (Er-4 alarm: coast to stop). If the communication recovers during the timer time, the command received in communication is run. But, operation is forced to stop it the error persists after the timer time.
			2	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop if the communication error persists after the timer time. If the communication recovers during the timer time, the command received in communication is run.
			3	No alarm (Er-4) even when a communication error (light alarm) occurs. The run command from the previous communication is held in the communication error state. If the communication recovers, the command received in communication is run.
o31	Operation time after detection of transmission failure	TIMER TL	0.01 to 20.00s	Operation time timer value [s] for a communication error (light alarm) is effective when o30=1 or 2.
o32	Transmission format selection	4W/8W SEL	0, 1	0: Format 1 (Standard format 4 W + 4 W) 1: Format 2 (FRENIC-VG format 8 W + 8 W)
			2 to 4	For CC-Link option. Not used for T-Link option.

No.	Function code name		Available scope	Description
	Name	Touch panel display		
H107	Light alarm target definition 2	L-ALM 2	0000 to 1111	Select the alarm operation upon occurrence of an inter-inverter link communication error ($Er-4$) and toggle error ($Ai-F$). $Er-4$ and $Ai-F$ represent the number of hundreds and the number of units, respectively. 0 in the corresponding decimal place: Alarm occurrence, 1: Light alarm ($L-AL$)
E10 | E13	Select X11 - X14 function.	X11 to X14 FUNC	***1**	Select the command when each of the X11 to X14 bits is 1. To perform toggle monitoring with the X terminal bits, set TGL1 and TGL2 for two of the terminals.

*1 For the details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Chap. 6 CONTROL OPTIONS

6.4.6 Protective operation

6.4.6.1 Light and heavy alarms

Failures of the he T-Link interface card are classified into light and heavy alarms depending on the severity level.

Upon occurrence of this failure, the inverter outputs Er-4 "network error" and the motor coasts to stop.

Table 6.4.5

Item		Light alarm	Heavy alarm	
Cause		Noise on communication line	Disconnection of communication line MICREX (PLC) power off	T-Link option hardware failure (damage, failure) Duplicated address (setting error of RSW1 and RSW 2)
Reset method		Resolve the cause (or wait for communication recovery) and give a reset command (touch panel, RST, or remote reset).	Remove the hardware failure and reset the power supply.	
Failure state control	o29=0	Alarms can be controlled with the function codes o30 and o31.	Momentary Er-4 alarm	
	o29=1	Available soon		
	o29=2			

Note: "Give a reset command" means supplying a reset input to the inverter in one of the following methods.

* Touch panel (RESET) key input

* Assign the failure reset RST with the X function selection and digitally input the command.

* Input the reset command via the communication line.

For a heavy alarm, the CPU may also require reset depending on the CPU state of MICREX.

You can check the communication error code for light and heavy alarms on the communication state screen of the maintenance information on the touch panel. To access this screen, press the (PRG) key to return to the menu screen, and move the arrow on the left edge of the screen to "5. Maintenance" using the (∧)/(∨) key, then press the (FUNC DATA) key. Press the (∨) key three times to show the screen below.

```
NRK=×××××
NRR=×××××    ××
NRO=×××××    ×|×  ←
NRL=×××××    ××
∧∨→PAGE SHIFT  4
```

-: No communication error
1: Light alarm *1
2: Heavy alarm
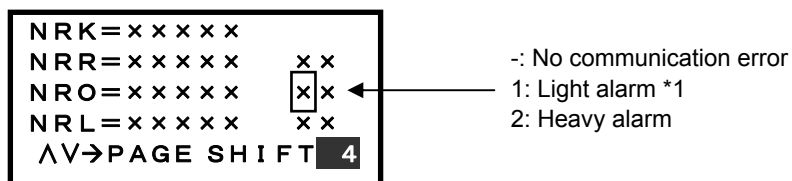
Figure 6.4.4

*1 When o30=0, a heavy alarm may be displayed as a light alarm depending on the timing.
This does not occur when o30=1 or 2, or o31=0.10 or higher.

6.4.6.2 Protective operation function code

The following explains how to control the $Er4$ alarm when a light alarm occurs while an operation command is given from MICREX via the T-Link.

[Operation Description]

The following describes an example of operation when operation and speed commands are given from MICREX and a communication error occurs during operation.

*1 During this period of time, if communication recovers and new settings are not sent, commands (for operation or speed, or both) received upon error occurrence are held.

(1) When function code o30 = 0
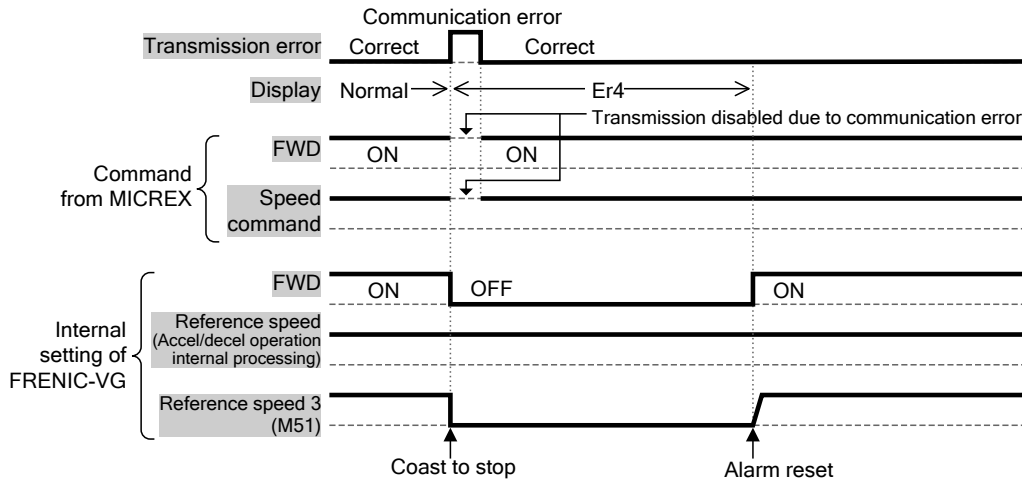
Figure 6.4.5

(2) When function code o30 = 1 and o31 = 5.0 (when a communication error occurs, the motor coasts to stop in five seconds.)
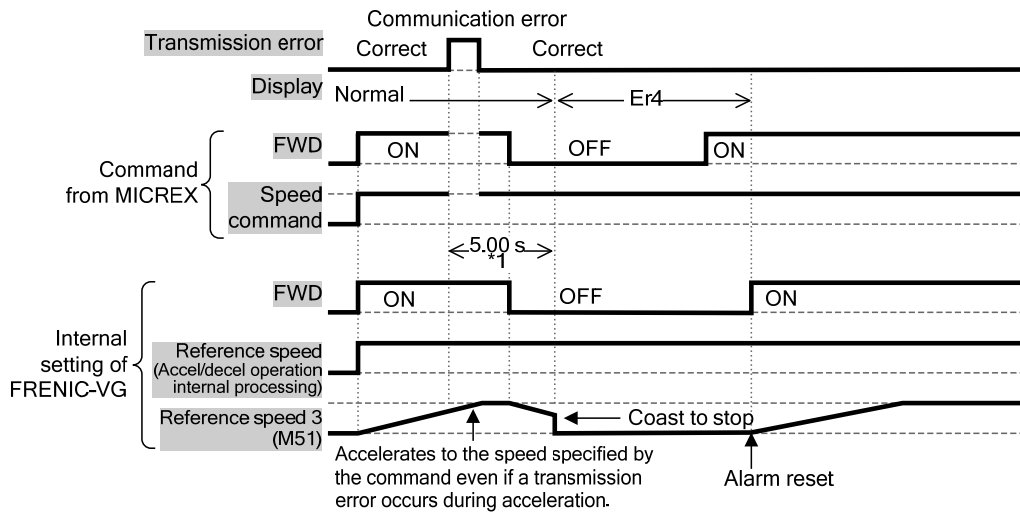
Figure 6.4.6

(3) When function code o30 = 2 and o31 = 5.0

(the communication error persists in five seconds after its occurrence and the $Er-4$ alarm occurs)
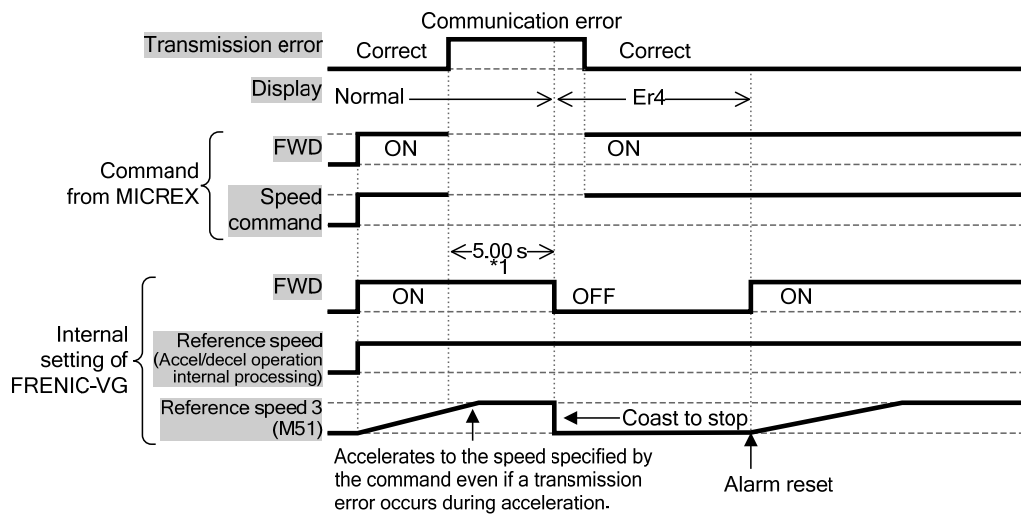
Figure 6.4.7

(4) When function code o30 = 2 and o31 = 5.0 (a communication error occurs and the communication recovers in five seconds)
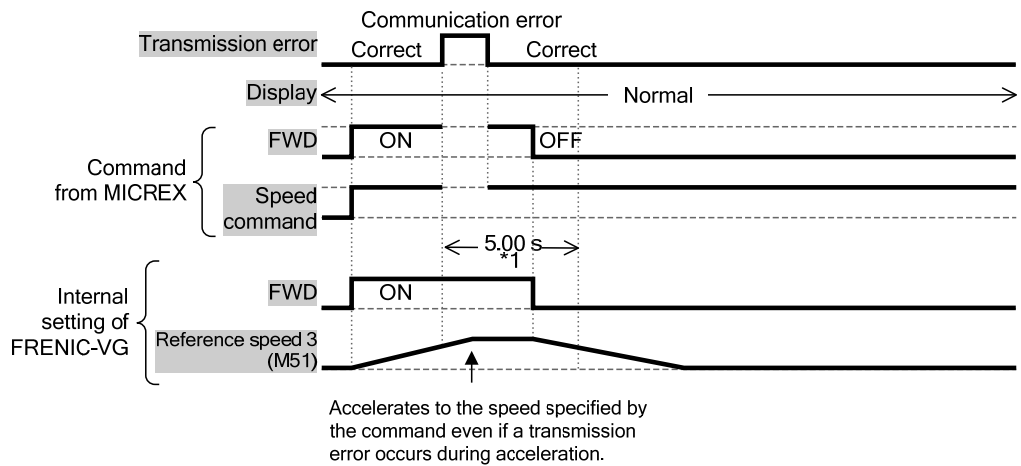
Figure 6.4.8

(5) When function code o30 = 3
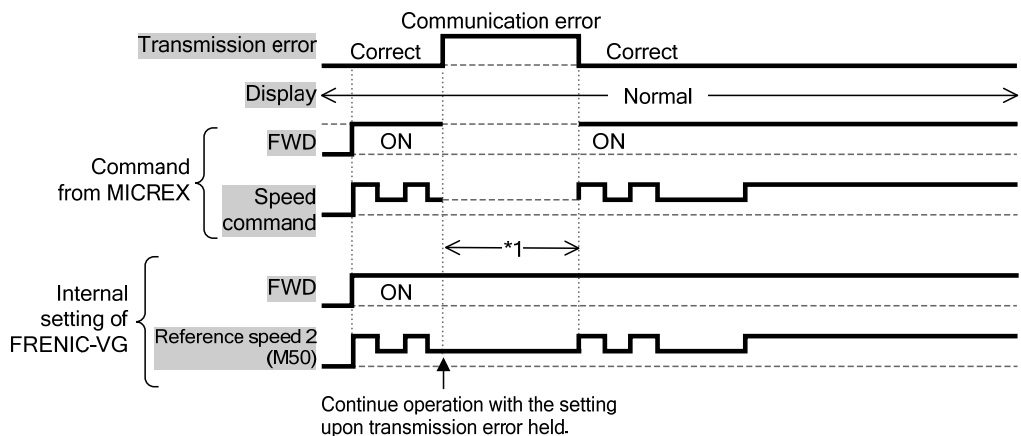
Figure 6.4.9

6.4.7　Data allocation addresses

6.4.7.1　Transmission format

One the following two transmission formats can be selected by the function code o32 "Transmission format selection".

(1)　o32 = 0 (Format 1, standard format: <u>number of words occupied 4W+4W</u>)

(2)　o32 = 1 (Format 2, FRENIC5000VG7, FRENIC-VG format: <u>number of words occupied 8W+8W</u>)

6.4.7.2　Occupied area

As shown in the figure below, within the input/output relay area, <u>contiguous eight or sixteen words</u> are occupied, and the two digits of the address (WB00<u>**</u> in the figure) are set by the <u>rotary switches RSW1 and RSW2 on the option card</u>.

Note: The bit address allocation is different between the Fuji programmable logic controllers MICREX-F and MICREX-SX as shown below.

MICREX-F: LSB bit is shown as F and MSB bit is shown as 0.
MICREX-SX: LSB bit is shown as 0 and MSB bit is shown as F.
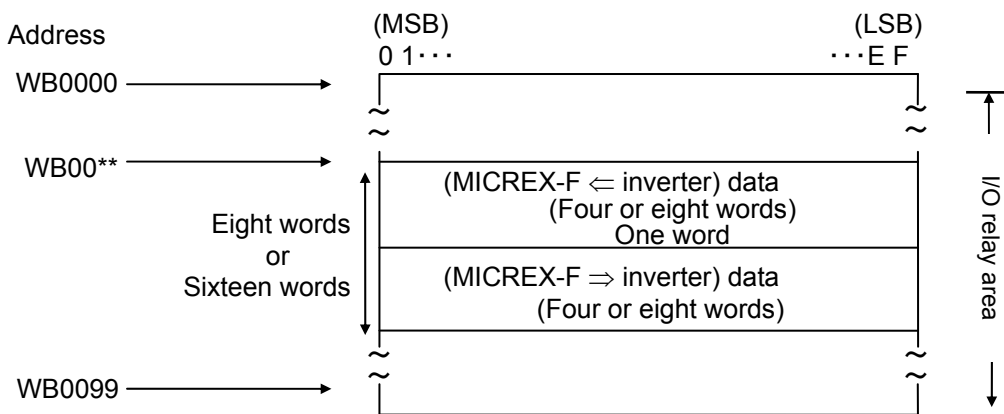
Figure 6.4.10　MICREX-F Area

6.4.7.3　Allocated Address

(1)　Format 1 (Standard format 4 W + 4 W)
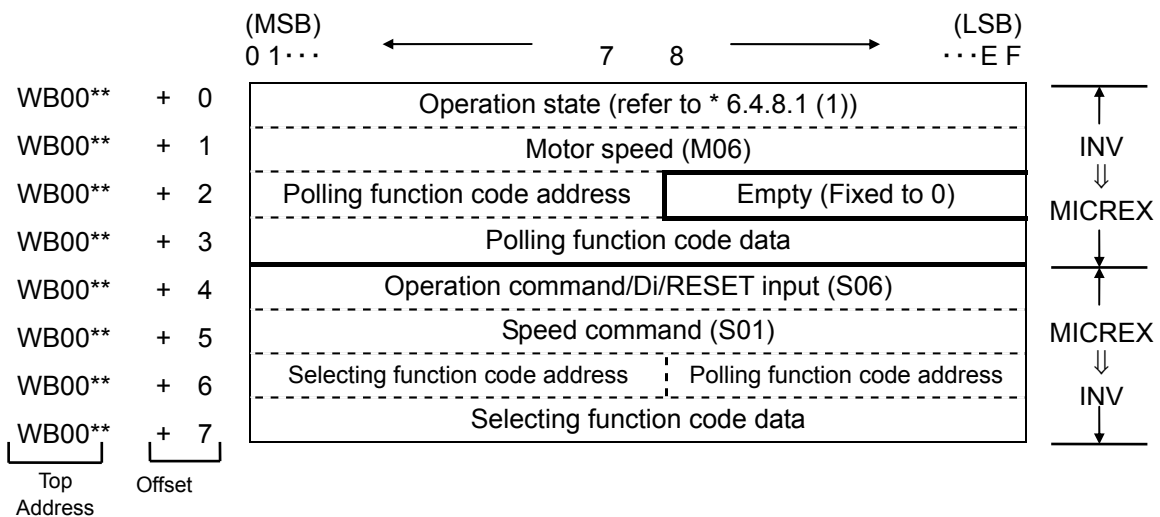
Figure 6.4.11

(2) Format 2 (FRENIC5000VG7, FRENIC-VG format 8W+8W)

		(MSB) 0 1··· 7	8 (LSB) ···E F	
WB00**	+ 0	Polling function code (1)	Polling function code (2)	
WB00**	+ 1	Polling function code (3)	Polling function code (4)	
WB00**	+ 2	Polling function code (1) data		
WB00**	+ 3	Polling function code (2) data		INV ⇓ MICREX
WB00**	+ 4	Polling function code (3) data		
WB00**	+ 5	Polling function code (4) data		
WB00**	+ 6	Motor speed (M06)		
WB00**	+ 7	Operation state (refer to * 6.4.8.1 (1))		
WB00**	+ 8	Selecting function code (1)	Selecting function code (2)	
WB00**	+ 9	Selecting function code (3)	Selecting function code (4)	
WB00**	+ 10	Selecting function code (1) data		
WB00**	+ 11	Selecting function code (2) data		MICREX ⇓ INV
WB00**	+ 12	Selecting function code (3) data		
WB00**	+ 13	Selecting function code (4) data		
WB00**	+ 14	Polling function code (1)	Polling function code (2)	
WB00**	+ 15	Polling function code (3)	Polling function code (4)	

Top Address / Offset

(MSB) 0 1··· ←————— 7   8 —————→ ···E F (LSB)

Figure 6.4.12

6.4.8   Transmission format

6.4.8.1   Data format (FRENIC-VG ⇒ MICREX)

(1)   Operate state (1 for all ON)

(MSB)   (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
BUSY	ERR	'	RL	ALM	DEC	ACC	IL	'	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward   TL   : Torque limiting   RL   : Communication selection
REV : Running reverse   (1: H30=2 or 3)
EXT : DC braking or pre-exciting   IL   : Current limiting
INT : Inverter shutdown   ACC : Accelerating
BRK : Braking   DEC : Decelerating   ERR   : Function code access error
NUV : DC link bus voltage   ALM : Batch failure   BUSY : Writing function code

• ERR is cleared to "0" when selecting (writing) and polling (reading) of the function code has been done correctly. If any of selecting or polling is not performed correctly, ERR is set to "1". The error cause in this case can be checked with the function code M26 (see the table below). When ERR is set to "1", resolve the cause and perform selecting or polling again. If the operation is successful, both of ERR and M26 are cleared to "0".

M26 value (HEX.)	Write/read error
78 (4EH)	Access to unused function code
79 (4FH)	Writing to a read-only function code
	Writing to a function code (during operation) which cannot be changed during operation
	Writing to a function code which cannot be changed with FWD/REV ON.
80 (50H)	Writing out-of-range data

BUSY is set to "1" while writing (processing) data. When writing consecutive data, wait for BUSY to be cleared to "0" and write the next data. A writing request made while this bit is set to "1" is ignored.

(2)   Motor speed

(MSB)   (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
					Motor speed (decimal) x 20000 / maximum speed => 16-bit data										

The maximum speed is set with the function code. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

(3) Polling function code address and data

Format 1

Polling function code address	Empty (Fixed to 0)
Polling function code data	
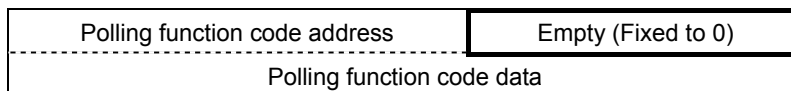
"Polling function code address" (eight bits) stores the link number corresponding to the function code requested for polling from MICREX. Its data is stored in "Polling function code data". Refer to "Function Code List" for the link numbers.

Format 2
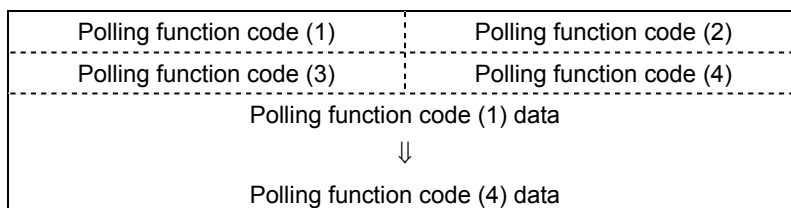
Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)
Polling function code (1) data	
⇓	
Polling function code (4) data	

"Polling function code (1) to (4)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX. Their data are stored in "Polling function code (1) to (4) data".

6.4.8.2 Data format (MICREX ⇒ FRENIC-VG)

(1) Operation command/Di/RESET input (1 for all ON)

(MSB)   (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD
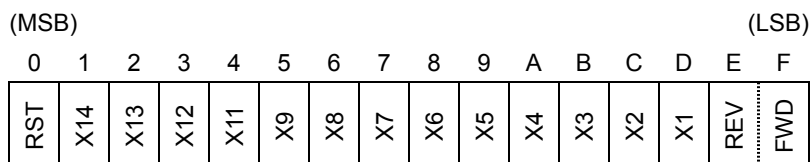
FWD and REV are available when the link command is permitted as instructed in "6.3.9.1 Link Command Permission Selection". X1 to X14 and RST are always available.

(2) Speed command
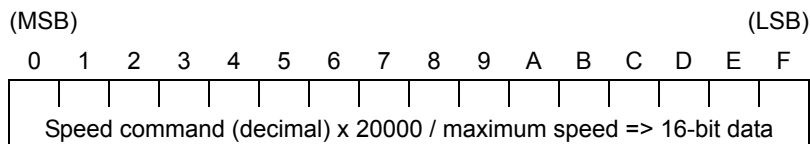
(MSB)   (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Speed command (decimal) x 20000 / maximum speed => 16-bit data															

The above is the same as the motor speed. The maximum speed is set with the function code. Provide the speed value as 16-bit data of the value calculated above. (Handle negative data as a complement of 2.)

(3)   Polling and selecting function code address and selecting function code data

Format 1

(MSB)   (LSB)
```
  0   1                    7   8                    E   F
 ┌─────────────────────────────┬─────────────────────────────┐
 │ Selecting function code address │ Polling function code address │
 ├─────────────────────────────┴─────────────────────────────┤
 │            Selecting function code data                      │
 └─────────────────────────────────────────────────────────────┘
```
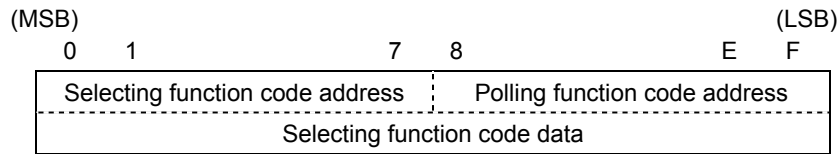
Write the function code data using the "selecting function code address" (8 bits) and "selecting function code data" (16 bits) above. Also, specify the link number corresponding to the function code number requested for polling using the "polling function code address" (8 bits).

Format 2
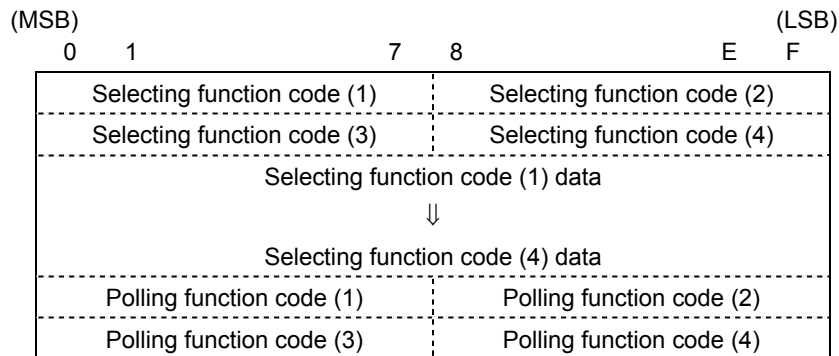
(MSB)   (LSB)
```
  0   1                    7   8                    E   F
 ┌─────────────────────────────┬─────────────────────────────┐
 │ Selecting function code (1)  │ Selecting function code (2)  │
 ├─────────────────────────────┼─────────────────────────────┤
 │ Selecting function code (3)  │ Selecting function code (4)  │
 ├─────────────────────────────┴─────────────────────────────┤
 │          Selecting function code (1) data                    │
 │                        ⇓                                     │
 │          Selecting function code (4) data                    │
 ├─────────────────────────────┬─────────────────────────────┤
 │ Polling function code (1)    │ Polling function code (2)    │
 ├─────────────────────────────┼─────────────────────────────┤
 │ Polling function code (3)    │ Polling function code (4)    │
 └─────────────────────────────┴─────────────────────────────┘
```

"Selecting function code (1) to (4)" (eight bits each) store the link number corresponding to the function code selected by MICREX. Write the data to "Selecting function code (1) to (4) data".

Note: Upon selecting, be sure to write the link number and data together.

Use the "polling function code (1) to (4)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

Selecting is available when editing links is permitted in "6.4.9.2 Link Edit Permission Selection". Pay attention to writing limitation including changing not available during operation.

Chap. 6

CONTROL OPTIONS

6.4.9 Link function

Use the function code H30 and X function "24: Link Operation Selection [LE]" to switch the command data (S area) target (REM/LOC/COM). Also refer to the control block diagram in Chapter 4.

Use the function code H29 and X function "23: Link Edit Permission Command [WE-LK]" to control writing of the function codes (F, E, C, P, H, A, o, U) from the link. Also refer to the control block diagram in Chapter 4.

6.4.9.1 Link command permission selection

<u>**Link Switch**</u>

By assigning "24: Link Operation Selection [LE]" to the X function input terminal, the mode is switched as shown below.

Table 6.4.6

Link operation selection signal assignment	Corresponding input terminal	Status
Not assigned	-	Link command permission mode
Assigned	ON	Link command permission mode
	OFF	Link command prohibition mode

In the link command prohibition mode, command data and operation data can be written from a link but <u>the data will not be reflected</u>. You can set data in advance in the link command prohibition mode, and then switch to the link command permission mode to reflect the data.

<u>Link Command</u>

In the link command permission mode, use the function code H30 (link function) to switch the command data and operation command between link (COM) and remote/local. REM (remote: terminal block) and LOC (local: touch panel) are shown here.

Table 6.4.7

H30 value	Link command permission mode		Link command prohibition mode
	Command data (S01 to S05, S08 to S12)	Operation command (FWD and REV)	
0	Link prohibited (REM/LOC)	Link prohibited (REM/LOC)	Link prohibited (REM/LOC)
1	Link permitted (COM)	Link prohibited (REM/LOC)	
2	Link prohibited (REM/LOC)	Link permitted (COM)	
3	Link permitted (COM)	Link permitted (COM)	

This functionality allows for flexible system construction where you can give operation commands from terminal block and speed command via communication.

6.4.9.2   Link edit permission selection

Link Edit Switch

By assigning "23: Link Edit Permission Command [WE-LK]" to the X function input terminal, you can protect the function code (F, E, C, P, H, A, o, U) from being written as shown below.

Table 6.4.8

Link edit permission command assignment	Corresponding input terminal	Status
Not assigned	-	Link edit permission mode (F to U can be written)
Assigned	ON	
	OFF	Link edit prohibition mode (F to U cannot be written)

Link Edit

With the function code H29, you can control writing to the function code (F, E, C, P, H, A, o, U) in the link edit permission mode.

Table 6.4.9

H29 data	Link edit permission mode	Link edit prohibition mode
0	Code (F, E, C, P, H, A, o, U) can be written	Code (F, E, C, P, H, A, o, U) cannot be written
1	Code (F, E, C, P, H, A, o, U) cannot be written	

6.4.9.3   Data transmission example

The following explains a data transmission example using the transmission format.

(1)   Speed setting

From MICREX, give commands to run forward (FWD) at 785 r/min.
(Condition: Function code H30 "Link Operation"=3, maximum speed 1500 r/min, T-Link station address: 10, 8+8 words)

Give S06 the forward running command (FWD: ON) and S01 the speed command.

WB18	0	6	0	1	Function code S06, S01 selecting (link No. 06h, 01h)
19	0	0	0	0	Selecting dummy data
20	0	0	0	1	Function code S06 FWD: ON
21	2	8	E	3	Function code 01 Speed setting 785/1500×20000＝10467＝28E3 (h)
	↓				After acceleration completes
WB16	2	8	E	3	Monitor the motor speed.

(2) Torque command monitor

Monitor the torque command value from MICREX.
(Condition: T-Link station address: 24, 8+8 words)

WB38	1	0	0	0
39	0	0	0	0

Torque command value monitor (link No. 10h)

↓   After read completes

WB24	1	0	0	0
25	0	0	0	0
26	1	3	8	8
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0

When the link number requesting polling is returned to this area, reading is completed.

Torque command value monitor data

1388 (h) × 100 (%) / 10000＝50 (%)

↓

From the above, the torque command value is "50% of drive".

(3) Function code data setting

Set the function code S08 "Acceleration time" to 30.5 seconds from MICREX.
(Condition: T-Link station address: 58, 4+4 words)

WB62	0	0	0	0
63	0	0	0	0
64	0	8	0	8
65	0	1	3	1

Function code S08 selecting (Link No. 08h)

131 (h) ＝305,305×0.1s＝30.5s

Poll the function code S08 to confirm setting completion.

↓After writing completes

WB58	*	*	*	*
59	*	*	*	*
60	0	8	0	0
61	0	1	3	1

Poll the function code S08.

131 (h) ＝305,305×0.1s＝30.5s

(Data is correctly set.)

(4) Toggle monitor

Monitor data toggling between MICREX and the inverter. This example set the X12 terminal to TGL1 and X13 terminal to TGL2. (*1)

Set E11=72 (TGL1), E12=73 (TGL2), H30=3, H144=0.10 (100 ms) in advance.

This sets

transmission toggle (MICREX→VG1): %QW254.0.10.13 bit 12 = TGL1 and bit 13 = TGL2.

The inverter monitors the toggle pattern sent from MICREX while the operation command is ON, and generates the toggle error $\mathit{Rr\text{-}F}$ if the toggle signal cannot be received within the time specified with H144.

*1 For the details of the toggle, refer to E01 to E13 toggle signal explanation in Chapter 4, Section 4.3 "Details of Function Codes."

*2 By setting the inverter function code H107, the inverter can continue operation with $\mathit{L\text{-}RL}$ display. Refer to the description of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

%QW254.0.10.13 | * | 0 | 0 | 0 | Send 0→1→2→3→0 to * ・・・ (toggle pattern)

↓ After sending toggle

%QW254.0.10.13 | * | 0 | 0 | 1 | Operation command (FWD)=ON

Note: If the network error $\mathit{Er\text{-}4}$ (light and heavy alarm 1) occurs while sending the toggle pattern, the toggle error $\mathit{Rr\text{-}F}$ may occur after the communication recovers. To avoid the toggle error $\mathit{Rr\text{-}F}$, stop sending the toggle pattern while the network error $\mathit{Er\text{-}4}$ is occurring.

Chap. 6 CONTROL OPTIONS

6-73

6.5 SX Bus Interface Card OPC-VG1-SX

6.5.1 Product overview

Use this option to control FRENIC-VG using the Fuji programmable logic controller MICREX-SX via the SX bus.

<u>Main Usage</u>

Using this option, you can:

- Input signals to start or stop operation, etc.: FWD, REV, X1 - X9, X11 - X14, RST
- Set the speed commands: 16-bit binary data
- Monitor the operation status (bit data)

  Running forward, running reverse, during DC braking or pre-exciting, inverter shutdown, braking, DC link bus voltage established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay output, remote/local, write error from T-link, and data writing in progress

- Monitor motor speed; 16-bit binary data
- Monitor the operation status (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)
- Reference and change function codes
- Monitor that the upper-level device and inverter are interoperating normally using the toggle monitor control.
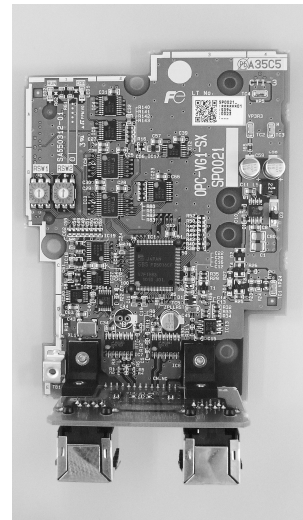
Function codes which can be accessed using this option are limited. For details, refer to "4.2 Function Code List" in Chapter 4.

6.5.2 Model and specifications

6.5.2.1 Inverter type

Model elements: OPC-<u>VG1</u>-<u>SX</u>

```
            Name of equipped inverter VG1 → FRENIC-VG
            Option name: SX→SX bus interface card
```
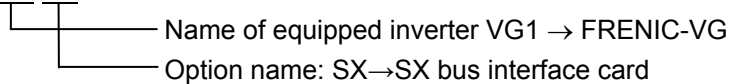
<u>Accessories</u>

Spacer   x 4
M3 screw   x 2

6.5.2.2   Specifications

```
⚠CAUTION
```

・	The system will not operate correctly if the switches (RSW1 and RSW2) on this option are not set properly. Read the instruction below and set them accordingly.
・	Be sure to power off the inverter before setting the switches (RSW1 and RSW2) on this option.

Table 6.5.1   Hardware Specifications

Item	Specifications
Name	SX Bus Interface Option
Transmission specifications	SX-bus slave, I/O transmission
Transmission speed	25 Mbps
Number of words occupied in transmission	Selected by the function code U11 "Transmission format selection" U11=0: Standard format (16 words 8W+8W) U11=1: UPAC compatible format (51 words 29W+22W) U11=2: Monitoring format (16 words 4W+12W) U11=3: Standard format 2 (set by 485No) (16 words 8W+8W)
Terminal/bus cable	IN, OUT/SX bus dedicated cable *NP1C-P3(0.3 m) to NP1C-25(25 m)
Rotary switches RSW1, 2	Station address setting. You can assign any station address from 1 to 238.
Status display LED RUN, ERR	Displays the status of the self station (operation and error) with LEDs.

(1) Rotary switches RSW1 and RSW2

Set the station address using the rotary switches RSW1 and RSW2 on the option board. In the hexadecimal display, "RSW1" represents the upper 4 bits and "RSW2" represents the lower 4 bits. For the SX bus station address, read it in decimal values.

Example) Station address 194 is C2(h) and set RSW1=C and RSW2=2.

RSW1 : Upper 4 bits
RSW2 : Lower 4 bits

RSW1   RSW2
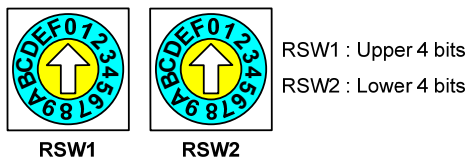
Figure 6.5.1

*   Set the same SX bus station address set in the MICREX-SX system definition. Since the address assigned by MICREX-SX is used as the actual SX bus station address, it may be different from the setting value of this rotary switch. (You can check the address with the function code U13 "SX bus station address monitor".)

*   When two or more cards are used, do not allocate the same SX bus station address to multiple stations.

*   The factory default is RSW1=0 and RSW2=0 (address = 00).

*   The RSW1 and RSW2 settings are recognized upon "power on" and "reset" of the SX bus (MICREX-SX).

*   When RSW1=0 and RSW2=0 (station address＝00) are set, communication is only possible when there is no degenerate system start-up. (If there is degenerate system start-up, MICREX-SX will encounter a heavy alarm and the address specified in the system definition of MICREX-SX is used.)

*   Even while the SX bus communication is established, and if a slave with an address duplicated with another slave on the SX bus is connected, the slave which has already established communication does not encounter an error and continues operation.

2) Status display LED <u>RUN, ERR</u>

The RUN and ERR LEDs on the option board display the status of the self station (operation and error). Since the option itself determines the status as a slave, the status may be different from RUN and ALM shown on the CPU of MICREX-SX.

Table 6.5.2   LED Display

RUN   **ERR**

Figure 6.5.2

LED States	RUN	ERR
ON	・ Link established 　(Light alarm if ERR is on)	・ Error (light or heavy alarm) is occurring
Flashing	・ Initial wait status ・ Inverter power OFF	–
OFF	・ SX bus power OFF ・ self station being reset 　(Heavy alarm if ERR is ON)	・ Link established ・ SX bus power OFF ・ Inverter being reset

Table 6.5.3   Software Specifications

Item		Specifications
Data update interval Note		Min. 400 μs
Operation	Run command	Running forward/reverse alarm reset, X1-X14 commands
	Speed command	16-bit binary data
	Operation state output	Bit data for operating, braking, torque limiting, alarm relay output signals, etc.
		Word data for motor speed, torque current command, etc.
Function code		You can reference and change the 255 functions assigned to the link numbers in the function code list.
		You can reference and change the function code with 485No. if the standard format 2 transmission format is selected.
Optional function code		o30, o31, U01 - 11, U13, U60 - 64
Protective Function		Er-4: Network failure (SX bus error)
		Light alarm*1: o30 and o31 can be used to control the Er-4 alarm.
		Heavy alarm *2: Momentary alarm
		Ai-F : Toggle error
		Monitors the 2-bit signals for the toggle signal 1 [TGL1] and toggle signal 2 [TGL2] sent from PLC, and generates this error if these the specified change pattern cannot be received within the time specified by H144. *3

*1   Light alarm: E.g., Signal noise. If the noise is not frequent, the Er-4 alarm can be controlled by o30 and o31 to continue operation.

*2   Heavy alarm: Fatal failure such as hardware failure.

*3   For the details of the toggle signals and toggle error, refer to TGL1 and TGL2 in E01 to E13 toggle signal explanation in "4.3 Function Code Details".

Note: The data update frequency depends on the carrier frequency setting, MICREX-SX SX bus tact frequency, and application program task frequency.

6.5.3 External Dimensions

90.5

45. 1

134

(Unit: mm)
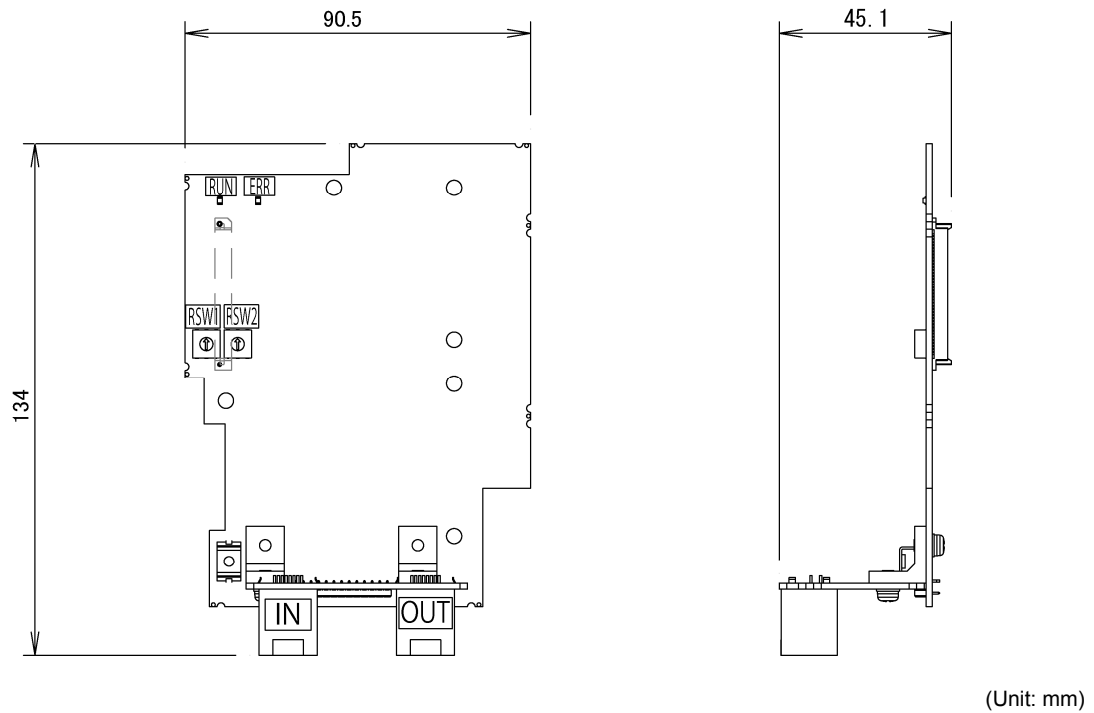
Figure 6.5.3 Option Print Board External Dimensions

■**Connectors CN2, CN3**

RUN ERR

RSW1 RSW2

OPC-VG1-SX

FG
(Do not connect.)

IN OUT

White Orange
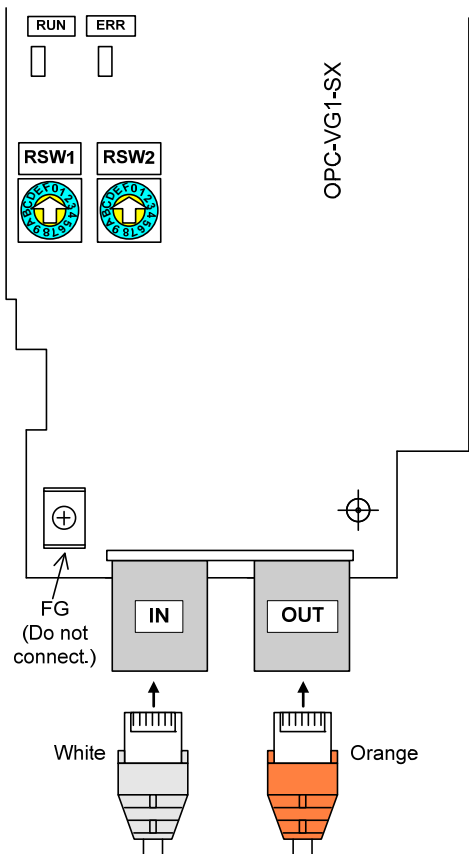
* FG terminal connection is not necessary. Do not connect it. Refer to "6.1.4 Installing internal options (OPC-VG1-□□)" before connecting the cables.

* This option print board does not include the SX bus cable (dedicated) and terminating connector. Prepare a cable for the bus connection distance. If the option is used at both ends of the SX bus, connect the terminating connector to one of the connector end. The terminating connector is supplied with the CPU module of MICREX-SX.

Figure 6.5.4

6.5.4 Basic connection diagram

Refer to "6.1.4 Installing internal options (OPC-VG1-□□)" before connecting the cables.

⚠WARNING
・ Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock.   ・ Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.   ・ Since the SX bus is powered from the PLC power supply module, ensure that the MICREX-SX and inverter power supplies are off when installing or removing this option.

⚠CAUTION
・ Do not use the product that is damaged or lacking parts to prevent an injury or damage.   ・ Incorrect handling in installation/removal jobs could result in a broken product.

The basic connection diagram is shown on the next page. When connecting the cables, observe the following precautions.

[Notes on connection]

(1) Be sure to use SX-bus dedicated cables.

Model: NP1C-P3 (0.3 m) to NP1C-25 (25 m)

Refer to the manual of MICREX-SX (hardware) for the cable specifications.

(2) Before proceeding with connection, make sure that both the MICREX-SX and the inverter are powered OFF.

(3) Put the terminating connectors (that come with the CPU module of the MICREX-SX) in both ends of the SX bus.

(4) To prevent an error due to noises, keep the SX bus cable apart from the main circuit cables of the inverter and other power cables as apart as possible (30 cm or more) and never put it in the same duct.

(5) One end of the SX-bus cable should be connected with the OUT connector on the base board, and the other end, with the IN connector. The OUT-OUT or IN-IN connection does not enable communication and the system does not operate. Route SX-bus cables so that the bending radius is at least 50 mm.

Terminating connector

IN

OUT

SX bus dedicated cable

OPC-VG1-SX

IN   OUT

Terminating connector

Figure 6.5.5

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Basic Connection Diagram

Figure 6.5.6

Note) Restrictions on system configuration

(1) Total length of SX bus cable
Keep the entire length of the SX extension cable within 25m.
(2) Number of inverters connected in series
If the serial connection is terminated by the base with the power supply module, up to 10 inverters counted from the base can be connected in series.
If each inverter is connected to the IN/OUT connector of a single base, up to 10 inverters can be connected in series for each connector.

6.5.5   Function code

⚠ WARNING
· Incorrect function code data may result in a dangerous situation. After setting and writing the data, check it again. **An accident could occur.**

In addition to the standard function code, you can set the optional dedicated function codes o30, o31, U01- 11, U13, U60 - 64.

Table 6.5.4

No.	Function code name		Setting range	Description
	Name	Keypad display		
H30	Link function	LINK FUNC	0 to 3	3: Set the operation command and command data valid via SX.
o30 *1	Error processing after detection of transmission failure	MODE ON ER	0	Immediately force operation to stop upon communication error (light alarm) occurrence ($Er\text{-}4$ alarm: coast to stop).
			1	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop after the timer time ($Er\text{-}4$ alarm: coast to stop). If the communication recovers during the timer time, the command received in communication is run. But, operation is forced to stop it the error persists after the timer time.
			2	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop if the communication error persists after the timer time. If the communication recovers during the timer time, the command received in communication is run.
			3	No alarm ($Er\text{-}4$) even when a communication error (light alarm) occurs. The run command from the previous communication is held in the communication error state. If the communication recovers, the command received in communication is run.
o31 *1	Operation time after detection of transmission failure	TIMER TL	0.01 - 20.00s	Operation time timer value [s] for a communication error (light alarm) is effective when o30=1 or 2.
U01 - 10	Universal data	USER P01 - 10	-32768 to 32767	You can read and write data as universal data via communication without affecting the inverter.
U11	SX transmission format selection	USER P11	0	Standard format selection Occupied words: 16 words (8W+8W)
			1	UPAC compatible format selection Occupied words: 51 words (29W+22W)
			2	Monitoring format selection Occupied words: 16 words (4W+12W)
			3	Standard format 2 (485No) selection Occupied words: 16 words (8W+8W)
			4-15	Reserved
U13	SX bus station address monitor	USER P13	1 to 238	You can check the SX bus station address of the self station assigned by MICREX-SX in the system configuration definition with this function code. Read-only
U60	U-Ai/ pulse data monitor selection	USER P60	0	Defines U61 - U63 as the user function codes or universal Ai monitor.
			1	Defines U61 to U63 as pulse data monitor.

No.	Function code name		Setting range	Description
	Name	Keypad display		
U61	U-Ai1/ Pulse train position command monitor	USER P61	-32768 to 32767	When U-Ai1 is selected: Universal Ai1(±16384/±10V) can be monitored.
				When pulse data is selected: Pulse train position command (PG(PR) input) data can be monitored.
U62	U-Ai2/ Position detection monitor	USER P62	-32768 to 32767	When U-Ai2 is selected: Universal Ai2(±16384/±10V) can be monitored.
				When pulse data is selected: Position detection (internal or PG(PD) input) data can be monitored.
U63	U-Ai3/ Position detection (Z-phase input) monitor	USER P63	-32768 to 32767	When U-Ai3 is selected: Universal Ai3(±16384/±10V) can be monitored.
				When pulse data is selected: Position detection (PG(PD) Z-phase input) data can be monitored.
U64	U-Ai4/ USER function code	USER P64	-32768 to 32767	When U-Ai4 is selected: Universal Ai4(±16384/±10V) can be monitored. If U-Ai is not defined, it acts as the user function code to read and write data as universal data without affecting the inverter operation.
H107	Light alarm target definition 2	L-ALM 2	0000 to 1111	Select the alarm operation upon occurrence of a SX bus error (Er-4) and toggle error (Ai-F). Er-4 and Ai-F represent the number of hundreds and the number of units, respectively. 0 in the corresponding decimal place: Alarm occurrence, 1: Light alarm (L-AL)
E10 | E13	Select X11 - X14 function.	X11 ~ X14 FUNC	*2	Select the command when each of the X11 to X14 bits is 1. To perform toggle monitoring with the X terminal bits, set TGL1 and TGL2 for two of the terminals.
o160 *3	Function code monitor (1) setting		0000h - FFFFh	Only available when the standard format 2 is used. Sets the function code continuously monitored by the function code monitor (1) with 485No.
o161 *3	Function code monitor (2) setting		0000h - FFFFh	Only available when the standard format 2 is used. Sets the function code continuously monitored by the function code monitor (2) with 485No.

*1   For the details of o30 and o31, refer to "6.5.6.2 Protective operation function code".

*2   For the details, refer to "4.3 Function Code Details".

*3   For the details of o160 and o161, refer to "6.5.8.1 (4) ② Function code monitor".

*4   For the details of user function code, refer to "6.5.5.1 Function code".

・   For other function codes, refer to Chapter 4.

6.5.5.1   Function code

U01 - U10	USER P01 - P10

You can read and write data as universal data via communication without affecting the inverter.

You can read values set with the keypad of the inverter (local) from MICREX-SX (remote), or check values set with the MICREX-SX with the keypad. The set value does not affect the inverter operation at all.

U11	SX transmission format

Select the transmission format used to communicate on the SX bus. Be sure to select the same format as specified in the CPU system configuration definition.

Setting range 0: Standard format (specified with the link No.) (8W+8W)

1: UPAC compatible format (29W+22W)

2: Monitoring format (4W+12W)

3: Standard format 2 (specified with 485No) (8W+8W)

4 - 15: Reserved

Note: When the T-Link interface option is also installed, the transmission format is fixed to the monitoring format and the U11 value is automatically changed to "2". However, be sure to set U11=2 for safety.

U13	SX bus station address monitor

You can check the SX bus station address of the self station assigned by MICREX-SX in the system configuration definition with this function code. (read-only). Be sure that the address is same as the one set with the rotary switches RSW1 and RSW2.

Note: This function code displays the station address in decimal. When configuring the station address with the station address switches, assign it in hexadecimal.

U60	U-Ai/pulse data monitor selection

Select whether the function codes U61 - U63 can monitor the U-Ai (universal Ai) or pulse data. U64 is excluded from pulse data monitoring.

The default value is U60=0 and the U-Ai function is not selected, and U61 to U64 all act as the user function codes. When U61 to U64 are set for monitoring (rather than as the user function codes), do not write data to them.

① When U60=0

U-Ai function is selected	U61	U62	U63	U64
Not selected	User function code	User function code	User function code	User function code
Selected	U-Ai1 monitor	U-Ai2 monitor	U-Ai3 monitor	U-Ai4 monitor

② When U60=1

U-Ai function is selected	U61	U62	U63	U64
Not selected	Pulse train position command (PG(PR) input) monitor	Position detection (internal or PG(PD) input) monitor	Position detection (PG(PD) Z-phase input) monitor	User function code
Selected				U-Ai4 monitor

・ When the U-Ai function is selected, the universal Ai (U-AI) is selected with Ai function selection (E49-E52).
・ U-Ai3 and U-Ai4 are only valid when OPC-VG1-AIO or OPC-VG1-AI is installed.

U61 - U63	U-Ai/pulse data monitor

U64	USER function code/U-Ai4

Data selected by the setting of the function code U60 and Ai function selection is allocated.

Specifications of each data are explained below.

① USER function code

Similar to U01 to U10, you can read and write data as universal data via communication without affecting the inverter.

② U-Ai (universal Ai)

You can read the analog quantity of a signal input to the Ai terminal of the inverter via the SX bus. When using this function, set the corresponding Ai terminal function to U-AI using the function codes E49-E52. This input data is simply provided to check existence of a signal via the SX bus, and does not affect the inverter operation at all.

Note: If you change the Ai terminal function to other than U-AI while U-Ai is used, U61 to U64 hold the values before change.

③ Pulse data

You can monitor pulse data when controlling synchronization and position with the pulse train.

Block Diagram Related to Pulse Data
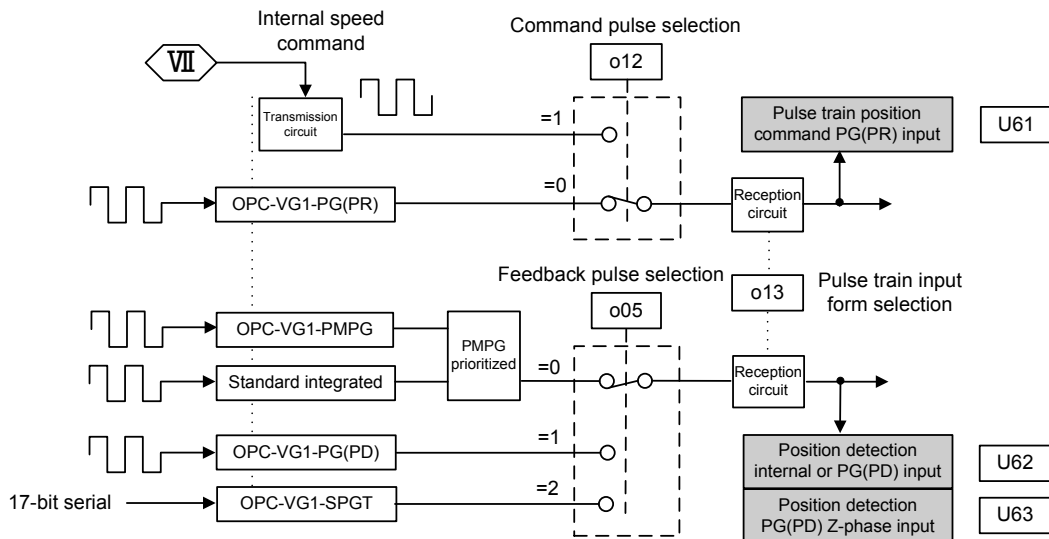
Note: Detection of the Z-phase standard position is enabled only when the OPC-VG1-PG (PD) option is installed. If this PG is selected while this option is not installed or the o05 feedback pulse is selected, the monitor data of U62 and U63 cannot be referenced.

Figure 6.5.7

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<u>*How to obtain pulse data</u>

The PG pulse data is incremented in B-phase forward (running forward) and decremented in A-phase forward (running backward). Therefore, obtain the difference of data sampled this time and last time for the t (ms) task, and add it for every t (ms) to calculate the pulse count value. As the pulse count value is obtained by multiplying the encoder value by four, the formula is "<u>4×encoder pulse count／revolution</u>".
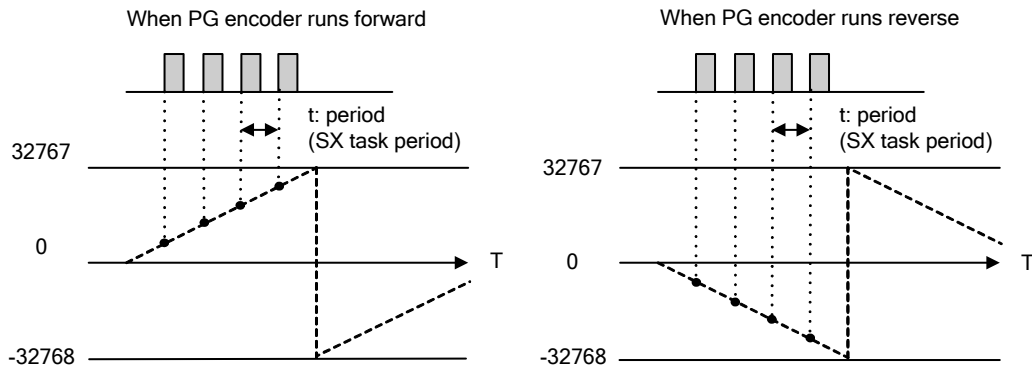
Figure 6.5.8

<u>*How to detect Z phase</u>

The PG pulse can be obtained as mentioned above. However, with differences of the U62 "Position detection (internal or PG(PD) input monitor" and U63 "Position detection (Z-phase input) (PG(PD) monitor" within a task as PG_CNT and PG_CNT_Z respectively, the added data within the task period (tms) is cleared to 0 by hardware Z-phase detection as shown in the figure below. By comparing each memory within the next task, Z phase is detected if they do not match.
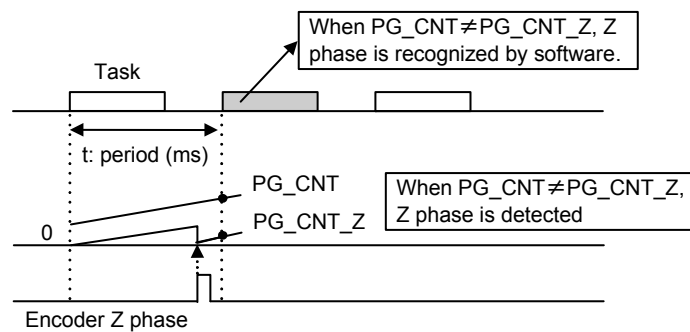
Figure 6.5.9

Note: Detection of the Z-phase standard position is enabled only when the OPC-VG1-PG (PD) option is installed. If this PG is selected while this option is not installed or the o05 feedback pulse is selected, the monitor data of U63 cannot be referenced.

6.5.6   Protective operation

6.5.6.1   Light and heavy alarms

The SX bus option can encounter light and heavy alarms depending on the failure level.

Upon occurrence of this failure, the inverter outputs Er-4 "network error" and the motor coasts to stop.

Table 6.5.5

Item	Light alarm	Heavy alarm 1	Heavy alarm 2
Card LED States	ERR ■ (ON) RUN ■ (ON)	ERR ■ (ON) RUN ■ (ON)	Undefined
Cause	• Communication data error due to noises on the communication line, etc.	• All masters go down • Disconnection detected • SX bus power down	• Option hardware failure • Option installation failure
Reset method *1	Resolve the cause (or wait for communication recovery) and give a reset command (keypad, RST, or remote reset).		Resolve the alarm cause and power cycle the inverter.
Failure state control	Alarm is only detected while operation commands are given via the SX bus.		
	Alarms can be controlled with the function codes o30 and o31.	An Er-4 alarm immediately occurs upon heavy alarm.	
Communication error code displayed on keypad *2	1	2	3
Alarm sub code *3	1 (hex)	2 (hex)	4 (hex)

*1   "Give a reset command" means supplying a reset input to the inverter in one of the following methods.

   * Keypad (RESET) key input

   * Assign the failure reset RST with the X function selection and digitally input the command.

   * Input the reset command via the communication line.

   For a heavy alarm, the CPU may also require reset depending on the CPU state of MICREX-SX.

*2   You can check the communication error code for light and heavy alarms on the communication state screen of the maintenance information on the keypad. To access this screen, press the (PRG) key to return to the menu screen, and move the arrow on the left edge of the screen to "5. Maintenance" using the (∧)/(∨) key, then press the (FUNC DATA) key. Press the (∨) key three times to show the screen below. Note that this error code displays the first cause for Er-4. Since every heavy alarm 1 is preceded with a light alarm, this code shows the light alarm even for a heavy alarm 1 when o30=0.

```
N R K = × × × × ×
N R R = × × × × ×   × ×
N R O = × × × × ×   × x ←
N R L = × × × × ×   × ×
∧ V → P A G E  S H I F T   4
```
-: No communication error
1: Light alarm
2: Heavy alarm 1
3: Heavy alarm 2
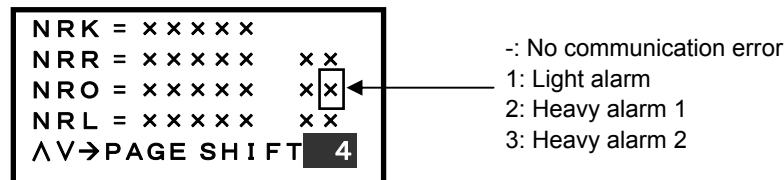
Figure 6.5.10

*3 You can check the Er-4 alarm sub code on the alarm history selection of the alarm information on the keypad. To access this screen, press the (PRG) key to return to the menu screen, and move the arrow on the left edge of the screen to "7. Alarm information" using the ⌃/⌄ key, then press the (FUNC/DATA) key. On the latest and last three alarm history item screen, select an item you are interested in, press the (FUNC/DATA) key, and then press the ⌃ key once to show the screen below. Note that this error code displays the first cause for Er-4. Since every heavy alarm 1 is preceded with a light alarm, this code shows the light alarm even for a heavy alarm 1 when o30=0.

```
SUB = × × × ×
AL = Er4   AL = × × ×
AL = × × ×   AL = × × ×

∧∨→PAGE SHIFT 2 3
```

1: Light alarm
2: Heavy alarm 1
4: Heavy alarm 2
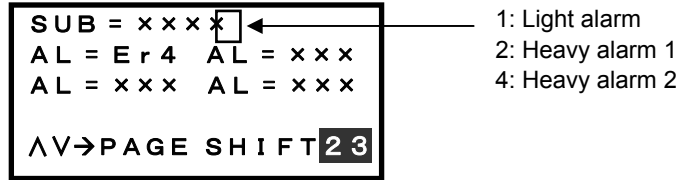
Figure 6.5.11   Alarm Subcode Confirmation Screen

6.5.6.2 Protective operation function code

The following explains how to control the Er-4 alarm when a light alarm occurs while an operation command is given from MICREX-SX via the SX bus.

[Operation Description]

The following describes an example of operation when operation and speed commands are given from MICREX-SX and a communication error occurs during operation.

*1 During this period of time, if communication recovers and new commands or settings are not sent, commands (for operation or speed, or both) received upon error occurrence are held.

(1) When function code o30 = 0
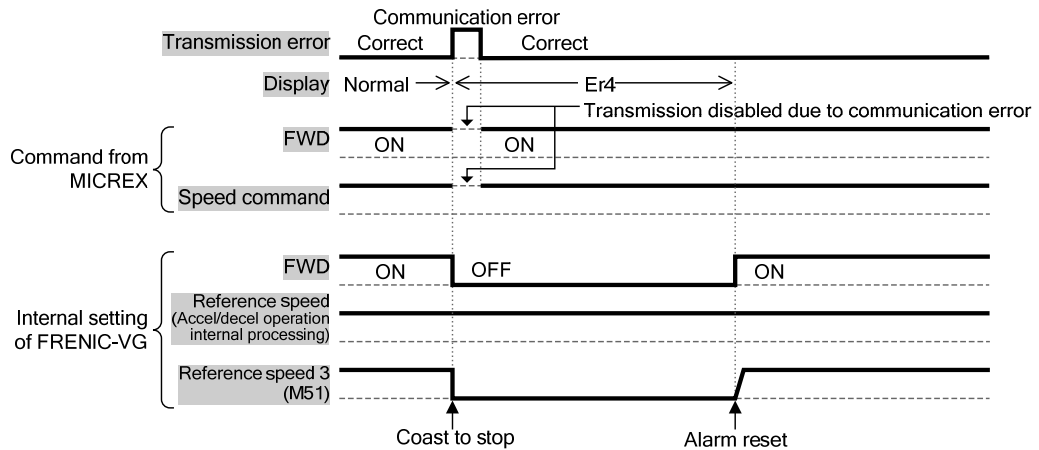
Figure 6.5.12

(2) When function code o30 = 1 and o31 = 5.0 (when a communication error occurs, the motor coasts to stop in five seconds.)

Figure 6.5.13

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(3) When function code o30 = 2 and o31 = 5.0

(the communication error persists in five seconds after its occurrence and the $Er-4$ alarm occurs)

Communication error

| Transmission error | Correct | | Correct |

Display — Normal — Er4

Command from MICREX
- FWD — ON — ON
- Speed command

5.00 s *1

Internal setting of FRENIC-VG
- FWD — ON — OFF — ON
- Reference speed (Accel/decel operation internal processing)
- Reference speed 3 (M51) — Coast to stop

Accelerates to the speed specified by the command even if a transmission error occurs during acceleration.

Alarm reset
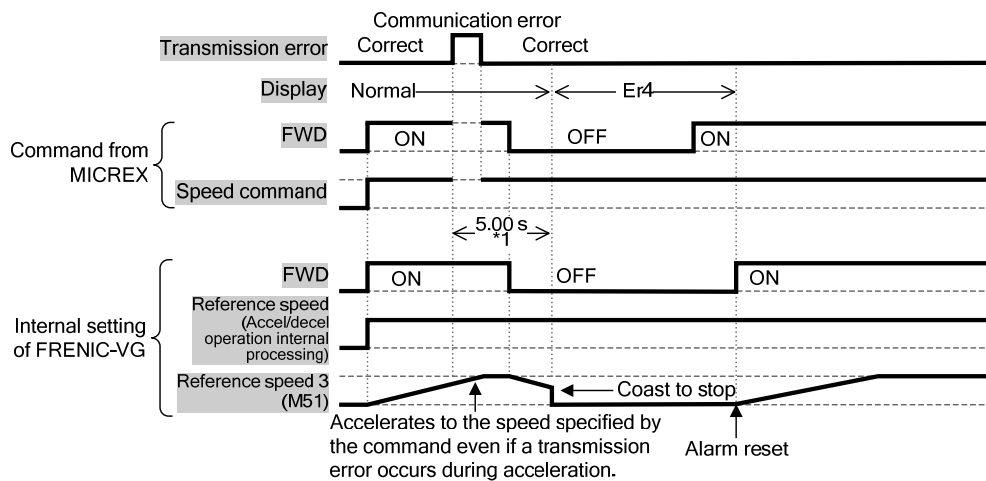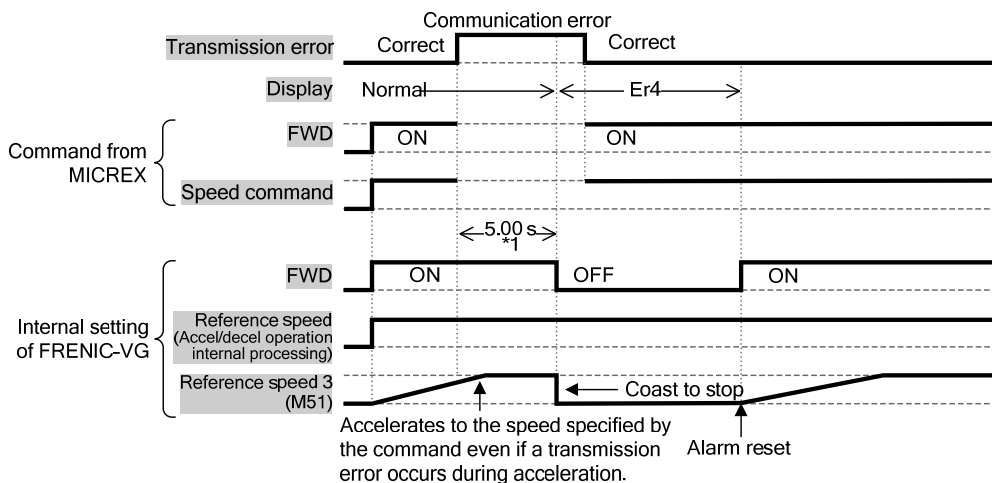
Figure 6.5.14

(4) When function code o30 = 2 and o31 = 5.0 (a communication error occurs and the communication recovers in five seconds)

Communication error

| Transmission error | Correct | | Correct |

Display — Normal

Command from MICREX
- FWD — ON — OFF
- Speed command

5.00 s *1

Internal setting of FRENIC-VG
- FWD — ON
- Reference speed 3 (M51)

Accelerates to the speed specified by the command even if a transmission error occurs during acceleration.
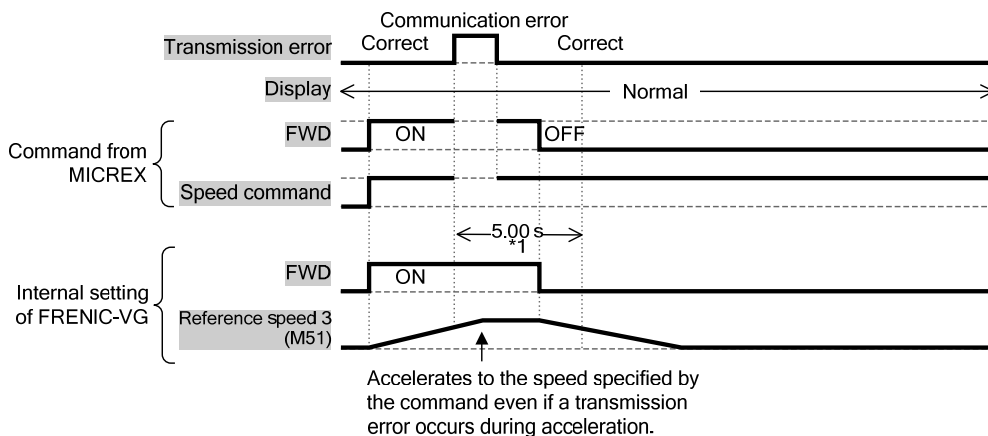
Figure 6.5.15

(5) When function code o30 = 3

Communication error

| Transmission error | Correct | | Correct |

Display — Normal

Command from MICREX
- FWD — ON — ON
- Speed command

*1

Internal setting of FRENIC-VG
- FWD — ON
- Reference speed (Accel/decel operation internal processing)

Continue operation with the setting upon transmission error held.
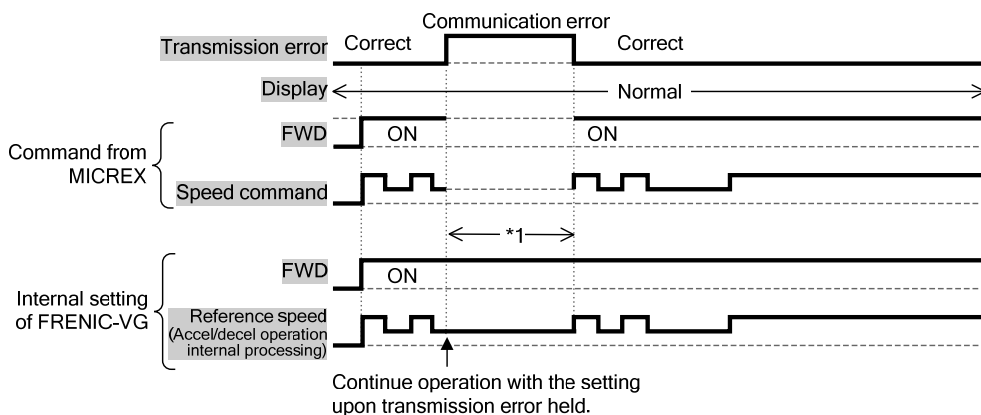
Figure 6.5.16

6.5.7   Data allocation addresses

6.5.7.1   Transmission format

One the following four transmission formats can be selected by the function code U11 "SX bus transmission format selection".

(1)   Standard format (U11=0)

This is the basic format which allows for monitoring of the motor speed and operation status as well as read and write of four function codes for each (specified by the link No.).

(2)   UPAC compatible format (U11=1)

This format provides the control variables which can be used for the UPAC option card (OPC-VG1-UPAC) as fixed frame. Two function codes can be read and written for each.

(3)   Monitoring format (U11=2)

This format is dedicated for monitoring and eight function codes can be read, but not be written.

(4)   Standard format 2 (U11=3)

This is the basic format which allows for monitoring of the motor speed and operation status as well as read and write of two function codes for each (specified by the 485No).

6.5.7.2   Area occupied and data allocation addresses

(1)   Standard format (specified by link No.)

When the standard format is selected (U11=0), as shown in the figure below, out of the I/Q area of the MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 8 words are used for read and upper 8 words are used for write.

Figure 6.5.17

```
                    (MSB)                                    (LSB)
                    15 14 …                    8   7              … 1 0
%IW***.  0   ┌─────────────────────────┬─────────────────────────┐   ↑
             │ Polling function code (1)│ Polling function code (2)│   │
%IW***.  1   ├─────────────────────────┼─────────────────────────┤   │
             │ Polling function code (3)│ Polling function code (4)│   │
%IW***.  2   ├─────────────────────────┴─────────────────────────┤
             │         Polling function code (1) data            │  FRENIC-VG
%IW***.  3   ├───────────────────────────────────────────────────┤
             │         Polling function code (2) data            │    ⇓
%IW***.  4   ├───────────────────────────────────────────────────┤
             │         Polling function code (3) data            │  MICREX-SX
%IW***.  5   ├───────────────────────────────────────────────────┤
             │         Polling function code (4) data            │    │
%IW***.  6   ├───────────────────────────────────────────────────┤    │
             │                Motor speed (M06)                  │   │
%IW***.  7   ├───────────────────────────────────────────────────┤   ↓
             │     Operation state (refer to * 6.5.8.1 (1))      │
%QW***.  8   ├─────────────────────────┬─────────────────────────┤   ↑
             │Selecting function code (1)│Selecting function code (2)│  │
%QW***.  9   ├─────────────────────────┼─────────────────────────┤   │
             │Selecting function code (3)│Selecting function code (4)│  │
%QW***. 10   ├─────────────────────────┴─────────────────────────┤
             │        Selecting function code (1) data           │  MICREX-SX
%QW***. 11   ├───────────────────────────────────────────────────┤
             │        Selecting function code (2) data           │    ⇓
%QW***. 12   ├───────────────────────────────────────────────────┤
             │        Selecting function code (3) data           │  FRENIC-VG
%QW***. 13   ├───────────────────────────────────────────────────┤
             │        Selecting function code (4) data           │    │
%QW***. 14   ├─────────────────────────┬─────────────────────────┤    │
             │ Polling function code (1)│ Polling function code (2)│   │
%QW***. 15   ├─────────────────────────┼─────────────────────────┤   ↓
             │ Polling function code (3)│ Polling function code (4)│
             └─────────────────────────┴─────────────────────────┘
```

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.18

(2) UPAC compatible format

When the UPAC compatible format is selected (U11=1), as shown in the figure below, out of the I/Q area of the MICREX-SX, 51 words are used for each FRENIC-VG, with the lower 29 words are used for read and upper 22 words are used for write.

Figure 6.5.19

		(MSB)		(LSB)
		15 14 …		… 1 0

%IW***. 0	Speed setting 4/Frequency command monitor	
%IW***. 1	Torque command 2	
%IW***. 2	Torque current command (final)	
%IW***. 3	Magnetic flux command (final)	
%IW***. 4	Actual speed (detected)	
%IW***. 5	Control data (CW) (Standard ＋DIOA, 16 bits)	
%IW***. 6	Operation status (SW)	
%IW***. 7	Speed setting 1/Frequency command (for V/f)	
%IW***. 8	Line speed input	FRENIC-VG
%IW***. 9	Pulse train position command (PG (PR))	⇓
%IW***. 10	Position detection (internal or PG (PD))	MICREX-SX
%IW***. 11	Position detection (PG (PD) Z-phase input)	
%IW***. 12	Position command	
%IW***. 13	VG DI (DIOB option: 16 bits)	
%IW***. 14	FRENIC-VG Ai (Ai1)	
%IW***. 15	FRENIC-VG Ai (Ai2)	
%IW***. 16	VG Ai (AIO/AI option, Ai3)	
%IW***. 17	VG Ai (AIO/AI option, Ai4)	
%IW***. 18	Polling function code 1 address	
%IW***. 19	Polling function code 1 data	
%IW***. 20	Polling function code 2 address	
%IW***. 21	Polling function code 2 data	

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.20

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```
                         (MSB)                                                (LSB)
                         15 14 …                                              …10
%QW***. 22    ┌─────────────── Speed setting 1/Frequency command (for V/f) ───────────┐   ↑
%QW***. 23    ├─────────────────────── Torque command 1 ──────────────────────────────┤
%QW***. 24    ├────────────────────── Torque current command ─────────────────────────┤
%QW***. 25    ├─────────────────────── Magnetic flux command ─────────────────────────┤
%QW***. 26    ├─────────────────────── Control data (CW) ─────────────────────────────┤
%QW***. 27    ├──────────────── VG DO1 (standard＋DIOA: 13 bits) ─────────────────────┤
%QW***. 28    ├─────────────────────── Acceleration time ─────────────────────────────┤
%QW***. 29    ├─────────────────────── Deceleration time ─────────────────────────────┤
%QW***. 30    ├──────────────────── Torque limiting value level 1 ────────────────────┤
%QW***. 31    ├──────────────────── Torque limiting value level 2 ────────────────────┤
%QW***. 32    ├────────────── Speed setting 4/Frequency command (for V/f) ────────────┤
%QW***. 33    ├─────────────────────── Torque command 2 ──────────────────────────────┤   MICREX-SX
%QW***. 34    ├─────────────────────────── Torque bias ───────────────────────────────┤
%QW***. 35    ├───────────────────── Speed supplement command ────────────────────────┤   ⇓
%QW***. 36    ├───────────────────── Actual speed (simulated) ────────────────────────┤
%QW***. 37    ├─────────────────── Selecting function code 1 address ─────────────────┤   FRENIC-VG
%QW***. 38    ├──────────────────── Selecting function code 1 data ───────────────────┤
%QW***. 39    ├─────────────────── Selecting function code 2 address ─────────────────┤
%QW***. 40    ├──────────────────── Selecting function code 2 data ───────────────────┤
%QW***. 41    ├──────────────────── Polling function code 1 address ──────────────────┤
%QW***. 42    ├──────────────────── Polling function code 2 address ──────────────────┤
%QW***. 43    ├──────────────────── VG DO2 (DIOB option: 10 bits) ───────────────────┤
%QW***. 44    ├───────────────────────── FRENIC-VG AO (AO1) ──────────────────────────┤
%QW***. 45    ├───────────────────────── FRENIC-VG AO (AO2) ──────────────────────────┤
%QW***. 46    ├───────────────────────── FRENIC-VG AO (AO3) ──────────────────────────┤
%QW***. 47    ├─────────────────── FRENIC-VG AO (AIO option, AO4) ────────────────────┤
%QW***. 48    ├─────────────────── FRENIC-VG AO (AIO option, AO5) ────────────────────┤
%QW***. 49    ├─────────────────────────── Dynamic SW1 ───────────────────────────────┤
%QW***. 50    └─────────────────────────── Dynamic SW2 ───────────────────────────────┘   ↓
```

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Refer to "6.5.8 Transmission Format" for the transmission format.

Figure 6.5.21

(3) Monitoring format

When the monitoring format is selected (U11=2), as shown in the figure below, out of the I/Q area of the MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 4 words are used for read and upper 12 words are used for write.
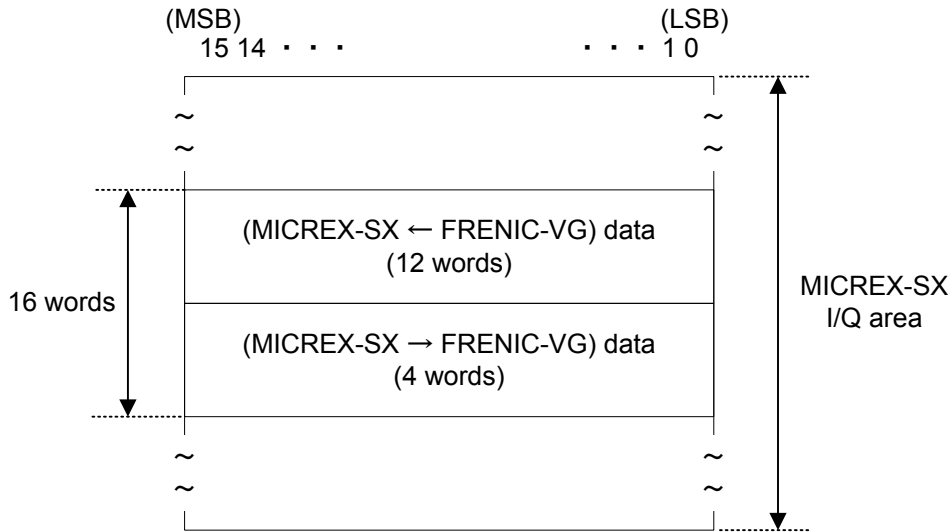
Figure 6.5.22
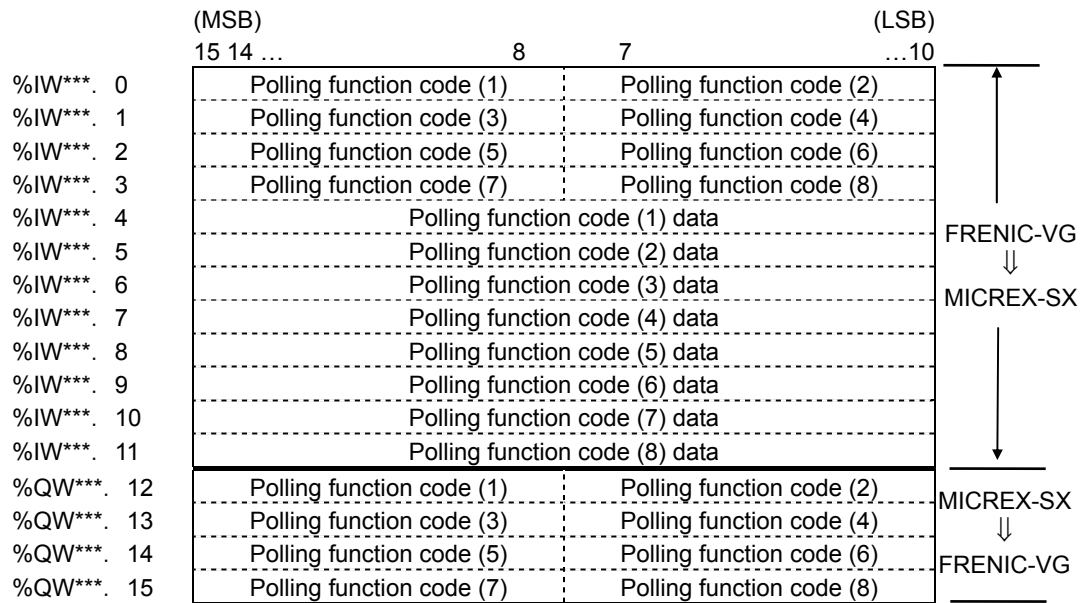
Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.23

(4) Standard format 2 (specified with 485No)

When the standard format 2 is selected (U11=3), as shown in the figure below, out of the I/Q area of MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 8 words are used for read and upper 8 words are used for write.
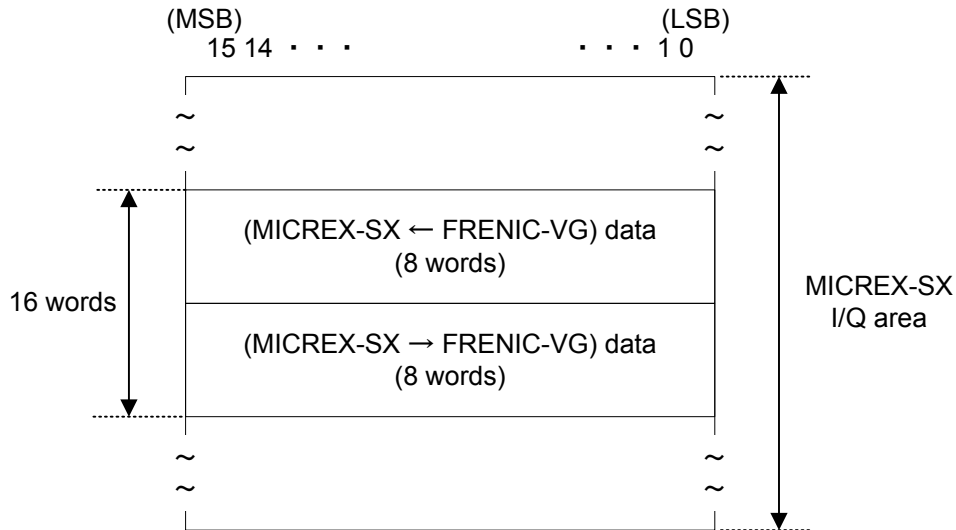
Figure 6.5.24

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.25

(4) Standard format 2 (specified with 485No)

When the standard format 2 is selected (U11=3), as shown in the figure below, out of the I/Q area of MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 8 words are used for read and upper 8 words are used for write.

(MSB) ... (LSB)
15 14 ... ... 1 0

~ ~
~ ~

(MICREX-SX ← FRENIC-VG) data
(8 words)

16 words

(MICREX-SX → FRENIC-VG) data
(8 words)

MICREX-SX I/Q area

~ ~
~ ~

Figure 6.5.24

(MSB) 15 14 … 8 7 …10 (LSB)	
%IW***. 0	Polling function code 485No (1)
%IW***. 1	Polling function code 485No (2)
%IW***. 2	Polling function code (1) data
%IW***. 3	Polling function code (2) data
%IW***. 4	Function code monitor (1)
%IW***. 5	Function code monitor (2)
%IW***. 6	Motor speed (M06)
%IW***. 7	Operation state (refer to * 6.5.8.1 (1))
%QW***. 8	Selecting function code 485No (1)
%QW***. 9	Selecting function code 485No (2)
%QW***. 10	Selecting function code (1) data
%QW***. 11	Selecting function code (2) data
%QW***. 12	Speed command (S01)
%QW***. 13	Operation command/Di/RESET input (S06)
%QW***. 14	Polling function code 485No (1)
%QW***. 15	Polling function code 485No (2)

FRENIC-VG ⇓ MICREX-SX (for rows 0–7)
MICREX-SX ⇓ FRENIC-VG (for rows 8–15)

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.25

6.5.8 Transmission format

6.5.8.1 Data Format (FRENIC-VG $\Rightarrow$ MICREX-SX)

(1) When standard format (specified by link No.) is selected

① Operate state (1 for all ON)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	ERR	-	RL	ALM	DEC	ACC	IL	-	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward   TL : Torque limiting   RL : Communication selection
REV : Running reverse   (1: H30 = 2 or 3)
EXT : DC braking or pre-exciting   IL : Current limiting
INT : Inverter shutdown   ACC : Accelerating
BRK : Braking   DEC : Decelerating   ERR : Function code access error
NUV : DC link bus voltage   ALM : Batch failure   BUSY: Writing function code

· ERR is cleared to "0" when selecting (writing) and polling (reading) of the function code has been done correctly. If any of selecting or polling is not performed correctly, ERR is set to "1". The error cause in this case can be checked with the function code M26 (see the table below). When ERR is set to "1", resolve the cause and perform selecting or polling again. If the operation is successful, both of ERR and M26 are cleared to "0".

M26 value (HEX.)	Write/read error
78 (4EH)	Access to unused function code
79 (4FH)	Writing to a read-only function code
	Writing to a function code (during operation) which cannot be changed during operation
	Writing to a function code which cannot be changed with FWD/REV ON.
80 (50H)	Writing out-of-range data

*1 If multiple errors occur simultaneously, the following priority is applied to the M26 error cause.

Selecting (2) > Selecting (1) > Polling (2) > Polling (1)

(For example, if selecting (2) and polling (1) are faulty, the cause for the selecting (2) error is stored in M26.)

· BUSY is set to "1" while writing (processing) data. When writing consecutive data, wait for BUSY to be cleared to "0" and write the next data. A writing request made while this bit is set to "1" is ignored.

② Motor speed

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Motor speed (decimal) x 20000 / maximum speed $\Rightarrow$ 16-bit data

The maximum speed is set with the inverter function code F03. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

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③ Polling function code address and data

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)

Polling function code (1) data
⇓
Polling function code (4) data
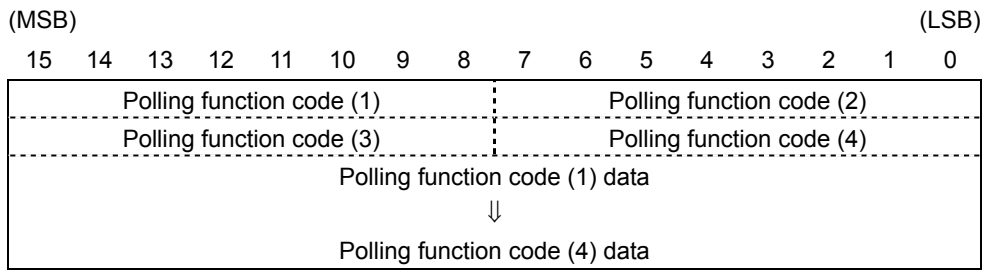
"Polling function code (1) to (4)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code (1) to (4) data".

(2) When UPAC compatible format is selected

① Speed setting 4/frequency command monitor, actual speed (detected), speed setting 1/frequency command (for V/f), line speed input
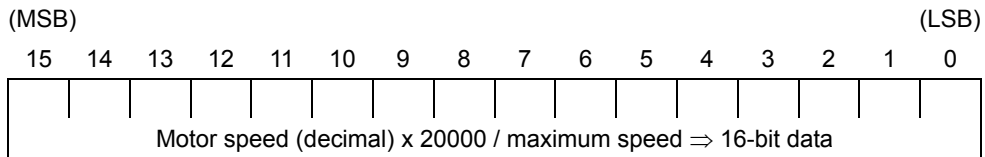
(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Motor speed (decimal) x 20000 / maximum speed ⇒ 16-bit data

The maximum speed is set with the function code. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

② Torque command 2, torque current command (final)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Torque command data
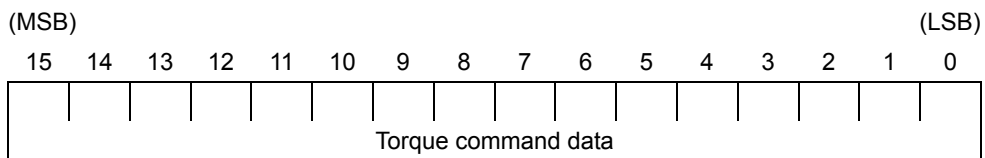
Torque command 2 data, torque current command data: 0.01%/1d (100% = rated toque)

③ Magnetic flux command (final)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Magnetic flux command data
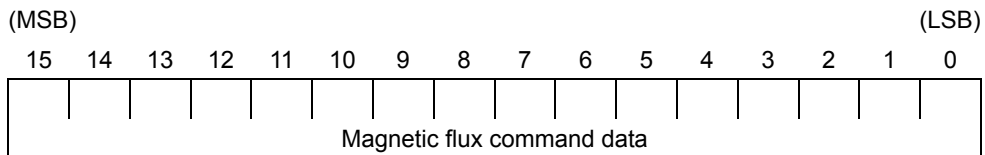
Magnetic flux command data: 0.01%/1d

④ Control data (CW) (Standard ＋DIOA, 16 bits)

```
        (MSB)              (LSB)
        15        8 7      0
        [_____][_____]
```

0) FWD (Run forward command)
1) REV (Run reverse command)
2) X1
3) X2
4) X3
5) X4
6) X5
7) X6
8) X7
9) X8
10) X9
11) X11
12) X12
13) X13
14) X14
15) RST (RESET command)

0: OFF, 1: ON
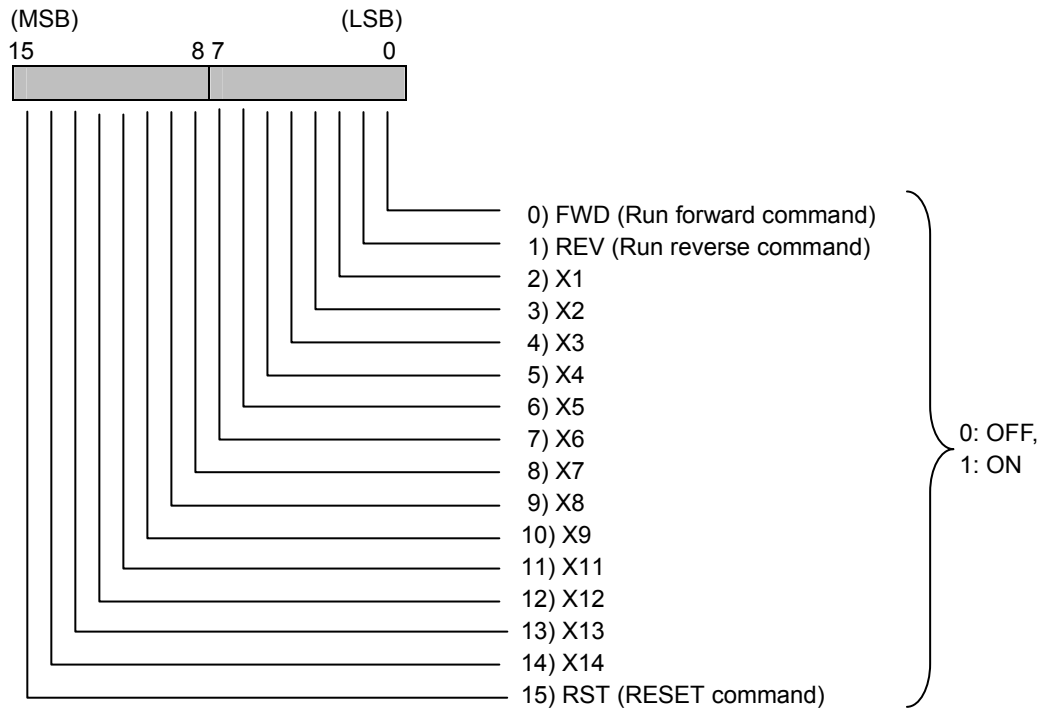
⑤ Operation status (SW)

Refer to the operation status of the standard format.

⑥ Pulse train position command (PG (PR)), position detection (internal or PG (PD)), position detection (Z-phase input) (PG (PD))

Refer to the explanation of U61 - U63 in "6.4.5.1 Function Code".

Note: The PG option (OPC-VG1-PG/PGo) is necessary to reference data for the pulse train position command and position detection (excluding internal data).

⑦ Position command (available soon)

⑧ VG DI (DIOB option: 16 bits)

```
        (MSB)              (LSB)
        15        8 7      0
        [_____][_____]
```

0) X21
1) X22
2) X23
3) X24
4) X25
5) X26
6) X27
7) X28
8) X29
9) X30
10) X31
11) X32
12) X33
13) X34
14) X35
15) X36

0: OFF, 1: ON
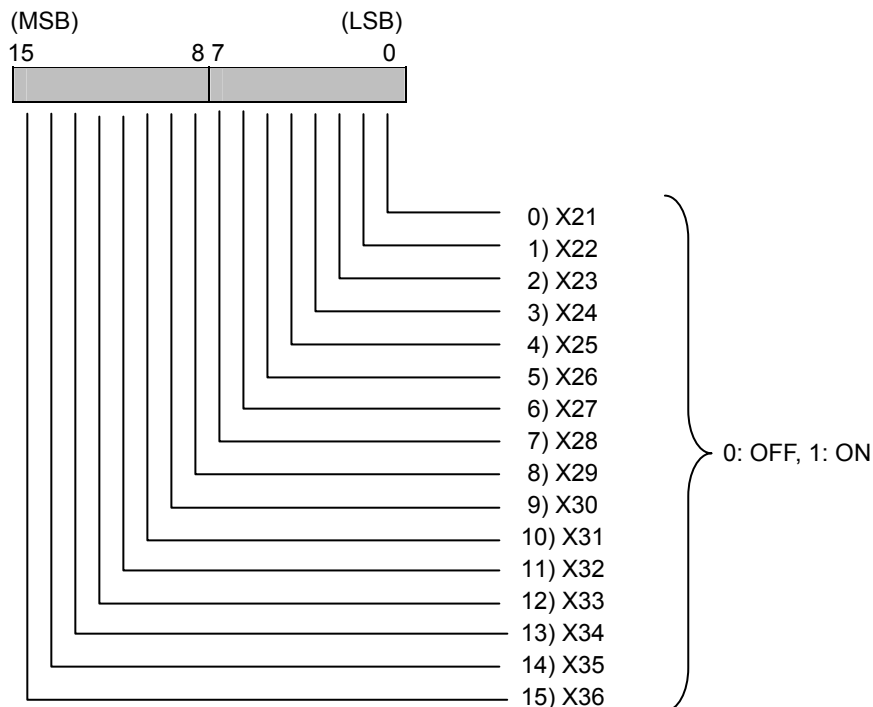
Note: The DIO option (OPC-VG1-DIO) is necessary to reference data for the VG DI (DIOB option: 16 bits).

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⑨ VG Ai (Ai1), VG Ai (Ai2), VG Ai (AIO/AI option, Ai3), VG Ai (AIO/AI option, Ai4)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
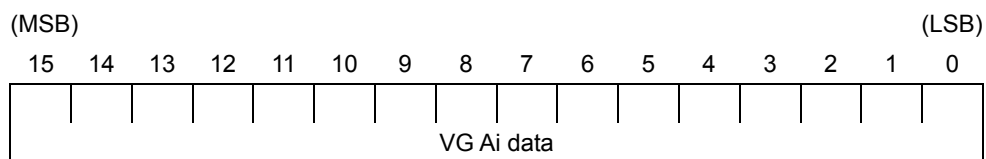
VG Ai data

VG Ai data: ±10 V = ±4000 h (±16384d)

Note: The AIO option (OPC-VG1-AIO) or AI option (OPC-VG1-AI) is necessary to reference data for VG Ai (AIO/AI option, Ai3) / (AIO/AI option, Ai4).

To enable this data, you need to assign the corresponding Ai terminal functions to the universal Ai (U-AI) using the function codes E49 to E52. If they are not assigned, the value will be 0.

To use Ai2, set SW3 on the control board to the V side. (For the switch, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches.")

⑩ Polling function code address and data

(MSB)   (LSB)

15	14		1	0
Polling function code 1 address				
Polling function code 1 data				
Polling function code 2 address				
Polling function code 2 data				
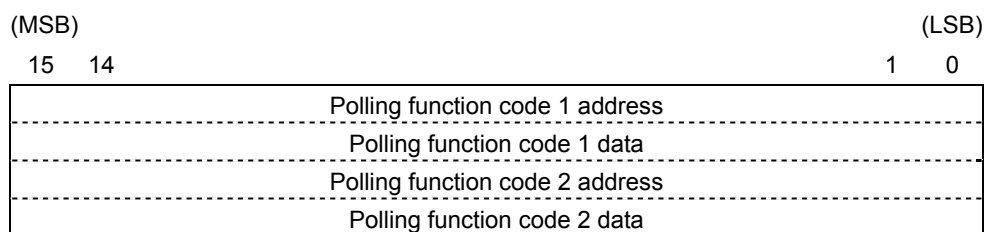
"Polling function code 1, 2 address" (16 bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code 1, 2 data".

(3) When monitoring format is selected

① Polling function code address and data

(MSB) (LSB)

15 14	8	7	1 0
Polling function code (1)		Polling function code (2)	
Polling function code (3)		Polling function code (4)	
Polling function code (5)		Polling function code (6)	
Polling function code (7)		Polling function code (8)	
Polling function code (1) data			
⇓			
Polling function code (8) data			
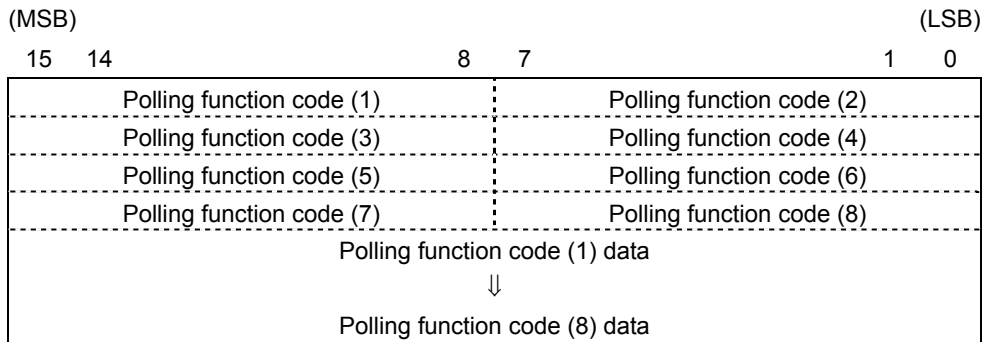
"Polling function code (1) to (8)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code (1) to (8) data".

(4) When standard format 2 (specified with 485No) is selected

① Polling function code address and data

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polling function code 485No (1)															
Polling function code 485No (2)															
Polling function code (1) data															
Polling function code (2) data															
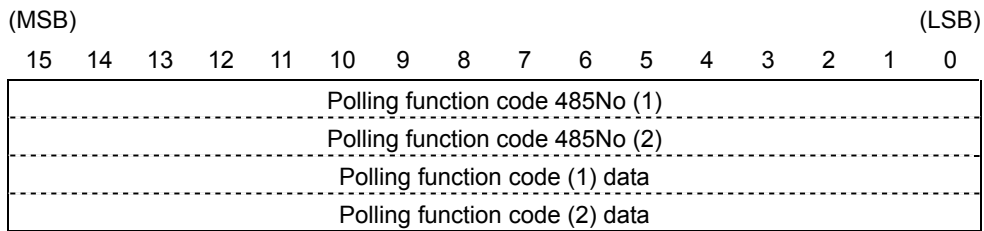
"Polling function code 485No (1) to (2)" (16 bits each) store the 485No corresponding to the function code requested for polling from MICREX-SX. The corresponding link numbers are stored in "Polling function code (1) to (2) data".

② Function code monitor

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function code monitor (1)															
Function code monitor (2)															
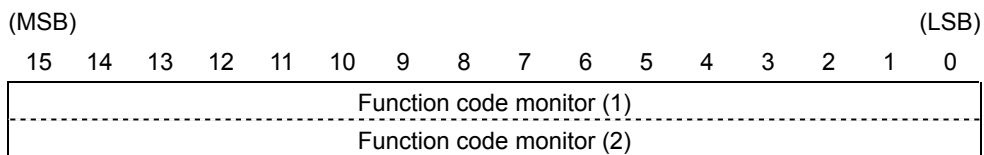
"Function code monitor (1), (2)" are the constant monitor of the function code. Set the target function code 485No with the function code o160 for "Function code monitor (1)" and o161 for "Function code monitor (2)".

③ Motor speed

Refer to the motor speed of the standard format.

④ Operation status

Refer to the operation status of the standard format.

6.5.8.2　Data format (MICREX-SX $\Rightarrow$ FRENIC-VG)

(1)　When standard format is selected

①　Selecting function code address and selecting function code data
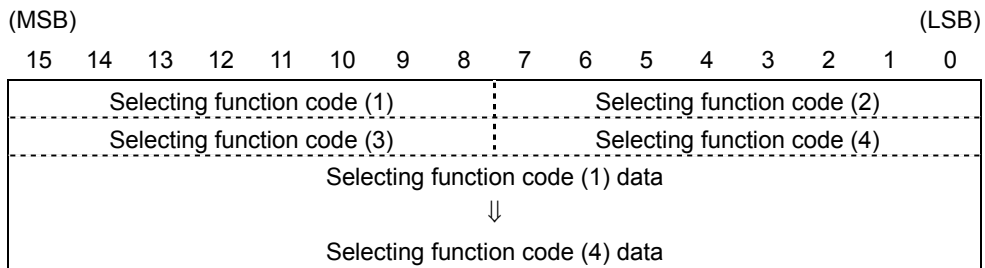
(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Selecting function code (1)	Selecting function code (2)
Selecting function code (3)	Selecting function code (4)

Selecting function code (1) data
$\Downarrow$
Selecting function code (4) data

"Selecting function code (1) to (4)" (eight bits each) store the link number corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code (1) to (4) data". Note that writing to the function code with this selecting function is done per the tact period of MICREX-SX.

Note 1)　Upon selecting, be sure to write the link number and data together.

Note 2)　If multiple selecting errors occur simultaneously with the selecting function codes (1) to (4), the following priority is applied to the function code M26 error cause.
Selecting function code (4) > (3) > (2) > (1)

②　Polling function code address
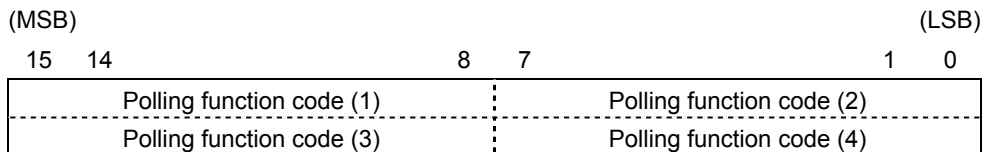
(MSB)   (LSB)

15	14	8	7	1	0

Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)

Use the "polling function code (1) to (4)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

(2) When UPAC compatible format is selected

① Control data (CW)
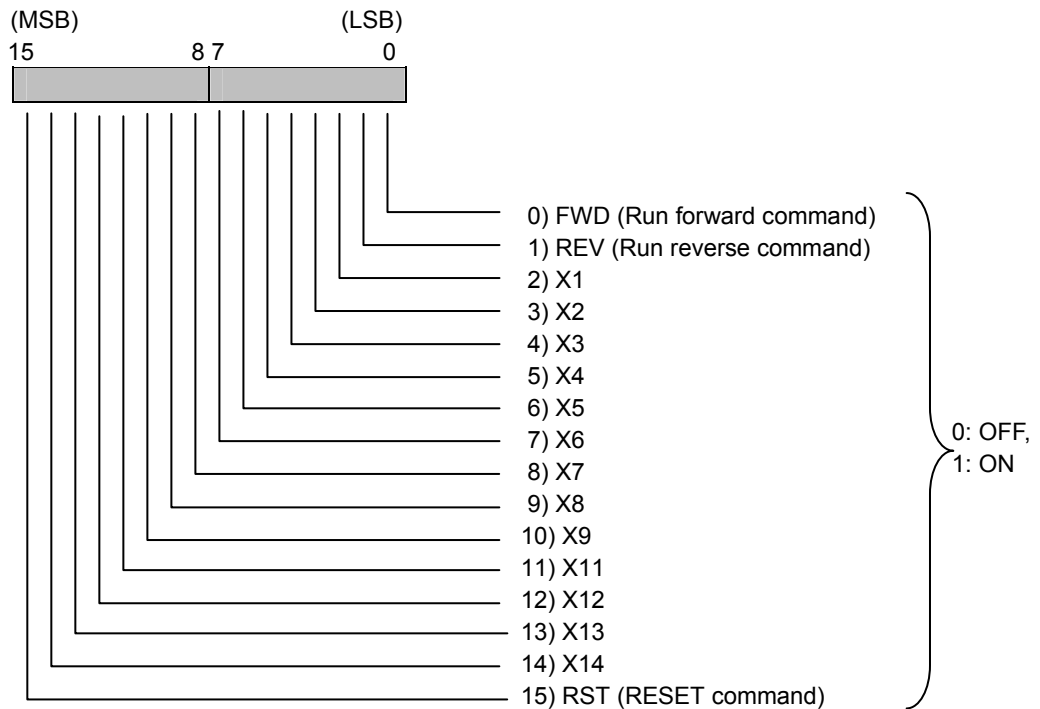
- FWD, REV and X1 to X14 are available when the link command is permitted as instructed in "6.4.9.1 Link Command Permission Selection". RST is always available.

- Note that the operation command (FWD/REV) specifications are different from when the UPAC option is used as shown below (available soon for the UPAC option).

- The AND condition of the operation commands defined in the UPAC option specifications is invalidated (deleted) for the SX bus option (when the UPAC compatible format is selected) (available soon for the UPAC option).
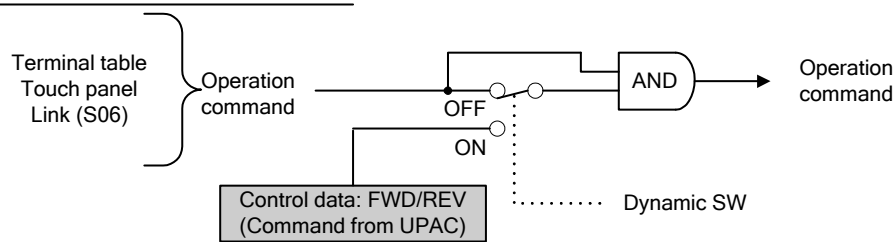
Figure 6.5.26

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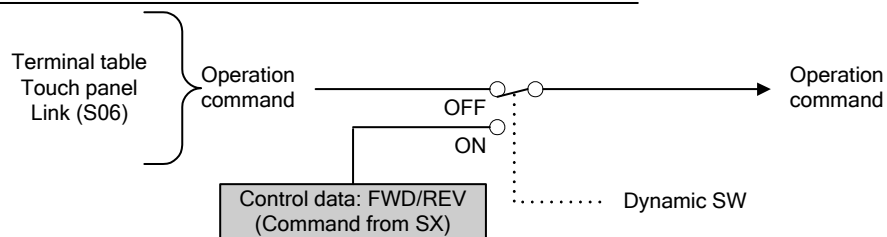
② Speed setting 1/frequency command (for V/f), speed setting 4/frequency command (for V/f), speed supplement command, actual speed (simulated)
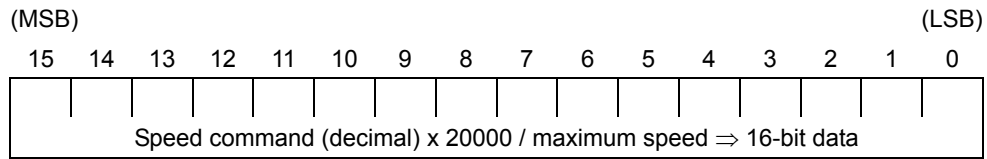
(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Speed command (decimal) x 20000 / maximum speed ⇒ 16-bit data

The above is the same as the motor speed. The maximum speed is set with the function code. Provide the speed value as 16-bit data of the value calculated above. (Handle negative data as a complement of 2.)

③ Torque command 1, torque command 2, torque current command, torque limiting level 1, torque limiting level 2, torque bias

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Torque command data
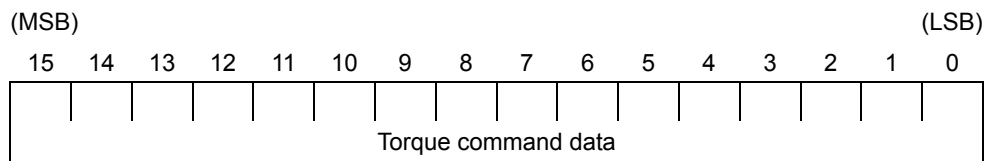
Torque command data: 0.01%/1d (100% = rated toque)

④ Magnetic flux command

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Magnetic flux command data
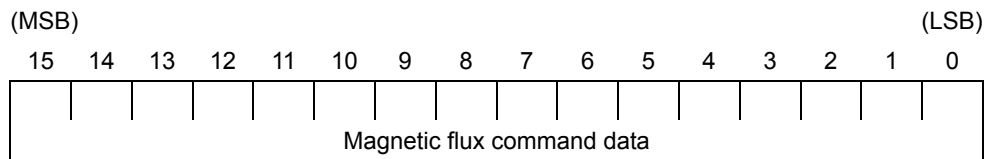
Magnetic flux command data: 0.01%/1d

⑤ VG DO1 (standard＋DIOA: 13 bits)

```
        (MSB)                    (LSB)
        15          8 7          0
        [███████████|████████████]
```

0) Y1
1) Y2
2) Y3
3) Y4
4) Y5A
5) Unused
6) Unused
7) Unused   } 0: OFF, 1: ON
8) Y11
9) Y12
10) Y13
11) Y14
12) Y15
13) Y16
14) Y17
15) Y18
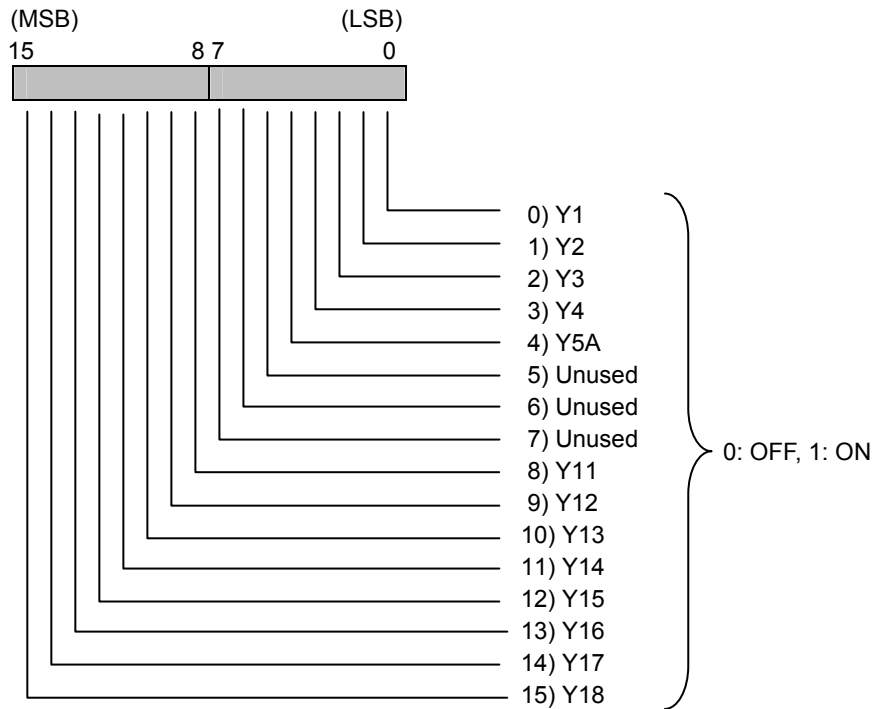
⑥ Acceleration time, deceleration time

| (MSB) | | | | | | | | | | | | | | | (LSB) |
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Acceleration (deceleration) time data															
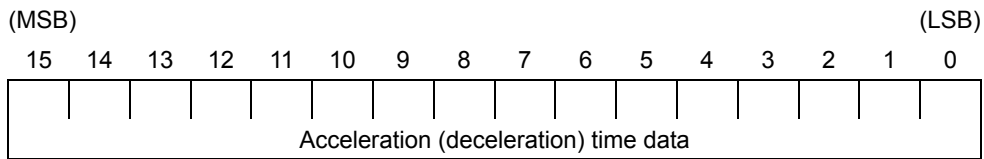
Acceleration (deceleration) time data: 0.1s/1d

⑦ Selecting function code address and selecting function code data

| (MSB) | (LSB) |
15 14	1 0
Selecting function code 1 address
Selecting function code 1 data
Selecting function code 2 address
Selecting function code 2 data
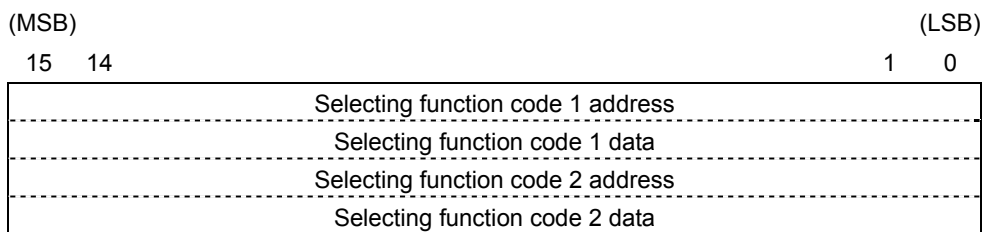
"Selecting function code 1, 2 address" (16 bits each) write the link number corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code 1, 2 data".

Note:・Upon selecting, be sure to write the link number and data together.

　　　・Writing from this frame to the S code is prohibited. For a command equivalent to the S code, give commands from each dedicated frame.

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⑧ Polling function code address

(MSB)   (LSB)

15	14		1	0
		Polling function code 1 address		
		Polling function code 2 address		
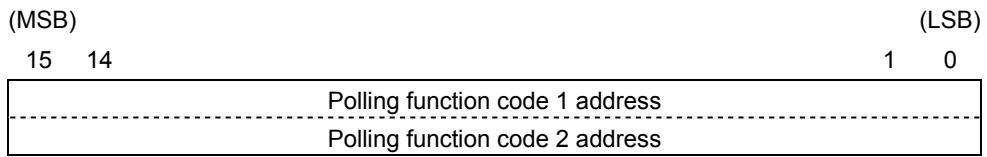
Use the "polling function code 1, 2 address" (16 bits) to specify the link number corresponding to the function code number requested for polling.

⑨ VG DO2 (DIOB option: 10 bits)

(MSB)   (LSB)

```
15        8 7        0
```

- 0) Y21   ⎫
- 1) Y22
- 2) Y23
- 3) Y24
- 4) Y25
- 5) Y26
- 6) Y27
- 7) Y28   ⎬ 0: OFF, 1: ON
- 8) Y29
- 9) Y30
- 10) Unused
- 11) Unused
- 12) Unused
- 13) Unused
- 14) Unused
- 15) Unused ⎭
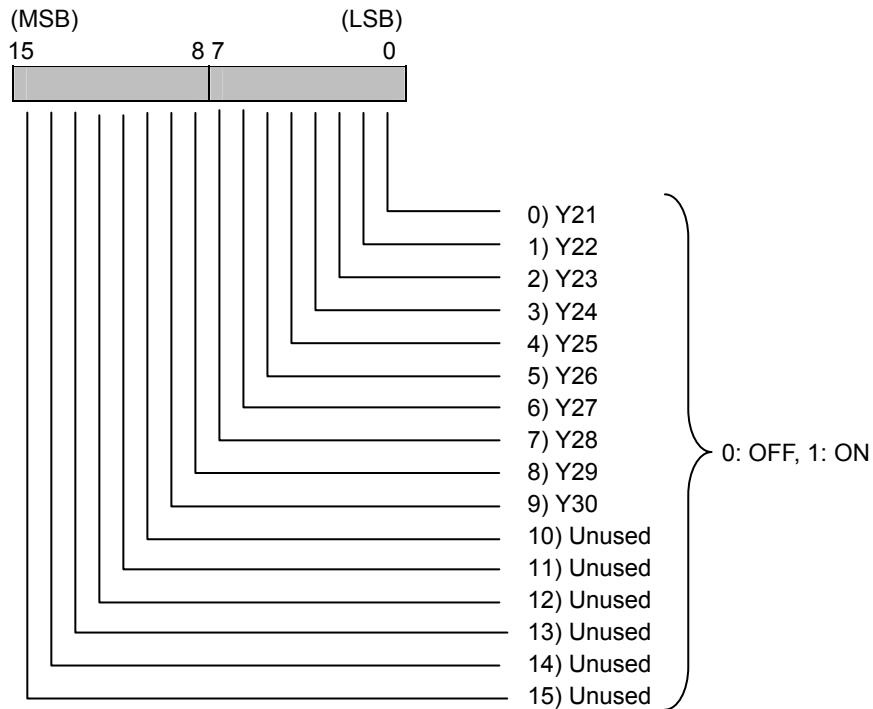
⑩ VG AO (AO1), VG AO (AO2), VG AO (AO3), VG AO (AIO option, AO4), VG AO (AIO option, AO5)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
							FRENIC-VG Ao data								
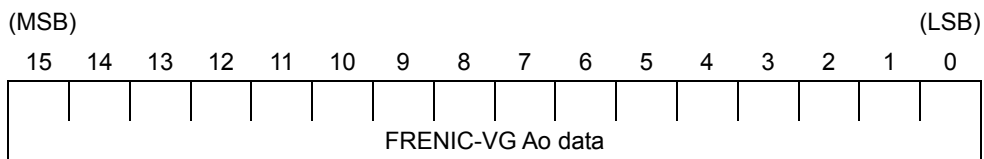
VG Ao data: ±10V = ±4000h (±16384d)

⑪ Dynamic SW1

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SW16	UPAC SW15	UPAC SW14	UPAC SW13	UPAC SW12	UPAC SW11	UPAC SW10	UPAC SW9	UPAC SW8	UPAC SW7	UPAC SW6	UPAC SW5	UPAC SW4	UPAC SW3	UPAC SW2	UPAC SW1

Dynamic SW2

(MSB)   (LSB)

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	UPAC SW30	UPAC SW29	UPAC SW28	UPAC SW27	UPAC SW26	SW22	SW21	SW20	SW19	SW18	SW17

Each bit operation of the dynamic SW reflects the control variable or modifies function code data.

1: Enabled (UPAC switch is enabled and the control variable data is reflected.)
0: Disabled (UPAC switch is disabled and the control variable data is not reflected.)

Note: ・ The dynamic switches to be used on the UPAC option are different from the above dynamic switches in bit assignment and ON/OFF definition. Be careful.
・ By default, all dynamic switches are set to 0 (disabled). When the control variable (MICREX-SX→VG) is enabled in the UPAC compatible format, be sure to enable the corresponding dynamic switch.
・ Refer to the UPAC SW shown in the control block diagram in Chapter 4 for the position of each dynamic switch.

SW name	Switching target	Corresponding control block
UPAC SW1 :	Speed setting 1/Frequency command (for V/f)	4.1.2
UPAC SW2 :	Torque command 1	4.1.6
UPAC SW3 :	Torque current command	4.1.7
UPAC SW4 :	Magnetic flux command	4.1.7
UPAC SW5 :	Control data (CW)	4.1.1
UPAC SW6 :	FRENIC-VG DO1(standard + DIOA: 13 bits)	4.1.12, 4.1.13
UPAC SW7 :	Acceleration time	4.1.3
UPAC-SW8 :	Deceleration time	4.1.3
UPAC SW9 :	Torque limiting value level 1	4.1.7
UPAC SW10 :	Torque limiting value level 2	4.1.7
UPAC SW11 :	Speed setting 4/Frequency command (for V/f)	4.1.6
UPAC SW12 :	Torque command 2	4.1.7
UPAC SW13 :	Torque bias	4.1.6
UPAC SW14 :	Speed supplement command	4.1.3
UPAC SW15 :	Actual speed (simulated)	4.1.4
SW16 :	Selecting function code 1 address	-
SW17 :	Selecting function code 1 data	-
SW18 :	Selecting function code 2 address	-
SW19 :	Selecting function code 2 data	-
SW20 :	Polling function code 1 address	-
SW21 :	Polling function code 2 address	-
SW22 to SW24 :	Reserved	-
SW25 :	FRENIC-VG DO2(DIOB option: 10 bits)	-
UPAC SW26 :	FRENIC-VG AO (AO1)	4.1.14
UPAC SW27 :	FRENIC-VG AO (AO2)	4.1.14
UPAC SW28 :	FRENIC-VG AO (AO3)	4.1.14
UPAC SW29 :	FRENIC-VG AO (AIO option AO4)	4.1.14
UPAC SW30 :	FRENIC-VG AO (AIO option AO5)	4.1.14
SW30, SW31 :	Reserved	-

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The relationship between the dynamic switch setting, link function selection (function code H30), and link operation selection (digital input LE) is shown below.

Table 6.5.6

H30 value	Link operation selection LE	Dynamic SW status		
		Command data SW1 to 4, 9 to 15	Operation command/control input SW5	Other SW6 to 8, 16 to 27
0	—	Fixed to off	Fixed to off	Can be switched
1	ON	Can be switched	Fixed to off	
1	OFF	Fixed to off	Fixed to off	
2	ON	Fixed to off	Can be switched	
2	OFF	Fixed to off	Fixed to off	
3	ON	Can be switched	Can be switched	
3	OFF	Fixed to off	Fixed to off	

Note:

⑤ The DIO option (OPC-VG1-DIO) is necessary to reference data Y11-Y18 for the FRENIC-VG DO1 (standard + DIOA: 13 bits). This command is effective without regard to the status of the function code H30 and link operation selection LE.

⑨ The DIO option (OPC-VG1-DIO) is necessary to reference data for the FRENIC-VG DO2 (DIOB option: 10 bits). This command is effective without regard to the status of the function code H30 and link operation selection LE.

⑩ AIO option (OPC-VG1-AIO) is necessary to reference data for the FRENIC-VG AO (AIO option, AO4) / (AIO option, AO5). To output this command to the AO terminal, you need to assign the corresponding AO terminal functions to the universal AO (U-A0) using the function codes E69 to E73. This command is effective without regard to the status of the function code H30 and link operation selection LE.

(3) When monitoring format is selected

① Polling function code address

(MSB) (LSB)

15	14		8	7		1	0

Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)
Polling function code (5)	Polling function code (6)
Polling function code (7)	Polling function code (8)

Use the "polling function code (1) to (8)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

(4) When standard format 2 (specified with 485No) is selected

① Selecting function code 485No, selecting function code data

(MSB)   (LSB)

15 14	1 0
Selecting function code 485No (1)	
Selecting function code 485No (2)	
Selecting function code (1) data	
Selecting function code (2) data	
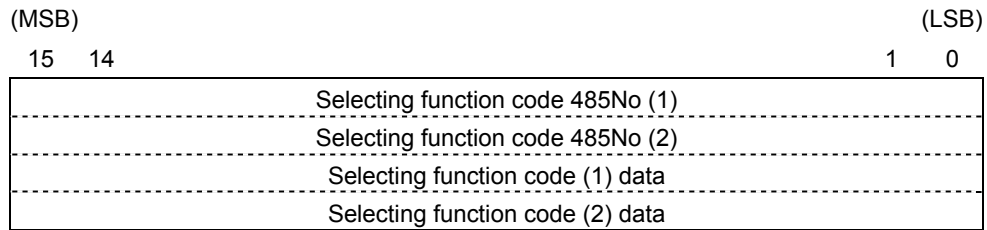
"Selecting function code 485No (1), (2)" (16 bits each) write the 485No. corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code (1), (2) data".

Note 1) Upon selecting, be sure to write the 485No. and data together.

Note 2) When writing data "0" to the function code F00 (485No.=0000h), first write data other than 0 or write to a function code other than F00, then write to F00.

Note 3) When the same function code is set to the selecting function codes (1) and (2), the selecting function code (2) takes precedence.

② Speed command (S01)

Refer to "(2) Speed command" in Section 6.3.8.2 of the T-Link interface.

③ Operation command/Di/RESET input (S06)

Refer to "(1) Operation command/Di/RESET input" in Section 6.3.8.2 of the T-Link interface.

④ Polling function code 485No

(MSB)   (LSB)

15 14	1 0
Polling function code 485No (1)	
Polling function code 485No (2)	
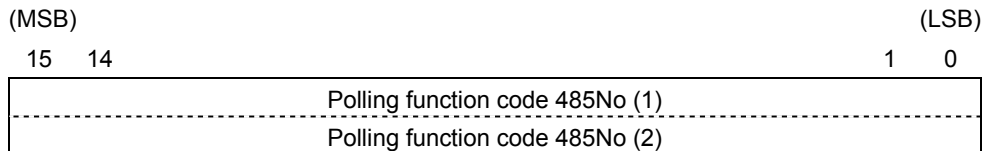
Use the "polling function code 485No (1), (2)" (16 bits) to specify the 485No. corresponding to the function code number requested for polling.

6.5.9　Link function

- Refer to "6.3.9 Link function" of the T-Link interface.
- When both of the SX bus interface card and T-Link interface card are installed, the link function targets communication via the T-Link.
- When only the SX bus interface card is installed and the monitoring format is selected, the link function targets communication from the integrated RS-485.

6.5.10　Data transmission example

The following explains a data transmission example using the transmission format.

(1)　Speed setting

From MICREX-SX, give commands to run forward (FWD) at 750r/min.
(Condition: Function code U11 "SX transmission format selection"= 0, H30 "Link operation"=3, maximum speed 1500 r/min, SX bus station address: 10)

Give S06 the forward running command (FWD: ON) and S01 the speed command.

%QW10.8	0	6	0	1	Function code S06, S01 selecting (link No. 06h, 01h)
%QW10.9	0	0	0	0	Selecting dummy data
%QW10.10	0	0	0	1	Function code S06 FWD=ON
%QW10.11	2	7	1	0	Function code S01　Speed setting 750/1500*20000=10000=2710(h)

↓　After acceleration completes

| %IW10.6 | 2 | 7 | 1 | 0 | Monitor the motor speed. |

(2)　Torque command monitor

Monitor the torque command value from MICREX-SX.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

| %QW10.14 | 1 | 0 | 0 | 0 | Torque command monitor (link No. 10h) |
| %QW10.15 | 0 | 0 | 0 | 0 | |

↓　After read completes

%IW10.0	1	0	0	0	When the link number requesting polling is returned to this area, reading is completed.
%IW10.1	0	0	0	0	Torque command value monitor data
%IW10.2	1	3	8	8	1388(h)×100(%)/ 10000 = 50(%)
%IW10.3	0	0	0	0	↓
%IW10.4	0	0	0	0	From the above, the torque command value is "50% of drive".
%IW10.5	0	0	0	0	

(3) Function code data setting

From MICREX-SX, set the function code S08 "Acceleration time" to 30.5s.

(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

%QW10.8	0	8	0	0	Function code S08 selecting (Link No. 08h)
%QW10.9	0	0	0	0	
%QW10.10	0	1	3	1	30.5=305 x 0.1s=305=131(h)
%QW10.11	0	0	0	0	
%QW10.12	0	0	0	0	
%QW10.13	0	0	0	0	
%QW10.14	0	8	0	0	Poll the function code S08 to confirm setting completion.

↓ After writing completes

%IW10.0	0	8	0	0	Poll the function code S08.
%IW10.1	0	0	0	0	
%IW10.2	0	1	3	1	131(h)=305×0.1s=30.5s (Data is correctly set.)
%IW10.3	0	0	0	0	
%IW10.4	0	0	0	0	
%IW10.5	0	0	0	0	

(4) Toggle monitoring

Monitor data toggling between MICREX-SX and the inverter. This example set the X12 terminal to TGL1 and X13 terminal to TGL2. (*1)

Set E11=72 (TGL1), E12=73 (TGL2), H30=3, H144=0.10 (100 ms) in advance.

This sets transmission toggle (MICREX-SX→VG1): %QW254.0.10.13 bit 12 = TGL1 and bit 13 = TGL2.

The inverter monitors the toggle pattern sent from MICREX-SX while the operation command is ON, and generates the toggle error $\mathit{Ar\text{-}F}$ if the toggle signal cannot be received within the time specified with H144.

*1 For the details of the toggle, refer to E01 to E13 toggle signal explanation in "4.3 Function Code Details".

*2 By setting the inverter function code H107, the inverter can continue operation with $L\text{-}AL$ display. Refer to the description of H107 in "4.3 Function Code Details".

*3 The tact period for an application which sends toggle patterns on the MICREX-SX side should be 1 ms or longer.

%QW254.0.10.13	*	0	0	0	Send 0→1→2→3→0 to *…(toggle pattern)

↓ After sending toggle

%QW254.0.10.13	*	0	0	1	Operation command (FWD)=ON

⇒ $Ar\text{-}F$ does not occur if the sent toggle is correct.

Note: If the network error $Er\text{-}4$ (light and heavy alarm 1) occurs while sending the toggle pattern and keeps the operation, the toggle error $Ar\text{-}F$ may occur after the communication recovers. To avoid the toggle error $Ar\text{-}F$, stop sending the toggle pattern while the network error $Er\text{-}4$ is occurring.

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6.5.11   System configuration definition

For the MICREX-SX series, you need to use the programming support tool Expert (D300win) to construct the system, configure the entire system for operation, set operation, and set individual modules.

The following describes how to configure the system definition of the inverter, which is connected to the SX bus as a slave module. For configuration of the PC, memory, program, and other individual modules than the inverter, refer to each user's manual of the corresponding MICREX-SX series product.

6.5.11.1   Programming support tool expert (D300win)

D300win is program creation system software for the MICREX-SX series. Note that you must use particular versions of D300win to configure the system definition of FRENIC-VG. Use a version shown below (or later). Screenshots may differ depending on the version used.

Expert (D300win) Version
    V3 series: 3.0.0.0 or later
    V2 series: 2.2.2.0 or later

Note: If you have a (registered) version of D300win which does not support FRENIC-VG, contact our sales personnel to upgrade it. You can check the current version of D300win by choosing [Information] from the [Help] menu.

D300win version

SX-Programmer Expert(D300win) Version V3.5.2.36
Copyright(C)2003-2011 Fuji Electric Co., Ltd.
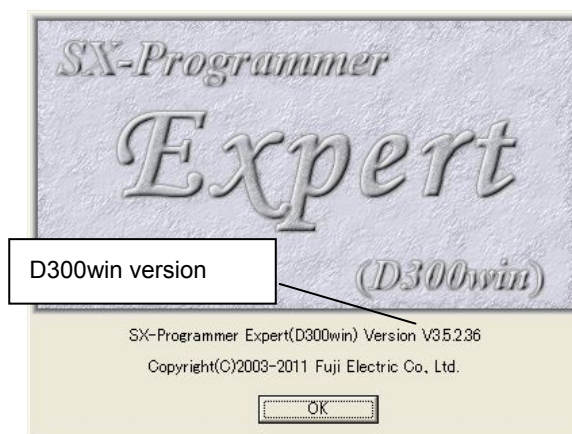
Figure 6.5.27

Note
When configuring the system definition including VG1, set the SX bas tact to 1 ms or longer.

[1]   System definition window

In system definition, you construct the system using the SX bus, configure the entire system for operation, configure operation, and configure individual modules. Double-click the [System_Definition] icon in the [Physical Hardware] configuration subtree to open the system configuration definition screen.
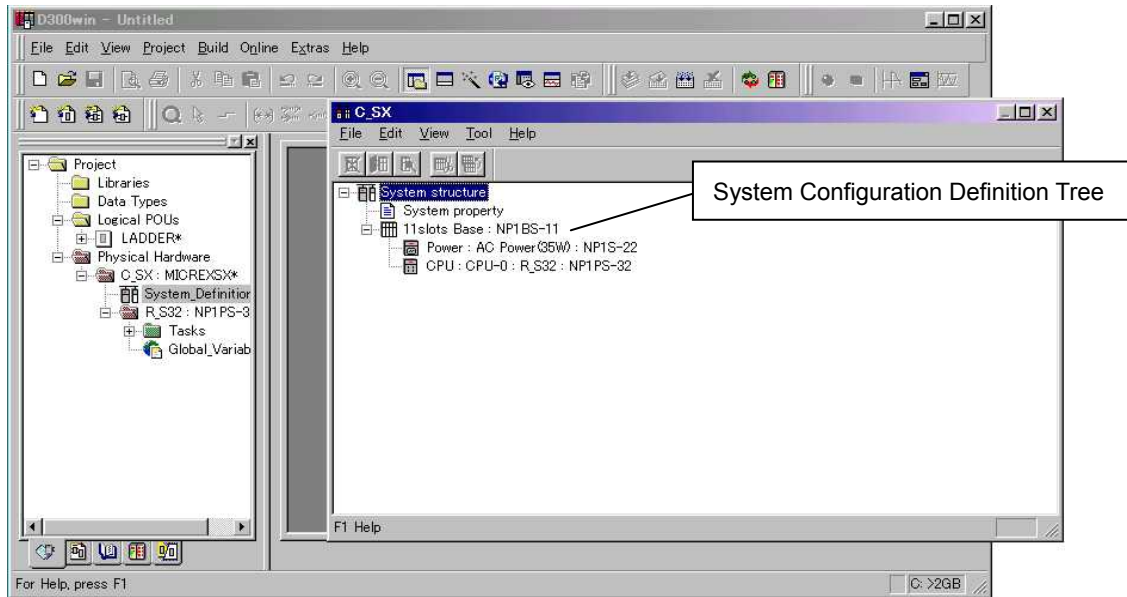
Figure 6.5.28

[2]   Adding a module

⚠CAUTION

・ If the transmission format settings are different, a heavy alarm occurs and communication is not available. Be sure to check the following for the correct settings.

For the MICREX-SX series, it is necessary to register all the modules (including the inverter) to use in the system configuration definition of the PC system.

To add the module (inverter), right-click the base module on the system configuration definition tree, and select [Insert] to open the [Module insert] dialog box.

Figure 6.5.29

6-113
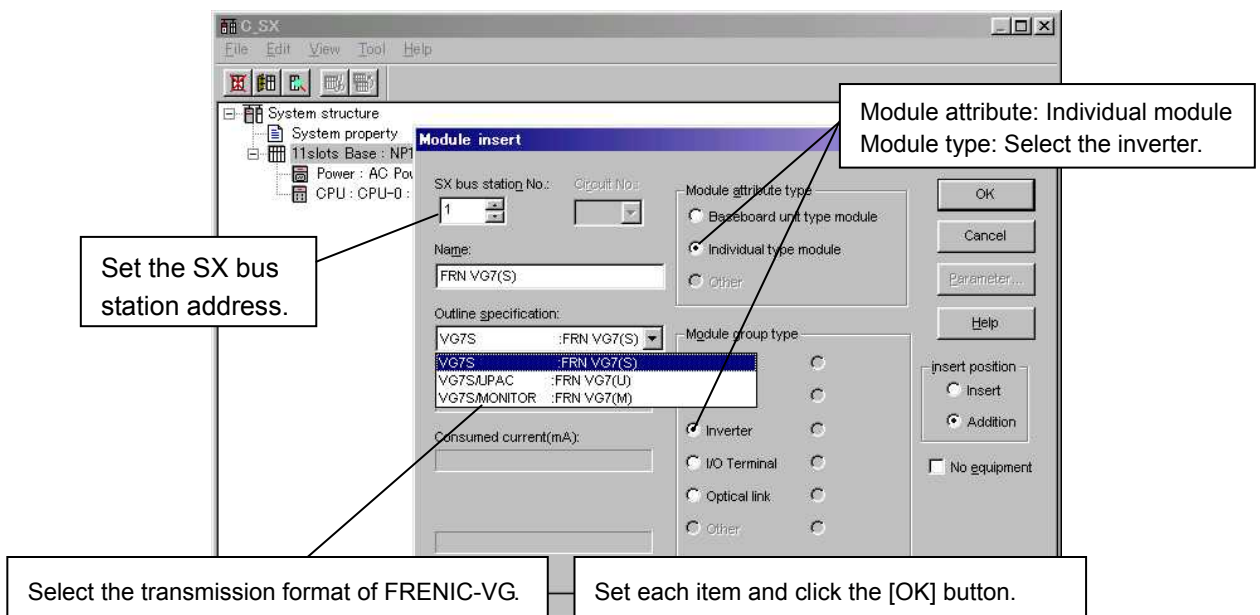
(1) Transmission format selection

In the [Summary Specifications] list box, select the transmission format of FRENIC-VG. For the detailed specifications of each transmission format, refer to the function code U11 "SX transmission format selection".

- Standard format 1 and 2   ⇒   VG7: FRN VG7(S)
  (for the latest version,
  VG1/VG7 (STD1): FRENIC-VG (S1))

- UPAC compatible format   ⇒   VG7S/UPAC: FRN VG7 (U)
  (for the latest version,
  VG1/VG7 (UPAC): FRENIC-VG (U))

- Monitoring format   ⇒   VG7S/MONITOR: FRN VG7 (M)
  (for the latest version,
  VG1/VG7 (MONITOR): FRENIC-VG (M))

Note: Be sure to select the same format as the function code U11. If the settings are different, the heavy alarm "Device configuration error" occurs and communication will not be available.

(2) I/O group setting

Allocate the module (inverter) in the MICREX-SX CPU. Incorrect allocation of the I/O group disables input/output control from the CPU.

Right-click the CPU on the system configuration definition tree, and select [Properties] to open the [Module Properties] dialog box.

Click the parameter and the [I/O Group Setting] tab to open the [I/O Group Setting] dialog box.

Note: In a multi-processor system, if an individual CPU module has a different control target, configure the I/O group for an individual CPU.
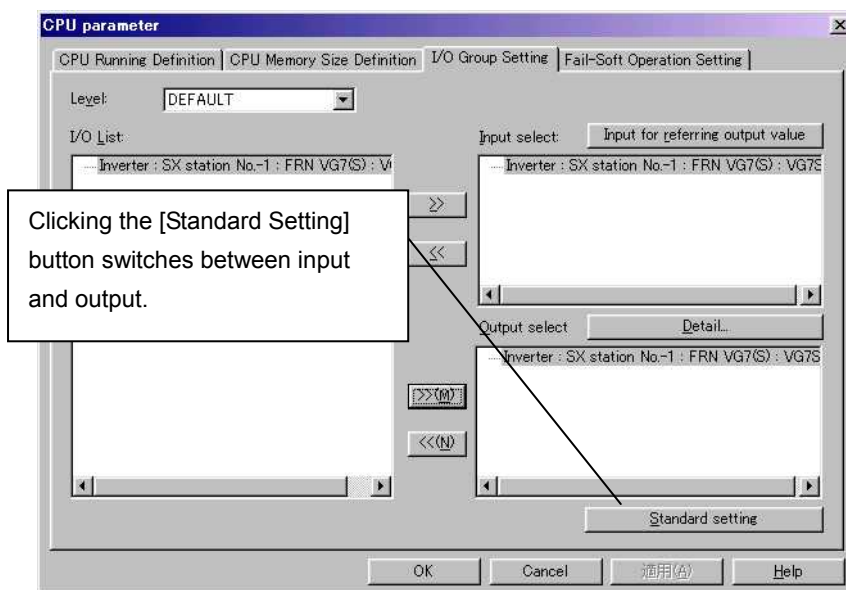
Figure 6.5.30

[3] Degenerate setting

The SX bus option supports the degenerate and degenerate system start-up operations. Each operation has restrictions including the degenerated condition and system settings. For the details, refer to the user's manual (reference) of each MICREX-SX series product.

The following explains the degenerate setting and degenerate system start-up setting. These settings are not required if the degenerate setting and degenerate system start-up operations are not necessary.

(1) Degenerate Setting

With the degenerate setting enabled, even when an inverter error occurs and the inverter stops, other normal module can continue operation.

Open the [CPU Parameter] dialog box, and click the [Degenerate Setting] tab.
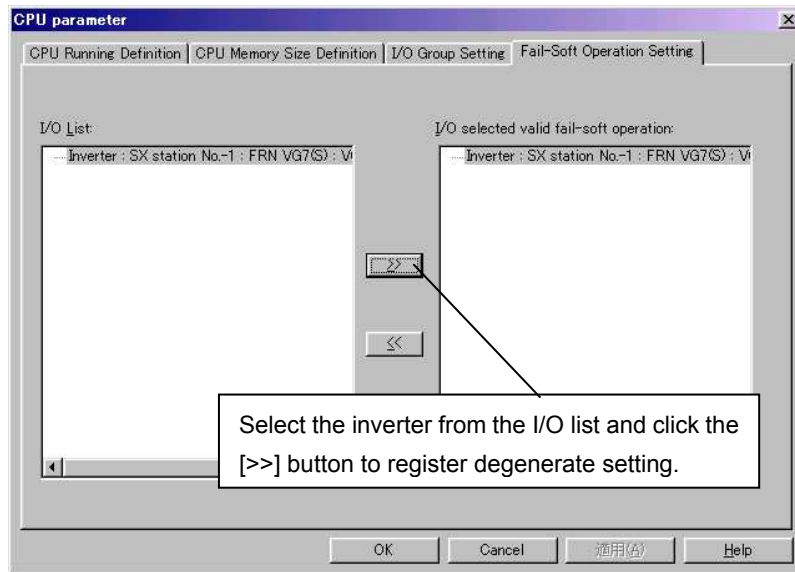
Figure 6.5.31

(2) Degenerate System Start-up Setting

With the degenerate system start-up setting enabled, when the SX bus system launches with the inverter powered off, the system will start up after the configuration check standby time, excluding the inverter, in a light alarm state.

In the [System Properties] dialog box, click the [Degenerate System Start-up Operation Definition] tab.
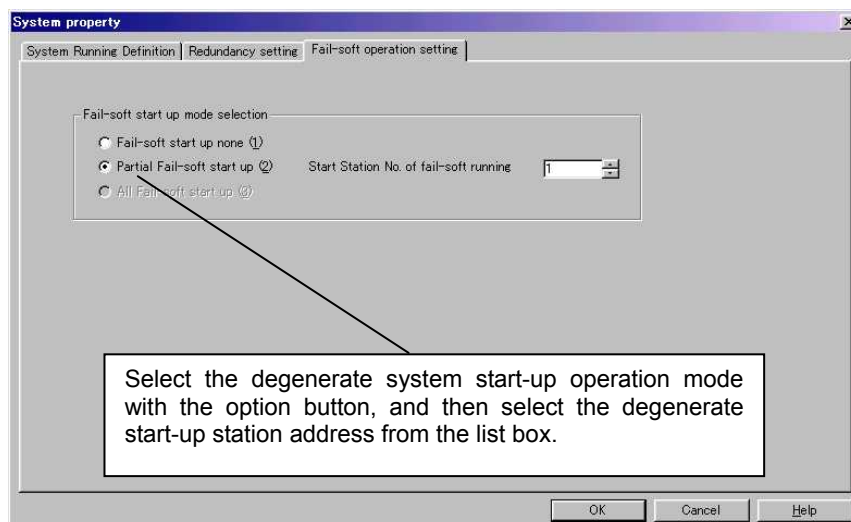
Figure 6.5.32

6.5.11.2   Application program examples

The following explains a data transmission example using the MICREX-SX application program.

(1)   Speed setting

From MICREX-SX, give commands to run forward (FWD) at 750r/min.
(Condition: Function code U11 "SX transmission format selection"= 0, H30 "Link Operation"=3, maximum speed 1500r/min, SX bus station address: 10)

Give S06 the forward running command (FWD: ON) and S01 the speed command.
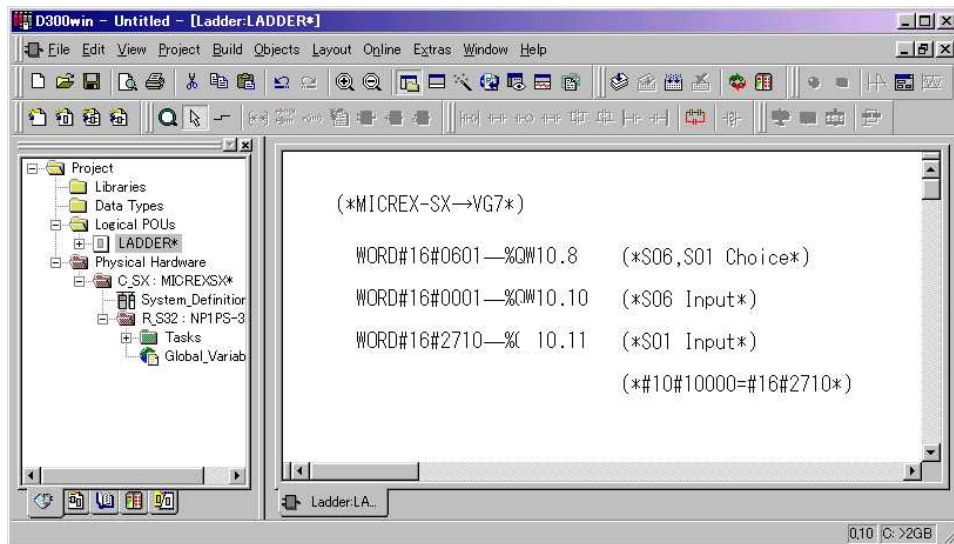
Figure 6.5.33

(2)   Torque command monitor

Monitor the torque command value from MICREX-SX.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)
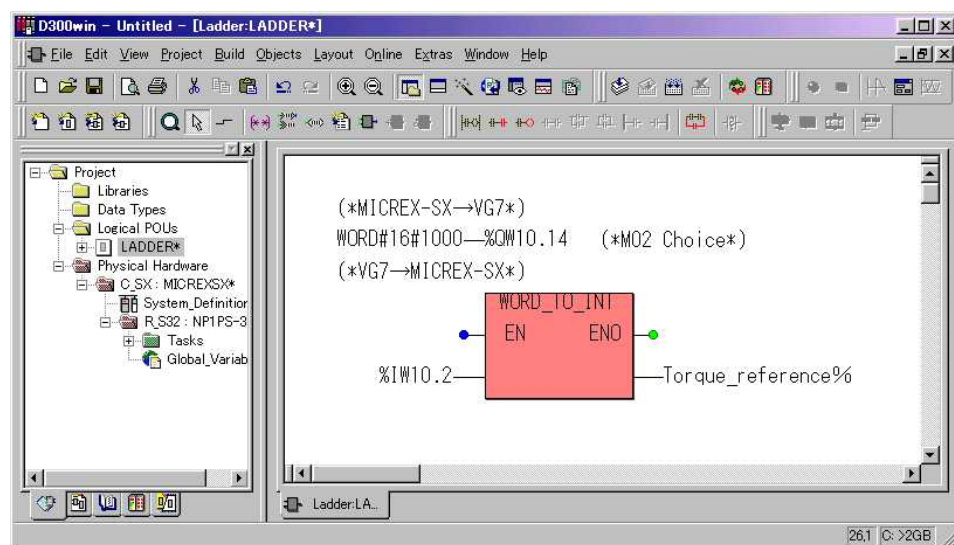
Figure 6.5.34

(3)   Function code data setting

From MICREX-SX, set the function code S08 "Acceleration time" to 30.5s.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)
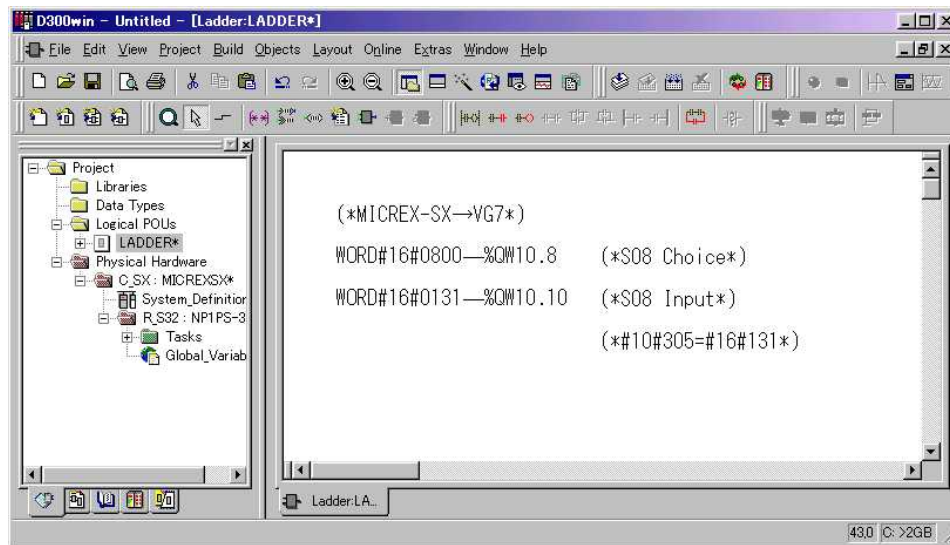
Figure 6.5.35

6.5.12 Multiple option application examples

6.5.12.1 Installed with T-Link interface card

The following shows an example where the T-Link interface card (OPC-VG1-TL) and SX bus interface card (OPC-VG1-SX).

<u>Connection example</u>
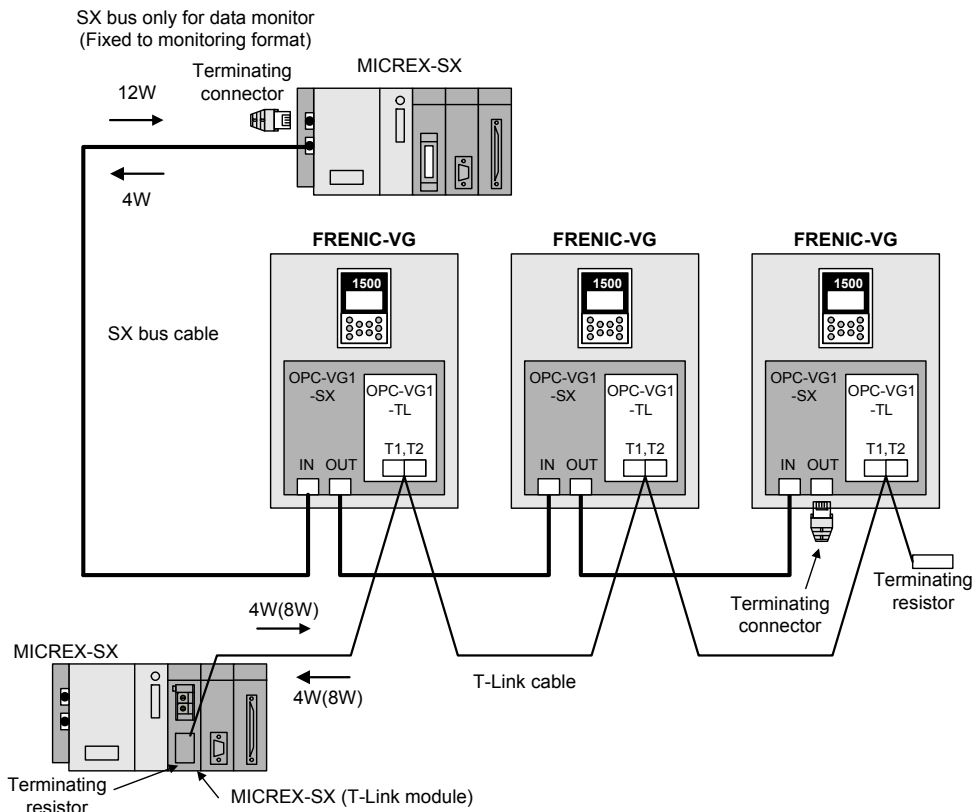
Figure 6.5.36

<u>Features</u>

You can construct the command system (T-Link) and monitoring system (SX bus) with separate link systems. While giving command via the T-Link, you can perform high-speed data monitoring via the SX bus.

<u>Detailed specifications</u>

(1) The transmission format of the SX bus is fixed to the monitoring format and dedicated to monitoring.
You need to configure the monitoring format with transmission format selection (U11) and system configuration definition.

(2) The link function (link command switch, link edit switch, etc.) is enabled for the T-Link.

(3) The communication error monitoring target is the T-Link, and communication errors occurring on the SX bus will not be detected.

(4) For the detailed specifications of the T-Link, refer to "6.3 T-Link Interface".

6.5.12.2   Installed with high-speed serial communication-capable terminal block

The following shows an example where the high-speed serial communication-capable terminal block (OPC-VG1-TBSI) and SX bus interface card (OPC-VG1-SX) are installed simultaneously to drive the multi-winding motor.

Connection example
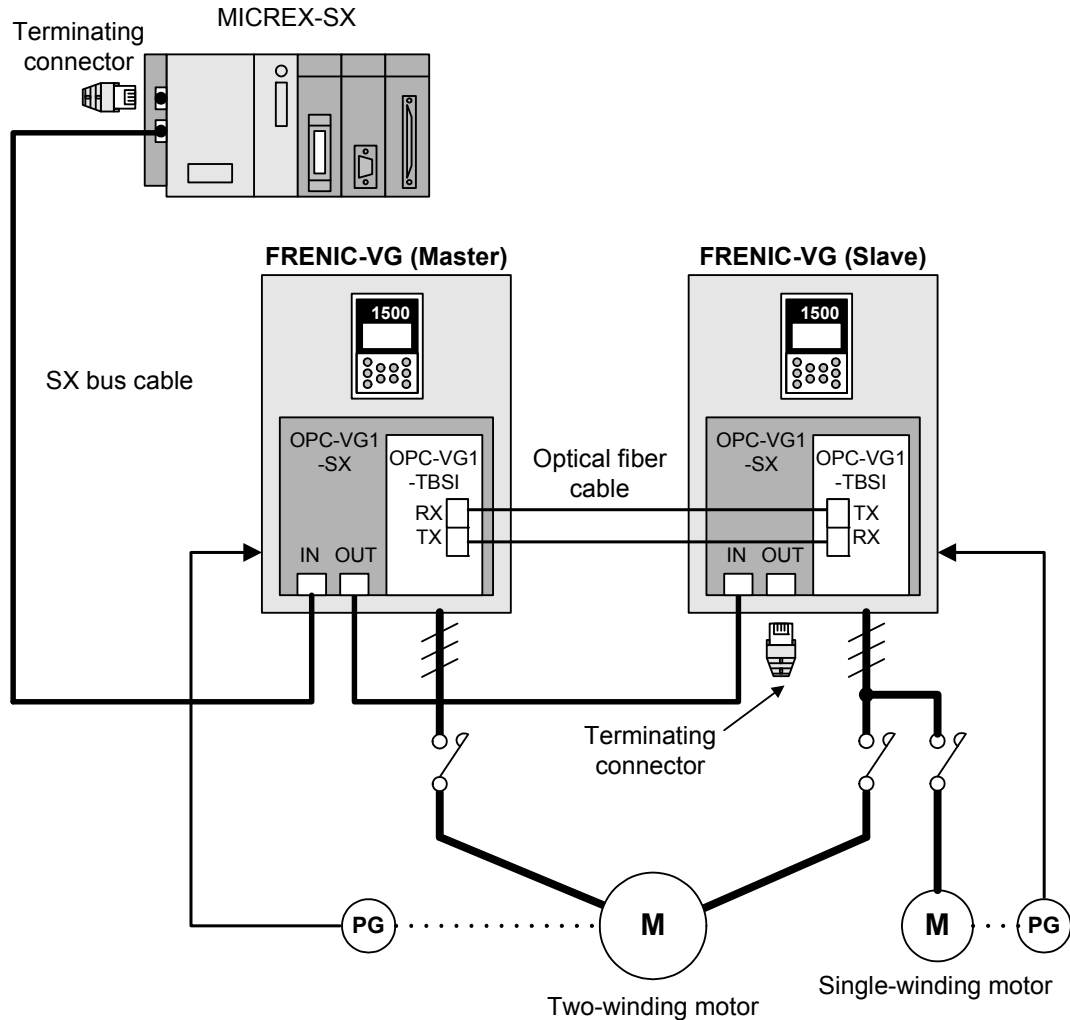
Figure 6.5.37

Features

You can link with a multi-winding motor drive system which can drive a high-capacity motor via the SX bus, to implement wire-saving, high-speed, and high-performance control.

If the SX bus option is also installed on the slave side, single-winding motors can be individually driven by switching the drive motors.

Detailed specifications

(1)   While driving a multi-winding motor, if a control command is input via the SX bus to the slave inverter, the data will not be reflected. The motor operates according to commands given to the master inverter.

(2)   Refer to the "6.6 High-Speed Serial Communication-Capable Terminal Block" for the detailed specifications of the multi-winding motor drive system card.

6.6 High-Speed Serial Communication-Capable Terminal Block OPC-VG1-TBSI

6.6.1 Product overview

6.6.1.1 Multiplex system

Connecting two or more FRENIC-VG inverters equipped with a high-speed serial communication-capable terminal block via optical fiber cables configures a multiple inverter system (multiplex connection) that makes it possible to drive large-capacity motors.

The maximum capacity of the FRENIC-VG unit is 630 kW. To drive a 1200 kW motor, connect three 400 kW inverters or two 630 kW ones.

■ Multiwinding motor drive (o33 = 1)

(1) Overview

This optional terminal block enables the FRENIC-VG to drive an induction motor (hereafter referred to as "motor") with 2 to 6 windings (hereafter referred to as "multiwinding").

The command to specify how much current each winding of the motor should bear is given in a moment from the master inverter to each slave inverter, via the high-speed serial communications link (optical link) using the optical fiber cable. Each inverter controls the current of each winding, enabling a multiwinding motor.

(2) Wiring saving

Like the standard models, the master inverter issues run and speed commands to the motor and connects the motor encoder for feedback (not required for sensorless control). The slave inverter does not require signal connection for run and speed commands.

(3) Switching between multiwinding motor drive and single-winding motor* drive

*Single-winding motor: Standard motor, etc.

After driving a multiwinding motor, the individual inverters can switch to a single-winding motor drive with a digital input signal. At the same time, the motor parameters to be used can be switched with the digital input signal.

Note that, if the PG or NTC signal is used, switch these signals externally (Separate option: MCA-VG1-CPG). For switching the secondary power lines, use an electromagnetic contactor (MC).

■ Direct parallel connection control system (o33 = 2)

(1) Overview

This optional terminal block enables this control system in which two or more inverters are connected in parallel to drive a single motor. The voltage command and current detection information are transferred in a moment from the slave inverters connected in parallel, via the high-speed serial communications link (optical link) using the optical fiber cable.

The master inverter carries out the current control (feedback control) for slave inverters, enabling motor drive in parallel connection.

(2) Features

① Multiplexing two or more inverters of small capacity makes it easier to recover from failures or replace inverters than the system configured with a single inverter of large capacity.

② It is possible to eliminate a faulty inverter(s) from the multiplex system and recover the system quickly without wiring change.

  • If some inverters go wrong during operation, the remaining normal ones can restart (reduced-inverters operation).

  • According to the load condition, the number of inverter units to be used can be changed (reduced-inverters operation).

  The reduced-inverters operation has the effect of energy saving by loss reduction during operation. Note that reducing the inverters without wiring change is possible from 2 units to 1 unit or from 3 units to 1 unit. ("From 3 units to 2 units" is available soon.)

③ Depending upon the machine specifications and load conditions, auto search for idling motor speed or pull-in operation with the reduced number of inverters is possible from a coast-to-stop state caused by a trip.

6.6.2   Model and specifications

6.6.2.1   Model

Model elements: OPC-<u>VG1</u>-<u>TBSI</u>

Name of equipped inverter VG1 -> FRENIC-VG

Option name: TBSI -> High-speed serial communication-capable terminal block
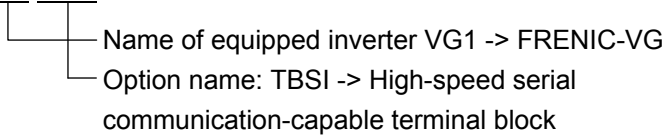
Accessories

Plastic optical fiber cable (with connector) x 1, 5 m

6.6.2.2   Specifications

⚠CAUTION
・ The system will not operate correctly if the function code setting is not correct. Read the instruction below and set them accordingly.

Table 6.6.1   Communication Specifications

Item	Specifications
Data transmission method	Loopback method Asynchronous serial communication using plastic optical fiber
Transmission rate	2.5 Mbps
Error check method	Hardware: parity, framing, overrun Software: BCC, timeout monitoring
Transmission distance	When using the plastic optical fiber cable: 5m (0 to 70°C)/Inter-inverter (Contact us if a cable longer than 5m is required.)

Table 6.6.2   Plastic Optical Fiber Cable Specifications

Item	Min.	Max.	Unit	Remarks
Storage temperature range	-40	+75	°C	
Tension		50	N	30 minutes or less
Short-time bending radius	10	—	mm	Will stop operation within one hour and the inter-inverter link error Er-b occurs.
Long-time bending radius	35	—	mm	If bent for 35 mm or less for a long period of time, the inter-inverter link error Er-b may occur. Curvature should be kept 35 mm or more.
Tensile strength (long time)	—	1	N	
Flexibility	—	1000	Times	Bend for 90 degrees on 10 mm mandrel (core bar, main axis)
Shock	—	0.5	kg	Shock test is in accordance with MIL-1678, Mothod2030, Procefurel.
Guaranteed minimum distance	10		m	Minimum guaranteed value due to transmission loss (0 to 70°C)
Weight	4.6		g/m	

Table 6.6.3 Software Specifications

Item		Specifications
Applicable inverter capacity		■ Multiwinding motor control system HD/LD/MD specifications (up to 630 kW x 6-winding available) ■ Direct parallel connection control system HD/LD/MD specifications (up to 630 kW x triple-multiplex available)
Motor control method		■ Multiwinding motor control system Vector control with speed sensor (Other controls are not available.) ■ Direct parallel connection control system Vector control with/without speed sensor, V/f control (available soon) (Note: Synchronous motor control is not available.)
Speed control	Maximum output frequency	120 Hz
	Control scope	1:1500 (vector control), 1:250 (sensorless control)
	Control accuracy	±0.005% of maximum speed (digital), ±0.1% (analog, 25±10°C)
	Setting resolution	0.005% of maximum speed
Multiplex system control		System definition is configured using the function code o33 "Multi-system control method". 0: Single-winding motor drive (Factory default) 1: Multiwinding motor control system 2: Multiplex system 1 (Direct parallel connection control system) 3: Multiplex system 2 4, 5: Reserved
Switching between multiwinding and single-winding motor drive		Dynamic switching by digital input signal ***MT-CCL***
Station address setting		The inverter station address is set using the function code o50 "Multi-system station address setting". For example, set the master to "0", slave 1 to "1", and slave 2 to "2".
Slave count setting		The number of optically linked slaves is set using the function code o34 "Multi-system slave count setting". For example, when four inverters are linked, the number of slaves is "3".
Functional restrictions		1) The multiplex system cannot be configured with inverters of different capacities. 2) The multiplex system cannot be configured together with older series of inverters (VG5, VG7). 3) The multiplex system disables the following functions. - Motor parameter tuning function (H01)* - Auto-reset function (H04) - Protective function for output phase loss OPL (H103, tenth digit) - Online tuning function (P32, A52, A152) - Phase sequence configuration of main circuit output wires (H75) The direct parallel connection control system is available. Note that the multiplex slave units have restrictions on I/O and monitors. See Section 6.6.7. 4) In the direct parallel connection control system, the carrier frequency is fixed at 2 kHz. Function code F26 (Motor sound, Carrier frequency) allows the setting other than 2 kHz; however, the carrier frequency is internally fixed at 2 kHz.

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Item		Specifications
Protective function	Protective function occurrence process	All unit batch alarm mode: Keypad alarm mode All unit batch alarm output: 30x output All unit batch inverter output shutdown However, all units should coast to stop with an external sequence upon 30x operation.
	Communication alarm function Operation procedure alarm function	Due to a communication error of the optical fiber cable or setting error of a related function code, the inter-inverter link error Er-b or operation procedure alarm operation Er-6 occurs.
	Protective function cancellation process	By giving the reset command to any of the units optically linked, all units will be batch reset.

6.6.3   External dimensions

(Unit: mm)
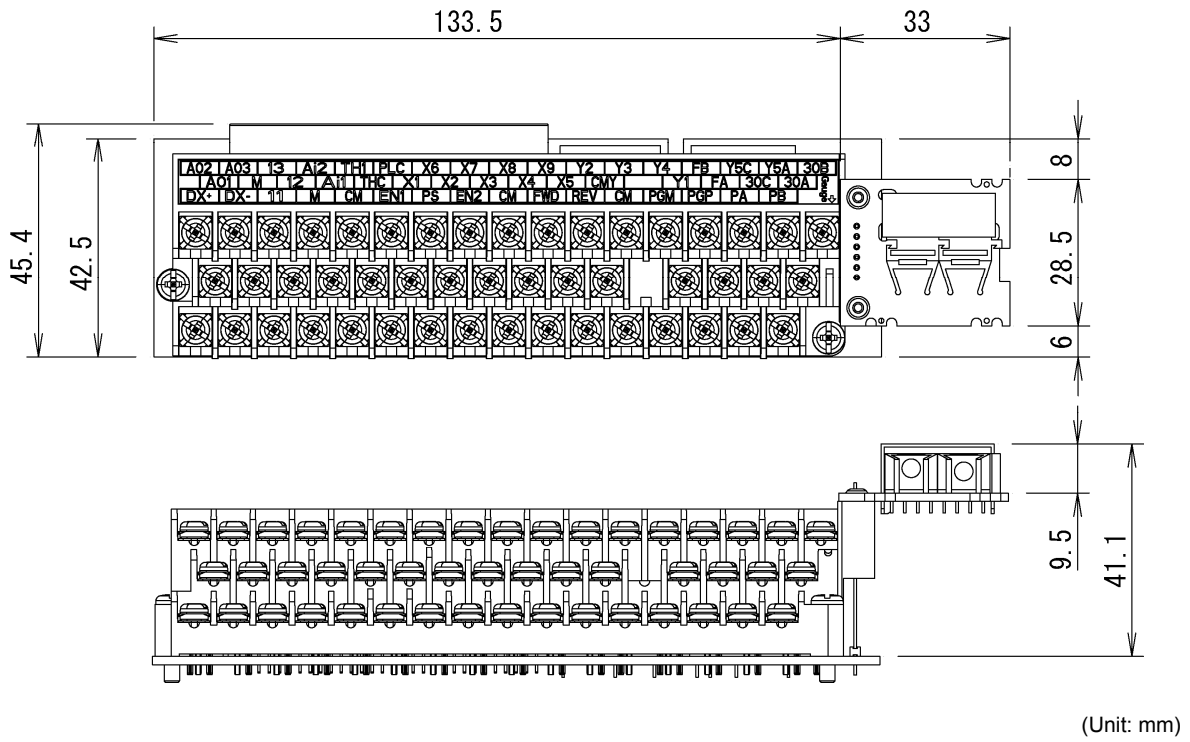
Figure 6.6.2   External Dimensions of Option

Connector with lock
(light gray)

Optical plastic cable

Connector with lock
(dark gray)
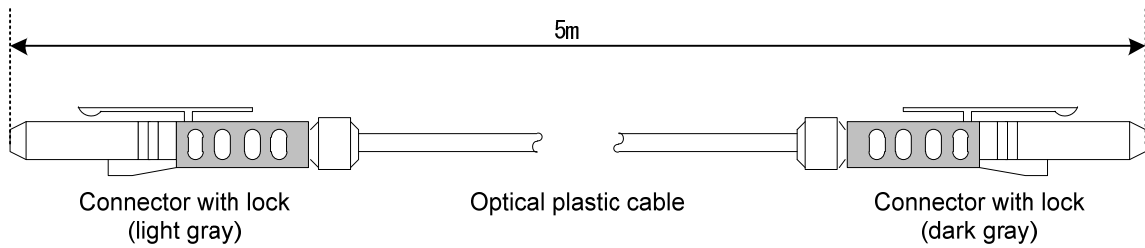
Figure 6.6.3   Plastic Optical Fiber Cable (Accessory)

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6.6.4   Connecting optical fiber cable

⚠ **WARNING**

・ Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock.

・ Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠ **CAUTION**

・ Do not use the product that is damaged or lacking parts to prevent an injury or damage.

・ Incorrect handling in installation/removal jobs could result in a broken product.

⚠ **CAUTION**

・ The cable may be pinched by the surface cover. To protect the cable, it is required to attach a fixing jig to guide the route or spiral tube around the cable.

・ If the plastic optical fiber is bent with curvature of 35 mm or less for a long period of time, the inter-interval link error "Er-b" may occur to generate an alarm, causing the inverter output shutdown and leaving the motor to coast to stop. Keep the curvature 35 mm or more.

・ The plastic optical fiber allows a strong light (e.g., flashlight) to pass. A strong light may cause the inter-interval link error "Er-b" to generate an alarm.

Use the supplied optical fiber cable to connect the inverter and the high-speed serial communication-capable terminal block. Note that the colors of the plugs at the ends of the cable are different; light gray and dark gray. Be sure to match the colors of the plug and connector when connecting them. Connect the inverters in a daisy-chain method. For example, when connecting three inverters (1, 2, and 3), use three cables to connect them in a loop in such a way: **1→2→3→1**.

Table 6.6.4   Optical Connectors of High-Speed Serial Communication-Capable Terminal Block

Part number	Name	Color	Overview
T-1528	TX	Light gray	Transmitter (optical communication)
R-2528	RX	Dark gray	Receiver (optical communication)

OPC-VG1-TBSI
slave

Dark gray   Light gray
(reception)   (transmission)

R-2528   T-1528

Dark gray   Light gray
(reception)   (transmission)

OPC-VG1-TBSI
master

Dark gray   Light gray
(reception)   (transmission)

R-2528   T-1528

Dark gray   Light gray
(reception)   (transmission)

Figure 6.6.3

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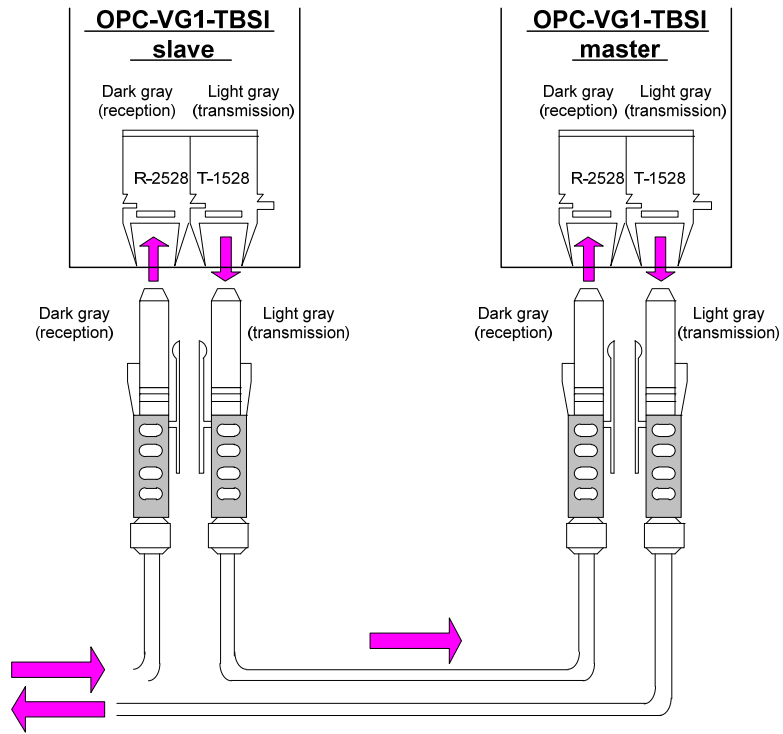
6.6.5　Basic connection diagrams

6.6.5.1　Connection diagram of multiwinding motor control system

⚠ WARNING
・ For safety, design the external circuit so that all inverter units should coast to stop when an alarm occurs (30x operation).

A connection example is shown below.
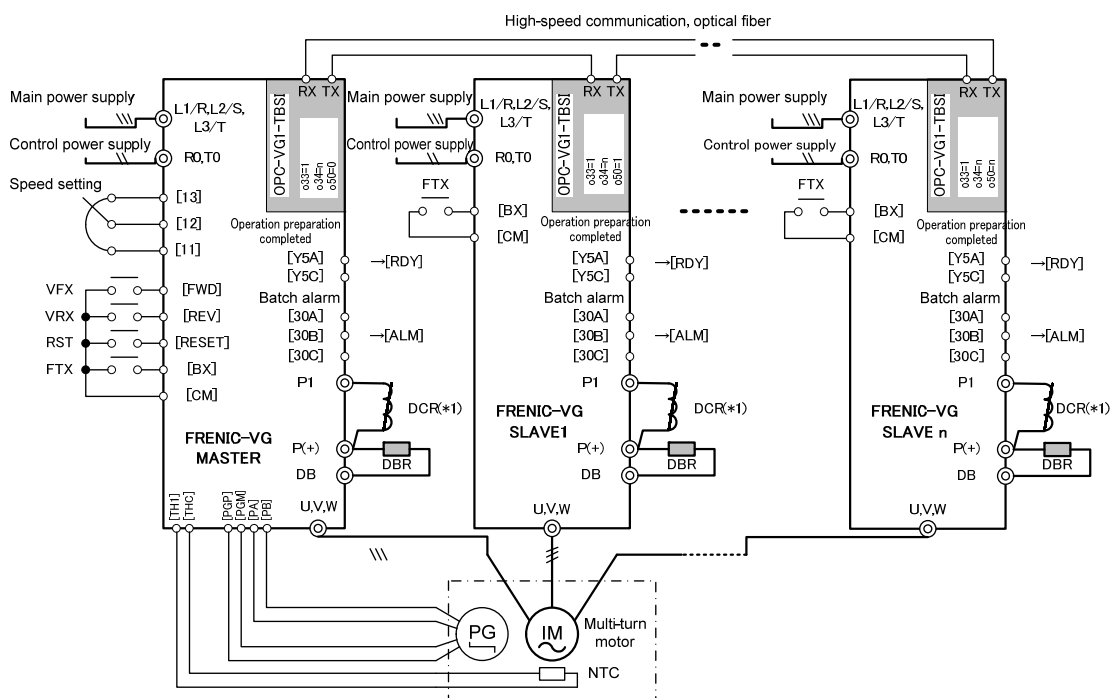
Figure 6.6.4

Special notices

(1) For safety, make sure that all inverter units should coast to stop when an alarm occurs (30x operation). Coast to stop command should be input to the contact BX.

(2) Make sure that FWD and REV are available only when all inverter units are ready for operation (RDY). This example shows an example where the operation ready signal is assigned to the relay output.

(3) The reset command (RST) to the master inverter unit can cancel alarms of all inverter units.
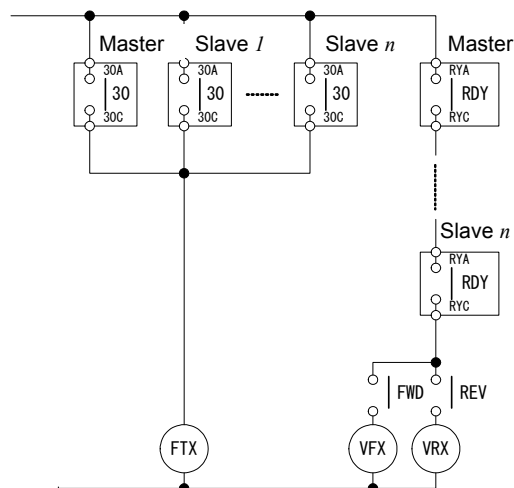
Figure 6.6.5

Note

(1) The DC reactor (DCR) is optional for 55 kW or lower and included for 75 kW or higher.

(2) Braking resistor (DBR) is optional.

Multiwinding motor specifications

Common-mode current is applied to the common-mode windings.
This drives a motor with capacity of the summed number of inverters.
For example, by using four (n = 4) 200 kW inverters to drive a four-winding motor, up to 800 kW output is available.
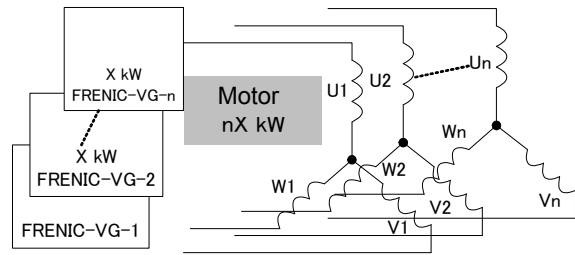
Figure 6.6.6

The relationship between the number of windings and the number of motor poles is as listed below because the former should be a divisor of the latter.

Table 6.6.5

Number of windings (n)	4P	6P	8P	12P
2	○	○	○	○
3	-	○	-	○
4	○	-	○	○
5	-	-	-	-
6	-	○	-	○

6.6.5.2 Connection diagram of direct parallel connection control system

6.6.5.2-1 Double-multiplex direct parallel connection

⚠ WARNING

· For safety, design the external circuit so that all inverter units should coast to stop when an alarm occurs (30x operation).

The following shows an example of two inverters used in direct parallel connection.

This connection diagram shows a configuration which has considered operation with reduced number of units. When operation with reduced number of units will not be conducted, elimination of inverter output contactors and simplification of operation sequence is possible.
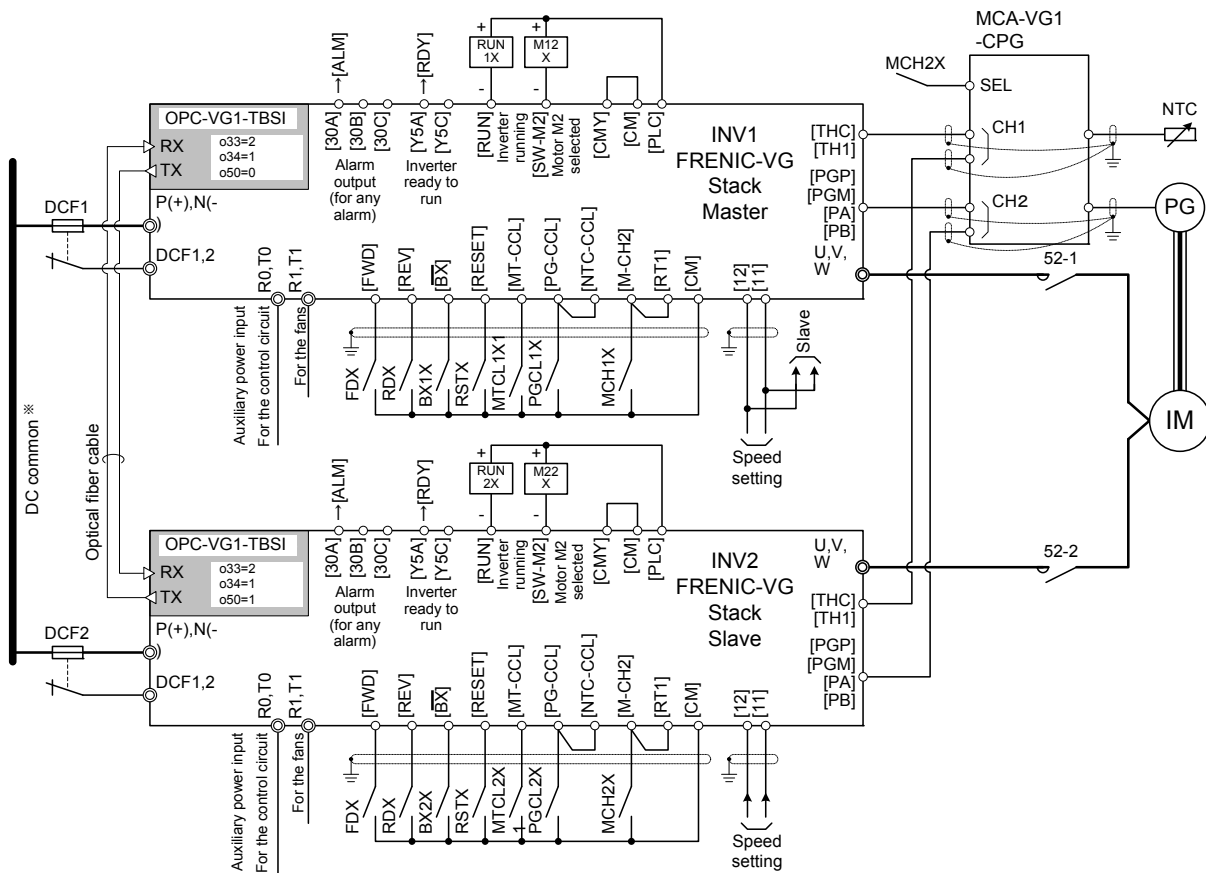
*Be sure to connect inverter units to the DC common.
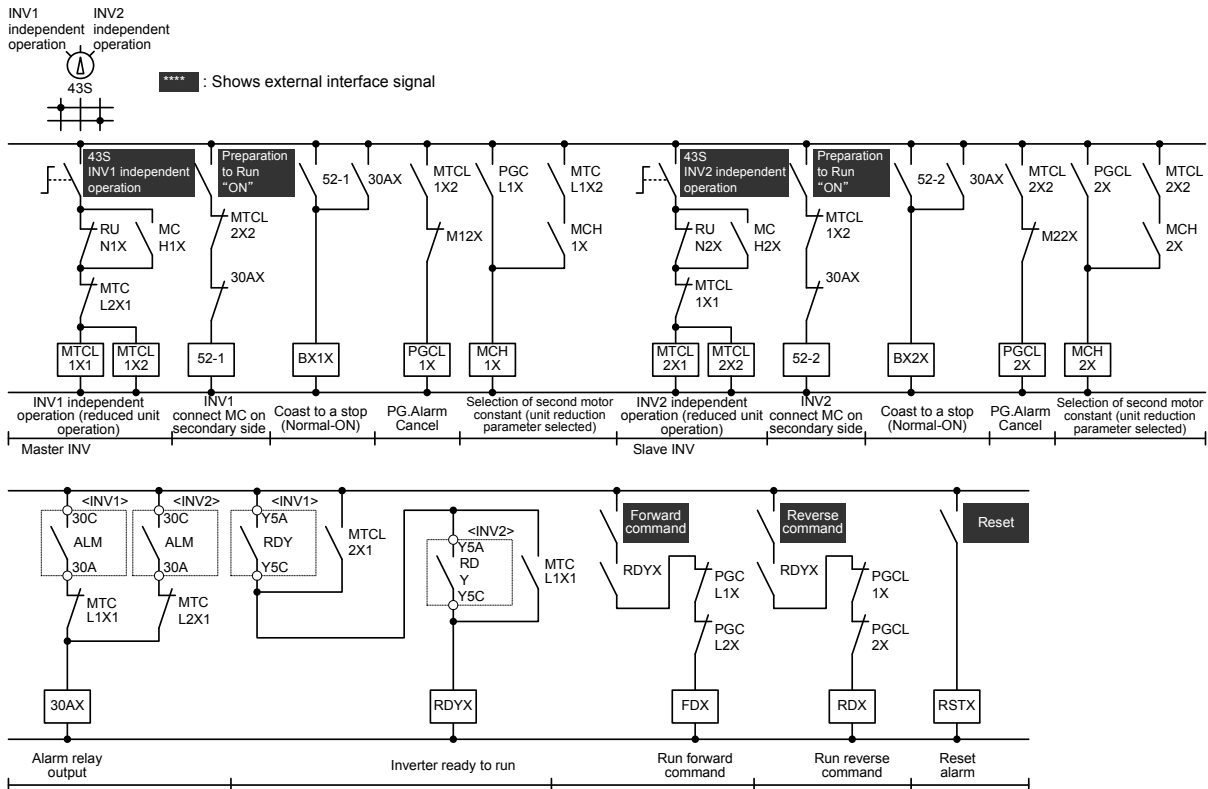
Figure 6.6.7 Basic Configuration for Direct Parallel Connection Control System Using Two Inverters

<Supplementary Explanation for the Connection Diagram>

Basic items

1) For safety, when alarm is activated (30X actuated) input free run command [BX] to the two inverter units.

   In the connection diagram shown, the free run command **is configured to normally on (ordinarily closed, open signifies free run command)**. This input should be constructed by hardware circuit for safety.

2) Configure the two inverters such that after operation preparation is complete [RDY], FWD and REV can be turned ON. The diagram shows the case where the operation preparation complete function is allocated to relay output.

3) The alarm of slave inverters can be released by the reset command [RST] of the master inverter.

4) For installations into facilities which restart after instantaneous power failures, use the running restart function which searches the direction and speed of free running rotation and picks up smoothly to reengage drive.

6.6.5.2-2 Triple-multiplex direct parallel connection

Circuit configuration for the case where operation with reduced number of units is not conducted, using three units in Direct Parallel Connection System, is shown below.

The relay circuit for the case of two units used in direct parallel connection is the same as in the diagram below if operation with reduced number of units is not conducted.
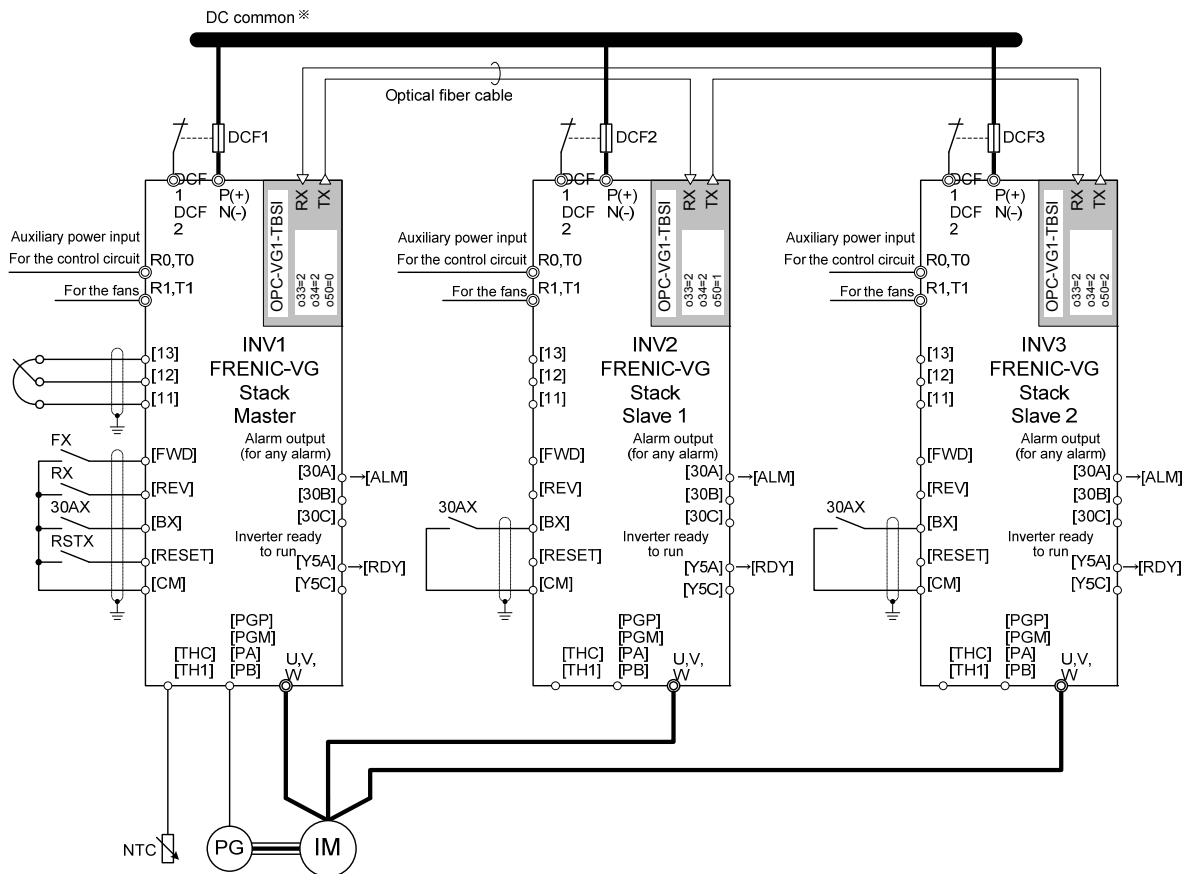
*Be sure to connect inverter units to the DC common.
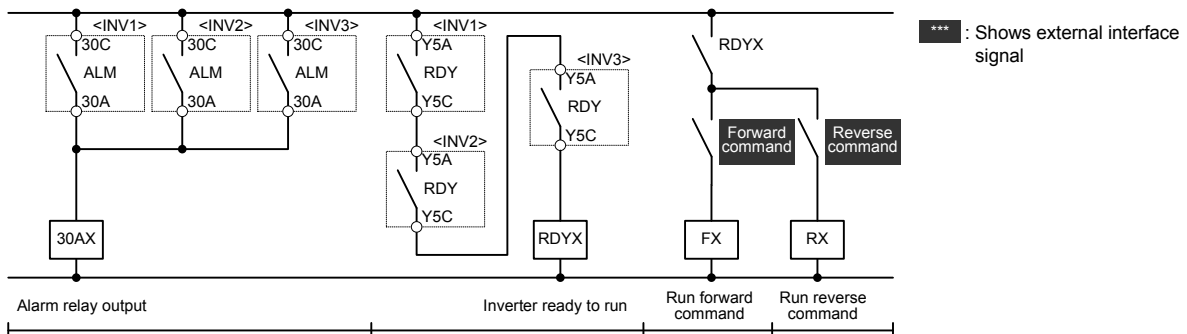
Figure 6.6.7 Basic Configuration (Without Operation in Reduced Number of Units) for Direct Parallel Connection System Using Three Inverters

<Supplementary Explanation for Connection Diagram>

1) For safety, when alarm is activated (30X actuated) input free run command [BX] to the three inverter units.

    This input should be constructed by hardware circuit for safety.

2) Configure the three inverters such that after operation preparation is complete [RDY], FWD and REV can be turned ON.

3) The alarm of slave inverters can be released by the reset command [RST] of the master inverter.

4) When installing into facilities which restart after instantaneous power failures, use the running restart function which searches the direction and speed of free running rotation and picks up smoothly to reengage drive.

5) The operation with reduced number of units from 3 units to 2 units, without change in wiring, **will be supported soon**.

    The current method requires changing the optical fiber cable connections and modifying the function code settings to realize the configuration for Direct Parallel Connection System using two units. Additionally, operation with reduced number of units from 3 units to 1 unit is possible. Refer to "6.6.11" for information.

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6.6.6 Configuration of function codes

Multiplex system requires configuring the function codes as listed below.

Table 6.6.6

No.	Name	Description
o33	Multiplex system (Control mode)	Select the control mode of the multiplex system.
o34	Multiplex system (No. of slave stations)	Specify the number of slave stations.
o50	Multiplex system (Station address assignment)	Assign the station address on the high-speed serial communications link terminal block (OPC-VG1-TBSI).
E01 to E13	X Terminal Function	57: Cancel multiplex system $\qquad$ *MT-CCL*
E15 to E27	Y Terminal Function	51: Multiplex system communications link being established *MTS* 52: Answerback to cancellation of multiplex system $\qquad$ *MEC-AB* 53: Multiplex system master selected $\qquad$ *MSS* 54: Multiplex system local station failure $\qquad$ *AL-SF*

---

o33	**Multiplex System (Control mode)**

o33 selects whether or not to use a high-speed serial communications terminal block OPC-VG1-TBS1 as a component of the multiwinding system or multiplex system

Refer to *MT-CCL* (Cancel multiplex system) in the description of E01 to E13 (Terminal X Function).

```
o 3 3 M W S   A C T I V E
```

Data setting range   0: Single-winding motor drive
            1: Multiwinding motor control system
            2: Direct parallel connection control system
            3 to 5: Reserved

---

o34	**Multiplex System (No. of slave stations)**

o34 specifies the number of slave inverter units connected via the optical fiber cable. Note that this is not the number of all inverters including the master.

```
o 3 4 M W S   S L A V E S
```

Data setting range: 1 to 5

Data setting range   1: 1 master + 1 slave = System with total of 2 units
            2: 1 master + 2 slaves = System with total of 3 units
            3: 1 master + 3 slaves = System with total of 4 units
            4: 1 master + 4 slaves = System with total of 5 units
            5: 1 master + 5 slaves = System with total of 6 units

o50	Multiplex System (Station address assignment)

o50 assigns the station address of an inverter unit in the multiplex system configuration (optical communication, multiwinding control). When o59 = 0, the inverter unit is defined as a master; when o59 ≠ 0, it is defined as a slave.

A setting discrepant in the system configuration, such as o50 > o32, causes an alarm $Er\text{-}6$.

```
o 5 0 M W S   S T − N O
```

Data setting range: 0 to 5

Data setting range 0: Master station
1: Slave station 1
2: Slave station 2
3: Slave station 3
4: Slave station 4
5: Slave station 5

The selection states of master and slave units can be checked with the following.

1. Digital signal **MSS** status (Multiplex system master selected)
    On the inverter unit that is defined as a master, the **MSS** signal is ON.

2. Menu #3 "OPR MNTR," page 3, (5) Drive control on the keypad
    Refer to Table 3.4-8, item (5) in Chapter 3.
    On page 3 in Menu #3, the selection states of master and slave units can be checked.

Configuration example

(1)   2-unit system
Set o34=1 for all systems.

(2)   4-unit system
Set o34=3 for all systems.

Note: Set the multi-system station addresses (o50) in the order connected to the master.
<Bad setting example>
Master (o50=0), slave 1 (o50=2)
Slave 2 (o50=1), slave 3 (o50=3)
* Bad setting is underlined.
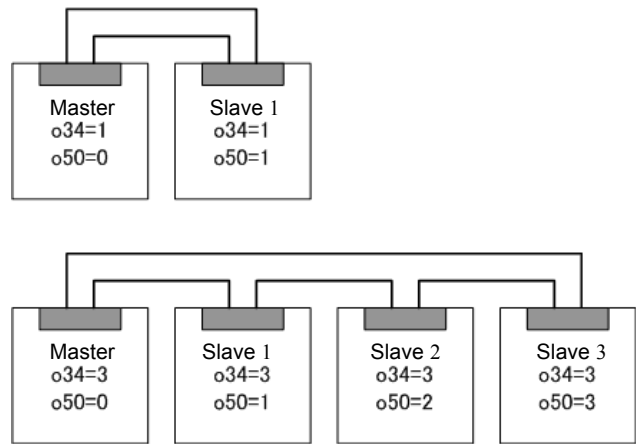
Figure 6.6.9

When the o34 setting is not correct, no alarm occurs or the system may not operate. Check the setting again.

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6.6.7　Operation procedure

6.6.7.1　Preparation

⚠**CAUTION**

・ After installation, cabling, and switch setting have been done, check the following before powering on the inverter:

　(1) Cabling is correct.

　(2) No wire dust or screw is left.

　(3) Screws and terminals are not loose.

　(4) Wire of the press-fit terminal does not contact other terminals.

Refer to Chapter 3 "Preparation and Test Run" for preparation.

(1) Power on

⚠**CAUTION**

If any one of the inverter units within a multi-winding system is not powered on and operation is started, the inter-inverter link error "$Er\text{-}b$" occurs. However, no alarm will be indicated until you start operation (FWD, REV).

It is not required to power on the inverters simultaneously or power them on in a particular sequence. Since no alarm will be indicated until you start operation (FWD, REV), you can power them on in an arbitrary order.

(2) Setting before operation

⚠**CAUTION**

Some function code settings need to be the same between the master and slave(s). If they differ, normal operation is not possible.

Set the following function codes to the same values for the master and slave(s) before operation. While they are set to the same values at factory, you need to check them again.

Table 6.6.7

Codes set to be same	Function	Remarks
F03 - F05, P, A all codes	Motor parameters	Be sure to set them correctly.
F14	Restart Mode after Momentary Power Failure (Mode selection)	Be sure to set them correctly.
F36	30Ry mode	Required to design a failure sequence externally.
F60	Output Unit (HP/kW)	Be sure to set them correctly.
F79	Motor Selection (M1, M2, M3)	Be sure to set them correctly.
F80	Current rating switching	Be sure to set them correctly.
o33 and o34	Multiplex system dedicated codes	Be sure to set them correctly.
H30	Communications Link Function (Link operation)	Be sure to set them correctly.
H106 to H111	Light Alarm Object Definition 1 to 6	Be sure to set them correctly.

(3) Checking the optical communications link

⚠CAUTION

Unless the optical communications link is established in the multiplex system, the **RDY** signal (Inverter ready to run) cannot be established so that the inverter does not accept a run command (**FWD**, **REV**). If this happens, no alarm is detected.

Whether the optical communications link is established can be checked with the following.

• Digital signal **MTS** status (Multiplex system communications link being established)
When the optical communications link between master and slaves is normally established, all inverter units in the multiplex system turn ON the **MTS** signal.

If the optical communications link is not established, check the following.

(1) Configuration of function codes on each inverter (refer to Section 6.6.6).

(2) Optical cable

　1) No connection or incomplete insertion to the connector.

　2) Rolled up with curvature of 30 mm or less. Bent.

　3) Mismatch between the color of the optical cable plug and that of the connector (gray or dark blue) on the printed circuit board.

　4) No loop formed. Signals sent from the master should be looped back.

6.6.7.2　Operation method

⚠CAUTION

・ Give the operation and speed commands to the master only.

・ Connect the PG and NTC feedback signals to the master only.
(PG connection is not necessary for sensorless operation.)

・ If the feedback is supplied to the slave(s) only, correct operation is not possible.

• Operation and command input

Give the commands (speed, torque, torque limiting) to the master inverter unit only. Optically linked slave inverter units can be considered as hardware which only controls current.

The operation method and command input method are the same as the standard product.
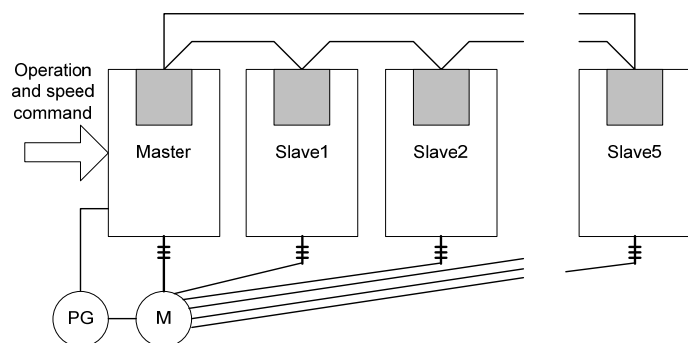
Figure 6.6.10

6.6.8　Protective Functions

```
⚠ WARNING
```

・ In a multi-system with two or more inverter units, if any one of the inverter enters an alarm state due to some reason, continuing operation with the remaining unit(s) may not be able to provide sufficient torque and normal operation of the system may not be possible. To prevent this situation, the multi-system puts all inverters linked via the high-speed serial communication-capable terminal block in the alarm state in a moment (within several milliseconds). You also need to design a sequence to stop all the inverters using 30X (Batch alarm output).

・ After the inverter protective function has acted and the cause has been removed, giving the alarm reset signal with the operation command ON (closed) will start the inverters. To prevent an injury, check that the operation command is OFF (open) before giving the alarm reset signal.

```
⚠ CAUTION
```

・ If the optical cable connecting the inverters get broken during operation, correct operation becomes impossible and the inverters are forced to enter the alarm state (inter-inverter link error Er-b). The motors will coast to stop. This alarm does not act while the inverter is stopped.

6.6.8.1　Process in Protective Operation

(1) Batch alarm process

When the master inverter unit enters the alarm state, the alarm is indicated on all stations via the optical link, the 30X operation is executed, and the inverters are shut down.

* "o" (other station) is shown for alarm indication on the slave inverters.

Example: Inter-Inverter Link Error (Er-b)
Master inverter unit alarm indication ：Er-b
Slave inverter unit alarm indication ：oEr-b

When a slave inverter unit enters the alarm state, the alarm is indicated on all stations via the optical link, the 30X operation is executed, and the inverters are shut down.

* "o" (other station) is shown for alarm indication on the master inverter.

Example: Inter-Inverter Link Error (Er-b)
Master inverter unit alarm indication ：oEr-b
Slave inverter unit alarm indication ：Er-b

(2) Reset process

When giving the reset command from the master, all stations are batch reset if the alarm cause has been removed.

When giving the reset command from a slave, all stations are batch reset if the alarm cause has been removed.

(3) Disabling disconnection detection

The slave inverter unit does not require feedback of the PG and NTC signals. Therefore, on an inverter configured as a slave in a multi-system, PG and NTC disconnection detection is disabled.

6.6.8.2   Processing for light alarms

In the multiplex system, if the inverter detects a light alarm, it does not inform other stations of the occurrence of a light alarm. It just displays the light alarm on itself.

To use the light alarm function, configure H106 to H108 so that the settings are the same on the master and slave units. To cancel the light alarm state, check that the alarm cause is removed and use a reset command for any one of the master and slave units. This reset operation cancels the light alarm states on all stations.

6.6.8.3   Inter-inverter link error ($\mathit{Er}\text{-}b$)

If the optical cable connecting the inverters get broken or comes off from the connector during operation, the inverters are forced to enter the alarm state with the inter-inverter link error $\mathit{Er}\text{-}b$, and the motors will coast to stop.

$\mathit{Er}\text{-}b$ can occur if a related function code is not set correctly.

While the alarm cause is not resolved, giving the reset command (from the keypad, terminal block, or communication system) does not cancel the alarm state. Be sure to resolve the cause before resetting the system.

Troubleshooting $\mathit{Er}\text{-}b$

$\mathit{Er}\text{-}b$ can be caused by the following reasons:

(1)   The optical cable is not connected or inserted to the connector incompletely.

(2)   The optical cable is bent with curvature of 35 mm or less.

(3)   The colors of the optical cable plugs and the connectors of the print board (light gray and dark gray) do not match.

(4)   Optical cable connection does not form a loop. Be sure that signals from the master are looped back.

(5)   Multi-system station address o50 settings are duplicated.

(6)   The operation command (FWD/REV) was input before the optical link communication is established.

(7)   Strong light (e.g., flashlight) is applied to the optical fiber.

If the alarm $\mathit{Er}\text{-}b$ cannot be cancelled after checking and removing these causes, the optical cable and/or optical link option print board may be faulty. Contact your local sales office or service center.

6.6.8.4   Operation procedure error ($\mathit{Er}\text{-}6$)

The operation procedure error ($\mathit{Er}\text{-}6$) can occur in the following cases:

(1)   The multiplex system station address o50 value is greater than the number of slave o34 value.

(2)   The motor control method is set to other than vector control.

(3)   Function code o33 (Multiplex system) $\geq$ 3

(4)   Function code o33 data is switched between "1" (Multiwinding motor system) and "2" (Multiplex system 1, Direct parallel connection). Turning the power ON again can only reset the inverter.

6.6.9 I/O interface

In the multiplex system, the slave unit has the following restrictions.

(1) I/O functions

The table below lists the I/O functions available in slave units. Functions not listed are not available.

Table 6.6.8   I/O Functions

	I/O functions	Terminal symbol	Remarks
DI	Coast to stop command	BX	Causes all units of the system to coast to stop.
	Error reset	RST	Resets all units of the system.
	External alarm	THR	
	Motor M2 selection	M-CH2	
	Motor M3 selection	M-CH3	
	Keypad edit permission command	WE-KP	
	Enable data change via communications link	WE-LK	
	Enable communications link	LE	
	Universal DI	U-DI	
	Short voltage cancel	LU-CCL	
	Multi-system cancel	MT-CCL	
	Safety function input terminal	EN1, EN2	Causes all units of the system to coast to stop. However, output shutdown by hardware is done only for units which have detected the signal.
DO	Operating	RUN	Functions with the operation information from the master.
	Undervoltage detected (Inverter stopped)	LU	
	Operation preparation completed	RDY	
	Motor M2 selected	SW-M2	
	Motor M3 selected	SW-M3	
	Alarm contents	AL1 - 8	Output with alarm information from the master added.
	Cooling fan operating	FAN	
	Universal DO	U-DO	
	Cooling fin overheat prediction	INV-OH	
	Life prediction	LIFE	
	Inverter overload prediction	INV-OL	
	DB overload prediction	DB-OL	
	Transmission error	LK-ERR	
	Multi-system communication established	MTS	
	Multi-system cancel response	MEC-AB	
	Multi-system self station failure	AL-SF	
	Batch alarm	ALM	
	Light alarm	L-ALM	
	Maintenance prediction	MNT	
	Braking transistor error	DBAL	
	DC fan lock signal	DCFL	
	73 input command	PRT-73F	
	Y terminal test output ON	Y-ON	
	Y terminal test output OFF	Y-OFF	
	System clock battery lifetime expired	BATT	
	EN terminal detection circuit failure	DECF	
	EN terminal OFF	ENOFF	
AI	All invalidated		

I/O functions		Terminal symbol	Remarks
AO	Motor current	**I-AC**	
	Motor voltage	**V-AC**	
	DC intermediate voltage	**VDC**	
	+10, -10V test	**P10, N10**	

(2) Keypad function

Only the functions listed below are available in the slave. Functions not listed are not available.

① LED monitor

Table 6.6.9   LED Monitor

Name	Remarks
Detected output current value	Displays the detected current value for a single slave.
Detected output voltage value	Displays the detected voltage value for a single slave.
Detected DC intermediate voltage value	Displays the detected intermediate voltage value for a single slave.

② Operation status monitor

Table 6.6.10   Operation Status Monitor

Page	Item	Remarks
2	Detected output current (Iout)	Detected current for a single slave
	Detected output voltage (Vout)	Detected voltage for a single slave
3	Current rating	Slave status
	Motor selected	Slave status
	Drive control	Slave status
	Current limit	Slave status
	Undervoltage/Voltage limit	Slave status
	Cause of trip	Slave status (only BX supported)

③ I/O check

Table 6.6.11   I/O Check

Page	Item	Page	Item
1, 2	Digital input signals at the control circuit terminal block	8	M1 to M3: Motor selection
3	Digital input signals via communications link	9, 10	Mounting status of control options
4	Transistor output common	14	AIO option input status
5	Analog input signals	16	DIOA option input status
6	Analog output signals	17	DIOA option output status
7	INT: Inverter shut off		
	NUV: DC link circuit voltage established		
	VL: Voltage limiting		
	IL: Current limiting		
	ALM: Alarm relay output		

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④ Maintenance

On slave units, the input watt-hour (Wh) and cumulative power data (PD) are fixed at "0" on the display. Other items show the actual slave states.

⑤ Load rate measurement

Slave units can measure only the maximum current and average current. The average braking power is fixed at 0%.

Table 6.6.12   Load Rate Measurement

Item	Display content
Maximum current (Imax)	Maximum current for a single slave
Average output current（Iave）	Average current for a single slave

⑥ Alarm information

Slave units support alarm information about items available in ② to ④ above.

*Alarm causes, data copy, and others are all enabled.

(3) Function code (F - U)

You can use the master in the same way as the standard product. The functionality of the slave is restricted as listed below. Refer to the following table to confirm the restrictions on the slave. In particular, make sure to set the codes indicated as "1" to the same values between the master and slave.

> 0: Setting is disabled.
> 1: Setting is enabled (and must be the same as the master).
> 2: Setting is enabled (and does not need to be the same as the master).
> 3: Setting is enabled (and setting specific to multi-winding is necessary).

Table 6.6.13   F00 to F85 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
F00	2	F11	0	F24	0	F42	0	F51	0	F60	1	F69	0	F80	1
F01	0	F12	0	F26	0	F43	0	F52	0	F61	0	F70	0	F81	0
F02	0	F14	1	F27	0	F44	0	F53	0	F62	0	F73	0	F82	0
F03	1	F17	0	F36	1	F45	0	F54	2	F63	0	F74	0	F83	0
F04	1	F18	0	F37	0	F46	0	F55	2	F64	0	F75	0	F84	0
F05	1	F20	0	F38	0	F47	0	F56	2	F65	0	F76	0	F85	0
F07	0	F21	0	F39	0	F48	0	F57	2	F66	1	F77	0		
F08	0	F22	0	F40	0	F49	0	F58	2	F67	0	F78	0		
F10	0	F23	0	F41	0	F50	0	F59	2	F68	0	F79	1		

Table 6.6.14   E01 to E118 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
E01	2	E14	2	E27	2	E40	0	E53	0	E66	0	E79	2	E106	0
E02	2	E15	2	E28	2	E41	0	E54	0	E67	0	E80	2	E107	0
E03	2	E16	2	E29	0	E42	0	E55	0	E68	0	E81	2	E108	0
E04	2	E17	2	E30	0	E43	0	E56	0	E69	2	E82	2	E109	0
E05	2	E18	2	E31	0	E44	0	E57	0	E70	2	E83	2	E110	0
E06	2	E19	2	E32	0	E45	0	E58	0	E71	2	E84	2	E114	0
E07	2	E20	2	E33	2	E46	0	E59	0	E72	2	E90	0	E115	0
E08	2	E21	2	E34	0	E47	0	E60	0	E73	2	E91	0	E116	0
E09	2	E22	2	E35	0	E48	0	E61	0	E74	2	E101	0	E117	0
E10	2	E23	2	E36	0	E49	0	E62	0	E75	2	E102	0	E118	0
E11	2	E24	2	E37	0	E50	0	E63	0	E76	2	E103	0		
E12	2	E25	2	E38	0	E51	0	E64	0	E77	2	E104	0		
E13	2	E26	2	E39	0	E52	0	E65	0	E78	2	E105	0		

Note: For E01 - E13, E15 - E27, and E69 - E73, only the functions listed in Table 6.6.8 are available.

*   C01 - C73: All 0

*   P01 to P27: 1, P28 to P51: 0

Table 6.6.15   H code on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
H01	0	H20	0	H36	2	H53	0	H74	0	H90	0	H118	0	H148	0
H02	2	H21	0	H37	2	H55	0	H75	0	H103	2	H125	0	H149	0
H03	2	H22	0	H38	2	H56	0	H76	2	H104	2	H126	0		
H04	0	H23	0	H39	2	H57	0	H77	2			H127	0		
H05	0	H24	0	H40	2	H58	0	H78	2	H106	1	H134	0		
H06	2	H25	0	H41	0	H60	0	H79	2	H107	1	H135	0		
H08	0	H26	0	H42	0	H61	0	H80	2	H108	1	H136	0		
H09	0	H27	0	H43	0	H62	0	H81	2	H109	1	H137	0		
H10	0	H28	0	H44	0	H63	0	H82	2	H110	1	H138	0		
H11	0	H29	2	H46	0	H64	0	H83	2	H111	1	H140	0		
H13	0	H30	1	H47	0	H65	0	H84	2	H112	0	H141	0		
H14	0	H31	2	H48	0	H66	0	H85	2	H113	0	H142	2		
H15	0	H32	2	H49	0	H67	0	H86	2	H114	0	H144	0		
H16	0	H33	2	H50	0	H68	2	H87	2	H115	0	H145	0		
H17	0	H34	2	H51	0	H70	0	H88	2	H116	0	H146	0		
H19	0	H35	2	H52	0	H71	0			H117	0	H147	0		

* H codes except the above listed ones: All 0

* A01 to A29, A61: 1, A30 to A60, A62 to A71: 0
  A101 to A129, A161: 1, A130 to A160, A162 to A171: 0

Table 6.6.16   o code on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
o11	1	o30	2	o33	3										
		o31	2	o34	3										
		o06	2	o50	3										

* o codes except the above listed ones: All 0

* L code: All 0

* U code: All 2

* SF code: All 0

(4) Function code (S: Command data)

You can use the master in the same way as the standard product. The functionality of the slave is restricted to S06 "Operation command 1" and S07 "Universal DO". However, the functions listed in Table 6.6.8 are only available.

(5) Function code (M: Monitor)

You can use the master in the same way as the standard product. The functionality of the slave is restricted as listed below. Refer to the following table to confirm the restrictions on the slave.

> 0: Data becomes 0.
> 1: Data is valid.
> 2: Data is valid (shows data specific to multi-winding)

Table 6.6.17   M code on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
M01	0	M26	1	M51	0	M77	0	M109	0	M136	1	M163	0	M220	0
M02	0	M27	0	M52	1	M78	0	M110	0	M137	1	M164	0	M221	0
M03	0	M28	0	M53	1	M79	1	M112	0	M138	1	M165	0	M222	0
M04	0	M29	0	M54	1	M80	1	M113	0	M139	1	M166	1		
M05	0	M30	0	M55	1	M81	1	M114	0	M140	1	M167	0		
M06	0	M31	0	M56	1	M82	1	M115	0	M141	1	M168	0		
M07	0	M32	0	M57	1	M83	1	M116	0	M142	1	M169	0		
M08	0	M33	0	M58	1	M84	1	M117	0	M143	1	M170	1		
M09	0	M34	0	M59	1	M85	1	M118	0	M144	1	M171	1		
M10	0	M35	0	M60	1	M86	1	M119	1	M147	0	M172	1		
M11	1	M36	0	M62	1	M91	1	M120	1	M148	1	M173	0		
M12	1	M37	1	M63	1	M92	1	M121	1	M149	1	M174	0		
M13	1	M38	1	M64	1	M93	1	M123	1	M150	1	M175	1		
M14	1	M39	1	M65	1	M94	1	M124	1	M151	1	M176	1		
M15	1	M40	1	M66	1	M95	1	M125	1	M152	1	M177	0		
M16	1	M41	1	M67	1	M96	1	M126	1	M153	1	M178	0		
M17	1	M42	1	M68	1	M100	1	M127	1	M154	1	M179	0		
M18	1	M43	1	M69	1	M101	1	M128	1	M155	1	M180	0		
M19	1	M44	1	M70	2	M102	1	M129	1	M156	1	M181	1		
M20	1	M45	1	M71	1	M103	0	M130	0	M157	1	M182	1		
M21	1	M46	1	M72	1	M104	1	M131	1	M158	1	M183	1		
M22	0	M47	1	M73	1	M105	1	M132	1	M159	1	M184	1		
M23	1	M48	1	M74	1	M106	0	M133	1	M160	1				
M24	1	M49	1	M75	2	M107	0	M134	1	M161	0				
M25	1	M50	0	M76	1	M108	0	M135	1	M162	0				

*   M codes except the above listed ones: All 0

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6.6.10 Switching between multiwinding and single-winding motor drive (Multiwinding system)

You can cancel the multi-winding motor drive and switch to the normal single-winding motor drive using the external digital input signal MT-CCL.

Figure 6.6.8 shows a simple connection example to switch between the two-winding and single-winding motor drive. In this case, the slave unit does not need run commands as well as the PG and NTC signal feedback. When switching the motors, it is also required to switch the PG and NTC signals in addition to the secondary power line.

If switching is also required for the slave, you need to manipulate the MT-CCL signal.
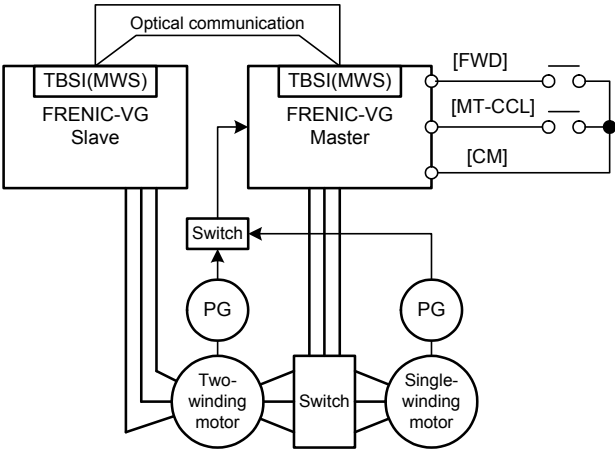
Figure 6.6.11

Table 6.6.18   Multiwinding/Single-Winding Motor Switching Specifications

Item	Function	Setting	Remarks
Function code E01 to E13	Terminal [X1] Function	57	Cancel multiplex system *MT-CCL* Function code o33 = 1 (Enable multiwinding system) and Contact ON(closed): Single-winding motor drive (Cancel multiwinding) Contact OFF (opened): Multiwinding motor drive
Function code E15 to E27	Terminal [Y1] Function	52	Answerback to cancellation of multiplex system *MEC-AB* When the *MT-CCL* is reflected, the *MEC-AB* is issued (Contact: ON)

6.6.11 Running with reduced number of units

When running with reduced number of units, realize the following setup.

1) Realize the setup in "Table 6.6.19" below for X terminal input (Di) and Y terminal output (Do).

Table 6.6.19 Required X Terminal Functions for Operation with Reduced Number of Units

	Specified value / Setup name	Explanation of use in Operation with Reduced Number of Units
Di	57 [MT-CCL] Cancel multiplex system	Release direct parallel connection when turned ON. The system will be able to run on one independent inverter (independent operation). When running independently on either of the two units, assign this function to both of the units.
	12 [M-CH2] Select motor 2	When running on a single unit, the second motor constant can be selected and run without changing the constants in motor 1.
	49 [PG-CCL] Cancel PG alarm	Alarm is temporarily cancelled for PG routing and NTC thermistor routing disconnection detecting function while preparing for operation with reduced number of units.
	75 [NTC-CCL] Cancel NTC thermistor alarm	However, if record of these two alarms does not cause a problem, this function does not have to be used. In this case, reset the alarm when running again.
	4 [RT1] Select ASR and ACC/DEC time	When running on a single unit using ASR constants (acceleration and deceleration times and ASR 1 hour P gain), the load inertia may be too large. This can cause overload alarm to trip. Avoid the overload trip by selecting the second ASR. Using the torque restriction (torque current restriction) is also effective.
Do	00 [RUN] Inverter running	Signal signifies that the inverter is running. During direct parallel connection operation, the motor running signal while the master inverter is running is output. Specifications are the same for single unit operation, with its own inverter outputting signal during operation.
	16 [SW-M2] Motor M2 selected	The second motor selection signal is input, and the signal for transfer complete to the second motor constants inside the inverter is output.

Perform the steps in the following order.
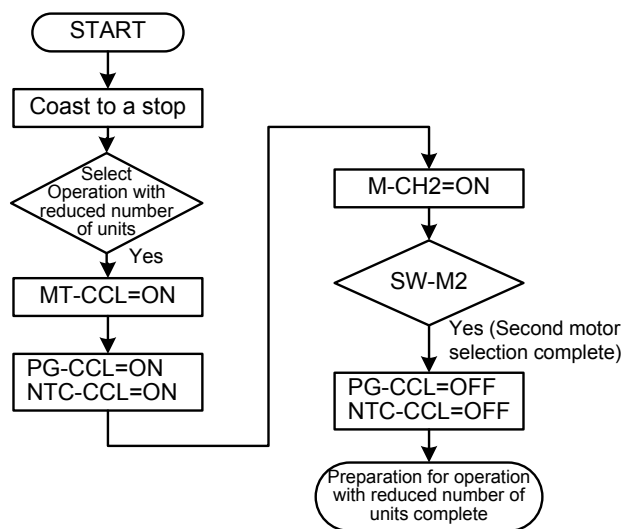
Figure 6.6.12 Switching Flowchart for Operation with Reduced Number of Units

2) For installations into facilities which restart after instantaneous power failures, use the running restart function which searches the direction and speed of free running rotation and picks up smoothly to reengage drive or use [IL] of the X terminal.

3) For simple systems, hardware can be constructed as Figure 6.6.7. However, when a more complex process sequence is desired, construction of a system structure which operates on communication with PLC is recommended.

4) Configuring motor parameters

Direct parallel connection method is a control method where a single winding motor is operated in parallel by plural inverters. Therefore, the motor constant required for inverter to control the motor is "1/number of connected inverter units".

When an operation with reduced number of inverters, a characteristic of the direct parallel connection system, is performed, the motor constants need to be changed. In this inverter, the motor constants can be used by switching in the selection of motor constant switching function of X terminal by presetting the constant codes of vector with speed sensor and sensorless vector for up to three motors.

Note At present, motor can be operated only by direct parallel connection with two or three inverters or by the operation reduced to one inverter

Table 6.6.20 shows a setting method of motor parameters including the time of the operation with reduced number of inverters.

When performing the operation with reduced number of inverters in the direct parallel connection system, set the motor constants after determining the definitions of motor constant codes.

<Definitions>

• M1: Maximum number of connected units — In the case of direct parallel connection of 2 units, use M2 codes as reference motor constants.

• M2: Maximum number of connected units-1 unit — In the case of direct parallel connection of 3 units, use M3 codes as reference motor constants.

• M3: Maximum number of connected units-2 units

Note The reference motor constants denote a state of connection in which the ratio of motor (one-coil motor) to inverter becomes 1:1.

Table 6.6.20   Explanation of Change of Motor Constants in the Operation with Reduced Number of Inverters

Parameter name	Parameter code			Coefficient of setting value in operation with reduced number of inverters
	M1 code	M2 code	M3 code	
Drive control	P01	A01	A101	
Motor selection	P02	A02	A102	
Maximum speed	F03	A06	A106	
Rated speed	F04	A03	A103	
Rated voltage	F05	A04	A104	
Rated capacity	**P03**	**A05**	**A105**	x (1/No. of units participating in direct parallel connection)
Rated current	**P04**	**A06**	**A106**	x (1/No. of units participating in direct parallel connection)
Number of poles	P05	A07	A107	
%R1	P06	A08	A108	
%X	P07	A09	A109	
Exciting current/ magnetic Flux weakening current (-Id)	**P08**	**A10**	**A110**	x (1/No. of units participating in direct parallel connection)

Parameter name		Parameter code			Coefficient of setting value in operation with reduced number of inverters
		M1 code	M2 code	M3 code	
Torque current		**P09**	**A11**	**A111**	x (1/No. of units participating in direct parallel connection)
Slip frequency (driving, braking)		P10, P11	A12, A13	A112, A113	
Iron loss factor 1 to 3		P12 to P14	A14 to A16	A114 to A116	
Magnetic saturation factor 1 to 5		P15 to P19	A17 to A21	A117 to A121	
Secondary time constant		P20	A22	A122	
Induced voltage factor		P21	A23	A123	
R2 correction factor 1 to 3		P22 to P24	A24 to P26	A124 to A126	
Exciting current correction factor		P25	A27	A127	
ACR Constant*2	P-gain	P26	A28	A128	
	I-time	P27	A29	A129	
Pulse resolution		P28	A30	A130	
Thermistor selection		P30	A31	A131	

Note
1) Shaded parts in Table show the codes for which different setting values are set in M1 to M2 (M3) in the operation with reduced number of inverters.

Set the same setting values for other codes in M1 up to M2 (M3).

2) ACR constant *2 should be less than the standard set value when operating at direct parallel connection. (Adjustment the constants while operating the motor.)

Use the reference setting values in the operation reduced to one unit of the inverter.

3) Use motor constants by assigning motor M2 selection and motor M3 selection [MCH2, MCH3] of the X terminal function.

Table below indicates the setting values of motor constants in the cases of the direct parallel connection system of two or three units of inverters and a single inverter, taking the motor constants of a 280 kW motor as an example.

Table 6.6.21　Setting Example of Motor Constants

Condition: No. of INVs		Setting value of function code			Remarks
		1 unit	2 units	3 units	No. of inverters connected to one unit of motor
Drive control	P01	0	0	0	
Motor selection	P02	37	37	37	
Maximum speed	F03	1500	1500	1500	
Rated speed	F04	750	750	750	
Rated voltage	F05	380	380	380	
Rated capacity	**P03**	280.00	**140.00**	**93.33**	x (1/No. of units participating in direct parallel connection)
Rated current	**P04**	565.0	**282.5**	**188.3**	x (1/No. of units participating in direct parallel connection)
Number of poles	P05	6	6	6	
%R1	P06	1.12	1.12	1.12	
%X	P07	15.41	15.41	15.41	

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			Setting value of function code			Remarks
Condition: No. of INVs			1 unit	2 units	3 units	No. of inverters connected to one unit of motor
Exciting current/ magnetic Flux weakening current (-Id)		**P08**	**240.3**	**120.2**	**80.10**	x (1/No. of units participating in direct parallel connection)
Torque current		**P09**	**508.1**	**254.1**	**169.4**	x (1/No. of units participating in direct parallel connection)
Slip frequency (driving)		P10	0.274	0.274	0.274	
Slip frequency (braking)		P11	0.274	0.274	0.274	
Iron loss factor	1	P12	3.00	3.00	3.00	
	2	P13	0.00	0.00	0.00	
	3	P14	0.00	0.00	0.00	
Magnetic saturation factor	1	P15	89.3	89.3	89.3	
	2	P16	83.3	83.3	83.3	
	3	P17	71.4	71.4	71.4	
	4	P18	59.5	59.5	59.5	
	5	P19	47.6	47.6	47.6	
Secondary time constant		P20	1.122	1.122	1.122	
Induced voltage factor		P21	350	350	350	
R2 correction factor	1	P22	1.000	1.000	1.000	
	2	P23	1.000	1.000	1.000	
	3	P24	1.000	1.000	1.000	
Exciting current correction factor		P25	0.000	0.000	0.000	
ACR Constant	P-gain	**P26**	**1.0**	**0.5**	**0.5**	Use these setting values as initial setting, and change them later. * Adjustment parameters (Change the setting while checking operation in test runs.)
	I-time	**P27**	**1.0**	**5**	**5**	
Pulse resolution		P28	1024	1024	1024	
Thermistor selection		P30	1	1	1	

Note

1) As a representative inverter, first motor codes are indicated. The same setting values apply to the second and third inverters when set/selected, too.

2) Setting values of P03, 04, 08, 09 become floating points. Set the values by calculating them to settable decimal point.

Set the values by rounding them when they cannot be divided.

3) Set ACR constant to the setting values specified in this Table for test runs. Then, change the values after checking operation conditions.

6.6.12   Wiring inductance (direct parallel connection)

When a motor is driven by the direct parallel connection system, the control by the direct parallel connection cannot be performed normally in some cases by the influence of a surge voltage caused by the switching of the inverters.

Therefore, it is recommended to insert OFLs that suppress the occurrence of the surge voltage.

If a space for storing OFL filters cannot be secured in a cabinet, however, the motor operation by the direct parallel connection system becomes possible when suppressing the surge voltage to a level that causes no trouble to the direct parallel control by **the wiring inductance between inverters and the motor (regulated by electric wire length).**

This section explains the wiring inductance (wiring length) in the direct parallel connection system.

Wiring restrictions of direct parallel operation
L1=L2 and according to "section 6.6.12.1" and "section 6.6.12.2."
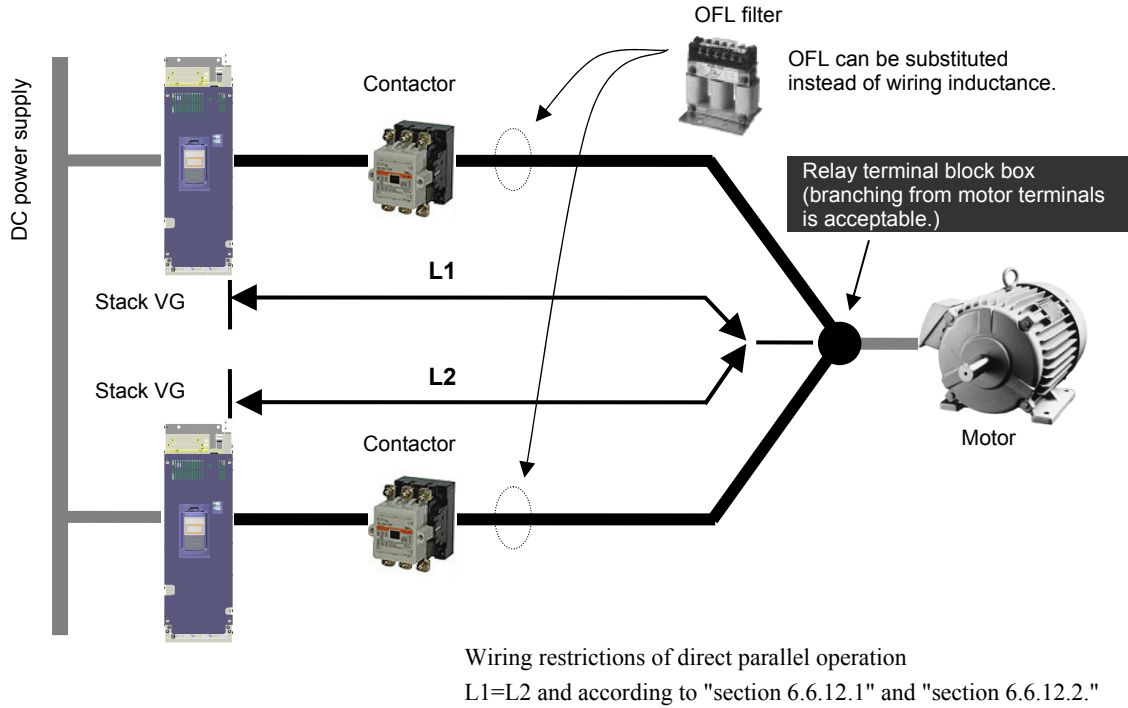
Figure 6.6.13   Explanation Figure of Restriction Items of Direct Parallel Connection

Note   Two inverters in the direct parallel connection are shown, but the same applies to the case of three inverters.

When cabtire cables or shielded wires are used from the relay terminal block BOX (branch point for the direct parallel connection), wiring length longer by three times or more than the lengths described in the "section 6.6.12.1" and "section 6.6.12.2" is required.

Make sure to connect the inverters with the electric wires of the same length. (Relationship of L1=L2 in the figure above)

Either primary or secondary side of contactor is allowed for use when using OFL filter.

However, the wiring length between OFL filters should be made 2 to 20 m.

(The total length for 3 units in the case of direct parallel connection of 3 units.)
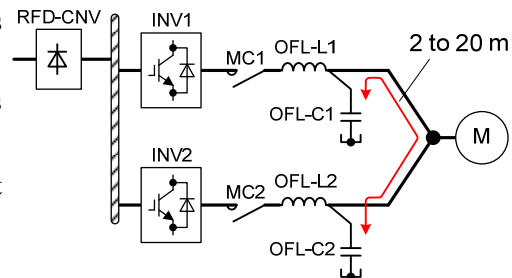
**Figure 6.6.14
Restrictions for use of OFL filter**

Composition of inverter and wire length of motor power line for direct parallel connection for motor capacity are described below.

However, combination other than as given in the chart may be used for direct parallel connection. Please feel free to contact us.

6.6.12.1 Wiring length in MD specification

Table 6.6.22 Rating in Direct Parallel Connection (MD Specification)

Motor specification			Rating specification in direct parallel connection				
Rated capacity [kW]	Current specification		INV type FRN□-4□	No. of units	Rated current [A]	Wiring length [m]	Fig.
	Rating [A]	Overload [A]					
355	650	975	200SVG1	x 2	716	14.6	(a)
400	740	1110	220SVG1		789	13.2	
500	960	1440	280SVG1		988	12.0	
630	1170	1755	220SVG1	x 3	1183	17.6	(b)
710	1370	2055	280SVG1		1482	15.6	
800	1480	2220				14.1	
1000	1850	2775	630BVG1	x 2	2223	4.7	(c)
1200	2220	3330					
1500	2775	4163	800BVG1		2812	4.0	
1800	3330	4995	630BVG1	x 3	3335	6.3	(d)
2000	3700	5550	710BVG1		3905	5.3	
2400	4218	6327	800BVG1		4218	4.9	
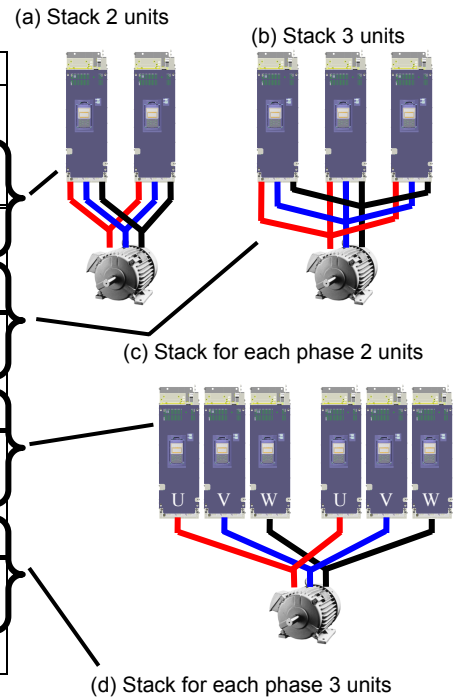
6.6.12.2 Wiring length in LD specification

Table 6.6.23 Rating in Direct Parallel Connection (LD Specification)

Motor specification			Rating specification in direct parallel connection				
Rated capacity [kW]	Current specification		INV type FRN□-4□	No. of units	Rated current [A]	Wiring length [m]	Fig.
	Rating [A]	Overload [A]					
400	740	1110	200SVG1	x 2	789	13.2	(a)
500	960	1440	250SVG1		988	12.0	
630	1170	1755	315SVG1		1235	17.6	
710	1370	2055	250SVG1	x 3	1482	17.6	(b)
800	1480	2220	250SVG1			15.6	
1000	1850	2775	315SVG1		1853	14.1	
1200	2220	3330	630BVG1	x 2	2603	4.7	(c)
1500	2775	4163	710BVG1		2812		
1800	3330	4995	800BVG1		3515	4.0	
2000	3700	5550	630BVG1	x 3	3905	6.3	(d)
2400	4218	6327	710BVG1		4218	5.3	
3000	5178	5695	800BVG1		5273	4.9	

(a) Stack 2 units

(b) Stack 3 units

(c) Stack for each phase 2 units

(d) Stack for each phase 3 units
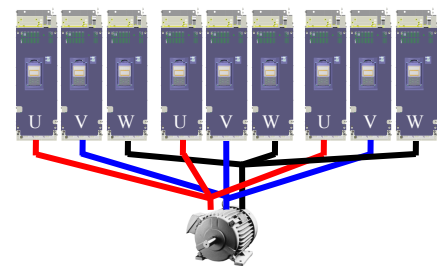
Figure 6.6.15 Explanation diagram

> **Note**　The electric wire sizes are specified by recommended electric wire sizes (FLSC electric wires) in the case of atmospheric temperature of 40°C or lower in Chapter 4. When significantly different electric wire sizes or cabtire cables/shielded wires are used, wiring length should be reconsidered as inductance of power line change.
>
> In identical power line size in cabtire radio shield wire, a long power line with approximately 3 times the length shown in the chart should be used.

6.7 CC-Link Interface Card OPC-VG1-CCL

6.7.1 Product overview

This card is used for a CC-Link master (Mitsubishi Electric PLC, etc.) to control FRENIC-VG via CC-Link.

CC-Link is an abbreviation of Control & Communication Link developed by Mitsubishi Electric Corporation as a next generation FA field network. The CC-Link system connects input/output units, special function units (e.g., inverter), etc., via dedicated cables, allowing the CPU for PLC to control such units. The CC-Link system can achieve wire-saving and high-speed data communications.

Major application

This card is available for the following.

- Applicable for CC-Link Ver. 1.10 and Ver. 2.00

- Supports new FRENIC-VG mode and existing FRENIC5000VG7 compatible mode

- Input of signals for operation, stop, etc.；FWD, REV, X1 to X9, X11 to X14, RST

- Setting of speed commands; 16-bit binary data

- Monitoring running status (bit data)
  Running forward, running reverse, with speed, speed match, arrival at speed, speed detection, operation preparation completed, alarm relay output, during monitoring, speed setting completed, command code execution completed, alarm state, remote station ready

- Monitoring motor speed; 16-bit binary data

- Monitoring running status (Word data)
  Speed command, output frequency, torque command value, output current, output voltage, cumulative run time, etc.

- Reference/change of function codes

6.7.2　Model and specifications

6.7.2.1　Model

Model content: OPC-<u>VG1</u>-<u>CCL</u>

Mounted inverter name VG1 -> FRENIC-VG

Option name: CCL -> CC-Link interface card
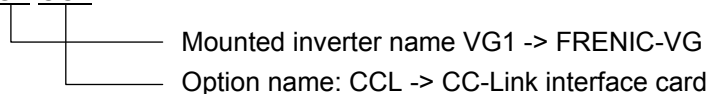
<u>**Accessories**</u>

Spacers: 3
Screws (M3): 3

6.7.2.2　Specifications

⚠CAUTION
・Incorrect setting of the switches (RSW1, 2, 3) on the option prevents the system from running normally. Fully understand the following settings to set them correctly.
・When setting the switches (RSW1, 2, 3) on the option, turn OFF the power supply to the inverter.

Table 6.7.1　Hardware Specifications

Item	Specifications
Name	CC-Link Interface Card
Station type	Remote device station
Number of units connectable	Up to 42 units, which can be shared with other models[1]
Number of stations occupied	1 station occupied (all Ver. 1, Ver. 2)
Terminal block for connection	Five terminal blocks (M3 X 5 screws)
Connection cable	CC-Link dedicated cable, and cable applicable for CC-Link Ver. 1.10 * The recommended CC-Link cable is FANC-110SBH made by Kuramo Electric Co., Ltd. For details, refer to CC-Link Catalog or Mitsubishi Electric Corporation FA Equipment Technical Information Service MELFANS website (http://www.nagoya.melco.co.jp/). For details about wiring for CC-Link, refer to the CC-Link Master User's Manual or CC-Link Cable Wiring Manual published by the CC-Link Partner Association. The CC-Link Cable Wiring Manual is available as a free download from the CC-Link Partner Association's website (http://www.cc-link.org/jp/material/).
Rotary switch RSW1, 2	Station address setting. Addresses 1 to 64 can be specified.
Rotary switch RSW3	Transmission speed (baud rate) can be specified: 10 M, 5 M, 2.5 M, 625 K, 156 Kbps
LED status indicators	L.RUN:.....Lights when the communications card is normally receiving refresh data. It goes off if data transmission is interrupted for a certain period of time. L.ERR: .....Lights when a communication error occurs in this station. The LED blinks when the rotary switch is operated while the power is turned ON. SD:............Lights during data transmission. RD: ....Lights during data reception.

*1 Number of units connectable Since the number of stations occupied differs depending on the use of a different unit (remote I/O station or remote device station) or use of different profiles, both the formulae must be satisfied.

♦ Formula 1: $(1 \times a) + (2 \times b) + (3 \times c) + (4 \times d) \leq 64$

a: Number with 1 station occupied, b: Number with 2 stations occupied, c: Number with 3 stations occupied, d: Number with 4 stations occupied

♦ Formula 2: $(16 \times A) + (54 \times B) + (88 \times C) \leq 2304$

A: Remote I/O station.. Max. 64 units
B: Remote device station.. Max. 42 units
C: Local station, standby master station, intelligent device station .... Max. 26 units
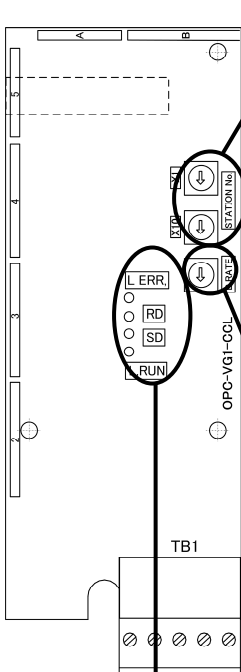
Rotary switch RSW1, 2

Before turning on the power supply to the inverter, specify inverter station addresses in the range of 1 to 64.
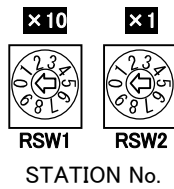
Figure 6.7.2

Note 1: Do not change station address settings when the inverter power is ON. If a station address is changed when the power is ON, the station address after the change is not available to provide data communications.

Note 2: If a station address is double assigned or is set out of the allowable range, normal communications cannot be carried out. (L.ERR LED lights.)

Note 3: Specify consecutive station addresses in connection order. (If station addresses are not specified consecutively, specify a "reserved station address" for each skipped station address.)

Figure 6.7.1

Transmission baud rate setting switch RSW3

Before turning on the power supply to the inverter, specify transmission baud rate in the range of 0 to 4.

Table 6.7.2 Baud rate specification

Number	Baud rate
0	156 Kbps（Factory default）
1	625 Kbps
2	2.5 Mbps
3	5 Mbps
4	10 Mbps
5 - 9	Setting error (L.ERR LED lights)

Figure 6.7.3

LED status indicators

The link status of CC-Link can be checked with four LEDs.

Table 6.7.3   LED status indicator specifications

Status				Operation Status
L.RUN	**L.ERR**	**SD**	**RD**	
●	○	★	●	Normal communications
●	★	★	●	Normally communicating. But sometimes a CRC error occurs due to electrical noise.
●	★	○	●	Received data contains a CRC error, so the communications card cannot respond.
●	○	○	●	Data destined for this station does not come.
○	★	★	●	Responding to polling. But refresh data received contains a CRC error.
○	★	○	●	Data destined for this station contains a CRC error.
○	○	○	●	No data destined for this station. Or data destined for this station cannot be received due to electrical noise.
○	●	○	●○	Baud rate, station address incorrectly specified.
●	★ (0.8-second intervals)	★	●	Baud rate or station address changed before completion.
○	○	★	●	Link has not been started up.
○	○	○	○	Data cannot be received due to wire break, power down, hardware reset in progress, E_r-$\exists$ power area failure

●: ON, ○: OFF, ★: Blinking (It may seem to be ON depending on the current transmission baud rate.)

Note 1: If LED lights due to a pattern other than the above, it can be assumed hardware error has occurred. Contact us.

Terminal block

FG	SLD	DG	DB	DA

Figure 6.7.4

Table 6.7.4 Terminal Block Specifications

Terminal Name	ID Color of Wire Sheath	Description	Remarks
DA	Blue		
DB	White	For communication data	
DG	Yellow		
SLD	Metallic	For connecting shielded wire of cable	SLD and FG are connected within the card.
FG	-	For earth	

Table 6.7.5 Software specifications

Item		Specifications
CC-Link version		Ver. 1.10 and Ver. 2.00 (Selectable with function code o32)
Operation	Run command	Run forward and reverse commands, Alarm reset command, X1 to X9 and X11 to X13 commands
	Speed command	16-bit binary data
	Running status output	Bit data for running, braking, torque limiting, alarm relay output signal, etc.
		Word data for motor speed, torque current command, etc.
Function code		VG1 mode (Ver. 1/Ver. 2): All function codes can be referred to or changed.
		VG7 compatible mode (Ver. 1): 255 types of function codes assigned to link Nos. in the function code list can be referred to or changed.
Option function code		o30, o31, o32 ....The factory default is "0".
Protective functions		Er-4: Network error (CC-Link error) * Light alarm: Communications link error (Function codes o30 and o31 are available to control the Er-4 alarm.) * Heavy alarm: Option card error, CC-Link version error (The stop method can be selected with function code o30 or o31.)

* Light alarm: If signal noise or others do not occur frequently, Er-4 alarm function codes o30 and o31 are available for control.

* Heavy alarm: Fatal failure, such as hardware failure

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6.7.3 External dimension drawing

(Unit: mm)
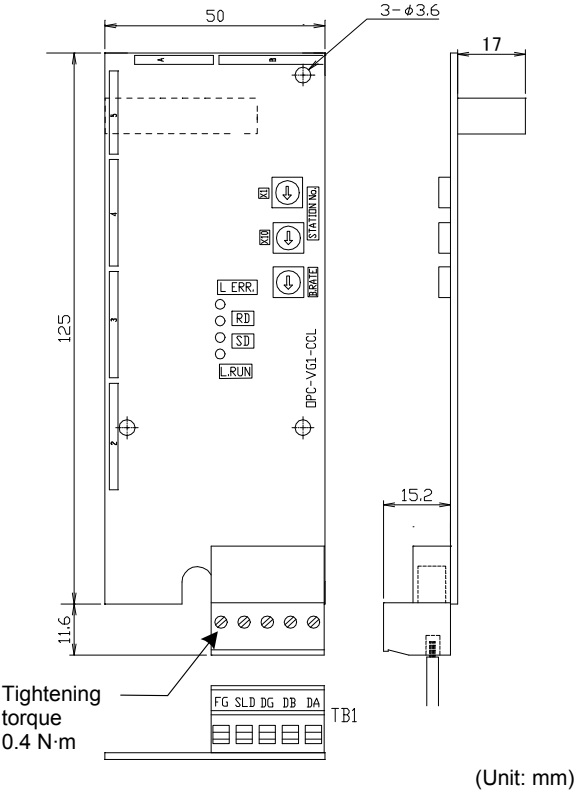
Figure 6.7.5　Option PCB Outline Drawing

6.7.4   Basic connection diagram

Refer to "6.1.4 Installing internal options (OPC-VG1-□□)", and then perform wiring and connecting jobs.

⚠ WARNING

・ Incorrect handling in connecting wires could cause an accident such as electric shock or fire. Qualified electricians should carry out connecting wires. If connecting wires, for example, after the power is turned ON requires any touching of an electric circuit, turn OFF (open) the breaker on the power supply side to prevent electric shock.

・ Since the smoothing condenser has been charged although the breaker is turned OFF (open), touching of an electric circuit causes an electric shock. Turn OFF the charge lamp (CHARGE) of the inverter, and confirm, with a tester, etc., that the DC voltage of the inverter has been reduced to the safety voltage.

⚠ CAUTION

・ Do not use the product that is damaged or lacking parts. Doing so could cause injury or damage.

・ Incorrect handling in installation/removal could result in a broken product.

The basic connection diagram is shown below. When connecting the communications card, observe the following precautions.

[Connecting precautions]

(1)   Use dedicated cables (refer to 6.7.2.2 "Specifications") for CC-Link connection.
       Be sure not to use soldered cables, which could cause disconnection or wire break.

(2)   Use terminating registers that came with the PLC.

(3)   For the maximum number of communications cards, refer to the number of units connectable in 6.7.2.2 "Specifications".

<u>When an inverter is connected</u>
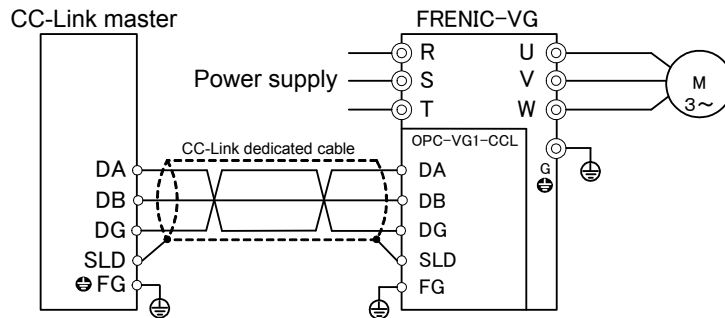
Figure 6.7.6   Inverter connection diagram (1 unit)

<u>When two or more inverters are connected</u>

For the number of inverters connectable, refer to Section 6.7.2.2 "Specifications."
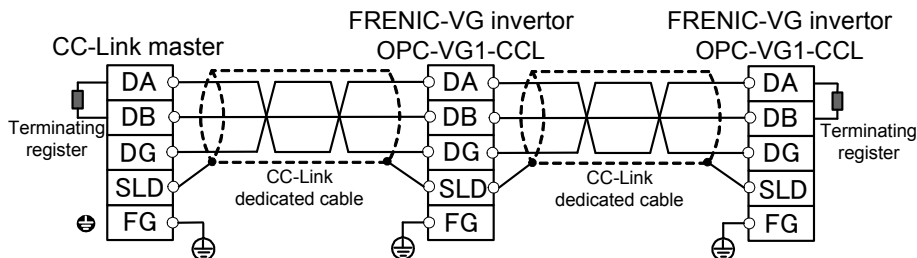
Figure 6.7.7   Inverter Connection Diagram (Two or More Inverters)

6.7.5　Function code

⚠CAUTION
・ Configuring the function codes wrongly may lead to dangerous conditions. When data has been set or written, be sure to confirm the data again. **Failure to observe this precaution could cause an accident.**

6.7.5.1　Standard function code

Standard function codes accessible from CC-Link differ depending on profile selection (o32). They are as shown in Table 6.7.6.

Note 1: When function codes are written via CC-Link, they are all written into volatile memory (RAM: data in memory is erased by turning off the power supply). Turning OFF the control power to the inverter therefore erases written data. Execute function code H02 "Save All Function", if necessary, to write data into non-volatile memory (EEPROM: data in memory is not erased even by turning OFF the power supply).

Table 6.7.6　Standard Function Codes Accessible from CC-Link

Profile selection (o32)	Accessible standard function code
VG7 compatible mode (o32=0)	Only the function codes corresponding to link No [1] in the function code list can be referred to and changed.
VG1 mode (o32=1 to 4)	Function codes (almost all function codes [2]) corresponding to 485No [1] in the function code list can be referred to and changed.

[1]　For 485No and link No, refer to Chapter 4, Section 4.2 "Function Code Tables."

[2]　Excepting for writing H01 and P02, all function codes are accessible.

6.7.5.2　Communication dedicated function codes

Common data formats (S code and M code) are available as communication dedicated specifications. Excepting standard function codes, command/monitor related data is defined. For details on the communication dedicated function codes, refer to Chapter 4. However, when the following communication dedicated codes are written via CC-Link, the restrictions shown in Table 6.7.7 are applied. (They can be read.)

Table 6.7.7　Restrictions on Writing of Communication Dedicated Function Codes

Profile selection (o32)	Restrictions on Writing of Communication Dedicated Function Codes
VG7 compatible mode (o32=0)	No data can be written into S01 speed command or S06 operation command 1.
VG1 mode (o32=1 to 4)	Restrictions on writing are not applied. However, if speed command by writing S01/S06, operation command, remote output, speed command by remote register, and operation command are carried out simultaneously, priority is given to the remote output and remote register.

6.7.5.3 Option dedicated function codes

Reloading the CC-Link card can operate o30 to o32 not only as standard function codes but also as option dedicated function codes.

Table 6.7.8 Option Dedicated Function Codes

No.	Function code name		Setting range		Description
	Name	**Keypad display**			
o30	Operation when an error occurs Note 1	MODE ON ER	0	Light alarm	If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), the motor coasts to stop with Er-4 alarm generated.
				Heavy alarm	If a failure occurs, immediate coast to a stop. Then Er-4 alarm is generated.
			1	Light alarm	If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), the Er-4 alarm is generated after stoppage.
				Heavy alarm	If a failure occurs, Er-4 alarm is generated after deceleration to stop.
			2	Light alarm	If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), Er-4 is displayed after stoppage (without alarm relay output). The motor restarts after returning to communications.
				Heavy alarm	If a failure occurs, Er-4 alarm is generated after deceleration to stop.
			3	Light alarm	When a failure occurs, Er-4 alarm is not generated.
				Heavy alarm	If a failure occurs, Er-4 alarm is generated after deceleration to stop.
o31	Operation time when an error occurs	TIMER TL	0.01 to 0.10 to 20.00s		Timer value for operation continuation time upon light alarm (enabled with o30=0, 1 ,2)
o32	Format selection Note 2	FORMAT SEL	0		VG7 compatible mode with 1 station occupied (CC-Link Ver. 1)
			1		1 X mode with 1 station occupied (CC-Link Ver. 1)
			2		2 X mode with 1 station occupied (CC-Link Ver. 2)
			3		4 X mode with 1 station occupied (CC-Link Ver. 2)
			4		8 X mode with 1 station occupied (CC-Link Ver. 2)

Note 1: For details on o30 and o31, refer to 6.7.6 "Protection operation."

Note 2: If the o32 value has been changed, the inverter power must be turned ON again to reflect the change content upon the operation.

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6.7.6 Protection operation

6.7.6.1 Light alarm and heavy alarm

Light alarm or heavy alarm is generated in the CC-Link card, depending on an error level. Occurrence of such an error makes the inverter generate $Er-4$ "Network error" alarm, resulting in coast to stop or deceleration to stop.

Table 6.7.9   Light Alarm and Heavy Alarm

Item	Light alarm (operation in case of CC-Link error)	Heavy alarm (in case of option error)
Cause of the error	・Master down, wire break detection ・Communication data error (Noise applied to communications line, etc.)	・Option card hardware error ・Defective installation of option card
Reset method Note 2	Perform resetting after removal of alarm cause (automatic release after returning to communications). Note 1:	After the inverter power is turned OFF, remove the alarm cause, and then turn ON the inverter power.
Alarm output control	・Only in CC-Link operation mode (refer to "6.7.13 Link Function"), error is detected ・Function code o30 or o31 is available to control the alarm output method when an error is detected.	Function code o30 or o31 is available to control the alarm output method when an error is detected.
Communications error code Note 5	2	3

Table 6.7.10   Operation in Case of Light Alarm (CC-Link Error)

o30 setting	When an error occurs in communications line			Communication error remains after the time specified by o31			When communications error is removed		
	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output
0	Operation continues	Normal display	Not output	Coast to a stop	Immediately $Er-4$ lights	Output	Stop status continues	$Er-4$ continues	Output continues
1	Operation continues	Normal display	Not output	Decelerate to stop Note 3	After stop $Er-4$ lights	After stop output	Stop status continues	$Er-4$ continues	Output continues
2	Operation continues	Normal display	Not output	Decelerate to stop Note 3, Note 4	After stop $Er-4$ lights	Not output	Restart Note 3	Normal display	Not output
3	Operation continues	Normal display	Not output	←	←	←	←	←	←

Table 6.7.11   Operation in Case of Heavy Alarm (Option Error)

o30 setting	When an option error occurs			Communication error remains after the time specified by o31			When the option error is removed		
	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output
0	Coast to a stop	Immediately $Er-4$ lights	Immediate output	Stop status continues	$Er-4$ continues	Output continues	←	←	←
1	Decelerate to stop Note 3	After stop $Er-4$ lights	After stop output	Stop status continues	$Er-4$ continues	Output continues	←	←	←
2	Decelerate to stop Note 3	After stop $Er-4$ lights	After stop output	Stop status continues	$Er-4$ continues	Output continues	←	←	←
3	Decelerate to stop Note 3	After stop $Er-4$ lights	After stop output	Stop status continues	$Er-4$ continues	Output continues	←	←	←

Note 1: "Perform resetting" means reset input by one of the following methods.
   * Entry by (RESET) key on the keypad
   * Error reset [RST] is assigned by selecting X function to set the applicable X terminal to ON (assigned to X8 by factory default).
   * Entry of reset command from communications

Note 2: In case of light alarm (o30=0/1), resetting can be performed unless alarm cause has been removed completely. In case of the light alarm (o30=2) or heavy alarm, however, resetting cannot be done until the cause has completely been removed.

Note 3: With o30=1, 2, or 3: For deceleration to stop, the motor stops with the time of deceleration (F08, C47, C57, or C67) specified at that time.
With o30=2: For restart, the motor accelerates in the acceleration time (F07, C46, C56, or C66) specified at that time.

Note 4: With o30=2, if an error in communications circuit is removed during deceleration, the motor reaccelerates at that time.

Note 5: Communications error codes for light alarm/heavy alarm can be confirmed on the communications status screen for maintenance information of the keypad.


```
N R K = × × × × ×
N R R = × × × × ×      × ×
N R O = × × × × ×      ⊠ ×    ←  -: Without error
N R L = × × × × ×      × ×       2: Light alarm (CC-Link error)
∧∨→P A G E   S H I F T  4        3: Heavy alarm (Option error)
```
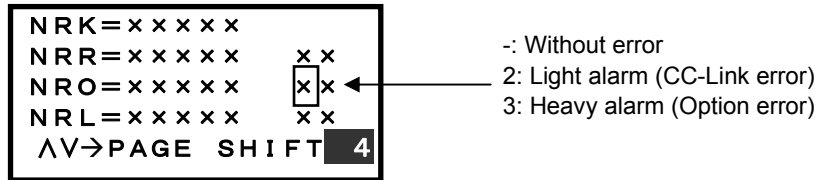
Figure 6.7.8 Communication Error Codes

6.7.6.2 Protection Operation Function Codes

This section describes operation to be performed when communications link errors occur in a state, where running command or speed command is given via CC-Link, while the inverter is running.

(1) Function code o30 = 0, o31 = 5.00 (Communication error continues for 5 or more seconds, and the motor coasts to stop)
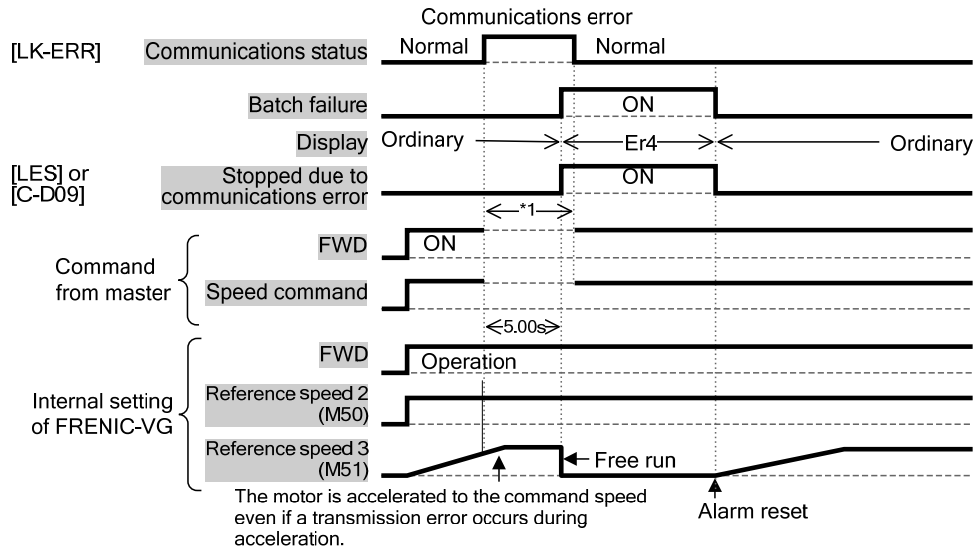
Figure 6.7.9

(2) Function code o30 = 0, o31 = 5.00 (Communication error continues for 5 or more seconds, and the motor decelerates to stop)
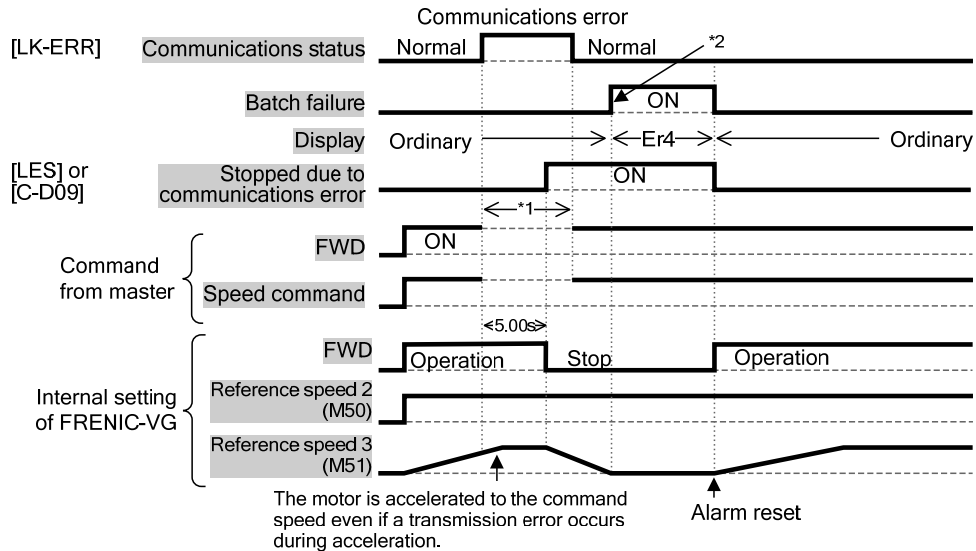
Figure 6.7.10

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

*2) During DC braking [DCBRK] or pre-exciting [EXITE] in deceleration to stop, alarm relay output is not performed until the stop of these commands.

(3) Function code o30 = 2, o31 = 5.00 (Communication error continues for 5 or more seconds, and the motor decelerates to stop)
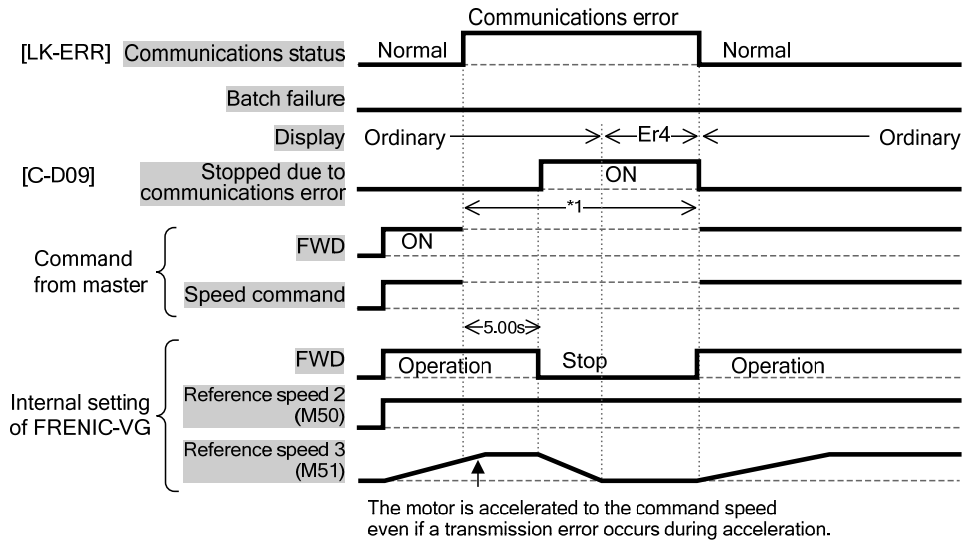
Figure 6.7.11

(4) Function code o30 = 2, o31 = 5.00 (After communication error continues for 5 or more seconds, returns to communications during deceleration to stop)
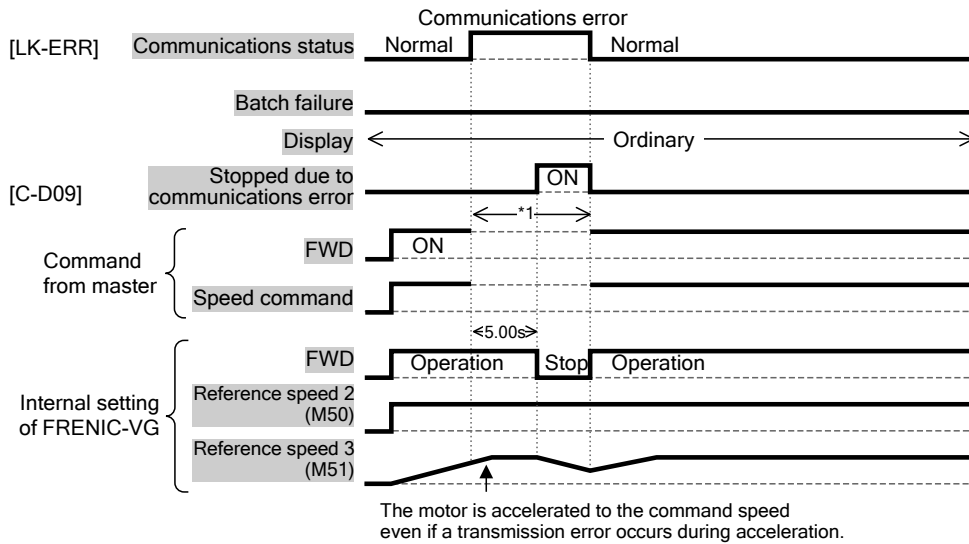
Figure 6.7.12

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

(5) For function code o30 = 3 (operation continues)
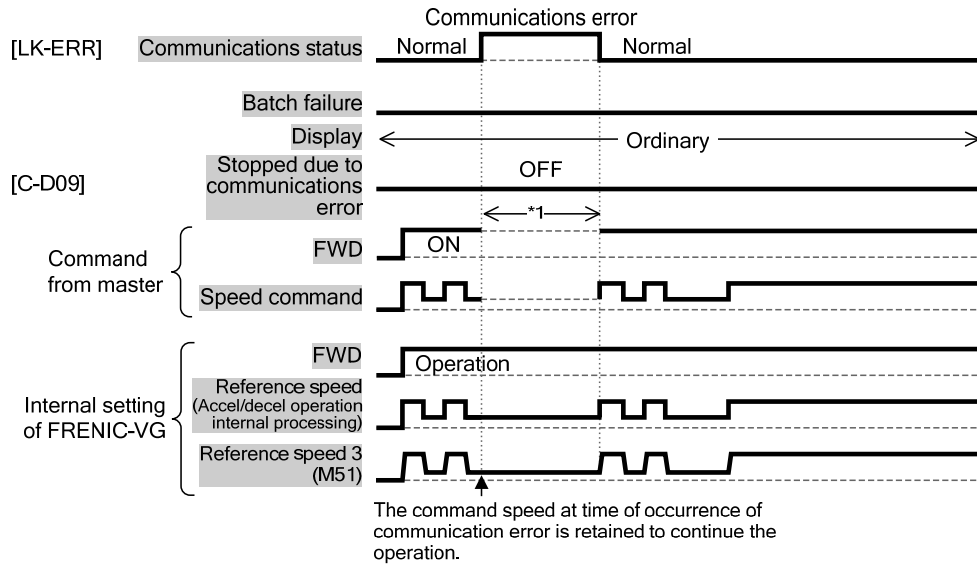
Figure 6.7.13

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

6.7.7   Applicable format list

This option card supports formats shown in Table 6.7.12.

Table 6.7.12   Applicable Format List

Function code	Name	Initial value	Setting	Description	Reference page
o32 *1	Format selection	0	0	VG7 compatible mode with 1 station occupied (CC-Link Ver. 1) *2	6-6-168
			1	1 X mode with 1 station occupied (CC-Link Ver. 1)	6-6-173
			2	2 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-179
			3	4 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-180
			4	8 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-182

*1   If the o32 value has been changed, the inverter power must be turned ON again to reflect the change content upon the operation.

*2   The program used for the FRENIC5000VG7S series is available.

*3   When 2 X, 4 X, or 8 X mode of CC-Link Ver. 2 is used, station information at the master station must also be set to 2 X, 4 X, or 8 X, respectively.

6.7.8   VG7 compatible mode with 1 station occupied (o32=0）

6.7.8.1   Remote I/O signal in the VG7 compatible mode

Table 6.7.13   Remote Output Signal in VG7 Compatible Mode (Master -> FRENIC-VG)

Device No.	Signal name	Description	
RYn0	Run forward command	OFF: Stop command ON: Run forward command (counterclockwise viewed from the motor axis direction)	Simultaneously turning RYn0 and RYn1 ON is functionally equivalent to a stop command.
RYn1	Run reverse command	OFF: Stop command ON: Run reverse command (counterclockwise viewed from the motor axis direction)	
RYn2	Terminal X1 function	Multiple speed (SS1/SS2/SS4/SS8) is selectable by combinations of terminals.	Functions to be provided by factory default are shown at left. Setting terminal X function can change the function of terminal X.
RYn3	Terminal X2 function		
RYn4	Terminal X3 function		
RYn5	Terminal X4 function		
RYn6	Terminal X5 function	ASR and acceleration/deceleration (RT1/RT2) can be selected by combinations of terminals.	
RYn7	Terminal X6 function		
RYn8	Terminal X8 function	Works as error reset (RST) when turned ON.	
RYn9	Terminal X7 function	Works as coast to stop command (BX) when turned ON. (output shut down on the secondary side)	
RYnA	Not used.	Should be turned OFF.	
RYnB			
RYnC	Monitor command	Turning the monitor command (RYnC) ON sets the monitored value to RWrn, turning the "Monitoring" signal (RXnC) ON. Note 1	
RYnD	Speed setting command (RAM)	Turning the speed setting command (RYnD) ON writes the speed command (RWwn+1) into the inverter's volatile memory (RAM). Note 2 Upon completion of writing, the speed setting completed signal (RXnD) is turned ON.	
RYnE	Not used.	Should be turned OFF.	
RYnF	Command code execution request	Turning the command code request signal (RYnF) ON executes processing corresponding to command codes specified in the command code (RWwn+2). Note 3 After execution of those command codes, the "Command code execution completed" signal (RXnF) is turned ON. If a command code execution error occurs, the response code (RWrn+2) is set to a value other than "0".	
RY(n+1)0 | RY(n+1)9	Not used.	Should be turned OFF.	
RY(n+1)A	Alarm reset request flag	When an inverter alarm is generated, turning the alarm reset request flag ON resets the inverter, turning the alarm status flag (RX(n+1)A) OFF. Note 4	
RY(n+1)B | RY(n+1)F	Not used.	Should be turned OFF.	

n: Value determined by a station address

Note 1: While the "Monitor command" (RYnC) is ON, the monitored values are constantly updated.

Note 2: While the "Speed setting" (RYnD) is ON, the value of speed command (RWwn+1) is constantly reflected on the speed.

Note 3: While the command code execution request is ON, the command code is constantly executed. (When reading, the read value is constantly updated. When writing, the written value is constantly reflected.)

Note 4: When the "Alarm reset request flag" signal (RY(n+1)A) is ON, alarm reset is constantly executed. After the release of the alarm, this signal should therefore be turned OFF. Alarm reset can be done regardless of operation mode.

Table 6.7.14   Remote Input Signal in VG7 Compatible Mode (FRENIC-VG -> Master)

Device No.	Signal name	Description	
RXn0	Running forward	OFF: Except running in forward direction (Stopped or Rotating in reverse direction) ON: Rotating in forward direction	
RXn1	Running reverse	OFF: Except running in reverse direction (Stopped or Rotating in forward direction) ON: Rotating in reverse direction	
RXn2	Terminal Y1 function	With speed. Turned ON with (N-EX)	Functions to be provided by factory default are shown at left. Setting terminal Y function can change output contents.
RXn3	Terminal Y2 function	Speed match. Turned ON with (N-AG1).	
RXn4	Terminal Y3 function	Arrival at speed. Turned ON with (N-AR).	
RXn5	Terminal Y4 function	Speed detection 1. Turned ON with (N-DT1)	
RXn6	Terminal Y5 function	Operation preparation completed. Turned ON with (RDY).	
RXn7	Alarm relay output	Inverter's protection function is operated, and the signal is turned ON when output stops.	
RXn8 | RXnB	Not used.	-	
RXnC	Monitoring	The "Monitoring" signal (RXnC) is turned ON when turning the "Monitor command" (RYnC) ON specifies a monitored value for remote register RWrn (refer to Table 6.7.16). Turning the "Monitor command" (RYnC) OFF turns this signal OFF.	
RXnD	Speed setting completed (RAM)	This signal is turned ON when turning the "Speed setting command" signal (RYnD) ON writes a speed command into the inverter's volatile memory (RAM). Turning the "Speed setting command" signal (RYnD) OFF turns the "Speed setting completed" signal (RXnD) OFF.	
RXnE	Not used.	-	
RXnF	Command code execution completed	This signal is turned ON when turning the "Command code execution request" (RYnF) ON has completed the execution of processing corresponding to the command code (RWwn+2). Turning the "Command code execution request" (RYnF) OFF turns the "Command code execution completed" signal (RXnF) OFF.	
RX(n+1)0 | RX(n+1)9	Not used.	-	
RX(n+1)A	Alarm state flag	This signal is turned ON when an inverter alarm (alarm other than $Er-3$) is generated.	
RX(n+1)B	Remote station ready	This signal is turned ON when completing initial data setting places the inverter in the ready status after the inverter has been powered ON or the hardware has been reset. (This signal is used for interlocking with reading or writing from/to the master unit.) This signal is turned OFF concurrently when the "Alarm state flag" (RX(n+1)A) is turned ON if the inverter alarm is generated.	
RX(n+1)C | RX(n+1)F	Not used.	-	

n: Value determined by a station address

Note 1:   When the condition setting switch of the master unit for "Input data status of data link error station (SW4)" is set to ON, input data from the data link error station is retained in the status just before the occurrence of the error. Note that this remains signals, e.g., remote station ready, etc., ON even if an inverter alarm is generated.

Note 2:   If an operation command is output from the master when the instruction via communications is disabled (H30=0, 1, or [LE] instruction OFF), the inverter does not run. However, the input signals "Speed setting completed" and "Command code execution completed" signal are turned ON. Care must be taken for this. In addition, "I/O check" can be performed on the keypad to confirm whether input signal is issued from the link (COM), even if the command via communications is disabled.

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6.7.8.2　Remote register in VG7 compatible mode (o32=0)

Table 6.7.15　Remote Register in VG7 Compatible Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code	This signal sets a monitor code to be referred to (refer to Table 6.7.17). After the setting is completed, turning RYnC signal ON sets the monitor data to RWrn.	
RWwn+1	Speed command	Specify the speed command. After it is set in this register, turning ON the RYnD described above writes the speed to the inverter. After completion of writing, the RXnD is turned ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code	Command codes (refer to Table 6.7.18) are set to execute operation mode rewrite, function code read, write, reference of alarm history, alarm reset, etc. After register setting is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	Set data to be specified with the commands above (if necessary). After writing the command codes above and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).

n: Value determined by a station address

Table 6.7.16　Remote Register in VG7 Compatible Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value	A monitored value specified with RWwn monitor code is set.	
RWrn+1	Motor speed	Current motor speed is constantly set.	0 to ±20000 (Nmax with ±20000)
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.19) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	

n: Value determined by a station address

6.7.8.3 Monitor code/command code (o32=0) in VG7 compatible mode

Table 6.7.17 Monitor Code (o32 = 0)

Code No.	Description	Unit	Remarks
0000$_H$	No monitoring (Fixed to 0)	—	
0001$_H$	Output frequency	0.01 Hz	In units of 0.1 Hz
0002$_H$	Output current	0.1 A	
0003$_H$	Output voltage	0.1 V	
0004$_H$	No monitoring (Fixed to 0)	—	
0005$_H$	Speed setting	1 r/min	
0006$_H$	Operation speed	1 r/min	
0007$_H$	Torque command value	0.1%	
0008$_H$	DC link bus voltage	0.1 V	In units of 1 V
0009$_H$ | 000D$_H$	No monitoring (Fixed to 0)		
000E$_H$	Motor output	0.01 kW	In units of 0.1 kW
000F$_H$	Operation command	—	
0010$_H$	Output terminate status	—	
0011$_H$	Torque current command value	0.1%	
0012$_H$	Flux command	0.01%	
0013$_H$	Position detection pulse	1 pulse	Quad multiplication of built-in PG
0014$_H$	Cumulative run time (Cumulative power-ON time)	1 hr	
0015$_H$ | 0019$_H$	No monitoring (Fixed to 0)		

♦ Detailed description on operation command

b15							b8	b7							b0
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

Figure 6.7.14

♦ Detailed description on output terminate status

b15							b8	b7							b0
Y18	Y17	Y16	Y15	Y14	Y13	Y12	Y11	-	-	-	Y5A	Y4	Y3	Y2	Y1

- : Empty (Fixed to 0)

Figure 6.7.15

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Table 6.7.18 Command Code (o32 = 0)

Item		Code number	Description	Remarks
Operation mode read Note 1		007B$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive 0002$_H$: Keypad operation	0000$_H$: ([LE]=ON, H30≠0, and remote mode) 0001$_H$: ([LE]=OFF or H30=0), F02=1 and remote mode 0002$_H$: (([LE]=OFF or H30=0), F02=0) or local mode
Writing of operation mode Note 1, Note 4		00FB$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive	0000$_H$: LE=ON 0001$_H$: LE=OFF • Assignment of LE to terminal X gives priority to the terminal. • 0 with the power turned OFF
Reading of alarm history No.1/No.2		0074$_H$	Reading of history No. 1/history No.2	L byte: History No.1, H byte: History No.2
Reading of alarm history No.3/No.4		0075$_H$	Reading of history No.3/history No.4	L byte: History No.3, H byte: History No.4
Reading of alarm history No.5/No.6		0076$_H$	Reading of history No.5/history No.6	L byte: History No.5, H byte: History No.6
Reading of alarm history No.7/No.8		0077$_H$	Reading of history No.7/history No.8	L byte: History No.7, H byte: History No.8
Reading of speed command		006D$_H$	Read speed command	0 to ±20000 (Max. with ±20000)
Writing of speed command		00ED$_H$	Write speed command	Also accessible from remote register
Reading of function code		0000$_H$ to 0063$_H$	Read or write link Nos. 0 to 255 by the combinations with link parameter extension setting.	For the link No./data format, refer to Chapter 4, Section 2 "Function Code List."
Writing of function code Note 2		0080$_H$ to 00E3$_H$		
Reset alarm		00FD$_H$	9696$_H$: Reset the alarm.	Only during link operation
Link parameter extension setting	Read	007F$_H$ Note 3	For selection of the area accessed by reading/writing function codes 0000$_H$: Link Nos. 0 to 99 0001$_H$: Link Nos. 100 to 199 0002$_H$: Link Nos. 200 to 255	
	Write	00FF$_H$ Note 3		

Note 1: Link operation selection [LE] is switched by switching the operation mode from CC-Link, as follows.
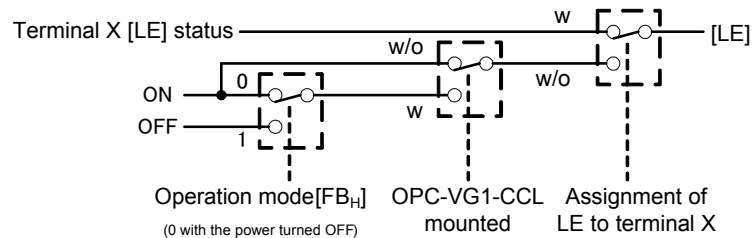
Figure 6.7.16 Link Operation Selection [LE] with CC-Link Used

Note 2: Writing a function code sets a value given by adding the offset value of 80$_H$ to the link No.

    Example: Function code "F03: M1 maximum speed"   Link № 51$_H$

    The command code for reading the function code is "51$_H$". The function code for writing function code is "D1$_H$", which is obtained by adding the offset value of 80$_H$.

Note 3: With code 007F, read the extension code setting. With code 00FF, write extension code setting.

Note 4: In local mode, running mode cannot be changed.

Table 6.7.19 Response Code (o32=0)

Code number	Item	Description
0000$_H$	Normal (No error)	Command code execution normally completed
0001$_H$	Write mode error	・Function code was written while the inverter was running ・Function code was written while EEPROM was being written. ・Function code was written at the time of transmission error. ・S code was written when upper link was enabled. ・Function code was written in a mode where edition is not permitted.
0002$_H$	Function code selection error	An inaccessible link No. was set.
0003$_H$	Out of setting range	Set data is out of changeable range.

6.7.9 1 X mode with 1 station occupied (o32=0)

6.7.9.1 Remote I/O signal in 1 X mode (o32=1)

Table 6.7.20 Remote Output (Master -> FRENIC-VG)

Device No.	Signal name	Description	
RYn0	Run forward command	OFF: Stop command ON: Run forward command (counterclockwise viewed from the motor axis direction)	Simultaneously turning RYn0 and RYn1 ON is functionally equivalent to a stop command.
RYn1	Run reverse command	OFF: Stop command ON: Run reverse command (counterclockwise viewed from the motor axis direction)	
RYn2	Terminal X1 function	Multiple speed (SS1/SS2/SS4/SS8) is selectable by combinations of terminals.	Functions to be provided by factory default are shown at left. Setting terminal X function can change the function of terminal X. (Function code E01-E10)
RYn3	Terminal X2 function		
RYn4	Terminal X3 function		
RYn5	Terminal X4 function		
RYn6	Terminal X5 function	ASR and acceleration/deceleration (RT1/RT2) can be selected by combinations of terminals.	
RYn7	Terminal X6 function		
RYn8	Terminal X8 function	Works as error reset (RST) when turned ON.	
RYn9	Terminal X7 function	Works as coast to stop command (BX) when turned ON. (output shut down on the secondary side)	
RYnA	Terminal X9 function	External alarm $\square H2$ is generated when turned ON.	
RYnB	Terminal X11 function	Command assigned with inverter function code E10	
RYnC	Monitor command	Turning the monitor command (RYnC) ON specifies a monitored value for monitored values 1 to 6, turning the "Monitoring" signal (RXnC) ON. Note 1	
RYnD	Speed setting command (RAM)	Turning the speed setting command (RYnD) ON writes the speed command (RWwn+1) into the inverter's volatile memory (RAM). Note 2 Upon completion of writing, the speed setting completed signal (RXnD) is turned ON.	
RYnE	Not used.	-	
RYnF	Command code execution request	Turning the command code request signal (RYnF) ON executes processing corresponding to command codes specified in command codes 1 to 6. Note 3 After execution of those command codes, the "Command code execution completed" signal (RXnF) is turned ON. If a command code execution error occurs, the response code (RWrn+2) is set to a value other than "0".	
RY(n+1)0 | RY(n+1)3	Not used.	Should be turned OFF.	
RY(n+1)4	Terminal X12 function	Command assigned with inverter function code E11	
RY(n+1)5	Terminal X13 function	Command assigned with inverter function code E12	
RY(n+1)6	Terminal X14 function	Command assigned with inverter function code E13	
RY(n+1)7 | RY(n+1)9	Not used.	Should be turned OFF.	
RY(n+1)A	Alarm reset request flag	When an inverter alarm is generated, turning the alarm reset request flag ON resets the inverter, turning the alarm status flag (RX(n+1)A) OFF. Note 4	
RY(n+1)B | RY(n+1)F	Not used.	Should be turned OFF.	

n: Value determined by a station address

Note 1: While the "Monitor command" (RYnC) is ON, the monitored values are constantly updated.

Note 2: While the "Speed setting" (RYnD) is ON, the value of speed command (RWwn+1) is constantly reflected on the speed.

Note 3: When the command execution request is switched from OFF to ON, the command code is executed only once.

Note 4: When the "Alarm reset request flag" signal (RY(n+1)A) is ON, alarm reset is constantly executed. After the release of the alarm, this signal should therefore be turned OFF. Alarm reset can be done regardless of operation mode.

Table 6.7.21 Remote Input (FRENIC-VG->Master)

Device No.	Signal name	Description	
RXn0	Running forward	OFF: Except running in forward direction (Stopped or Rotating in reverse direction) ON: Rotating in forward direction	
RXn1	Running reverse	OFF: Except running in reverse direction (Stopped or Rotating in forward direction) ON: Rotating in reverse direction	
RXn2	Terminal Y1 function	With speed. Turned ON with (N-EX)	Functions to be provided by factory default are shown at left. Setting terminal Y function can change output contents.
RXn3	Terminal Y2 function	Speed match. Turned ON with (N-AG1).	
RXn4	Terminal Y3 function	Arrival at speed. Turned ON with (N-AR).	
RXn5	Terminal Y4 function	Speed detection 1. Turned ON with (N-DT1)	
RXn6	Terminal Y5 function	Operation preparation completed. Turned ON with (RDY).	
RXn7	Alarm relay output	Inverter's protection function is operated, and the signal is turned ON when output stops.	
RXn8	Terminal Y11 function	Status assigned with inverter function E20	
RXn9	Terminal Y12 function	Status assigned with inverter function E21	
RXnA	Terminal Y13 function	Status assigned with inverter function E22	
RXnB	Terminal Y14 function	Status assigned with inverter function E23	
RXnC	Monitoring	The "Monitoring " signal (RYnC) is turned OFF when turning the "Monitor command" (RYnC) ON specifies a monitored value for monitored values 1 to 6. Turning the "Monitor command" (RYnC) OFF turns this signal OFF.	
RXnD	Speed setting completed (RAM)	This signal is turned ON when turning the "Speed setting command" signal (RYnD) ON writes a speed command into the inverter's volatile memory (RAM). Turning the "Speed setting command" signal (RYnD) OFF turns the "Speed setting completed" signal (RXnD) OFF.	
RXnE	Not used.	-	
RXnF	Command code Execution completed	This signal is turned ON when turning the "Command code execution request" (RYnF) ON has completed the execution of processing corresponding to command codes 1 to 6. Turning the "Command code execution request" (RYnF) OFF turns the "Command code execution completed" signal (RXnF) OFF.	
RX(n+1)0 | RX(n+1)9	Not used.	-	
RX(n+1)A	Alarm status flag	This signal is turned ON when an inverter alarm (alarm other than $Er\text{-}3$) is generated.	
RX(n+1)B	Remote station ready	This signal is turned ON when completing initial data setting places the inverter in the ready status after the inverter has been powered ON or the hardware has been reset. (This signal is used for interlocking with reading or writing from/to the master unit.) This signal is turned OFF concurrently when the "Alarm state flag" (RX(n+1)A) is turned ON if the inverter alarm is generated.	
RX(n+1)C | RX(n+1)F	Not used.	-	

n: Value determined by a station address

Note 1: When the condition setting switch of the master unit for "Input data status of data link error station (SW4)" is set to ON, input data from the data link error station is retained in the status just before the occurrence of the error. Note that this remains signals, e.g., remote station ready, etc., ON even if an inverter alarm is generated.

Note 2: If an operation command is output from the master when the instruction via communications is disabled (H30=0, 1, or [LE] instruction OFF), the inverter does not run. However, the input signals "Speed setting completed" and "Command code execution completed" signal are turned ON. Care must be taken for this. In addition, "I/O check" can be performed on the keypad to confirm whether input signal is issued from the link (COM), even if the command via communications is disabled.

6.7.9.2   Remote register signal in 1 X mode (o32 = 1)

Table 6.7.22   Remote Register in 1 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Write the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command/ torque command *1	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000 in the speed command, and 0.01%/1d in the torque command) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).

n: Value determined by a station address

*1   With H41 (torque command selection) = 4 (link enabled), RWwn+1 = torque command value. With H41≠4, RWwn+1 = speed command value.

Table 6.7.23   Remote Register in 1 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	

n: Value determined by a station address

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6.7.9.3 Monitor code/command code (o32 = 1 to 4)

Table 6.7.24 Monitor Code List (With o32 = 1 to 4)

Code No.	Monitor item	Unit	Remarks
00H	RWr0, RWr4-7: No monitoring (Fixed to 0) RWr1: Motor speed	—	
01H	Output frequency	0.01 Hz	
02H	Output current	0.01 A/0.1 A	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
03H	Output voltage	0.1 V	
05H	Speed setting	1 r/min	
06H	Rotating speed	1 r/min	
07H	Calculated torque	0.1%	
08H	DC link bus voltage	0.1 V	
09H | 0AH	No monitoring (Fixed to 0)	—	
0BH	Output current peak value	0.01 A/0.1 A	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
0DH	Power consumption (input power)	0.01 kW/0.1 kW	
0EH	Motor output	0.01 kW/0.1 kW	
0FH	Operation command	—	
10H	Output terminate status	—	
11H	Motor load (torque current)	0.1%	
12H	Flux command	0.01%	
13H	Position pulse	1 pulse	
14H	Cumulative power-ON time	1 hr	
15H | 16H	No monitoring (Fixed to 0)	—	
17H	Cumulative motor 1 run time	1 hr	
18H	Motor load factor	0.1%	
19H	Input watt-hour	1 kWhr	
20H	Torque command	0.1%	
21H	Torque current command	0.1%	
22H	Motor output	0.01 kW/0.1 kW	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
23H | 33H	No monitoring (Fixed to 0)	—	
34H	PID command value	0.1%	
35H	PID feedback	0.1%	
36H	PID deviation	0.1%	

Detailed description on operation command

b15								b8	b7						b0
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

Figure 6.7.17

Detailed description on output terminate status

b15								b8	b7						b0
Y18	Y17	Y16	Y15	Y14	Y13	Y12	Y11	-	-	-	Y5A	Y4	Y3	Y2	Y1

- : Empty (Fixed to 0)

Figure 6.7.18

Table 6.7.25   Command Code List (With o32 = 1 to 4)

Item	Code number	Description	Remarks
Reading of function code	0000$_H$ to FF63$_H$	Reads or writes data from/to inverter's function codes.	Inverter's function codes should be specified in the format shown in Table 6.7.27.
Writing of function code	0080$_H$ to FFE3$_H$	Writes data into inverter's function codes.	Data cannot be written into function code H01 or P02.
Reading of operation mode	007B$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive 0002$_H$: Keypad operation 0003$_H$: Others	0000$_H$: ([LE]=ON, H30≠0, and remote mode) 0001$_H$: ([LE]=OFF or H30=0), F02=1, and remote mode 0002$_H$: (([LE]=OFF or H30=0) and F02=0) or local mode 0003$_H$: Others
Writing of operation mode (Note 2)	00FB$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive 0002$_H$: Keypad operation	0000$_H$: Writing of H30=3, [LE]=ON (Note 1) 0001$_H$: Writing of H30=0, F02=1 0002$_H$: Writing of H30=0, F02=1, F01=0
Alarm code Reading of latest and last codes	0074$_H$	Alarm content Reading of latest and last codes.	Lower byte: Latest alarm code Higher byte: Last alarm code
Alarm code Reading of 2nd last and 3rd last codes	0075$_H$	Alarm content Reading of 2nd last and 3rd last codes.	Lower byte: 2nd last alarm code Higher byte: 3rd last alarm code
Alarm code Reading of 4th last and 5th last codes	0076$_H$	Alarm content Reading of 4th last and 5th last codes.	Lower byte: 4th last alarm code Higher byte: 5th last alarm code
Alarm code Reading of 6th last and 7th last codes	0077$_H$	Alarm content Reading of 6th last and 7th last codes.	Lower byte: 6th last alarm code Higher byte: 7th last alarm code
Reading of speed command	006D$_H$	Reads out the speed command value. (Monitoring of frequency set via CC-Link)	The allowable setting range is from 0 to +/-20000. Specify the ratio of the frequency relative to the maximum frequency (defined by F03 in Hz) being assumed as 20000.
Writing of speed command	00ED$_H$	Write speed command	
Clear alarm history	00F4$_H$	9696$_H$: Clears alarm history.	
Function code initialization	00FC$_H$	9696$_H$: H03=1	
Inverter reset	00FD$_H$	9696$_H$: Clear alarm	

(Note 1)   Assignment of [LE] to terminal X gives priority to [LE] via terminal X.

(Note 2)   In local mode, running mode cannot be changed.

Table 6.7.26   Response Code List (With o32 = 1 to 4)

Code number	Item	Description
00$_H$	Normal (No error)	Command code execution normally completed
01$_H$	Write mode error	・Function code was written while the inverter was running ・Function code was written while E2PROM was being written. ・Function code was written at the time of transmission error. ・S code was written when upper link (loader etc.) was enabled. ・Function code was written in a mode where edition is not permitted.
02$_H$	Function code selection error	・Accessed to a nonexistent function code ・Data was written to a read only function code.
03$_H$	Out of setting range	Set data is out of changeable range.

Table 6.7.27 Function Code Selection by Command Code (With o32=1 to 4)

(bit 15)															(bit 0)
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Identification code (table below)								0: Read 1: Write	Function code No. (low-order 2 digits) *1 00 to 99 (00h to 63h)						

*1 Even when a function code No. exceeds 99 (example: E101, etc.) is specified, set low order 2 digits.
(Example: the code No. is E101 -> Identification of function code "E1": 1Eh, function code No.: 01h)

Function code		Type Code	Group name	Remarks
F		00h	Fundamental function	
E	E01 to E99	01h	Terminal functions	
E1	E100 to E199	1Eh		
C		02h	Control function	
P		03h	Motor parameter M1	
H	H01 to H99	04h	High performance function	
H1	H100 to H199	1Fh		
H2	H200 to H299	20h		
A	A01 to A99	05h	Motor parameters M2 and M3	
A1	A100 to A199	24h		
o	o01 to o99	06h	Option function	
o1	o100 to o199	25h		
S		07h	Communication command function	
M	M01 to M99	08h	Communication monitor function	Read only
M1	M100 to M199	29h		
M2	M200 to M299	2Ah		
L		09h	Elevator function	
U	U01 to U99	0Bh	User function	
U1	U101 to U199	27h		
SF		28h	Safety function	Read only

Function code selection by command codes

・ Example 1: When reading of M126 "Cumulative M1 motor run time" is selected,
identification code M1->29h, function code No. 26->1Ah, write/read bit -> 0 => command code = <u>291Ah</u>

・ Example 2: S08 "Acceleration time" is specified by writing it
Identification code   S->07h, function code No. 7 -> 07h, read/write bit -> 1   Command code = <u>0787h</u>

6.7.10　2 X mode with 1 station occupied (o32=2)

6.7.10.1　Remote I/O signal in 2 X mode (o32=2)

o32=1　Same as the case of 1 X mode with 1 station occupied

6.7.10.2　Remote register signal in 2 X mode (o32=2)

Table 6.7.28　Remote Register in 2 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Write the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command/ torque command*1	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000 in the speed command, and 0.01%/1d in the torque command) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (listed in Table 6.7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. (□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		

n: Value determined by a station address

*1　With H41 (torque command selection) = 4 (link enabled), RWwn+1 = torque command value. With H41≠4, RWwn+1 = speed command value.

Table 6.7.29　Remote Register in 2 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	Available with 2 X setting
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		

n: Value determined by a station address

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6.7.11 4 X mode with 1 station occupied (o32=3)

6.7.11.1 Remote I/O signal in 4 X mode (o32=3)

o32=1   Same as the case of 1 X mode with 1 station occupied

6.7.11.2 Remote register signal in 4 X mode (o32=3)

Table 6.7.30   Remote Register in 4 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Specify the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYnC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (refer to Table 6.7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. (□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		
RWwn+8	Alarm history	Specify an alarm code to be read by writing 0000, 0100, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, or 0A00 into RWwn+8, corresponding to the latest, 2nd last, 3rd last, 4th last, 5th last, 6th last, 7th last, 8th last, 9th last, or 10th last error, respectively. (Don't care for the lower 8 bits.) The content of the specified alarm code and its related information are stored in RWr+8, 9, A, B, and C. For 0Bxx or later, the alarm codes are responses fixed to 0000.	Latest: 0000 Last: 0100 2nd last: 0200 ↓ 7th last: 0700 8th last: 0800 9th last: 0900 10th last: 0A00
RWwn+9 | RWwn+B	Not used.	Should be set to 0000h.	
RWwn+C	Torque command value	Specify the torque command. When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	
RWwn+D | RWwn+F	Not used.	Should be set to 0000h.	

n: Value determined by a station address

Table 6.7.31   Remote Register in 4 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		
RWrn+8	Alarm code	The content of the alarm code specified in RWwn+8 is automatically written into the lower 8 bits of RWrn+8. The upper 8 bits of RWwn+8 will be echoed back into the upper 8 bits of RWrn+8.	For the alarm code, refer to Chapter 4, Section 4.2.4.2, Type [14].
RWrn+9	Motor speed at the time of latest alarm	The motor speed with the alarm, specified with RWwn+8, generated is stored. For alarms other than the latest one, response is given with "0".	0 to ±20000 (Nmax with ±20000) Supported only for the latest alarm.
RWrn+A	Output current at the time of latest alarm.	This register stores the output current applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Rating of less than 75 kW: Unit of 0.01 A Rating of 75 kW or more: Unit of 0.1 A
RWrn+B	Output voltage at the time of latest alarm.	This register stores the output voltage applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit of 0.1 V. "0" except for the latest alarm.
RWrn+C	Cumulative power-ON time at the latest alarm occurrence	This register stores the cumulative power-ON time elapsed until the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit: 1 h
RWrn+D | RWrn+F	Not used.	-	

n: Value determined by a station address

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6.7.12　8 X mode with 1 station occupied (o32=4)

6.7.12.1　Remote I/O signal in 8 X mode (o32=4)

o32=1　Same as the case of 1 X mode with 1 station occupied

6.7.12.2　Remote register signal in 8 X mode (o32=4)

Table 6.7.32　Remote Register Signal in 8 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Specify the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYnC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (refer to Table 6.7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. ("□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		
RWwn+8	Alarm history	Specify an alarm code to be read by writing 0000, 0100, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, or 0A00 into RWwn+8, corresponding to the latest, 2nd last, 3rd last, 4th last, 5th last, 6th last, 7th last, 8th last, 9th last, or 10th last error, respectively. (Don't care for the lower 8 bits.) The content of the specified alarm code and its related information are stored in RWrn+8, 9, A, B, and C. For 0Bxx or later, the alarm codes are responses fixed to 0000.	Latest: 0000 Last: 0100 2nd last: 0200 ↓ 7th last: 0700 8th last: 0800 9th last: 0900 10th last: 0A00
RWwn+9 ┃ RWwn+B	Not used.	Should be set to 0000h.	
RWwn+C	Torque command value	Specify the torque command. When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	
RWwn+D ┃ RWwn+F	Not used.	Should be set to 0000h.	
RWwn+10	Command code 2	Use these registers in the same way as RWwn+2. After writing into these registers, turning the RYnF ON executes these command codes in the order of RWwn+2, 10, 12, 14, 16, and 18. Upon completion of execution of RWwn+18, the RXnF is turned ON. To nullify the execution of RWwn+10 to 18, FFFF$_H$ should be written into these registers.	

Address	Signal name	Description	Remarks
RWwn+11	Write data 2	If data is to be written with RWwn+10, 12, 14, 16, and 18 command codes used, set the data in this register. RWwn+10, 12, 14, 16, and 18 correspond to 11, 13, 15, 17, and 19, respectively. Set the register corresponding to the command codes of RWwn+10, 12, 14, 16, and 18, and then turn RYnF ON. If write codes are unnecessary, "0" should be written.	
RWwn+12	Command code 3	Same as command code 2	
RWwn+13	Write data 3	Same as write data 2	
RWwn+14	Command code 4	Same as command code 2	
RWwn+15	Write data 4	Same as write data 2	
RWwn+16	Command code 5	Same as command code 2	
RWwn+17	Write data 5	Same as write data 2	
RWwn+18	Command code 6	Same as command code 2	
RWwn+19	Write data 6	Same as write data 2	
RWwn+1A | RWwn+1F	Not used.	Should be set to 0000h.	

n: Value determined by a station address

Table 6.7.33   Remote Register in 8 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		
RWrn+8	Alarm code	The content of the alarm code specified in RWwn+8 is automatically written into the lower 8 bits of RWrn+8. The upper 8 bits of RWwn+8 will be echoed back into the upper 8 bits of RWrn+8.	For the alarm code, refer to Chapter 4, Section 4.2.4.2, Type [14].
RWrn+9	Motor speed at the time of latest alarm	The motor speed with the alarm, specified with RWwn+8, generated is stored. For alarms other than the latest one, response is given with "0".	0 to ±20000 (Nmax with ±20000) Supported only for the latest alarm.
RWrn+A	Output current at the time of latest alarm.	This register stores the output current applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Rating of less than 75 kW: Unit of 0.01 A Rating of 75 kW or more: Unit of 0.1 A
RWrn+B	Output voltage at the time of latest alarm.	This register stores the output voltage applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit of 0.1 V. "0" except for the latest alarm.
RWrn+C	Cumulative power-ON time at the latest alarm occurrence	This register stores the cumulative power-ON time elapsed until the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit: 1 h
RWrn+D | RWrn+F	Not used.	-	-

Address	Signal name	Description	Remarks
RWwn+10	Response code 2	Turning the RYnF ON stores the response code (Table 6.7.26) corresponding to the command code specified in RWwn+10, 12, 14, 16, and 18. If the command code has normally been executed, zero (0) is automatically written; if any error has occurred during processing of the command code, any value other than zero is written.	Enabled with 8X setting
RWwn+11	Read data 2	If the command code specified in RWw10, 12, 14, 16, or 18 has normally been executed, the response data for that command code is automatically written.	
RWwn+12	Response code 3	Same as command code 2	
RWwn+13	Read data 3	Same as write data 2	
RWwn+14	Response code 4	Same as command code 2	
RWwn+15	Read data 4	Same as write data 2	
RWwn+16	Response code 5	Same as command code 2	
RWwn+17	Read data 5	Same as write data 2	
RWwn+18	Response code 6	Same as command code 2	
RWwn+19	Read data 6	Same as write data 2	
RWwn+1A | RWwn+1F	Not used.	-	

n: Value determined by a station address

6.7.13   Link function

The availability (REM/LOC/COM) of the command data (S area) is switched by function code H30 "Link operation" and X function "24: link operation selection [LE]". Be familiar with this together with the control block (refer to Chapter 4).

Writing the standard function codes (F, E, C, P, H, A, o, U, and L) from a link is controlled by function code H29 "link function code protection" and X function "23: link edition permission command [WE-LK]". Be familiar with this together with the control block (refer to Chapter 4).

6.7.13.1   Link command permission selection

Performing the operation of the inverter via CC-Link requires switching of the mode to the link command permission mode to select a command (other than 0) via communications by function code H30 "Link operation". (The system configuration is so flexible that switching a value selected for "link operation", for example, can select an operation command on the terminal block and a speed command through communications).

Table 6.7.34

Condition			Mode
Assignment status of 24: link operation selection [LE] to function codes E01 to E13 "X function selection"	Not assigned (Factory default)	Command code FB$_H$ (Operation mode) = 0	Link command permission mode
		Command code FB$_H$ (Operation mode) = 1.2	Link command no permission mode
	Assigned	When applicable terminal X is ON	Link command permission mode
		When applicable terminal X is OFF	Link command no permission mode

Table 6.7.35

H30 setting	Link command permission mode		Link command no permission mode	
	Command data (S01 to S05, S08 to S17)	Operation command (S06)	Command data (S01 to S05, S08 to S17)	Operation command (S06)
0	×	×	×	
1	○	×	×	
2	×	○	×	
3	○	○	×	

O: Command enabled via communications, X: Command disabled via communications (operated by the command from terminal block or keypad)

Note 1: S code (command data/operation data) can be written even in the link command no permission status.

Note 2: Writing data into function code S08 "Acceleration time"/S09 "Deceleration time" is independent of link command permission mode and function code H30 "link operation". The data is always overwritten into function code F07/F08 "acceleration/deceleration time".

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6.7.13.2   Link edition permission selection

Confirmation (reading) of function codes via CC-Link is always enabled. For changing (writing) function codes, however, function code H29 "link function code protection" must be write-enabled (=0) in the link edition permission mode. (It is put in "link edition permission mode" by factory default.)

Table 6.7.36

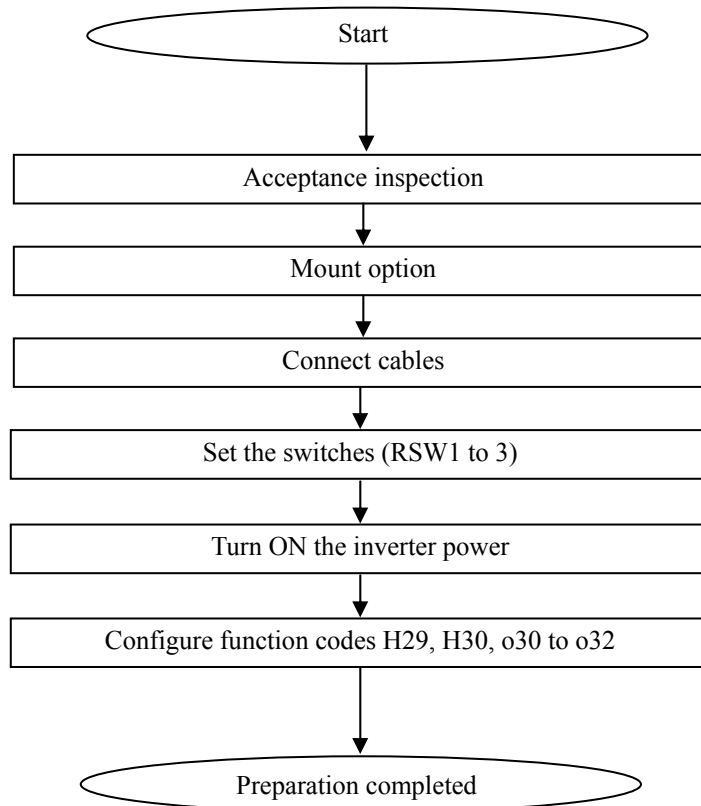| Condition			Mode
Assignment status of 23: link edition permission command [WE-LK] to function codes E01 to E13 "X function selection"	Not assigned (Factory default)		Link edition permission mode
	Assigned	When applicable terminal X is ON	Link edition permission mode
		When applicable terminal X is OFF	Link edition no permission mode

Table 6.7.37

H29 setting	Link edition permission mode	Link edition no permission mode
0	○	×
1	×	×

O: Function codes (F, E, C, P, H, A, o, L, and U) are write-enabled, X: Function codes are write-disabled

Note 1: Wiring into S codes (command data, operation data, etc.) is always enabled regardless of this function.

6.7.14   Setting-up procedure

The following flow shows the initial setting-up procedure for the CC-Link option, using the procedure given in this chapter.

```
                    Start
                      │
            ┌─────────▼─────────┐
            │ Acceptance inspection │
            └─────────┬─────────┘
            ┌─────────▼─────────┐
            │    Mount option   │
            └─────────┬─────────┘
            ┌─────────▼─────────┐
            │   Connect cables  │
            └─────────┬─────────┘
            ┌─────────▼─────────┐
            │ Set the switches (RSW1 to 3) │
            └─────────┬─────────┘
            ┌─────────▼─────────┐
            │ Turn ON the inverter power │
            └─────────┬─────────┘
            ┌─────────▼─────────┐
            │ Configure function codes H29, H30, o30 to o32 │
            └─────────┬─────────┘
                      ▼
            Preparation completed
```

Now the inverter is ready to run via CC-Link.

After the CC-Link master becomes ready, run the master to operate the inverter via CC-Link.

6.7.15   Application program examples

6.7.15.1   System configuration
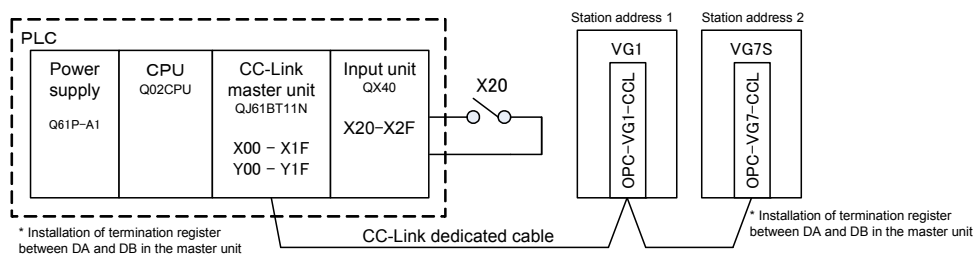
Figure 6.7.19   System Configuration

6.7.15.2   Master unit outline

This section outlines the CC-Link master unit necessary for execution of application program examples. For details, refer to Mitsubishi Electric CC-Link System Master Local Unit user's manual (volume on details).

6.8 17-bit High Resolution ABS Interface Card OPC-VG1-SPGT

6.8.1 Product overview

This option allows the FRENIC-VG to interface with the 17-bit, high-resolution ABS encoder manufactured by Tamagawa Seiki Co., Ltd.

(1) 17-bit, high-resolution ABS interface card

Available for induction motor/synchronous motor control PG serial interface (speed/position feedback)

Available for machine axis serial PG interface (position feedback) (available in the near future)

For the connectable PG format, refer to Table 6.8.1.

(2) Pulse frequency dividing output

Feedback signals from serial encoder are frequency-divided to output pulse signals.
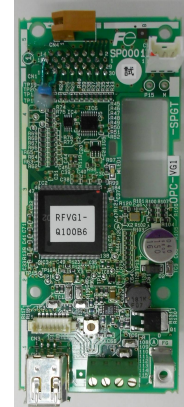
⚠CAUTION

・ This option and some of other options cannot be mounted at the same time. If this option is combined with an option that cannot be mounted at the same time, operation procedure error $Er-6$ is output.

6.8.2 Model and specifications

6.8.2.1 Model

Model content: OPC-VG1-SPGT

Mounted inverter name VG1 -> FRENIC-VG

Option name: SPGT -> 17-bit, high-resolution serial encoder interface option
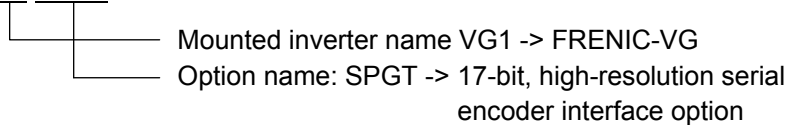
Accessories

Three spacers
Terminating resistance (220 Ω, 1/4 W)

⚠CAUTION

・Do not use the product that is damaged or lacking parts.
Doing so could cause injury or damage.

6.8.2.2 Specifications

Table 6.8.1 Hardware Specifications

Item	Specifications
Applicable PG model	17-bit, high-resolution ABS encoder manufactured by Tamagawa Seiki Co., Ltd. TS5667N253/TS5667N650
Allowable revolution speed	TS5667N253: 3,000 r/min TS5667N650: 1,500 r/min
Power supply for PG	Power is supplied from this option board to PG. Voltage: 5 V ± 5 %, and current: 70 mA, Typ. (during normal operation)
Allowable wire length/connection	60 m max. Wire is short when the voltage drop is high. The following distribution cables have been prepared, but are arranged separately. WSC-P06P05-W (5 m) WSC-P06P10-W (10 m) WSC-P06P15-W (15 m) WSC-P06P20-W (20 m) If a cable required is longer than 20 m, contact us separately. If the cable is longer than 50 m, the attached terminating resistance must be installed.
Power supply for option board	The power is supplied from the PCB of the main unit (15 V). Connect the power harness to CN12 of the main unit.
Pulse frequency dividing output	5V Line driver A-/B-phase signal output (FA+/-, FB+/-) Signals obtained by frequency-dividing 17-bit serial data are output. Maximum frequency of 1 MHz. Note that the frequency dividing rate is "function code E109/E110". * Calculation example of output frequency (E109=1000, E110=32767, P28=32768, Serial PG installation axis frequency = 25 Hz) When a 17-bit serial encoder is used, the pulse resolution (P28) is "17 bits ÷ 4-multiplied = 32768". Pulse output (Hz) = (E109/E110) x 25 (Hz) x P28 (1000/32767) x 25(Hz) x 32768 = 25.001 kHz (A-/B-phase output)

Chap. 6 CONTROL OPTIONS

Table 6.8.2　Software Specifications

Item		Specifications
Motor drive control		For induction motor: Vector control with speed sensor Function codes P01, A01, and A101, "Drive control selection" = "0" For synchronous motor: Vector control with speed sensor Function codes P01, A01, and A101, "Drive control selection" = "3"
Speed control	Speed control range	1:1500 (minimum speed: Base speed, 1 to 1500 r/min when converted with 4P) 1:6 (Constant torque area: constant output area, with induction motor) May not be achieved in a synchronous motor due to electric characteristics of the motor.
	Speed control accuracy	Analog setting: ±0.1% of maximum speed Digital setting: ±0.005% of maximum speed
Position control (pulse train synchronous operation) (available soon)	Position response	10 Hz Response is adjusted with APR gain and ASR gain.
	Position precision	Within encoder ±2 bits (At the time of steady state/ transition, F/F gain = setting of 1.0) With F/F gain ≠1.0, steady state/transition deviation occurs.
	Lock precision	Within encoder ± 2 bits, 150% is allowed for resistance torque.
Serial encoder interface function	With the motor integrated/ directly connected	Specify function codes P01, A01, and A101 with "Drive control selection" = "0 (induction motor)" or "3 (synchronous motor)" are set. When the SPGT option is mounted, SPGT pulse train fed back is automatically selected to disable the integrated PG input PA/PB terminal.
	For machine axis pulse feedback (available in the near future)	The machine axis position can be controlled with signals from serial PG mounted in the machine axis. The motor requires an independent PG to detect motor speed/position.
	Serial PG dedicated alarm	Mounting this option adds the following protection functions to the standard functions in connection with the interface with PG. Encoder error ($Et\ I$), encoder communication error (EC)
Position control dedicated function (available soon)	Control	Synchronous operation system *The straight line position control system should be constructed on the UPAC or SX (PLC) side.
	Monitor	1-rotation data (17 bits), multi-rotation data (16 bits)
	I/O terminal function	X function selection/Y function selection

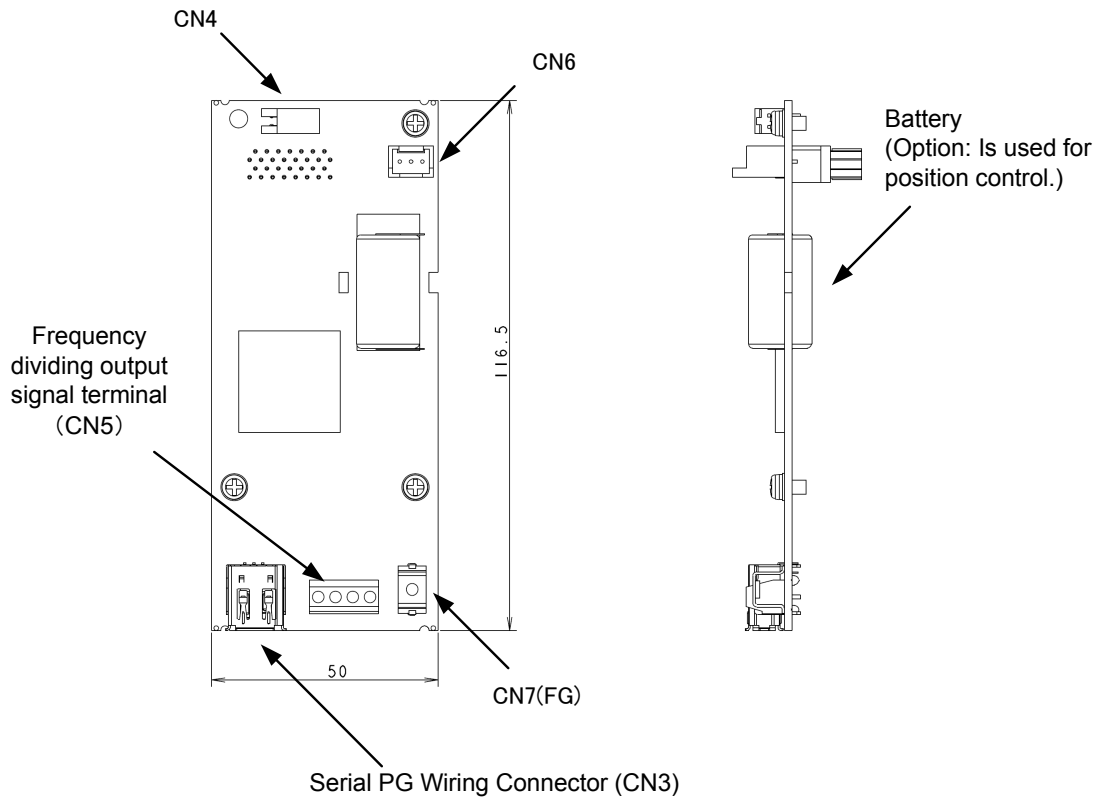## 6.8.3   External dimension drawing

Figure 6.8.1   Card Outline Drawing

6.8.4 Connection

Refer to 6.1.4 "Installing internal options (OPC-VG1-□□)", and then perform wiring and connecting wires.

This option should be mounted at port B (CN2).

⚠ WARNING

- Incorrect handling in connecting job could cause an accident such as electric shock or fire. Qualified electricians should carry out connecting wires. If connecting wires, for example, after the power is turned ON requires any touching of an electric circuit, turn OFF (open) the breaker on the power supply side to prevent electric shock.

- Since the smoothing condenser has been charged although the breaker is turned OFF (open), touching an electric circuit causes an electric shock. Confirm, with a tester, etc., that the charge lamp (CHARGE) of the inverter is turned OFF and the DC voltage of the inverter has been reduced to the safety voltage.

⚠ CAUTION

- Do not use the product that is damaged or lacking parts. Doing so could cause injury or damage.

- Incorrect handling in installation/removal could result in a broken produce.

6.8.4.1 Connector and terminal specifications

Connector specifications for serial encoder wiring
· Model : 53984-0671 (Molex) (IEEE1394)

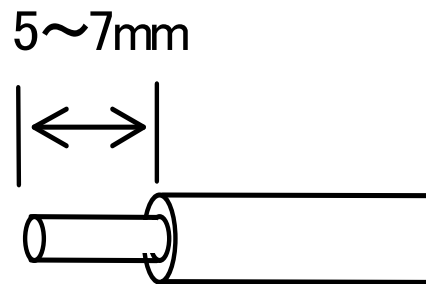| Pin No.	Signal name	Function
1	P5	5 V power supply
2	M	GND
3	BAT+	Battery output (+)
4	BAT-	Battery output (-)
5	SIG-	Serial communication (-)
6	SIG+	Serial communication (+)

Frequency output signal terminal
Applicable wire: AWG24-18 (0.25 to 0.75 mm^2)
Tightening torque: 0.22 to 0.25 N･m

Pin No.	Signal name	Function
1	FA+	A-phase differential output (+)
2	FA-	A-phase differential output (-)
3	FB+	B-phase differential output (+)
4	FB-	B-phase differential output (-)

FG terminal
Recommended wire size: 1.25 mm^2
Tightening torque: 0.7 N･m

5～7mm

Figure 6.8.2 Connector Layout

5-7 mm
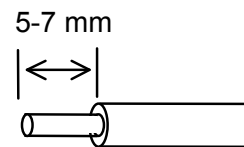
Figure 6.8.3 Wire Tip Treatment
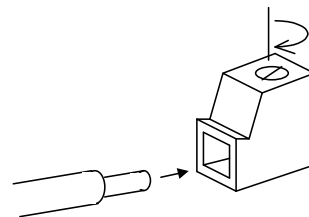
6.8.4.2   Basic connection diagram

When motor-integrated or directly-connected high resolution serial encoder is used to perform control
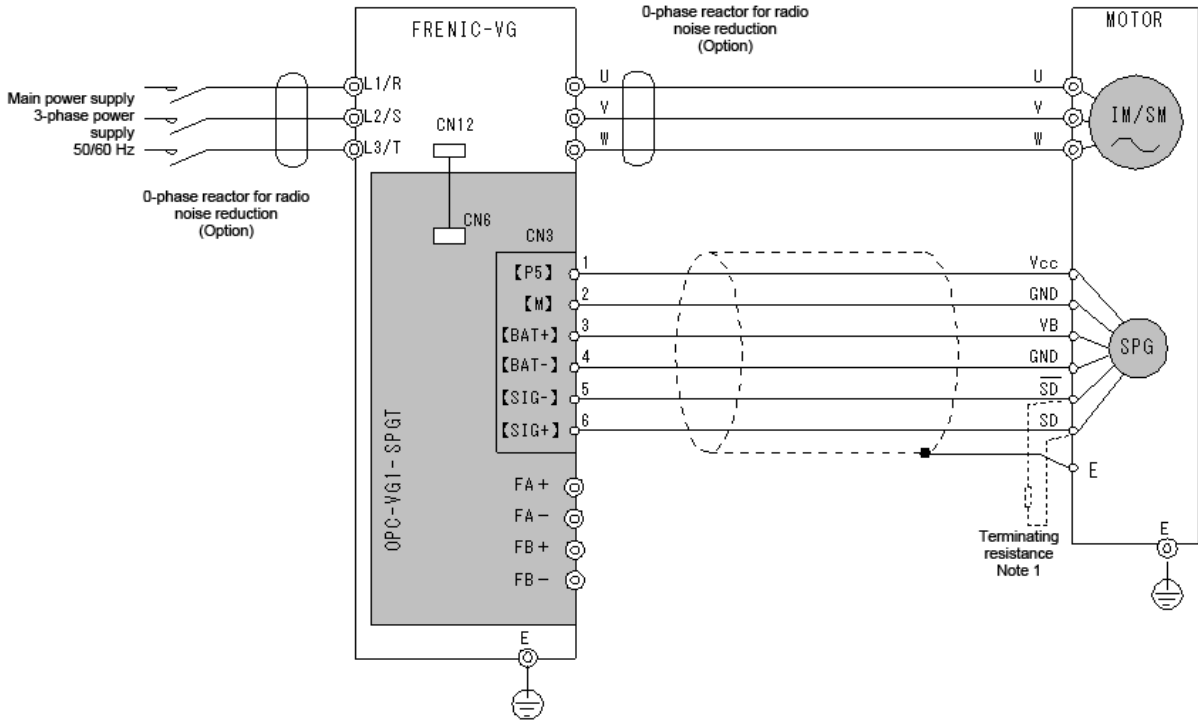

Figure 6.8.4

When high resolution serial encoder mounted in the machine axis is used to perform control (available soon)
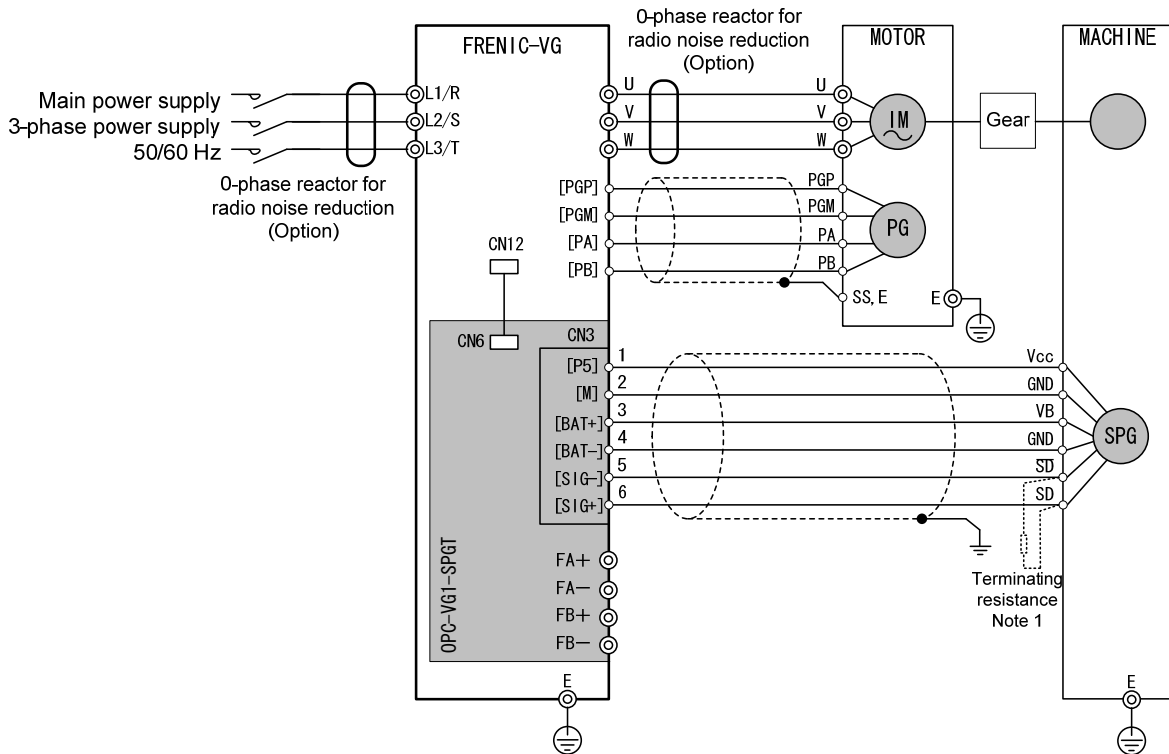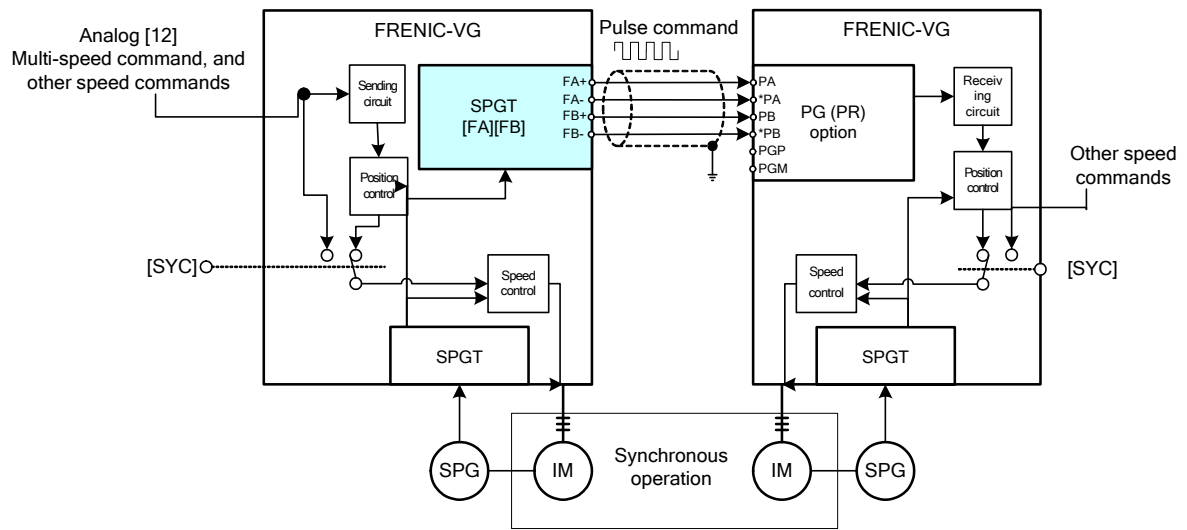

Figure 6.8.5

Note 1: If the cable is longer than 50 m, install the supplied terminating resistance (220 Ω, 1/4 W) between the encoder terminal $\overline{\text{SD}}$ and the SD terminal.

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When frequency dividing output pulse of the master axis is used for synchronous operation as a pulse command (available soon)

Figure 6.8.6

6.8.5 Function code

⚠ WARNING
・ Configuring the function codes wrongly may lead to dangerous conditions. When data has been set or written, be sure to confirm the data again. **Failure to observe this precaution could cause an accident.**

Mounting this option board can perform driving in combinations with the induction motor or synchronous motor. In addition, position control can be done. Function code settings in each condition are as follows.

Table 6.8.3

Motor	Serial encoder installation position	Position control (available in the near future)	Setting function code		
			P01, A01, A101	o09, A59, A159	o05
Induction motor	Motor (including 1-to-1 machine axis)	No	0	-	-
		Yes			-
	Machine axis (Motor with standard PG)	Yes			2
Synchronous motor	Motor (including 1-to-1 machine axis)	No	3	6	-
		Yes		6	-
	Machine axis (Motor with PMPG)	Yes		0 to 2	2

Note: "-" indicates setting is unnecessary (optional).

6.8.5.1 Function codes related to motor control

Motor parameters must be set according to the motor (M1 to 3) in use. For details, refer to the explanation on P code and A code in Chapter 4.

(1) For induction motor

Set P28 (with M1 selected), A30 (with M2 selected), and A130 (with M3 selected) according to the maximum speed of the motor.

(2) For synchronous motor

With the following contents, set the codes.

・ Motor parameter (supports the synchronous motor)
・ Magnetic pole position adjustment of synchronous motor
・ Inverter's function codes

For magnetic pole position adjustment of synchronous motor

When the card is combined with a motor for the first time after the purchase to drive a synchronous motor, the confirmation, adjustment and setting of the magnetic pole position are required. (Settings differ depending on the motor.)

Set the magnetic pole position offset value of the applicable motor, or confirm and adjust the magnetic pole position according to the following procedure. (If the values described in the test report have been set, confirm the position according to the following procedure,)

If the card was already combined for operation after it had been purchased, if PG is installed later, or if replacement of PG is required, the confirmation, adjustment and setting must be performed without fail.

⚠CAUTION

- The adjustment of magnetic pole position must observe the following.
- If the operation is for the first time after the purchase or after the replacement of the motor, PG, or inverter unit, the adjustment must be performed without fail.
- If the operation is performed without adjusting the magnetic pole position (o10, A60, A160) or when settings significantly deviate from true values, operation in opposite direction or runaway may occur in the worst cases.

**Failure to observe this precaution could cause an accident.**

Failure to observe this precaution could cause injury.

◆ Pre-setting of parameters

E69 (Ao1 assignment) :	26 (U-phase voltage)
E70 (Ao2 assignment) :	39 (SMP)
E84 (Ao1-5 filter setting) :	0.000s (Filter cancel)

◆ Rotating the motor manually, confirm that the position relationships between Ao1 and Ao2 waveforms are as shown below.

If waveform is significantly broken, adjust the value of o10 (with M1 selected), A60 (with M2 selected), or A160 (with M3 selected) to achieve the relationships shown in Figure 6.8.7.
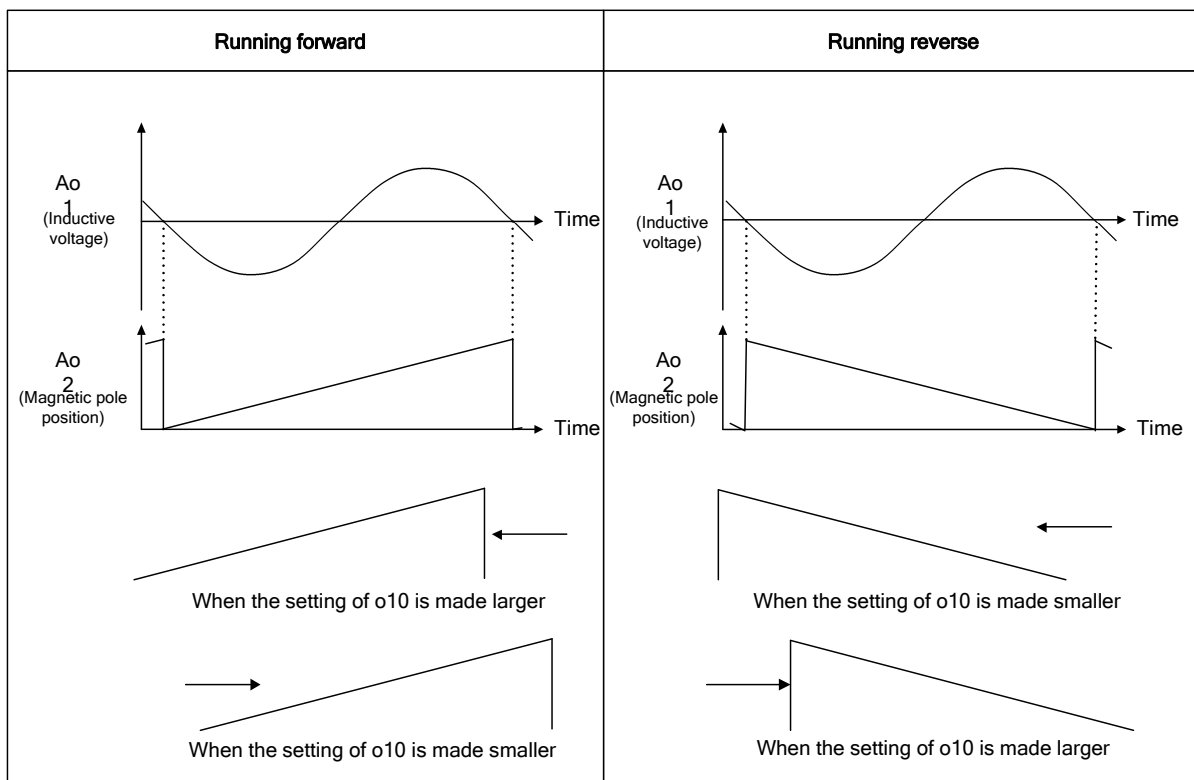
Figure 6.8.7 Adjustment of Magnetic Pole Position

Inverter's function codes

o09	M1 ABS signal input definition

A59	M2 ABS signal input definition

A159	M3 ABS signal input definition

Function code for synchronous motor. It selects an interface system for encoder ABS signal.

	o	0	9	M	1	–	A	B	S		D	E	F
	A	5	9	M	2	–	A	B	S		D	E	F
A	1	5	9	M	3	–	A	B	S		D	E	F

Setting range   0:   1 bit (terminal; F0) Z-phase interface (available in the near future)

1:    3 bits (Terminal; F0, F1, F2) U-/V-/W-phase interface

2:    4 bits (Terminal; F0, F1, F2, F3) Gray code interface

3-5:   Not used.

6:    SPGT 17-bit serial interface

7-16:   Not used.

o10	M1 magnetic pole position offset

A60	M2 magnetic pole position offset

A160	M3 magnetic pole position offset

Function code for synchronous motor. It defines the offset to encoder reference position and actual motor magnetic pole position.

	o	1	0	M	1	–	S	M		O	F	S	
	A	6	0	M	2	–	S	M		O	F	S	
A	1	6	0	M	3	–	S	M		O	F	S	

Setting range: 0.0 to 359.9/0 to 359.9° CCW direction

Enter the value described in the test report of the applicable motor or make adjustments according to the magnetic pole position adjustment procedure.

o11	M1 salient pole ratio (%Xq, %Xd)

A61	M2 salient pole ratio (%Xq, %Xd)

A161	M3 salient pole ratio (%Xq, %Xd)

Function code for synchronous motor. It uses a q-axis/d-axis ratio to set a difference in reactance given by the difference in magnetic resistance between the q-axis and the d-axis of the IPM motor.

	o	1	1	M	1	–	X	q	/	X	d		
	A	6	1	M	2	–	X	q	/	X	d		
A	1	6	1	M	3	–	X	q	/	X	d		

Setting range: 1.000 to 5.000

The value must be calculated based on the setting of each motor. If the value is unknown, contact us. For the SPM motor, it should be set to 1.000.

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6.8.6　Protective functions

6.8.6.1　Alarm display list

Mounting this option card adds the standard protection functions as well as the following protection functions.

Item	Content	Display	Related code
Encoder error 1	ABS encoder position detection data error. (Serial communications are carried out normally.) As an alarm release method, resupply the power.	$Et\ 1$	
Encoder communications error	The operation is performed when serial communications with the ABS encoder cannot be established. The operation is performed when communications cannot be established between the option card and the inverter.	EC	
Operation procedure error	The operation is performed when two or more communications options are mounted. With SPGT mounted, installing SPGT on the A-port side (CN3 side) activates the operation.	$Er-6$	

6.8.6.2　Actions to be taken for alarms

Item	Possible cause	Action to be taken
$Et\ 1$	Data received from the encoder is wrong.	Use shielded wire to prevent being affected by noise.
	The encoder has been broken.	Replace the encoder.
EC	Communications with the encoder are interrupted.	・Visually check the encoder cable and check the disconnection status. ・Check the encoder model.
	Disconnection or poor connection of encoder cable	・Check that the encoder terminating resistance (220Ω, 1/4W) has been installed. ・Check that the option card power connector is connected appropriately. ・Insert the ferrite core.
	Inappropriate installation of the option card	・Check the installation of the option card and the length of the spacer.
$Er-6$	Combinations of options that cannot be mounted at the same time.	・Remove option cards, if any, that cannot be mounted at the same time.
	SPGT is mounted on the A-port side (CN3 side).	・Check and correct the mounting place of SPGT. ・Mount SPGT on the B-port side (CN2 side).

6.8.7　Check function

6.8.7.1　Option mounting check

Checking for mounting of the SPGT option can be checked on the keypad.

Move from the operation mode screen to the program menu screen, and select "4. I/O check" with the $\bigwedge/\bigvee$ key to switch the screen. As shown at right, screen 9 is available to check for mounting of it.

```
O P T I O N
A :
B : V G 1 - S P G T
C :
∧ V → P A G E  S H I F T   9
```

For details, refer to the keypad operation procedure.

If the SPGT card has been mounted, the screen is displayed as shown at right.

6.8.8   Related option

■ Distribution cable (Product to be arranged independently)

Length and model

L [mm]	Model	Terminal treatment on the PG side	Remarks
$5,000^{+500}$	WSC-P06P05-W	Unfastened leads (Illustration A)	
	WSC-P06P05-E	Connector (Illustration B)	
$10,000^{+1,000}$	WSC-P06P10-W	Unfastened leads (Illustration A)	
	WSC-P06P10-E	Connector (Illustration B)	
$15,000^{+1,500}$	WSC-P06P15-W	Unfastened leads (Illustration A)	
	-	-	
$20,000^{+2,000}$	WSC-P06P20-W	Unfastened leads (Illustration A)	
	WSC-P06P20-E	Connector (Illustration B)	
$50,000^{+2,000}$	WSC-P06P50	Connector (Illustration B)	Handled as a special-purpose item.

When an applicable serial PG is incorporated into our motor, PG wire can support either unfastened leads (terminal block) or connector.

(Illustration A)
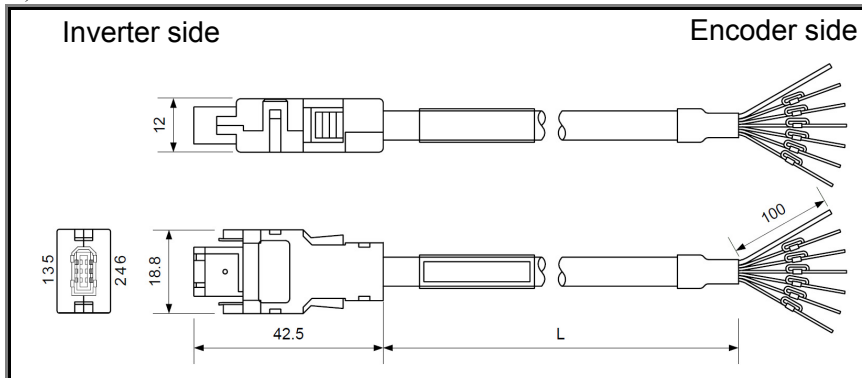
Connector model

Connector on the inverter side

Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

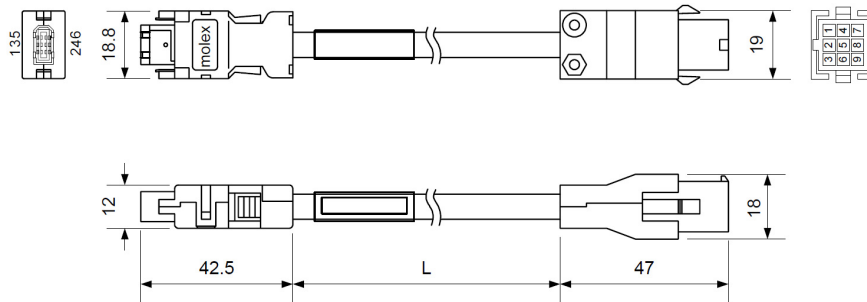**Figure 6.8.8   Cable for Encoder Connection**

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Green

Pin No.		1	2	3	4	5	6	Case
Green	①	Red	Black	Orange	Orange/white	Sky blue	Sky blue/white	Protection tube
	②	White	Black	Yellow	Brown	Red	Blue	
Signal name		P5	M5	BAT+	BAT−	SIG+ [*1]	SIG− [*2]	

For green, either 1) or 2) is applicable.

※1 : Connect the negative logic side of the communications signal.

※2 : Connect the positive logic side of the communications signal.

(Illustration B)

Connector model

Connector on the inverter side	
Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

Connector on the motor side	
Cap housing	1-172332-9
Socket	170361-1
Cover (X2)	316455-1
Screw (X2)	XPB M2.6×10
Nut (X2)	M2.6

Manufactured by Tyco Electronics

Green

Option card side		1	2	3	4	5	6	Shell
Motor side		7	8	1	2	5	4	3
Green	①	Red	Black	Orange	Orange/white	Blue/white	Blue	Shield
	②	White	Black	Yellow	Brown	Blue	Red	Shield
Signal name		P5	M5	BAT+	BAT-	SIG+ [*1]	SIG− [*2]	FG

*1:   Connect the negative logic side of the communications signal.

*2:   Connect the positive logic side of the communications signal.

* When you prepare cables, the following electric wires are recommended.
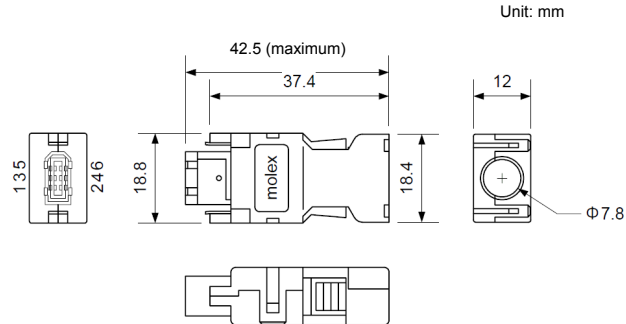
Recommended electric wires

When the cable length is 10 m or less: RMCV-SB-A-AWG#25/2P+AWG#23/2C or AWG#23/3P

When the cable length is more than 10 m and less than or equal to 50 m: RMCV-SB-A AWG#25/2P+AWG#17/2C or the equivalent

Connector kit

・Connector on the inverter side
  Model: WSK-P06P-M

Outline drawing

Unit: mm

42.5 (maximum)
37.4
12
13.5
24.6
18.8
18.4
Φ7.8
molex

Component parts

Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

* The connector manufacturer's models are subject to change without notice.

・Connector on the motor side
  Model: WSK-P09P-D

Outline drawing

Unit: mm

47
19
14
8
5
18
12
14
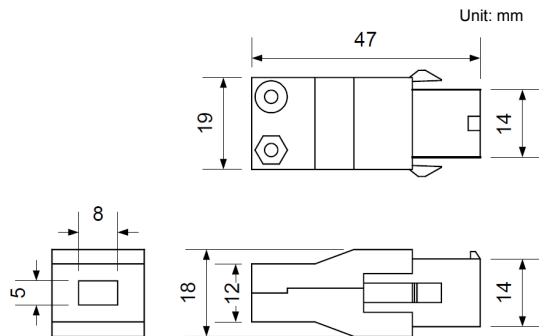
Component parts

Cap	172161-9
Cap cover	316455-1
Socket	170365-1 (Unfastened status) 170361-1 (Concatenate)
Socket	170366-1 (Unfastened status) 170362-1 (Concatenate)

Manufactured by Tyco Electronics

* The connector manufacturer's models are subject to change without notice.

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■ Wiring connection diagram with option cables used
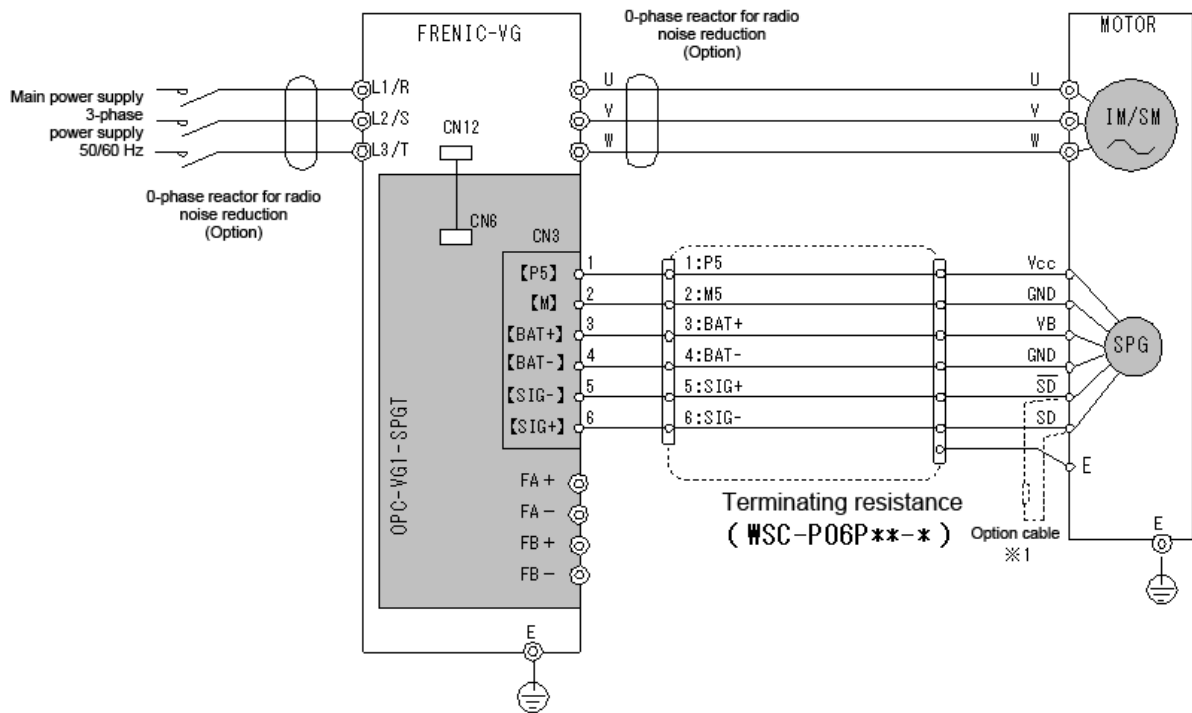
Note 1: If the cable is longer than 50 m, install the supplied terminating resistance (220Ω, 1/4W) between the encoder terminal $\overline{\text{SD}}$ and the SD terminal.

6.9 F/V Converter OPC/MCA-VG1-FV (available soon)

6.9.1 Product overview

OPC-VG1-FV is one of the FRENIC-VG analog interface option OPC series products. A single unit of the FRENIC-VG analog interface option OPC series product can be installed in a single FRENIC-VG inverter unit.

OPC-VG1-FV converts frequency signals into voltage signals. It is used to detect a signal (e.g., line speed) by a pulse encoder and convert it into an analog signal.

MCA-VG1-FV is an optional unit containing OPC-VG1-FV for separate installation.

MCA-VG1-FV can be used in combination with other model (FRENIC series inverter).
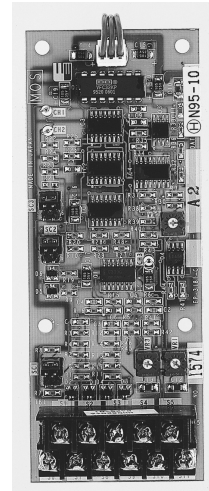
<div style="text-align:right">

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</div>

⚠ WARNING

- The switches and volumes inside the option have been adjusted at the factory. Never touch a volume or switch other than those used for adjustment by the user.
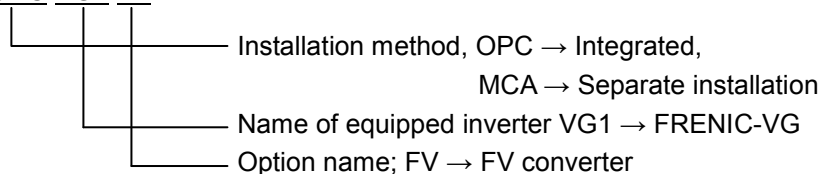

⚠ CAUTION

- Install the MCA (separate installation) type with the connection terminal side down, near the inverter, and connect the cables so that no noise will be applied to signals.

  The MCA (separate installation) type requires a separate power supply (±15 V DC), which is not supplied from FRENIC-VG. Prepare a stabilized power supply (±15 V) separately.

6.9.2 Model and specifications

6.9.2.1 Model

Model elements: MCA/OPC-VG1-FV

    Installation method, OPC → Integrated,
                         MCA → Separate installation
    Name of equipped inverter VG1 → FRENIC-VG
    Option name; FV → FV converter

OPC type accessories

Spacer x 3
M3 screw x 3
Power supply harness (for ±15V power supply) x 1

6.9.2.2   Specifications

> ### ⚠ CAUTION
>
> • The MCA (separate installation) type requires a separate power supply (±15V), which is not supplied from FRENIC-VG. Prepare a stabilized power supply (±15V) separately.

(1)   Hardware specifications

Table 6.9.1   General Specifications

Item	Specifications	
	OPC-VG1-FV	MCA-VG1-FV
Voltage and required power supply	P: ＋15.0 VDC ±2.0 V Approx. 65 mA (Supplied from the control printed board CN12)	Supplied from the motherboard printed board
	N: -15.0 VDC ±2.0 V Approx. 35 mA (Supplied from the control printed board CN12)	Supplied from an external source (±15V) to the motherboard
Frequency input	5 kHz to 40 kHz Internally switched	

Table 6.9.2   I/O Terminal Specifications

Terminal	Usage	I/O scope quantity	Remarks		
S1 S7 S6(M)	A-phase pulse (Refer to the basic connection diagram for connection of each terminal.)	MAX 5 V to 15 V square wave	Voltage pulse (Complementary) input	SC1: 1-2 3-4 switching	Input Impedance 10 kΩ
		MAX 5 V square wave Positive phase/negative phase input	Line driver input	SC1: 5-6 short-circuit	
S3 S9 S8(M)	B-phase pulse (Refer to the basic connection diagram for connection of each terminal.)	MAX 5 V to 15 V square wave	Voltage pulse (Complementary) input	SC1: 1-2 3-4 switching	Input Impedance 10 kΩ
		MAX 5 V Square wave Positive phase/negative phase input	Line driver input	SC1: 5-6 short-circuit	
S5	F/V output	0 to + 10 V, MAX 3.4 mA $R_L \geq 3.0$ kΩ	Single polarity, positive output without regard to the PG phase		
S4	F/V output	0 to + 10 V, MAX 3.4 mA $R_L \geq 3.0$ kΩ	Double polarity, negative output with A-phase delayed (switched by SC3) Polarity switching available. Refer to "6.9.5 Adjustment Method" for the details.		
S10(M) S11(M)	Reference potential	0 V	Common to the M terminal of the inverter.		
S2	Empty pin				

Table 6.9.3   List of Input Terminals on MCA-VG1-FV Motherboard Printed Board

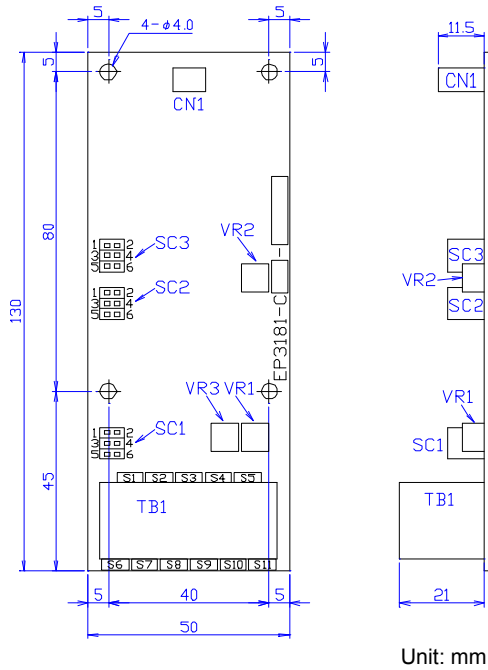| Terminal	Usage	Level/type	Specifications	Remarks
S1 S2 S3	Empty pin			
P15	Power supply voltage	P	Within DC + 15 V ±2.0 V Approx. 65 mA	Prepare a separately installed stabilized power supply (±15 V).
M		M	0 VDC	
N15		N	Within -15 ±2.0 VDC Approx. 35 mA	

6.9.3   External dimensions

Unit: mm

Unit: mm

Figure 6.9.1   OPC-VG1-FV External Dimensions   **Figure 6.9.2   MCA-VG1-FV External Dimensions**
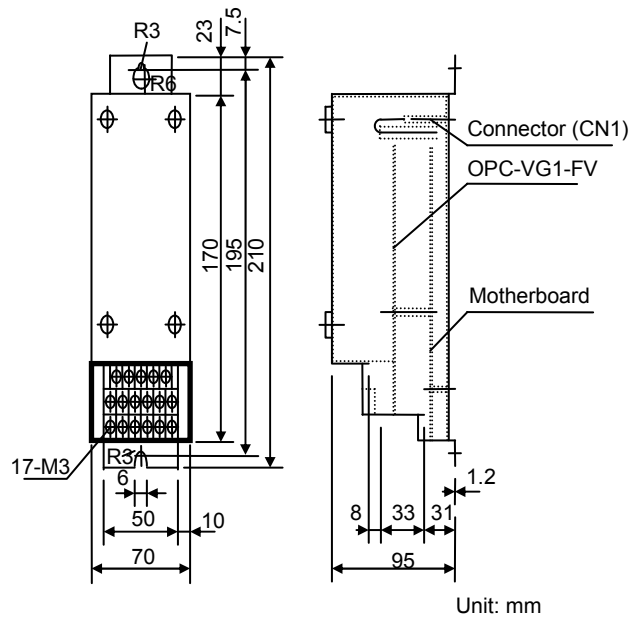
Terminal Block Arrangement

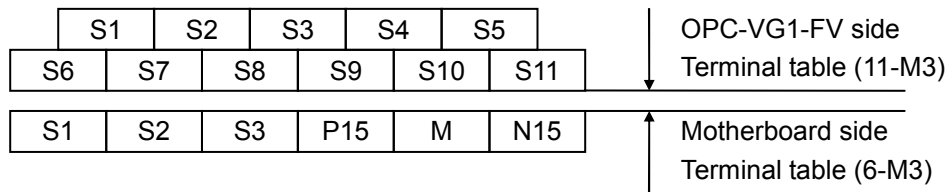|	S1	S2	S3	S4	S5		OPC-VG1-FV side
S6	S7	S8	S9	S10	S11		Terminal table (11-M3)

S1	S2	S3	P15	M	N15	Motherboard side
						Terminal table (6-M3)

Figure 6.9.3   MCA-VG1-FV Terminal Block Arrangement

Chap. 6   CONTROL OPTIONS
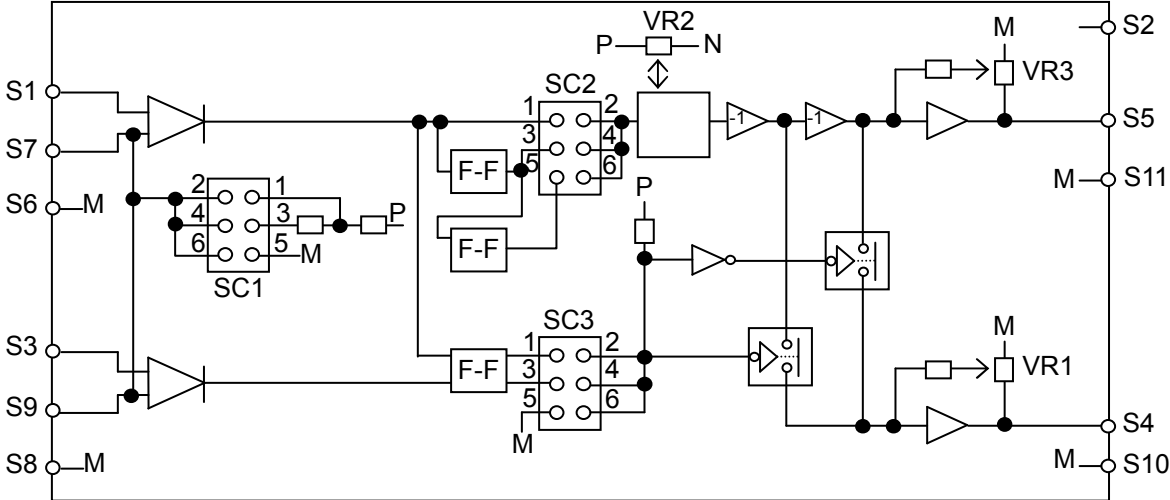
6.9.4   Internal block diagram

Figure 6.9.4   Internal Block Diagram

6.9.5 Adjustment method

⚠ WARNING

- The switches and volumes inside the option have been adjusted at the factory. Never touch a volume or switch other than those used for adjustment by the user.

(1) Adjust SC1 to SC3 depending on the input form and usage.

(2) Set VR1 and VR3 as 0 notch.

(3) Adjust VR2 so that the voltage output S4 and S5 become minimum with the minimum frequency input.

(4) Adjust VR1 and VR3 so that the voltage output S4 and S5 become maximum with the maximum frequency input.

(5) Repeat (3) and (4) until the settings converge.
(For S4, the polarity of the output is reversed depending on the A- and B- phases when SC3: 1-2 is shorted.)
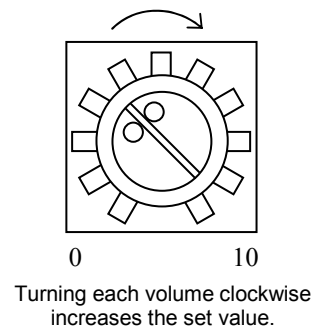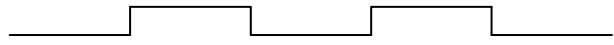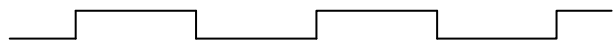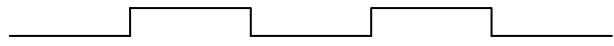
Turning each volume clockwise increases the set value.

Figure 6.9.5

Table 6.9.4

Adjustment position	Name	Adjustment contents
SC1	Input frequency switching Common to A- and B-phase pulses	1-2 side: (Threshold level 5.1 V) $V_L = 0$ to 1 V, $V_H = 8$ to 15 V
		3-4 side: (Threshold level 2.5 V) $V_L = 0$ to 1 V, $V_H = 3.5$ to 5 V
		5-6 side: (A, A, etc. for differential input)
SC2	Input frequency division switching	1-2 side: Maximum input frequency 5 to 10 kHz
		3-4 side: Maximum input frequency 10 to 20 kHz
		5-6 side: Maximum input frequency 20 to 40 kHz
SC3	F/V output polarity switching	1-2 side: Double polarity (S4 becomes negative with A-phase delayed) *Note 1
		3-4 side: Single polarity, output polarity is fixed (S4 is positive).
		5-6 side: Single polarity, output polarity is fixed (S4 is negative).
VR1	Gain adjustment	Adjust the gain against the voltage output S4.
VR2	Bias adjustment	Adjust the F/V bias.
VR3	Gain adjustment	Adjust the gain against the voltage output S5.

* Refer to Note 1.

Table 6.9.5

	Input square wave (voltage pulse input)		S4 output
A-phase delay	A-phase	B-phase	Negative polarity
A-phase advance	A-phase	B-phase	Positive polarity

• Factory setting

    SC1 to SC3:   1-2 side.

    VR1 to VR3:   With the pulse input 0 to 15 V, 0 to 10 kHz, the voltage output (S5) is 0 to +10 V and voltage output (S4) is 0 to ±10 V, double polarity (A-phase is delayed after B-phase for negative polarity).

6.9.6 Basic connection diagram

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠ WARNING

- Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock.

  Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠ CAUTION

- Do not use the product that is damaged or lacking parts to prevent an injury or damage.
- Incorrect handling in installation/removal jobs could result in a broken product.

  Install the MCA (separate installation) type with the connection terminal side down, near the inverter, and connect the cables so that no noise will be applied to signals.

---

(1) For voltage output PG
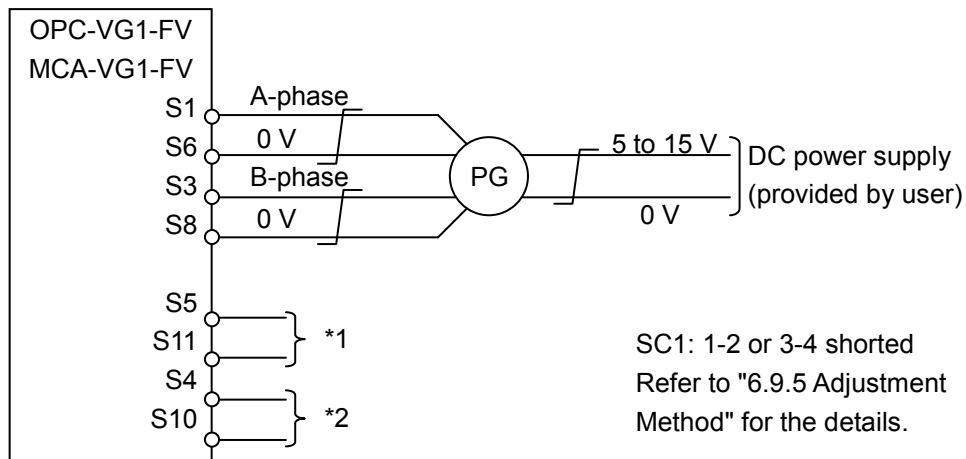

Figure 6.9.6
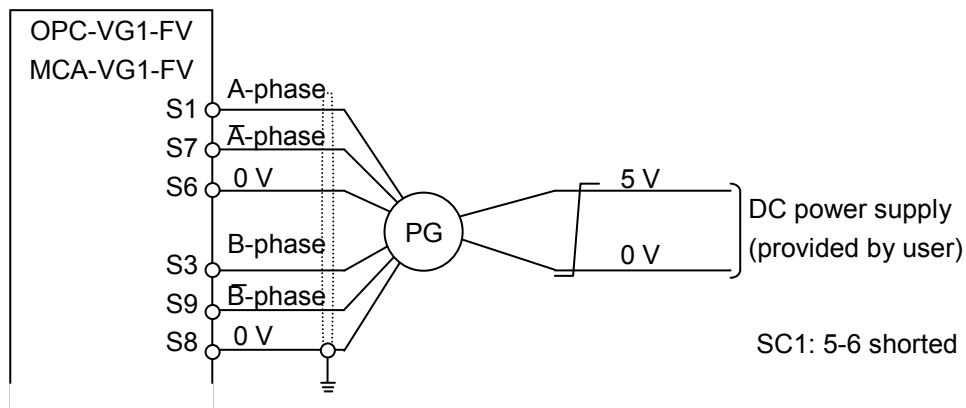
(2) For line driver PG

Figure 6.9.7

Note: The shielded wire is basically connected to the earth. However, if external induction noises greatly affects the wire, connect it to 0 V to suppress the noise effect.

When using output from this printed board (OPC-VG1-FV or MCA-VG1-FV) to control the line speed or motor speed (whichever prioritized) via FRENIC-VG, connect the voltage output terminal S4 to Ai1 (or Ai2) and S10 to M (0V) on the inverter, and configure the parameter settings (*3) before use.

*1, *2 Output terminal specifications.
    Refer to the "Hardware Specifications I/O Terminal Specifications" when using the option for other purposes.
*3   Parameter setting example
    (When inputting the line speed (F/V output) to Ai1 in controlling the line speed or motor speed (whichever prioritized))
    Refer to H53 in Chapter 4, Section 4.3 "Details of Function Codes" and perform the following settings:
    1. Set E49 "Ai1 FUNC" to "11".
    2. Set H53 "N - FB SEL" to "3".
    3. If the gain adjustment for line speed is necessary, use E53 "Ai1 GAIN".

(3)   Complementary explanation of PG output form

(3)-1 Voltage Output: Circuit to output from the collector side of the transistor earthed via the emitter.
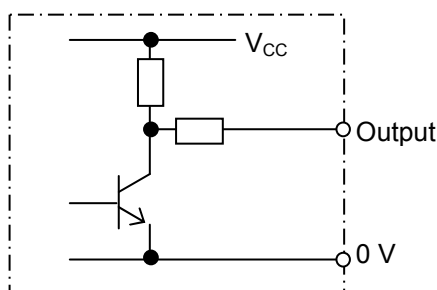
Figure 6.9.8   Voltage Output

(3)-2 Line driver: Signals are output in the positive or negative phase. Applied to high-speed transmission.
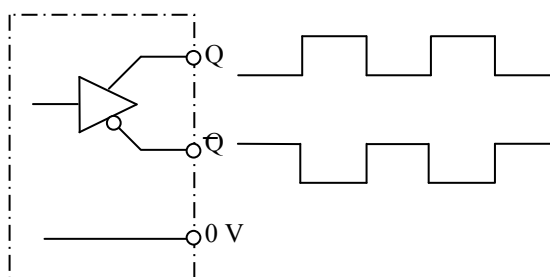
Figure 6.9.9   Line Driver Output

(3)-3 Complementary: Constant-voltage output circuit with the emitter follower matched.
    Applied to high-speed response and/or long-distance transmission.

Figure 6.9.10   Complementary Output

6.10   Synchro Interface OPC/MCA-VG1-SN

6.10.1   Product overview

The OPC-VG1-SN is an OPC series interface option for the FRENIC-VG. The OPC series consists of printed circuit board-type control options that are installed into the inverter unit. One analog interface option OPC series product can be installed in each inverter unit.

The OPC-VG1-SN, which is used to perform position control using a synchro transmitter, converts synchro transmitter signals to signals in the range of 0 V to ±10 V.

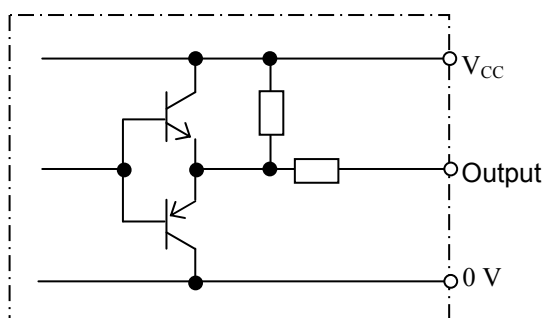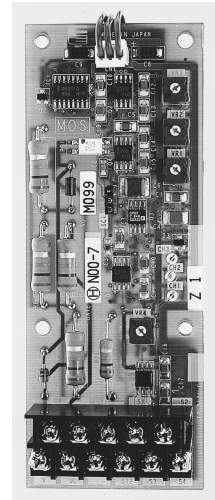The MCA-VG1-SN is a standalone option unit with built-in OPC-VG1-SN functionality. It can also be used in combination with other models (FRENIC series inverters).

The MCA-VG1-SN is available soon.

⚠ WARNING

- The synchro interface's internal switches and knobs are pre-adjusted at the factory. Never touch knobs, switches, or other adjustments other than those designed to be adjusted or set by the user.

⚠ CAUTION

- Place the MCA (standalone type) vertically with the connection terminals facing down near the inverter and connect wiring so as to protect signals from noise. The MCA (standalone type) uses a separate power supply (±15 V). You will need to provide a stabilized power supply (±15 V DC) since power is not supplied from the FRENIC-VG.

6.10.2   Model and specifications

6.10.2.1   Model

Model format: MCA/OPC-VG1-SN

Installation method: OPC → Internal type,
MCA → Standalone type
Host inverter name: VG1 → FRENIC-VG
Option name: SN → Synchro converter
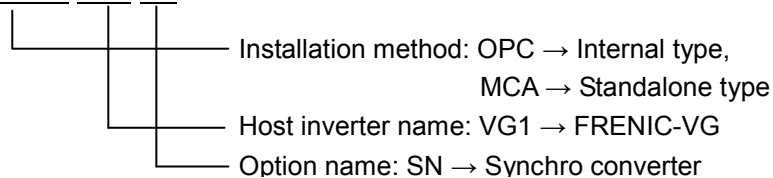
OPC type accessories

Spacers: 3
Screws (M3): 3
Power supply harness (for ±15 V power supply): 1

6.10.2.2　Specifications

┌───┐
│　　　　　　　　　　　⚠CAUTION
│
│ • The MCA (standalone type) uses a separate power supply (±15 V). You will need to provide a
│   stabilized power supply (±15 V DC) since power is not supplied from the FRENIC-VG.
└───┘

Table 6.10.1　I/O Terminal Specifications

Pin	Application	I/O range	Remarks
UH-V	Synchro synchronous power supply	180 VAC to 235 VAC, 50/60 Hz	Input capacity: Approx. 4 VA
UL-V		90 VAC to 121 VAC, 50/60 Hz	Input capacity: Approx. 2 VA
SY1 to SY2	Synchro output signals	31 VAC to 78 VAC, 50/60 Hz	Approx. 0.3 VA/78 V (110 V AC max)
S1	Potential auxiliary input (position voltage signal input)	-10V to 10V	Input impedance: Approx. 13 k (10 V max.)
S3	Position meter output	-10V to 10V	Load impedance: 2.5 kΩ or greater
S4	Position output	-10V to 10V	
S2	Reference voltage	M (0V)	

Table 6.10.2　MCA-VG1-SN Motherboard Printed Circuit Board Input Terminals

Pin	Application	Level/type	Specifications	Remarks
S1 S2 S3	Unused pins			
P15	Supply voltage	P	Max. +15 VDC ± 2.0 V Approx. 65 mA	Provide a separate stabilized power supply (±15 V).
M		M	0 VDC	
N15		N	Max. +15 VDC ± 2.0 V Approx. 35 mA	

6.10.3 External dimension diagram

Unit: mm
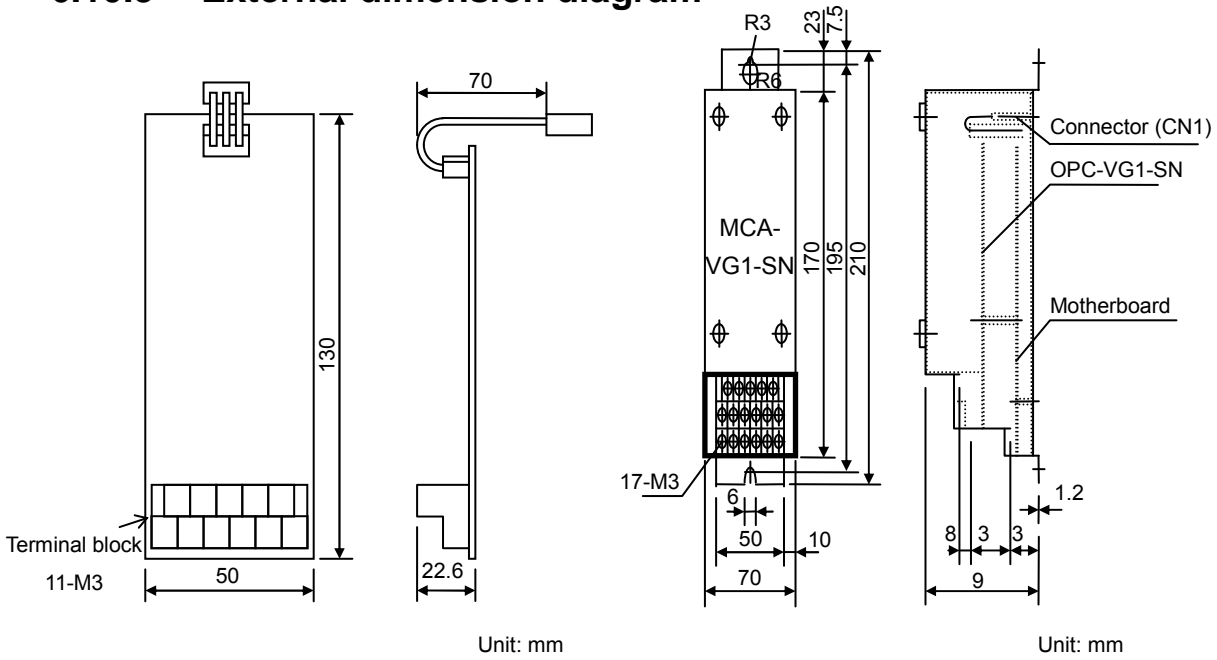
Figure 6.10.1 OPC-VG1-SN External Dimensions

Figure 6.10.2 MCA-VG1-SN External Dimensions

Unit: mm

■Terminal block layout

Figure 6.10.3 MCA-VG1-SN Terminal Block Layout

6.10.4 Internal block diagram

Figure 6.10.4 Internal Block Diagram

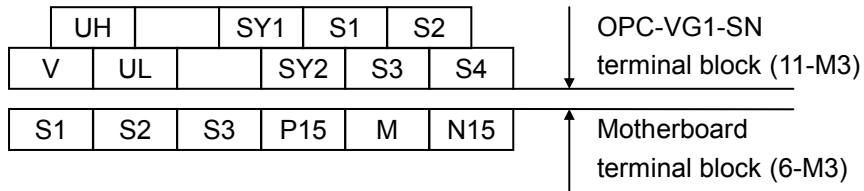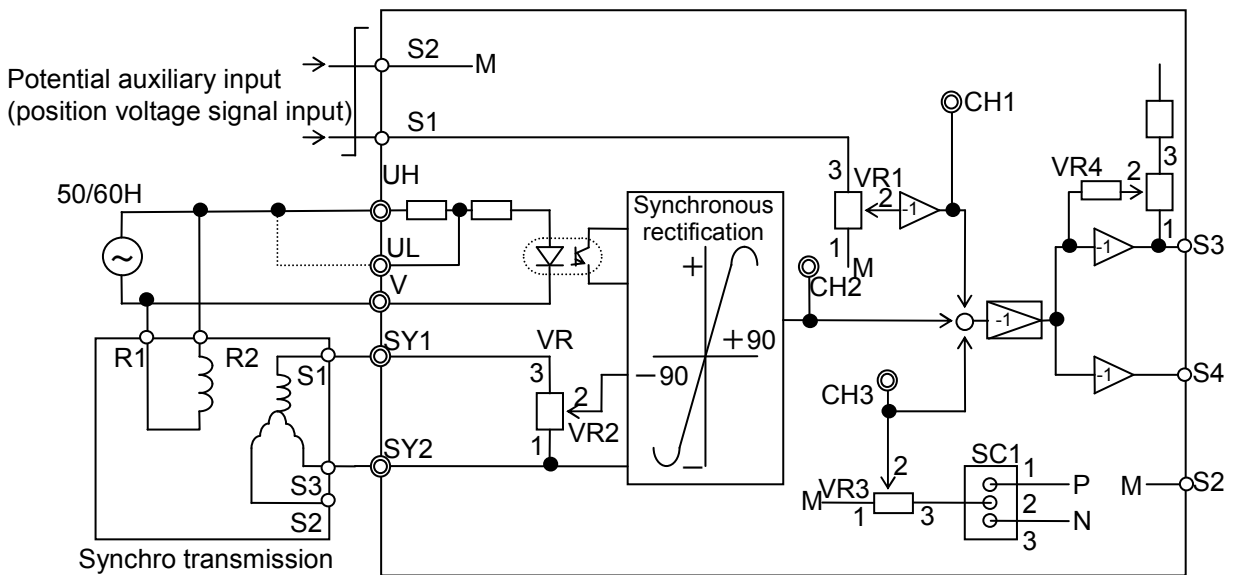Chap. 6 CONTROL OPTIONS

6.10.5　Adjustment method

<div style="border:1px solid black; padding:10px;">

⚠ WARNING

- The synchro interface's internal switches and knobs are pre-adjusted at the factory. Never touch knobs, switches, or other adjustments other than those designed to be adjusted or set by the user.

</div>

6.10.5.1　Description of adjustment locations

Table 6.10.3

Adjustment location	Name	Adjustment description
SC1	Bias load switching	1-2 shorted: Bias voltage (+)
		2-3 shorted: Bias voltage (-)
VR1	Potential auxiliary input signal adjustment	Adjusts the potential auxiliary input signal from 0 V to voltage input (S1).
VR2	Synchro transmitter output adjustment	Adjusts synchro transmitter output using voltage division.
VR3	Bias adjustment	Adjusts the bias voltage (as selected with SC1) (0 V to ±10.7 V).
VR4	Position meter output adjustment	Adjusts position meter output from -10 V to +10 V (gain 0.7 to 1.77).

Adjustment locations
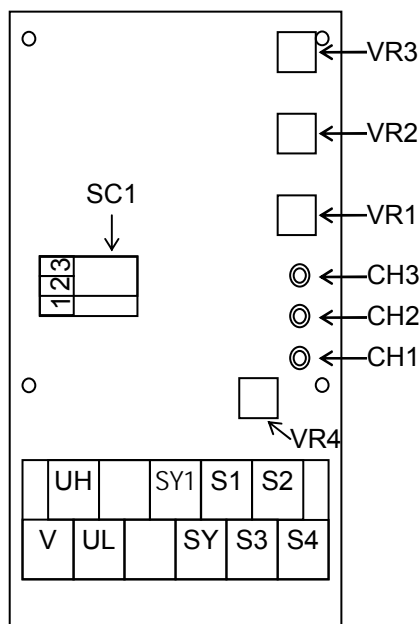
Figure 6.10.5　Adjustment Locations

- Fuji factory adjustment settings

  SC1:　The unit ships with 1-2 shorted.

  VR1:　The unit is adjusted to yield a CH1 voltage of -10 V (so that the amp gain is 1) when the potential auxiliary input signal (S1) is +10 V.

  VR2:　The unit is adjusted to yield voltage output (S4) of ±10 V DC with input of 78 V AC, assuming that synchro transmitter output is 78 V AC with an operating angle of ±60°C.

  VR3:　The unit ships with a 0 notch setting (CH3 voltage: 0 V).

  VR4:　The unit is adjusted so that voltage output (S5) is the same as voltage output (with an output stage amp gain of 1).

6.10.5.2   Installing and adjusting the synchro interface

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING

• Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.

  The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠CAUTION

• Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.

• Inappropriate installation or removal of the product may cause damage to the product.

  Place the MCA (standalone type) vertically with the connection terminals facing down near the inverter and connect wiring so as to protect signals from noise.

• Install the controlled device so that the synchro transmitter's output increases as the speed increases. (The voltage output S4 provides the maximum compensation to increase the speed at positive polarity [+10 V].) To change the polarity, change the SY1 and SY2 connections.

• When installing the synchro transmitter on a piece of machinery, adjust the angle so that the synchro output is 0 V at the center of the synchro movable shaft's maximum span of motion. After adjusting the configuration with VR2 so that the voltage output (S4) is 10 V DC in the maximum speed-increasing direction, verify that the voltage output (S4) is -10 V DC (±0.5 V) in the maximum speed-decreasing direction.

• Refer to the following figures since the speed-increasing direction changes based on the location in which the synchro transmitter is installed (relative to the inverter). (When performing winding control, see Figure 6.10.6; when performing rewinding control, see Figure 6.10.7.)
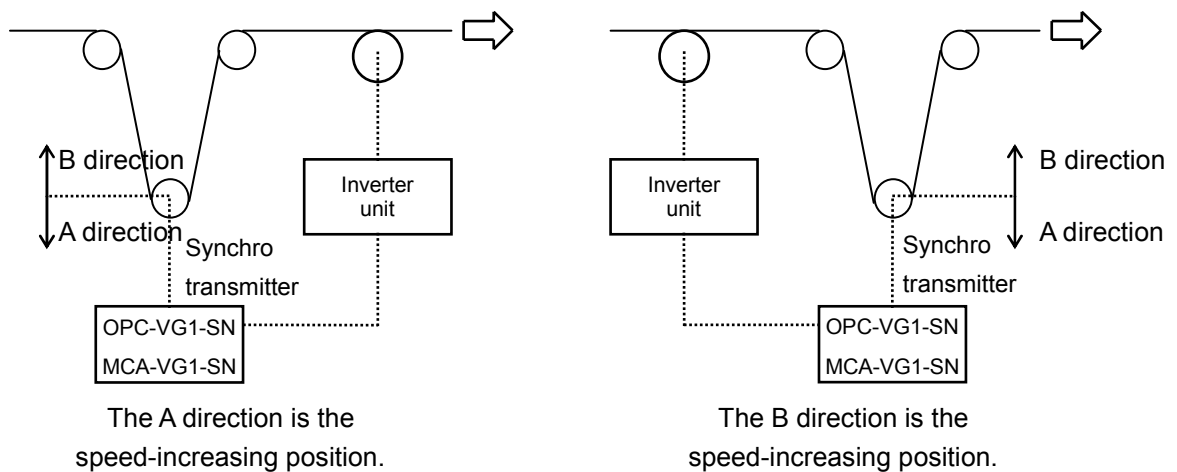

The A direction is the
speed-increasing position.

Figure 6.10.6

The B direction is the
speed-increasing position.

Figure 6.10.7

Chap. 6

CONTROL OPTIONS

6.11 DI Interface Card OPC-VG1-DI

6.11.1 Product overview

The OPC-VG1-DI option allows use of input including speed settings, torque commands, torque current commands, and torque limits as 16-bit digital data.

Two DI interface cards may be installed at once by choosing DIA or DIB with a switch on each card. In this way, it is possible to perform control with 16-bit digital input for speed settings and torque limits at the same time.

(1) Photocoupler insulation

The input interface uses photocoupler insulation. Signal wires can be up to dozens of meters long.

(2) Sink/source

The input interface can be switched between current sink output ("sink") and current source output ("source"). Typically, sink interfaces are commonly used in Japan and the U.S. Such interfaces are characterized by a voltage of 0 V when the signal is active. By contrast, source interfaces are often used in Europe. In such interfaces, active signals result in a positive voltage. When the PLC terminal is used with a circuit that manipulates the inverter's built-in digital input terminals (FWD, REV, X1 to 9), the OPC-VG1-DI cannot be used. Please contact Fuji for more information.

(3) I/O check function

Regardless of whether DIA or DIB has been selected, the state of each input signal can be checked on the keypad and via the unit's communications interfaces (RS-485, T-link, CC-Link, SX bus, Fieldbus, UPAC, etc.).

(4) Option function codes

Option function codes allow selection of binary input (0000 0000 0000 0000) or BCD input (7999). Additionally, functionality for holding data values based on contact input is provided to allow elimination of variation in the lower bits of digital data when signals are relayed via an external A/D converter.
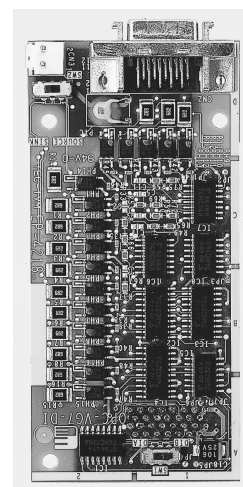
6.11.2   Model and specifications

6.11.2.1   Model

Model format: OPC-<u>VG1</u>-<u>DI</u>

Host inverter name: VG1 → FRENIC-VG
Option name: DI → Digital input option
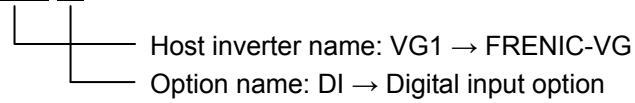
<u>Accessories</u>

Flag (type: 20-pin 10120-3000PE by Sumitomo 3M Limited)

Housing (cover) (type: 20-pin 10320-52A0-008 by Sumitomo 3M Limited)

Spacers: 3

Screws (M3): 3

Power supply harness (for 24 V power supply): 1

[Installation constraints]

(1)   Supported option combinations

• Two DI interface cards may be installed at the same time as long as they are set as DIA and DIB.
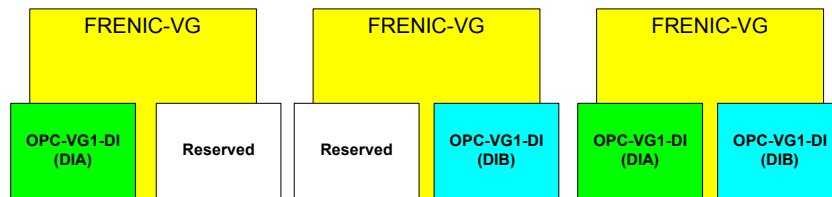
Figure 6.11.1

(2)   Unsupported combinations (will result in an operation procedure error)

When two cards are being used at the same time, both cannot be set to either DIA or DIB. Attempting to use the inverter in this configuration will result in operation procedure error $Er-6$.

Figure 6.11.2

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CONTROL OPTIONS
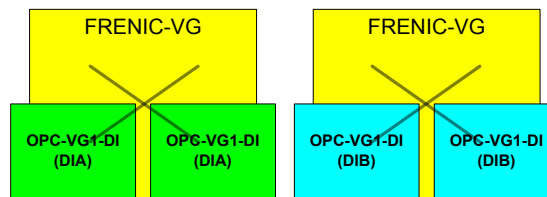
6.11.2.2 Specifications

┌───┐
| ⚠CAUTION |
├───┤
| • Failure to set the switches on the DI interface expansion card (SW1, SW2) correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly. |
└───┘

Table 6.11.1   Hardware specifications

Item		Specifications
Name		DI interface card
Type		OPC-VG1-DI *SW1 is used to switch between the DIA and DIB settings.
Input	No. of contacts	16 contacts (4 bits × 4 digits)
	Ground	CM; common ground for all 4 contacts
	Circuits	Photocoupler insulation SW2 is used to switch between current sink output (sink) and current source output (SOURCE). Flowing current per circuit: Approx. 3 mA
Power supply		24 V Power is supplied from the inverter's printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.

(1)   Printed circuit board switch

Figure 6.11.3 illustrates the general position of the switches as seen from the top surface of the printed circuit board.

- Use SW2 on the DI interface card's printed circuit board to select between sink and source control input.
- Use SW1 on the card's printed circuit board to select between the DIA and DIB settings.

Table 6.11.2

Switch	Factory default
SW2	SINK
SW1	DIA
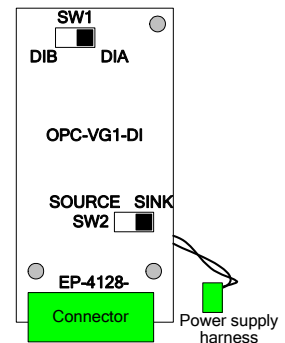
Figure 6.11.3

(2)   Input circuits

The following figure illustrates the circuit architecture for the SW2 sink and source settings:
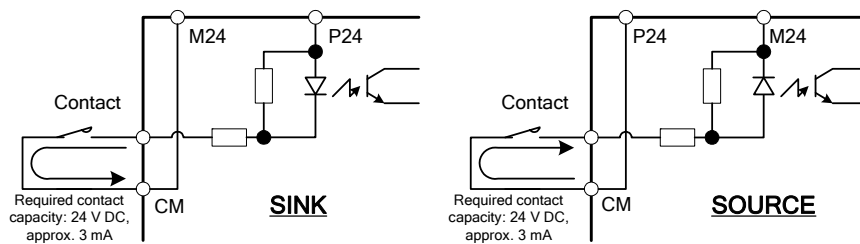
Figure 6.11.4

The option supplies a 24 V power supply (P24: 24 V; M24: ground).

Table 6.11.3 Software specifications

Item	Specifications	
Input data read period	Values are read at a period of 1 ms and are locked when 2 consecutive readings agree.	
Data latch function	Input data hold based on the [DIA] and [DIB] contacts	
Applications	Speed settings:	Input is enabled by setting function code F01 or C25 to 6 (DIA) or 7 (DIB).
	Torque commands:	Input is enabled by setting function code H41 to 2 (DIA) or 3 (DIB).
	Torque current commands:	Input is enabled by setting function code H42 to 2 (DIA) or 3 (DIB).
	Torque limit commands:	Torque limit level 1 input is enabled by setting function code F42 to 2 (DIA) or 3 (DIB).
	Torque limit commands:	Torque limit level 2 input is enabled by setting function code F43 to 2 (DIA) or 3 (DIB).

⚠CAUTION

• When using DI input as the speed setting and torque, install two cards for use as DIA and DIB. When the unit is configured so that the same DI input is used as both the speed setting and the torque, the torque setting takes priority.

   Example: When the function code F01 (speed setting N1) is set to 6 (DIA) and the function code H41 (torque command selection) is set to 2 (DIA), the inverter's internal controlled variable for the speed setting will be calculated using the torque command formula.

Chap. 6

CONTROL OPTIONS

6.11.3　External dimension drawing
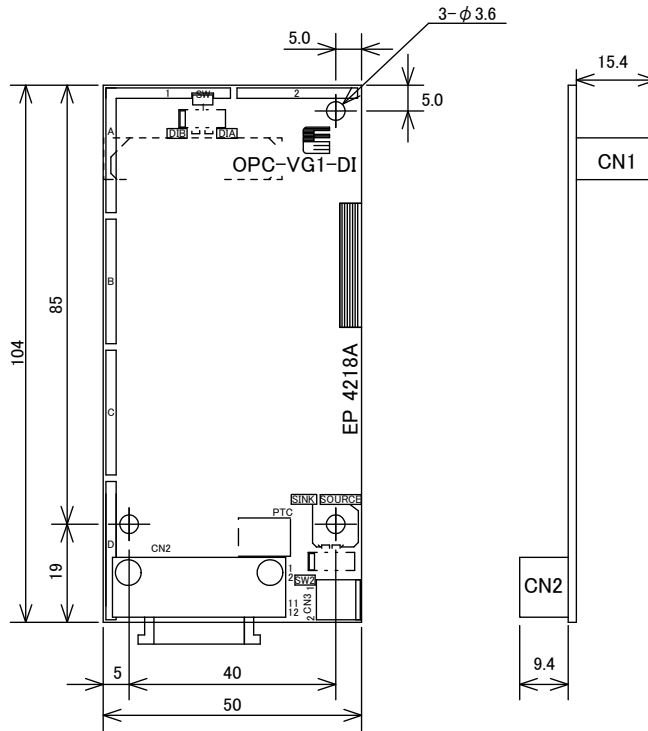
■Accessories
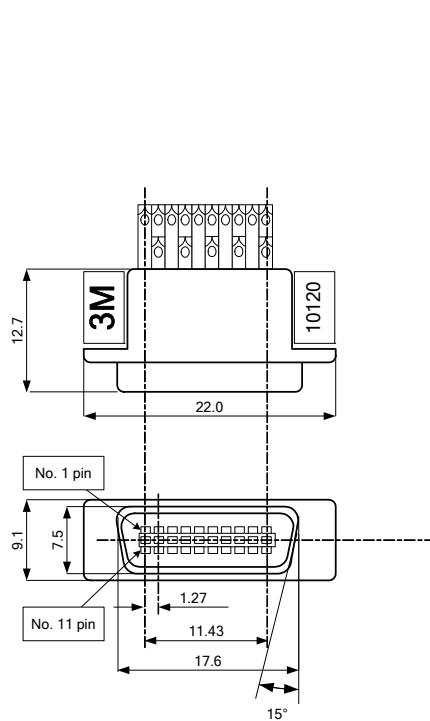
Model: 10120-3000PE
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.11.5　Plug
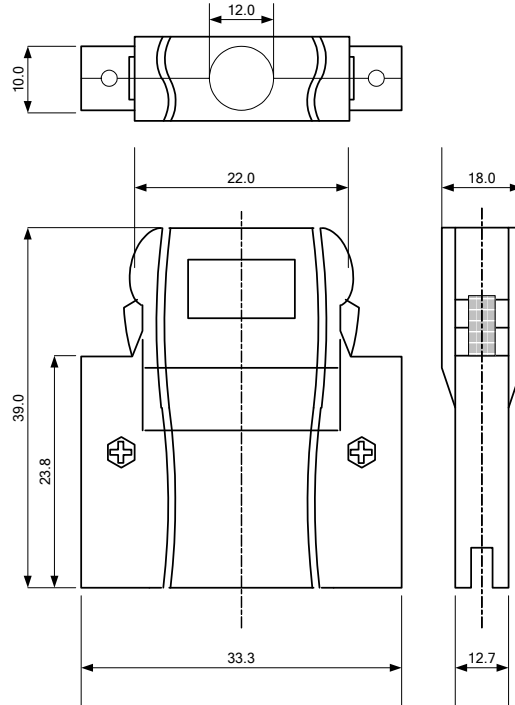
Model: 10320-52A0-008
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.11.6　Housing

* Plug and housing are included with the product.

6.11.4 Basic connection diagram

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠ WARNING

- Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.

  The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠ CAUTION

- Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.

  Inappropriate installation or removal of the product may cause damage to the product.

Table 6.11.4   Terminal Function Descriptions

| Pin No.	Name	Function		Pin No.	Name	Function	
		BINARY	BCD			BINARY	BCD
[1]	CM			[11]	CM		
[2]	DI0	$2^0 = 1$	$1 \times 10^0 = 1$	[12]	DI8	$2^8 = 256$	$1 \times 10^2 = 100$
[3]	DI1	$2^1 = 2$	$2 \times 10^0 = 2$	[13]	DI9	$2^9 = 512$	$2 \times 10^2 = 200$
[4]	DI2	$2^2 = 4$	$4 \times 10^0 = 4$	[14]	DI10	$2^{10} = 1024$	$4 \times 10^2 = 400$
[5]	DI3	$2^3 = 8$	$8 \times 10^0 = 8$	[15]	DI11	$2^{11} = 2048$	$8 \times 10^2 = 800$
[6]	CM			[16]	CM		
[7]	DI4	$2^4 = 16$	$1 \times 10^1 = 10$	[17]	DI12	$2^{12} = 4096$	$1 \times 10^3 = 1000$
[8]	DI5	$2^5 = 32$	$2 \times 10^1 = 20$	[18]	DI13	$2^{13} = 8192$	$2 \times 10^3 = 2000$
[9]	DI6	$2^6 = 64$	$4 \times 10^1 = 40$	[19]	DI14	$2^{14} = 16384$	$4 \times 10^3 = 4000$
[10]	DI7	$2^7 = 128$	$8 \times 10^1 = 80$	[20]	DI15	$2^{15} = 32768$	Sign (ON: negative)
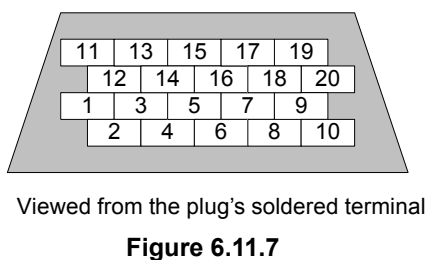
Viewed from the plug's soldered terminal

Figure 6.11.7

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.
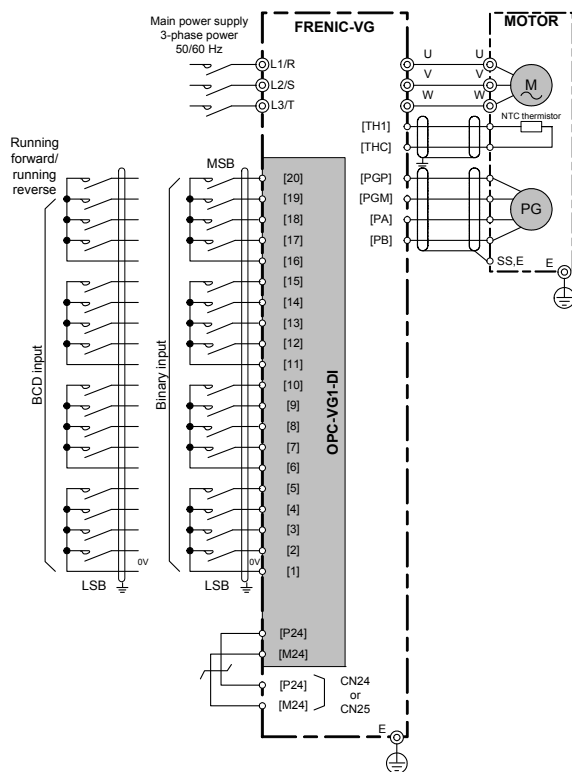
Figure 6.11.8

6.11.5   Function codes

<div align="center">

⚠ WARNING

</div>

• Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data. **Risk of accident**

Installation of the DI interface card allows use of function codes o01 to o04. These function codes are not normally (when the option had not been installed) displayed on the keypad.

<div align="center">

Table 6.11.5

</div>

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o01	DIA function selection	DIA FUNC	0, 1	0: Binary 1: BCD
o02	DIB function selection	DIB FUNC	0, 1	0: Binary 1: BCD
o03	DIA BCD input setting	BCD CMND A	99 - 7999	
o04	DIB BCD input setting	BCD CMND B	99 - 7999	

6.11.5.1   Data latch function

DI input data is normally captured internally and applied inside the inverter every 1 ms. A data latch function can be used when you wish to hold DI input data or reduce variation in lower bits when capturing input from an external A/D converter.

[Setting method]

Set function codes X1 to X14 corresponding to the desired contact to 55 (DIA) or 56 (DIB) to assign data latch operation. Then set the contact in question as follows:

On: Normal capture

Off: DI input hold (data is not captured, and the last data value before the contact was turned off)

6.11.5.2   Selecting binary or BCD input

(1)   Example input when o01 and o02 are set to binary input
Values from -32,768 to 32,767 are valid.

Table 6.11.6

(MSB)															(LSB)	Converted data
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	20000
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32767
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-32768
1	0	1	1	0	0	0	1	1	1	1	0	0	0	0	0	-20000
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	-2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1

(2)   Example input when o01 and o02 are set to BCD input
Values from -7,999 to 7,999 are valid.

Table 6.11.7

(MSB)															(LSB)	Converted data
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	4620
0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	7999
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-2
1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	-4620
1	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	-7999

Sign	Thousands place	Hundreds place	Tens place	Ones place

6.11.5.3   Controlled variable input

(1)   Speed settings

When using DI input to set the speed, set function code F01 or C25 (whichever is to be enabled) according to the switch state (DIA or DIB). For example, to enable F01 on a card set to DIA, set F01 to 6.

Control inputs [N2/N1] are used to switch between F01 and C25.

Table 6.11.8

When set to binary input	Set the maximum speed (F03) to 1,500 r/min.
To assign a speed setting of 600 r/min.	$600 \times \dfrac{20000}{1500} = 8000(d)$ $= 1F40(h)$ = Input 0001_1111_0100_0000 (B) to the DI card.
To assign a speed setting of -1000 r/min.	$-1000 \times \dfrac{20000}{1500} = -13333(d)$ $= CBEB(h)$ = Input 1100_1011_1100_1011(B) to the DI card.

BCD input is used in applications where the motor speed is converted to the machine speed. For example, when a motor operating at 1,500 r/min. is connected to a machinery shaft via a 5:1 gear, the machinery shaft will rotate at 300.0 r/min. DI input of 3,000 while using a BCD setting (o03 or o04) of 3,000 with these function codes would result in rotation of 300.0 r/min. (1,500 r/min. for the motor).

Table 6.11.9

When set to BCD input	Set the maximum speed (F03) to 1,500 r/min. Set the BCD input setting (o03 or o04) to 3,000. (When the motor operates at 1,500 r/min., the machinery shaft will rotate at 300.0 r/min.)
To set the machinery shaft to a speed of 75.0 r/min. (375 r/min. for the motor)	$75.0 = 0750(BCD)$ = Input 0000_0111_0101_0000 (B) to the DI card.
To set the machinery shaft to a speed of -300.0 r/min. (-1500 r/min. for the motor)	$-300.0 = (-)3000(BCD)$ = Input 1011_0000_0000_0000(B) to the DI card.

(2)   Torque, torque current, and torque limit input

When assigning DI input to torque (torque commands, torque current commands, and torque limits), it is necessary to define DIA and DIB use with the function codes H41, H42, F42, and F43 according to the function being used. For more information, see the corresponding sections of Chapter 4.

Table 6.11.10

| When set to binary input	The torque scale uses the value 10,000 to represent 100%.
To assign 70% torque	$70 \times \dfrac{10000}{100} = 7000(d)$ $= 1B58(h)$ = Input 0001_1011_0101_1000(B) to the DI card.
To assign -25% torque	$-25 \times \dfrac{10000}{100} = -2500(d)$ $= F63C(h)$ = Input 1111_0110_0011_1100(B) to the DI card.

6.11.6   Check functions

6.11.6.1   Option installation check

You can check on the keypad whether the DI interface card is set to DIA or DIB.

```
OP—A:VG1—DIA
OP—B:
OP—C:

∧V→PAGE SHIFT  9
```

From the Operating Mode screen, go to the Program Menu screen and select "4. I/O check." Use the ∧ and ∨ keys to switch screens and check the screen corresponding to the DI interface card.

For more information, see the section on keypad operation.

If the card is set to DIA, □ will change to ■ on the LCD screen, as shown in the sample to the right.
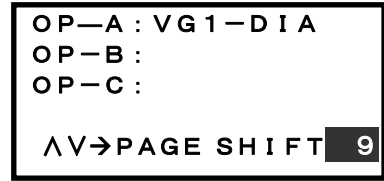
6.11.6.2   I/O check

You can check the DI interface card's digital input status on the inverter's keypad. From the Operating Mode screen, go to the Program Menu screen and select "4. I/O check." Use the ∧ and ∨ keys to switch screens and check the screen corresponding to the DI interface card.

```
■DIA ■BCD □BIN
A =×××××
□DIB □BCD □BIN
B =×××××
∧V→PAGE SHIFT 18
```

Input data is displayed as "XXXXX" in the screenshot to the right.

For example, an indication of "A = 4000" would indicate BCD input of 4000.
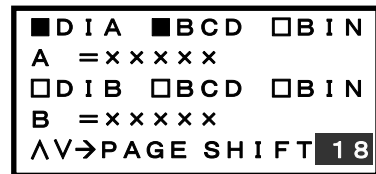
6.12 DIO Expansion Card OPC-VG1-DIO

6.12.1 Product overview

The use of optional OPC-VG1-DIO expansion cards makes it possible to add I/O points, i.e., up to 16 DI points and 10 DO points can be added per optional expansion card. The use of the OPC-VG1-UPAC as another option (available soon) will enable user programs to operate these optional I/O points.

(1) Main applications

Use SW2 on the optional expansion card to select DIOA or DIOB.

If DIOA is selected:

If DIOA is selected, four DI points and eight DO points will be available. In that case, the control functions of the FRENIC-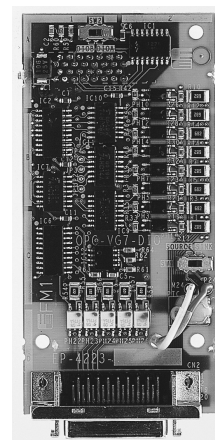VG will be available as well. These control functions include input control functions, such as coast-to-stop command, multistep speed change, servo lock functions, and output control functions, such as speed agreement and running functions.

If DIOB is selected:

If DIOB is selected, 16 DI points and 10 DO points will be available. These I/O points are operable through an UPAC option. That is, these I/O will be operable on user programs written with an UPAC option.

The I/O control of DIOB cards mounted to other inverters will be possible if a terminal block supporting high-speed serial communication is mounted in addition to the UPAC option.

(2) Photocoupler insulation

The I/O interface block is photocoupler insulated.

(3) Sink/Source

The I/O interface block allows the section of current sink output (hereinafter referred to as SINK) and current source output (hereinafter referred to as SOURCE).

The output interface block allows bi-directional power connections.

Interfaces in general often used in Japan and the United States has SINK output. This output is set to 0 V with signals activated. Interfaces often used in Europe has SOURCE output. This output is set to +V with signals activated.

OPC-VG1-DIO expansion cards will not be available if a PLC terminal is used for the circuit in control of the built-in digital input pins (FWD, REV, and X1-9) of the FRENIC-VG. For details, contact your Fuji Electric representative.

(4) I/O check functions

The selection of either DIOA or DIOB makes it possible to confirm the ON/OFF status of each I/O signal through the keypad or over communication (RS-485, T Link, CC-Link, SX bus, and UPAC).

(5) Optional function codes

Function codes to allocate FRENIC-VG I/O control functions will be operable if DIOA is selected. Specifically, the corresponding function codes (E10 to E13 and E20 to E27) will be displayed on the keypad by selecting DIOA if the option is mounted. Use these functions to allocate functions to four DI points and eight DO points.

(6)   UPAC function

Optional I/O points will be operable through the program for the UPAC option if DIOB is selected. Optional I/O points will be operable in the same manner if DIOA is selected. Therefore, up to 20 DI points and 18 DO points will be operable if two DIO expansion cards as options are used and one of the expansion cards is set to DIOA and the other one is set to DIOB. This means that the operation of up to 31 DI points and 23 DO points will be available to a single FRENIC-VG unit with consideration of the number of built-in I/O points.

The two DIO expansion cards mounted cannot be both set to DIOA or DIOB. If such settings are made, operating procedure alarm E_r-6 will result.

6.12.2   Models and specifications

6.12.2.1   Models

⚠CAUTION
• An UPAC option will be required if an optional DIO expansion card is set to DIOB (16 DI points and 10 DO points). The standard I/O functions of the FRENIC-VG will be available if the optional DIO expansion card is set to DIOA.

An optional DIO expansion card for the FRENIC-VG incorporates a hardware switch (SW1), with which DIOA or DIOB will be selectable according to the application.

Model legend: OPC-VG1-DIO

Name of inverter mounted: VG1→ FRENIC-VG
Name of option: DIO → Digital I/O option
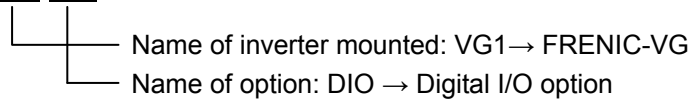
Accessories

Plug (Model: Sumitomo 3M's 10136-3000VE for 36 pins)
Housing (Model: Sumitomo 3M's 10336-52F0-008 for 36 pins)
Spacer: 3
Screw (M3): 3

[Mounting restrictions]

(1)   Mountable combinations

• Two optional DIO expansion cards will be mountable if one of them is set to DIOA and the other one is set to DIOB.
• Use the optional UPAC card as well in the case of making DIOB settings.

Figure 6.12.1

(2) Combinations not mountable (operating procedure error)

The two DIO expansion cards mounted cannot be both set to DIOA. The two DIO expansion cards mounted cannot be both set to DIOB, either. If such settings are made, operating procedure error $Er-6$ will result.
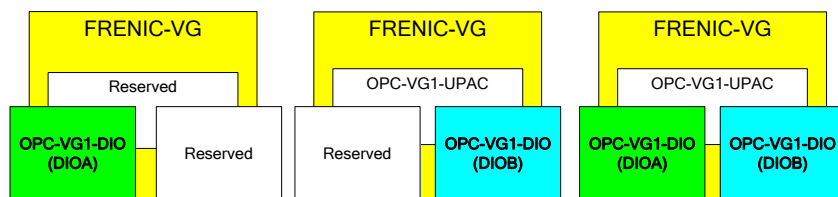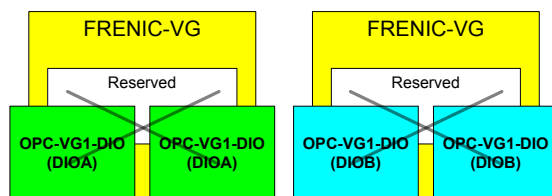

Figure 6.12.2

6.12.2.2　Specifications

⚠CAUTION
• The system will not operate normally if settings for the switches (SW1 and SW2) on the optional expansion cards are wrong. Refer to the following settings and make correct settings.

Table 6.12.1　Hardware Specifications

Item		Specification	
		DIOA	DIOB (dedicated to UPAC)
Name		DIO expansion card	
Model		OPC-VG1-DIO *DIOA or DIOB is selected with SW2.	
Input	Number of points	4 (X11-X14)	16 (X21-X36)
	Ground	CM: Ground common to all the four points.	
	Circuit	Photocoupler-insulated circuit SW1 is used to select current sink output (SINK) or current source output (SOURCE). Rated continuous current per circuit: Approximately 3 mA	
Output	Number of points	8 (Y11-Y18)	10 (Y21-Y30)
	Ground	CME: Ground common to both two points.	
	Circuit	Photocoupler-insulated circuit (50 mA DC max. at 28 V max.) Bi-directional connections possible. (SINK and SOURCE)	
Power supply		24 V Power is supplied through the PCB of the FRENIC-VG. Connect the power supply harness to CN24 or CN25 of the FRENIC-VG.	

(1)   PCB switch

Figure 7-41 shows approximate positions of the switches seen from the front side of the PCB.

• Use SW1 on the PCB of the optional expansion card to select SINK or SOURCE control input. Not control output switching is available.

• Use SW2 on the PCB of the optional expansion card to select DIOA or DIOB.
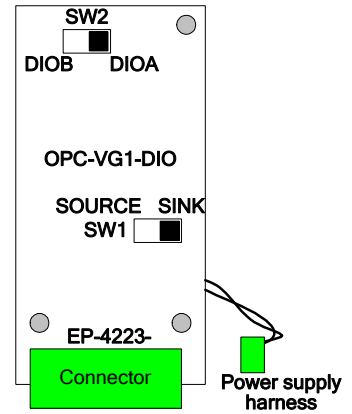
Table 6.12.2

Switch	Factory default
SW1	SINK
SW2	DIOA

Figure 6.12.3

(2)   Input circuit

The respective circuit configurations below show examples of SW1 set to SINK and SOURCE.
In these cases, 24-V power is supplied from the optional expansion card. (P24: 24 V; M24: Ground)
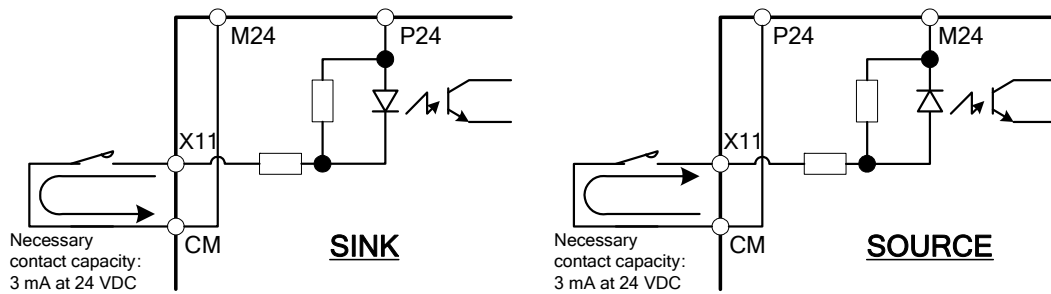
Figure 6.12.4

(3) Output circuit

The output interface block allows bi-directional power connections. The CME is common to all contacts (Y11 to Y30). Therefore, no bi-directional signals can coexist.

Power supply voltage: 28 V max.
Continuous current: 50 mA max.

CEM is isolated from CM.

Power supply voltage: 28 V max.
Continuous current: 50 mA max.

CEM is isolated from CM.
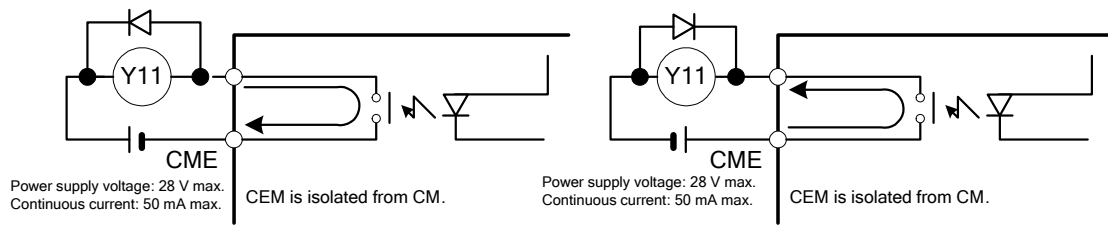
Figure 6.12.5

As shown in Figure 6.12.5, connect a surge-absorbing diode to both ends of the excitation coil when connecting the control relay.

Table 6.12.3   Software Specifications

Item		Specification
Input data	Read cycle	Data is read at 1-ms cycles and determined if the data consecutively read twice coincides.
	Function allocation	Possible if DIOA is used. See table 6.12.6.
Output data	Refresh cycle	Refreshed at 1-ms cycles. Some output functions may be refreshed at cycles longer than 1 ms.
	Function allocation	Possible if DIOA is used. See table 6.12.7.

6.12.3   Dimensions
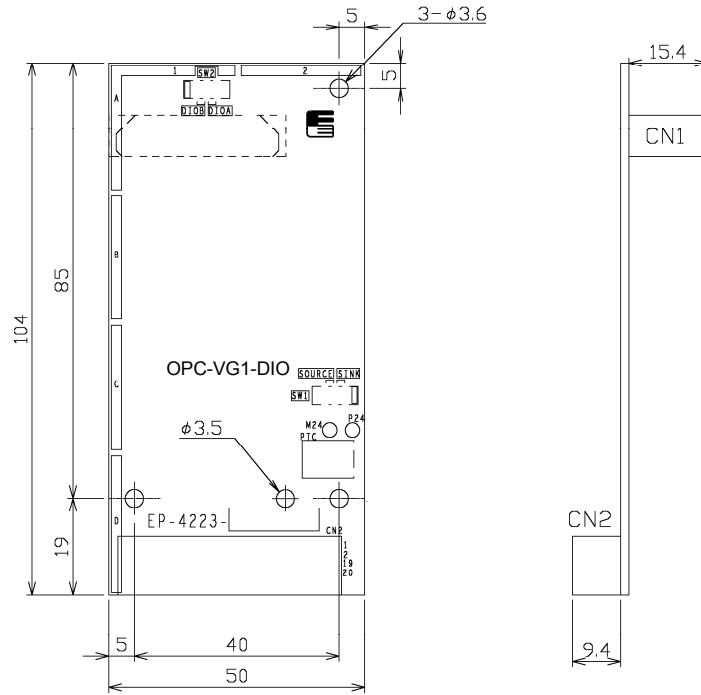
Accessories
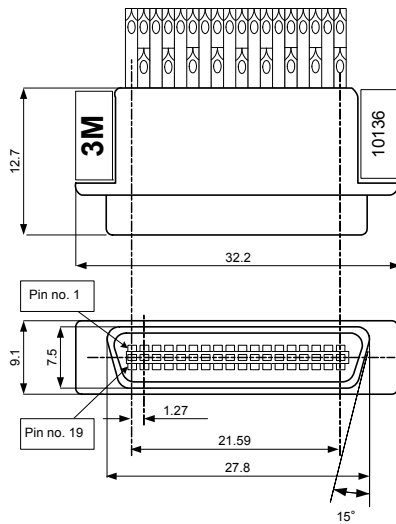
Model: 10136-3000PE
Specifications: Sumitomo 3M's for 36 pins

Figure 6.12.6   Plug
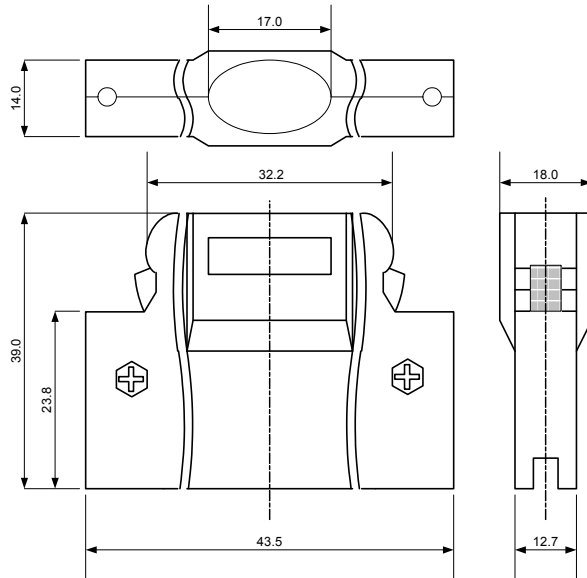
Model: 10336-52A0-008
Specifications: Sumitomo 3M's for 36 pins

Figure 6.12.7   Housing

* The plug and housing are provided with the product.

Chap. 6   CONTROL OPTIONS

6.12.4 Basic schematic diagrams

Refer to 6.1.4 Installing Internal Options (OPC-VG1-□□) and wire and connect the FRENIC-VG.

⚠**WARNING**

- Improper connections may result in disasters, such as electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work.

  Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

⚠**CAUTION**

- Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result.

  Incorrect handling in installation/removal jobs could cause a failure.

6.12.4.1 Basic schematic diagram (DIOA)

Table 6.12.4 shows the plug pin arrangement.

Figure 6.12.4

| Pin no.	Name	Function	Pin no.	Name	Function
[1]	CM	Common (M24)	[13]	Y11	Control output Y11
[2]	X11	Control input X11	[14]	Y12	Control output Y12
[3]	X12	Control input X12	[15]	Y13	Control output Y13
[4]	X13	Control input X13	[16]	Y14	Control output Y14
[5]	X14	Control input X14	[17]	Y15	Control output Y15
[6]	CM	Common (M24)	[18]	CME	Output common
[7]-[12]	-	Not connected	[19]-[30]	-	Not connected
			[31]	Y16	Control output Y16
			[32]	Y17	Control output Y17
			[33]	Y18	Control output Y18
			[34],[35]	-	Not connected
			[36]	CME	Output common
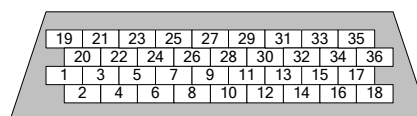
Viewed from the soldered pin side of the plug

Figure 6.12.8

Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0-V line.
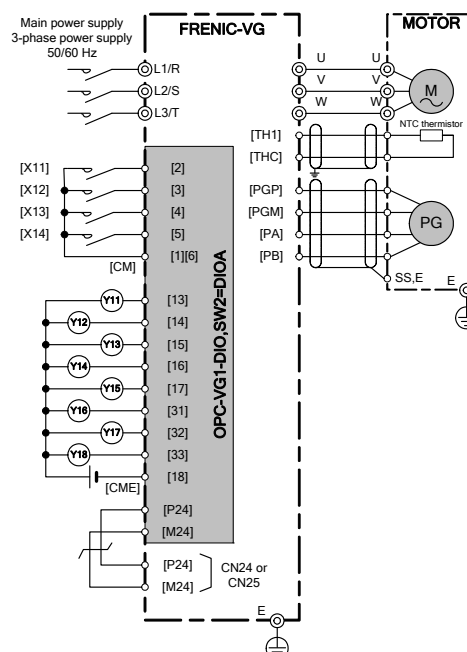
Figure 6.12.9

6.12.4.2   Basic schematic diagram (DIOB)

Only the use of the OPC-VG1-UPAC as another option (available soon) will make it possible to operate the I/O points of the DIO expansion card.

Table 6.12.5 shows the plug pin arrangement.

Figure 6.12.5

Pin no.	Name	Function	Pin no.	Name	Function
[1]	CM	Common (M24)	[13]	Y21	Control output Y21
[2]	X21	Control input X21	[14]	Y22	Control output Y22
[3]	X22	Control input X22	[15]	Y23	Control output Y23
[4]	X23	Control input X23	[16]	Y24	Control output Y24
[5]	X24	Control input X24	[17]	Y25	Control output Y25
[6]	CM	Common (M24)	[18]	CME	Output common
[7]	X25	Control input X25	[31]	Y26	Control output Y26
[8]	X26	Control input X26	[32]	Y27	Control output Y27
[9]	X27	Control input X27	[33]	Y28	Control output Y28
[10]	X28	Control input X28	[34]	Y29	Control output Y29
[11]	-	Not connected	[35]	Y30	Control output Y30
[12]	-	Not connected	[36]	CME	Output common
[19]	CM	Common (M24)			
[20]	X29	Control input X29			
[21]	X30	Control input X30			
[22]	X31	Control input X31			
[23]	X32	Control input X32			
[24]	CM	Common (M24)			
[25]	X33	Control input X33			
[26]	X34	Control input X34			
[27]	X35	Control input X35			
[28]	X36	Control input X36			
[29]	-	Not connected			
[30]	-	Not connected			

19	21	23	25	27	29	31	33	35
20	22	24	26	28	30	32	34	36
1	3	5	7	9	11	13	15	17
2	4	6	8	10	12	14	16	18

Viewed from the soldered pin side of the plug

Figure 6.12.11

Figure 6.12.10

Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0-V line.
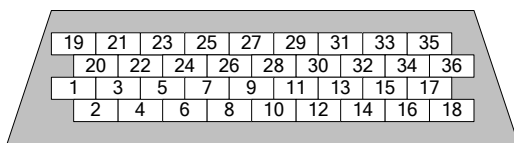
Chap. 6 CONTROL OPTIONS

6-233
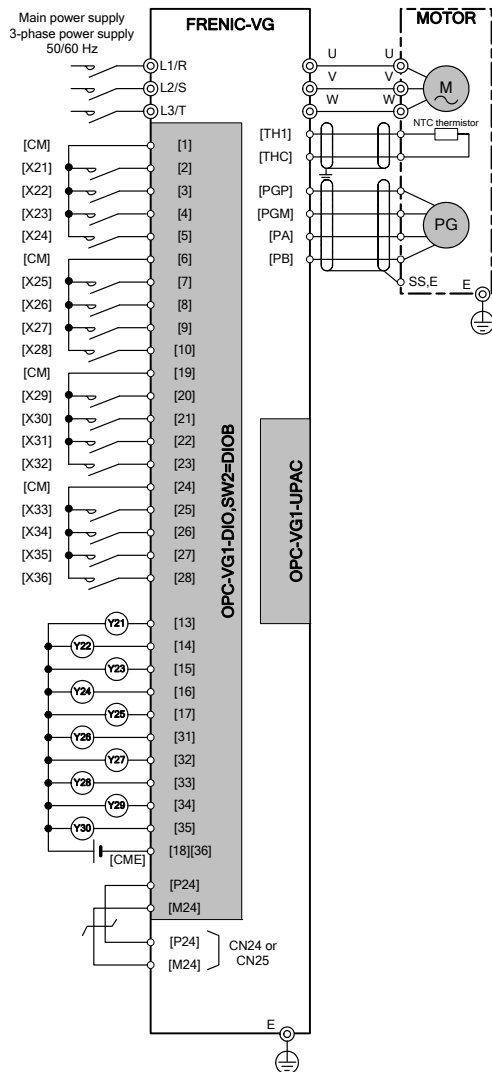
6.12.5 Function codes

⚠ WARNING
• A dangerous condition may result if a mistake is made in function code data. Check the data again after the data is set and entered. **Otherwise, an accident could occur.**

6.12.5.1 DIOA selected

(1) Input

The following functions can be set freely to four digital input pins (X11 to X14).

The functions are set with functions codes E10 - E13.

For the X terminal functions, refer to Chapter 4, E01 to E13 (X Terminal Function).

(2) Output

The following functions can be set freely to eight digital output pins (Y11 to Y18).

The functions are set with functions codes E20 - E27.

For the Y terminal functions, refer to Chapter 4, E15 to E27 (Y Terminal Function).

Function Codes

The following function codes are used to allocate I/O functions.

Table 6.12.6

No.	Parameter name		Setting range	Description
	Name	Keypad display		
E10	X11 function selection	X11 FUNC	0-76	See Chapter 4
E11	X12 function selection	X12 FUNC	0-76	
E12	X13 function selection	X13 FUNC	0-76	
E13	X14 function selection	X14 FUNC	0-76	
E20	Y11 function selection	Y11 FUNC	0-81	See Chapter 4
E21	Y12 function selection	Y12 FUNC	0-81	
E22	Y13 function selection	Y13 FUNC	0-81	
E23	Y14 function selection	Y14 FUNC	0-81	
E24	Y15 function selection	Y15 FUNC	0-81	
E25	Y16 function selection	Y16 FUNC	0-81	
E26	Y17 function selection	Y17 FUNC	0-81	
E27	Y18 function selection	Y18 FUNC	0-81	

6.12.5.2 DIOB selected

Only the use of the OPC-VG1-UPAC as another option (available soon) will make it possible to operate the following functions.

DIOB functions are allocated to control variables (to be specific, global variables allocated to the control variables) that will be available at the time of selecting a six-unit FRENIC-VG system.

To use DIOB functions, select the corresponding control variables from the list of control variables or specify the address (%IQ area) of each DIOB function and register the control variable, and check the box in the system definition.

The optional OPC-VG1-SIU module is required to operate DIOB options INV2 through INV6.

Table 6.12.7

Address	No	Area	Name	Data category	Type	Direction	
%IW1.13	14	INV1	DI control of INV1 (DIOB option; 16 bits)	Data category; 26	W	INV12,3,4,5,6→UPAC	The UPAC is in DI control of INV1 through INV6. Used by INV1 through INV6.
%IW2.13	14	INV2	DI control of INV2 (DIOB option; 16 bits)	Data category; 26	W		
%IW3.13	14	INV3	DI control of INV3 (DIOB option; 16 bits)	Data category; 26	W		
%IW4.13	14	INV4	DI control of INV4 (DIOB option; 16 bits)	Data category; 26	W		
%IW5.13	14	INV5	DI control of INV5 (DIOB option; 16 bits)	Data category; 26	W		
%IW6.13	14	INV6	DI control of INV6 (DIOB option; 16 bits)	Data category; 26	W		
%QW1.41	24	INV1	DO control of INV1 (DIOB option; 10 bits)	Data category; 27	W	UPAC→INV1,2,3,4,5,6	The UPAC is in DO control of INV1 through INV6. Used by INV1 through INV6.
%QW2.41	24	INV2	DO control of INV2 (DIOB option; 10 bits)	Data category; 27	W		
%QW3.41	24	INV3	DO control of INV3 (DIOB option; 10 bits)	Data category; 27	W		
%QW4.41	24	INV4	DO control of INV4 (DIOB option; 10 bits)	Data category; 27	W		
%QW5.41	24	INV5	DO control of INV5 (DIOB option; 10 bits)	Data category; 27	W		
%QW6.41	24	INV6	DO control of INV6 (DIOB option; 10 bits)	Data category; 27	W		

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6.12.6　Check function

6.12.6.1　Mounting check on optional cards

When an optional DIO expansion card is mounted, it will be possible to check with the keypad whether the optional DIO expansion card is set to DIOA or DIOB.

```
ОР―A:VG1―DIOA
OP―B:
OP―C:

∧∨➔PAGE SHIFT 9
```

Go to the Program Menu screen from the Operation Mode screen and select "4. I/O CHECK". Select the screen with the UP and DOWN keys (⌃ and ⌄) and check the screen corresponding to the optional DIO expansion card.

For details, refer to the information provided in this manual on how to operate the keypad.

As shown in the LCD screen example on the right-hand side, the corresponding number will be highlighted (□→■) if DIOA is set.

6.12.6.2　I/O check

It is possible to check with the keypad of the inverter the digital I/O status of optional DIO expansion cards. Go to the Program Menu screen from the Operation Mode screen and select "4. I/O CHECK." Select the screen with the UP and DOWN keys (⌃ and ⌄) and check the screen corresponding to the optional DIO expansion card.

The number corresponding to a contact will be highlighted (□→■) if the contact is ON.

```
R□×11  C□×11
 □×12   □×12
 □×13   □×13
 □×14   □×14
∧∨➔PAGE SHIFT 16
```
DIOA I/O status

```
X□21□25□29□33
 □22□26□30□34
 □23□27□31□35
 □24□28□32□36
∧∨➔PAGE SHIFT 19
```
DIOB input status

```
□Y21 □Y25 □Y29
□Y22 □Y26 □Y30
□Y23 □Y27
□Y24 □Y28
∧∨➔PAGE SHIFT 20
```
DIOB output status

6.13　AIO Expansion Card OPC-VG1-AIO

6.13.1　Product overview

The FRENIC-VG incorporates six built-in analog I/O points, i.e., one I/O point each allocated to pin numbers [Ai1], [Ai2], [AO1], [AO2], and [AO3] besides an input point (speed command input dedicated) dedicated to number 12.

The use of an optional OPC-VG1-AIO expansion card makes it possible to add 2 [Ai] and 2 [AO] points.

(1)　Main applications

The OPC-VG1-AIO enables control functions that are the same as those of the built-in analog I/O of the FRENIC-VG. For example, the available analog input functions include auxiliary speed setting 1, torque bias, torque command, and magnetic flux reference functions and analog output functions include speedometer, torque meter, torque current meter, and line speed detection functions.

(2)　Covering a shortage of analog I/O points

Apply the OPC-VG1-AIO to a system employing the UPAC (available soon) or control system that uses the built-in PID control of the inverter if the number of built-in analog I/O points is insufficient.

In the case of using the WPS-VG1-TEN in tension control, for example, the three built-in points of the FRENIC-VG will be all occupied for line speed, tension setting, and tension detection purposes. This expansion card will be required if the user wants to add one more point to such a system.

If the system, however, uses the OPC-VG1-SN as an optional synchronous interface for dancer control, this expansion card cannot be used due to the mounting limits on the analog option. Furthermore, if the built-in PID control of the inverter is used, the PID command (for process settings) and PID feedback amount (process amount) will occupy Ai1 and Ai2. This expansion card will be required if the user wants to add a point, e.g., a PID correction gain, to the system.
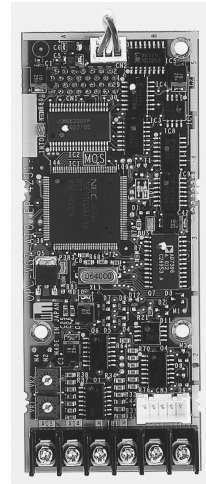
6.13.2　Models and specifications

6.13.2.1　Models

⚠CAUTION
• Only a single optional AIO expansion card can be mounted on the control PCB. The optional AIO expansion card cannot be mounted if an OPC-VG1-SPGT or other optional (FV or SN) analog card is already mounted.

Model legend: OPC-VG1-AIO

　　　　　　　　　　　　Name of inverter mounted: VG1→ FRENIC-VG
　　　　　　　　　　　　Name of option: AIO → Analog I/O option
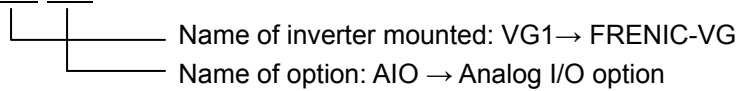
Accessories

Spacer: 3

Screw (M3): 3

Power supply harness (±15 V power supply): 1

[Mounting restrictions]

(1)　Combinations not mountable

The optional AIO expansion card cannot be mounted if an OPC-VG1-SPGT, OPC-VG1-FV, or other optional (SN) analog card is already mounted.

Figure 6.13.1

6.13.2.2   Specifications

⚠ **CAUTION**
• The built-in variable resistors (VR1 and VR2) of the optional AIO expansion card are adjusted before shipping. Never touch the variable resistors.

Table 6.13.1   Hardware Specifications

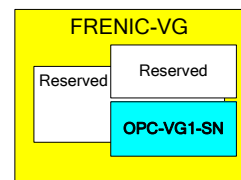|	Item	Specification
	Name	AIO Expansion Card
	Model	OPC-VG1-AIO
Input	No. of points	2 ([Ai3] and [Ai4])
Input	Ground	[M] (internally connected to built-in control terminal [M] of the card)
Input	Circuit	Input voltage: 0 to ±10 VDC; resolution: 11 bits (signed) Input impedance: 10 kΩ
Output	No. of points	2 ([AO4] and [AO5])
Output	Ground	[M] (internally connected to built-in control terminal [M] of the card)
Output	Circuit	Output voltage: 0 to ±10 VDC; resolution: 12 bits (signed) Output impedance: 3 kΩ min.
	Power supply	±15 V Power is supplied through the PCB of the FRENIC-VG. Connect the power supply harness to CN12 of the FRENIC-VG.
	VR1 and VR2	These variable resistors are adjusted before shipping. Never touch them.

Table 6.13.2   Software Specifications

	Item	Specification
Input data	Read cycle	1 ms
Input data	Function allocation	Set with functional codes E51 and E52.
Input data	Input processing	Bias, gain, filter, increment/decrement limiter, zero-hold, polarity changeover, offset, and dead zone settings are possible individually.
Output data	Refresh cycle	1 ms
Output data	Function allocation	Set with functional codes E72 and E73.
Output data	Output processing	Bias and gain settings are possible individually. Filter settings for all AO functions are possible.

(1)   Input

Two analog input points ([Ai3] and [Ai4]) can be freely set to the following functions.

The functions are set with functions codes E51 through E52. If the same function is assigned to both [Ai3] and [Ai4], Ai3 takes precedence. If the same function is assigned to [Ai1] - [Ai4], [Ai1] has priority.

For the Ai functions, refer to Chapter 4, E49 to E52 (Terminal Ai Function) in the FRENIC-VG User's Manual (Unit Type / Function Codes Edition).

(2)   Output

Two analog output points ([AO4] and [AO5]) can be freely set to the following functions.

The functions are set with functions codes E72 and E73.

For the Ao functions, refer to Chapter 4, E69 and E73 (Terminal Ao Function) in the FRENIC-VG User's Manual (Unit Type / Function Codes Edition).

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6.13.3　Dimensions
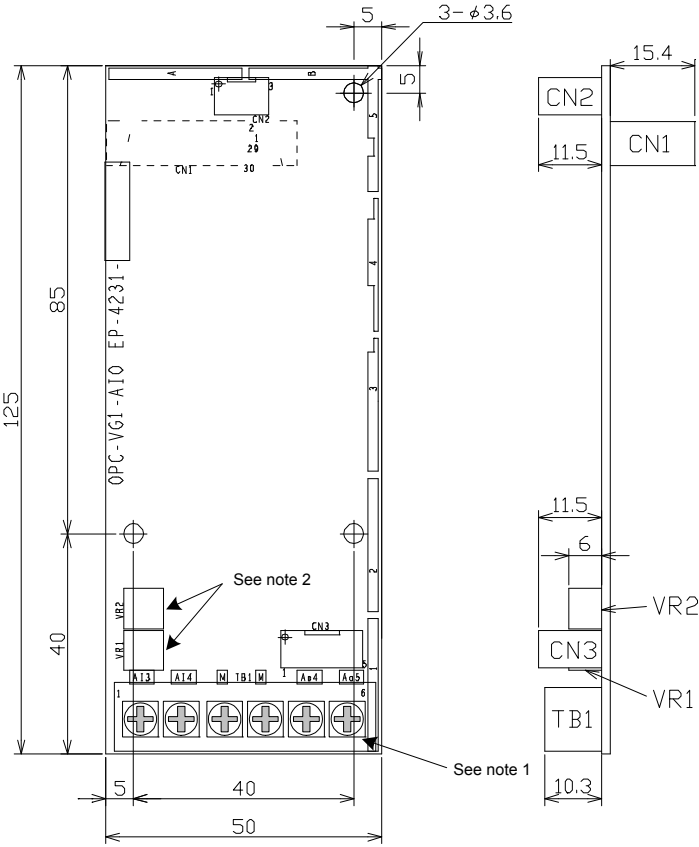
Figure 6.13.2

Note 1: Terminal screw size: M3

Note 2: The variable resistors (VR1 and VR2) are adjusted before shipping. Never make VR1 or VR2 setting changes.

6.13.3.1   Specifications

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠ WARNING

• Improper connections may result in disasters, such as electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work.

Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

⚠ CAUTION

• Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result.

Incorrect handling in installation/removal jobs could cause a failure.

Figure 6.13.3

6.13.4 Function codes

<div style="border:1px solid">
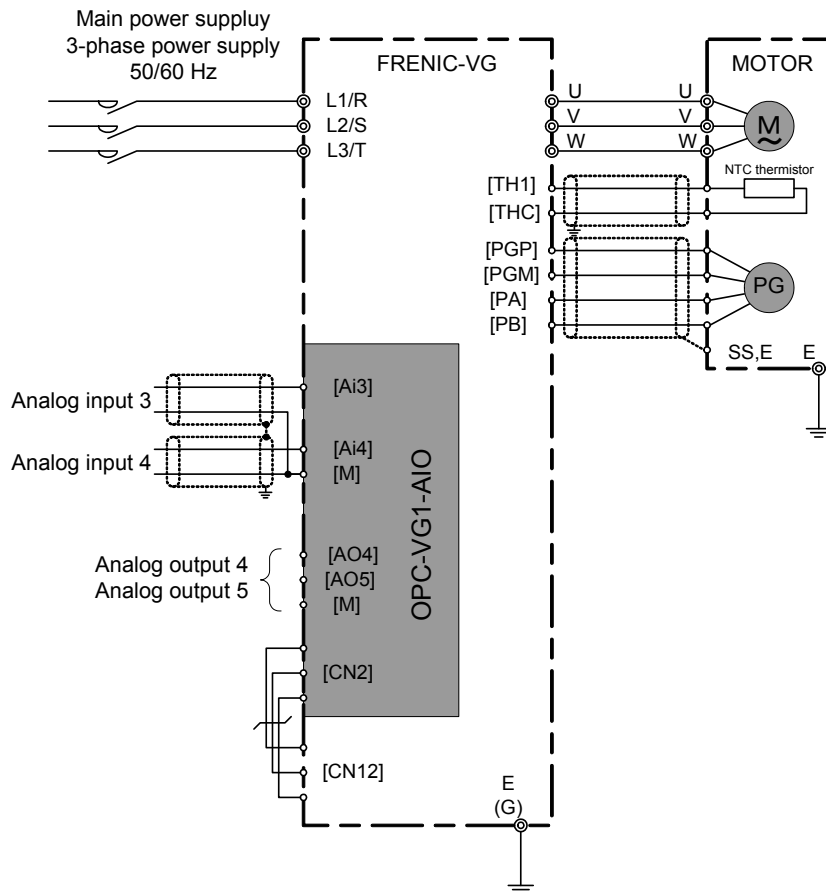
⚠WARNING

- A dangerous condition may result if a mistake is made in function code data. Check the data again after the data is set and entered.

  Otherwise, an accident could occur.

</div>

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⚠CAUTION

- The keypad will not display any optional function codes of the optional AIO expansion card (i.e., E51, E52, E55, E56, E59, E60, E63, E64, E67, E68, E72, E73, E77, E78, E82, E83, E103, E104, E107, or E108) unless the optional AIO expansion card is mounted. These optional function codes will be displayed only after the optional expansion card is mounted.

</div>

Function codes E51, E52, E55, E56, E59, E60, E63, E64, E67, E68, E72, E73, E77, E78, E82, E83, E103, E104, E107, and E108 will be operable with this optional expansion card mounted.

The keypad will display these function codes with the optional AIO expansion card mounted. Otherwise, the keypad will not display the functions.

Table 6.13.3

No.	Parameter name		Setting range	Description
	Name	Keypad display		
E51	Ai3 function selection	Ai3 FUNC	0-27	
E52	Ai4 function selection	Ai4 FUNC	0-27	
E55	Ai3 gain setting	GAIN Ai3	-10.000-10.000 (times)	
E56	Ai4 gain setting	GAIN Ai4	-10.000-10.000 (times)	
E59	Ai3 bias setting	BIAS Ai3	-100.0-100.0(%)	
E60	Ai4 bias setting	BIAS Ai4	-100.0-100.0(%)	
E63	Ai3 filter setting	FILTER Ai3	0.000-0.500(s)	
E64	Ai4 filter setting	FILTER Ai4	0.000-0.500(s)	
E67	Increment/decrement limiter (Ai3)	A/D-L-Ai3	0.00-60.00(s)	
E68	Increment/decrement limiter (Ai4)	A/D-L-Ai4	0.00-60.00(s)	See Chapter 4.
E72	AO4 function selection	AO4 FUNC	0-40	
E73	AO5 function selection	AO5 FUNC	0-40	
E77	AO4 gain setting	GAIN AO4	-100.00-100.00 (times)	
E78	AO5 gain setting	GAIN AO5	-100.00-100.00 (times)	
E82	AO4 bias setting	BIAS AO4	-100.0-100.0(%)	
E83	AO5 bias setting	BIAS AO5	-100.0-100.0(%)	
E84	AO1-5 filter setting	FILT AO1-5	0.000-0.500(s)	
E103	Ai3 offset	Ai3 OFSET	-100.00-100.00(%)	
E104	Ai4 offset	Ai4 OFSET	-100.00-100.00(%)	
E107	Ai3 dead zone	Ai3 BLIND	0.00-10.00(%)	
E108	Ai4 dead zone	Ai4 BLIND	0.00-10.00(%)	

6.13.5   Check function

(1)   Optional Module Mounting Check

It is possible to check with the keypad whether the optional AIO expansion card is correctly mounted.

Go to the Program Menu screen from the Operation Mode screen and select "4. I/O CHECK."

Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional AIO expansion card.

For details, refer to the information provided in this manual on how to operate the keypad.

As shown in the LCD screen example on the right-hand side, the corresponding number will be highlighted (□→■) if it is correctly mounted.

```
ＯＰ－Ａ：ＶＧ１－ＡＩＯ
ＯＰ－Ｂ：
ＯＰ－Ｃ：

∧Ｖ→ＰＡＧＥ  ＳＨＩＦＴ  9
```

(2)   I/O check

It is possible to check with the keypad of the inverter the I/O status of optional AIO expansion cards.

Check with Monitor LED

Press the FUNC/DATA key (FUNC/DATA) in the operation mode screen and select the corresponding item.

The 7-segment LED indicator will display the current analog input status in percentage.

Analog input gain and bias settings can be made by referring to the LED indicator.

(The LED indicator will not display any analog output status).

```
＜ＬＥＤ  ＭＮＴＲ＞    １８
Ａｉ  ＡＤＪＵＳＴＭＥＮＴ
（Ａｉ３）

Ｆ／Ｄ→ＬＥＤ  ＳＨＩＦＴ
```

Check with LCD screen

Go to the Program Menu screen from the Operation Mode screen and select "4. I/O CHECK."

Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional AIO expansion card.

The screen will display the input voltages of [Ai3] and [Ai4] and the output voltages of [AO4] and [AO5].

```
Ａｉ３＝±××．×Ｖ        ←──── AIO I/O status 1 (Ai3): "0,0" if not connected.
Ａｉ４＝ ××．×Ｖ        ←──── AIO I/O status 1 (Ai4): "0,0" if not connected.
ＡＯ４＝±××．×Ｖ        ←──── AIO I/O status 1 (Ao4)
ＡＯ５＝±××．×Ｖ        ←──── AIO I/O status 1 (Ao5)
∧Ｖ→ＰＡＧＥ  ＳＨＩＦＴ１４
```

Chap. 6

CONTROL OPTIONS

6.14 Optional PG Changeover Card MCA-VG1-CPG (available soon)

6.14.1 Product overview

This optional card enables a single FRENIC-VG inverter to select and drive two motors provided with speed sensors alternately.

The motors are selected by switching pulse generator (PG) and NTC thermistor signals.

This optional card does not incorporate a function to switch the U, V, or W output wire to the motors. Select the wires with a magnetic contactor (MC) or similar device externally. Switching signals can be output from the FRENIC-VG.

Main Applications

• Multi-winding motor drive
• Driving of a number of motors with a single inverter.

6.14.2 Model and specifications

6.14.2.1 Model

Model legend: MCA-<u>VG1</u>-<u>CPG</u>

Name of inverter mounted: VG1→ FRENIC-VG
Name of option: CPG→PG changeover unit
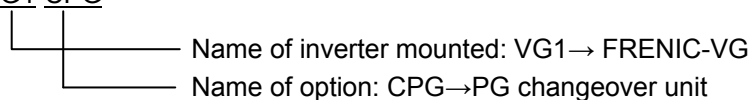
6.14.2.2 Specifications

Table 6.14.1 Hardware Specifications

Item	Specification
Name	PC Changeover Card
Changeover signal	Selection of either NTC or PG signal with the SEL terminal.
PG signal	15-V complementary output
NTC signal	Analog signal at 0 to 10 V
Current consumption	80 mA max. at 24 V

6.14.3   Dimensions

Figure 6.14.1   Product Dimensions

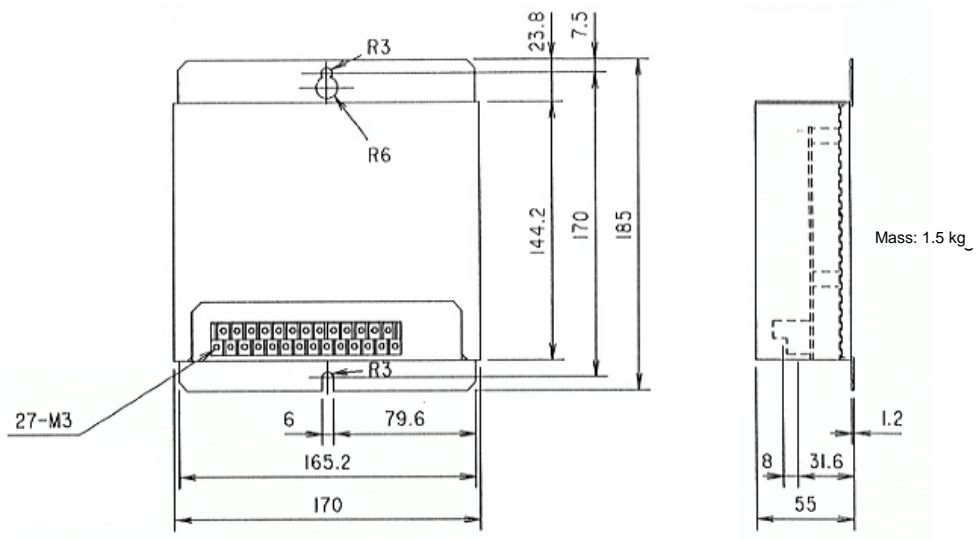| TT1	TC1	PA1	PP1			PA	PGP		TT2	TC2	PA2	PP2
			PB1	PM1	THT	THC	PB	PGM	P24	SEL		PB2	PM2
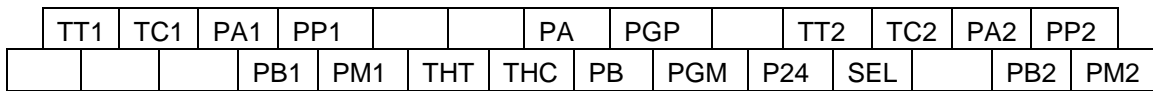
Screw size: M3

Figure 6.14.2   Terminal Arrangement

6.14.4   Installation method

Mount the PG changeover card (unit) with an M5 bolt each on the upper and lower sides of the unit to a sturdy structure so that the characters on the label of the unit will be visible on the front side.

⚠ WARNING
• Install the card on metallic or other nonflammable structure.   **Otherwise, a fire may result.**

⚠CAUTION
• Make sure that no foreign substances, such as lint, paper, wood chips, dust, or scrap metal will penetrate into the unit.   **Otherwise, a fire may result.**

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6.14.5　Basic schematic diagram

Refer to 6.1.4 Installing Internal Options (OPC-VG1-□□) and wire and connect the FRENIC-VG.

⚠WARNING
• Improper connections may result in electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work. Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

⚠CAUTION
• Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result. Incorrect handling in installation/removal jobs could cause a failure.

There are terminal blocks under the lower part of the unit (see figure 6.14.1 and figure 6.14.2). Wire the terminal blocks with the following items kept on mind.

Make sure that the terminal blocks are wired as shown in figure 6.14.3. Prepare a circuit that switches over the main circuit wires (U, V, and W) in synchronization with the SEL contacts. Use crimp terminals with high connection reliability to wire the terminals. Check the following items on completion of wiring work.

   a. Check that the wires are connected correctly.
   b. Check that no wires are left unconnected.
   c. Check that no terminals or wires are short-circuited or resulting in ground faults.

Basic Schematic Diagram
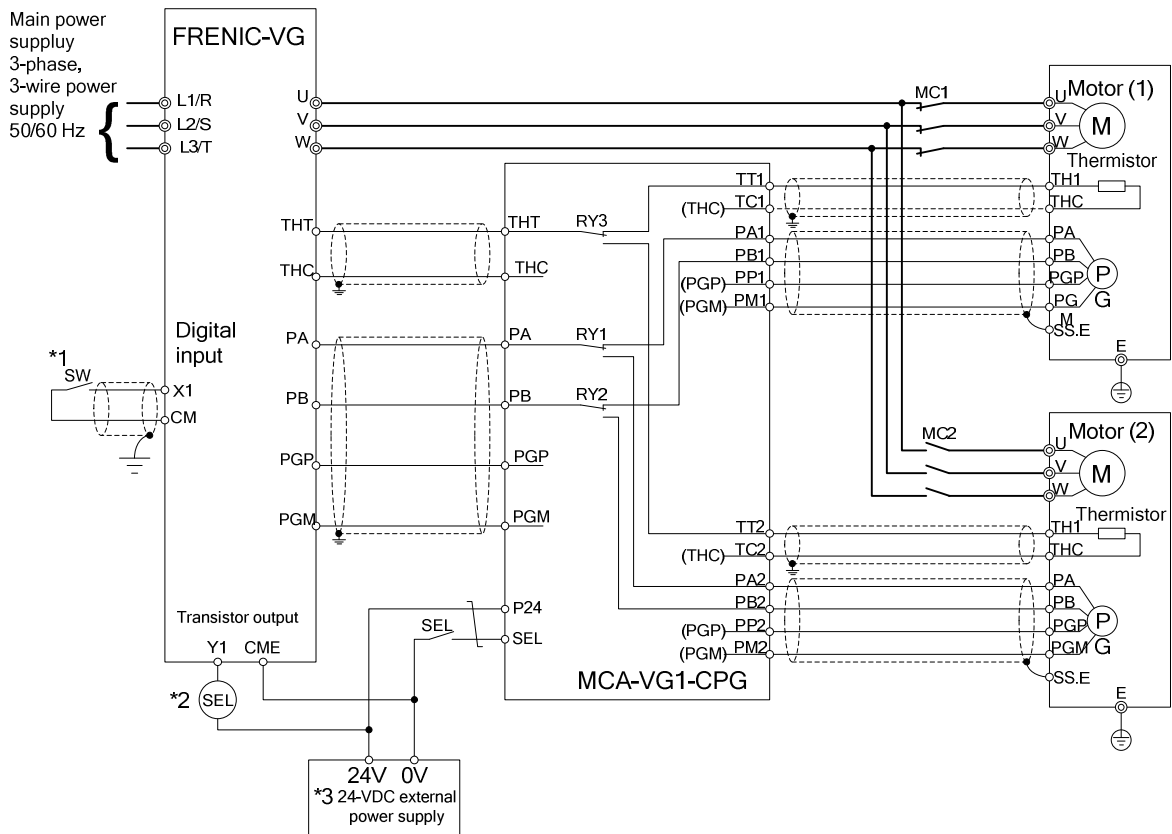
Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0 V line.

Figure 6.14.3   Schematic Diagram of Inverter Unit

*1   The above example shows the following allocation of digital input (X1) and transistor output (Y1).

Table 6.14.2

Function code	Function name	Set value	Description	Operation
E01	X1 function selection	12	Motor M2 selection	Select motor 2 with the SW turned ON.
E15	Y1 function selection	16	Motor M2 selection state	Turn ON the SEL with the SW turned ON.

*2   Prepare a different circuit so that the main circuit wires will be switched over with the coil (SEL) as shown below.

Table 6.14.3

SW	SEL	MC1	MC2	Motor selection
OFF	OFF	ON	OFF	1
ON	ON	OFF	ON	2

*3   Current required by 24-V power supply: 70 mA + Coil (SEL) driving current

Conformable Wire Size

Use wires with a thickness ranging from 0.5 to 1.25 (mm^2).

For the wiring of the main circuit terminals (U, V, and W), refer to the Operation Manual and User's Manual for this inverter.

6.14.6   Operation method

The encoder (1) and NTC thermistor (1) will be connected when the SEL terminal of the terminal block and the 0-V external power supply terminal are open.

The encoder (2) and NTC thermistor (2) will be connected when the SEL terminal of the terminal block and the 0-V external power supply terminal are closed.

Table 6.14.4

SEL terminal	Encoder and NTC thermistor connected
OFF	Encoder (1) and NTC thermistor (1)
ON	Encoder (2) and NTC thermistor (2)

⚠CAUTION

- No functions are incorporated to change over the motor power wires (U, V, and W). Use a magnetic contactor (MC) to change them over externally.
- Never make connection changes while the motor during conduction.

  Otherwise, the motor may go out of control or the inverter may malfunction.
- The PG signal common terminal (PGM) and thermistor common terminal (THC) are isolated from each other. Do not short-circuit them with external wires.
- Do not use more than one unit to change over three or more motors. (The power supply to the PG is not changed over. Therefore, the current may exceed the PG current capacity limit of the inverter.)

  Otherwise, the inverter may be damaged.

6.15   E-SX Bus Interface Card OPC-VG1-ESX

6.15.1   Product overview

This option card is used to control the FRENIC-VG from the Fuji Programmable Logic Controller MICREX-SX SPH3000MM via the E-SX bus.
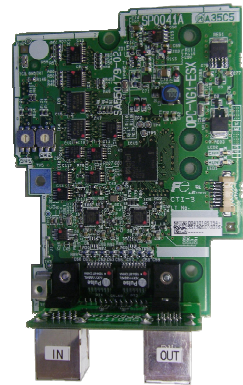
<u>Main uses</u>

The following can be performed from the option card.

- Input of run, stop, and other signals: FWD, REV, X1 - X9, X11 - X14, RST

- Speed command and torque command settings: 16-bit binary data

- Operation status monitor (bit data)
  Running forward, running reverse, during DC breaking or during pre-excitation, inverter shutdown, braking, DC link established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay, remote/local, write error from link, data writing (processing) in progress

- Motor speed / torque monitor: 16-bit binary data

- Operation status monitor (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)

- Referencing/changing function codes

- The tact cycle of the PLC (SPH3000MM) and the control cycle of the inverter can be synchronized by E-SX bus.[1]

- Toggle monitor control enables monitoring of whether the mutual functioning of the host device and inverter is normal.

  [1]   For synchronization, refer to "6.15.10 Synchronization of E-SX bus tact cycle and inverter control cycle".

6.15.2   Model and specifications

6.15.2.1   Model

Model details: OPC-<u>VG1</u>-<u>ESX</u>

Installed inverter name: VG1→FRENIC-VG
Option name: ESX→E-SX bus interface card
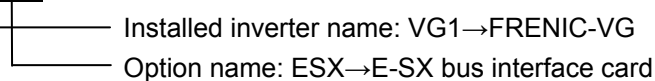
<u>Accessories</u>

Spacers: 4
Screws (M3): 2

6.15.2.2   Specifications

| ⚠CAUTION |
|---|
| ・ If the rotary switches (SW1, 2) on the option are not set correctly, the system will not operate properly. Set as indicated below, taking care to ensure that all settings are correct.
・ Set the rotary switches (SW1, 2) on the option with the inverter power OFF. |

Table 6.15.1   Hardware Specifications

Item	Specifications
Name	E-SX Bus Interface Option
Transmission specifications	E-SX bus slave, I/O transmission
Transmission speed	100 Mbps
Distance between stations	Maximum 100 m
Total extension distance	Maximum 1,000 m
E-SX bus consumption current	Normal operation: Maximum 6 mA, bypass operation (inverter power OFF): Maximum 93 mA
Number of words occupied in transmission	16 words (I area 8 words / Q area 8 words)
Terminals / bus cable	IN, OUT / E-SX bus cable *NU1C-P3 (0.3 m) - NU1C-A0 (100 m)
Rotary switches RSW 1, 2	Station address setting, any station address from 1 to 283 can be assigned.
Status display LED RUN, ERR	Status of local station (running/error) is indicated by LED

(1) Rotary switches SW1, 2

The station address is set with rotary switches SW1 and SW2 on the option board. The display is hexadecimal, with "SW1" corresponding to the upper 4 bits and "SW2" corresponding to the lower 4 bits. For the E-SX bus station address, read as a decimal display.

Example: For station address 194, this is C2 (h), and SW1 = C, SW2 = 2 are set.

SW1 : Upper 4 bits
SW2 : Lower 4 bits

SW1   SW2
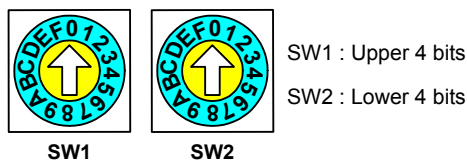
Figure 6.15.1   Station Address Setting Switches

* Set the same address as the E-SX bus address set in the MICREX-SX system definitions. The address assigned from MICREX-SX will be the actual E-SX bus address, so this may differ from the set values of these rotary switches. (This can be checked in Function Code U13 "SX Bus Address Monitor".)

* When multiple units are used, make sure that duplicate E-SX bus addresses are not set.

* The factory defaults are SW1 = 0, SW2 = 0 (station address 00 (h)). In this case, the station address set in the "Expert (D300win)" support tool system definitions is set (no degenerate system startup). If there is degenerate system startup, a heavy alarm will occur on the MICREX-SX.

* SW1 and SW2 settings are detected during "power on" and "reset" of the E-SX bus (MICREX-SX).

(2) Status display LED   <u>RUN, ERR</u>

The status of the local station (running/error) is indicated by the RUN/ERR LED on the option board. The option determines the status of the local station, which is a slave station, and thus this may differ from the RUN/ALM status displayed on the MICREX-SX CPU.

Table 6.15.2   LED Display

	Status of slave		RUN (green)	ERR (red)
Initial	E-SX bus transmission not received		☐OFF	☐OFF
	E-SX bus transmission received		■Flashing	☐OFF
Normal			■ON	☐OFF
Heavy alarm	Option hardware error		☐OFF	■ON
	Master down detected		■ON	■ON
Light alarm			■ON	■ON
· Local station setting error (does not match master or station address outside range)				
· Communication error detected (missed reception 3 tacts in succession)				
· Other inverter alarm occurred				
Inverter power OFF (including bypass operation)			☐OFF	☐OFF

Table 6.15.3   Software Specifications

Item		Specifications
Data update cycle (*1)		Minimum 250 μs
Operation	Run command	Run forward and reverse commands, alarm reset command, X1 to X14 commands
	Speed/torque command	1-word data
	Operation status output	Bit data of running, braking, torque limiting, alarm relay and other signals
		Return speed (1 word), torque output (1 word), current return position (2 words) (supported in near future)
Option function codes		o30, o31, U11 to U13
Protective functions		Er-4: Network error (E-SX bus error) (*2)
		*Light alarm: Er-4 alarm action can be set with o30, o31.
		*Heavy alarm: Immediate Er-4 alarm.
		Ar-F: Toggle error (*3)
		The 2-bit signals sent by the PLC, toggle signal 1 TGL1 and toggle signal 2 TGL2, are monitored, and this error occurs if the specified change pattern is not received before the time set in H144 elapses.
		Ar-E: E-SX bus tact synchronization error (*4)
		Occurs when synchronization of the E-SX tact cycle and inverter control cycle is lost due to noise or other factors.

*1   The data update cycle depends on the carrier frequency setting, E-SX bus tact cycle of the MICREX-SX, and task cycle of the application program.

*2   For light and heavy alarms, refer to "6.15.6 Protective operations".

*3   For details on toggle signals and toggle errors, refer to "TGL1" and "TGL2" in the explanation of E01 to E13 in Chapter 4, Section 4.3 "Details of Function Codes." The toggle pattern for ON/OFF of TGL1 and TGL2 must be created in the MICREX-SX program.

*4   For E-SX bus tact synchronization errors (Ar-E), refer to Section 6.15.10 "Synchronization of E-SX bus tact cycle and inverter control cycle."

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6.15.3   External dimension drawings
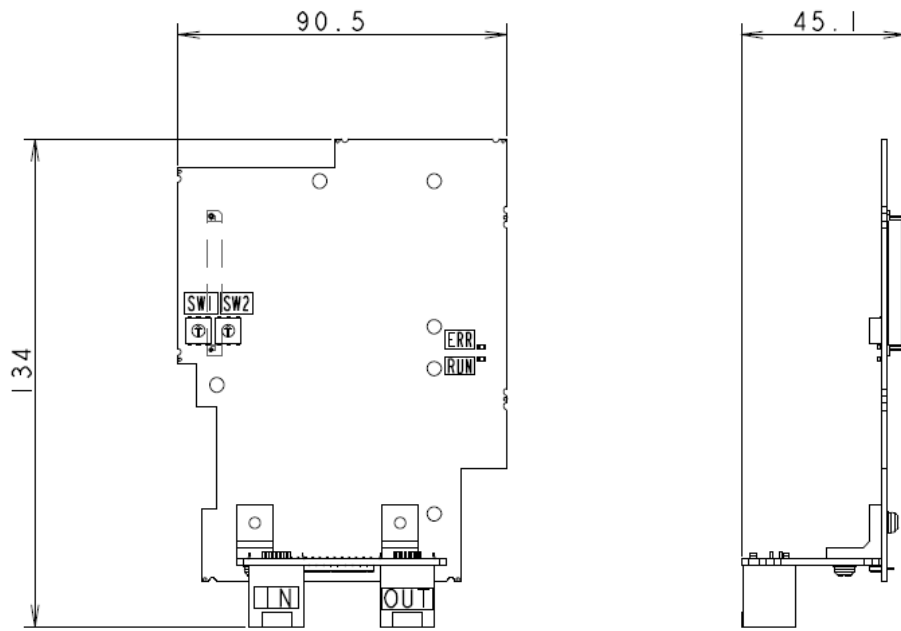
(Unit: mm)

Figure 6.15.2   Option Print Board Outline Drawings

■ **E-SX bus cable connections**
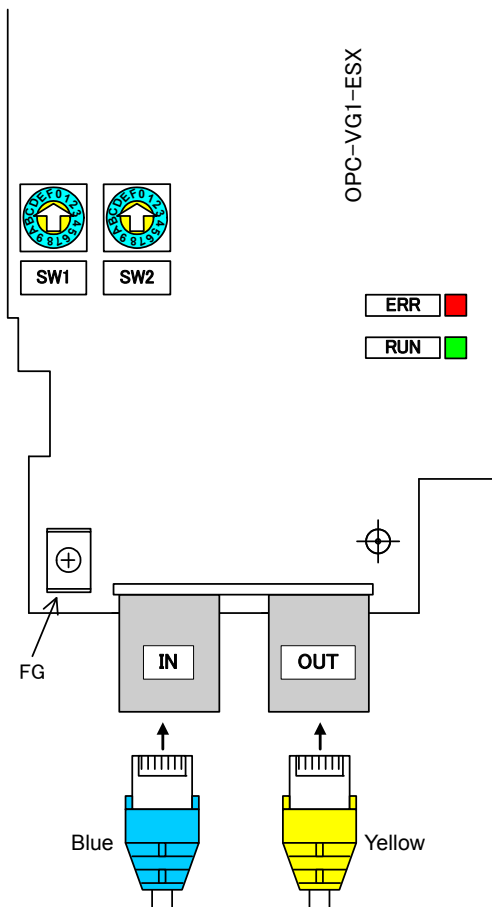
· Connection of the FG terminal is not necessary. Do not connect. For the installation procedure, refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)."

· A connector to which the E-SX bus cable is not connected should be left unconnected. Never connect a terminating connector.

Figure 6.15.3   E-SX Bus Cable Connections

6.15.4 Basic connections

Perform the wiring and connection work as explained in Section 6.1.4 "Installing internal options (OPC-VG1-□□)."

⚠ WARNING

- Risk of electric shock, fire, and other hazards if improper wiring work is performed. Only a qualified electrician should make the connections. If it is necessary to touch electrical circuits to make connections after the power has been connected, switch the power breaker to the OFF (open) position to prevent electric shock.

- Even when the breaker is OFF (open), the smoothing capacitor is charged and will cause electric shock if touched. Make sure the inverter CHARGE lamp is off and use a tester to verify that the DC voltage of the inverter has fallen to a safe level.

- The E-SX bus voltage is supplied from the PLC power module. Before installing or removing this option, make sure that the MICREX-SX power and inverter power are OFF.

⚠ CAUTION

- Do not use a product if parts are damaged or missing. Risk of injury and damage.

- Improper work when installing or removing the product may cause product damage.

Follow the rules below when making connections.

[Rules for connections]

(1) Use dedicated cables for the E-SX bus.

Model: NU1C-P3 (0.3 m) to NU1C-A0 (100 m)

For cable specifications, refer to the MICREX-SX manual (Hardware).

(2) Before performing work, make sure that both the MICREX-SX and the inverter are powered OFF.

(3) For the E-SX bus cable wiring, the main circuit wires of the inverter should be kept as far away as possible (at least 30 cm) from other power lines to prevent malfunctioning due to noise. Never insert in the same duct.

(4) Connect the wiring of the E-SX bus cable from OUT to IN on the SPH3000MM, or from IN to OUT. Communication is not possible with an OUT-OUT or IN-IN connection, and thus the system will not operate. Connection of a terminating connector is prohibited. Never connect a terminating connector.
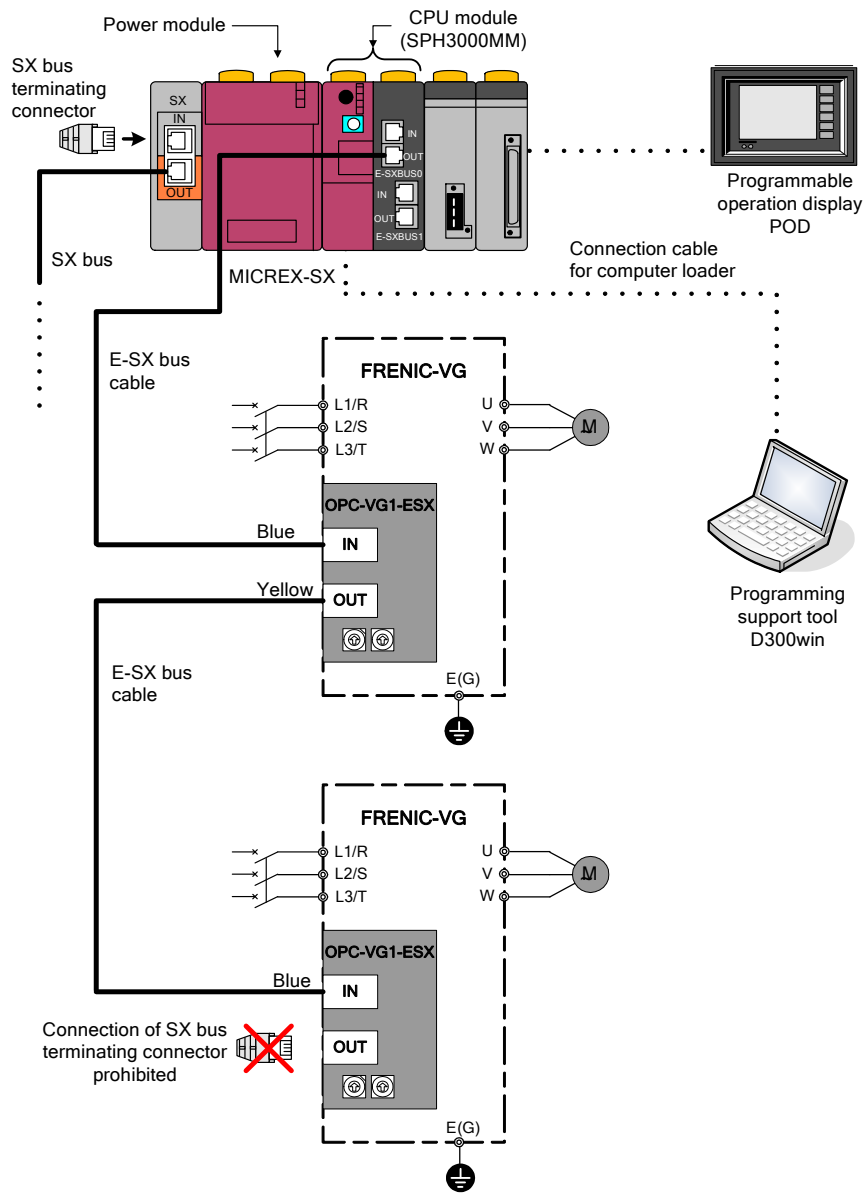
Example of basic connections

Figure 6.15.4   Example of Basic Connections

6.15.5   Related function codes

⚠ WARNING
· Incorrect function code data may create a hazardous condition. After setting and writing data, recheck the data. **Risk of an accident**

Inverter function codes related to the E-SX bus interface card are described below.

Table 6.15.4   Related Function Codes

No.	Function code name		Setting range	Description
	Name	Keypad display		
H30	Link function	Link function	0 to 3	3: Set run command / command data enable via E-SX.
o30 *1	Action when transmission error occurs	Link mode	0	Immediate forcible stop when communication error occurs (light alarm) ($Er-4$ alarm: coast to stop)
			1	Continue operation for timer time after a communication error (light alarm) occurs (in a communication error state, the previous run command from communication is held) Forcible stop after timer time ($Er-4$ alarm: coast to stop) If communication recovers within timer time, operates according to the communication command. If after timer time, forcible stop.
			2	Continue operation for timer time after a communication error (light alarm) occurs (in a communication error state, the previous run command from communication is held). If communication error recovery does not take place within timer time, forcible stop. If communication recovers within timer time, operates normally according to the communication command.
			3	No alarm ($Er-4$) when a communication error (light alarm) occurs. In a communication error state, the previous communication command is held When communication recovers, operates normally according to the communication command.
o31 (*1)	Action time when transmission error occurs	Link timer	0.01 to 20.00s	Operation timer value [s] when communication error (light alarm) occurs. Enabled when o30 = 1 or 2
U11	E-SX transmission format selection	USER P11	3	Standard format: 2 Number of words occupied: 16 words (8W+8W)
			Other than above	Reserved (do not set)
F26	Carrier frequency	Carrier Hz	2 to 15	Set the carrier frequency (= inverter control cycle). The SPH3000MM tact cycle and inverter control cycle are only synchronized when F26 = 4 or 8.
H107	Light alarm definition 2	Light alarm 2	0000 to 1111	Select the alarm action when an E-SX bus error ($Er-4$) or toggle error ($Ar-F$) occurs. The $Er-4$ digit is 100, and $Ar-F$ digit is 1. Set applicable digit to 0: alarm occurs or 1: light alarm ($L-AL$)
H108	Light alarm definition 3	Light alarm 3	0000 to 1111	Select the alarm action when an E-SX bus tact synchronization error ($Ar-E$) occurs. Set the "1" digit to 0: $Ar-E$ alarm occurs or 1: light alarm ($L-AL$)
E10 | E13	X11 to X14 function selection	X11 to X14 functions	*2	Select the command when each X11 to X14 bit = 1. To perform toggle monitoring by X terminal bit, set TGL1, TGL2 in either of the two terminals.
E15 | E27	Y function selection	Y function	*2	Select the Y1 to Y5 and Y11 to Y18 functions. To check the E-SX tact synchronization status, set C-Do10 in any one of the terminals.*3
o160	Function code monitor (1) setting	Lead code 1	0000h to FFFFh	Only valid when standard format 2 is used. Use 485No to set the function code to be constantly monitored by function code monitor (1).
o161	Function code monitor (2) setting	Lead code 2	0000h to FFFFh	Only valid when standard format 2 is used. Use 485No to set the function code to be constantly monitored by function code monitor (2).

*1 For details on o30 and o31, refer to "6.15.6.1 (2) Action when a light alarm occurs (o30, o31)".

*2 For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

*3   For E-SX tact synchronization, refer to Section 6.15.10 "Synchronization of E-SX bus tact cycle and inverter control cycle".

6.15.6   Protective operations

6.15.6.1   Light alarms and heavy alarms in E-SX bus communication (Er-4)

(1)   Causes of light alarms and heavy alarms (Er-4)

Light alarms and heavy alarms are generated on the E-SX bus interface card depending on the alarm level.

When an alarm occurs, the inverter outputs an Er-4 "network error" and the motor coasts to stop.*1

*1   Inverter function code H107 can be set to display L-AL and continue operation when an alarm occurs. Refer to the explanation of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

Table 6.15.5   Causes of Light Alarms and Heavy Alarms (Er-4)

Item	Light alarm	Heavy alarm 1	Heavy alarm 2
Card LED state	ERR ■ (lit) RUN ■ (lit)	ERR ■ (lit) RUN ■ (lit)	Undefined
Cause *2	• Normal reception failed 3 times in succession due to noise on communication line or other cause.	• All masters down (Cable break, PLC power interrupted)	• Card hardware failure • Improper card installation
Reset method	Clear alarm cause (auto clear by communication reset) or set H30 = 0, 1 or [LE] = OFF and issue reset command.*3		After clearing the alarm cause, cycle the inverter power off/on (clearing is not possible until the power is turned off).
Control of alarm state	Alarms can be controlled by function codes o30, o31.	When a heavy alarm occurs, an Er-4 alarm is generated immediately.	
Communication error code displayed on keypad*4	1	2	3
Alarm sub-code *5	01(hex)	02(hex)	04(hex)

*2   When a light alarm cause occurs and command via E-SX is enabled (H30 = 2, 3 and LE = ON; for details, refer to the explanation of H30 in Chapter 4, Section 4.3 "Details of Function Codes"), Er-4 is generated. With heavy alarm 1, when run command via E-SX is ON, Er-4 is generated. With heavy alarm 2, Er-4 is generated regardless of the settings when the cause occurs.

*3   "Issue a reset command" at light alarm and heavy alarm 1 refers to inverter reset input by any of the following methods.

   ＊   Keypad (RESET) key input
   * Assign error reset [RST] by X function selection and input digitally.
   * RST bit = 1 in Q area from E-SX communication
   Depending on the MICREX-SX CPU state, the CPU may need to be reset as well when heavy alarm 1 occurs.

*4   The communication error code for a light alarm or heavy alarm can be checked in the communication status screen of the maintenance information on the keypad. Press the (PRG) key in the operation mode screen of the communication status screen to change to the menu screen, move the arrow on the left side of the screen to "5. Maintenance" with the (∧)/(∨) key, and press the (FUNC/DATA) key. Press the (∨) key 3 times to display the screen below. This error code indicates the first factor that caused Er-4 to occur. A light alarm always occurs before heavy alarm 1 occurs, and thus when o30 = 0, this code shows the light alarm code even when the state is heavy alarm 1.

```
NRK = × × × × ×
NRR = × × × × ×      × ×
NRO = × × × × ×      × X
NRL = × × × × ×      × ×
∧V→PAGE SHIFT  4
```
   -: No communication error
   1: Light alarm
   2: Heavy alarm1
   3: Heavy alarm2
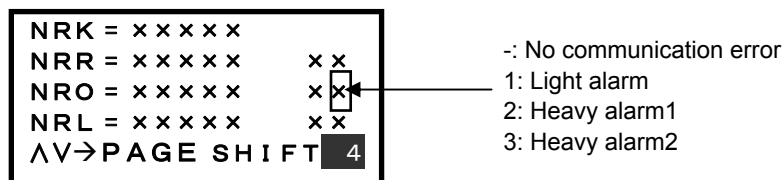
Figure 6.15.5   Communication Error (Er-4) Code Screen

*5 The alarm sub-code of Er-4 can be checked in alarm history selection in the alarm information of the keypad. The alarm sub-code screen can be displayed as follows: Press the (PRG) key in the operation mode screen to change to the menu screen. Move the arrow at the left side of the screen to "7. Alarm Information" with the ⌃/⌄ key and press the (FUNC/DATA) key. Select the alarm you want to view in the alarm information selection screen that shows the most recent alarm and the previous 3 alarms, and press the (FUNC/DATA) key. Press the ⌃ key once. The screen below appears. This alarm sub-code indicates the first factor that caused Er-4 to occur. A light alarm always occurs before heavy alarm 1 occurs, and thus when o30 = 0, this code shows the light alarm code even when the state is heavy alarm 1.

```
SUB = × × × X  ◄───────   1: Light alarm
AL = Er4   AL = × × ×       2: Heavy alarm1
AL = × × ×   AL = × × ×     4: Heavy alarm2
∧V→PAGE SHIFT 23
```
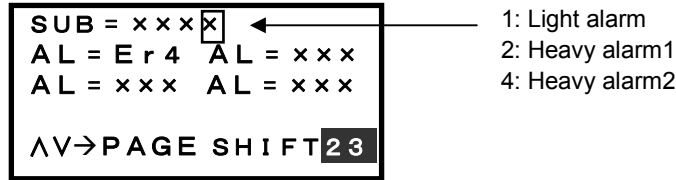
Figure. 6.15.6   Alarm Sub-Code Screen

(2) Action when light alarm occurs (o30, o31)

This section explains the control methods for Er-4 alarms by inverter function codes o30, o31 when a communication error (light alarm state) occurs while a run command is issued from the MICREX-SX via the E-SX bus.

1) Function code o30 = 0 (immediate coast to stop when communication error (light alarm) occurs)
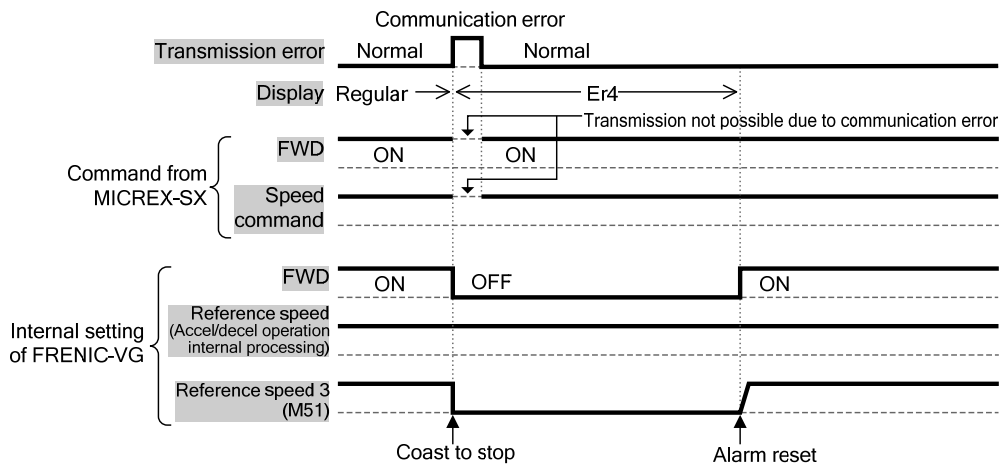
Figure 6.15.7

2) Function code o30 = 1, o31 = 5.0 (<u>coast to stop</u> after 5 seconds when communication error (light alarm) occurs)

Figure 6.15.8

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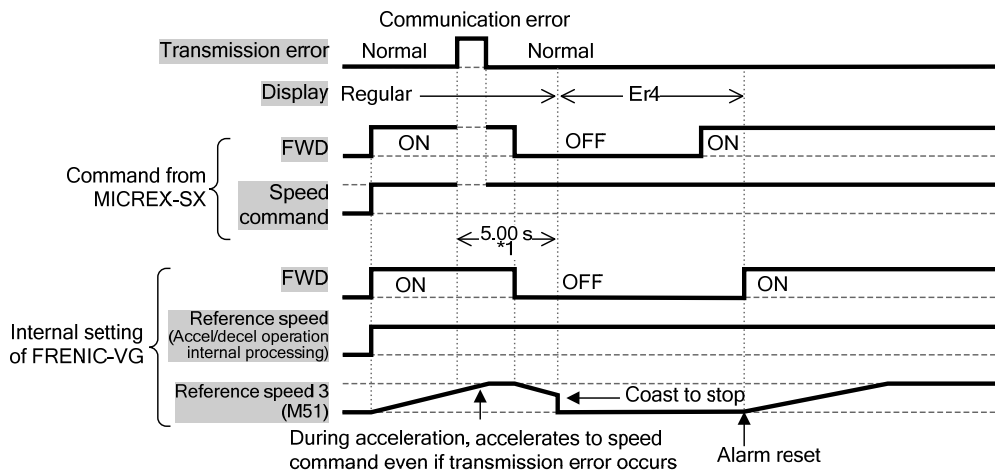
3) Function code o30 = 2, o31 = 5.0

(Er-4 alarm occurs if communication does not recover within 5 seconds after communication error (light alarm) occurs)

Communication error

| Transmission error | Normal | | Normal |

Display Regular — Er4 —

Command from MICREX-SX
- FWD — ON / ON
- Speed command

5.00 s *1

Internal setting of FRENIC-VG
- FWD — ON / OFF / ON
- Reference speed (Accel/decel operation internal processing)
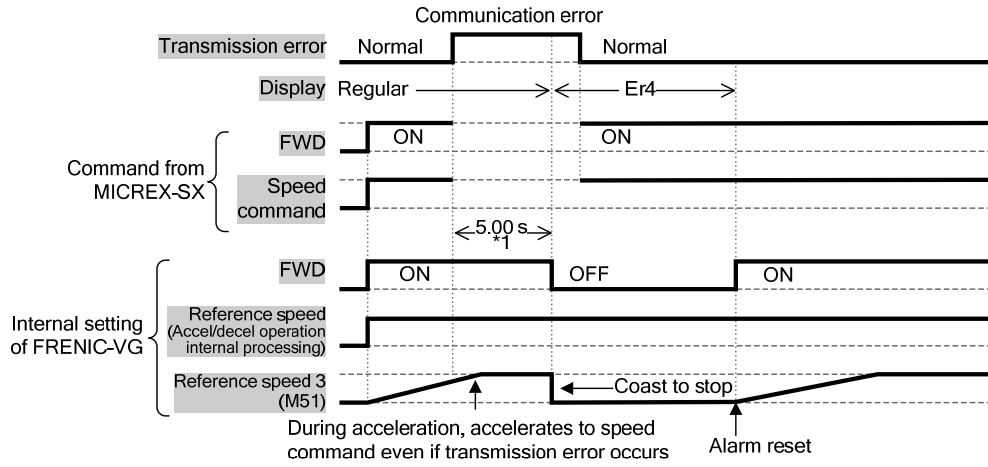- Reference speed 3 (M51) — Coast to stop

During acceleration, accelerates to speed command even if transmission error occurs

Alarm reset

Figure 6.15.9

4) Function code o30 = 2, o31 = 5.0 (communication recovers within 5 seconds after communication error (light alarm) occurs)

Communication error

| Transmission error | Normal | | Normal |

Display — Regular —

Command from MICREX-SX
- FWD — ON / OFF
- Speed command

5.00 s *1

Internal setting of FRENIC-VG
- FWD — ON
- Reference speed 3 (M51)

During acceleration, accelerates to speed command even if transmission error occurs
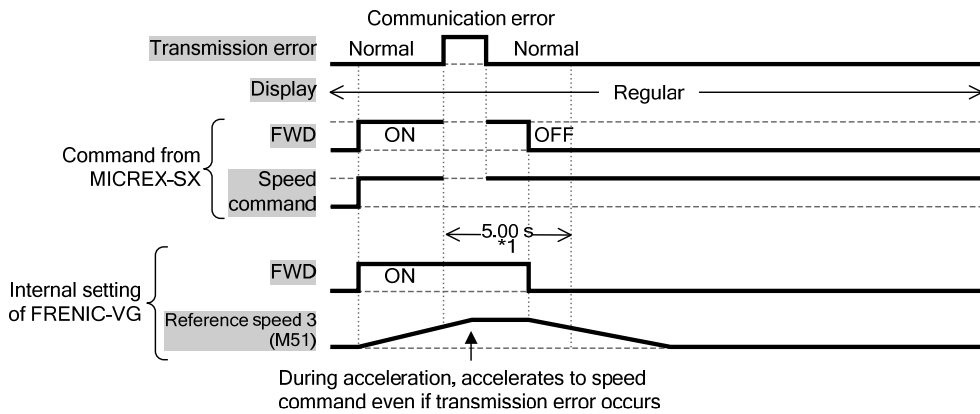
Figure 6.15.10

5) Function code o30 = 3 (operation continues)

Communication error

| Transmission error | Normal | | Normal |

Display — Regular —

Command from MICREX-SX
- FWD — ON / ON
- Speed command

*1

Internal setting of FRENIC-VG
- FWD — ON
- Reference speed (Accel/decel operation internal processing)

Holds setting that was in effect when transmission error occurred and continues operation
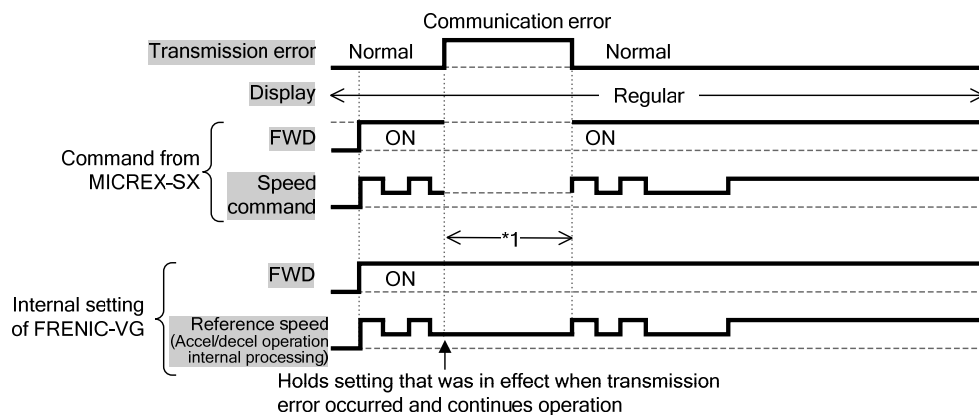
Figure 6.15.11

*1 During this period, if communication does not recover and a new command and setting are not sent, the command (run command, speed command, or both) from communication before the communication error occurred is held.

6.15.6.2 E-SX related alarms ($\mathit{Ar\text{-}E}$, $\mathit{Ar\text{-}F}$)

The causes of E-SX related alarms $\mathit{Ar\text{-}E}$ and $\mathit{Ar\text{-}F}$ are shown in Tables 6.15.6 and 6.15.7.

Table 6.15.6 $\mathit{Ar\text{-}E}$ Alarm Causes

Item	E-SX bus tact synchronization error
Card LED state	ERR ■ (lit) RUN ■ (lit)
Cause	Synchronization of tact cycle and inverter control cycle lost due to noise or other cause.
Reset method	After clearing the cause of the alarm, issue a reset command. After the alarm is reset, the ERR LED turns off.
Communication error code displayed on keypad	-
Alarm sub-code *1	01(hex)

Table 6.15.7 $\mathit{Ar\text{-}F}$ Alarm Causes

Item	Toggle error
Card LED state	ERR ■ (lit) RUN ■ (lit)
Cause	Normal toggle signal pattern of TGL1 and TGL2 signals not received within time set by inverter function code H144.
Reset method	After clearing the cause of the alarm, issue a reset command. After the alarm is reset, the ERR LED turns off.
Communication error code displayed on keypad	-
Alarm sub-code *1	04(hex)

*1 Alarm sub-codes can be checked as explained in *5 of "6.15.6.1 Light alarms and heavy alarms in E-SX bus communication".

6.15.6.3 Other inverter alarms

The card treats inverter alarms other than the above as light alarms. The actions indicated in Table 6.15.8 take place.

Table 6.15.8 Actions When Other Alarms Occur

Item	Inverter alarm other than an E-SX related alarm
Card LED state	ERR ■ (lit) RUN ■ (lit)
Reset method	After clearing the cause of the alarm, issue a reset command. After the alarm is reset, the ERR LED turns off.
Others	Inverter alarm codes (other than $\mathit{Er\text{-}4}$) can be checked on the E-SX bus light alarm information tab of alarm diagnosis in the Expert (D300win) support tool. Hexadecimal values are shown in the following format in Expert (D300win). | b8	b7	b6	b5	b4	b3	b2	b1	b0
---	---	---	---	---	---	---	---	---
1	1	Alarm code (M16) (*1)							

*1 For details on alarm codes, refer to Chapter 4, Section 4.2.4 "Data Format List."

6.15.7 Data addresses (IQ area)

6.15.7.1 Supported formats

Function code U11 "SX bus transmission format selection" can be set to 3 to support the transmission format below.

(1) Standard format 2 (U11 = 3)

Basic format that allows reading/writing of the motor speed, operation status monitor, and two function codes each (specified in 485No).
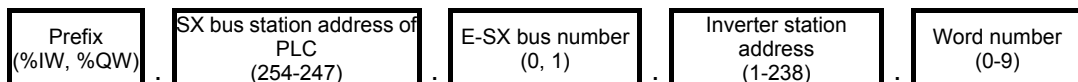
6.15.7.2 Input/output data address assignments

(1) Standard format 2

(*1)	bit 15 — bit 0
%IWx.x.*.0	Polling function code 485No (1)
%IWx.x.*.1	Polling function code 485No (2)
%IWx.x.*.2	Data of polling function code (1)
%IWx.x.*.3	Data of polling function code (2)
%IWx.x.*.4	Data of function code monitor (1), *Selected by o160
%IWx.x.*.5	Data of function code monitor (2), *Selected by o161
%IWx.x.*.6	Motor speed
%IWx.x.*.7	BUSY ERR - RL ALM DEC ACC IL - TL NUV BRK INT EXT REV FWD
%QWx.x.*.8	Selecting function code 485No (1)
%QWx.x.*.9	Selecting function code 485No (2)
%QWx.x.*.10	Data of selecting function code (1)
%QWx.x.*.11	Data of selecting function code (2)
%QWx.x.*.12	Speed command
%QWx.x.*.13	RST X14 X13 X12 X11 X9 X8 X7 X6 X5 X4 X3 X2 X1 REV FWD
%QWx.x.*.14	Polling function code 485No (1)
%QWx.x.*.15	Polling function code 485No (2)

Figure 6.15.12   Standard Format 2

*1 The address structure is as follows.

Prefix (%IW, %QW)	.	SX bus station address of PLC (254-247)	.	E-SX bus number (0, 1)	.	Inverter station address (1-238)	.	Word number (0-9)

For address details, refer to the MICREX-SX SPH User's Manual, SPH3000MM (FH302).
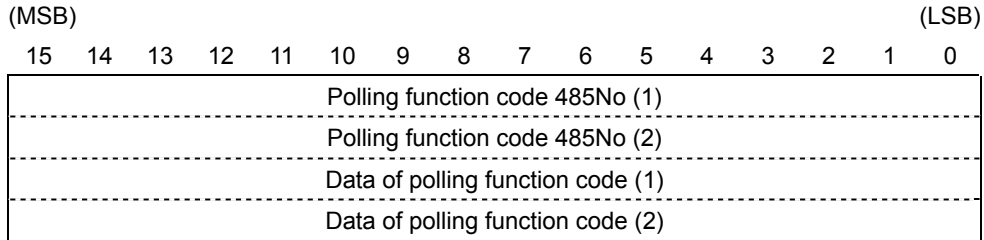
6.15.8 Format details
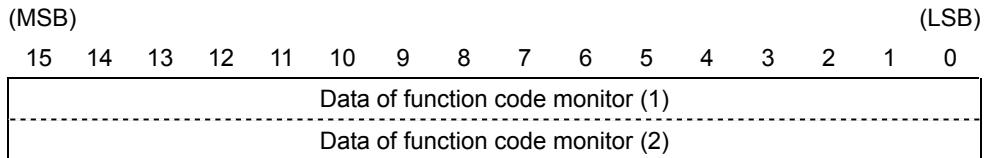
6.15.8.1 I area (MICREX-SX ← FRENIC-VG)

(1) Standard format 2 (U11 = 3)

① Polling function code address, polling function code data

(MSB)   (LSB)

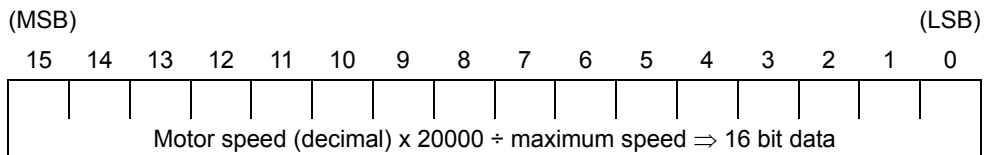| 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polling function code 485No (1)															
Polling function code 485No (2)															
Data of polling function code (1)															
Data of polling function code (2)															

The 485No corresponding to the function code in the polling request from the MICREX-SX is stored in "Polling function code 485No (1), (2)" (16 bits). The data are respectively stored in "Data of polling function code (1), (2)".

② Function code monitor

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data of function code monitor (1)															
Data of function code monitor (2)															

"Function code monitor (1), (2)" are constant monitors of function code data. Set the 485Nos. of the function codes to be monitored in function code o160 for "Function code monitor (1)" and o161 for "Function code monitor (2)".

③ Motor speed

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Motor speed (decimal) x 20000 ÷ maximum speed ⇒ 16 bit data															

The maximum speed is the speed set in inverter function code F03. To use r/min units, calculate the above equation in reverse. When the data is negative (2's complement), the command becomes a reverse speed command.

④ Operation status (1 when all are ON)

(MSB)   (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	ERR	-	RL	ALM	DEC	ACC	IL	-	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward   TL : Torque limiting   RL : Communication selection
REV : Running in reverse   (1: H30 = 2 or 3)
EXT : DC braking / pre-excitation   IL : Current limiting
INT : Inverter shutdown   ACC : Accelerating   -   (FRENIC-VG is always 0)
BRK : Braking   DEC : Decelerating   ERR : Function code access error
NUV : DC link voltage established   ALM : Alarm relay   BUSY : Writing function code

· ERR is "0" when function code selecting (writing) and polling (reading) all took place normally. If a selecting or polling operation was abnormal, ERR becomes "1"*1. The cause of the error can be checked in function code M26 (the table below). When this bit is "1", remove the cause of the error as indicated in M26 and perform selecting/polling. If all finish normally at this time, ERR and M26 automatically change to "0".

| Value of M26 (HEX.)	Write/read error
78 (4EH)	Accessed unused function code
79 (4FH)	Write to read-only function code
	Write while running to function code that cannot be changed while running
	Write to function code that cannot be changed when FWD/REV is ON
80 (50H)	Out of range data write

*1 If multiple errors occur simultaneously, the M26 error cause will be shown in the following order of priority:
Selecting (2) > Selecting (1) > Polling (2) > Polling (1).
(For example, if both selecting (2) and polling (1) are errors, the cause of the selecting (2) error will be stored in M26.)

· BUSY is "1" during data writing (processing). To successively write data, wait until this bit is "0" before writing the next data. Data written while this bit is "1" will be disregarded.

6.15.8.2 Q area (MICREX-SX → FRENIC-VG)

(1) Standard format 2 (U11 = 3)

① Selecting function code 485No, selecting function code data

(MSB) (LSB)

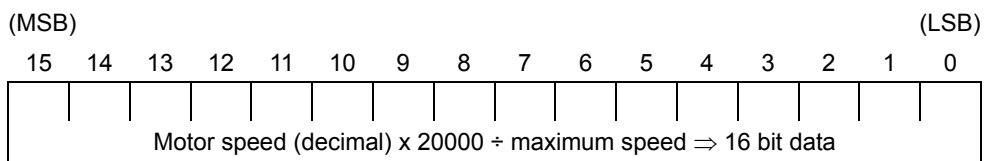| 15	14		1	0
		Selecting function code 485No (1)		
		Selecting function code 485No (2)		
		Data of selecting function code (1)		
		Data of selecting function code (2)		
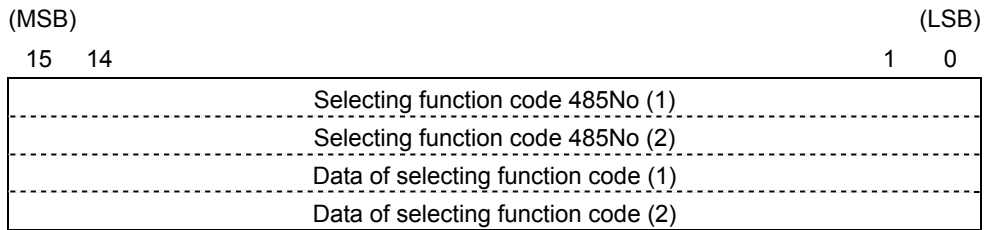
The 485No corresponding to the function code for selecting from the MICREX-SX is written to "Selecting function code 485No (1), (2)" (16 bits). At the same time, write the data respectively to "Data of selecting function code (1), (2)".

Note 1: When selecting, write the 485No. and data at the same time.

Note 2: Writing to function code F00 (485No. = 0000h) is not possible in this format. If writing is attempted, a "Write to read-only function code error" will occur and 79 (4FH) will be written to M26.
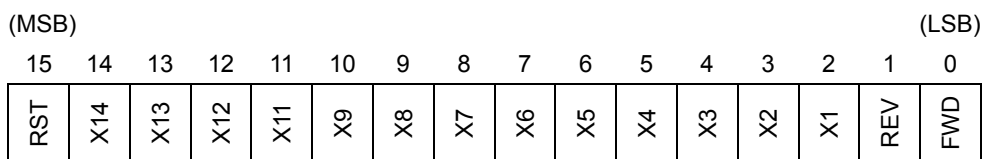
Note 3: If the same function code is set in selecting function code (1) and (2), the specification by selecting function code (2) is given priority.

② Speed command (S01)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
					Motor speed (decimal) x 20000 ÷ maximum speed ⇒ 16 bit data										

The maximum speed is the speed set in inverter function code F03. To use r/min units, calculate the above equation in reverse. When the data is negative (2's complement), the command becomes a reverse speed command.

③ Run command / Di / RESET input (S06)

(MSB) (LSB)

| 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

FWD : Run forward command   X1-X14 : Terminal input (Di)
REV : Run reverse command   RST : Reset alarm

If a link command is allowed, FWD and REV are valid. X1 to X14 and RST are always valid.

For link commands, refer to Section 6.4.9 "Link function."

④ Polling function code 485No

(MSB) (LSB)

15	14		1	0
		Polling function code 485No (1)		
		Polling function code 485No (2)		
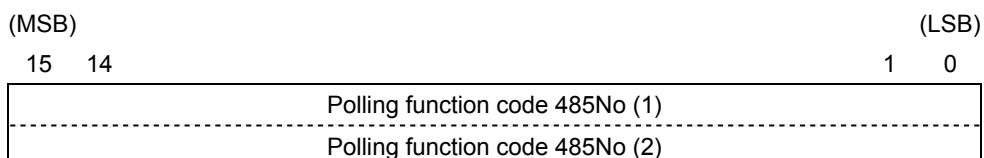
Specify the 485No corresponding to the polling request function code in "Polling function code 485No (1), (2)" (16 bits).

Chap. 6   CONTROL OPTIONS

6.15.9 Data transmission examples

Examples of data transmission using standard format 2 are described below.

Conditions
Function code U11 "SX transmission format selection" = 3, H30 "Link Operation" = 3, maximum speed: 1500 r/min,
E-SX bus station address: 10, E-SX master station address: 254, E-SX bus used

(1) Speed setting / run command

Issuing run forward (FWD) and 750 r/min speed commands from the MICREX-SX

| %QW254.0.10.12 | 2 | 7 | 1 | 0 | $750 \div 1500 \times 20000 = 10000 = 2710$(hex) |
| %QW254.0.10.13 | 0 | 0 | 0 | 1 | FWD = 1 |

(2) Method of using function code monitor

Constant monitoring from the MICREX-SX of the calculated torque value M07 and the effective output current value M11.
Set o160 = 0807 (hex) and o161 = 080B (hex) in advance.
(485No. of M07 is 0807 (hex), 485No. of M11 is 080B (hex))

↓

| %IW254.0.10.4 | 0 | 7 | 0 | A | M07 = 1388 (hex) = 5000 $\Rightarrow$ 50.00% |
| %IW254.0.10.5 | 0 | 5 | B | 4 | M11 = 05B4 (hex) = 1460 $\Rightarrow$ 146.0A |

(3) Function code data settings

Setting 30.5 s in function code S08 "acceleration time" from the MICREX-SX.

%QW254.0.10.8	0	7	0	8	Selecting of function code S08 (485No. 0708h)
%QW254.0.10.9	0	0	0	0	
%QW254.0.10.10	0	1	3	1	30.5 = 305 × 0.1s = 305 = 0131 (hex)
%QW254.0.10.11	0	0	0	0	
%QW254.0.10.12	0	0	0	0	
%QW254.0.10.13	0	0	0	0	
%QW254.0.10.14	0	7	0	8	Polling of function code S08 to confirm completion of setting

↓ After write is completed

%IW254.0.10.0	0	8	0	7	Polling response of function code S08
%IW254.0.10.1	0	0	0	0	
%IW254.0.10.2	0	1	3	1	131 (hex) = 305 × 0.1 s = 30.5 s (Indicates that data was set normally.)
%IW254.0.10.3	0	0	0	0	

(4)   Toggle monitor

Performing data toggle monitor between the MICREX-SX and inverter. This example describes how to set the X12 terminal to TGL1 and the X13 terminal to TGL2.*1

Set E11 = 72 (TGL1), E12 = 73 (TGL2), H30 = 3, and H144 = 0.10 (100 ms) in advance.

As a result,
Transmission toggle (MICREX-SX→VG1): %QW254.0.10.13 bit 12 = TGL1, bit 13 = TGL2

The inverter monitors the toggle pattern sent from the MICREX-SX while the run command is ON, and if the correct toggle signal is not received within the time set in H144, generates toggle error Ai-F.

*1   For details on toggling, refer to the E01 to E13 toggle signal section in Chapter 4, Section 4.3 "Details of Function Codes."

Inverter function code H107 can be set to display L -Ai and continue operation when an alarm occurs. Refer to the explanation of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

When F26 "Carrier frequency" is set to a value other than 4 or 8, set the tact cycle of the application that sends the MICREX-SX transmission toggle to 0.5 ms or higher.

%QW254.0.10.13 | * | 0 | 0 | 0 | $0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 0$... is sent to * (toggle pattern transmission)

↓ After toggle transmission

%QW254.0.10.13 | * | 0 | 0 | 1 | Run command (FWD) = ON

Note: If an Er-4 E-SX bus communication error (light alarm, heavy alarm 1) occurs during toggle transmission and toggle transmission is continued, an Ai-F toggle error may occur immediately after communication recovers normally. To avoid an Ai-F toggle error, stop toggle transmission when an Er-4 E-SX bus communication error occurs.

6.15.10 Synchronization of E-SX bus tact cycle and inverter control cycle

6.15.10.1 Conditions required for tact synchronization

Connecting the card to the E-SX bus makes it possible to synchronize the E-SX bus tact cycle and the inverter control cycle. By doing this, the control timing of multiple inverters can be synchronized, making it easy to implement control that requires high-accuracy timing.

However, the processing that synchronizes the inverter control cycle and the E-SX bus tact cycle requires that the following conditions (1) and (2) both be satisfied. If either condition is not satisfied, the tact cycle and inverter control cycle will operate asynchronously. When the conditions are both satisfied, synchronization is performed automatically after E-SX bus communication is established.

Table 6.15.9 Tact Synchronization Conditions

	Synchronization condition
Condition (1)	The E-SX bus tact cycle is one of the following (recommended tact cycles are underlined).*1 0.25 ms, 0.5 ms, 0.75 ms, 1 ms, 1.25 ms, 1.5 ms, 1.75 ms 2 ms, 2.5 ms, 3 ms, 3.5 ms, 4 ms, 4.5 ms, 5 ms, 5.5 ms, 6 ms 6.5 ms, 7 ms, 7.5 ms, 8 ms, 8.5 ms, 9 ms, 9.5 ms, 10 ms
Condition (2)	Inverter function code F26 "Carrier Frequency" is set to either of the following frequencies.*2 4 kHz, 8 kHz

*1 If the tact cycle is other than a recommended cycle, the control cycle timing will not be the same for multiple inverters.

*2 When F26 "Carrier Frequency" is set to other than 4 kHz or 8 kHz, set the bus tact cycle to 0.5 ms or more.

6.15.10.2 Checking the tact synchronization status

The tact synchronization status can be checked by the methods indicated in Table 6.15.10.

Table 6.15.10 Tact Synchronization Status

Method	Operation
Function of Y terminal C-Do10	Tact synchronizing: C-Do10 = ON *1
Function code M142	Tact synchronizing: M142 bit 0 = 1*2

*1 To assign C-Do10 to the Y terminal, refer to E15 to E27, Y function selection in Chapter 4, Section 4.3 "Details of Function Codes."

*2 Can be checked in the data confirmation screen of the keypad even if C-Do10 is not assigned to the Y terminal.

6.15.10.3 Action when synchronization is lost ($Ai\text{-}E$)

If synchronization is lost due to noise or other cause after the E-SX bus tact cycle and inverter control cycle are synchronized, the inverter operates as described below.

Table 6.15.11 Action When Synchronization is Lost

Error	Operation
Synchronization is lost	"$Ai\text{-}E$" (alarm sub-code 1) occurs as an E-SX bus tact synchronization error.*1 Resynchronization is performed automatically, and "$Ai\text{-}E$" reset can take place when resynchronization is completed.

*1 If the tact cycle or inverter function code F26 is changed during synchronization so that the synchronization conditions are no longer met, synchronization will be lost; however, $Ai\text{-}E$ will not occur in this case.

Note: Inverter function code H108 can be set to display $L\text{-}AL$ and continue operation when an alarm occurs. Refer to the explanation of H108 in Chapter 4, Section 4.3 "Details of Function Codes."

6.15.11 Support tool interface

6.15.11.1 Configuration definition method

The configuration definition method in the "Expert (D300win)" support tool for the inverter is explained below.

① In "E-SX bus" under "CPU" below, select the IN terminal or OUT terminal that connects the inverter, and right-click to perform "Insert".

② In the "Module insert" window, select the individual module in "Module attribute type", select the inverter in "Module group type", and select model "FRN-VG1 (STD1)" in "Outline specification".

③ Parameter settings are not necessary (parameters cannot be set). Press OK.
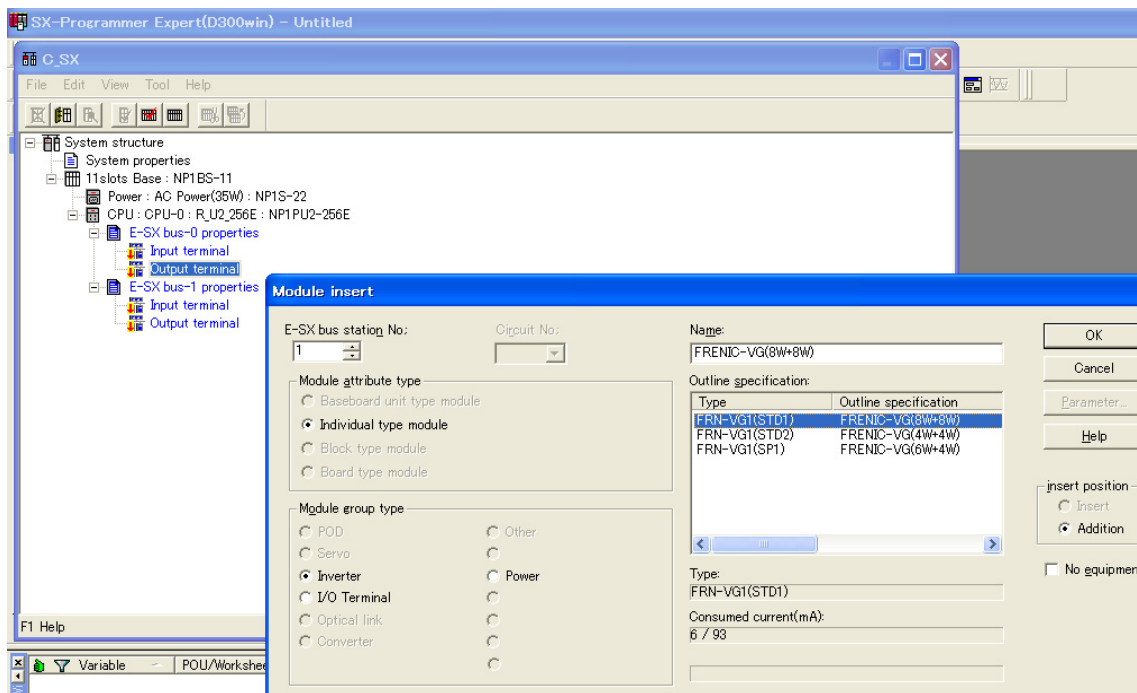
6.15.11.2 Compatible versions of the SPH3000MM and support tool

(1) Compatible versions of the inverter support tool are as follows.

・Expert (D300win) : V3.5.2.36 or later
・Standard   : V3.0.3.34 or later

(2) Compatible versions of the inverter SPH3000MM are as follows.

・Hardware   : V20 or later
・Firmware   : V02 or later

High Performance, Vector Control Inverter

FRENIC-VG

User's Manual
(Option Edition)

First Edition, March 2013

Fuji Electric Co., Ltd.

The purpose of this manual is to provide accurate information in the handling, setting up and operating of the FRENIC-VG series of inverters. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

2013-03