Ethernet/IP & Modbus-TCP

For RSi “S” & “SW” Series Variable Frequency Drive Instruction Manual

890049-09-00

BENSHAW
Applied Motor Controls

890053-03-00

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 H2 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 “S” Series and the “SW” Series inverters 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.

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

2. Technical Specifications

Transmission Speed	10Mbps, 100Mbps
Transmission Method	Baseband
Max. Extensible Distance between Nodes	100m (Node-Hub)
Max. Node Number	Hub connection
Auto-Negotiation	Supported
Max. Frame Size	1,500 bytes
Communication Zone Access Method	CSMA/CD
Frame Error Checking Method	CRC32
Recommended TCP Socket	2 Sockets

3. Package Components

Benshaw Part #: PC-100092-00

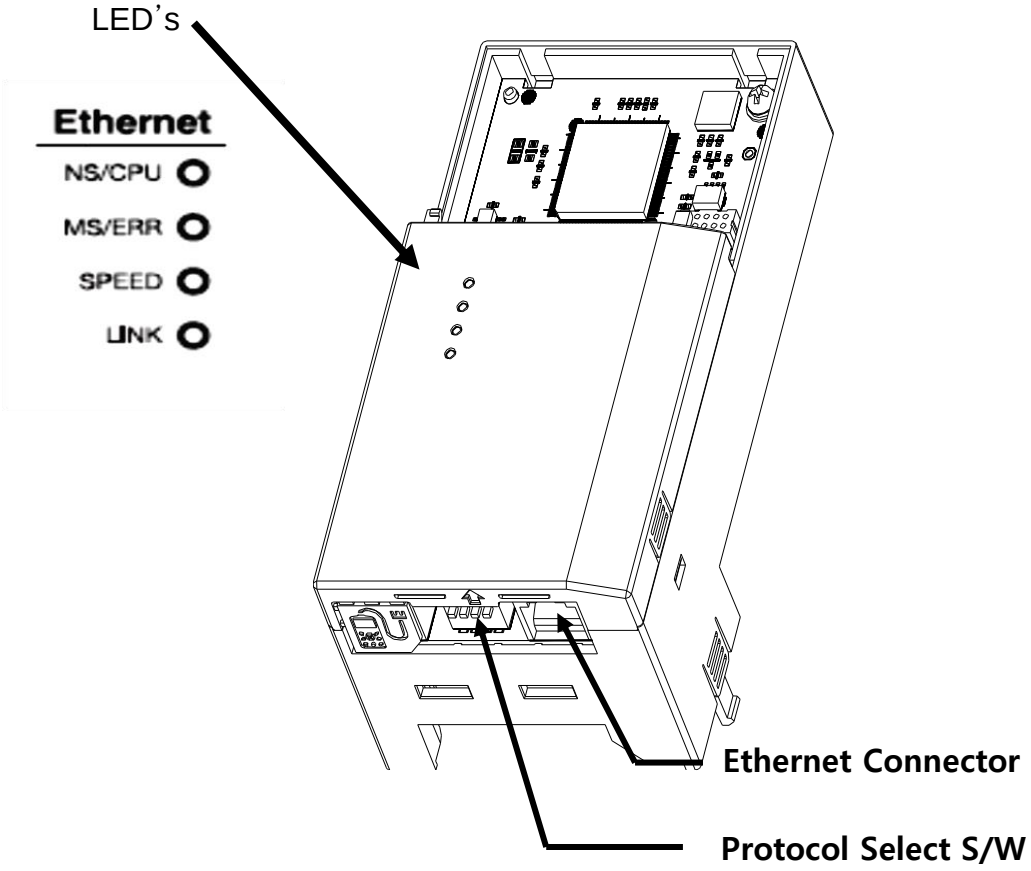
The product contains:

- 1 x Communication Module
- 1 x Brass Standoff (M3xL23)
- 1 x Brass Standoff (M3xL17.3)
- 2 x Mounting Screws (M3xL8)
- 1 x Instruction Manual

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

4. Module Layout and Installation

4.1 Layout

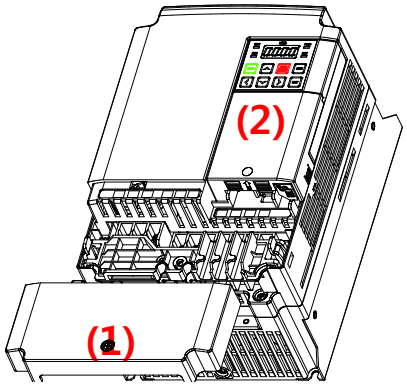


4.2 Installation

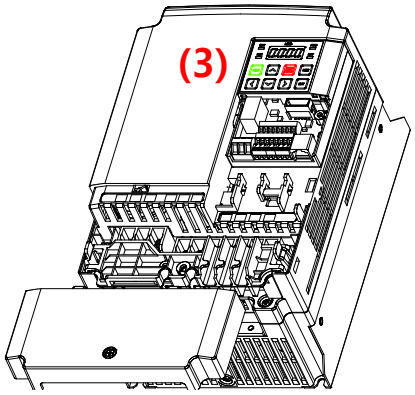
⚠ Warning

- **Do not install or remove the communication board to or from the inverter while the inverter is turned on.**
- **Ensure that the charge in the capacitors inside the inverter is completely**

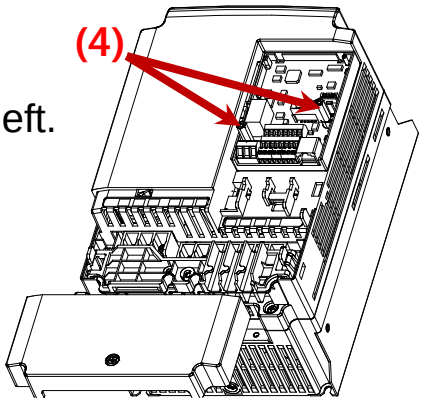
■ Loosen the front cover screws to remove the front cover (1) and remove I/O cover (2).



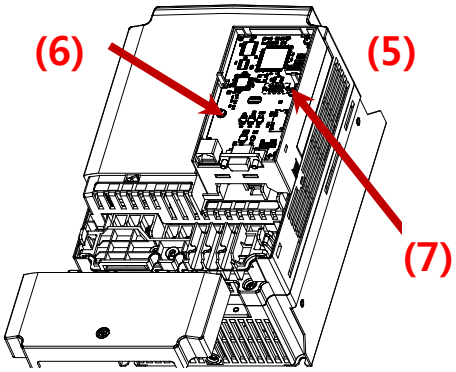
■ Remove the keypad (3).



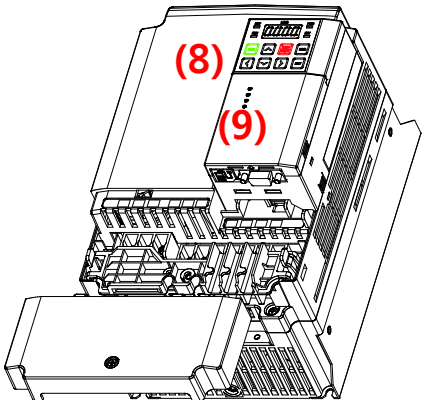
■ Remove a screw (bottom left) from the I/O board and install the provided brass standoffs, longer one at bottom left.



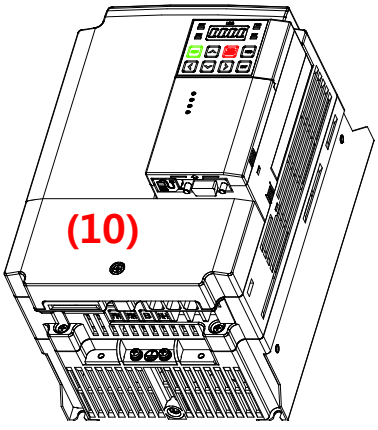
■ Mount the Communication Module (5) and install the removed screw (6) and the supplied screw (7).



■ Install the keypad (8) first, then the communication module cover (9).



■ Install the front cover(10) and installation is completed.

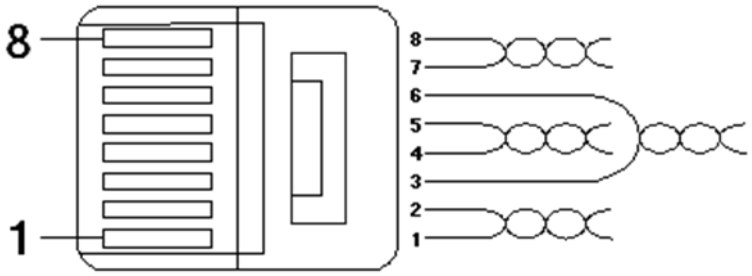


5. Network Connection

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

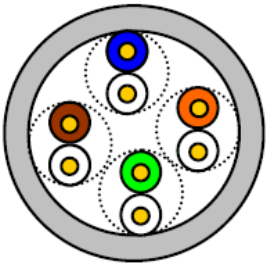
5.2 Cable Connector



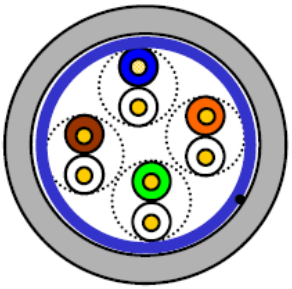
※ Make sure that cables connected to Pin1 and 2 are twisted together.
※ Make sure that cables connected to Pin3 and 6 are twisted together

6. Network Cable Specification

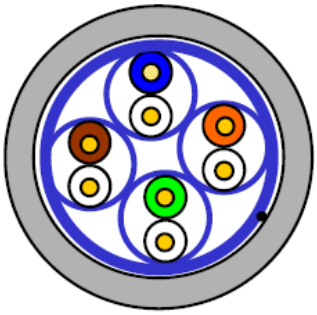
There are five types of UTP cable specifications according to different applications, from category 1 through category 5. Category 5 network cables are required for utilizing the communication board.
Category 5 network cables support a frequency band up to 100 MHz, with up to 60 MHz channel performance and up to 100 Mbps data transmission speed.



UTP



FTP



STP

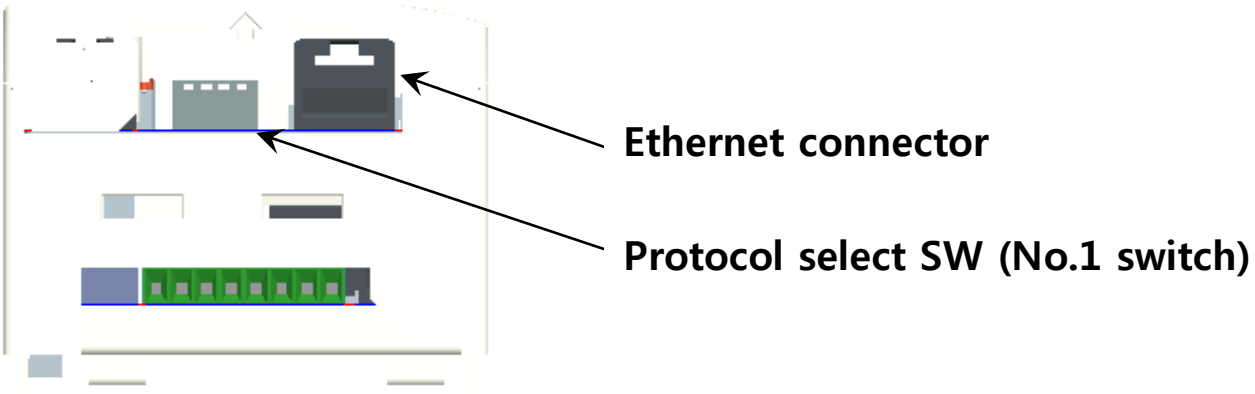
Category	Description	Specifications/Usage
UTP (U.UTP)	Unshielded Twisted Pair cable for high speed signals	200 MHz max. Voice + Data + Low quality video signals
FTP (S.UTP)	Single insulation for the cable core * Insulation material: AL / Plastic complex foil or copper braid	100 MHz max. Protection against 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. Protocol Selection

The communication module includes both Modbus-TCP and Ethernet/ IP. You can select one of the protocols with position No.1 of the switch located next to the Ethernet connector. Positions No. 2, 3 and 4 of the switch are not used.

Switch State	Protocol
OFF (Switch at the upper position)	**Modbus TCP**
ON (Switch at the lower position	**Ethernet IP**

If the option module is operating, protocol will not be changed even if switch selection is changed. Protocol is determined by the state of switch when the option module is powered on or the inverter is initialized by CM.94 (Comm Update) to “yes”.

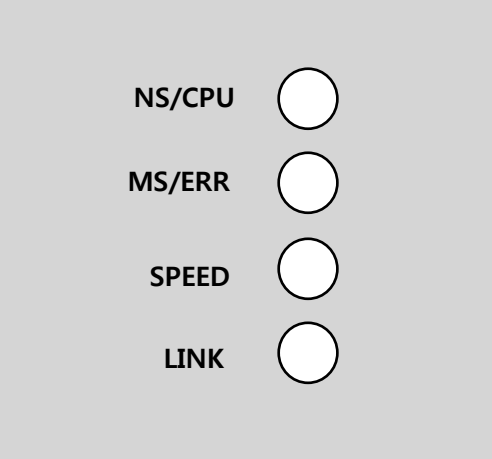


Bottom side of Ethernet Communication Module

8. LED information

8.1 LED Display

Four LEDs are located on Communication Module. Each LED indicates different functions and displays the status of Ethernet Protocol.



8.2 The status of Ethernet Line LED (Ethernet/IP and Modbus/TCP are same)

LED	Color	Status	Function
SPEED	Green	ON	It indicates the communication speed is 100Mbps.
		OFF	It indicates the communication speed is 10Mbps.
LINK	Green	ON	It indicates the communication module is ready to communicate.
		OFF	When Link LED is turned Off, check if wiring is correct or that wiring has a fault.

8.3 The status of Modbus-TCP LED & Troubleshooting

LED	Color	Status	Function and Troubleshooting
CPU	Green	Flash	The CPU of Modbus/TCP is operating normally when the power is supplied to the communication module.
		OFF	Failure in power supply to the communication module. Re-install the module.
ERROR	Red	OFF	The communication module is normal, without error.
		ON	The IP address is set to 0.0.0.0 or 255.255.255.255. Please do not use the IP address. It is only used for a specific case.
		CPU and Flash	1. The communication is interrupted. Turn off the power and then reinstall the module. 2. The data from inverter is not updated to Ethernet Module. Execute Comm. Update or cycle the power again.
		Flashing slower than CPU	IP address is conflicted in a network. Check if IP address is appropriate.

8.4 The status of Ethernet/IP LED & Troubleshooting

LED	Color	Status	Function and Troubleshooting
NS	Green	ON	The status is I/O communicating when Class 1 connection is well connected.
		OFF	Client and TCP are not connected.
		Flash	UCMM communication is available by the registration after Client and TCP are connected.
	Red	ON	Displayed if an IP address is clashed with the same IP address in a network. Please check whether IP address is right or not.
		OFF	Communication module is normal
		Flash	Class 1 connection is disconnected abnormally. Check if the Network cable and connection state are correct.
MS	Green	ON	Communication module board is normal.
		OFF	Communication module has a problem.
	Red	ON	It means IP address sets to 0.0.0.0 or 255.255.255.255. Please do not use the address IP Address because it can be only used for the specific case.
		OFF	It means Communication module is normal.
		Flash	1. It means the communication is interrupted. Turn off the power and then reinstall the module. 2. The data from inverter is not updated to Ethernet Module. Do Comm. Update or re-generate the power again.

Notice

1) When the module is initialized by the selection of Ethernet/IP, LED turns on and off in order as below.
   (MS LED(GREEN) -> NS LED(RED) -> MS LED(RED) -> NS LED(GREEN) -> NS LED(RED)-> NS LED(OFF)->MS LED(GREEN))
2) When IP address is crashed, please reset IP and execute Comm. Update.
3) Do not use Comm Update (CM.94 → 1, yes) when the inverter is working or in cyclic communication.

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 section. Inverter parameters of Modbus-TCP and Ethernet/IP are listed as shown below. (Protocol 'M' is used for Modbus/TCP and Protocol 'E' is used for Ethernet/IP).

Code Number	The Name of Parameter	Initial Value	Range	Definition	Protocol
drv	Command Source	Keypad	0 ~ 5	Set to (4) FieldBus for communications	M/E
Frq	Frequency Reference Source	Keypad	0 ~ 16	Set to (8) FieldBus for communications	M/E
CM.06	FBus S/W Ver	-	-	Communication module S/W version.	M/E
CM.09	FBus Led			Shows the ON/OFF data of the LED's on the communication module.	M/E
CM.10	Opt Parameter1	0	0 ~ 255	Set up the IP Address.	M/E
CM.11	Opt Parameter2	0	0 ~ 255		
CM.12	Opt Parameter3	0	0 ~ 255		
CM.13	Opt Parameter4	0	0 ~ 255		
CM.14	Opt Parameter5	0	0 ~ 255	Set up the Subnet Mask.	M/E
CM.15	Opt Parameter6	0	0 ~ 255		
CM.16	Opt Parameter7	0	0 ~ 255		
CM.17	Opt Parameter8	0	0 ~ 255		
CM.18	Opt Parameter9	0	0 ~ 255	Set up the Gateway Address.	M/E
CM.19	Opt Parameter10	0	0 ~ 255		
CM.20	Opt Parameter11	0	0 ~ 255		
CM.21	Opt Parameter12	0	0 ~ 255		
CM.22	Opt	0	0~2	Set the Ethernet	M/E

Code Number	The Name of Parameter	Initial Value	Range	Definition	Protocol
	Parameter13			communication speed.	
CM.29	In Instance	1	0~11	CIP Input Instance	E
CM.30	ParaStatus Num	3	0~8	Automatically set according to the CIP Input Instance.	E
CM.31	Para Status-1	0x000A	0x0000 ~0xFFFF	Set up the inverter data addresses to be read by the client.	E
CM.32	Para Status-2	0x000D	0x0000 ~0xFFFF		E
CM.33	Para Status-3	0x000F	0x0000 ~0xFFFF		E
CM.34	Para Status-4	0x0000	0x0000 ~0xFFFF		E
CM.35	Para Status-5	0x0000	0x0000 ~0xFFFF		E
CM.36	Para Status-6	0x0000	0x0000 ~0xFFFF		E
CM.37	Para Status-7	0x0000	0x0000 ~0xFFFF		E
CM.38	Para Status-8	0x0000	0x0000 ~0xFFFF		E
CM.49	Out Instance	1	0~11	CIP Output Instance	E
CM.50	Para Ctrl Num	2	0~8	Automatically set according to the CIP Output Instance.	E
CM.51	Para Control-1	0x0005	0x0000 ~0xFFFF	Client set up the reference Inverter Data Address.	E
CM.52	Para Control-2	0x0006	0x0000 ~0xFFFF		E
CM.53	Para Control-3	0x0000	0x0000 ~0xFFFF		E
CM.54	Para Control-4	0x0000	0x0000 ~0xFFFF		E
CM.55	Para Control-5	0x0000	0x0000 ~0xFFFF		E
CM.56	Para Control-6	0x0000	0x0000 ~0xFFFF		E
CM.57	Para Control-7	0x0000	0x0000 ~0xFFFF		E

Code Number	The Name of Parameter	Initial Value	Range	Definition	Protocol
CM.58	Para Control-8	0x0000	0x0000 ~0xFFFF		E
CM.94	Comm Update	0	0:NO 1:YES	Update keypad parameters related to network communication.	M/E

Code Number	Parameter Name	Default	Set Value	Description
Pr-12	Lost Cmd Mode	"None"	"None" "Free-Run" "Dec" "Hold Input" "Hold Output" "Lost Preset"	If Lost Command occurs, sets up the Inverter action. (Note1)
Pr-13	Lost Cmd Time	1.0	0.1~120.0 sec	Sets up Lost Command occurrence time
Pr-14	Lost Preset F	0	0~600.00 Hz	Sets up speed of Lost Preset

(Note1) Lost Command Mode

Set Value	Function
"None"	Maintains the previous status.
"Free-Run"	Lost Command Trip occurs and Free Run stops.
"Dec"	Lost Command Trip occurs and stops by Trip deceleration time.
"Hold Input"	Lost Command Warning occurs and operates by the previous operation reference.
"Hold Output"	Lost Command Warning occurs and operates at the previous operation speed.
"Lost Preset"	Lost Command Warning occurs and operates at the speed set up in the Pr-14.

9.1.1 dr.06 - Cmd Source

Select the command source for the inverter. Set to “4 (Field Bus)" to set communications as the command source and receive start/stop commands via network.

9.1.2 dr.07 - Freq Ref Src

Select the frequency reference source for the inverter. Set to “8 (Field Bus)" to set communications as the frequency reference source and receive the frequency reference via network.

9.1.3 CM.06 - FBus S/W Ver

CM.06 automatically indicates the version of the communication module installed in the inverter.

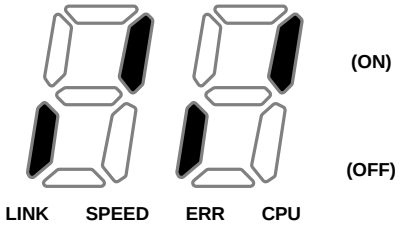
9.1.4 CM.09 - FBus Led

① Modbus/TCP
ON/OFF state of the 4 communication module LED’s is displayed at keypad parameter CM.09. The display LED segments represent the 4 communication LED’s according to:

(Left -> Right) LINK, SPEED, ERR, and CPU.

When the display upper LED segment is on, this designates the communication LED is ON. When the lower LED segment is on, this designates the communication LED is OFF.

(Ex. CM.09 LED)

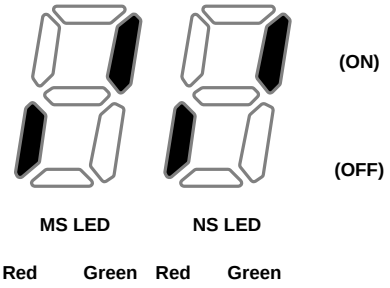


LINK LED	SPEED LED	ERR LED	CPU LED
OFF	ON	OFF	ON

② Ethernet/IP

ON/OFF state and Color are displayed at keypad parameter CM.09. The display LED segments represent 2 communication LED's along with the color (4 segments are used). Ethernet communication module uses MS LED and NS LED only. It displays the information according to:
(left to right) MS LED Red, MS LED Green, NS LED Red and NS LED Green.

(Ex. CM.09 LED)



Above shows that NS LED is currently Green and MS LED is Green.

MS LED(Red)	MS LED(Green)	NS LED(Red)	NS LED(Green)
OFF	ON	OFF	ON

9.1.5 CM.10~ CM.21 IP Address, Subnet Mask, Gateway Address

The IP ver. supported by Ethernet Module is v4. All the addresses and masks are expressed with
(decimal).(decimal).(decimal).(decimal)
and each decimal number is within 0~255. In Ethernet communication Module, decimal numbers can be entered in Opt Parameter directly. Each Opt Parameters has the value 0 through 255, which is implemented with each field of the addresses divided by a decimal point '.'.

Ex) To set up IP Address 196.168.10.131, enter the Opt Parameter as shown in the table below.

Code Number	The name of Parameter	Input value
CM.10	Opt Para-1	196
CM.11	Opt Para-2	168
CM.12	Opt Para-3	10
CM.13	Opt Para-4	131

9.1.6 CM.22 - Ethernet Speed

Ethernet speed can be set up within the range of 0~2

Set Value	Speed
0	Set the speed automatically
1	100Mbps
2	10Mbps

Automatic speed setting function automatically sets up the highest speed in the network.

9.1.7 CM.29 - CIP Input Instance

This parameter is displayed when the protocol setting is the Ethernet/IP. It specfies the data format of the inverter status sent from the inverter to the Client (Originator) during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the Ethernet/IP.

Set Value	Input Instance Value	Data Size	The number of Parameter
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

9.1.8 CM.49 - CIP Output Instance

This parameter is displayed only when protocol sets to Ethernet/IP. It specifies the data format of the inverter command sent from the Client (Originator) to control the inverter during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the Ethernet/IP.

Set Value	Output Instance Value	Data Size	The number of Parameter
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

9.1.9 CM.30 - CM.38 Para Status

This parameter is not used with Modbus TCP. This parameter appears only when the value of the Input Instance (CM.17) in the Ethernet IP is set to 4 or above and Comm Update (CM.94:YES) is done. CM.30 Para Status Num cannot be set up but the number of the parameters of the settled instance is shown. Enter the address of the inverter data sent for the reference data of the Client (Originator) at the same number as that of the set parameters in the CM.31~38.

9.1.10 CM.50 - CM.58 Para Control

This parameter is not used with Modbus TCP. This parameter appears only when the set value of the Output Instance (CM.18) in the Ethernet IP is 4 or above and Comm Update(CM.94:YES) is done.CM.50 Para Ctrl Num cannot be set up but the number of the parameters of the settled instance is shown. Enter the address of the inverter data used for the reference data of the Client (Originator) at the same number as that of the set parameters in the CM.51~58.

9.1.11 CM.94 - Comm Update

The CM group parameters display the settings stored in the inverter and the changes made on the keypad are not directly reflected in the communication module.
Set CM.94 (Comm Update) to “1 (Yes)”. The changed settings will be reflected in the communication module.

9.1.12 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).

9.1.13 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.

9.1.14 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].

Lost command conditions by protocol

Modbus-TCP Lost Command Status

If the Modbus TCP receives no data from Client for 100msec, the Option becomes Lost Command status, and after the time set up in the Pr.13, the Inverter operates according to the settings in the Pr.12.

Ethernet/IP Lost Command Status

If there is no Implicit Message Connection (Class1 Connection) between the Originator (PLC or Client) and Target (Inverter), the Option becomes Lost Command status, and after the time set up in the Pr.13, the Inverter operates according to the settings in the Pr.12.

10. Modbus-TCP

10.1 Modbus-TCP Frame Structure

MBAP Header(7 bytes)	PDU (5 bytes ~)

In general, Ethernet communication uses Ethernet II frames.

[MODBUS Application Protocol Header (MBAP Header)]

Header	Length	Description
Transaction Identifier	2 Bytes	Unique transmission number, which increases by 1 each time the client sends data frame to the server.
Protocol Identifier	2 Bytes	Fixed as 0
Length	2 Bytes	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.

10.2 Function Code Description

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.

10.3 Read Holding Register

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.

Required Frame	Length	Value
Function Code	1 Bytes	0x03
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Number of data requests	2 Bytes	1~16

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

Responded Frame	Length	Value
Function Code	1 Bytes	0x03
Comm. Address	1 Bytes	2 x 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

10.4 Read Input Register

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.

Required Frame	Length	Value
Function Code	1 Bytes	0x04
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Number of data requests	2 Bytes	1~16

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

Required Frame	Length	Value
Function Code	1 Bytes	0x04
Comm. Address	1 Bytes	2 x 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

10.5 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.

Required Frame	Length	Value
Function Code	1 Byte	0x06
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Data Value	2 Bytes	0x0000 ~ 0xFFFF

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

Required Frame	Length	Value
Function Code	1 Byte	0x06
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Data Value	2 Bytes	0x0000 ~ 0xFFFF

10.6 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.

Required Frame	Length	Value
Function Code	1 byte	0x10
Comm. Address	2 bytes	0x0000 ~ 0xFFFF
Number of data to write	2 bytes	1~16
Byte Count	1 byte	2 X Number of data
Number of data to write	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.

Required Frame	Length	Value
Function Code	1 Byte	0x10
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Number of data to write	2 Bytes	1~16

10.7 Except Frame

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

10.8 Exception Frame Structure

The following table explains the components of an exception frame.

Error Frame	Length	Value
Error Code	1byte	0x80 + Function Code requested by the client
Exception Code	1byte	0x0000 ~ 0xFFFF

Exception Code

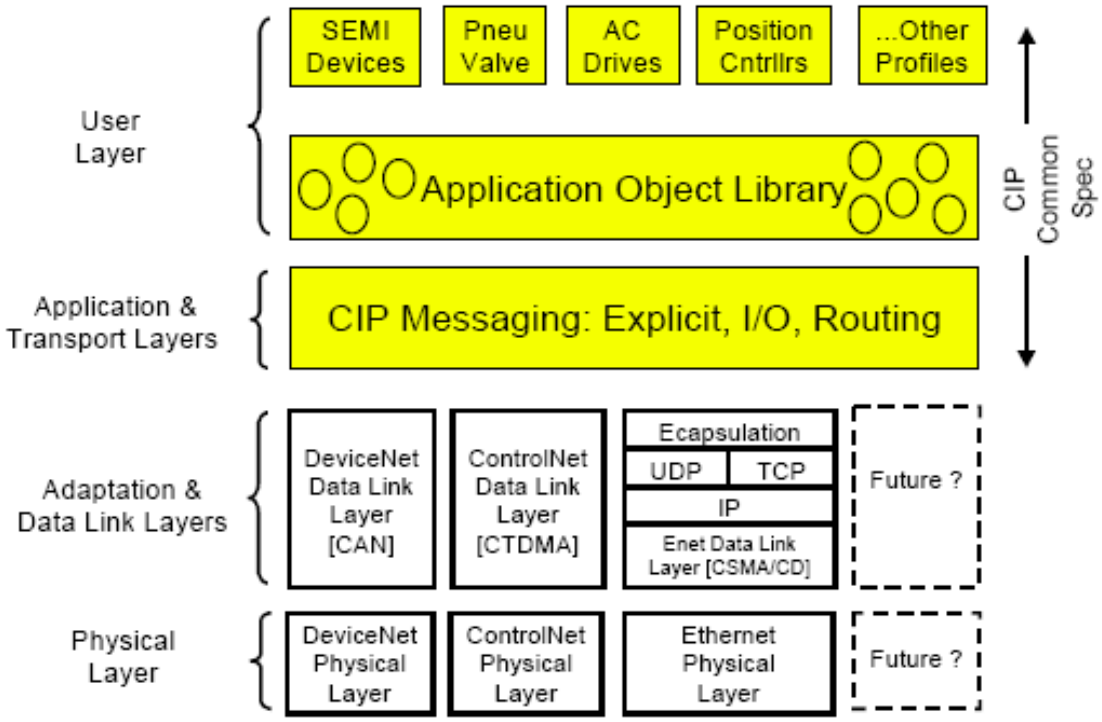
Type	Code	Description
ILLEGAL FUNCTION	0x01	Unsupported function has been requested
ILLEGAL DATA ADDRESS	0x02	An unused address has been requested or modification has been requested for the data at an unused address.
ILLEGAL DATA VALUE	0x03	A data modification request has been made out of the range of the available value.
SLAVE DEVICE FAILURE	0x04	Server error occurred (CAN communication error with the drive, communication module 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 module)
WRITE PERMITION ERROR	0x20	Unique code for Benshaw Inverters. An attempt was made to change a write-protected parameter

11. Ethernet/IP

11.1 Basic protocol configuration

The Ethernet/IP is a protocol implemented with the CIP (Common Industrial Protocol), defined by the ODVA, by using TCP and UDP.

※Originator: It is the device requesting connection, called Client. The device represents a PLC or a scanner.
※Target : It is the device responded to the connection, called Server. The device represents an Inverter.



11.2 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 Supported range

- Transport Type
  1. Originator->Target: Point to Point
  2. Target->Originator: Multicast, Unicast (Ethernet V3.0 or higher)

- Transport Trigger: Cyclic

- Configuration Connection: 1

- Connection Tag: Not supported

- Priority
  1. Originator->Target: Scheduled
  2. Target->Originator: Scheduled
  3. Configuration Data: Not supported

② Input Instance

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								
	2	Speed Actual (Low Byte) – RPM unit (note 1)							
	3	Speed Actual (High Byte) – RPM unit							
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
	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 (Hi Byte)							
142	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
143	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
144	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
145	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
146	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							
147	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (Hi Byte)							
148	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (Hi Byte)							
	14	Status Parameter - 8 data (Low Byte)							
	15	Status Parameter - 8 data (Hi 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 to running	0x29	9
Ctrl From Net	Run/Stop control	0x29	15
Ref From Net	Speed control	0x2A	29
At Reference	Reach at reference Speed	0x2A	3
Drive State	Current Motor State	0x29	6
Speed Actual	Speed Command	0x2A	7

③ Output Instance

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 (note2)	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
	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 (Hi Byte)							
122	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
123	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
124	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
125	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
126	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
127	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (Hi Byte)							
128	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (Hi Byte)							
	14	Control Parameter - 8 data (Low Byte)							
	15	Control Parameter - 8 data (Hi 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	Speed Command	0x2A	8

note1) refer to the Drive Run and Fault in the Control Supervisor Object (Class 0x29).

note2) the setting of the Reference Control and Run/Strop Control can be made only by the LCD Control Panel. Therefore, NetRef and NetCtrl are not used at the Instances 21 and 101.

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11.3 Explicit Message

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.

- Class3 Connection: 1EA (Minimum 100ms interval is required)

11.4 Supported Object

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 (AC Drive)	Word	2
3	Get	Product Code	Word	10 note1)
4	Get	Low Byte - Major revision High Byte - Minor revision	Word	note2) 0x0102
5	Get	Status	Word	note3)
6	Get	Serial Number	Double Word	note4)
7	Get	Product Name	12 Byte	Ethernet

note1) Product code '6' refers to the Benshaw inverter.

note2) The Upper and Lower byte represent the Major Revision and Minor Revision, respectively. For example, 0x0102 means 2.01. The version of the Ethernet communication is indicated in the Keypad CM.06 FBus S/W Ver.

note3) Definition of each bit of status.

Bit	Definition
0	0: Device is not connected to Master. 1: Device is connected to Master.
1	Reserved
2	Configured (always '0' since LS ELECTRIC Ethernet/IP is not supported.)
3	Reserved
4	0 : Unknown 2: in case of incorrect I/O connection. 3: in case of no previous I/O connection at all.
5	
6	

7	5: Major Fault 6: I/O in connection.
8	Minor Recoverable Fault (In case of Warning state of inverter)
9	Minor Unrecoverable Fault (N/A)
10	Major Recoverable Fault (In case of H/W trip state of inverter)
11	Major Unrecoverable Fault (In case of trip state except for H/W trip of inverter)

note4) Serial number is made by last four numbers of MAC ID.
For example, if MAC ID is 00:0B:29:00:00:22, Serial number will be 0x29000022

[Service]

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x05	Reset	No	Yes
0x10	Set Attribute Single	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 Current	0.0~1000.0	[Get] Read Rated Current of bA.13. [Set] The setting value is reflected on Rated Current of bA.13 Scale: 0.1
7	Get/Set	Motor Rated Voltage	0~690	[Get] Read Rated Voltage of bA.15 [Set] The setting value is reflected on Rated Voltage of bA.15 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 Object (Class 0x29, Instance 1)

[Attribute]

Attribute ID	Access	Attribute Name	Range	Definition
3	Get / Set	Forward Run Cmd.	0	Stop
			1	Operation in normal direction (Note1)
4	Get / Set	Reverse Run Cmd.	0	Stop
			1	Operation in reverse direction (Note1)

Attribute ID	Access	Attribute Name	Range	Definition
5	N/A	Net Control	-	Can be set up as Inverter parameter only.
6	Get	Drive State	0	Vendor specific
			1	Startup
			2	Not Ready (resetting)
			3	Ready (stopping)
			4	Enabled (running, except decelerating to stop)
			5	Stopping (decelerating to stop)
			6	Fault Stop
			7	Faulted (tripped)
7	Get	Running Forward	0	Stopping
			1	Operating in normal direction
8	Get	Running Reverse	0	Stopping
			1	Operating in reverse direction
9	Get	Drive Ready	0	Being reset or tripped
			1	Normal condition for Inverter operation
10	Get	Drive Fault	0	Presently not tripped
			1	Presently being tripped.
12	Get / Set	Drive Fault Reset	0	Trip Reset after a trip. Reset can be done only when TRUE is inputted in FALSE status (Note2).
			1	
13	Get	Drive Fault Code		See the Drive Fault Code Table below (Note2).
14	Get	Control From Net.	0	Provide operation reference through a source other than FieldBus communication.

Attribute ID	Access	Attribute Name	Range	Definition
			1	Provide operation reference through FieldBus communication source.

(Note1) Drive Run Command
It is inverter operation using Forward Run Cmd. and Reverse Run Cmd.

Run1	Run2	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 module 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 module.

(Note2) Drive Fault
If the Inverter is tripped, the Drive Fault becomes TRUE.
At this time, the Drive Fault Codes are as follow;

[Drive Fault Code]

Fault Code Number	Description
0x0000	None
0x1000	Ethermal Out Phase Open InverterOLT

Fault Code Number	Description
	InPhaseOpen ThermalTrip UnderLoad ParaWriteTrip IOBoardTrip PrePIDFail OptionTrip1 OptionTrip2 OptionTrip3 LostCommand UNDEFINED LostKeypad
0x2200	OverLoad
0x2310	OverCurrent1
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]

At 0 → 1 (FALSE → TRUE), the Drive Fault Reset gives TRIP RESET reference to Inverter. Overwriting 1 (TRUE) on 1 (TRUE) does not generate RESET reference to the Inverter trip. To send RESET reference from Option to Inverter in 1 (TRUE) status, write 0 (FAULT) and 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 AC Drive Object (Class 0x2A, Instance 1)

[Attribute]

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	At Reference	0	Means that the output frequency has not reached the set up frequency, yet.
			1	Means that the output frequency has reached the set up frequency.
4	Not supported	Net Reference	-	-
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	Speed Actual	0~ 24000	Displayed present output frequency in [rpm] unit.
8	Get/Set	Speed Ref	0~ 24000	Give reference after converting the target frequency in [rpm] unit. For this, the DRV-07 Freq Ref Src must have been set up to FieldBus.
9	Get	Actual	0~111.0 A	Monitor present current

Attribute ID	Access	Attribute Name	Range	Definition
		Current		by 0.1 A unit basis.
29	Get	Ref.From Network	0	The frequency reference source is not the FieldBus communication.
			1	The frequency reference source is the FieldBus communication.
100	Get	Actual Hz	0~400.00 Hz	Monitor present operating frequency by Hz unit.
101	Get/Set	Reference Hz	0~400.00 Hz	When the dr-07 Freq Ref Src is set to FieldBus, the reference frequency can be set up by communication.
102	Get/Set	Acceleration Time (Note2)	0~6000.0 sec	Set-up/monitor Inverter acceleration time.
103	Get/Set	Deceleration Time (Note3)	0~6000.0 sec	Set-up/monitor Inverter deceleration time.

(Note1) It is related with dr.10 Torque Control and AP.01 App mode. If the dr.10 Torque Control is set to ‘Yes,’ Drive Mode becomes “Torque Control,” and if AP.01 App mode is set to Proc PID, the Drive Mode becomes “Process Control (e.g. PI).”

(Note2) dr.03: Acc Time value.
(Note3) dr.04: Dec Time value.

[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 Keypad Parameters of the Inverter.

[Attribute]

Instance	Access	Attribute Number	Attribute Name	Attribute Value
1 (dr Group)	Get/Set	Identical to Instruction Manual Code No.	Keypad Title (Refer to Instruction Manual)	Setting range of inverter parameter (Refer to Instruction Manual)
2 (bA Group)				
3 (Ad Group)				
4 (Cn Group)				
5 (In Group)				
6 (OU Group)				
7 (CM Group)				
8 (AP Group)				
9 (Reserved)				
10 (Reserved)				
11 (PRT Group)		Identical to Instruction Manual Code No.		
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

Revision History

No	Date	Edition	Changes
0	2021-02-25	Initial Release	

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