e-Front runners

RS485 USER'S MANUAL

FRENIC Mini SERIES

FRENIC Eco SERIES

MEH448a

FRENIC-Mini
FRENIC-Eco

User's Manual
for RS485 Communications Card

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Preface

The functions such as remote operation from the keypad and RS485 communications can be expanded using the RJ-45 connector for connecting the keypad (modular jack) and RS485 communications card (option) equipped on the inverter. This manual describes the functional expansion. For the handling of the inverter, see each User's Manual and Instruction Manual.

Please read through this user's manual to familiarize yourself with proper use. Improper handling or misuse may result in malfunction, shorter service life or failure.

The following shows relevant documents. Use the documents according to your purpose.

FRENIC-Mini

Name	Document number	Description
User's Manual	MEH446	Overview of FRENIC-Mini, how to operate the keypad, control block diagram, selection of peripherals, capacity selection, specifications, function codes, etc.
Catalog	MEH441	Overview of FRENIC-Mini, features, specifications, outline drawing, options, etc.
Instruction Manual	INR-SI47-0791-E	Inspection at the time of product arrival, installation and wiring, how to operate the keypad, troubleshooting, maintenance and inspection, specifications, etc.
RS485 communications card Installation Manual	INR-SI47-0773	Inspection at the time of arrival, how to install the product

FRENIC-Eco

Name	Document number	Description
User's Manual	MEH456	Overview of FRENIC-Eco, how to operate the keypad, control block diagram, selection of peripherals, capacity selection, specifications, function codes, etc.
Catalog	MEH442	Overview of FRENIC-Eco, features, specifications, outline drawing, options, etc.
Instruction Manual	INR-SI47-0882-E	Inspection at the time of product arrival, installation and wiring, how to operate the keypad, troubleshooting, maintenance and inspection, specifications, etc.
RS485 communications card Installation Manual	INR-SI47-0872	Inspection at the time of arrival, how to install the product

These documents are subject to revision as appropriate. Obtain the latest versions when using the product.

■ Safety Precautions

Prior to installation, connection (wiring), operation, maintenance or inspection, read through this user's manual as well as the instruction and installation manuals to ensure proper operation of the product. Familiarize yourself with all information required for proper use, including knowledge relating to the product, safety information, and precautions.

This user's manual classifies safety precautions as shown below according to the severity of the accident that may occur if you fail to observe the precaution:

⚠ 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.

⚠ CAUTION

The FRENIC-Mini/Eco is not designed for use in appliances and machinery on which lives depend. Consult Fuji before considering the FRENIC-Mini/Eco series of inverters for equipment and machinery related to nuclear power control, aerospace uses, medical uses or transportation. When the product is to be used with any machinery or equipment on which lives depend or with machinery or equipment which could cause serious loss or damage should this product malfunction or fail, ensure that appropriate safety devices and/or equipment are installed.

Wiring

⚠ WARNING

- Before starting wiring, confirm that the power is turned OFF (open).
  An electric shock may result.

⚠ CAUTION

- The product cannot be connected directly to an RS232C interface.
- Before connecting wiring to the RJ-45 connector (modular jack) for connecting the keypad, equipped on the inverter (FRENIC-Eco) or the RJ-45 connector (modular jack) on the RS485 communications card (option) (FRENIC-Mini), confirm the wiring of the device to be connected. For further information, see "2.2 Connections" under Chapter 2 of this manual.
  Failure may result.

Operation

⚠ WARNING

- Note that the inverter starts to supply power to the motor and the motor runs upon resetting of an alarm with the operation command ON (closed).
  An accident may result.

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CHAPTER 4 FUJI GENERAL-PURPOSE INVERTER PROTOCOL

CHAPTER 5 FUNCTION CODES AND DATA FORMATS

CHAPTER 1
OVERVIEW

This chapter describes the functions that can be realized by performing RS485 communications.

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1.1 Features

The functions listed below can be implemented using RS485 communications.

- The keypad can be mounted on the easy-to-access front of control panel with an extension cable (option).
- The function code data of the inverter can be edited and the operation status of the inverter can be monitored by connecting it to a personal computer on which inverter support software runs (see the "Inverter Support Software FRENIC Loader Instruction Manual").
- The inverter can be controlled as a subordinate device (slave) by connecting it to an upper level device (host (master)) such as a PLC or personal computer.

As the communication protocols for controlling inverter, the Modbus RTU widely used by a variety of appliances, and the Fuji general-purpose inverter protocol common to Fuji's inverters are available.

Modbus RTU protocol

The Modbus RTU protocol is a set of communications specifications defined to connect Modicon's PLCs (Programmable Logic Controllers) in a network. A network is established between PLCs or between a PLC and another slave unit(s) (inverter(s), etc.). The main functions include:

- supporting both a query-response format and a broadcast format for messages.
- enabling the host unit as the master to transmit queries to each inverter as a slave, and each slave to send back responses to the queries to the master.
- supporting two modes, RTU mode and ASCII mode, as transmission mode for the standard Modbus Protocol. FRENIC-Mini/Eco supports the RTU mode only, which provides a high transmission density.
- performing an error check through a CRC (cyclic redundancy check) to ensure accurate data transmission.

Fuji general-purpose inverter protocol

This protocol is commonly used for all models of Fuji's general-purpose inverters. The main functions include:

- enabling, as a common protocol, operation of all models of Fuji's general-purpose inverters with the same host program (function codes cannot be generally edited because specifications are different among models).
- adopting fixed-length transmission frames as standard frames to facilitate developing communication control programs for hosts.
- reducing the communications time in response to operation commands and frequency setting which are required quick response by using optional transmission frames.

CAUTION

- Since the protocol switches to the keypad dedicated protocol automatically by connecting the keypad, it is not necessary to set up the communications- related functions.
- Although the personal computer loader uses a dedicated protocol for loader commands, part of the communications conditions must be set. (For further information, see the "Inverter Support Software FRENIC Loader Instruction Manual (INR-S147-0903-E).")
- With regard to a FRENIC-Mini that uses inverter ROM 0399 or earlier version, part of the RTU protocol functions are restricted. Contact us for these restrictions.
  Confirm the ROM version according to the menu "*5_14*" described in "3.2.2 [5] Reading Maintenance Information" under Chapter 3 of the FRENIC-Mini Instruction Manual (INR-SI47-0791-E).

1.2 Differences in the Inverter Series

RS485 communications is supported differently depending on the model of the inverter series.

Table 1.1 Differences in the inverter series

<table>
<tr><th rowspan="2">Series</th><th rowspan="2">Support method</th><th rowspan="2">Connector</th><th colspan="4">Supported functions*3</th></tr>
<tr><th>Keypad*1</th><th>Inverter support loader software</th><th>Modbus RTU*2</th><th>Fuji general-purpose inverter protocol</th></tr>
<tr><td>FRENIC-Mini</td><td>RS485 communications card (option)</td><td>RJ-45 connector</td><td>Only remote keypad is supported</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td rowspan="2">FRENIC-Eco</td><td>Connector for a keypad on the inverter</td><td>RJ-45 connector</td><td>○</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>RS485 communications card*4 (option)</td><td>Terminal block</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
</table>

*1 FRENIC-Mini supports the remote keypad (TP-E1: option) only. For FRENIC-Eco, the keypad is mounted on the inverter as the standard equipment. In addition, the multi-function keypad can also be connected as an option.

*2 The Modbus RTU of FRENIC-Eco supports coil commands unlike the Modbus RTU of FRENIC-Mini. For details, refer to chapter 3 "Modbus RTU Protocol."

*3 Each supported function has a different support scope depending on the inverter series, for example, data monitored by the keypad, loader function, and accessible function codes. For details, refer to the manual of each supported function.

*4 Use function codes y11 to y20 for communications setting of the RS485 communications card (option) of FRENIC-Eco.

1.3 List of Functions

The functions listed below become available by operating the appropriate function codes from the host controller.

The chapters that follow describe these functions in detail.

Table 1.2 List of RS485 communications functions

Function	Description	Related function code
Operation	The functions equivalent to the terminal functions shown below can be executed through communications: -Forward operation command "FWD" and reverse operation command "REV" -Digital input commands ([FWD], [REV], [X1] - [X5] terminals) ([X4] and [X5] are not supported by FRENIC-Mini.) -Alarm reset command ("RST")	S codes (dedicated to communi-cations)
Frequency setting	Either of the following two setting methods can be selected: -Set up as "±20000/maximum output frequency." -Frequency (adjustable unit: 0.01 Hz) without polarity	
PID command	-Set up as "±20000/100%."	
Operation monitor	The items below can be monitored: -Frequency command -Actual values (frequency, current, voltage, etc.) -Operation status, information on general-purpose output terminals, etc.	M codes
Maintenance monitor	The items below can be monitored: -Cumulative operation time, DC link voltage -Information to determine the service life of parts to be periodically replaced (main circuit capacitor, PC board capacitor, cooling fan) -Model codes, capacity codes, ROM version, etc.	W codes X codes Z codes
Alarm monitor	The items below can be monitored: -Monitoring alarm history (last four alarms) -Monitoring information when an alarm occurs (last four alarms) Operation information (output/set frequencies, current, voltage, etc.) Operation status, information on general-purpose output terminals Maintenance information (cumulative operation time, DC link voltage, heat sink temperature, etc.)	(dedicated to communica-tions)
Function code	All types of function code data can be monitored and changed.	All function codes other than above

CHAPTER 2
COMMON SPECIFICATIONS

This chapter describes the specifications common to the Modbus RTU protocol, Fuji general-purpose inverter protocol, and loader protocol. For further information about the specific specifications of each protocol, see Chapter 3 "Modbus RTU Protocol" and Chapter 4 "Fuji General-purpose Inverter Protocol."

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2.1 Specifications of RS485 Communications

Table 2.1 shows the specifications of RS485 communications.

Table 2.1 RS485 communications specifications

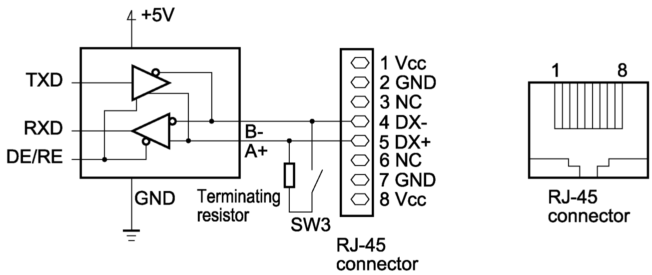
Item	Specification		
Protocol	FGI-BUS	Modbus RTU	Loader commands
Complying with	Fuji general-purpose inverter protocol	Modicon Modbus RTU-compliant (only in RTU mode only)	Special commands dedicated to inverter support loader software (not disclosed)
No. of supporting stations	Host device: 1 Inverters: up to 31		
Physical level	EIA /RS485		
Connection to RS485	Connect using an 8-wire RJ-45 connector or terminal block		8-wire RJ-45 connector
Synchronization method of character	Start-Stop system		
Transmission mode	Half-duplex		
Transmission speed (bps)	2400, 4800, 9600, 19200 and 38400 (maximum 19200 for FRENIC-Mini)		
Maximum transmission cable length	500m		
No. of available station addresses	1 to 31	1 to 247	1 to 255
Message frame format	FGI-BUS	Modbus RTU	Loader command
Synchronization method of transmission frames	Detection SOH (Start Of Header) character	Detection of no-data transmission time for 3 byte period	Start code 96H detection
Frame length	Normal transmission: 16 bytes (fixed) High-speed transmission: 8 or 12 bytes	Variable length	Variable length
Maximum transfer data	Write: 1 word Read: 1 word	Write: 50 words Read: 50 words	Write: 41 words Read: 41 words
Messaging system	Polling/Selecting/Broadcast		Command message
Transmission character format	ASCII	Binary	Binary
Character length	8 or 7 bits (selectable by the function code)	8 bits (fixed)	8 bits (fixed)
Parity	Even, Odd, or None (selectable by the function code)		Even
Stop bit length	1 or 2 bits (selectable by the function code)	No parity: 2 bits Even or Odd parity: 1 bit	1 bit (fixed)
Error checking	Sum-check	CRC-16	Sum-check

2.1.1 Specification of the RJ-45 connector for RS485 communications (modular jack)

The RS485 communications port of the FRENIC-Mini's RS485 communications card (option) and the RS485 communications port for connecting the keypad equipped on the FRENIC-Eco are the RJ-45 connectors with the pin assignment shown below.

Pin No.	Signal name	Function	Remarks
1, 8	Vcc	Power source for the keypad	5V
2, 7	GND	Reference voltage level	Ground (0V)
3, 6	NC	No connection	–
4	DX-	RS485 communications data (-)	A terminating resistor of 112Ω is incorporated. Connection/ cut off is selected by a switch*.
5	DX+	RS485 communications data (+)	

* For the details of the switch, refer to 2.2.2 [2] “About terminating resistors”.



CAUTION A power supply for the keypad is connected to the RJ-45 connector for RS485 communications (via pins 1, 2, 7, and 8). Note that the pins assigned to the power supply must not be connected when connecting the inverter with another device.

2.1.2 Specification of connection cable

The specification of the connection cable is as follows to ensure the reliability of connection.

	Specification
Common specification	Straight cable for 10BASE-T/100BASE-TX, satisfying the US ANSI/TIA/EIA-568A category 5 standard (commercial LAN cable)
Extension cable for remote operations (CB-5S)	Same as above, 8-core, 5m long, RJ-45 connector (both ends)
Extension cable for remote operations (CB-3S)	Same as above, 8-core, 3m long, RJ-45 connector (both ends)
Extension cable for remote operations (CB-1S)	Same as above, 8-core, 1m long, RJ-45 connector (both ends)

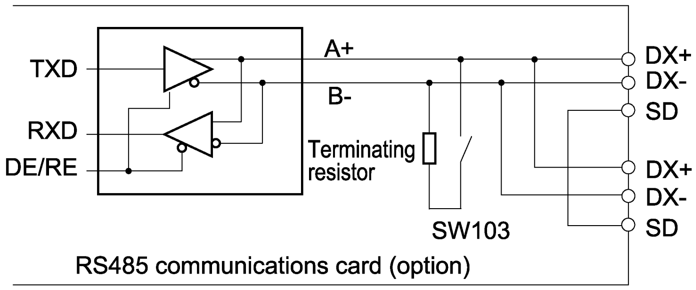
To connect a keypad, use an 8-core straight cable. Use an extension cable for remote operations (CB-5S, CB-3S, or CB-1S) or a commercial LAN* cable (20m max.).

2.1.3 Specification of the terminal for RS485 communications

FRENIC-Eco's RS485 communications card is equipped with a pair of terminals for multidrop. The terminal symbols, terminal names, and functions of the respective terminals are as shown in the table below.

Terminal symbol		Terminal name	Function description
1	DX+	RS485 communications data (+) terminal	This is the (+) terminal of RS485 communication data.
	DX–	RS485 communications data (-) terminal	This is the (–) terminal of RS485 communication data.
	SD	Communications cable shield terminal	This is the terminal for relaying the shield of the shielded cable, insulated from other circuits.
2	DX+	DX+ relay terminal for multidrop	This is the relay terminal of RS485 communications data (+).
	DX–	DX- relay terminal for multidrop	This is the relay terminal of RS485 communications data (-).
	SD	SD relay terminal for multidrop	This is the terminal for relaying the shield of the shielded cable, insulated from other circuits.
Internal switch		Terminating resistor switching	A terminating resistor of 112Ω is incorporated. Connection/release is switched by this switch*.

* For the details of the switch, see section 2.2.1 "Basic connection diagrams."



2.1.4 Specification of connection cable for RS485 terminal

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

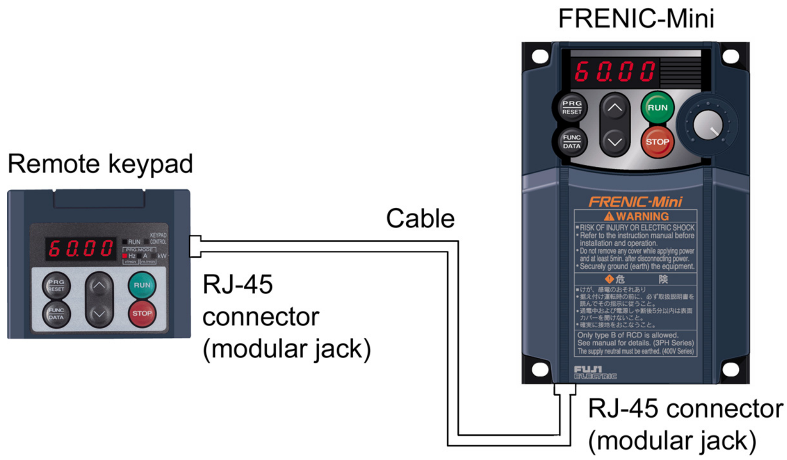
2.2 Connections

2.2.1 Basic connection

When connecting the keypad with the inverter or connecting the inverter with a host such as personal computer or PLC, use a standard LAN cable (straight for 10BASE-T). A converter is necessary to connect a host not equipped with RS485 interface.

(1) Connection with the keypad

FRENIC-Mini:



FRENIC-Eco:

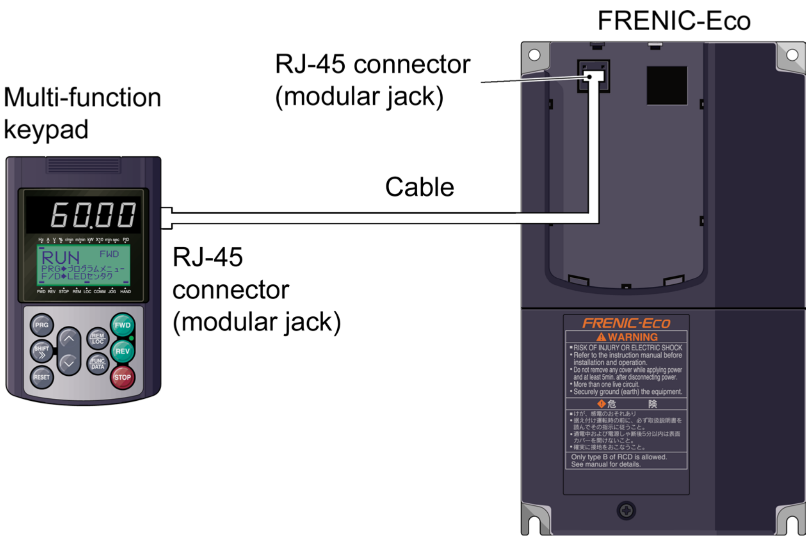


Figure 2.1 Connection with the keypad

Cable: extension cable for remote operations (CB-5S, CB-3S, or CB-1S) or commercial LAN cable

CAUTION
- For the keypad, be sure to turn off the terminating resistor.
- Keep wiring length 20m or less.
- For FRENIC-Mini, only the remote keypad is available. In addition, the RS485 communications card (option) is necessary for connection.

(2) Connection with a personal computer (when connecting with the USB port via a recommended converter)

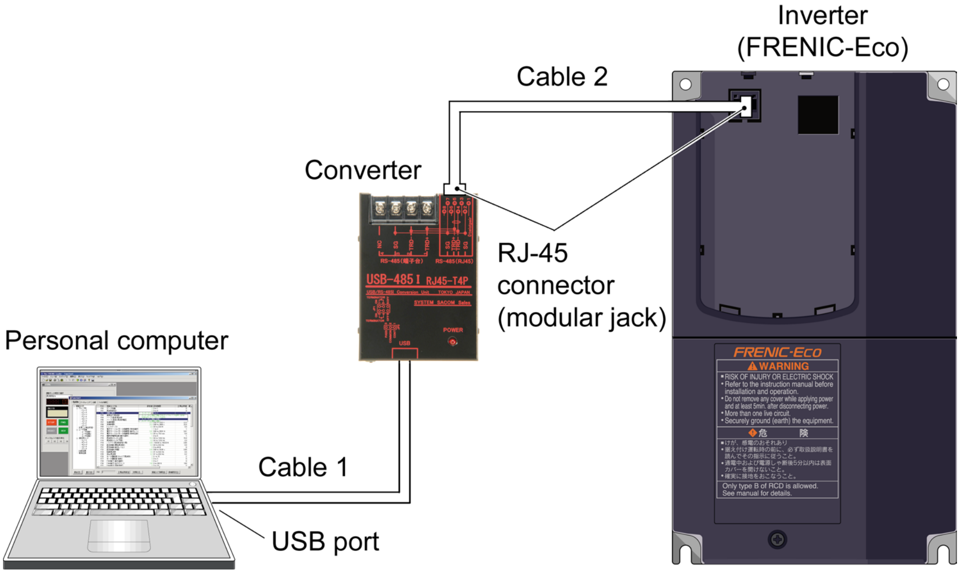


Figure 2.2 Connection with a personal computer

Converter: USB-485I, RJ45-T4P (System Sacom Sales Corp., Japan)

Cable 1: USB cable supplied with the converter

Cable 2: extension cable for remote operations (CB-5S, CB-3S, or CB-1S) or commercial LAN cable

CAUTION For FRENIC-Mini, the RS485 communications card (option) is necessary for connection.

(3) Example of typical connection other than above (Multidrop connection using the RJ-45 connector)

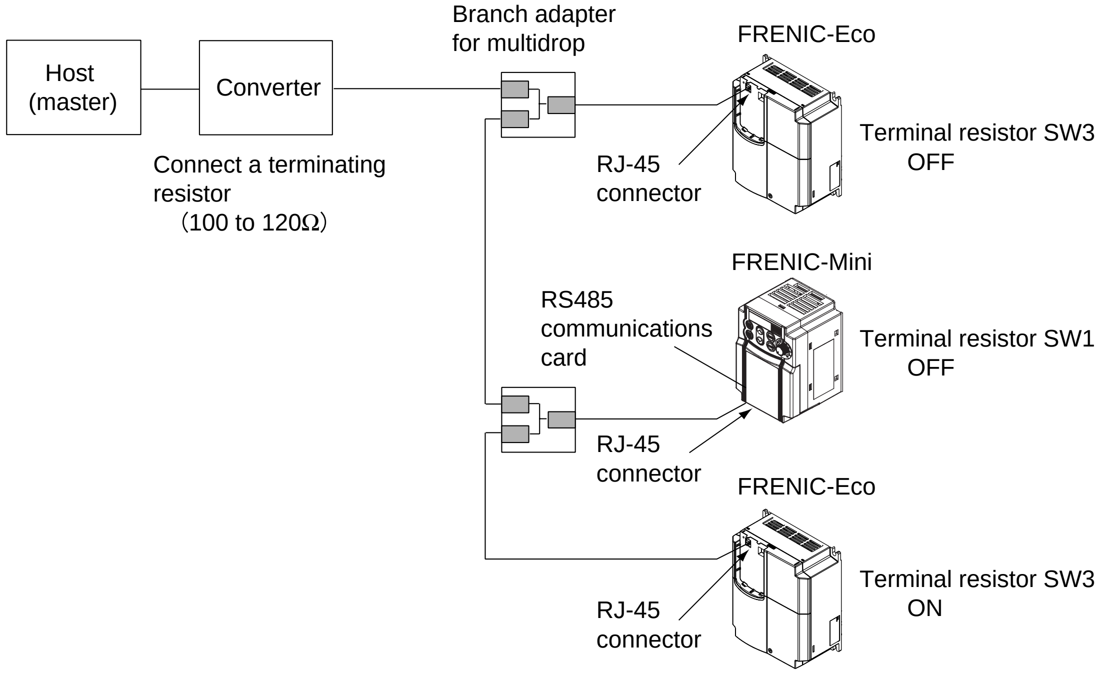


Figure 2.3 Multidrop connection diagram (connection via the RJ-45 connector)

Converter:	Not necessary if the host is equipped with RS485 interface.
Branch adapter for multidrop:	Useful when implementing 1:n multidrop configuration using a cable with a RJ-45 connector.
Cable:	Use a connection cable meeting the specification. (Refer to 2.1.4.)

CAUTION

- A power supply for the keypad is connected to the RJ-45 connector of the inverter (via pins 1, 2, 7, and 8). When connecting the inverter with another device, do not use the pins assigned to the power supply but use the signal pins (pins 4 and 5).
- When selecting additional devices to prevent the damage or malfunction of the control PCB caused by external noises or eliminate the influence of common mode noises, be sure to see section 2.2.3 "Devices for connection."
- Keep the total wiring length 500m max.
- For FRENIC-Mini, the RS485 communications card (option) is necessary for connection.

(4) Multidrop connection using terminal block

When using the RS485 communication card (option) to connect FRENIC-Eco with a host by multidrop connection, connect them as shown in the figure below. Turn on the SW103 switch for inserting a terminating resistance, equipped on the RS485 communications card (option) mounted on the inverter used as the terminator.

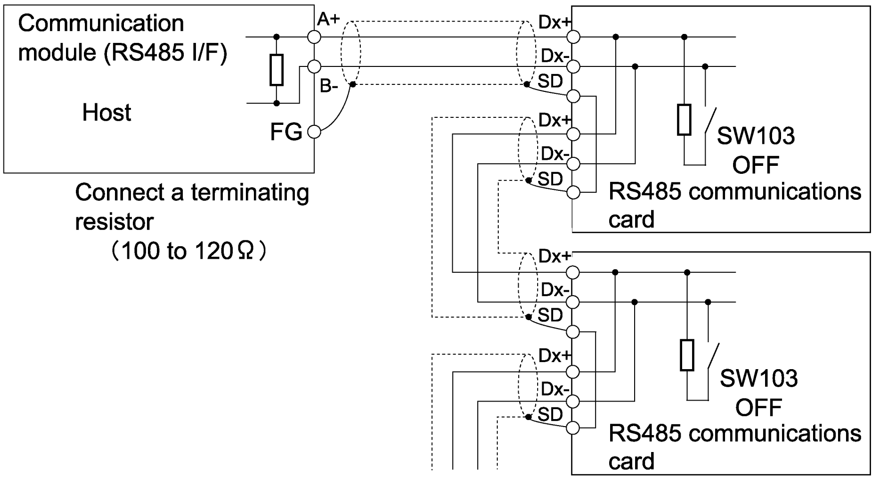


Figure 2.4 Multidrop connection diagram (terminal block connection)

For the details of SW103, see "RS485 Communications Card Installation Manual (INR-SI47-0872)."

CAUTION
- When selecting additional devices to prevent the damage or malfunction of the control PCB caused by external noises or eliminate the influence of common mode noises, be sure to see section 2.2.3 "Devices for connection."
- Keep the total wiring length 500m max.

2.2.2 Connection procedures

This section describes the knowledge necessary for connecting with a host.

[1] RJ-45 connector (modular jack) pin layout

To facilitate connection with a typical RS232C to RS485 converter, the FRENIC-Mini/Eco assigned pin No. 4 to DX- signals and pin No. 5 to DX+ signals.

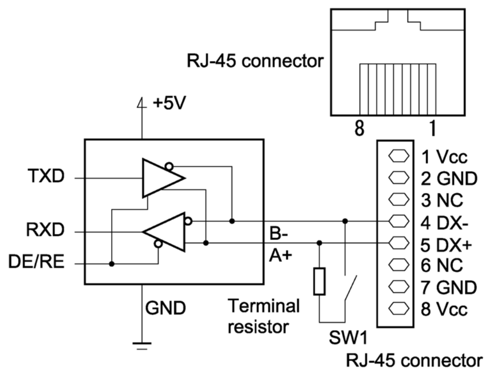


Figure 2.5 Pin layout of RJ-45 connector

CAUTION
- Pins 1, 2, 7, and 8 are assigned to the power supply for the keypad. Do not use these pins when connecting the inverter with another device via the RJ-45 connector but use signal pins (pins 4 and 5) only.
- To connect the FVR-E11S series inverter on the communications network on which the FRENIC-Mini/Eco exists, pin Nos. 3 and 5 must be switched using a connection cable, etc. Table 2.2 makes a comparison of pin layout between the FRENIC-Mini/Eco and the FVR-E11S series.

Table 2.2 Comparison of pin layout between the FRENIC-Mini/Eco and the FVR-E11S

Pin No.	FRENIC-Mini/Eco	FVR-E11S	Remarks
1	VCC (+5V)	SEL_TP (keypad selected)	The power supply is short-circuited when connected.
2	GND	GND	
3	NC	DX+	
4	DX-	DX-	
5	DX+	SEL_ANY (optional)	
6	NC	GND	
7	GND	VCC	The power supply is short-circuited when connected.
8	VCC (+5V)	VCC	The power supply is short-circuited when connected.

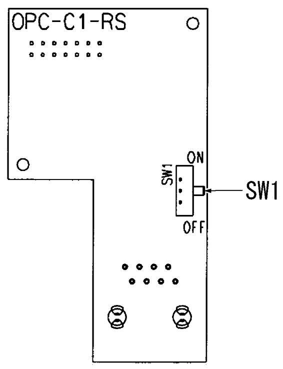
[2] About terminating resistors

Insert a terminating resistor (100 to 120Ω) into both the ends of the connection cable. This allows controlling signal reflection and reducing noises.

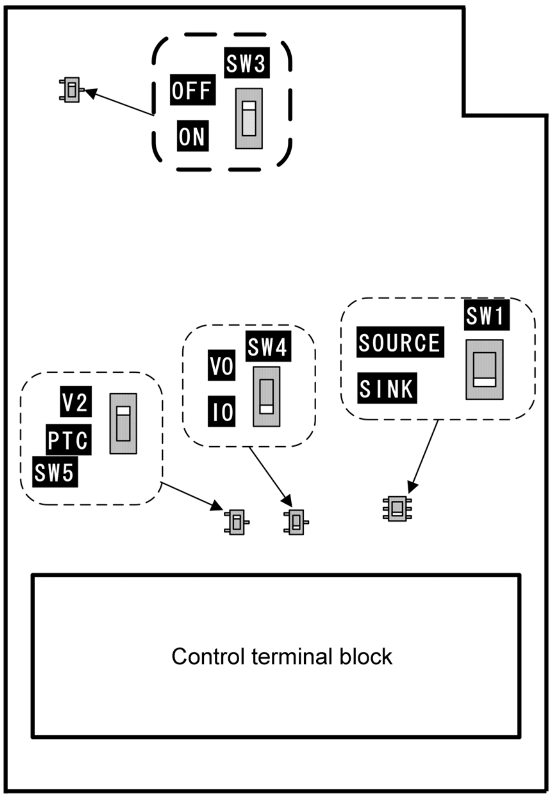
Be sure to insert a terminating resistor into the terminating host side and the side of the device connected to the final stage, in short, both the terminating devices configuring the network. Terminating resistors are inserted into total two positions. Note that the current capacity of signals may be insufficient if terminating resistors are inserted into three or more devices.

If the inverter is used as a terminating device, turn on the switch for terminal resistor insertion.

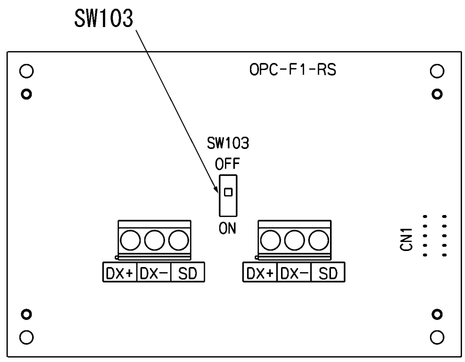
Model	Objective PCB	Switch No.	Layout
FRENIC-Mini	RS485 communications card	SW1	See Figure 2.6(a).
FRENIC-Eco	Control PCB of inverter	SW3	See Figure 2.6(b).
	RS485 communications card	SW103	See Figure 2.6(c).



(a) RS485 communications card
(for FRENIC-Mini)



(b) Control PCB (FRENIC-Eco)



(c) RS485 communications card
(for FRENIC-Eco)

Figure 2.6 Layout of the switches for inserting a terminating resistance

[3] Connection with a four-wire host

Although FRENIC-Mini/Eco uses two-wire cables, some hosts adopt only four-wire cables. Connect to such a host by connecting the driver output with the receiver input with a crossover cable on the host side to change the wiring method to two-wire.

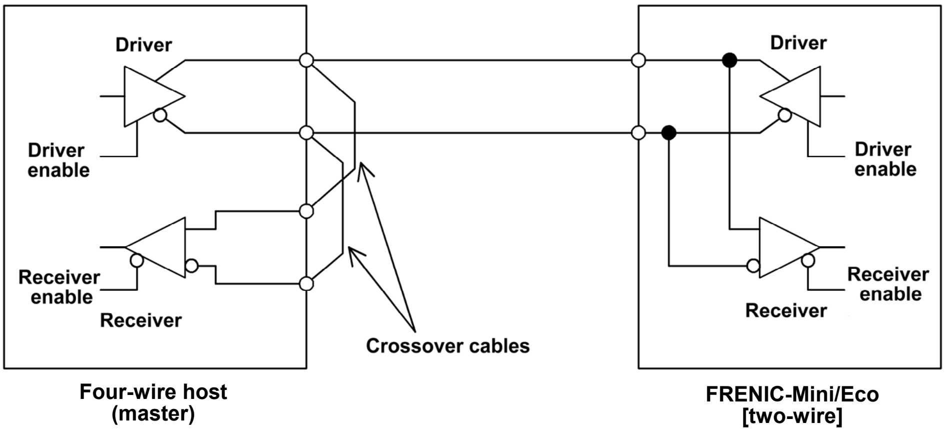


Figure 2.7 Connection with a four-wire host

CAUTION

- The driver circuit on the host side must have a function to set the driver output to high impedance (driver enable: OFF). Though products conforming to RS485 normally has this function, check the specifications of the host.
- Keep the output of the driver circuit on the host side in the status of high impedance except when the host is transmitting data (driver enable: OFF).
- Keep the receiver circuit of the host device deactivated (receiver enable: OFF) while the host is transmitting data to prevent the host from receiving the data it transmitted. If the receiver cannot be deactivated, program the host so that the data transmitted by the host is discarded.

2.2.3 Devices for connection

This section describes the devices necessary for connecting a host not equipped with RS485 interface, such as a personal computer, or for multidrop connection.

[1] Converter

In general, personal computers are not equipped with an RS485 port. An RS232C to RS485 converter or USB to RS485 converter is therefore required. Use a converter meeting the following recommended specifications for proper operation. Note that proper performance may not be expected from a converter other than the recommended one.

Specifications of the recommended converter

Transmission/receiving switching system: Automatic switching by monitoring transmission data on the personal computer side (RS232C)

Isolation: The RS232C side of the converter must be isolated from the RS485 side.

Failsafe: Equipped with a failsafe function (*)

Other requirements: The converter must have enough noise immunity for successful communications.

* The failsafe function means a function that keeps the RS485 receiver's output at high logic level even when the RS485 receiver's input is open or short-circuited or when all the RS485 drivers are inactive.

Recommended converter

System Sacom Sales Corporation (Japan) : KS-485PTI (RS232C to RS485 converter)
: USB-485I RJ45-T4P (USB to RS485 converter)

Transmission/receiving switching system

Since RS485 communications adopts the half-duplex system (two-wire system), the converter must have a transmission/receiving switching function. The following two systems are available as the switching system.

(1) Automatic turnaround of the transceiver buffer

(2) RTS- or DTR- controlled turnaround of the transceiver buffer

When a personal computer for inverter loader has Microsoft Windows 98 or older operating system, the switch system of (2) above is not supported.

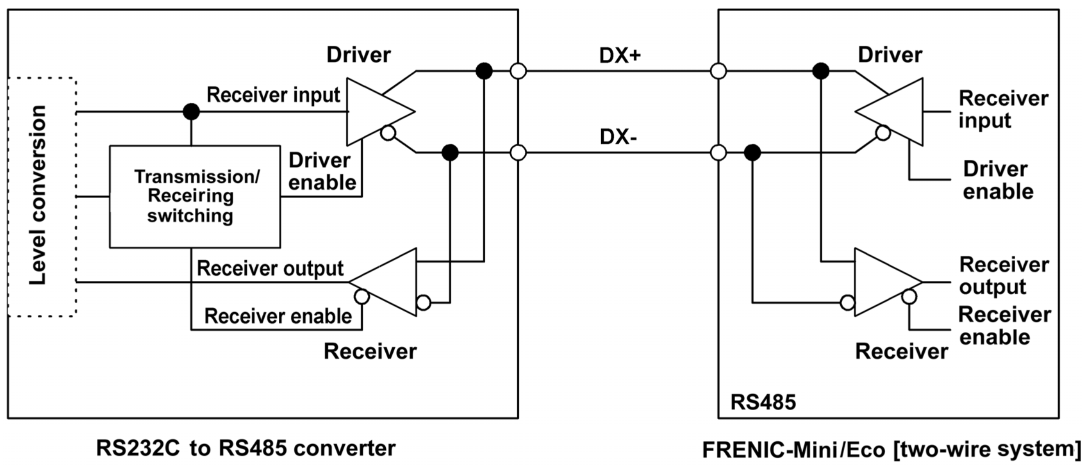


Figure 2.8 Communications level conversion

[2] Branch adapter for multidrop

When a slave unit has only 1 port of RJ-45 connector (moduler jack), a branch adaptor is necessary for multidrop connection using standard LAN cables.

Recommended branch adapter

SK Kohki (Japan): MS8-BA-JJJ

2.2.4 Measures against noise

Depending on the operating environment, normal communications cannot be performed or instruments and converters on the host side may malfunction due to the noise generated by the inverter. This section describes measures to be taken against such problems. Consult Appendix A "Advantageous Use of Inverters (Notes on electrical noise)" in "FRENIC-Mini User's Manual (MEH446)" or "FRENIC-Eco User's Manual (MEH456)."

[1] Measures for devices subjected to noise

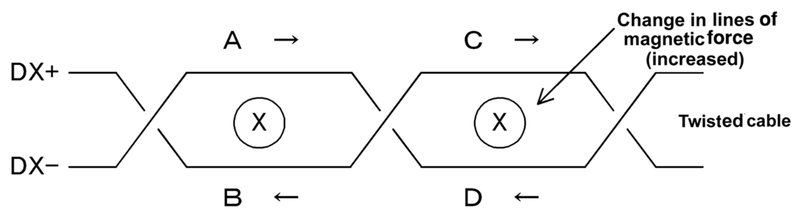
Using an isolated converter

An isolated converter suppresses common mode noise that exceeds the specified operating voltage range of the receiver in case of long-distance wiring. However, since the isolated converter itself may malfunction, use a converter insusceptible to noise.

Using a category 5 compliant LAN cable

Category 5 compliant LAN cables are generally used for RS485 communications wiring. To obtain an improved preventive effect on electromagnetically induced noise, use Category 5 conformed LAN cables with four twisted-pair-cores and apply one twisted pair, DX+ and DX-. To ensure a high preventive effect on electrostatically induced noise, use Category 5 conformed LAN cables with four shielded-and-twisted-pair-cores, and ground the shield at the master-side end.

Effect of twisted pair cables



A uniform magnetic flux directing from the face to back of the paper exists, and if it increases, electromotive force in the direction of → is generated. The electromotive forces of A to D are the same in intensity, and their directions are as shown in the above figure. In the cable DX+, the direction of electromotive forces B is reverse to that of electromotive force C, then the electromotive forces B and C offset each other, and so do electromotive forces A and D in the cable DX-. So, normal mode noise caused by electromagnetic induction does not occur. However, noise cannot be completely suppressed under such conditions as an uneven twist pitch. Thus, noise is eliminated in twisted cables but normal mode noise occurs in parallel cable.

Shield effect

1) When the shield is not grounded,
   the shield functions as an antenna and receives noise.
2) When the shield is grounded at both ends,
   if the grounding points are separated from each other, the ground potential may be different between them, and the shield and the ground form a loop circuit in which a current flows and may cause noise. Additionally, the magnetic flux within the loop may vary and generate noise.
3) When the shield is grounded at either end,
   the effect of electrostatic induction can be completely eliminated within the shielded section.

Connecting terminating resistors

Insert a resistor equivalent to the characteristic impedance of the cables (100 to 120Ω) into both end terminals of the wiring (network) to prevent ringing due to the reflection of signals.

Separating the wiring

Separate the power lines (input L1/R, L2/S, and L3/T and output U, V, and W) from the RS485 communications line, because induced noise can be prevented.

Separating the grounding

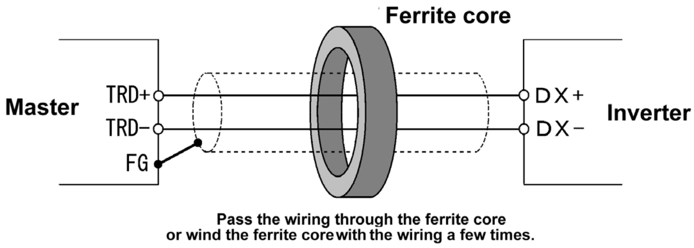
Do not ground instruments and the inverter together. Noise may conduct through the grounding wire. Use as a thick wire as possible for grounding.

Isolating the power supply

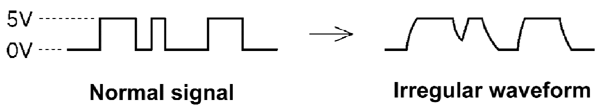
Noise may carry through the power supply line to instruments. It is recommended that the distribution system be separated or a power isolation transformer (TRAFY) or noise suppression transformer be used to isolate the power supply for such instruments from the power supply for the inverter.

Adding inductance

Insert a chalk coil in series in the signal circuit, or pass the signal wiring through a ferrite core, as shown in the figure below. This provides the wiring higher impedance against high-frequency noise, and suppresses the propagation of high-frequency noise.



CAUTION If an inductance is added, the signal waveform may become irregular and a transmission error may result during communications at a high baud rate. In this case, reduce the baud rate by changing the setting of function code y04.



[2] Measures against noise sources

Reducing carrier frequency

By lowering data of function code F26 "motor sound (carrier frequency)," the noise level can be reduced. However, reducing the carrier frequency increases the motor sound.

Installing and wiring an inverter

Passing the power lines through metal conduit or adopting metal control panels can suppress radiation or induction noise.

Isolating the power supply

Using a power isolation transformer on the line side of the inverter can cut off the propagation (transmission) of noise.

[3] Additional measures to reduce the noise level

Consider using a zero-phase reactor or EMC compliance filter. The measures described in [1] and [2] above can generally prevent noise. However, if the noise does not decrease to the permissible level, consider additional measures to reduce the noise level. For further information, see "6.4.1 Peripheral Equipment Options" under Chapter 6 of the FRENIC-Mini User's Manual (MEH446) or FRENIC-Eco User's Manual (MEH456).

2.3 Switching to Communications

2.3.1 Functions for the switching

Figure 2.9 below shows a block diagram via communications for frequency setting and operation commands.

This block diagram indicates only the base of the switching section, and some settings may be given higher priority than the blocks shown in this diagram or details may be different due to functional expansion and so on. For details, see chapter 4 "Control Block Diagram" in the "FRENIC-Mini User's Manual (MEH446)" or "FRENIC-Eco User's Manual (MEH456)."

CAUTION Operation commands herein include digital input signals via communications.

According to the setting of function code H30 link function (operation selection), the command system when communications is valid is selected.

Even if digital input is set to link enable (LE), when the link becomes invalid ("LE" = OFF), the command system switches from communications to other settings including digital input signal. In short, the frequency setting, forward operation command, and X1 signal in Figure 2.9 switch from communications dedicated function codes S01, S05, and S06 to terminals [12], [FWD], and [X1], respectively.

Function code data can be read and written through communications regardless of the setting function code H30 (link function (operation selection)).

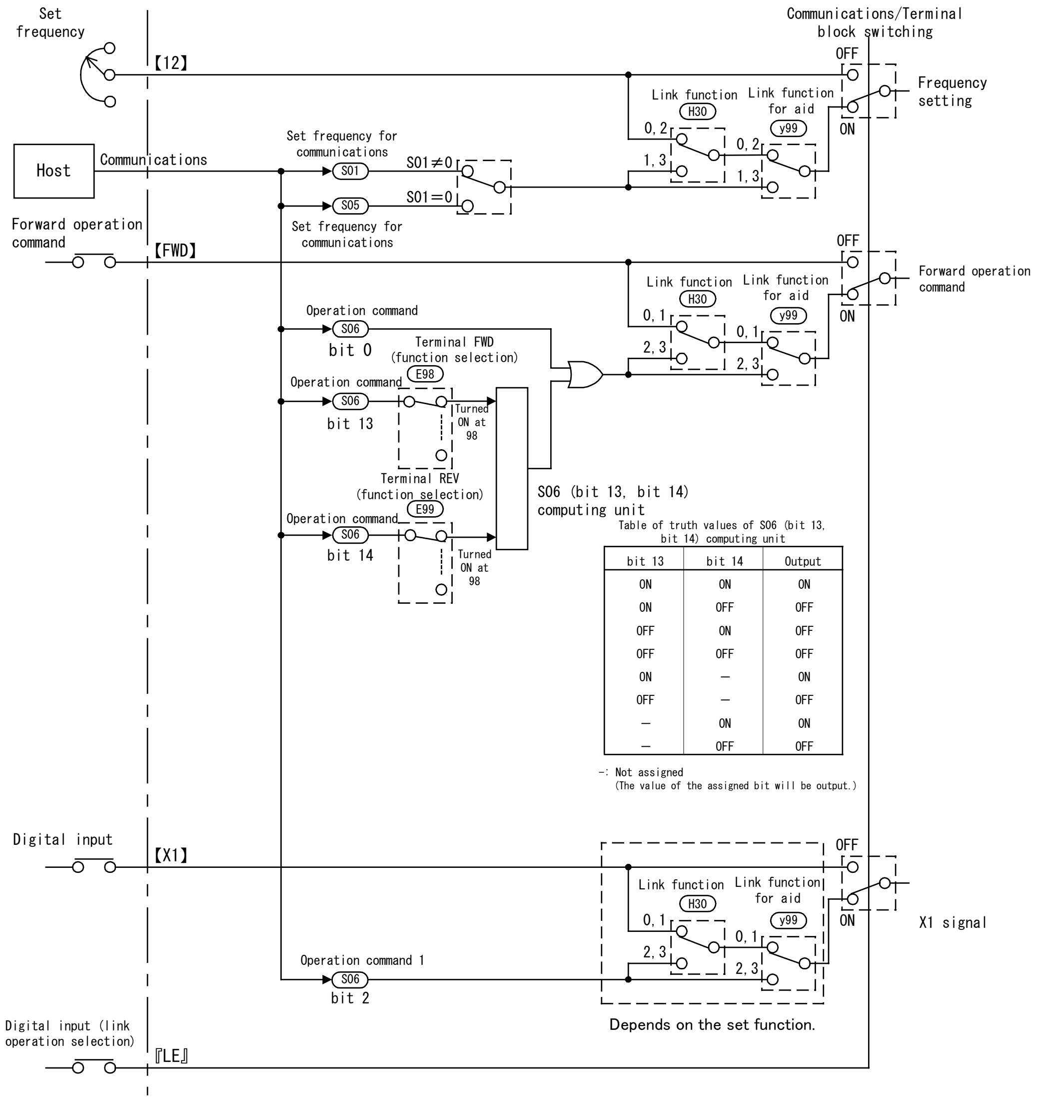


Table of truth values of S06 (bit 13, bit 14) computing unit

bit 13	bit 14	Output
ON	ON	ON
ON	OFF	OFF
OFF	ON	OFF
OFF	OFF	OFF
ON	—	ON
OFF	—	OFF
—	ON	ON
—	OFF	OFF

-: Not assigned
(The value of the assigned bit will be output.)

Figure 2.9 Operation command block diagram via communications

2.3.2 Link functions (operation selection)

According to the setting of function code H30: Serial link (function select), the frequency setting and the operation command source (via-communications command or command selected by function codes F01/C30 and F02 when communications is valid can be selected.

Table 2.3 Link function H30 (operation selection)

<table>
<tr><th rowspan="2">Data of link function H30</th><th colspan="2">When communications are valid</th><th colspan="2">Support</th></tr>
<tr><th>Frequency setting</th><th>Operation command</th><th>Mini</th><th>Eco</th></tr>
<tr><td>0</td><td>F01/C30, F02</td><td>F01/C30, F02</td><td rowspan="4">Supported</td><td rowspan="9">Supported</td></tr>
<tr><td>1</td><td>Through RS485 communications</td><td>F01/C30, F02</td></tr>
<tr><td>2</td><td>F01/C30, F02</td><td>Through RS485 communications</td></tr>
<tr><td>3</td><td>Through RS485 communications</td><td>Through RS485 communications</td></tr>
<tr><td>4</td><td>Through RS485 (option) communications</td><td>F01/C30, F02</td><td rowspan="5">Not supported</td></tr>
<tr><td>5</td><td>Through RS485 (option) communications</td><td>Through RS485 communications</td></tr>
<tr><td>6</td><td>F01/C30, F02</td><td>Through RS485 (option) communications</td></tr>
<tr><td>7</td><td>Through RS485 communications</td><td>Through RS485 (option) communications</td></tr>
<tr><td>8</td><td>Through RS485 (option) communications</td><td>Through RS485 (option) communications</td></tr>
</table>

FRENIC-Mini supports data 0 to 3 only. FRENIC-Mini's RS485 communications card supports data 1 to 3 through RS485 communications.

HINT By selecting continuous communications valid without setting any digital input terminal, and switching the data of H30 to communications valid/invalid (external signal input valid), communications valid/invalid can be switched in the same manner as switching at the digital input terminal. See the next section or later.

2.3.3 How to switch communications enabled/disabled

To issue a frequency setting or operation command through communications to control the inverter, select "Through RS485 communications" by function code H30: link function (operation selection).

In addition, when switching control through communications with control from the terminal block (frequency setting from terminal [12], operation command from terminal [FWD] and so on) to switch remote operations with operations on the inverter body, assign "link operation selection" (data = 24: "LE") to the function code related to the digital input terminal (one of E01-E05: terminals [X1] to [X5], E98: terminal [FWD], or E99: terminal [REV]). (FRENIC-Mini does not support E04, E05, [X4], and [X5].) Control can be switched by the terminal to which "link operation selection" (data = 24: "LE") is assigned.

Communications automatically becomes valid when link operation selection is not assigned to any digital input terminal.

Table 2.4 Digital input terminal settings and communications statuses

Input terminal	Status
OFF	Communications invalid
ON (short-circuited to the terminal [CM])	Communications valid

CAUTION

- Via-communications command data and operation data must be rewritten from the host (controller) because the memory is initialized when the power is turned ON.
- Although command data and operation data can be written even if communications is invalid, they will not be validated because the switch is made invalid by link operation selection. If communications is made valid with no operation data written (operation command OFF, frequency setting = 0Hz) during operation, the running motor decelerates to a stop and may exert impact on the load depending on the set deceleration time. Operation can be switched without causing impact to the load by setting data in communications invalid mode in advance and then switching the mode to valid.
- If negative logic is set as Link enable (data 1024), the logical value corresponding to the ON/OFF status of the command "LE" will be reversed.
- FRENIC-Eco has the field bus option other than RS485 communications. The field bus option is handled prior to RS485 communications depending on the setting of it in some cases. For details, refer to "FRENIC-Eco User's Manual (MEH456)."

2.3.4 Link functions for supporting data input (operation select)

According to the setting of function code y99: link function for supporting data input (operation select), the frequency setting and the operation command source (via-communications command or command specified by function code H30 and y98) when communications is valid can be selected individually.

CAUTION
- This function code is designed for inverter support software for personal computer loaders such as FRENIC Loader, and forcibly makes communications valid without changing the setting of H30. Do not change the current setting unless otherwise required.
- FRENIC-Mini operates in the same way as y99 is set to 0 even if y99 is set 1, 2, or 3 when this function code is changed from the keypad. When setting a value other than 0, the value of y99 must be written through communications.
- The data of this function code cannot be saved in the inverter and will return to 0 when the power supply is turned off.

Table 2.5 Link functions for supporting data input

Link function y99	When communications is valid	
	Frequency setting	Operation command
0	Frequency setting specified by H30 and y98	Operation command specified by H30 and y98
1	Communications valid (S01, S05)	
2	Frequency setting specified by H30 and y98	Communications valid (S06)
3	Communications valid (S01, S05)	

2.4 Making RS485-related Settings

2.4.1 Link function (RS485 setting)

Use function codes (y01 to y10 and y11 to y20) to make settings for RS485 communications functions. However, y11 to y20 are FRENIC-Eco's function code for the RS485 communications card.

Station address (y01, y11)

Set a station address for RS485 communications. The setting range depends on the protocol.

Table 2.6 RS485 setting (station addresses)

Protocol	Range	Broadcast
Modbus RTU protocol	1 to 247	0
Protocol for loader commands	1 to 255	–
Fuji general-purpose inverter protocol	1 to 31	99

CAUTION
- No response is expected if an address number out of the specified range is set.
- Match the station address with that of the personal computer when a personal computer loader is connected.

Operation made selection when an error occurs (y02, y12)

Set the operation performed when an RS485 communications error occurs.

RS485 communications errors are logical errors such as an address error, parity error, or framing error, transmission error, and communication disconnection error set by y08 and y18. In any case, error is detected only while the inverter is running in the link operation made for both the operation command and frequency setting. If neither the operation command nor frequency setting is sent through RS485 communications or the inverter is not running, error is ignored.

Table 2.7 RS485 setting (operations when an error has occurred)

y02, y12 data	Function
0	Indicates an RS485 communications error (Er-8 for y02 and Er-P for y12), and stops operation immediately (alarm stop).
1	Runs during the time set on the error processing timer (y03, y13), and then displays an RS485 communications error (Er-8 for y02 and Er-P for y12) and stops operation (alarm stop).
2	Runs during the time set on the error processing timer (y03, y13). If communications are recovered, continues operation. Otherwise, displays an RS485 communications error (Er-8 for y02 and Er-P for y12) and stops operation (alarm stop).
3	Continues operation even after a communication error has occurred.

Timer for y02 and y12 (y03, y13)

Set a timer for error detection.

It is judged as an error that the response to a request is not received within time set because of no response of the other end and so on. See the section of "Communication disconnection detection time (y08, y18)."

- Data input range: 0.0 to 60.0 (s)

Baud rate (y04, y14)

Set a baud rate.

- Setting when a personal computer loader is connected
  Match the baud rate with that of the personal computer.

Table 2.8 Baud rate

Data	Baud rate
0	2400 bps
1	4800 bps
2	9600 bps
3	19200 bps
4	38400 bps (FRENIC-Mini does not support it.)

Data length (y05, y15)

Set a character length.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to eight bits (as in the Modbus RTU protocol).

Table 2.9 Data length

Data	Function
0	8 bits
1	7 bits

Parity check (y06, y16)

Set a parity bit.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to even parity.

Table 2.10 Parity check

Data	Function
0	No parity bit
1	Even parity
2	Odd parity

Stop bits (y07, y17)

Set a stop bit.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to 1.

- In the Modbus RTU protocol, this code does not need to be set because it is automatically determined in conjunction with the parity bit.

Table 2.11 Stop bits

Data	Function
0	2 bits
1	1 bit

No response error detection time (y08, y18)

In a system designed to be sure to access a station (inverter) managed by a host within a specific period of time, access may be lost during RS485 communications due to wire disconnections. In such a case, the inverter starts the operation of communications error set up by y02 and y12 if the inverter detects the symptom and access is still lost even after the communications disconnection detection time has passed.

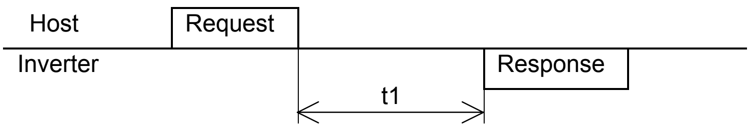
Table 2.12 No response error detection time

Data	Function
0	No response error detection disabled
1 to 60	Detecting time from 1 to 60 seconds

Response interval (y09, y19)

Set the time from the completion of receipt of a request from the host, to the return of response to it. Even in a slow processing device, timing can be adjusted by changing the response interval time.

- Data setting range: 0.00 to 1.00 (second)



t1 = Response interval time + α

α: The processing time within the inverter. It depends on the timing and command given. For further information, see the procedure for each protocol on the host below:
Modbus RTU protocol → Chapter 3 "3.2 Host Side Procedures"
Fuji general-purpose inverter protocol → Chapter "4.2 Host Side Procedures"

- Setting when FRENIC Loader is connected
  Set the response interval time according to the performance and conditions of the personal computer and converter (RS232C TO RS485 converter, etc.).
  (Some converters monitor the communications status and use a timer to switch transmission/receiving.)

Protocol select (y10, Y20)

Select a communications protocol.

- Setting when FRENIC Loader is connected
  Select the protocol for FRENIC Loader commands (y10 = 1).

Table 2.13 Protocol select

Data	Protocol
0	Modbus RTU
1	FRENIC Loader (supported by y10 only)
2	Fuji general-purpose inverter

CHAPTER 3

Modbus RTU PROTOCOL

This chapter describes the Modbus RTU protocol, as well as the host side procedure for using this protocol and error processing.

The Modbus RTU protocol was a set of specifications developed in the United States. For the FRENIC-Mini of which inverter ROM version is 0399 or earlier, the Modbus RTU functions are partially restricted. Contact us about details of restrictions. Check the inverter ROM version with menu "*5_14*" described in "3.8 Reading Maintenance Information" under Chapter 3 of the FRENIC-Mini Instruction Manual (INR-SI47-0791-E).

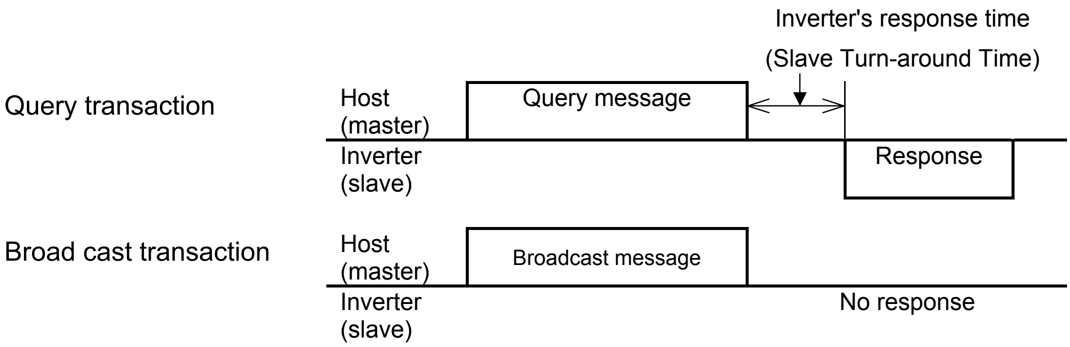
In addition, for FRENIC-Eco, coil support (coil reading out, coil reading in, and serial coil writing) is added to the protocol of Modbus RTU.

Table of Contents

3.1 Messages

3.1.1 Message formats

The regular formats for transmitting RTU messages are shown below:



If the inverter receives from the host a message in the standby status and considers it properly received, it executes a transaction in response to the request and sends back normal response. If the inverter judges that the message has not been received properly, it returns error response. The inverter does not send back any response in the case of broadcast transactions.

3.1.2 Message types

Message types are classified into four types; query, normal response, error response, and broadcast.

Query

The host sends messages to an inverter.

Normal response

After the inverter received a query from the host, the inverter executes a transaction in response to the request, and sends back corresponding normal response.

Error response

If the inverter receives a query but cannot execute the requested function because an invalid function code is specified or for other reasons, it sends back error response.
The error response is accompanied by a message describing the reason the request cannot be executed.
The inverter cannot send back any response in case of a CRC or physical transmission error (parity error, framing error, overrun error).

Broadcast

The master uses address 0 to send messages to all slaves. All slaves, which receive a broadcast message, execute the requested function. This transaction will be terminated upon timeout of the master.

3.1.3 Message frames

As shown below, a transmission frame consists of four blocks, which are called fields. Details depend on FC (RTU function codes). To make a clear distinction between RTU function codes and the inverter's function codes, the former will be hereinafter referred to as 'FC'.

1 byte	1 byte	Up to 105 bytes	2 bytes
Station address	FC (RTU function code)	Information	Error check

Station address

The station address field is one byte long, in which a station address between 0 and 247 can be selected.
Selecting address 0 means the selection of all slave stations and a broadcast message.

'FC' (RTU function code)

The 'FC' field is one byte long, in which a function code is defined with a number from 0 to 255. The 'FCs' marked with "*" are available. Do not use any unavailable 'FC'. Failure to observe this rule results in error response.

Table 3-1 List of 'FC'

'FC'		Description
0		Unused
1	*	Read Coil Status (80 coils maximum) (not supported by FRENIC-Mini)
2		Unused
3	*	Read Holding Registers (50 registers maximum)
4		Unused
5	*	Force Single Coil (not supported by FRENIC-Mini)
6	*	Preset Single Register
7		Unused
8	*	Diagnostics
9 to 14		Unused
15	*	Force Multiple Coils (16 coils maximum) (not supported by FRENIC-Mini)
16	*	Preset Multiple Registers (50 registers maximum)
17 to 127		Unused
128 to 255	*	Reserved for exception response

Information

The information field contains all information (function code, byte count, number of data, data, etc.). For further information about the information field for each message type (broadcast, query, normal response, error response), see "3.1.4 Message categories."

Error check

The error check field is a CRC-16 check system and two bytes long. Since the length of the information field is variable, the frame length required for calculating the CRC-16 code is calculated based on the 'FC' and the byte count data.
For further information about CRC-16 calculations and algorithm, see "3.4 CRC-16."
For byte counts, see "3.1.4 Message categories."

Character format

Each byte of a message is transmitted as a character. Character formats are described on the following page.
A character comprises a start bit (logical value 0), 8-bit data, an additional (optional) parity bit, and a stop bit (logical value 1).

A character always consists of eleven bits, and the number of stop bits varies depending on whether parity exists.

Without parity

LSB MSB

0	1 2 3 4 5 6 7 8	9 10
Start	Data	Stop

With parity

LSB MSB

0	1 2 3 4 5 6 7 8	9	10
Start	Data	Parity (optional)	Stop

3.1.4 Message categories

There are eight RTU message categories; read holding registers, preset single register, preset multiple registers, diagnostics, read coil status, force single coil, force multiple coils and error response.
Each category is described below:

[1] Read holding registers

<u>Query</u>

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	03_H	Function code	Number of read data	Error check
		Hi Lo	Hi Lo	

<u>Normal response</u>

1 byte	1 byte	1 byte	2 to 100 bytes	2 bytes
Station address	03_H	Byte count	Read data	Error check
			Hi, Lo (data 0); Hi, Lo (data 1); ·····	

<u>How to set a query</u>

- This request is not available for broadcast transactions. Station address 0 will become invalid (no response).
- 'FC' = 3 (03_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).

(Example) When the function code is E15, the Hi byte is 01_H and the Lo byte is $0F_H$.

Table 3.2 Function code group/code conversion table

Group	Code		Name	Group	Code		Name
F	0	00_H	Fundamental function	M	8	08_H	Monitor data
E	1	01_H	Extension terminal function	J	13	$0D_H$	Application function
C	2	02_H	Control function of frequency				
P	3	03_H	Motor parameter	y	14	$0E_H$	Link function
				W	15	$0F_H$	Monitor 2
H	4	04_H	High performance function	X	16	10_H	Alarm 1
s	7	07_H	Command/ Function data	Z	17	11_H	Alarm 2
o	6	06_H	Operational function				

- The length of the read data is up to 50 words (2 byte each).
- If the read data contains an unused function code, 0 will be read, which will not result in an error.
- Data does not extend over two or more function code groups. If, for example, reading of 40 words is specified from F40 but only function codes up to F40 are available, the data of F40 will be set at the first word, and the other 49 words will be 0.

Interpretation of normal response

- The data range of byte counts is between 2 and 100. A byte count is double the number of read data (1 - 50 data) of the response.
- The read data contains each word data in order of Hi byte and Lo byte, and each word data is sent back in order of the data of the function code (address) requested by the query, the data of that address number plus 1, the data of that number address number plus 2 ... If two or more function data are read and the second or any of the following data contains an unused function code (F09, etc.), the read data will become 0.

[2] Preset single register

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06_H	Function code	Write data	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06_H	Function code	Write data	Error check

How to set a query

- When address 0 is selected, broadcast is available. In this case, all inverters do not respond even if a broadcast request is executed.
- 'FC' = 6 (06_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).
- The written data field is fixed two bytes long. Set the data on the function code to be written.

Interpretation of normal response

The frame is the same as the query.

[3] Preset multiple registers

Query

1 byte	1 byte	2 bytes	2 bytes	1 byte	2 to 100 bytes	2 bytes
Station address	10_H	Function code	Number of write data	Byte count	Write data	Error check
		Hi Lo	Hi Lo		Hi, Lo; Hi, Lo…	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	10_H	Function code	Number of write data	Error check

How to set a query

- When the station address 0 is selected, broadcast is available. In this case, all inverters do not respond even if a broadcast request is executed.
- 'FC' = 16 (10_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).
- The number of write data is two bytes long, and the setting range is from 1 to 50. If 51 or a higher value is set, error response will result.
- The byte count field is one byte long, and the setting range is from 2 to 100. Set a value equivalent to the double of the number of write data.
- Set the lowest order code (the data on the function code requested by the query) at the first two bytes of the write data, and the higher order data (address plus 1, address plus 2 ...) at the following bytes.
- If the write data contains an unused function code, the writing will be ignored, which will not result in an error.

Interpretation of normal response

- With regard to the function code and the number of write data, the same values as those of the query will be sent back.

[4] Diagnostics

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08_H	Sub function code 0000_H	Write data	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08_H	Sub function code 0000_H	Write data	Error check

How to set a query

- This request cannot use broadcast. Station address 0 will become invalid (no response).
- 'FC' = 8 (08_H)
- Set the sub function code field to be 2 bytes long fixed 0000_H. Error response will result if data other than 0000_H is set.
- The write data field is two bytes long, and any contents of data can be set.

Interpretation of normal response

- The frame is the same as the query.

[5] Read coil status (not supported by FRENIC-Mini)

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	01_H	Coil address	No. of coils	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	1 byte	1 to 10 bytes	2 bytes
Station address	01_H	Byte count	Read data	Error check

How to set a query

- Broadcast with station address 0 is not usable. If this address is used, no response is returned.
- 'FC'=1 (01_H)
- Read out a coil (bit data) by specifying the top address of the coil to be read out and the number of points read out (number of coils).
- For the assignment of a coil (bit data), see table 3.3. For each content, refer to the S and M codes in the remarks column.

Table 3.3 Description of coil (bit data)

Coil number	+7	+6	+5	+4	+3	+2	+1	+0	Remarks
1	X6	X5	X4	X3	X2	X1	REV	FWD	S06: Run operation command (Read/Write)
9	RST	XR	XF	–	–	X9	X8	X7	
17	VL	TL	NUV	BRK	INT	EXT	REV	FWD	M14: Run status (Read only)
25	BUSY	WR		RL	ALM	DEC	ACC	IL	
33	FAN	KP	OL	IPF	SWM2	RDY	FDT	FAR	M70: Run status 2 (Read only)
41	–	–	IDL	ID	OPL	LIFE	OH	TRY	
49	X6	X5	X4	X3	X2	X1	REV	FWD	M13: Run operation command (final command) (Read only)
57	RST	XR	XF	–	–	X9	X8	X7	
65	–	–	–	Y5	Y4	Y3	Y2	Y1	M15: General-purpose output terminal information (Read only)
73	–	–	–	–	–	–	–	30	

- The "–" symbols in the table mean that the bit is reserved and always zero.
- Coil addresses are 0 to 79, calculated by subtracting one from coil numbers. If a coil address is 80 or more, an error occurs because of an incorrect address.
- The number of coils is 1 to 80. If the number of coils exceeds the range, an error occurs because of an incorrect address.
- No error occurs even if the sum of the numbers of coil addresses and coils exceeds the coil range.

Interpretation of normal response

- Data are stored from the LSB (the rightmost bit in the table above) in ascending order of coil number. When a coil is turned on, the data becomes one, and all the remaining bits are changed to zero.
- The byte length of the read data is filled in the byte count field.
- For a data example, see table 3.4.

Table 3.4 Example of coil address = 13 and the number of coils = 9

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data's 1st byte	BRK	INT	EXT	REV	FWD	RST	XR	XF
Data's 2nd byte	0	0	0	0	0	0	0	NUV

[6] Force single coil (not supported by FRENIC-Mini)

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	05_H	Coil address	Data	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	05_H	Coil address	Data	Error check

How to set a query

- Broadcast with station address 0 is not usable. If used, no response is returned.
- 'FC' = 5 (05_H)
- Turn on/off a coil (bit data) by specifying only a bit.
- For the assignment of a coil (bit data), see table 3.5. For each content, refer to the S and M codes in the remarks column.

Table 3.5 Description of coil (bit data)

Coil number	+7	+6	+5	+4	+3	+2	+1	+0	Remarks
1	X6	X5	X4	X3	X2	X1	REV	FWD	S06: Run operation command (Read/Write)
9	RST	XR	XF	–	–	X9	X8	X7	

- The "–" symbol in the table means that the bit is reserved, and writing is ignored.
- The coil address is 0 to 15, calculated by subtracting one from the coil number. If a coil address is 16 or more, an error occurs because of an incorrect address.
- When a coil is turned off, data are 0000_H. When a coil is turned on, data are $FF00_H$.

Interpretation of normal response

- The format of normal response is the same as that of inquiry.
- No response is returned to the broadcast command.

[7] Force multiple coils (not supported by FRENIC-Mini)

Query

1 byte	1 byte	2 bytes	2 bytes	1 byte	1 to 2 bytes	2 bytes
Station address	$0F_H$	Coil address	No. of coils	Byte account	Write data	Error check
		Hi Lo	Hi Lo		Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	$0F_H$	Coil address	No. of coils	Error check
		Hi Lo	Hi Lo	

How to set a query

- Broadcast with station address 0 is not usable. If is used, no response is returned.
- 'FC' = 15 ($0F_H$)
- Write a coil (bit data) by specifying the top address of the coil to be written, the number of points written (number of coils), and data to be written.
- For the assignment of a coil (bit data), see table 3.6. For each content, refer to the S and M codes in the remarks column.

Table 3.6 Description of coil (bit data)

Coil number	+7	+6	+5	+4	+3	+2	+1	+0	Remarks
1	X6	X5	X4	X3	X2	X1	REV	FWD	S06: Run operation command (Read/Write)
9	RST	XR	XF	–	–	X9	X8	X7	

- The "-" symbol in the table means that the bit is reserved and always zero.
- The coil address is 0 to 15, calculated by subtracting one from the coil number. If a coil address is 16 or more, an error occurs because of an incorrect address.
- If the byte count is 0 or 3 or more, an error occurs because of an incorrect data.
- The number of coils is 1 to 16. If 0 or 17 or more, an error occurs because of an incorrect address.
- No error occurs even if the coil address plus number of coils exceeds the coil range.
- If the number of coils is 9 or more and the byte count is 1 or less, an error occurs because of an incorrect data.
- If the number of coils is 8 or less and the byte count is 2, no error occurs.
- Data are stored from the LSB (the rightmost bit in the table above) in ascending order of coil number. When a coil is turned on, the data becomes one. When a coil is turned off, the data becomes zero. All the remaining bits are ignored.
- The byte count field indicates the byte length of the write data.
- For a data example, see table 3.7.

Table 3.7 Example of coil address = 2 and the number of coils = 9

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Data's 1st byte	X8	X7	X6	X5	X4	X3	X2	X1
Data's 2nd byte	0	0	0	0	0	0	0	X9

Interpretation of normal response

- The forms of coil address and number of coils are the same as the forms of query.
- No response is returned to the broadcast command.

[8] Error response

If the inverter receives an improper query, it will not execute it, which will result in error response.

Error response

1 byte	1 byte	1 byte	2 bytes
Station address	Exception function	Subcode	Error check

Interpretation of error response

- The station address is the same as that of the query.
- The exception function is a value obtained by adding 80_H to the 'FC' of the query message (or the value of the 'FC' if the 'FC' is larger than 80_H).
  For example, when the 'FC' is 3, the exception function is 3 + 128 = 131 (83_H).
- The subcode represents the code of the reason for the improper query.

Table 3.8 Subcodes

Subcode	Item		Description
1	Improper 'FC'		FRENIC-Mini: A 'FC' other than 3, 6, 8, or 16 has been received. FRENIC-Eco: A 'FC' other than 1, 3, 5, 6, 8, 15, or 16 has been received.
2	Improper address	Improper function code	An unused function code or a function code out of range was received. When the read/write data (except the first one) containing an unused function code. - In Read holding registers Zero (0) will be read, which will not result in an error. - In preset multiple registers The writing will be ignored, which will not result in an error.
		Improper number of data	- When the number of read/write data is not between 1 and 50. - No error will result when the value of the function code plus the number of data is beyond the setting range of the function code.
		Subfunction code error (diagnostics)	A value other than 0 was received although the subfunction code as the diagnostics was fixed to 0.
3	Improper data	Data range error	The write data is beyond the permissible write range.
7	NAK	No right of writing	FRENIC-Mini: This error does not occur. FRENIC-Eco: No right of writing by H30/y98/y99
		Write disable	- Writing was attempted to the functions to which writing from RTU is prohibited or to which writing is disabled during operation. - Writing was attempted to a function code (other than S01, S05, S06, S13, and S14) that could not be written when the voltage was insufficient.

- If response is sent back to an improper query, a subcode will be set in an error code (that can be referred to with M26).

3.1.5 Communications examples

Typical communications examples are shown below (the station address is 5 in all cases).

(Example 1) M06: Output frequency 1 will be read.

Query (host ⇒ inverter)

05	03	08	06	00	01	67	EF

Normal response (inverter ⇒ host)

05	03	01	27	10	A3	B8

The detected speed value is 2710_H, or 10000_d. The actual frequency is 30 Hz according to the expression shown below:

$$10000 \times \frac{\text{Maximum output frequency}}{20000} = 30\ (\text{Hz})$$

(Maximum output frequency: 60 Hz)

(Example 2) S01: The value of 15Hz will be written to frequency command (maximum output frequency: 60 Hz).

According to the expression shown below, the value to be written is 1388_H.

$$15\text{Hz} \times \frac{20000}{60\ (\text{Hz})} = 5000_d = 1388_H$$

Query (host ⇒ inverter)

05	06	07	01	13	88	D5	AC

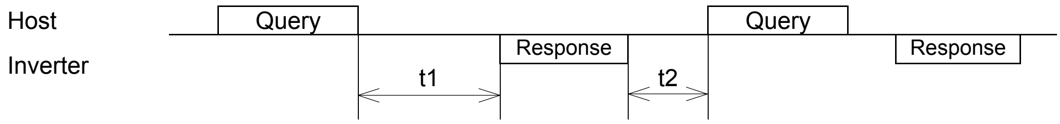
Normal response (inverter ⇒ host)

05	06	07	01	13	88	D5	AC

3.2 Host Side Procedures

3.2.1 Inverter's response time

Upon receipt of a query from the host, the inverter executes the queried transaction and sends back response after the response time shown below:



t1: Response interval time

The response interval time is the longest time out of the time setting by a function code, 3-character time, or inverter's processing time.

(1) y09/y19: setting of response interval time
0.00-1.00(s), factory shipment setting: 0.01(s)
You can set the time from receiving a request issued from a host to starting to send a response. By setting a response interval time, even the host side which is slower than the inverter can meet timing.

(2) 3-character time (maximum value)

Table 3.9 3-character time (maximum time)

Baud rate (bps)	2400	4800	9600	19200	38400 (Not supported by FRENIC-Mini)
3-character time (ms)	15	10	5	5	5

(3) Inverter processing time (The data volume shown below indicates the number of words.)
1) Read holding registers, read coil status, multiple read holding registers

Table 3.10 Inverter processing time

Data count	Inverter processing time (minimum to maximum)
1 to 7	5 to 10 (ms)
8 to 16	10 to 15 (ms)
n	Int ((n-1)/8)×5 to int ((n-1)/ 8)×5+5 (ms)

2) Preset single register, preset multiple registers, force single coil, and force multiple coils

Table 3.11 Inverter processing time

Data count	Inverter processing time (minimum to maximum)
1	25 to 30 (ms)
2	45 to 50 (ms)
3	65 to 70 (ms)
4	85 to 90 (ms)
n	$n\times20+5$ to $n\times20+10$ (ms)

However, the inverter processing time is 5 (s) maximum when H03=1 is written, and 500(ms) maximum when H03=2 is written in P02.

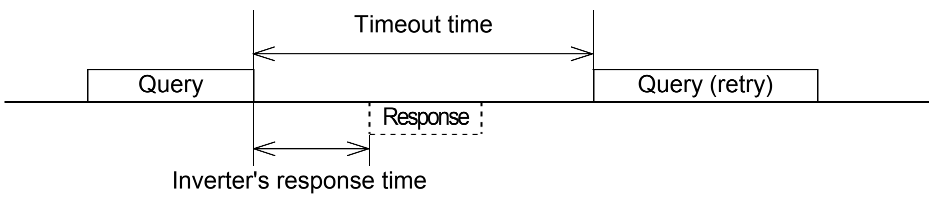
3) Maintenance code: 10 (ms)

t2: See section 3.2.3 "Receiving preparation complete time and message timing from the host."

3.2.2 Timeout processing

To read/write data from/to the host, transmit the next frame after confirming response. If response is not transmitted from the inverter for more than a specified period of time (timeout time), it is a timeout, and perform a retry. (If a retry begins before a timeout time elapses, the requested frame cannot be received properly.)

The timeout time must be set longer than the response time of the inverter. In case of a timeout, retransmit the same frame or read details of the error (M26) to confirm whether the inverter sends back normal response. If normal response is returned, this indicates that some transient transmission error occurred due to noise or for other reasons, and subsequent communications is normal. (However, if this phenomenon frequently occurs even when normal response is sent back, some problem may exist. Perform a close investigation.) In case of no response, perform another retry. If the number of retries exceeds the set value (generally about three times), there may be a problem with the hardware and the software of the host. Investigate and correct the cause.



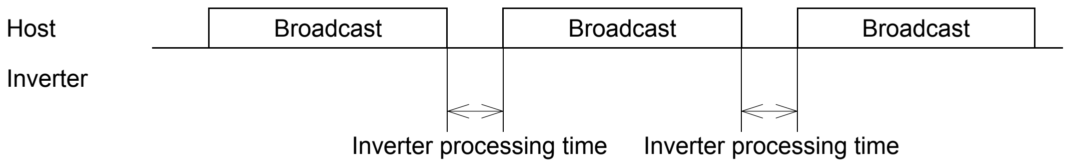
3.2.3 Receiving preparation complete time and message timing from the host

The time from the return of response by the inverter until the completion of receiving preparation of the communications port (switching from transmission to receiving) is called a receiving preparation complete time.
Transmit the following messages after the receiving preparation complete time:

Receiving preparation complete time: 3-character time

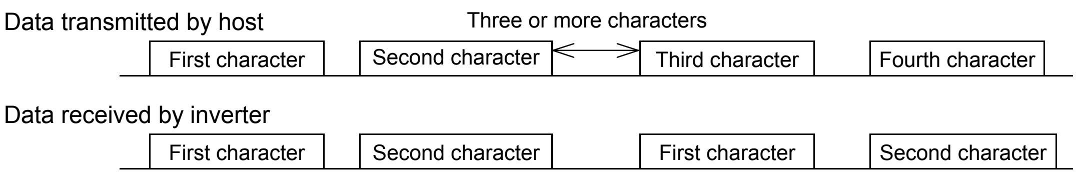
In the case of broadcast

Upon receipt of a query message from the host by broadcast, the inverter executes the query and enters the receiving enabled status.
When sending a message from the host after broadcast is performed, send the message after the inverter processing time shown in section 3.2.1 "Inverter response time" has passed.



3.2.4 Frame synchronization method

Since the RTU transmits and receives binary data without using header characters for frame synchronization, a frame synchronization system is defined as a time without data to identify the head of the frame.
If data communications does not occur for a period equal to three characters (33 bits including the start and stop bits) at the current transmission speed during receiving standby, initialize the frame information, and consider the first received data the first byte of the frame. If a character interval reaches the length of three characters or more while a frame is received, the frame is discarded.
For this reason, the host must transmit data at a time interval of three or less characters between two characters.



With regard to data to another station, messages from the host and response from that station will be received. In response transmission to identify the head of the frame, a waiting time of three characters (33 bits including the start and stop bits) is required between the completion of data receipt by the station and the start of transmission.
Any devices multidropped also requires such a waiting time.

3.3 Communications Errors

3.3.1 Categories of communications errors

The communications-related errors the inverter detects are listed below:

Table 3.12 Communications errors detected by inverter

Error category	Error name	Description	Error code (M26)
Logical error	Improper 'FC'	See "Table 3.8 Subcodes" shown in 3.1.4 [8].	1(01H)
	Improper address		2(02H)
	Improper data		3(03H)
	NAK		7(07H)
Transmission error	CRC error	The frame to the local station is found unmatched in CRC collation.	71(47H)
	Parity error	The parity is unmatched.	72(48H)
	Other errors	Receiving errors other than the abovementioned (framing error, overrun error)	73(49H)
Communica-tions disconnection error	Communications disconnection error	The inverter did not receive a normal frame addressed to local or to other stations within the communications disconnection time set with the function code.	—

Logical error (error codes 1 to 7)

When a logical error is detected, an error response frame reports it. For further information, see "3.1.4 [8] Error response."

Transmission error (error codes 71 to 73)

When a transmission error occurs eight straight times, it is handled as a communications error. However, the inverter does not return response in order to avoid overlapping of response from multiple inverters. The count of eight straight times will be cleared upon normal receipt of a frame to another station or to the local inverter (station) itself.

Communications disconnection error

If the inverter in operation does not receive a normal frame to itself or to other stations when it has received a normal frame more than once and is operating via communications (frequency command or operation command), this status is considered disconnected.
If the status of disconnection continues for the communication disconnection time set up by function code (y08, y18), error processing is performed as a communication error.

1) Communications disconnection detection time (y08, y18): 0 (without detection), 1 to 60 (seconds)

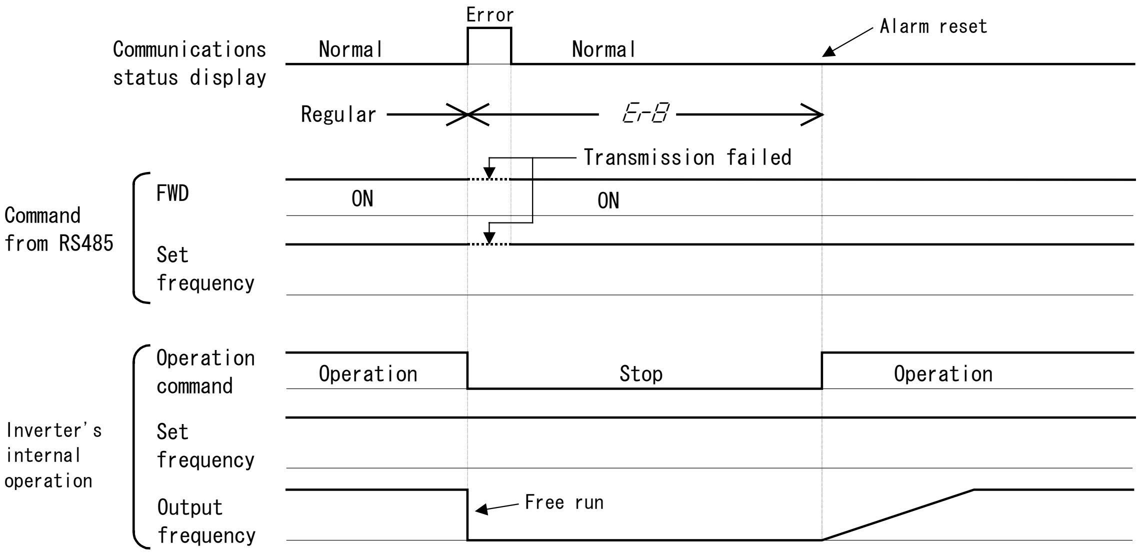
2) Condition to clear communications disconnection detection timer:
It will be cleared in a status other than disconnection.

When it is necessary to take action against errors by factor, the factor can be identified by reading M26. (M26 stores the latest communications error codes.)

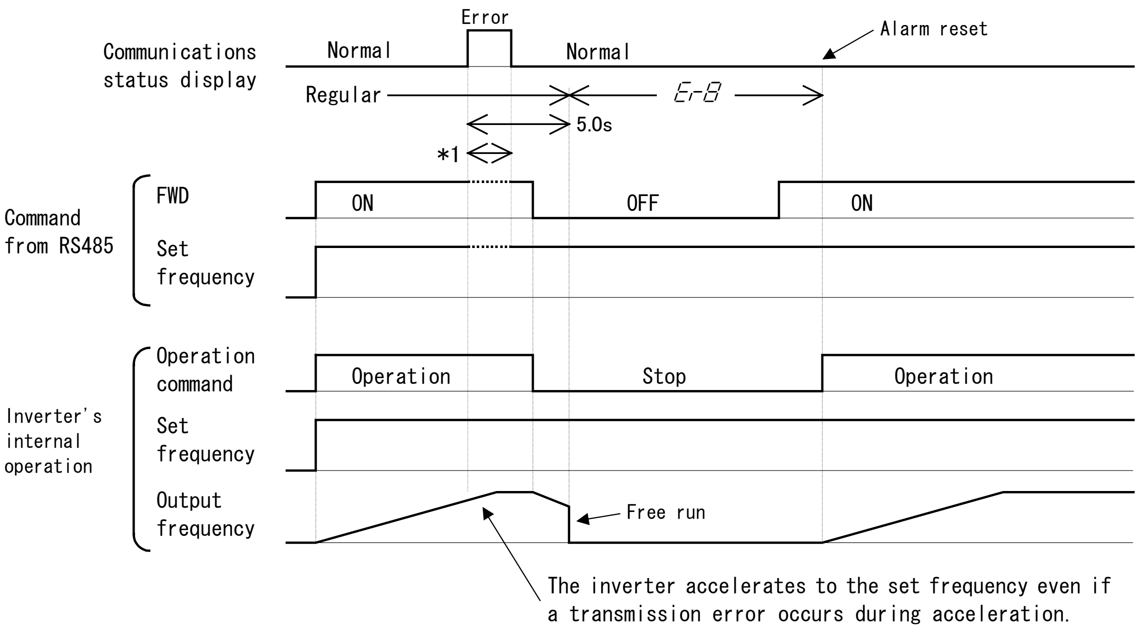
3.3.2 Operations in case of errors

The action when a transmission or communications disconnection error occurs can be selected with function code y02, y12. (For further information, see "2.4 Making RS485-related settings.") This section shows specific examples of action by different settings of function code y02. (The same operation is performed for y12 as well. In this case, the y02 and y03 in the figure are replaced with y12 and y13, and the error indication becomes Er-P.

When y02 = 0 (mode in which the inverter is forced to immediately stop in case of communications error)



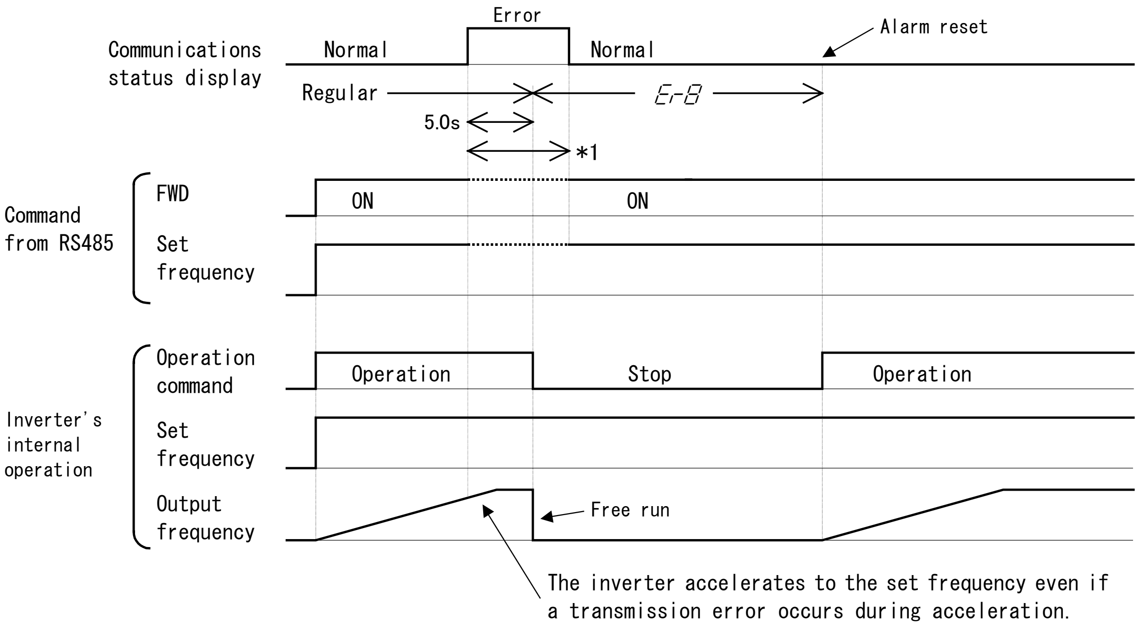
When y02 = 1 and y03 = 5.0 (seconds) (mode in which the inverter is forced to stop five seconds after a communications error occurred)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 2 and y03 = 5.0 (seconds)

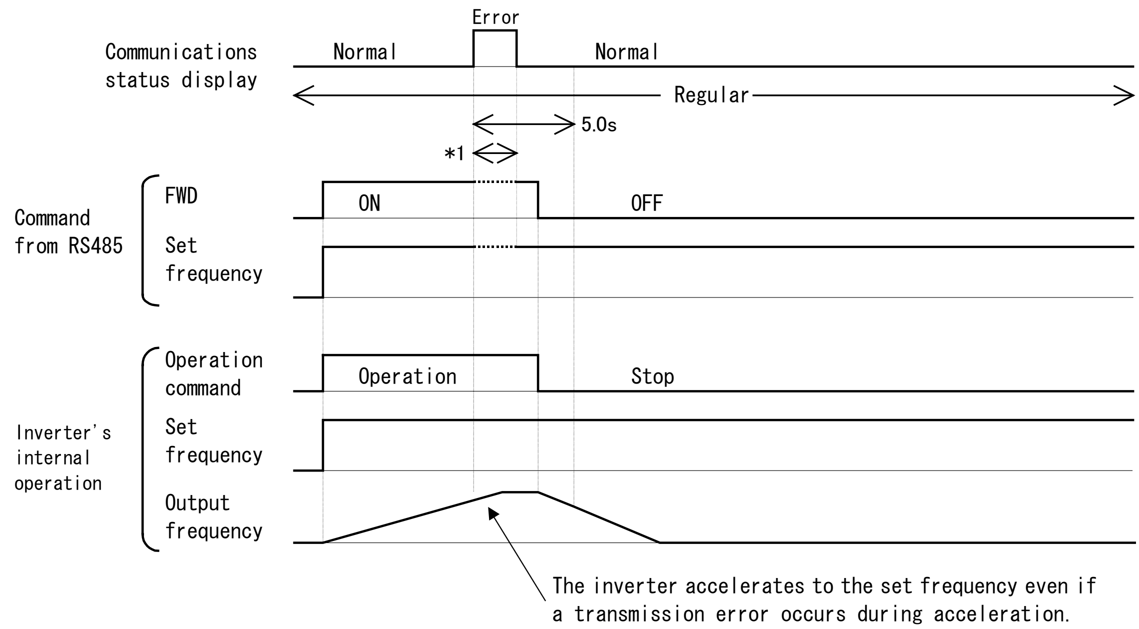
(when communications is not recovered although five seconds elapsed from the occurrence of a communications error, and an Er-8 trip occurs)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 2 and y03 = 5.0 (seconds)

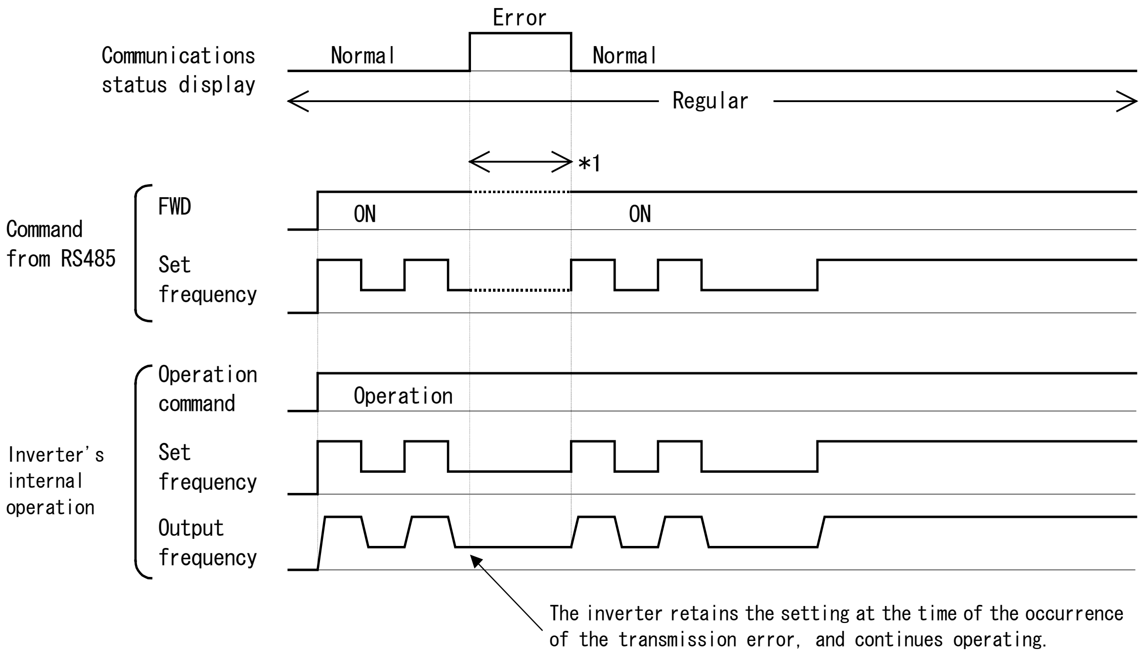
(when a communications error occurred but communications was recovered within five seconds)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 3

(mode in which the inverter continues operating when a communications error occurs)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

3.4 CRC-16

3.4.1 Overview of the CRC-16

The CRC (cyclic redundancy check) is a system to confirm whether there is any error in the communications frame during data transmission.
The CRC is among the most effective error check systems. The transmission station calculates and adds CRC data to the last block of the frame, and the receiving station also calculates CRC data against the data received, and compares them with each other.

Steps to calculate CRC data

- Divide data expressed as a polynomial (for example, 0000 0001 0000 0011 0000 0011 0000 0010 0000 0000 0001 0100, the 48-bit data shown in section 3.4.3 "Calculation example" → $X^{40}+X^{33}+X^{32}+X^{25}+X^{24}+X^{17}+X^{4}+X^{2}$) by a generative polynomial expression (17 bits; $X^{16}+X^{15}+X^{2}+1$). CRC data is the remainder (16 bits) of this division.
- Ignore the quotient, and send a message with the remainder added to the final two characters of the data.
- The receiving station divides this message (with the CRC added) by the generative polynomial expression, and considers the transmitted message to have been received without any error if the "remainder" is 0.

CRC-16

The generative polynomial expression is expressed as a multiplier of X, such as $X^3 + X^2 + 1$, in place of the description of binary code 1101. Although any prime polynomial expression is acceptable as the generative polynomial expression, some standard generative polynomial expressions for optimizing error detection are defined and proposed. The RTU protocol uses the generative polynomial expression ($X^{16} + X^{15} + X^2 + 1$) corresponding to binary code 1 (1000 0000 0000 0101). In this case, the CRC generated is well known as CRC-16.

3.4.2 Algorithm

Figure 3.1 on the following page shows the algorithm for calculating CRC-16. Consult it together with the calculation example that follows.

In this figure, the transmission station calculates CRC data and finally adds it to the transmission frame as a check code.

The receiving station uses the same algorithm to perform a transaction. However, it collates the CRC data it calculated with the transmitted CRC data.

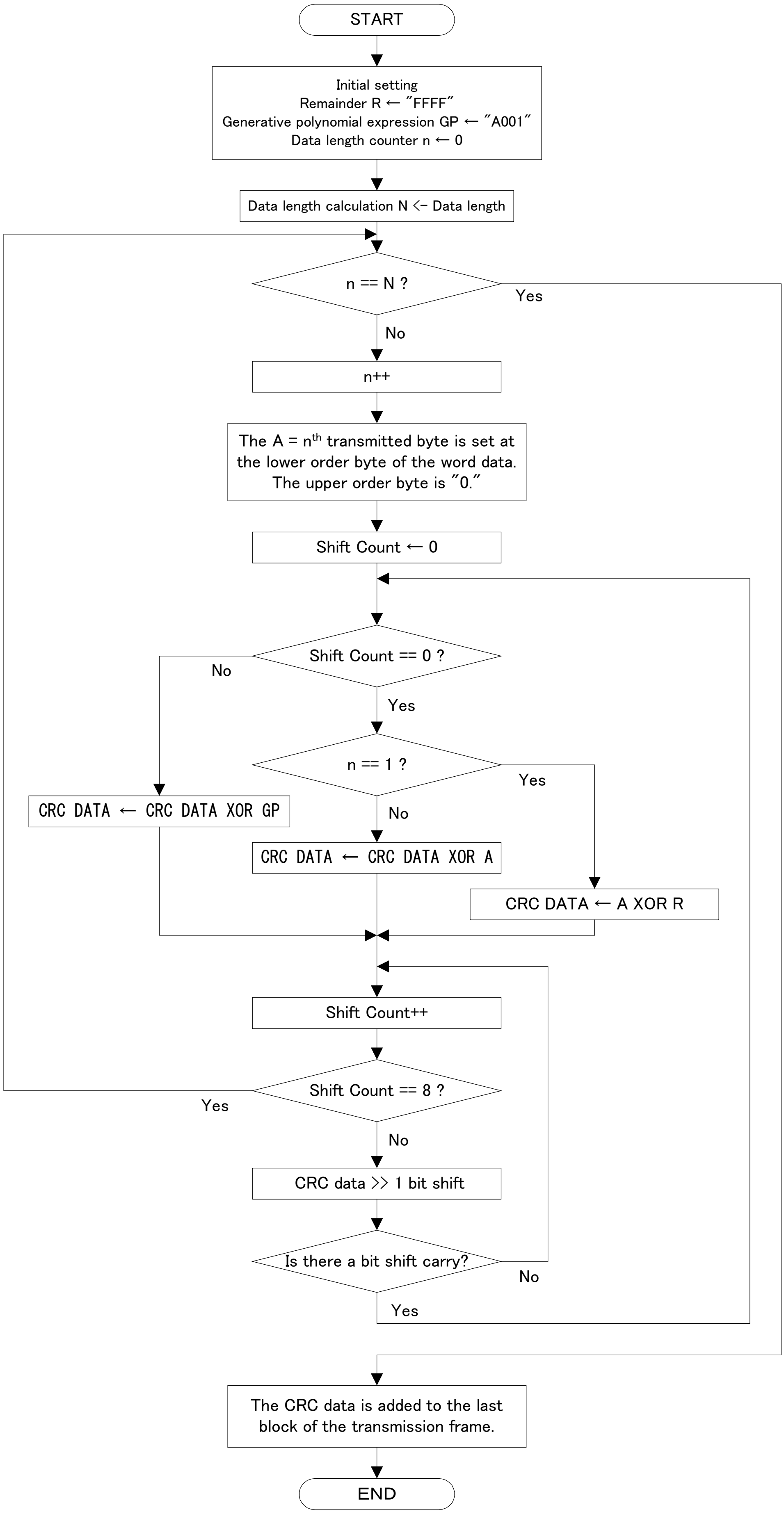


Figure 3.1 CRC algorithm

3.4.3 Calculation example

Example of transmitting read data

Station address = 1, 'FC' = 3, function code = P02 (P = 03_H, 02 = 02_H), number of read data = 20, GP = generative polynomial expression(1010 0000 0000 0001)

Station address	'FC'	Function code		Number of read data	
01_H	03_H	03_H	02_H	00_H	14_H

Table 3.13 CRC data calculation table

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 Xor 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 Xor GP	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 Xor GP	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 Xor GP	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift >> 2 (shift of No. 8 terminated)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC = No.10 Xor GP	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 Xor 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 Xor GP	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 Xor GP	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 Xor GP	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	0	1	1
21	CRC = No.20 Xor GP	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift >> 2 (shift of No. 8 terminated)	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 Xor 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 Xor GP	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 Xor GP	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 Xor GP	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	0	0	0	0	1	0	
32	CRC = No.30 Xor No.31	1	1	1	1	0	0	0	1	0	1	1	0	0	0	1	0	
33	Shift >>2	0	0	1	1	1	1	0	0	0	1	0	1	1	0	0	0	1
34	CRC = No.33 Xor GP	1	0	0	1	1	1	0	0	0	1	0	1	1	0	0	1	
35	Shift >> 1	0	1	0	0	1	1	1	0	0	0	1	0	1	1	0	0	1
36	CRC = No.35 Xor GP	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1	
37	Shift >> 1	0	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1

(To be continued)

Table 3.13 CRC data calculation table (Continued)

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
38	CRC = No.37 Xor GP	1	1	0	1	0	1	1	1	0	0	0	1	0	1	1	1	
39	Shift >> 1	0	1	1	0	1	0	1	1	1	0	0	0	1	0	1	1	1
40	CRC = No.39 Xor GP	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1	0	
41	Shift >>2	0	0	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1
42	CRC = No.41 Xor GP	1	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1	
43	Shift >> 1	0	1	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1
44	CRC = No.43 Xor GP	1	1	1	0	1	0	0	1	0	1	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 Xor No.45	1	1	1	0	1	0	0	1	0	1	1	1	0	0	0	0	
47	Shift >> 5	0	0	0	0	0	1	1	1	0	1	0	0	1	0	1	1	1
48	CRC = No.47 Xor GP	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1	0	
49	Shift >> 2	0	0	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1
50	CRC = No.49 Xor GP	1	0	0	0	1	0	0	1	1	1	0	1	0	0	1	1	
51	Shift >> 1	0	1	0	0	0	1	0	0	1	1	1	0	1	0	0	1	1
52	CRC = No.51 Xor GP	1	1	1	0	0	1	0	0	1	1	1	0	1	0	0	0	
53	6th data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
54	CRC = No.52 Xor No.53	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	
55	Shift >> 3	0	0	0	1	1	1	0	0	1	0	0	1	1	1	1	1	1
56	CRC = No.55 Xor GP	1	0	1	1	1	1	0	0	1	0	0	1	1	1	1	0	
57	Shift >> 2	0	0	1	0	1	1	1	1	0	0	1	0	0	1	1	1	1
58	CRC = No.57 Xor GP	1	0	0	0	1	1	1	1	0	0	1	0	0	1	1	0	
59	Shift >> 2	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	1	1
60	CRC = No.59 Xor GP	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	
61	Shift >> 1 (shift of No. 8 terminated)	0	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0
	Transmitted CRC data	4				1				E				4				

From the above calculation, the transmitted data is as shown below:

Station address	'FC'	Function code		Number of read data		CRC check	
01_H	03_H	03_H	02_H	00_H	14_H	$E4_H$	41_H

3.4.4 Frame length calculation

To calculate CRC-16, it is necessary to know the length of variable length messages. The length of all types of messages can be determined according to Table 3.14 Lengths of response messages.

Table 3.14 Length of response messages

'FC'	Description	Query/Broadcast message length (except CRC code)	Length of response message (except CRC code)
1	Read coil status	6 bytes	3+(3rd) bytes*
3	Read holding reisters	6 bytes	3 + (3rd) bytes*
5	Force single coil	6 bytes	6 bytes
6	Preset single register	6 bytes	6 bytes
8	Diagnostics	6 bytes	6 bytes
15	Force multiple coils	7 + (7th) bytes*	6 bytes
16	Preset multiple registers	7 + (7th) bytes*	6 bytes
128 to 255	Exception function	Unused	3 bytes

* 7th, 3rd: The 7th and 3rd byte count values stored in the frame.

CHAPTER 4

FUJI GENERAL-PURPOSE INVERTER PROTOCOL

This chapter describes the Fuji general-purpose inverter protocol, a common protocol to Fuji general-purpose inverters, as well as the host side procedure to use this protocol and error processing.

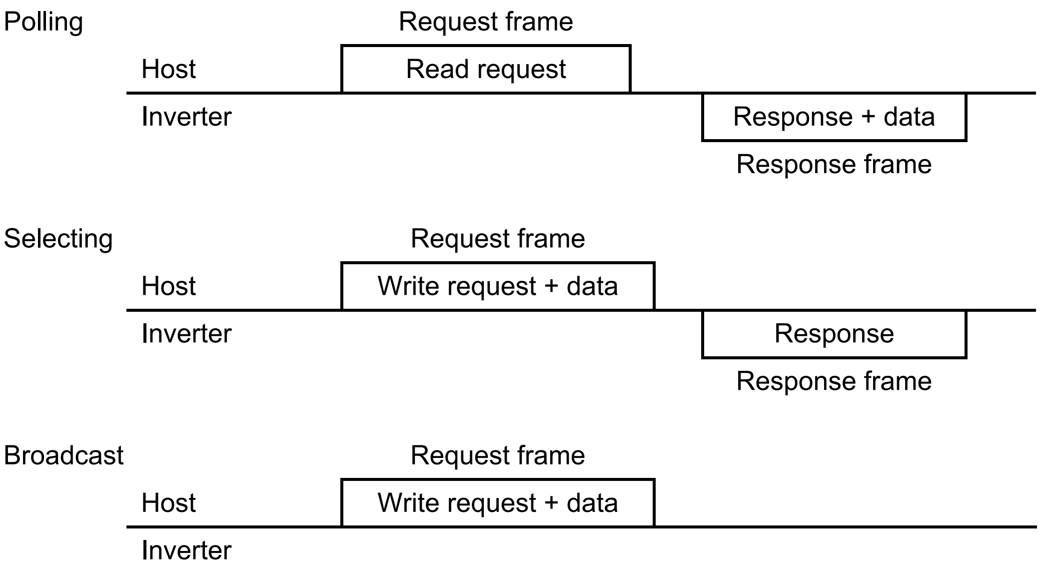
Table of Contents

4.1 Messages

4.1.1 Message formats

The polling/selecting system is used to transmit and receive messages. The inverter always waits for selecting (write requests) or polling (read requests) from a host such as a personal computer or PLC.
When the inverter in the standby status receives a request frame from the host addressed to itself (local station) and considers the request frame to have been normally received, the inverter executes the transaction in response to the request, and sends back an acknowledgement (ACK) frame (or response and data in the case of polling). If the inverter judges that the receiving failed, it returns negative acknowledgment (NAK) frame. In the case of broadcast (all station batch selecting), the inverter does not send back response.

(Each frame is described in "4.1.2 Transmission frames.")



Broadcast (all station batch selecting)

A frame with the station address set to 99 is treated by all inverters as broadcast.
By using broadcast, operation or frequency commands can be simultaneously assigned to all inverters.
In broadcast communications, only selecting of S01, S05, S06, S13, and S14 in the standard frame, and commands (W, E, a, e, f, and m) in the optional frame are valid.

4.1.2 Transmission frames

Transmission frames are classified into two types; standard fames with which all communications functions are available, and optional frames, allowing high-speed communications, but whose function is limited to issuing commands to and monitoring the inverter.

All characters (including BCC) comprising both standard and optional frames are represented by ASCII codes. The lengths of standard and optional frames are as shown in Table 4.1 below:

Table 4.1 Lengths of transmission frames

Frame type			Frame length
Standard frame	Selecting	Request	16 bytes
		Response	16 bytes
	Polling	Request	16 bytes
		Response	16 bytes
Optional frame	Selecting	Request	12 bytes
		Response	8 bytes
	Polling	Request	8 bytes
		Response	12 bytes

[1] Standard frame

Standard frames are classified into request frame, ACK frame, and NAK frame, and their frame configurations are as shown below.

For the meanings of the fields comprising each frame, see the tables shown on the pages that follow.

Request frame [host ⇒ inverter]

0	1 2	3	4	5	6 7	8	9 12	13	14 15
SOH	Station address	ENQ	Command	Function code group	Function code identification number	SP	Data	ETX	BCC
1	2	1	1	1	2	1	4	1	2 (byte)

For BCC (bytes 1 to 13)

ACK frame [inverter ⇒ host]

0	1 2	3	4	5	6 7	8	9 12	13	14 15
SOH	Station address	ACK	Command	Function code group	Function code identification number	SP	Data	ETX	BCC
1	2	1	1	1	2	1	4	1	2 (byte)

For BCC (bytes 1 to 13)

NAK frame [inverter ⇒ host]

0	1 2	3	4	5	6 7	8	9 12	13	14 15
SOH	Station address	NAK	Command	Function code group	Function code identification number	SP	Data	ETX	BCC
1	2	1	1	1	2	1	4	1	2 (byte)

For BCC (bytes 1 to 13)

Table 4.2 Request frame

Byte	Field	Value: ASCII format	Value: Hexadecimal format	Description
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3, 9	30_H to 33_H 39_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 R W A E	 52_H 57_H 41_H 45_H	Request command Polling (read) Selecting (write) High-speed response selecting (write) *2 Alarm reset
5	Function code group *1	 F E C P H J y s M W X Z	 46_H 45_H 43_H 50_H 48_H $4A_H$ 59_H 53_H $4D_H$ 57_H 58_H $5A_H$	Function code group *3 Fundamental function Extension terminal function Control function of frequency Motor parameter High performance function Application function Link function Command data Monitor data 1 Monitor data 2 Alarm data 1 Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP	20_H	Unused (space fixed)
9	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
10		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
11		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for an alarm reset command.

*2 Use high-speed response selecting to read the monitor when a command, which takes time for selecting (see Table 4.12 in "4.2 Host Side Procedures"), is written. The inverter does not respond to the regular write command W until writing is completed. With regard to high-speed response command A, the inverter sends back response upon receipt of a write request and communications can, therefore, continue even during writing. To confirm whether writing is completed in this case, read the BUSY flag (M14: 15 bits). If additional writing is performed during writing, NAK (error during writing) will result.

*3 Function codes are divided into function codes that can be edited from the keypad of the inverter, and communications dedicated function codes.

1) Function codes editable from the keypad

Fundamental function:	F code
Extension terminal function:	E code
Control function of frequency:	C code
Motor parameter:	P code
High performance function:	H code
Application function:	J code
Link function:	y code

For further information about these codes, see "2.4 Making RS485-related settings" in Chapter 2 of this manual, and "Chapter 9 Function Codes" of the FRENIC-Mini User's Manual (MEH446) or FRENIC-Eco User's Manual (MEH456)

2) Communications dedicated function codes

Command data:	S code
Monitor data 1:	M code
Monitor data 2:	W code
Alarm data 1:	X code
Alarm data 2:	Z code

For further information about these codes, see "Chapter 5 Function Codes and Data Formats."

Table 4.3 ACK frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK	ACK	06_H	Transmission response Acknowledgement: There was no receiving or logical error.
4	Command	 R W A E	 52_H 57_H 41_H 45_H	Answerback of request command Polling (read) Selecting (write) High-speed response selecting (write) Alarm reset
5	Function code group *1	 F E C P H J y S M W X Z	 46_H 45_H 43_H 50_H 48_H $4A_H$ 59_H 53_H $4D_H$ 57_H 58_H $5A_H$	Function code group Fundamental function Extension terminal function Control function of frequency Motor parameter High performance function Application function Link function Command data Monitor data 1 Monitor data 2 Alarm data 1 Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP -	20_H $2D_H$	Fixed to "sp (space)" normally. "-" for negative data
9	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
10		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
11		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for an alarm reset command.

Table 4.4 NAK frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	NAK	NAK	15_H	Transmission response Negative acknowledgement: There was a logical error in the request.
4	Command *1	 R W A E	 52_H 57_H 41_H 45_H	Answerback of request command Polling (read) Selecting (write) High-speed response selecting (write) Alarm reset
5	Function code group *1	 F E C P H J y S M W X Z	 46_H 45_H 43_H 50_H 48_H $4A_H$ 59_H 53_H $4D_H$ 57_H 58_H $5A_H$	Function code group Fundamental function Extension terminal function Control function of frequency Motor parameter High performance function Application function Link function Command data Monitor data 1 Monitor data 2 Alarm data 1 Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP	20_H	Unused (space fixed)
9	Data	SP	20_H	Unused (space fixed)
10		SP	20_H	Unused (space fixed)
11		0 to F	30_H to $3F_H$	Communications error code higher order (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Communications error code lower order (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for a transmission format or transmission command error.

[2] Optional frame

This section describes the structure and meaning of each optional frame.

Selecting request frame [host ⇒ inverter]

0	1 2	3	4	5 8	9	10 11
SOH	Station address	ENQ	Command	Data	ETX	BCC
1	2	1	1	4	1	2 (byte)
	For BCC (bytes 1 to 9)					

Table 4.5 Selecting request frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3, 9	30_H to 33_H 39_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 a e f m	 61_H 65_H 66_H $6D_H$	Request command Speed setting (S01) Frequency command (S05) Operation command (S06) Reset command (The data part is all zero)
5	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
6		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
7		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
8		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
9	ETX	ETX	03_H	End of message
10	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
11		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Selecting response frame [inverter ⇒ host]

0	1 2	3	4	5	6 7
SOH	Station address	ACK/NAK	Command	ETX	BCC
1	2	1	1	1	2 (byte)
	For BCC				

Table 4.6 Selecting response frame

Byte	Field	Value: ASCII format	Value: Hexadecimal format	Description
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK/NAK	 ACK NAK	 06_H 15_H	Transmission response Acknowledgement: There was no receiving or logical error. Negative acknowledgment: There was a logical error in the request.
4	Command	 a e f m	 61_H 65_H 66_H $6D_H$	Request command Speed setting (S01) Frequency command (S05) Operation command (S06) Reset command
5	ETX	ETX	03_H	End of message
6	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
7		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Polling request frame [host ⇒ inverter]

0	1 2	3	4	5	6 7
SOH	Station address	ENQ	Command	ETX	BCC
1	2	1	1	1	2 (byte)
	For BCC				

Table 4.7 Polling request frame

Byte	Field	Value: ASCII format	Value: Hexadecimal format	Description
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 g j k h	 67_H $6A_H$ $6B_H$ 68_H	Request command Actual frequency, actual speed (M06) Output frequency monitor (M09) Operation status monitor (M14) Torque monitor (M07) (not supported by FRENIC-Mini)
5	ETX	ETX	03_H	End of message
6	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
7		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Polling response frame [inverter ⇒ host]

0	1 2	3	4	5 8	9	10 11
SOH	Station address	ACK/NAK	Command	Data	ETX	BCC
1	2	1	1	4	1	2 (byte)
	For BCC					

Table 4.8 Polling response frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK/NAK	ACK NAK	06_H 15_H	Transmission request Acknowledgement: There was no receiving or logical error. Negative acknowledgment: There was a logical error in the request.
4	Command	g j k h	67_H $6A_H$ $6B_H$ 68_H	Request command Actual frequency, actual speed (M06) Output frequency monitor (M09) Operation status monitor (M14) Torque monitor (M07) (not supported by FRENIC-Mini)
5	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
6		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
7		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
8		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
9	ETX	ETX	03_H	End of message
10	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
11		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

[3] NAK frame

When the response frame length is determined by the command type and the command type character is correctly identified, response will be given according to the frame length specified by the command in principle.

Table 4.9 Negative acknowledgment (NAK) frame

No.	Frame/ Command type	Cause of error	NAK response frame	Error code (M26)
1	Standard frame Optional frame	The ENQ was not detected in the specified position.	Standard fame (16 bytes long)	Format error [74]
2	Selecting command (a, e, f, m)	The ETX was not detected in the specified position.	Optional frame (8 bytes long)	Format error [74]
3	Polling command (g, j, k, h)	The ETX was not detected in the specified position.	Optional frame (12 bytes long)	Format error [74]
4	Other than specified commands	A command other than the specified commands (R, W, A, E, a, e, f, g, j, k, h, m) was detected.	Standard frame (16 bytes long)	Command error [75]

CAUTION When negative acknowledgement (NAK) for a format or command error is returned with the standard format as in the case of No. 1 and No. 4, the contents of the command type, function code group, and function code identification number fields will be undefined.

4.1.3 Descriptions of fields

[1] Command field

The table below shows command types. The applicable frame is different among the command types.

Table 4.10 Command formats

Command	Description	Applicable frame
ASCII R	Reads function code data (polling).	Standard frame
ASCII W	Writes function code data (selecting).	
ASCII A	Writes function code data at high speed (writing that does not wait for writing to be completed).	
ASCII E	Resets an alarm.	
ASCII a	Gives a frequency command (S01). *1	Optional frame
ASCII e	Gives a frequency command (S05). *1	
ASCII f	Gives an operation command (S06). *1	
ASCII g	Reads the output frequency (M06). *1	
ACCII h	Reads the torque monitor (M07). *1 (not supported by FRENIC-Mini)	
ASCII j	Reads the output frequency (M09). *1	
ASCII k	Reads the operation status monitor (M14). *1	
ASCII m	Resets an alarm.	

*1 The above commands "a" to "k" are used to read or write data in the function code data format specified in parentheses.

[2] Data field

Standard frame

8	9	10	11	12
Special additional data	Data's first character	Data's second character	Data's third character	Data's fourth character

Optional frame

9	10	11	12
Data's first character	Data's second character	Data's third character	Data's fourth character

All data, except for some special ones, are treated as 16 bits long. In the data field of the communications frame, data is hexadecimal (0000_H – $FFFF_H$), and each digit is represented by an ASCII code. Negative integer data (signed data) is treated as a complement of 2 of the integer data without the sign.

CAUTION
- The alphabetic characters A to F of hexadecimal data must be uppercase.
- Set 0 in all the data fields of the request frame for polling.
- In selecting, the data field of the ACK frame will be undefined.

(Example) When setting 20Hz with function code S01 (speed setting 1) (maximum output frequency = 60Hz)

1) Calculate the set value according to the data format of S01 (±20000/maximum output frequency).
   Data = 20Hz x ±20000/60Hz (+ for forward rotation, – for reverse rotation)
   =±6666.6
   ≈±6667

2) Convert the data into hexadecimal (a complement of 2 in the case of negative data).
   Data = 6667 .... (forward rotation)
   $=1A0B_H$
   Data = –6667 .... (reverse rotation)
   = 0 – 6667
   Thus,
   $65536 - 6667 = 58869 = E5F5_H$

3) Set the data.

Position	Set value (forward rotation)	Set value (reverse rotation)
Data's first character	ASCII 1	ASCII E
Data's second character	ASCII A	ASCII 5
Data's third character	ASCII 0	ASCII F
Data's fourth character	ASCII B	ASCII 5

[3] Checksum field

The data in this field is intended to check whether there is any error in the communications frame at the time of data transmission. Calculate the data by adding one byte to all fields, except for S0H and the checksum field, treating the last byte of the result as a two-digit hexadecimal value, and converting each digit into an ASCII code.

(Example) When the result of addition is 0123_H

Position	Set value (forward rotation)
Checksum 1	ASCII 2
Checksum 2	ASCII 3

4.1.4 Communications examples

Typical communications examples are shown below (the station number is 12 in all cases):

[1] Standard frame

(Example 1) Selecting S01: speed setting 1 (write)

10Hz command x 20,000/maximum output frequency 50Hz = 4000d = $0FA0_H$

Request frame (host ⇒ inverter)

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

ACK frame (inverter ⇒ host)

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

NAK frame (inverter ⇒ host) ... Link priority error

SOH	1	2	NAK	W	S	0	1	SP	SP	4	C	0	ETX	8	D

(Example 2) Polling of M09: output frequency (read)

Request frame (host ⇒ inverter)

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

ACK frame (inverter ⇒ host)

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

[2] Optional frame

(Example 1) Selecting of operation command (write)

Request frame (host ⇒ inverter) ... FWD command

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

ACK frame (inverter ⇒ host)

SOH	1	2	ACK	f	ETX	D	2

NAK frame (inverter ⇒ host)

The cause of the error can be confirmed with function code M26 (transmission error transaction code).

SOH	1	2	NAK	f	ETX	E	1

(Example 2) Selecting of operation command in broadcast (write)

Request frame (host ⇒ inverter) ... REV command

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

The inverter does not respond to broadcast.

Table 4.11 ASCII code table

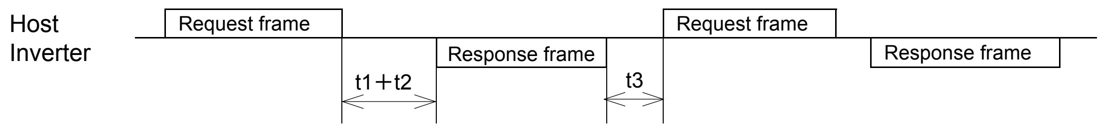
	00_H	10_H	20_H	30_H	40_H	50_H	60_H	70_H
0_H	NUL	DLE	SP	0	@	P	`	p
1_H	SOH	DC1	!	1	A	Q	a	q
2_H	STX	DC2	“	2	B	R	b	r
3_H	ETX	DC3	#	3	C	S	c	s
4_H	EOT	DC4	$	4	D	T	d	t
5_H	ENQ	NAK	%	5	E	U	e	u
6_H	ACK	SYN	&	6	F	V	f	v
7_H	BEL	ETB	‘	7	G	W	g	w
8_H	BS	CAN	(	8	H	X	h	x
9_H	HT	EM	)	9	I	Y	i	y
A_H	LF	SUB	*	:	J	Z	j	z
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

The shaded codes are used for this communications protocol.

4.2 Host Side Procedures

4.2.1 Inverter's response time

Upon receipt of a query request from the host, the inverter executes the requested command, and sends back response after the response time shown below:



t1 + t2: Inverter's response time

t1: Response interval time (function code: y09)
The time until the inverter starts to send response to the request from the host can be set. Setting the response interval time enables even the host side with a slow transaction execution speed to adjust timing.

t2: Inverter's transaction time
This is the time until the inverter executes the request and sends back response as shown in Table 4.12 below.

t3: See "4.2.3 Receiving preparation complete time and message timing from the host."

Table 4.12 Inverter's transaction time

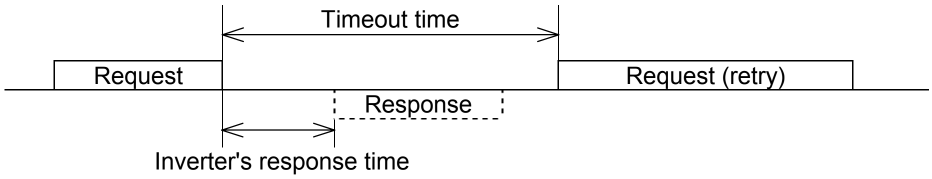
Command	Transaction	Description	t2	Timeout time (recommended)
R	Function code read data		≤10ms	0.1 sec
W	Function code write data	S code commands other than S08 or S09	≤10ms	0.1 sec
		H03 = 2: Motor parameter initialization	≤500ms	1.0 sec
		H03 = 1: Data initialization	≤5s	10.0 sec
		Function code other than above	≤100ms	0.5 sec
A	Function code data high-speed writing		≤10ms	0.1 sec
E, m	Alarm reset		≤10ms	0.1 sec
a, e, f	Specific function code write data		≤10ms	0.1 sec
g, h, j, k	Specific function code read data		≤10ms	0.1 sec

4.2.2 Timeout processing

To read/write data from/to the host, transmit the next frame after confirming response. If response is not transmitted from the inverter for more than a specified period of time (timeout time), it is a timeout, and perform a retry. (If a retry begins before a timeout, the requested frame cannot be received properly.)

The timeout time must be set longer than the response time of the inverter. Table 4.12 above mentioned shows recommended timeout times when no response interval time is set.

In case of a timeout, retransmit the same frame or perform polling (M26) for reading details of an error to confirm whether the inverter sends back normal response. If normal response is returned, this indicates that some transient transmission error occurred due to noise or other reasons, and subsequent communications is normal. (However, if this phenomenon frequently occurs even when normal response is sent back, some problem may exist. Perform a close investigation.) In case of no response, perform another retry. If the number of retries exceeds the set value (generally about three times), there may be a problem with the hardware and the software for the host controller. Investigate and correct the cause.



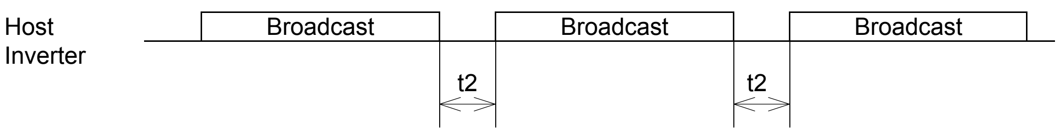
4.2.3 Receiving preparation complete time and message timing from the host

The time from the return of response by the inverter to the completion of receiving preparation of the communications port (switching from transmission to receiving) is called a receiving preparation complete time.
Transmit the following messages after the receiving preparation complete time:

Receiving preparation complete time: 5ms or less
Message timing from the host (t3): t3 > 5ms

In the case of broadcast

Upon receipt of a request for a query message from the host by broadcast, the inverter executes the command and enters the receiving enabled status.
Transmit the next message from the host following broadcast after the transaction time (t2) of the inverter.



Chap. 4 FUJI GENERAL-PURPOSE INVERTER PROTOCOL

4.3 Communications Errors

4.3.1 Categories of communications errors

The communications-related errors the inverter detects are listed below:

Table 4.13 Communications errors detected by inverter

Error category	Error name	Description	Error code (M26)
Transmission error	Checksum error	The frame to the local station is found unmatched in checksum collation.	71(47$_H$)
	Parity error	The parity is unmatched.	72(48$_H$)
	Other errors	Receiving errors other than the abovementioned (framing error, overrun error)	73(49$_H$)
Logical error	Format error	- The characters of the transmission request are incorrect. - The last character of the message is not in the specified position.	74(4A$_H$)
	Command error	A command that does not exist was transmitted.	75(4B$_H$)
	Link priority error (does not occur for FRENIC-Mini)	A frequency command, PID command, or change command of the run command (writing request to S01, S05, S06, and S13) are sent through the communication route other than that specified with H30.	76(4C$_H$)
	Function code error	A function code that does not exist was requested.	78(4E$_H$)
	Write disabled error	- An attempt was made during operation to write the function code for write disabled or for write disabled during operation.	79(4F$_H$)
	Data error	The write data is beyond the writable range.	80(50$_H$)
	Error during writing	An attempt was made to write another function data during function writing with command A.	81(51$_H$)
Communi-cations disconnec-tion error	Communications disconnection error	The inverter did not receive a normal frame addressed to local station or to other stations within the communications disconnection detection time set with the function code.	–

Transmission error (error codes 71 to 73)

When a transmission error occurs eight straight times, it is handled as a communications error. However, the inverter does not return response in order to avoid overlapping of response from multiple inverters. The count of eight straight times will be cleared upon normal receipt of a frame to another station or to the local inverter (station) itself.

Logical error (error codes 74 to 81)

When a logical error is detected, a negative acknowledgment (NAK) frame reports it. For further information, see the NAK response of each frame.

Communications disconnection error

If the inverter in operation does not receive a normal frame to itself (local station) or to another station when it has received a normal frame more than once and is operating via communications (frequency command or operation command), this status is considered disconnected.
When a disconnection status is set and remains over the setting time of function code y08, y18 (communications disconnection detection time), it is treated as a communications error.

1) Communications disconnection detection time (y08, y18): 0 (without detection), 1 to 60 (seconds)
2) Condition to clear communications disconnection detection timer: It will be cleared in a status other than disconnection.

When it is necessary to take action against errors by factor, the factor can be identified by reading M26. (M26 stores the latest communications error codes.)

4.3.2 Operations in case of communications errors

Operations in case of a transmission or communications disconnection error are the same as those of the Modbus RTU protocol. See "3.3.2 Operations in case of errors" in Chapter 3 Modbus RTU Protocol.

CHAPTER 5

FUNCTION CODES AND DATA FORMATS

This chapter describes communications dedicated function codes and the data formats of communications frames. FRENIC-Mini and FRENIC-Eco support different function codes. For details, see the description of each function code.

Table of Contents

5.1 Communications Dedicated Function Codes

5.1.1 About communications dedicated function codes

Communications dedicated function codes are available to monitor the operation and status of the inverter via communications. They are classified into the groups shown in Table 5.1 below:

Table 5.1 Types of communications dedicated function codes

Communications dedicated function code group	Function
S	Command data
M	Monitor data (for reading only)
W	Monitor data out of keypad display information (for reading only)
X	Alarm information out of keypad display information (for reading only)
Z	Alarm information out of keypad display information (for reading only)

The sections that follow describe communications dedicated function codes of each group.

5.1.2 Command data

[1] Frequency and PID command data

Table 5.2 Function codes for frequency and PID command data

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W *
S01	Frequency command (p.u.)	Frequency command via communications (value based on the maximum output frequency)	-32768 to 32767 (±20,000 = maximum output frequency)	1	–	R/W
S05	Frequency command	Frequency command from communications (by 0.01Hz)	0.00 to 655.35	0.01	Hz	R/W
S13	PID command	PID command from communications	-32768 to 32767 (±100% at ±20,000)	1	–	R/W

* R: Read only, W: Write only, R/W: Read/Write

1) When both S01 and S05 are set and S01 is not 0, the command of S01 has precedence over that of S05.
2) The actual operation specified by each command is limited by internal processing of the inverter. For example, a value over 20,000 can be written to S01, but the actual frequency is limited to the maximum output frequency or to the upper limit frequency set with another function code. (The FRENIC-Mini/Eco treats negative data of S13 as 0.)
3) When an attempt is made to read the command data shown here, the data previously directed by communications, not the command value for actual operation, will be read. (Obtain the latest command value by reading the M code.)
4) At S01, set a value based on ±20,000 as the maximum output frequency. For example, when the maximum output frequency is 60Hz, set 20,000 at S01 with a set frequency of 60Hz, or 10,000 with a set frequency of 30Hz.

Chap. 5 FUNCTION CODES AND DATA FORMATS

[2] Operation command data

Table 5.3 Function codes for operation command data

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W *
S06	Operation command	Operation command via communications (general-purpose input terminal functions (X1 – X5, XF (FWD), XR (REV)) and communications dedicated command (FWD, REV, RST)	0000_H to $FFFF_H$	1	-	R/W
S14	Alarm reset command	Alarm reset command via communications	0 or 1	1	–	R/W

* R: Read only; W: Write only; R/W: Read/Write

1) To make alarm resetting with S06, bit 15 must be set to 1 and then set back to 0. Alarm resetting is impossible unless the communications side is made valid by the settings of function codes H30 and y99 and the "LE" assigned terminal.
2) S14 does not require the operation described in 1) above, and writing 1 permits alarm resetting (because writing the value once turns ON the reset command that will be turned OFF after a specific period of time). This command is 0 whenever it is read, and is always valid, irrespective of function codes H30 and y99 and the status of the "LE" assigned terminal.
3) X1 – X5, XF (FWD), and XR (REV) operate according to the functions set with function codes E01 – E05, E98, and E99.
   General-purpose input terminals X4 and X5 and function codes E04 and E05 are not supported by FRENIC-Mini.
4) When giving operation command S06 via communications, the relation between S06 and the inverter terminal (external signal input) command is shown in Table 5.4 on the next page. The "Support" column of the table indicates whether each function is supported by the respective models or not. ○ indicates the function is supported, and × indicates the function is not supported.

WARNING

If alarm resetting is performed with the operation command (S06) uncleared, the inverter will start to operate just upon alarm resetting. Before alarm resetting, confirm that the operation command is cleared.

Otherwise, an accident may result.

Table 5.4 Relation between operation command (S06) and inverter terminal command (external signal input)

Function				When not assigned (positive logic)	Command		Support	
Type	Assign-ment number	Internal operation command symbol	Name		Com-Munica-tions	Terminal block	Mini	Eco
Fixed function	–	FWD	Forward operation/stop command	–	Valid	Invalid	○	○
		REV	Reverse operation/stop command	–			○	○
		RST	Alarm reset	–			○	○
General-purpose input X1 X2 X3 X4 X5 XF (FWD) XR (REV)	0	SS1	Multistep frequency 1	OFF	Valid	Invalid	○	○
	1	SS2	Multistep frequency 2	OFF			○	○
	2	SS4	Multistep frequency 4	OFF			○	○
	4	RT1	Acceleration/Deceleratio n time selection	OFF			○	×
	6	HLD	3-wire operation stop command	OFF	Invalid		○	○
	7	BX	Coast-to-stop command	OFF	Valid		○	○
	8	RST	Alarm reset	OFF			○	○
	9	THR	Trip command (External fault)	ON	Invalid	Valid	○	○
	10	JOG	Jogging operation	OFF	Invalid		○	×
	11	Hz2/Hz1	Frequency setting 2/1 switching command	OFF	Valid	Invalid	○	○
	13	DCBRK	DC braking command	OFF			×	○
	15	SW50	Switching to commercial power supply (50Hz)	OFF			×	○
	16	SW60	Switching to commercial power supply (60Hz)	OFF			×	○
	17	UP	UP command	OFF	Invalid	Valid	×	○
	18	DOWN	DOWN command	OFF			×	○
	19	WE-KP	Write enable for keypad	ON	Valid		○	○
	20	Hz/PID	PID control cancel	OFF	Valid	Invalid	○	○
	21	IVS	Normal/Inverse mode changeover	OFF			○	○
	22	IL	Interlock	OFF	Invalid	Valid	×	○
	24	IL	Link operation enable	ON			○	○
	25	LE	Universal DI	OFF			×	○
	26	U-DI	Start characteristic selection	OFF	Valid		×	○
	30	STOP	Forced stop	ON			×	○
	33	PID-RST	PID integration/differential reset	OFF	Valid	Invalid	○	○

(X4, X5: not supported by FRENIC-Mini)

Chap. 5 FUNCTION CODES AND DATA FORMATS

Table 5.4 Relation between operation command (S06) and inverter terminal command (external signal input) (Continued)

Function				When not assigned (positive logic)	Command		Support	
Type	Assign-ment number	Internal operation command symbol	Name		Com-Munica-tions	Terminal block	Mini	Eco
General-purpose input X1 X2 X3 X4 X5 XF (FWD) XR (REV)	34	PID-HLD	PID integration hold	OFF	Valid	Invalid	○	○
	35	LOC	Local (keypad) command selection	OFF	Invalid	Valid	×	○
	38	RE	Run enable	ON	Valid	Invalid	×	○
	39	DWP	Condensation protection	OFF			×	○
	40	ISW50	Switching to commercial power supply incorporated sequence (50Hz)	ON			×	○
	41	ISW60	Switching to commercial power supply incorporated sequence (60Hz)	ON			×	○
	87	FR2/FR1	Run command 2/run command 1	OFF			×	○
	88	FWD2	Forward run/stop command 2	OFF			×	○
	89	REV2	Reverse run/stop command 2	OFF			×	○
	98	FWD*	Forward operation/stop command	OFF			○	○
	99	REV*	Reverse operation/stop command	OFF			○	○

(X4, X5: not supported by FRENIC-Mini)

* Terminals FWD/REV only

[3] Function data

Table 5.5 Function code and data (S08, S09)

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W
S08	Acceleration time F07	Set data with common code numbers and in common communications formats to models.	0.0 to 3600.0	0.1	s	R/W
S09	Deceleration time F08		0.0 to 3600.0	0.1	s	R/W

1) When an attempt is made to enter a value out of the appropriate permissible setting range, an out-of-range error will result.
2) The acceleration time of S08 and the deceleration time of S09 are set to F07 (acceleration time 1) and F08 (deceleration time 1), respectively.
(When F07 or F08 is changed on the keypad and so on, the changed data is reflected onto S08 or S09, respectively.)
3) The figures below the fourth place figure of the S08 acceleration time and the S09 deceleration time are omitted within the inverter. (If, for example, 123.4s is written, 123.0s is entered.)

[4] Universal D0 and universal A0

(Not supported by FRENIC-Mini)

Table 5.6 Function code and data (S07, S12)

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W
S07	Universal D0	Command from communications function to terminal D0	0000_H to $FFFF_H$	1	–	R/W
S12	Universal A0	Command from communications function to terminal A0	-32768 to 32767 (Full scale by ±20000)	1	–	R/W

1) A host can control the output terminal of the inverter through the communications function to issue commands to peripheral devices.
2) When universal D0 and universal A0 are assigned to the following signals, the signals operate as simple output regardless of inverter's operation.
Universal D0: Transistor output (Y1, Y2, Y3), relay output (Y5A/C, 30A/B/C)
Universal A0: Analog output (FMA), pulse output (FMP)

5.1.3 Monitor data

Function codes for monitor data (M codes) are described in the four tables (1 to 4) below. These function codes are for reading only.

These function codes are for reading only. The "Support" column of the table indicates whether each function is supported by the respective models or not. ○ indicates the function is supported, and × indicates the function is not supported.

Table 5.7 Monitor data function codes (1)

Code	Name	Description	Monitor range	Min. step	Unit	Support	
						Mini	Eco
M01	Frequency command (p.u.) (final command)	Frequency command based on the maximum output frequency	-32768 to 32767 (±20,000 = maximum output frequency)	1	–	○	○
M05	Frequency command (final command)	Frequency command with min. step 0.01Hz	0.00 to 655.35	0.01	Hz	○	○
M06	Output frequency 1 (p.u.)	Output frequency based on the maximum output frequency (before slip compensation)	-32768 to 32767 (±20,000 = maximum output frequency)	1	–	○	○
M07	Output torque	Motor output torque based on the motor's rated torque (100%)	-327.68 to 327.68	0.01	%	×	○
M09	Output frequency 1	Output frequency with min. step 0.01Hz	FGI: -655.35 to 655.35 RTU: 0.00 to 655.35	0.01	Hz	○	○
M10	Input power	Power consumption value based on the "nominal applicable motor output" (100%)	0.00 to 399.99	0.01	%	○	○
M11	Output current effective value	Output current effective value based on the inverter rated current	0.00 to 399.99 (100% = inverter rated current)	0.01	%	○	○
M12	Output voltage effective value	Output voltage effective value (min. step: 1.0V)	0.0 to 1000.0	0.1 *1	V	○	○
M13	Operation command (final command)	Displays the final command created by information from the keypad, terminal block, and communications, and transmitted to the inverter inside.	0000_H to $FFFF_H$	–	–	○	○
M14	Operation status	Displays the operation status in bit signal.	0000_H to $FFFF_H$	–	–	○	○
M15	General-purpose output terminal information	General-purpose output terminal information is monitored.	0000_H to $FFFF_H$	–	–	○	○

1* Since M12 does not have any data after the decimal point, the minimum step is 1.0.

Table 5.8 Monitor data function codes (2)

Code	Name	Description	Monitor range	Min. step	Unit	Support	
						Mini	Eco
M16	Latest alarm contents	Display alarm contents in the form of code.	0 to 127	–	–	○	○
M17	Last alarm contents						
M18	Second last alarm contents						
M19	Third last alarm contents						
M20	Cumulative operation time	–	0 to 65535	1	h	○	○
M21	DC link circuit voltage	Displays the DC link circuit voltage of the inverter.	0 to 1000	1	V	○	○
M23	Model code	Displays the series, generation, model, and voltage series in four-digit HEX data.	0000_H to $FFFF_H$	–	–	○	○
M24	Capacity code	Displays the capacity of the inverter.	0 to 65535	1	–	○	○
M25	ROM version	Displays the ROM version used in the inverter.	0 to 9999	1	–	○	○
M26	Transmission error transaction code	Communications error code of RS485	0 to 127	–	–	○	○
M27	Frequency command on alarm (p.u.) (final command)	Data equivalent to M01 on alarm	-32768 to 32767 (±20,000 = maximum output frequency)	1	–	○	○
M31	Frequency command on alarm (final command)	Data equivalent to M05 on alarm	0.00 to 655.35	0.01	Hz	○	○
M32	Output frequency 1 on alarm (p.u.)	Data equivalent to M06 on alarm	-32768 to 32767 (±20,000 = maximum output frequency)	1	–	○	○
M33	Output torque on alarm	Data equivalent to M07 on alarm	-327.68 to 327.67	0.01	%	×	○
M35	Output frequency 1 on alarm	Data equivalent to M09 on alarm	FGI: -655.35 to 655.35 RTU: 0.00 to 655.35	0.01	Hz	○	○
M36	Input power on alarm	Data equivalent to M10 on alarm	0.00 to 399.99	0.01	%	○	○
M37	Output current effective value on alarm	Data equivalent to M11 on alarm	0.00 to 399.99 (100% = inverter rated current)	0.01	%	○	○
M38	Output voltage effective value on alarm	Data equivalent to M12 on alarm	0.0 to 1000.0	1.0	V	○	○

Table 5.9 Monitor data function codes (3)

Code	Name	Description	Monitor range	Min. step	Unit	Support	
						Mini	Eco
M39	Operation command on alarm	Data equivalent to M13 on alarm	0000_H to $FFFF_H$	–	–	○	○
M40	Operation status on alarm	Data equivalent to M14 on alarm	0000_H to $FFFF_H$	–	–	○	○
M41	General-purpose output terminal information on alarm	Data equivalent to M15 on alarm	0000_H to $FFFF_H$	–	–	○	○
M42	Cumulative operation time on alarm	Data equivalent to M20 on alarm	0 to 65535	1	h	○	○
M43	DC link circuit voltage on alarm	Data equivalent to M21 on alarm	0 to 1000	1	V	○	○
M44	Inverter internal air temperature on alarm	Air temperature inside the inverter on alarm	0 to 255	1	°C	×	○
M45	Heat sink temperature on alarm	Data equivalent to M62 on alarm	0 to 255	1	°C	○	○
M46	Life of main circuit capacitor	The capacity of the main circuit capacitor is 100% when delivered from the factory	0.0 to 100.0	0.1	%	○	○
M47	Life of PC board electrolytic capacitor	Cumulative operation time of the capacitor packaged on the PC board	0 to 65535	1	h	○	○
M48	Life of heat sink	Cumulative operation time of the heat sink	0 to 65535	1	h	○	○
M49	Input terminal voltage ([12])	Input voltage of terminal [12] (-20,000/-10V, 20,000/10V)	-32678 to 32767	1	–	○	○
M50	Input terminal current ([C1])	Input current of terminal [C1] (0/0mA, 20,000/20mA)	0 to 32767	1	–	○	○
M54	Input terminal voltage ([V2])	Input voltage of terminal [V2] (-20000/10V to 20000/10V)	-32768 to 32767	1	–	×	○
M61	Inverter internal air temperature	Current temperature inside the inverter	0 to 255	1	°C	×	○
M62	Heat sink temperature	Current temperature of the heat sink within the inverter	0 to 255	1	°C	○	○
M63	Load rate	Load rate based on the motor rating	-327.68 to 327.67	0.01	%	×	○
M64	Motor output	Motor output based on the motor's rated output (kW)	-327.68 to 327.67	0.01	%	×	○
M65	Motor output on alarm	Data equivalent to M64 on alarm	-327.68 to 327.67	0.01	%	×	○

Table 5.9 Monitor data function codes (4)

Code	Name	Description	Monitor range	Min. step	Unit	Support	
						Mini	Eco
M68	PID final command	±20000/±100%	–32678 to 32767	1	–	O	O
M69	Inverter rated current	FGI	0.00 to 9999	Vari-able	A	O	O
		RTU (inverter capacity 22kW (30HP) or less)	0.00 to 655.35	0.01	A	O	O
		RTU (inverter capacity 30kW (40HP) or more)	0.0 to 5000.0	0.1	A	×	O
M70	Operation status 2	Displays the operation status in the form of a bit signal.	0000_H to $FFFF_H$	1	–	O	O
M71	Input terminal information	Operation command information from the terminal block and communications	0000_H to $FFFF_H$	1	–	O	O
M72	PID feedback	PID feedback based on 100% of analog input (±20000/100%)	–32768 to 32767	1	–	×	O
M73	PID output	PID output based on the maximum output frequency (F03) (±20000/100%)	–32768 to 32767	1	–	×	O

5.1.4 Information displayed on the keypad

The function codes used to read, via RS485, information displayed on the keypad are classified into W codes, X codes, and Z codes. All of these function codes are for read only.

The function codes shown in Tables 5.10 to 5.12 correspond to the menu numbers displayed on the LEDs on the keypad shown in the "LED display" field. The "Support" column of the table indicates whether each function is supported by the respective models or not. ○ indicates the function is supported, and × indicates the function is not supported.

For further information about data displayed on the keypad, see Chapter 3 "OPERATION USING THE KEYPAD" of the FRENIC-Mini Instruction Manual (INR-SI47-0791-E) or FRENIC-Eco Instruction Manual (INR-SI47-0882-E).

RTU and FGI in the Remarks field represent the Modbus RTU protocol and the Fuji general-purpose inverter protocol, respectively.

Table 5.10 Keypad-related function code (W codes)

Code	Name	Monitor range	Min step	Unit	LED display	Support		Remarks
						Mini	Eco	
W01	Operation status	0000_H to $FFFF_H$	1	–	3_07	○	○	
W02	Frequency command	0.00 to 655.35	0.01	Hz	3_05	○	○	
W03	Output frequency (before slip compensation)	0.00 to 655.35	0.01	Hz	3_00	○	○	
W04	Output frequency (after slip compensation)	0.00 to 655.35	0.01	Hz	3_01	○	×	
W05	Output current	0.00 to 9999	Variable	A	3_02	○	○	FGI
		0.00 to 655.35	0.01	A	3_02	○	○	RTU (inverter capacity 22kW (30HP) or less)
		0.0 to 5000.0	0.1	A	3_02	×	○	RTU (inverter capacity 30kW (40HP) or more)
W06	Output voltage	0.0 to 1000.0	0.1	V	3_03	○	○	
W07	Torque operation value	-999 to 999	1	%	3_04	×	○	
W08	Motor speed	0.00 to 99990	Variable	r/min	3_08	×	○	
W09	Load rotation speed	0.00 to 99990	Variable	r/min	3_09	○	○	
W10	Line speed	0.00 to 99990	Variable	m/min	3_09	○	×	
W11	PID process command	-999 to 9990	Variable	–	3_10	○	○	PID process command or PID feedback value converted to the physical quantity of the control target by E40 and E41
W12	PID feedback value	-999 to 9990	Variable	–	3_11	○	○	
W16	Motor speed set value	0.00 to 99990	Variable	r/min	Speed monitor	×	○	
W17	Load speed set value	0.00 to 99990	Variable	r/min	Speed monitor	○	○	
W18	Line speed set value	0.00 to 99990	Variable	r/min	Speed monitor	○	×	
W19	Constant feed time set value	0.00 to 999.9	Variable	min	Speed monitor	○	×	
W20	Constant feed time	0.00 to 999.9	Variable	min	Speed monitor	○	×	
W21	Input power	0.00 to 9999	Variable	kW	Operation status monitor	○	○	
W22	Motor output power	0.00 to 9999	Variable	kW	Operation status monitor	×	○	
W23	Load factor	-999 to 999	1	%	Operation status monitor	×	○	
W27	Timer operation remaining time	0 to 9999	1	s	Operation status monitor	○	×	
W28	Operation command source	0 to 22	1	–	–	○	○	*1
W29	Frequency, PID command source	0 to 35	1	–	–	○	○	*2
W30	Speed (unit: %)	0.00 to 100.00	0.01	%	Speed monitor	×	○	
W31	Speed setting (unit: %)	0.00 to 100.00	0.01	%	Speed monitor	×	○	
W32	PID output	0 to 150.0	0.1	%	Operation status monitor	×	○	PID output expressed by a percentage with setting the maximum output frequency (F03) to 100%

Table 5.10 Keypad-related function code (W codes) (Continued)

Code	Name	Monitor range	Min step	Unit	LED display	Support		Remarks
						Mini	Eco	
W33	Analog input monitor	-999 to 9990	Variable	–	Operation status monitor	×	○	Inverter's analog input converted by E40 and E41
W40	Control circuit terminal (input)	0000_H to $FFFF_H$	1	–	4_00	○	○	
W41	Control circuit terminal (output)	0000_H to $FFFF_H$	1	–	4_00	○	○	
W42	Communications control signal (input)	0000_H to $FFFF_H$	1	–	4_01	○	○	
W43	Communications control signal (output)	0000_H to $FFFF_H$	1	–	4_01	○	○	
W44	Terminal [12] input voltage	0.0 to 12.0	0.1	V	4_02	○	○	

*1 Operation command source code

Indicates the current source of operation commands.
For FRENIC-Mini, this code is 20 when operation commands from the loader are effective.

Code	Description	Mini	Eco
0	Run by the keypad (rotation direction: depends on the terminal input)	O	O
1	Run by the terminals	O	O
2	Run by the keypad (forward rotation)	O	O
3	Run by the keypad (reverse rotation)	O	O
4	Run command 2 (when FR2/FR1 is ON)	×	O
20	RS485 channel 1 *3	O	O
21	RS485 channel 2 *3	×	O
22	Bus option	×	O
23	Loader	×	O

*2 Frequency command source/PID command source code

FRENIC-Mini : Indicates a frequency command source even if PID is effective. This code is 20 when the frequency command from the loader is effective.

FRENIC-Eco : Indicates a PID command source if PID is effective (code 30 or later). Indicates a frequency command source if PID is not effective (code 29 or less).

Code	Description	Mini	Eco
0	Keypad key operations	O	O
1	Voltage input (terminal 12)	O	O
2	Current input (terminal C1)	O	O
3	Voltage input (terminal 12) + current input (terminal C1)	O	O
4	Inverter volume	O	×
5	Voltage input (terminal V2)	×	O
7	UP/DOWN	×	O
20	RS485 channel 1*3	O	O
21	RS485 channel 2*3	×	O
22	Bus option	×	O
23	Loader (20 for FRENIC-Mini)	×	O
24	Multi-step frequency	×	O
30	PID keypad command	×	O
31	PID analog command 1	×	O
33	PID UP/DOWN command	×	O
34	PID communications process command	×	O
36	PID multi-step command	×	O

*3 RS485 channel

	FRENIC-Mini	FRENIC-Eco
RS485 channel 1	RS485 communications card (option)	Keypad connection connector on the inverter
RS485 channel 2	–	RS485 communications card (option)

Table 5.10 Keypad-related function code (W codes) (Continued)

Code	Name	Monitor range	Min step	Unit	LED display	Support		Remarks
						Mini	Eco	
W45	Terminal [C1] input current	0.0 to 30.0	0.1	mA	4_03	○	○	
W46	FMA output voltage	0.0 to 12.0	0.1	V	4_04	○	○	
W47	FMP output voltage	0.0 to 12.0	0.1	V	4_05	×	○	
W48	FMP output frequency	0 to 6000	1	–	4_06	×	○	The output pulse rate of terminal FMP expressed by (p/s)
W49	Terminal [V2] input voltage	0.0 to 12.0	0.1	V	4_07	×	○	
W50	FMA output current	0.0 to 30.0	0.1	MA	4_08	×	○	
W70	Cumulative operation time	0 to 65535	1	h	5_00	○	○	
W71	DC link circuit voltage	0 to 1000	1	V	5_01	○	○	
W72	Maximum temperature of internal air	0 to 255	1	°C	5_02	×	○	
W73	Maximum temperature of heat sink	0 to 255	1	°C	5_03	○	○	
W74	Maximum effective current value	0.00 to 9999	Variable	A	5_04	○	○	
W75	Capacitor of the DC bus capacitor	0.00 to 100.0	0.1	%	5_05	○	○	
W76	Cumulative operation time of electrolytic capacitor on PC board	0 to 65535	1	h	5_06	○	○	
W77	Cumulative operation time of cooling fan	0 to 65535	1	h	5_07	○	○	
W78	Number of startups	0 to 65535	1	Times	5_08	○	○	
W79	Cumulative operation time of motor	0 to 65535	1	h	5_23	×	○	
W80	Standard fan life	0 to 65535	1	h	–	×	○	
W81	Integral electric power consumption	0.001 to 9999	Variable	–	5_09	×	○	Value calculated by assuming an integral power consumption of 100kWh as one (100kWh when W81=1)
W82	Integral electric power consumption data	0.001 to 9999	Variable	–	5_10	×	○	Value calculated as integral power consumption (kWh) multiplied by function code E51
W83	Number of RS485 Ch1 errors	0 to 9999	1	Times	5_11	○	○	
W84	Contents of RS485 Ch1 error	0 to 127	1	–	5_12	○	○	
W85	Number of RS485 Ch2 errors	0 to 9999	1	Times	5_17	×	○	
W87	Inverter's ROM version	0 to 9999	1	–	5_14	○	○	
W89	Remote/multi-function keypad ROM version	0 to 9999	1	–	5_16	○	○	
W90	Option ROM version	0 to 9999	1	–	5_19	×	○	
W94	Content of RS485 Ch2 error	0 to 127	1	–	5_18	×	○	
W95	Number of option communications errors	0 to 9999	1	Times	5_13	×	○	
W96	Content of option communications error	0 to 9999	1	–	–	×	○	*

* Indicates the content of a communications error between the inverter and an option card. For details, see the manual of each option.

Table 5.11 Keypad-related function codes (X codes)

Code	Name	Monitor range	Min step	Unit	LED display	Support: Mini	Support: Eco	Remarks
X00	Alarm history (latest)	0000_H to $FFFF_H$	1	–	6_AL	○	○	Contents of 1 in alarm list (example: 1.OL1)
X01	Multiple alarm 1 (latest)	0000_H to $FFFF_H$	1	–	6_ 16	○	○	
X02	Multiple alarm 2 (latest)	0000_H to $FFFF_H$	1	–	6_ 17	○	○	
X03	Sub-code	0 to 9999	1	–	–	×	○	
X05	Alarm history (last)	0000_H to $FFFF_H$	1	–	6_AL	○	○	Contents of 2 in alarm list (example: 2.OC1)
X06	Multiple alarm 1 (last)	0000_H to $FFFF_H$	1	–	6_ 16	○	○	
X07	Multiple alarm 2 (last)	0000_H to $FFFF_H$	1	–	6_ 17	○	○	
X08	Sub-code	0 to 9999	1	–	–	×	○	
X10	Alarm history (second last)	0000_H to $FFFF_H$	1	–	6_AL	○	○	Contents of 3 in alarm list (example: 3.OC1)
X11	Multiple alarm 1 (second last)	0000_H to $FFFF_H$	1	–	6_ 16	○	○	
X12	Multiple alarm 2 (second last)	0000_H to $FFFF_H$	1	–	6_ 17	○	○	
X13	Sub-code	0 to 9999	1	–	–	×	○	
X15	Alarm history (third last)	0000_H to $FFFF_H$	1	–	6_AL	○	○	Contents of 4 in alarm list (example: 4.LU)
X16	Multiple alarm 1 (third last)	0000_H to $FFFF_H$	1	–	6_ 16	○	○	
X17	Multiple alarm 2 (third last)	0000_H to $FFFF_H$	1	–	6_ 17	○	○	
X18	Sub-code	0 to 9999	1	–	–	×	○	
X20	Latest information on alarm (output frequency)	0.00 to 655.35	0.01	Hz	6_00	○	○	
X21	(output current)	0.00 to 9999	Variable	A	6_01	○	○	FGI
		0.00 to 655.35	0.01	A	6_01	○	○	RTU (inverter capacity 22kW (30HP) or less)
		0.0 to 5000.0	0.1	A	6_01	×	○	RTU (inverter capacity 30kW (40HP) or more)
X22	(output voltage)	0 to 1000	1	V	6_02	○	○	
X23	(torque operation value)	-999 to 999	1	%	6_03	×	○	
X24	(set frequency)	0.00 to 655.35	0.01	Hz	6_04	○	○	
X25	(operation status)	0000_H to $FFFF_H$	1	–	6_06	○	○	
X26	(cumulative operation time)	0 to 65535	1	h	6_07	○	○	
X27	(number of startups)	0 to 65535	1	Times	6_08	○	○	
X28	(DC link circuit voltage)	0 to 1000	1	V	6_09	○	○	
X29	(internal air temperature)	0 to 255	1	°C	6_ 10	×	○	
X30	(heat sink temperature)	0 to 255	1	°C	6_ 11	○	○	
X31	(control circuit terminal (input))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 13	○	○	
X32	(control circuit terminal (output))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 14	○	○	
X33	(communications control signal (input))	0000_H to $FFFF_H$	1	–	6_ 18 6_ 19	○	○	
X34	(communications control signal (output))	0000_H to $FFFF_H$	1	–	6_ 18 6_20	○	○	

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Table 5.11 Keypad-related function codes (X codes) (Continued)

Code	Name	Monitor range	Min step	Unit	LED display	Support		Remarks
						Mini	Eco	
X60	Last information on alarm (output frequency)	0.00 to 655.35	0.01	Hz	6_00	○	○	
X61	(output current)	0.00 to 9999	Variable	A	6_01	○	○	FGI
		0.00 to 655.35	0.01	A	6_01	○	○	RTU (inverter capacity 22kW (30HP) or less)
		0.0 to 5000.0	0.1	A	6_01	×	○	RTU (inverter capacity 30kW (40HP) or more)
X62	(output voltage)	0 to 1000	1	V	6_02	○	○	
X63	(torque operation value)	-999 to 999	1	%	6_03	×	○	
X64	(set frequency)	0.00 to 655.35	0.01	Hz	6_04	○	○	
X65	(operation status)	0000_H to $FFFF_H$	1	–	6_06	○	○	
X66	(cumulative operation time)	0 to 65535	1	h	6_07	○	○	
X67	(number of startups)	0 to 65535	1	Times	6_08	○	○	
X68	(DC link circuit voltage)	0 to 1000	1	V	6_09	○	○	
X69	(internal air temperature)	0 to 255	1	°C	6_10	×	○	
X70	(heat sink temperature)	0 to 255	1	°C	6_11	○	○	
X71	(control circuit terminal (input))	0000_H to $FFFF_H$	1	–	6_12 6_13	○	○	
X72	(control circuit terminal (output))	0000_H to $FFFF_H$	1	–	6_12 6_14	○	○	
X73	(communications control signal (input))	0000_H to $FFFF_H$	1	–	6_18 6_19	○	○	
X74	(communications control signal (output))	0000_H to $FFFF_H$	1	–	6_18 6_20	○	○	

Table 5.12 Keypad-related function codes (Z codes)

Code	Name	Monitor range	Min step	Unit	LED display	Support		Remarks
						Mini	Eco	
Z00	Second last information on alarm (output frequency)	0.00 to 655.35	0.01	Hz	6_00	○	○	
Z01	(output current)	0.00 to 9999	Variable	A	6_01	○	○	FGI
		0.00 to 655.35	0.01	A	6_01	○	○	RTU (inverter capacity 22kW (30HP) or less)
		0.0 to 5000.0	0.1	A	6_01	×	○	RTU (inverter capacity 30kW (40HP) or more)
Z02	(output voltage)	0 to 1000	1	V	6_02	○	○	
Z03	(torque operation value)	-999 to 999	1	%	6_03	×	○	
Z04	(set frequency)	0.00 to 655.35	0.01	Hz	6_04	○	○	
Z05	(operation status)	0000_H to $FFFF_H$	1	–	6_06	○	○	
Z06	(cumulative operation time)	0 to 65535	1	h	6_07	○	○	
Z07	(number of startups)	0 to 65535	1	Times	6_08	○	○	
Z08	(DC link circuit voltage)	0 to 1000	1	V	6_09	○	○	
Z09	(internal air temperature)	0 to 255	1	°C	6_ 10	×	○	
Z10	(heat sink temperature)	0 to 255	1	°C	6_ 11	○	○	
Z11	(control circuit terminal (input))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 13	○	○	
Z12	(control circuit terminal (output))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 14	○	○	
Z13	(communications control signal (input))	0000_H to $FFFF_H$	1	–	6_ 18 6_ 19	○	○	
Z14	(communications control signal (output))	0000_H to $FFFF_H$	1	–	6_ 18 6_20	○	○	
Z50	Third last information on alarm (output frequency)	0.00 to 655.35	0.01	Hz	6_00	○	○	
Z51	(output current)	0.00 to 9999	Variable	A	6_01	○	○	FGI
		0.00 to 655.35	0.01	A	6_01	○	○	RTU (inverter capacity 22kW (30HP) or less)
		0.0 to 5000.0	0.1	A	6_01	×	○	RTU (inverter capacity 30kW (40HP) or more)
Z52	(output voltage)	0 to 1000	1	V	6_02	○	○	
Z53	(torque operation value)	-999 to 999	1	%	6_03	×	○	
Z54	(set frequency)	0.00 to 655.35	0.01	Hz	6_04	○	○	
Z55	(operation status)	0000_H to $FFFF_H$	1	–	6_06	○	○	
Z56	(cumulative operation time)	0 to 65535	1	h	6_07	○	○	
Z57	(number of startups)	0 to 65535	1	Times	6_08	○	○	
Z58	(DC link circuit voltage)	0 to 1000	1	V	6_09	○	○	
Z59	(internal air temperature)	0 to 255	1	°C	6_ 10	×	○	
Z60	(heat sink temperature)	0 to 255	1	°C	6_ 11	○	○	
Z61	(control circuit terminal (input))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 13	○	○	
Z62	(control circuit terminal (output))	0000_H to $FFFF_H$	1	–	6_ 12 6_ 14	○	○	
Z63	(communications control signal (input))	0000_H to $FFFF_H$	1	–	6_ 18 6_ 19	○	○	
Z64	(communications control signal (output))	0000_H to $FFFF_H$	1	–	6_ 18 6_20	○	○	

5.2 Data Formats

5.2.1 List of data format numbers

The following table shows the communications data format numbers for function code data. Create data according to the data format specifications described below. For data ranges and units, see "Chapter 9 Function Codes" of the FRENIC-Mini User's Manual (MEH446) or FRENIC-Eco User's Manual (MEH456). The "Support" column of the table indicates whether each function is supported by the respective models or not. ○ indicates the function is supported, and × indicates the function is not supported.

RTU and FGI in the Format number field mean the Modbus RTU protocol and the Fuji general-purpose inverter protocol, respectively.

Table 5.13 List of data format numbers (F codes)

Code	Name	Format number	Support	
			Mini	Eco
F00	Data Protection	[1]	○	○
F01	Frequency Command 1	[1]	○	○
F02	Operation Method	[1]	○	○
F03	Maximum Frequency	[3]	○	○
F04	Base Frequency	[3]	○	○
F05	Rated Voltage (at the base frequency)	[1]	○	○
F07	Acceleration Time 1	[12]	○	○
F08	Deceleration Time 1	[12]	○	○
F09	Torque Boost	[3]	○	○
F10	Electronic Thermal Simulator (Overload Detection for Motor Protection) (Selection of motor cooling fan property)	[1]	○	○
F11	Electronic Thermal Simulator (Overload Detection for Motor Protection) (Level)	[24] (FGI)	○	○
		[19] (RTU)	○	○
F12	Electronic Thermal Simulator (Overload Detection for Motor Protection) (Thermal time constant)	[3]	○	○
F14	Restart Mode after momentary Power Failure	[1]	○	○
F15	Frequency Limiter (High)	[3]	○	○
F16	Frequency Limiter (Low)	[3]	○	○
F18	Bias (for Frequency command 1)	[6]	○	○
F20	DC Braking (Starting frequency)	[3]	○	○
F21	DC Braking (Braking level)	[1]	○	○
F22	DC Braking (Braking time)	[5]	○	○
F23	Starting Frequency	[3]	○	○
F25	Stopping Frequency	[3]	○	○
F26	Motor Sound (Carrier frequency)	[1] *1	○	○
F27	Motor Sound (Sound tone)	[1]	○	○
F29	Analog Output [FMA] (Selection)	[1]	×	○
F30	Analog Output [FMA] (Voltage adjust)	[1]	○	○
F31	Analog Output [FMA] (Function)	[1]	○	○
F33	Digital Output Signal Selection for [FMP] (Pulse rate)	[1]	×	○
F34	Digital Output signal Selection for [FMP] (Voltage adjust)	[1]	×	○
F35	Digital Output Signal Selection for [FMP] (Function)	[1]	×	○
F37	Load Selection/Auto Torque Boost/Auto Energy Saving Operation	[1]	○	○
F43	Current Limiter (Operation condition)	[1]	○	○
F44	Current Limiter (Limiting level)	[1]	○	○

Table 5.13 List of data format numbers (F codes) (- to be continued -)

Code	Name	Format number	Support	
			Mini	Eco
F50	Electronic Thermal Overload Relay (for braking resistor) (Discharging capability)	[1] *2	○	×
F51	Electronic Thermal Overload Relay (for braking resistor) (Allowable average loss)	[7]	○	×

*1 The frequency of 0.75kHz will be treated as 0.
*2 The value of 999 will be treated as $7FFF_H$.

Table 5.14 List of data format numbers (E codes)

Code	Name	Format number	Support	
			Mini	Eco
E01	Terminal Command Assignment to: [X1]	[1]	○	○
E02	Terminal Command Assignment to: [X2]	[1]	○	○
E03	Terminal Command Assignment to: [X3]	[1]	○	○
E04	Terminal Command Assignment to: [X4]	[1]	×	○
E05	Terminal Command Assignment to: [X5]	[1]	×	○
E10	Acceleration Time 2	[12]	○	×
E11	Deceleration Time 2	[12]	○	×
E20	Status signal Assignment to: [Y1]	[1]	○	○
E21	Status signal Assignment to: [Y2]	[1]	×	○
E22	Status signal Assignment to: [Y3]	[1]	×	○
E24	Relay Contact Output [Y5A/C]	[1]	×	○
E27	Relay Contact Output [30A/B/C]	[1]	○	○
E31	Frequency Detection (FDT) (Detection level)	[3]	○	○
E34	Overload Early Warning/Current Detection (Level)	[24] (FGI)	○	○
		[19] (RTU)	○	○
E35	Overload Early Warning/Current Detection (Timer)	[5]	○	○
E39	Coefficient for Constant Feeding Rate Time	[7]	○	×
E40	PID Display Coefficient A	[12]	○	○
E41	PID Display Coefficient B	[12]	○	○
E43	LED Monitor (Function)	[1]	○	○
E45	LCD Monitor (Item selection)	[1]	×	○
E46	LCD Monitor (Language selection)	[1]	×	○
E47	LCD Monitor (Contrast control)	[1]	×	○
E48	LED Monitor (Speed monitor item)	[1]	○	○
E50	Coefficient for Speed Indication	[5]	○	○
E51	Display Coefficient for Input Watt-hour Data	[45]	×	○
E52	Keypad (Menu display mode)	[1]	○	○
E60	Built-in Potentiometer (Function selection)	[1]	○	×
E61	Analog Input Signal Selection for: [12]	[1]	○	○
E62	Analog Input Signal Selection for: [C1]	[1]	○	○
E63	Analog Input Signal Selection for: [V2]	[1]	×	○
E64	Saving of the Digital Set Frequency	[1]	×	○
E65	Command Loss Detection (Level)	[1] *1	×	○
E80	Detect Low Torque (Detection level)	[1]	×	○
E81	Detect Low Torque (Timer)	[5]	×	○
E98	Terminal Command Assignment to: [FWD]	[1]	○	○
E99	Terminal Command Assignment to: [REV]	[1]	○	○

*1 999 is handled as $7FFF_H$.

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Table 5.15 List of data format numbers (C codes)

Code	Name	Format number	Support	
			Mini	Eco
C01	Jump Frequency 1	[3]	○	○
C02	Jump Frequency 2	[3]	○	○
C03	Jump Frequency 3	[3]	○	○
C04	Jump Frequency (Hysteresis)	[3]	○	○
C05	Multistep Frequency Settings 1	[5]	○	○
C06	Multistep Frequency Settings 2	[5]	○	○
C07	Multistep Frequency Settings 3	[5]	○	○
C08	Multistep Frequency Settings 4	[5]	○	○
C09	Multistep Frequency Settings 5	[5]	○	○
C10	Multistep Frequency Settings 6	[5]	○	○
C11	Multistep Frequency Settings 7	[5]	○	○
C20	Jogging Frequency	[5]	○	×
C21	Timer Operation	[1]	○	×
C30	Frequency Command 2	[1]	○	○
C32	Analog Input Adjustment (Gain for terminal input [12])	[5]	○	○
C33	Analog Input Adjustment (Filter time constant)	[5]	○	○
C34	Analog Input Adjustment (Gain base point)	[5]	○	○
C37	Analog Input Adjustment (Gain for terminal input [C1])	[5]	○	○
C38	Analog Input Adjustment (Filter time constant)	[5]	○	○
C39	Analog Input Adjustment (Gain base point)	[5]	○	○
C42	Analog Input Adjustment (Gain for terminal input [V2])	[5]	×	○
C43	Analog Input Adjustment (Filter time constant)	[5]	×	○
C44	Analog Input Adjustment (Gain base point)	[5]	×	○
C50	Bias (Frequency command 1) (Bias base point)	[5]	○	○
C51	Bias (PID command 1) (Bias value)	[6]	○	○
C52	Bias (PID command 1) (Bias base point)	[5]	○	○
C53	Selection of Normal/Inverse Operation for the Frequcency Command 1	[1]	×	○

Table 5.16 List of data format numbers (P codes)

Code	Name		Format number	Support	
				Mini	Eco
P01	Motor (No. of the poles)		[1]	×	○
P02	Motor (Rated capacity)	When P99 = 0, 3 or 4	[11]	○	○
		When P99 = 1	[25]	○	○
P03	Motor (Rated current)		[24] (FGI)	○	○
			[19] (RTU)	○	○
P04	Motor (Auto-tuning)		[21]	×	○
P06	Motor (No load current)		[24] (FGI)	×	○
			[19] (RTU)	×	○
P07	Motor (%R1)		[5]	×	○
P08	Motor (%X)		[5]	×	○
P09	Motor (Slip compensation gain)		[3]	○	×
P99	Motor Selection		[1]	○	○

Table 5.17 List of data format numbers (H codes)

Code	Name	Format number	Support	
			Mini	Eco
H03	Data Initializing (Data reset)	[1]	○	○
H04	Auto-reset (Times)	[1]	○	○
H05	Auto-reset (Reset interval)	[3]	○	○
H06	Cooling Fan Control	[1]	○	○
H07	Acceleration/Deceleration Pattern	[1]	○	○
H09	Start Mode (Synchronization mode)	[1]	×	○
H11	Deceleration Mode	[1]	×	○
H12	Instantaneous Overcurrent Limiting	[1]	○	○
H13	Auto-restart (Restart time)	[3]	×	○
H14	Auto-restart (Frequency fall rate)	[5] *1	×	○
H15	Auto-restart (Holding DC voltage)	[1]	×	○
H16	Auto-restart (Allowable momentary power failure time)	[3] *1	×	○
H17	Start Mode (Synchronous frequency)	[5]	×	○
H26	PTC Thermistor Input	[1]	○	○
H27	PTC Thermistor Input (Level)	[5]	○	○
H30	Communication Link Operation (Function selection)	[1]	○	○
H42	Capacity of DC Link Bus Capacitor	[1]	○	○
H43	Accumulated Run Time of Cooling Fan	[1]	○	○
H47	Initial Capacity of DC Link Bus Capacitor	[1]	×	○
H48	Accumulated Run Time of Capacitors on the PCB	[1]	×	○
H49	Pick up Start Mode (Pick up start time)	[3]	×	○
H50	Non-linear V/f Pattern (Frequency)	[3]	○	○
H51	Non-linear V/f Pattern (Voltage)	[1]	○	○
H54	ACC/DEC Time (Jogging operation)	[12]	○	×
H56	Deceleration Time for Forced Stop	[12]	×	○
H63	Low Limiter (Select)	[1]	×	○
H64	Low Limiter (Specify the lower limiting frequency)	[3]	○	○
H69	Automatic Deceleration	[1]	○	○
H70	Overload Prevention Control (Frequency drop rate)	[5] *1	○	○
H71	Deceleration Characteristics	[1]	×	○
H80	Gain for Suppression of Output Current Fluctuation for Motor	[5]	○	○
H86	Reserved. *2	[1]	×	○
H87	Reserved. *2	[1]	×	○
H88	Reserved. *2	[3]	×	○
H89	Reserved. *2	[1]	×	○
H90	Reserved. *2	[1]	×	○
H91	Reserved. *2	[1]	×	○
H92	Continue to Run (P component: gain)	[7] *1	×	○
H93	Continue to Run (I component: time)	[7] *1	×	○
H94	Accumulated Run Time of Motor	[1]	×	○
H95	DC Braking (Braking response mode)	[1]	×	○
H96	STOP Key Priority/Start Check Function	[1]	○	○
H97	Clear Alarm Data	[1]	○	○
H98	Protection/Maintenance Function (Specify operation)	[1]	○	○

*1 The value of 999 will be treated as $7FFF_H$.

*2 The H86 through H91 are displayed, but they are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

Table 5.18 List of data format numbers (J codes)

Code	Name	Format number	Support	
			Mini	Eco
J01	PID Control	[1]	○	○
J02	PID Control (Remote process command)	[1]	○	○
J03	PID Control P (Gain)	[7]	○	○
J04	PID Control I (Integration time)	[3]	○	○
J05	PID Control D (Differentiation time)	[5]	○	○
J06	PID Control (Feedback filter)	[3]	○	○
J10	PID Control (Anti reset windup)	[1]	×	○
J11	PID Control (Select alarm output)	[1]	×	○
J12	PID Control (High limit alarm (AH))	[2]	×	○
J13	PID Control (Low limit alarm (AL))	[2]	×	○
J15	PID Control (Stop frequency for slow flowrate)	[1]	×	○
J16	PID Control (Elapsed stop time for slow flowrate)	[1]	×	○
J17	PID Control (Starting frequency)	[1]	×	○
J18	PID Control (Upper limit of PID process output)	[1] *1	×	○
J19	PID Control (Lower limit of PID process output)	[1] *1	×	○
J21	Dew Condensation Protection (Duty)	[1]	×	○
J22	Commercial Line Switching Sequence	[1]	×	○

*1 999 is handled as $7FFF_H$.

Table 5.19 List of data format numbers (y codes)

Code	Name	Format number	Support	
			Mini	Eco
y01	RS485 Communication (Standard) (Station address)	[1]	O	O
y02	RS485 Communication (Standard) (Mode selection on no response error)	[1]	O	O
y03	RS485 Communication (Standard) (Timer)	[3]	O	O
y04	RS485 Communication (Standard) (Baud rate)	[1]	O	O
y05	RS485 Communication (Standard) (Data length)	[1]	O	O
y06	RS485 Communication (Standard) (Parity check)	[1]	O	O
y07	RS485 Communication (Standard) (Stop bits)	[1]	O	O
y08	RS485 Communication (Standard) (No response error detection time)	[1]	O	O
y09	RS485 Communication (Standard) (Response interval)	[5]	O	O
y10	RS485 Communication (Standard) (Protocol selection)	[1]	O	O
y11	RS485 Communication (Option) (Station address)	[1]	×	O
y12	RS485 Communication (Option) (Mode selection on no response error)	[1]	×	O
y13	RS485 Communication (Option) (Timer)	[3]	×	O
y14	RS485 Communication (Option) (Baud rate)	[1]	×	O
y15	RS485 Communication (Option) (Data length)	[1]	×	O
y16	RS485 Communication (Option) (Parity check)	[1]	×	O
y17	RS485 Communication (Option) (Stop bits)	[1]	×	O
y18	RS485 Communication (Option) (No response error detection time)	[1]	×	O
y19	RS485 Communication (Option) (Response interval)	[5]	×	O
Y20	RS485 Communication (Option) (Protocol selection)	[1]	×	O
y98	Bus Link Function	[1]	×	O
y99	Loader Link Function	[1]	O	O

Table 5.20 List of data format numbers (S codes)

Code	Name	Format number	Support	
			Mini	Eco
S01	Frequency command (p.u.)	[29]	O	O
S05	Frequency command	[22]	O	O
S06	Operation command	[14]	O	O
S07	Universal D0	[15]	×	O
S08	Acceleration time	[3]	O	O
S09	Deceleration time	[3]	O	O
S12	Universal A0	[29]	×	O
S13	PID command	[29]	O	O
S14	Alarm reset command	[1]	O	O

Table 5.21 List of data format numbers (M codes)

Code	Name		Format number	Support	
				Mini	Eco
M01	Frequency command (p.u.) (final command)		[29]	○	○
M05	Frequency command (final command)		[22]	○	○
M06	Output frequency 1 (p.u.)		[29]	○	○
M07	Output torque		[6]	×	○
M09	Output frequency 1		[23] (FGI)	○	○
			[22] (RTU)	○	○
M10	Input power		[5]	○	○
M11	Output current effective value		[5]	○	○
M12	Output voltage effective value		[3]	○	○
M13	Operation command (final command)		[14]	○	○
M14	Operation status		[16]	○	○
M15	General-purpose output terminal information		[15]	○	○
M16	Latest alarm contents		[10]	○	○
M17	Last alarm contents		[10]	○	○
M18	Second last alarm contents		[10]	○	○
M19	Third last alarm contents		[10]	○	○
M20	Cumulative operation time		[1]	○	○
M21	DC link circuit voltage		[1]	○	○
M23	Model code		[17]	○	○
M24	Capacity code	When P99 = 0, 3 or 4	[11]	○	○
		When P99 = 1	[25]	○	○
M25	ROM version		[35]	○	○
M26	Transmission error transaction code		[20]	○	○
M27	Frequency command on alarm (p.u.) (final command)		[29]	○	○
M31	Frequency command on alarm (final command)		[22]	○	○
M32	Output frequency 1 on alarm (p.u.)		[29]	○	○
M33	Output torque on alarm		[6]	×	○
M35	Output frequency 1 on alarm		[23] (FGI)	○	○
			[22] (RTU)	○	○
M36	Input power on alarm		[5]	○	○
M37	Output current effective value on alarm		[5]	○	○
M38	Output voltage effective value on alarm		[3]	○	○
M39	Operation command on alarm		[14]	○	○

Table 5.21 List of data format numbers (M codes) (Continued)

Code	Name	Format number	Support	
			Mini	Eco
M40	Operation status on alarm	[16]	○	○
M41	General-purpose output terminal information on alarm	[15]	○	○
M42	Cumulative operation time on alarm	[1]	○	○
M43	DC link circuit voltage on alarm	[1]	○	○
M44	Inverter internal air temperature on alarm	[1]	×	○
M45	Heat sink temperature on alarm	[1]	○	○
M46	Life of main circuit capacitor	[3]	○	○
M47	Life of PC board electrolytic capacitor	[1]	○	○
M48	Life of heat sink	[1]	○	○
M49	Input terminal voltage ([12])	[29]	○	○
M50	Input terminal current ([C1])	[29]	○	○
M54	Input terminal voltage ([V2])	[29]	×	○
M61	Inverter internal air temperature	[1]	×	○
M62	Heat sink temperature	[1]	○	○
M63	Load rate	[6]	×	○
M64	Motor output	[6]	×	○
M65	Motor output on alarm	[6]	×	○
M68	PID final command	[29]	○	○
M69	Inverter rated current	[24] (FGI)	○	○
		[19] (RTU)	○	○
M70	Operation status 2	[44]	○	○
M71	Input terminal information	[14]	○	○
M72	PID feedback	[29]	×	○
M73	PID output	[29]	×	○

Chap. 5 FUNCTION CODES AND DATA FORMATS

Table 5.22 List of data format numbers

Code	Name	Format number	Support	
			Mini	Eco
W01	Operation status	[16]	○	○
W02	Frequency command	[22]	○	○
W03	Output frequency (before slip compensation)	[22]	○	○
W04	Output frequency (after slip compensation)	[22]	○	×
W05	Output current	[24] (FGI)	○	○
		[19] (RTU)	○	○
W06	Output voltage	[3]	○	○
W07	Torque operation value	[2]	×	○
W08	Motor speed	[37]	×	○
W09	Load rotation speed	[37]	○	○
W10	Line speed	[37]	○	○
W11	PID process command	[12]	○	○
W12	PID feedback value	[12]	○	○
W16	Motor speed set value	[37]	×	○
W17	Load speed set value	[37]	○	○
W18	Line speed set value	[37]	○	×
W19	Constant feed time set value	[37]	○	×
W20	Constant feed time	[37]	○	×
W21	Input power	[24]	○	○
W22	Motor output power	[24]	×	○
W23	Load factor	[2]	×	○
W27	Timer operation remaining time	[1]	○	×
W28	Operation command source	[1]	○	○
W29	Frequency, PID command source	[1]	○	○
W30	Speed (unit: %)	[3]	×	○
W31	Speed setting (unit: %)	[3]	×	○
W32	PID output	[12]	×	○
W33	Analog input monitori	[12]	×	○
W40	Control circuit terminal (input)	[43]	○	○
W41	Control circuit terminal (output)	[15]	○	○
W42	Communications control signal (input)	[14]	○	○
W43	Communications control signal (output)	[15]	○	○
W44	Terminal [12] input voltage	[4]	○	○
W45	Terminal [C1] input current	[4]	○	○
W46	FMA output voltage	[3]	○	○
W47	FMP output voltage	[3]	×	○
W48	FMP output frequency	[1]	×	○
W49	Terminal [V2] input voltage	[4]	×	○
W50	FMA output current	[3]	×	○
W70	Cumulative operation time	[1]	○	○
W71	DC link circuit voltage	[1]	○	○
W72	Maximum temperature of internal air	[1]	×	○
W73	Maximum temperature of heat sink	[1]	○	○
W74	Maximum effective current value	[24] (FGI) [19] (RTU)	○	○
W75	Capacitor of the DC bus capacitor	[3]	○	○
W76	Cumulative operation time of electrolytic capacitor on PC board	[1]	○	○

Table 5.22 List of data format numbers (Continued)

Code	Name	Format number	Support	
			Mini	Eco
W77	Cumulative operation time of cooling fan	[1]	○	○
W78	Number of startups	[1]	○	○
W79	Cumulative operation time of motor	[1]	×	○
W80	Standard fan life	[1]	×	○
W81	Integral electric power consumption	[45]	×	○
W82	Integral electric power consumption data	[45]	×	○
W83	Number of RS485 Ch1 errors	[1]	○	○
W84	Contents of RS485 Ch1 error	[20]	○	○
W85	Number of RS485 Ch2 errors	[1]	×	○
W87	Inverter's ROM version	[35]	○	○
W89	Remote/multi-function keypad ROM version	[35]	○	○
W90	Option ROM version	[35]	×	○
W94	Content of RS485 Ch2 error	[20]	×	○
W95	Number of option communications errors	[1]	×	○
W96	Content of option communications error	[1]	×	○

Table 5.23 List of data format numbers (X codes)

Code	Name	Format number	Support	
			Mini	Eco
X00	Alarm history (latest)	[41]	○	○
X01	Multiple alarm 1 (latest)	[40]	○	○
X02	Multiple alarm 2 (latest)	[40]	○	○
X03	Sub-code	[1]	×	○
X05	Alarm history (last)	[41]	○	○
X06	Multiple alarm 1 (last)	[40]	○	○
X07	Multiple alarm 2 (last)	[40]	○	○
X08	Sub-code	[1]	×	○
X10	Alarm history (second last)	[41]	○	○
X11	Multiple alarm 1 (second last)	[40]	○	○
X12	Multiple alarm 2 (second last)	[40]	○	○
X13	Sub-code	[1]	×	○
X15	Alarm history (third last)	[41]	○	○
X16	Multiple alarm 1 (third last)	[40]	○	○
X17	Multiple alarm 2 (third last)	[40]	○	○
X18	Sub-code	[1]	×	○
X20	Latest information on alarm (output frequency)	[22]	○	○
X21	(output current)	[24] (FGI)	○	○
		[19] (RTU)	○	○
X22	(output voltage)	[1]	○	○
X23	(torque operation value)	[6]	×	○
X24	(set frequency)	[22]	○	○
X25	(operation status)	[16]	○	○
X26	(cumulative operation time)	[1]	○	○
X27	(number of startups)	[1]	○	○
X28	(DC link circuit voltage)	[1]	○	○
X29	(internal air temperature)	[1]	×	○
X30	(heat sink temperature)	[1]	○	○
X31	(control circuit terminal (input))	[43]	○	○
X32	(control circuit terminal (output))	[15]	○	○
X33	(communications control signal (input))	[14]	○	○
X34	(communications control signal (output))	[15]	○	○
X60	Last information on alarm (output frequency)	[22]	○	○
X61	(output current)	[24] (FGI)	○	○
		[19] (RTU)	○	○
X62	(output voltage)	[1]	○	○
X63	(torque operation value)	[6]	×	○
X64	(set frequency)	[22]	○	○
X65	(operation status)	[16]	○	○
X66	(cumulative operation time)	[1]	○	○
X67	(number of startups)	[1]	○	○
X68	(DC link circuit voltage)	[1]	○	○
X69	(internal air temperature)	[1]	×	○
X70	(heat sink temperature)	[1]	○	○
X71	(control circuit terminal (input))	[43]	○	○
X72	(control circuit terminal (output))	[15]	○	○
X73	(communications control signal (input))	[14]	○	○
X74	(communications control signal (output))	[15]	○	○

Table 5.24 List of data format numbers (Z codes)

Code	Name		Format number	Support	
				Mini	Eco
Z00	Second last information on alarm	(output frequency)	[22]	○	○
Z01		(output current)	[24] (FGI)	○	○
			[19] (RTU)	○	○
Z02		(output voltage)	[1]	○	○
Z03		(torque operation value)	[6]	×	○
Z04		(set frequency)	[22]	○	○
Z05		(operation status)	[16]	○	○
Z06		(cumulative operation time)	[1]	○	○
Z07		(number of startups)	[1]	○	○
Z08		(DC link circuit voltage)	[1]	○	○
Z09		(internal air temperature)	[1]	×	○
Z10		(heat sink temperature)	[1]	○	○
Z11		(control circuit terminal (input))	[43]	○	○
Z12		(control circuit terminal (output))	[15]	○	○
Z13		(communications control signal (input))	[14]	○	○
Z14		(communications control signal (output))	[15]	○	○
Z50	Third last information on alarm	(output frequency)	[22]	○	○
Z51		(output current)	[24] (FGI)	○	○
			[19] (RTU)	○	○
Z52		(output voltage)	[1]	○	○
Z53		(torque operation value)	[6]	×	○
Z54		(set frequency)	[22]	○	○
Z55		(operation status)	[16]	○	○
Z56		(cumulative operation time)	[1]	○	○
Z57		(number of startups)	[1]	○	○
Z58		(DC link circuit voltage)	[1]	○	○
Z59		(internal air temperature)	[1]	×	○
Z60		(heat sink temperature)	[1]	○	○
Z61		(control circuit terminal (input))	[43]	○	○
Z62		(control circuit terminal (output))	[15]	○	○
Z63		(communications control signal (input))	[14]	○	○
Z64		(communications control signal (output))	[15]	○	○

5.2.2 Data format specifications

The data in the data fields of a communications frame are 16 bits long, binary data, as shown below.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16-bit binary data															

For the convenience of description, 16-bit data is expressed in hexadecimal with one upper-order byte (eight bits from 15 to 8) and one lower-order byte (eight bits from 7 to 0).

For example, the following data is 1234H in hexadecimal and expressed as | 12_H | 34_H | .

0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Data format [1] Integer data (positive): Minimum step 1

(Example) When F05 (base) frequency voltage = 200V

200 = $00C8_H$ Consequently ⇒ | 00_H | $C8_H$ |

Data format [2] Integer data (positive/negative): Minimum step 1

(Example) When the value is -20

-20 = $FFEC_H$ Consequently, ⇒ | FF_H | EC_H |

Data format [3] Decimal data (positive): Minimum step 0.1

(Example) When F17 (gain frequency set signal) = 100.0%

100.0 x 10 = 1000 = $03E8_H$ Consequently, ⇒ | 03_H | $E8_H$ |

Data format [4] Decimal data (positive/negative): Minimum step 0.1

(Example) When C31 (analog input offset adjustment) = -5.0%

-5.0 x 10 = -50 = $FFCE_H$ Consequently, ⇒ | FF_H | CE_H |

Data formant [5] Decimal data (positive): Minimum step 0.01

(Example) C05 (multistep frequency) = 50.25Hz

50.25 x 100 =5025 =$13A1_H$ Consequently, ⇒ | 13_H | $A1_H$ |

Data format [6] Decimal data (positive/negative): Minimum step 0.01

(Example) When M07 (actual torque value) = -85.38%

-85.38 x 100 =-8538 = $DEA6_H$ Consequently, ⇒ | DE_H | $A6_H$ |

Data format [7] Decimal data (positive): Minimum step 0.001

(Example) When F51(electronic thermal (permissible loss)) = 0.105kW

0.105 x 1000 = 105 = 0069_H Consequently, ⇒

00_H	69_H

Data formant [8] Decimal data (positive/negative): Minimum step 0.001

(Example) When the data is -1.234

-1.234 x 1000 = -1234 = $FB2E_H$ Consequently, ⇒

FB_H	$2E_H$

Data format [10] Alarm codes

Table 5.25 List of alarm codes

Code	Description		Code	Description	
0	No alarm	---	22	Braking resistor overheat	dbH
1	Overcurrent (during acceleration)	OC1	23	Motor overload	OL1
2	Overcurrent (during deceleration)	OC2	25	Inverter overload	OLU
3	Overcurrent (during constant speed operation)	OC3	31	Memory error	Er1
5	Ground fault	EF	32	Keypad communications error	Er2
6	Overvoltage (during acceleration)	OU1	33	CPU error	Er3
7	Overvoltage (during deceleration)	OU2	34	Option communications error	Er4
8	Overvoltage (during constant speed operation or stopping)	OU3	35	Option error	Er5
10	Undervoltage	LU	36	Run operation error	Er6
11	Input phase loss	Lin	37	Tuning error	Er7
14	Fuse blown	FUS	38	RS485 Ch1 communications error	Er8
16	Charging circuit fault	PbF	46	Output phaseloss	OPL
17	Heat sink overheat	OH1	51	Data save error on insufficient voltage	ErF
18	External alarm	OH2	53	RS485 Ch2 communications error	ErP
19	Internal air overheat	OH3	54	LSI error (power PCB)	ErH
20	Motor protection (PTC thermistor)	OH4			

(Example) In the case of overvoltage (during acceleration) (OU1)

6 = 0006_H Consequently, ⇒

00_H	06_H

Data format [11] Capacity code (unit: kW)

As shown in the table below, the capacity (kW) is multiplied by 100.

Table 5.26 Capacities and data

Capacity (kW)	Data	Capacity (kW)	Data	Capacity (kW)	Data
0.06	6	22	2200	280	28000
0.1	10	30	3000	315	31500
0.2	20	37	3700	355	35500
0.4	40	45	4500	400	40000
0.75	75	55	5500	450	45000
1.5	150	75	7500	500	50000
2.2	220	90	9000	550	55000
3.7	370	110	11000	600	60000
5.5	550	132	13200	650	60650
7.5	750	160	16000	700	60700
11	1100	200	20000	750	60750
15	1500	220	22000	800	60800
18.5	1850	250	25000	1000	61000

(Example) When the capacity is 2.2 kW

2.20 x 100 = 220 = $00DC_H$ Consequently, ⇒

00_H	DC_H

Data format [12] Floating point data (accel./decal. time, PID display coefficient)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polarity	0	0	0	Exponent		Mantissa									
	Unused														

Polarity: 0 → Positive (+), 1 → Negative (-) Exponent: 0 to 3 Mantissa: 1 to 999

Value expressed in this form = (polarity) Mantissa x (Exponent - 2) power of 10

Value	Mantissa	Exponent	(Exponent - 2) power of 10
0.01 to 9.99	1 to 999	0	0.01
10.0 to 99.9	100 to 999	1	0.1
100 to 999	100 to 999	2	1
1000 to 9990	100 to 999	3	10

(Example) When F07 (acceleration time 1) = 20.0 seconds

20.0 = 200 x 0.1 => $0000\ 0100\ 1100\ 1000_b$ = $04C8_H$ ⇒
Consequently,

04_H	$C8_H$

Data format [14] Operation command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RST	XR (REV)	XF (FWD)	0	0	0	0	0	0	X5	X4	X3	X2	X1	REV	FWD
↑ Alarm reset	General-purpose input		Unused		General-purpose input									FWD: Forward command REV: Reverse command	

(All bits are turned ON when set to 1.)

(Example) When S06 (operation command) = FWD, X1 = ON

0000 0000 0000 0101_b = 0005_H Consequently, ⇒

00_H	05_H

Data format [15] General-purpose output terminal

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	30	0	0	0	Y5	0	Y3	Y2	Y1
Unused							↑ Alarm (general-purpose output)	Unused			General-purpose output				

(All bits are turned ON when set to 1.)

(Example) When M15 (general-purpose output terminal) = Y1 = ON

0000 0000 0000 0001_b = 0001_H Consequently, ⇒

00_H	01_H

Data format [16] Operation status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	0	0	RL	ALM	DEC	ACC	IL	VL	0	NUV	BRK	INT	EXT	REV	FWD

(All bits are turned ON or become active when set to 1.)

FWD : During forward rotation
REV : During reverse rotation
EXT : During DC braking (or during pre-exciting)
INT : Inverter shut down
BRK : During braking (fixed to 0 for FRENIC-Mini)
NUV : DC link circuit voltage established (0 = undervoltage)
VL : During voltage limiting
IL : During current limiting
ACC : During acceleration
ALM : Alarm relay (for any fault)
RL : Communications effective
BUSY : During function code data writing

Data format [17] Model code

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Model				Generation				Destination				Input power supply			

Table 5.27 List of model codes

Code	1	2	3	4	5	6	7	8	9	A	B
Model	VG	G	P	E	C	S	DPS	DGS	H (1667Hz)	H (3000Hz)	F
Generation	11 series	7 series	1 series								
Destination	Japan (standard)	Asia	China	Europe	U.S.A.						
Input power supply	Single-phase 100V	Single-phase 200V	Three-phase 200V	Three-phase 400V							

(Example) When the inverter type is FRN1.5C 1 S-2 J

- Destination: Japan
- Input power supply: 3-phase 200V
- Structure: Standard
- Generation: 1 series
- Model: C

Since "model ":C is represented by code 5, "generation": 1 series by code 3, "destination": Japan (standard) by 1, and "input power supply": 3-phase 200V by 3, the model code is 5313_H.

Data format [19] Current value

Current values are decimal data (positive). The minimum step is 0.01 for an inverter capacity of 22kW (30HP) or less and 0.1 for an inverter capacity of 30kW (40HP) or more.

When inverter capacity is 22kW (30HP) or less, any data higher than 655A cannot be written. No correct value can be read out when a direction for write data higher than 655A is issued.

Current data is rounded down on and after the fifth digit inside the inverter. (Ex.: When a writing direction of 107.54A is issued to an inverter with a capacity of 22kW (30HP), 107.5A is written.)

(Ex.) When F11 (electronic thermal operation level) = 107.0A (40HP)

$107.0 \times 10 = 1070 = 042E_H$, consequently ⇒

04_H	$2E_H$

(Ex.) When F11 (electronic thermal operation level) = 3.60A (1HP)

$3.60 \times 10 = 360 = 0168_H$, consequently ⇒

01_H	68_H

Data format [20] Communications error

Table 5.28 Communications error codes (common to both protocols)

Code	Description	Code	Description
71	Checksum error, CRC error ⇒ No response	73	Framing error, overrun error, buffer full ⇒ No response
72	Parity error ⇒ No response		

Table 5.29 Communications error codes (for Fuji general-purpose inverter protocol)

Code	Description	Code	Description
74	Format error	78	Function code error
75	Command error	79	Write disabled
76	Link priority error	80	Data error
77	Function code data write right error	81	Error during writing

Table 5.30 Communications error codes (for RTU protocol)

Code	Description	Code	Description
1	Improper 'FC'	3	Improper data (range error)
2	Improper address (function code error)	7	NAK (link priority, no right, write disabled)

(Example) In case of an improper address

2 = 0002_H Consequently, ⇒

00_H	02_H

Data format [21] Auto tuning (not supported by FRENIC-Mini)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	REV	FWD	Data part							
Not used															

When FWD is 1, this data is the forward rotation command. When REV is 1, this data is the reverse rotation command. However, if both FWD and REV are 1, the command is not effective. Both FWD and REV are 0 for reading.

(Ex.) When P04 (motor 1 automatic tuning) = 1 (forward rotation),

$0000\ 0001\ 0000\ 1001_b = 0101_H$ Consequently, ⇒

01_H	01_H

Data format [22] Frequency data

Decimal data (positive): Resolution 0.01Hz

Data format [23] Polarity + decimal data (positive)

(for Fuji general-purpose inverter protocol)

Decimal data (positive): Resolution 0.01Hz

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
16-bit binary data ⇒ 4-digit ASCII code															

For reverse rotation, add a negative sign (-) (ASCII) to the special additional data in the standard frame, or for forward rotation, enter a space (ASCII).

(Example) When maximum output frequency = 60Hz and M09 (output frequency) = 60.00Hz (forward rotation)

$60.00 \times 100 = 6000 = 1770_H$ Consequently, ⇒

	1	7	7	0

(Positive data is in the same data format as data format [5].)

Data format [24] Floating point data

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent		Mantissa													

Exponent: 0-3 Mantissa: 1 to 9999

The value expressed by this format = the mantissa $\times$ $10^{(exponent-2)}$

Numeric value	Mantissa	Exponent	$10^{(exponent-2)}$
0.01 to 99.99	1 to 9999	0	0.01
100.0 to 999.9	1000 to 9999	1	0.1
1000 to 9999	1000 to 9999	2	1
10000 to 99990	1000 to 9999	3	10

Data format [25] Capacity code (for HP)

As shown in the table below, the capacity (HP) is multiplied by 100.

Table 5.31 Capacities and data (for HP)

Code	Capacity (HP)	Code	Capacity (HP)	Code	Capacity (HP)
7	0.07 (reserved)	3000	30	40000	400
15	0.15 (reserved)	4000	40	45000	450
25	0.25	5000	50	50000	500
50	0.5	6000	60	60000	600
100	1	7500	75	60700	700
200	2	10000	100	60750	750
300	3	12500	125	60800	800
500	5	15000	150	60850	850
750	7.5	17500	175	60900	900
1000	10	20000	200	60950	950
1500	15	25000	250	61000	1000
2000	20	30000	300	61050	1050
2500	25	35000	350		

(Example) When the capacity is 3HP

3 x 100 = 300 = $012C_H$ Consequently, ⇒ | 01_H | $2C_H$ |

Data format [29] Positive/Negative data of values converted into standard (p.u.) with 20,000

(Example) Speed (frequency) Data of ±20,000/±maximum speed (frequency)

Data format [35] ROM version

Range: 0 to 9999

Data format [37] Floating point data (load rotation speed, etc.)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent		Mantissa													

Exponent: 0-3 Mantissa: 1 to 9999

The value expressed by this format = the mantissa $\times$ $10^{(\text{exponent-2})}$

Numeric value	Mantissa	Exponent	$10^{(\text{exponent-2})}$
0.01 to 99.99	1 to 9999	0	0.01
100.0 to 999.9	1000 to 9999	1	0.1
1000 to 9999	1000 to 9999	2	1
10000 to 99990	1000 to 9999	3	10

Data format [41] Alarm history

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Number of serial occurrences of same alarm								Alarm code (See Table 5.25.)							

Indicates the content of an alarm that has occurred and the number of serial occurrence times of the alarm.

Data format [43] Operation command (for I/O check)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	X5	X4	X3	X2	X1	REV	FWD
Unused						General-purpose input								General-purpose input	

(All bits are turned ON when set to 1.)

Data format [44] Operation status 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	IDL	ID	OLP	LIFE	OH	TRY	FAN	KP	OL	IPF	0	RDY	FDT	FAR

(All bits are turned ON or become active when set to 1.)

FAR: Frequency arrival signal
FDT: Frequency level detection
RDY: Inverter ready to run
IPF: Auto-restarting after recovery of power
OL: Motor overload early warning
KP: Running per keypad
FAN: Cooling fan in operation
TRY: Retry in operation
OH: Heat sink overheat early warning
LIFE: Lifetime alarm
OLP: Overlaod prevention control
ID: Current detection
IDL: Low level current detection
However, RDY, KP, FAN, and OH are not supported by FRENIC-Mini.

Data format [45] Floating point data

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent		Mantissa													

Exponent: 0-3 Mantissa: 1 to 9999

The value expressed by this format = the mantissa $\times$ $10^{(exponent-3)}$

Numeric value	Mantissa	Exponent	$10^{(exponent-3)}$
0.001 to 9.999	1 to 9999	0	0.001
10.0 to 99.9	1000 to 9999	1	0.01
100.0 to 999.9	1000 to 9999	2	0.1
1000 to 9999	1000 to 9999	3	1

FRENIC-Mini
FRENIC-Eco

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