Ethernet/IP & Modbus-TCP

For RSi GM2Series Variable Frequency Drive

Instruction Manual

890054-02-00

BENSHAW
Applied Motor Controls

Safety Information

- Always follow safety instructions to prevent accidents and potentially hazardous situations.
- Safety precautions are classified into “WARNING” and “CAUTION,” and their meanings are as follows:

⚠ Warning

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

⚠ Caution

Indicates a potentially hazardous situation, which, if not avoided, may cause minor injury or damage to the product.

- Symbols used in this document and on the product indicate the following.

⚠ Read and follow the instructions carefully to avoid dangerous situations.

⚠ Presence of "dangerous voltage" inside the product that may cause harm or electric shock.

- Keep the operating instructions handy for quick reference.
- Read the operating instructions carefully to fully understand the functions of the GM2 series inverters and use them properly.

⚠ Caution

- **Be careful not to damage the CMOS elements on the communication board.**
  Static charge may cause malfunctioning of the product.
- **Turn off the inverter before connecting communication cables.**
  Otherwise, the module may be damaged or a communication error may result.
- **Correctly align the communication board to the installation connector for installation and ensure that it is firmly connected to the inverter.**
  Otherwise, the module may be damaged or a communication error may result.
- **Check the parameter units when configuring the parameter values.**
  Otherwise, a communication error may occur.

Table of Contents

1 Overview

The Ethernet/IP & Modbus-TCP communication board allows the GM2 inverter to connect to an EtherNet network that is compliant with international standards*. The communication board supports two protocols: EtherNet/IP, and Modbus TCP.

By utilizing the 100 Mbps auto negotiation feature, the communication board provides real-time network communication without collisions and allows for controlling and monitoring of the inverter via PLC sequence programs or a Modbus master module.

Compatible with GM2 inverter OS version V1.22 or higher (parameter dr.97).

With simple network cable wiring, installation times can be reduced and maintenance becomes easier.

*Ref.: IEC 61158 Type 21 , and IEC 62439, RRP.

2 Technical Specifications

Items	Description	
Communication Protocol	EtherNet/IP, Modbus TCP	
Communication speed	100Mbps	
Communication type	Auto negotiation	
Communication range	100 m (twisted pair)	
Service	Smart scaling	Up to 8 words
Max. number of stations	64 stations	
Topology	Line/Ring topology	
Communication range	100 m (twisted pair)	
Recommended cable	UTP, FTP, STP	

3 Package Components

Benshaw Part #: PC-100093-00

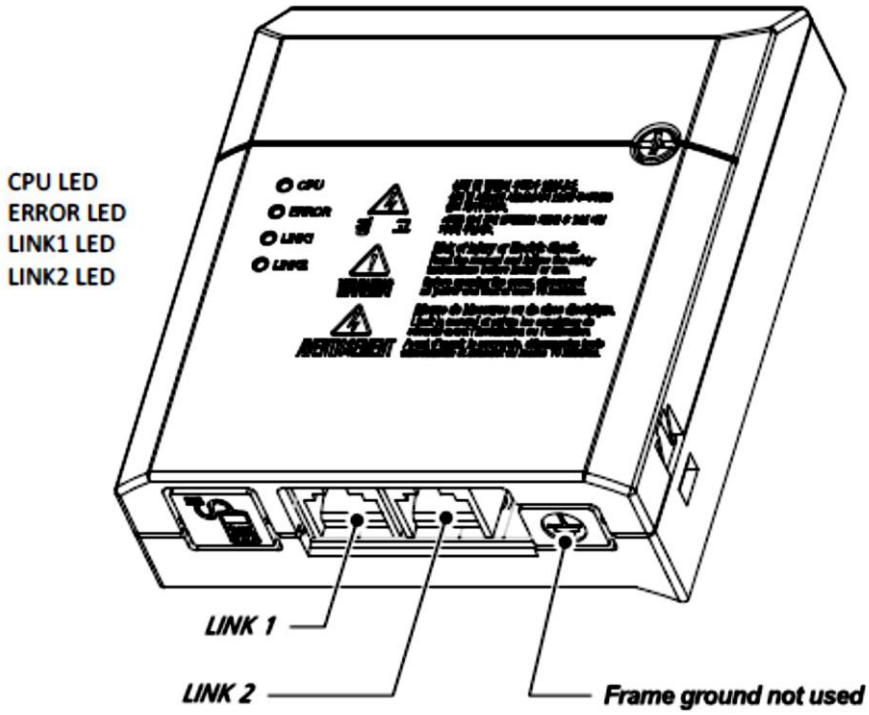
The product package contains:

- 1 x Communication board
- 1 x Mounting screw
- 1 x Communication board Instruciton Manual
- 1 x RJ45 cable (for internal use)

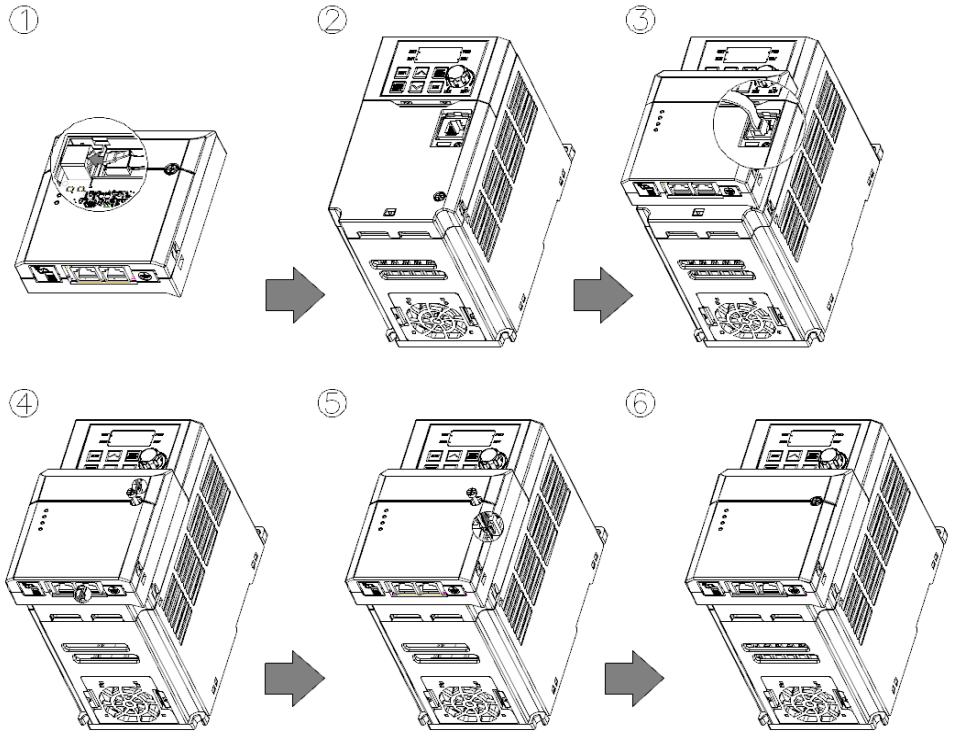
Note: EDS file for Ethernet required. Download at Benshaw.com.

4 Board Layout and Installation

4.1 Layout



4.2 Installation



1 Connect the included RJ-45 cable to communication board.

2 Remove the front cover from the GM2 inverter.

3 Connect the communication module to the GM2 inverter using the included RJ-45 network cable.

4 Hook up the communication module to the installation slot on the inverter.

5 Install and tighten the screw provided with the communication module.

6 The communication module has been connected to the GM2 inverter.

⚠ Warning

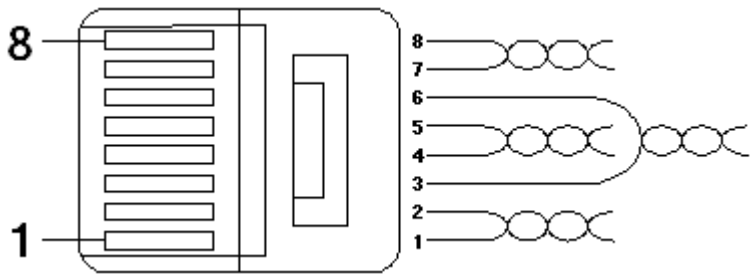
- Do not install or remove the communication board to or from the GM2 inverter while the inverter is turned on.
- Ensure that the charge in the capacitors inside the inverter is completely discharged before installing or uninstalling the communication board.
- Ensure that the RJ-45 cable is firmly fixed to the inverter and the option board.
- Frame ground (FG) should not be used on the communication option boards.

5 Network Connection

5.1 Cable Wiring

Pin no.	Signal	Description	Cable color
1	TX+	Data transmission (+)	White/Yellow
2	TX-	Data transmission (-)	Yellow
3	RX+	Data reception (+)	White/Green
4	NONE	Not used	Blue
5	NONE	Not used	White/Blue
6	RX-	Data reception (-)	Green
7	NONE	Not used	White/Brown
8	NONE	Not used	Brown

5.2 Cable Connector



** The cables connected to pin 1 and pin 2 must be twisted in a pair.
** The cables connected to pin 3 and pin 6 must be twisted in a pair.

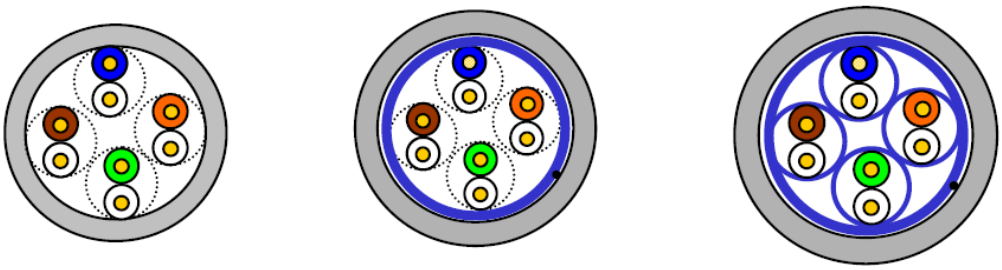
6 Network Cable Specifications

6.1 Frequency Band

There are five types of UTP cable specifications according to different applications, from category 1 through category 5. Category 5 network cables are required for utilizing the communication board.

Category 5 network cables support a frequency band up to 100 MHz, with up to 60 MHz channel performance and up to 100 Mbps data transmission speed.

6.2 Twisted Pair Cable Types



UTP FTP STP

Category	Description	Specifications/Usage
UTP (U.UTP)	Unshielded Twisted Pair cable for high speed signals	200 MHz max. Voice + Data + Low quality video signals
FTP (S.UTP)	Single insulation for the cable core * Insulation material: AL / Plastic complex foil or copper braid	100 MHz max. Protection against EMI, electrically stable Voice + Data + Low quality video signals
STP (S.STP)	Dual insulation for the pair and the cable core * Material for cable pair insulation: AL/Plastic complex foil * Material for cable core insulation: AL / Plastic complex foil or copper braid	500MHz max. Voice + Data + Video signals Replaces 75Ω coaxial cable

7 Inverter Communication Addresses

Refer to “Chapter 7, RS-485 Communication Features” and “Chapter 8, Table of Functions” of the “GM2 Instruction Manual” for details.

8 Keypad Parameters

The following table lists the inverter parameters related to EtherNet/IP and Modbus-TCP communication features. Application types for each parameter is specified in the “Protocol” column: E (EtherNet/IP) or M (Modbus TCP).

Setting Start/Stop: Using the keypad, set drv parameter (Cmd Source) to “4 (Fieldbus)” if you want to operate (start/stop) the GM2 inverter via communications.

Setting Frequency Reference: Using the keypad, set Frq parameter (Frq Ref Src) to “8 (Fieldbus)” if you want to provide the frequency reference via communications.

Keypad parameters related to GM2 communication board					
Code No.	**Parameter Name**	**Initial Value**	**Range**	**Description**	**Protocol**
drv	Cmd Source	1	0 – 4	4: Set to “Field Bus.”	E/M
Frq	Freq Ref Src	0	0 – 8	8: Set to “Field Bus.”	E/M
CM-06	FBus S/W Ver	-	-	Indicates the version of the installed option board.	E/M
CM-07	FBus ID	1	0 – 255	Set the station number of the communication board.	E
CM-09	FBus Led			Displays the on/off status of the LED indicators on the communication board.	E/M
CM-10	Opt Parameter1	192	0 – 255	Sets the IP address.	E/M
CM-11	Opt Parameter2	168	0 – 255		
CM-12	Opt Parameter3	1	0 – 255		
CM-13	Opt Parameter4	101	0 – 255		
CM-14	Opt Parameter5	255	0 – 255	Set the subnet mask.	E/M
CM-15	Opt Parameter6	255	0 – 255		
CM-16	Opt Parameter7	255	0 – 255		
CM-17	Opt Parameter8	0	0 – 255		
CM-18	Opt Parameter9	192	0 – 255	Sets the Gateway address.	E/M
CM-19	Opt Parameter 10	168	0 – 255		
CM-20	Opt Parameter 11	1	0 – 255		
CM-21	Opt Parameter 12	10	0 – 255		
CM-22	Opt Parameter 13	0	0	Set the network communication speed. (fixed to 100 Mbps Auto)	E/M
CM-23	Opt Parameter 14	1	0 – 11	CIP Input Instance	E
CM-24	Opt Parameter 15	1	0 – 11	CIP Output Instance	E
CM-25	Opt Parameter 16	2	0 – 2	0: RAPIEnet Disable	E

Ref.

After making changes to parameter CM-07 and parameters CM-10 – 25, you must set CM-94 (Comm-Update) to “1 (Yes)” to save the changes. If CM-94 [Comm-Update] has not been set after making the parameter changes, the LED indicator will flash in red at 2-second intervals to warn the user.

Keypad parameters related to GM2 communication board					
Code No.	Parameter Name	Initial Value	Range	Description	Protocol
CM-30	Para Status Num	3	0 – 8	Automatically set according to the CIP Input Instance.	E
CM-31	Para Status-1	000A	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-32	Para Status-2	000E	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-33	Para Status-3	000F	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-34	Para Status-4	-	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-35	Para Status-5	-	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-36	Para Status-6	-	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-37	Para Status-7	-	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-38	Para Status-8	-	0x0000 -0xFFFF	Sets up the inverter data address to be read by the client. (Hex.)	E
CM-50	Para Ctrl Num	2	0 – 8	Automatically set according to the CIP Output Instance.	E
CM-51	Para Control-1	0005	0x0000 -0xFFFF	Sets up the client’s command address. (Hex.)	E
CM-52	Para Control-2	0006	0x0000 -0xFFFF	Sets up the client’s command address. (Hex.)	E
CM-53	Para Control-3	-	0x0000	Sets up the client’s	E

Keypad parameters related to GM2 communication board					
			-0xFFFF	command address. (Hex.)	
CM-54	Para Control-4	-	0x0000 -0xFFFF	Sets up the client's command address. (Hex.)	E
CM-55	Para Control-5	-	0x0000 -0xFFFF	Sets up the client's command address. (Hex.)	E
CM-56	Para Control-6	-	0x0000 -0xFFFF	Sets up the client's command address. (Hex.)	E
CM-57	Para Control-7	-	0x0000 -0xFFFF	Sets up the client's command address. (Hex.)	E
CM-58	Para Control-8	-	0x0000 -0xFFFF	Sets up the client's command address. (Hex.)	E
CM-94	Comm Update	0	0: NO 1: YES	Update keypad parameters related to network communication.	E/M
Pr-12	Lost Cmd Mode Note 1	None	0: None 1: Free-Run 2: Dec 3: Hold Input 4: Hold Output 5: Lost Preset	Set the inverter operation for when a Lost Command has occurred. (Note1)	E/M
Pr-13	Lost Cmd Time	1.0	0.1 – 120	Lost Command trigger time	E/M
Pr-14	Lost Preset F	0.00	0.05 – 60.00	Sets the Lost Preset speed	E/M

Note1: Pr-12, Lost Command Mode

Set value	Function
"None"	Maintains the previous status.
"Free-Run"	Lost Command Trip occurs and a free run stop is made.
"Dec"	Lost Command Trip occurs and a deceleration stop is made.
"Hold Input"	Lost Command Warning occurs and the inverter operates with the previous speed reference.
"Hold Output"	Lost Command Warning occurs and the inverter operates with the previous running speed.
"Lost Preset"	Lost Command Warning occurs and the inverter operates with speed reference set at Pr-14.

9 Description of Keypad Parameters

9.1 Description of Keypad Parameters (simplified)

The following table lists the simplified information of keypad parameters. The detailed information is provided in the following sections (9.2 ~ 9.5, Groups section).

Code	Parameter Name	Description
drv	Cmd Source	Command Source
Frq	Freq Ref Src	Frequency reference source
CM	06 FBus S/W Ver	Communication option S/W version
	07 FBus ID	Station ID of the communication board (communication board ID)
	09 FBus Led	Information about LED indicators on the communication board
	10 opt para-1	Enter the 1st decimal number of the IP address.
	11 opt para-2	Enter the 2nd decimal number of the IP address.
	12 opt para-3	Enter the 3rd decimal number of the IP address.
	13 opt para-4	Enter the 4th decimal number of the IP address.
	14 opt para-5	Enter the 1st decimal number of the subnet address.
	15 opt para-6	Enter the 2nd decimal number of the subnet address.
	16 opt para-7	Enter the 3rd decimal number of the subnet address.
	17 opt para-8	Enter the 4th decimal number of the subnet address.
	18 opt para-9	Enter the 1st decimal number of the gateway address.
	19 opt para-10	Enter the 2nd decimal number of the gateway address.
	20 opt para-11	Enter the 3rd decimal number of the gateway address.
	21 opt para-12	Enter the 4th decimal number of the gateway address.
	22 opt para-13	Network communication speed (0 fixed, automatically set to 100 Mbps)
	23 opt para-14	EtherNet/IP: Set the Input Instance
	24 opt para-15	EtherNet/IP: Set Output Instance
	25 opt para-16	0: RAPIEnet Disable
	30 ParaStatus Num	Displays the number of transmitted data
	31 Para Status-1	Set address 1 for storing the transmitted data.

Code	Parameter Name	Description
	32 Para Status-2	Set address 2 for storing the transmitted data.
	33 Para Status-3	Set address 3 for storing the transmitted data.
	34 Para Status-4	Set address 4 for storing the transmitted data.
	35 Para Status-5	Set address 5 for storing the transmitted data.
	36 Para Status-6	Set address 6 for storing the transmitted data.
	37 Para Status-7	Set address 7 for storing the transmitted data.
	38 Para Status-8	Set address 8 for storing the transmitted data.
	50 Para Ctrl Num	Displays the number of received data
	51 Para Control-1	Set address 1 for storing the received data.
	52 Para Control-2	Set address 2 for storing the received data.
	53 Para Control-3	Set address 3 for storing the received data.
	54 Para Control-4	Set address 4 for storing the received data.
	55 Para Control-5	Set address 5 for storing the received data.
	56 Para Control-6	Set address 6 for storing the received data.
	57 Para Control-7	Set address 7 for storing the received data.
	58 Para Control-8	Set address 8 for storing the received data.
	94 Comm Update	Reflect the network parameter changes.
Pr	12 Lost Cmd Mode	Select operation mode for a lost command.
	13 Lost Cmd Time	Set the decision time for a lost command.
	14 Lost Preset F	Set the start frequency for a lost command.

9.2 Operation Group

① **[drv] Cmd Source: Command Source**

Select the command source for the GM2 inverter. Set to “4 (Field Bus)" to set the communication board as the command source and provide commands via network.

② **[Frq] Freq Ref Src: Frequency reference source**

Select the frequency reference source for the GM2 inverter. Set to “8 (Field Bus)" to set the communication board as the frequency reference source and provide frequency reference via network.

9.3 CM Group

① **[CM-06] FBus S/W Ver: Communication option S/W version**

Automatically indicates the version of the communication board installed to the GM2 inverter.

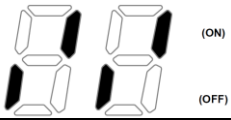
② **[CM-07] FBus ID: Station ID of the communication board (communication board ID)**

Set the station ID for the GM2 communication board. A total of 255 station IDs are available from 0 to 255 (The station ID must be set before you can configure network communication using the protocol.)
When setting the station ID, be careful not to use a station ID that is not already occupied by the PLC system or other network devices.
After making setting changes, you must set CM-94 (Comm Update) to “1 (Yes)” before the changes can take effect.

③ **[CM-09] FBus Led: Information about LED indicators on the communication board**

Displays on the Keypad the status of the LED indicators on the GM2 communication board. Refer to sections "10.4 LED indications and troubleshooting."

Example of COM-09 (FBus LED) indication



LINK1	LINK2	ERROR	CPU
LED is OFF	LED is ON	LED is ON	LED is ON

④ **[CM-22] opt para-13: Set the network communication speed. (100 Mbps, Auto Negotiation)**

The EtherNet speed parameter is fixed at "0" by default for 100 Mbps communication speed.

⑤ **[CM-23] opt para-14: CIP Input Instance - Transmission Data Setting**

This parameter is required for EtherNet/IP protocol service. It specifies the data format of the inverter status to be transmitted to the client (originator) during an I/O communication via a CIP (Common Industrial Protocol). Refer to the Assembly Object section of EtherNet/IP.

Select one of the data transmission addresses from CM-31 to CM-38 for monitoring.

You can set “opt para-14 to between “0” and “11.” Refer to the following table for the description of the “opt para-14” settings.

Set value	Input instance value	Data size	Number of parameters
0	70	4	X
1	71	4	X
2	110	4	X
3	111	4	X
4	141	2	1
5	142	4	2
6	143	6	3
7	144	8	4
8	145	10	5
9	146	12	6
10	147	14	7
11	148	16	8

⑥ [CM-24] opt para-15: CIP Output Instance - Reception Data Setting

This parameter is required for EtherNet/IP protocol service. It configures the format of the command data received by the inverter from the client (originator) during the I/O communication via the CIP (Common Industrial Protocol). Refer to the Assembly Object section of EtherNet/IP.

Select one of the data reception addresses from CM-51 to CM-58 for monitoring.

You can set “opt para-15 to between “0” and “11.” The description of the “opt para-15” settings are as follows.

Set value	Output instance value	Data size	Number of parameters
0	20	4	X
1	21	4	X
2	100	4	X
3	101	4	X
4	121	2	1
5	122	4	2
6	123	6	3
7	124	8	4
8	125	10	5
9	126	12	6
10	127	14	7
11	128	16	8

⑦ [CM-25] RAPIEnet Enable/Disable settings

This option is not used by Benshaw. Set CM-25 to “0” to disable. To utilize as an EtherNet communication board, set parameter CM-25 to “0”. Then set parameter CM-94 “Comm Update” to “1” (Yes) to continue with settings.

⑧ [CM-30] ParaStatus Num: Number of Transmission data

You can set CM-23 (opt para-14) to change the number of transmission data to between “0” and “8.” The communication board can transmit up to 8 pieces of data. You can configure the address of the transmission data with parameters CM-31 through CM-38.

⑨ **[CM-31] Para Status1 – [CM38] Para Status8: Transmission data address settings**

After setting the number of transmission data with CM-23, enter the matching number of data addresses for the data to transmit to the client (originator) with parameters CM-31 through CM-38.

This parameter setting is not required for Modbus TCP network communications.

⑩ **[CM-50] Para Ctrl Num: Number of Reception data**

You can set CM-24 (opt para-15) to change the number of reception data to between “0” and “8.” The communication board can receive up to 8 pieces of data. You can configure the address for the received data with parameters CM-51 through CM-58.

⑪ **[CM-51] Para Control1 – [CM58] Para Control8: Reception data address settings**

After setting the number of reception data with CM-24, enter the matching number of data addresses for receiving command data from the client (originator) with parameters CM-51 through CM-58.

This parameter setting is not required for Modbus TCP network communications.

⑫ **[CM-94] Comm Update: Update setting changes via the communication board**

The CM group parameters display the settings stored on the inverter connected to the communication board and the changes made on the keypad are not directly relected on the communication board.

Set COM-94 (Comm Update) to “1 (Yes)”. The changed settings will be reflected on the communication board. Parameters that require communication updates include CM-07 and CM-10 through COM-25.

9.4 PRT Group (Lost Command)

① [Pr-12] Lost Cmd Mode

When controlling the inverter speed through communications, you can select the inverter response (operating mode) when a network failure occurs (including a connection failure between the inverter and communication). Choices for Pr-12 include Decel, Hold Input, Hold Output or Preset Frequency (Pr-14).

② [Pr-13] Lost Cmd Time

Set the delay time for the inverter to respond to a speed reference loss. The inverter will operate based on the Pr-12 setting after the delay time set in Pr-13. Delay time can be set between "0.1" and "120" seconds.

③ [Pr-14] Lost Preset Frequency

When the lost command mode (Pr-12) is set to Preset Frequency, set the operating speed for continued inverter operation. The Preset Frequency can be set between the start frequency and the max frequency [Hz].

④ Lost command conditions by protocol

- EtherNet/IP

If the implicit message connection (Class 1 Connection) between the originator (a PLC or client) and the target (inverter) breaks for longer than one second, the EtherNet communication board enters lost command mode and the inverter will operate according to the settings at Pr-12 after the time set with Pr-13 has elapsed.

- Modbus TCP

If the Modbus TCP receives no data from the client for five seconds, the EtherNet communication board enters lost command mode and the inverter will operate according to the settings at Pr-12 after the time set with Pr-13 has elapsed.

10 Connecting with Other Products

10.1 Introduction

This chapter explains the services utilizing EtherNet/IP and Modbus TCP protocols when the communication board is connected with other manufacturer's products.

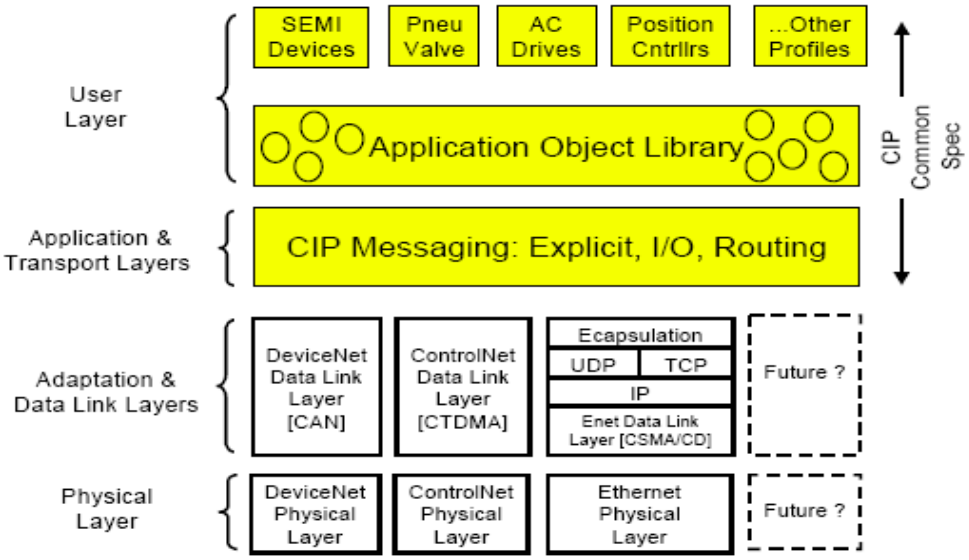
To utilize as an EtherNet communication board or a Modbus TCP board,

- set parameter CM-25 to "0".
- set parameter CM-94 "Comm Update" to "1" (Yes).

Above settings are required to disable a feature not utilized by Benshaw.

10.2 EtherNet/IP

10.2.1 Basic Protocol Structure



The EtherNet/IP is a protocol which implements the CIP (Common Industrial Protocol, specified by the ODVA) using the TCP and UDP protocols.

Originator: Devices that make connection requests, which are also called clients. PLCs or scanners are examples of originators.

Target: Devices that respond to connection requests, which are also called servers. Inverters are examples of targets.

10.2.2 Implicit Message

Implicit messages are also called I/O messages. It refers to the data communicated between the client (originator) and the server (target) at predefined intervals, via input and output instances.

The class 1 connection is used for implicit messages.

① Scope of support

Transport type

Originator->Target: Point to Point

Target->Originator: Multicast

Transport trigger: Cyclic

Configuration connection: 1

Connection tag: Not available

Priority

Originator->Target: Scheduled

Target->Originator: Scheduled

Configuration data: Not available

② Input instances

Input instances refer to the status data periodically sent from the inverter to PLC or other client devices.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running 1 (Fwd)		Faulted
	1	Speed Actual (Low Byte) – RPM unit (note 1)							
	2	Speed Actual (High Byte) – RPM unit							
	3								
71	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – RPM unit							
	3	Speed Actual (High Byte) – RPM unit							
110	0						Running 1 (Fwd)		Faulted

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	1								
	2	Speed Actual (Low Byte) – Hz unit (note 1)							
	3	Speed Actual (High Byte) – Hz unit							
111	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running 1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – Hz unit							
	3	Speed Actual (High Byte) – Hz unit							
141	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
142	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
143	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
144	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
145	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
146	0	Status Parameter - 1 data (Low Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
147	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (High Byte)							
148	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	14	Status Parameter - 8 data (Low Byte)							
	15	Status Parameter - 8 data (High Byte)							

The following table explains the data (bytes 0 and 1) for instances 70, 71, 110, and 111.

Name	Description	Related attribute	
		Class	Attr. ID
Faulted	Inverter Error	0x29	10
Warning	Not supported	0x29	11
Running1	Motor is running Forward	0x29	7
Running2	Motor is running Reverse	0x29	8
Ready	Motor is ready for operation	0x29	9
Ctrl From Net	Run/Stop control	0x29	15
Ref From Net	Speed control	0x2A	29
At Reference	Reached reference Speed	0x2A	3
Drive State	Current motor status	0x29	6
Actual speed	Reference speed	0x2A	7

③ Output instances

Output instances refer to the status data periodically sent from the PLC or other client devices to the inverter.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
21	0		NetRef (note 2)	NetCtrl (note2)			Fault reset	Run Rev	Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
100	0						Fault reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
101	0		NetRef	NetCtrl			Fault reset	Run Rev	Run Fwd

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
121	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
122	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
123	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
124	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
125	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
126	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
127	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (High Byte)							
128	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (High Byte)							
	14	Control Parameter - 8 data (Low Byte)							
	15	Control Parameter - 8 data (High Byte)							

The following table explains the data (bits for byte 0) for instances 20, 21, 100, and 101.

Name	Description	Related attribute	
		Class	Attr. ID
Run Fwd (Note1)	Forward Run Command	0x29	3
Run Rev (Note1)	Reverse Run Command	0x29	4
Fault reset (Note1)	Fault Reset Command	0x29	12
NetRef (Note2)	Not used	0x2A	4
NetCtrl (Note2)	Not used	0x29	5
Speed Reference	Reference speed	0x2A	8

(Note1) Refer to the Drive Run and Fault sections in the "Control Supervisor Object (Class 0x29)".

(Note2) Reference speed and Run/Strop control can be set only on the LCD control panel. Network control instances 21 and 101 (NetRef, NetCtrl) are not available.

10.2.3 Explicit Messages

Explicit messages refer to non-periodic data communications used for reading or writing attribute values of an inverter on an EtherNet/IP.

Using the UCMM communication (unconnected messages), data exchange is made without connecting the originator and the target, and periodic data exchange is available as well using the Class 3 connection.

10.2.4 Supported Objects

① Identity Object (Class 0x01, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Data Length	Attribute Value
1	Get	Vendor ID	Word	259
2	Get	Device Type (inverter)	Word	2
3	Get	Product Code	Word	100 (Note1)
4	Get	Revision High Byte - Major Revision Low Byte - Minor Revision	Word	(Note2) 0x0101
5	Get	Status	Word	(Note3)
6	Get	Serial Number	Double Word	(Note4)
7	Get	Product Name	4 Byte	CENT

(Note1) Product Code 100 refers to the Benshaw inverter.

(Note2) The revision number is identical to the version of the EtherNet communication board. The high byte stands for a major revision number, and the low byte stands for a minor revision number. For example, “0x0102” stands for "version 1.02."
The version of the EtherNet communication board can be displayed on the Keypad using the CM-06 (FBus S/W Ver) parameter.

(Note3) Definition of status bits

Bit	Description
0	0: Device is not connected to the master 1: Device is connected to the master
1	Reserved
2	Configured (fixed as ‘0’ because EtherNet/IP is not supported)
3	Reserved
4	0: Unknown 2: Faulty IO connection 3: IO connection has not been made 5: Major fault 6: IO connection has been made
5	
6	
7	
8	Minor recoverable fault (Inverter is in warning status)
9	Minor unrecoverable fault (N/A)
10	Major recoverable fault (inverter H/W trip occurred)
11	Major recoverable fault (inverter non-H/W trip occurred)

(Note4) Serial number uses the last 4 digits of the MAC ID.
E.g.) The serial number is 0x29000022 when the MAC ID is "00:0B:29:00:00:22".

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x05	Reset	No	Yes
0x01	Get Attribute All	No	Yes

② Motor data object (Class 0x28, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	Motor Type	0 – 10	0: Non-standard motor 1: PM DC Motor 2: FC DC Motor 3: PM Synchronous Motor 4: FC Synchronous Motor 5: Switched Reluctance Motor 6: Wound Rotor Induction Motor 7: Squirrel Cage Induction Motor 8: Stepper Motor 9: Sinusoidal PM BL Motor 10: Trapezoidal PM BL Motor
6	Get/Set	Motor Rated Curr	0.0 – 1000.0	[Get] Reads the value at bA-13 Rated Curr. [Set] Set value is reflected to bA-13 Rated Curr. Scale 0.1
7	Get/Set	Motor Rated Volt	0 – 690	[Get] Reads the value of the bA-15 Rated Voltage. [Set] Set value is reflected in the bA-15 Rated Voltage. Scale 1

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

③ Control Supervisor Objects (Class 0x29, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get/Set	Forward Run Cmd.	0	Stopped
			1	Forward run (Note1)
4	Get/Set	Reverse Run Cmd.	0	Stopped
			1	Reverse run (Note1)
5	N/A	Net Control	-	Configurable only with the inverter parameter.
6	Get	Drive State	0	Vendor Specific
			1	Startup
			2	Not Ready (resetting in progress)
			3	Ready (stopping in progress)
			4	Enabled (running, not applicable to deceleration stop)
			5	Stopping (decelerating)
			6	Fault Stop
			7	Faulted (trip occurred)
7	Get	Running Forward	0	Drive stopped.
			1	Running Forward
8	Get	Running Reverse	0	Drive stopped.
			1	Running Reverse
9	Get	Drive Ready	0	Resetting in progress or trip occurred
			1	Inverter is ready for operation
10	Get	Drive Fault	0	Trip has not occurred
			1	Trip has occurred
12	Get/Set	Drive Fault Reset	0	Trip reset to release the trip. Resetting will begin only when the

Attribute ID	Access	Attribute Name	Range	Definition
			1	value changes from FALSE to TRUE. (Note2)
13	Get	Drive Fault Codes		Refer to the following Drive Fault Code table (Note2)
14	Get	Control From Net.	0	Commands are made using sources other than the DeviceNet communication.
			1	Commands are made using the DeviceNet communication as the source.

(Note1) Drive Run Inverter operation using Command Forward Run Cmd. and Reverse Run Cmd.

Run1	Run1	Trigger Event	Run Type
0	0	Stop	NA
0 → 1	0	Run	Run1
0	0 → 1	Run	Run2
0 → 1	0 → 1	No Action	NA
1	1	No Action	NA
1 → 0	1	Run	Run2
1	1 → 0	Run	Run1

In the table above, Run1 indicates Forward Run Cmd. and Run 2 indicates Reverse Run Cmd. Commands are made by the EtherNet communication board when the value changes from 0 (FALSE) to 1 (TRUE). The Forward Run Cmd. value does not indicate the present operation status of the inverter; it indicates the operation command value on the EtherNet communication board.

(Note2) Drive Fault

The Drive Fault becomes TRUE when the inverter is tripped.

The Drive Fault Codes for the trips are as follows.

Drive Fault Codes

Fault Code Number	Description		
0x0000	None		
0x1000	Ethermal	Out Phase Open	InverterOLT
	InPhaseOpen	ThermalTrip	UnderLoad
	ParaWriteTrip	IOBoardTrip	PrePIDFail
	OptionTrip1	OptionTrip2	OptionTrip3
	LostCommand	UNDEFINED	LostKeypad
0x2200	OverLoad		
0x2310	OverCurrent1		

Fault Code Number	Description	
0x2330	GFT	
0x2340	OverCurrent2	
0x3210	OverVoltage	
0x3220	LowVoltage	
0x2330	GroundTrip	
0x4000	NTCOpen	
0x4200	OverHeat	
0x5000	FuseOpen	HWDiag
0x7000	FanTrip	
0x7120	No Motor Trip	
0x7300	EncorderTrip	
0x8401	SpeedDevTrip	
0x8402	OverSpeed	
0x9000	ExternalTrip	BX

Drive Fault Reset

The Drive Fault Reset gives TRIP RESET reference to the inverter when the setting value changes from 0 to 1 (FALSE to TRUE). Overwriting 1 (TRUE) over 1 (TRUE) does not generate RESET reference for a trip. To allow the EtherNet communication board to send a RESET command to the inverter when the value is 1 (TRUE), write 0 (FAULT) first, then write 1 (TRUE) again.

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

④ Inverter Objects (Class 0x2A, Instance 1)

Attribute

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	At Reference	0	The output frequency has not reached the reference frequency.
			1	The output frequency has reached the reference frequency.
4	N/A	Net Reference	-	

Attribute ID	Access	Attribute Name	Range	Definition
6	Get	Drive Mode (Note1)	0	Vendor Specific Mode
			1	Open Loop Speed (Frequency)
			2	Closed Loop Speed Control
			3	Torque Control
			4	Process Control (e.g. PI)
7	Get	SpeedActual	0 – 24000	Displays the present output frequency in [rpm].
8	Get/Set	SpeedRef	0 – 24000	Displays the reference frequency in [rpm]. Reflected when Frq (Freq Ref Src) is set to FieldBus.
9	Get	Actual Current	0 – 111.0 A	Monitors the present current in 0.1 A increment/decrement.
29	Get	Ref.From Network	0	Command source is not the DeviceNet communication.
			1	Command source is the DeviceNet communication.
100	Get	Actual Hz	0 – 400.00 Hz	Monitors the present operation frequency (Hz).
101	Get/Set	Reference Hz	0 – 400.00 Hz	Speed reference may be given via a network communication if Frq (Freq Ref Src) is set to 8 (FieldBus).
102	Get/Set	Acceleration Time (Note2)	0 – 6000.0 sec	Sets/monitors the acceleration time of the inverter.
103	Get/Set	Deceleration Time (Note3)	0 – 6000.0 sec	Sets/monitors the deceleration time of the inverter.

(Note1) Related to AP-01 (App Mode) settings. When AP-01 (App Mode) is set to Proc PID, MMC, then the Drive Mode becomes "Process Control (e.g. PI)."
(Note2) Value at ACC (Acc Time)
(Note3) Value at deC (Dec Time)

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

⑤ Class 0x64 (Inverter Object) – Manufacture Profile

This object is used to access the Keypad Parameters of the inverter.

Attribute

Instance	Access	Attribute Number	Attribute Name	Attribute Value
1 (DRV Group)	Get/Set	Identical to the GM2 Manual Code number. .	GM2 Keypad Title (Refer to the GM2 inverter instruction manual)	Parameter setting range for the GM2 inverter (Refer to the GM2 inverter instruction manual)
2 (BAS Group)				
3 (ADV Group)				
4 (CON Group)				
5 (IN Group)				
6 (OUT Group)				
7 (COM Group)				
8 (APP Group)				
9 (AUT Group)				
10 (APO Group)				
11 (PRT Group)				
12 (M2 Group)				

Service

Service code	Definition	Support for class	Support for instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

10.3 Modbus TCP Frame

10.3.1 Modbus TCP Frame Structure

MBAP Header (7 bytes)	PDU (5 bytes or greater)

In general, EtherNet communication uses EtherNet II frames.

MODBUS Application Protocol header (MBAP header)

The following table explains the components of a MBAP header.

Section	Length	Description
Transaction identifier	2 byte	Unique transmission number, which increases by 1 each time the client sends data frame to the server.
Protocol identifier	2 byte	Fixed at 0.
Length	2 byte	Data frame length of the Modbus communication, which represents the length (in byte unit) from the MBAP header to the unit identifier.
Unit identifier	1 byte	When communications using Modbus TCP and Modbus RTU are connected via a gateway, the unit identifier indicates the slave number. The address is fixed to 0xFF when Modbus TCP communication is used alone.

Protocol Data Unit (PDU)

PDU is the actual data in the Modbus TCP communication, which is composed of a function code and data.

Refer to "10.3.2 Function codes" below for detailed information.

10.3.2 Function Codes

The Modbus TCP communication involves clients and a server. During communication, clients send commands to the server, and the server responds to the commands. In general, devices such as a PLC, HMI, and PC are used as the client, and the inverter works as a server.

① Read Holding registers

Read Input registers are functions used to read the server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 byte	0x03
Comm. address	2 byte	0x0000–0xFFFF
Number of data requests	2 byte	1–16 (inverters)

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 byte	0x03
Comm. address	1 byte	2 x the number of data requests
Number of data requests	Number of data requests x 2 bytes	Data value of the given number from the comm. address

② Read Input registers

Read Input registers are functions used to read the server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 byte	0x04
Comm. address	2 byte	0x0000–0xFFFF
Number of data requests	2 byte	1–16 (inverters)

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 byte	0x03
Comm. address	1 byte	2 x the number of data requests
Number of data requests	Number of data requests x 2 bytes	Data value of the given number from the comm. address

③ Write Single register

Write Single registers are functions used to write a single server (inverter) data.

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1 byte	0x06
Comm. address	2 byte	0x0000–0xFFFF
Data value	2 byte	0x0000–0xFFFF

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 byte	0x06
Comm. address	2 byte	0x0000–0xFFFF
Data value	2 byte	0x0000–0xFFFF

④ Write Multiple register

Write Multiple registers are functions used to write 1 to 16 consecutive data items on the server (inverter).

The following table explains the components of a request data frame from a client to a server.

Request frame	Length	Value
Function code	1bytes	0x10
Comm. address	2bytes	0x0000–0xFFFF
Number of data to write	2byte	1–16 (inverters)
Byte Count	1byte	2 x the number of data
Number of data to write	The number of data x 2 bytes	Data to write

The following table explains the components of a response data frame from a server to a master.

Response frame	Length	Value
Function code	1 byte	0x10
Comm. address	2 byte	0x0000–0xFFFF
Number of data to write	2 byte	1–16 (inverters)

10.3.3 Exception (Except) Frame

An exception frame is a response frame from a server when an error occurs while responding to the client.

The following table explains the components of an exception frame.

Error frame	Length	Value
Error code	1bytes	0x80 + function code requested by the client
Exception code	1bytes	0x0000–0xFFFF

Exception code

Type	Code	Description
ILLEGAL FUNCTION	0x01	Unsupported function has been requested
ILLEGAL DATA ADDRESS	0x02	An unused address has been requested or modification has been requested for the data at an unused address.
ILLEGAL DATA VALUE	0x03	A data modification request has been made out of the range of the available value.
SLAVE DEVICE FAILURE	0x04	Server error occurred (CAN communication error with the drive, communication board initialization error, or data communication error with the drive)
SLAVE DEVICE BUSY	0x06	Server is unable to respond because it is executing another process (in the middle of a drive parameter initialization or the initial setting of the communication board)
WRITE PERMITION ERROR	0x20	Unique code for Benshaw inverters. An attempt was made to change a write-protected parameter

10.4 LED Indications and Troubleshooting

LED name	Color	Description	Status	Status
LINK1	Green	Network normal	ON	Network connection at LINK 1 is operating normal
	Orange	Check network settings	ON	Check EtherNet settings*1 When the communication cycle stops for longer than one second.
	-	LINK 1 Not connected	OFF	Trying EtherNet communication, network cable not connected to LINK 1
LINK2	Green	Network normal	ON	Network connection at LINK 2 is operating normal
	Orange	Network fault	ON	Check EtherNet settings*1
	-	LINK 1 Not connected	OFF	Trying EtherNet communication, network cable not connected to LINK 2

*1: For EtherNet network settings, check keypad parameters CM-10, CM-11, CM-14, CM-15, CM-23, and CM-24, and the settings for the client devices, such as the PLC.

LED name	Color	Description	Status	Status
ERROR	Red	Normal operation	OFF	Communication between the communication board and the inverter is normal.
		Network fault	Flashing Synchronous flashing with LED (1 second interval)	Communication between the communication board and the inverter is abnormal.
			Flashing (2 second interval)	The communication board parameters are set differently from the communication parameter settings on the keypad*2
			ON	EEPROM failure No network connection to LINK 1 and LINK 2 IP collision occurred
CPU	Green	Normal operation	Flashing (1 second interval)	The communication board has been properly installed on the inverter.

*2: To synchronize the EtherNet communication board settings with the keypad parameter settings, check the CM Group parameter settings and set CM-94 (Comm. Update) to "1 (yes)."

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