

TECO Frequency Inverter
PA-C Communication Interface

APPLICATION MANUAL

Content

- 1. INTRODUCTION 2**
- 2. SPECIFICATION 2**
- 3. WIRING DIAGRAM 3**
- 4. DESCRIPTION OF TERMINAL, LED, DIP SWITCH AND JUMPER 4**
- 5. INSTALLATION 6**
- 6. INVERTER SETTING 6**
 - 1. Set method 6**
 - 2. Inverter Communication Status 6**
- 7. MODBUS ASCII PROTOCOL 7**
 - 1. Modbus ASCII Protocol Format..... 7**
 - 2. Message Format 9**
 - 3. Holding Register Tag List 13**
 - 4. Error Response..... 24**
- 8. METASYS N2 PROTOCOL 25**
 - 1. MetaSys N2 protocol supported in PA-C card. 25**
 - 2. PA-C Card Point Map..... 27**
 - 3. Error Code List 29**

1. Introduction

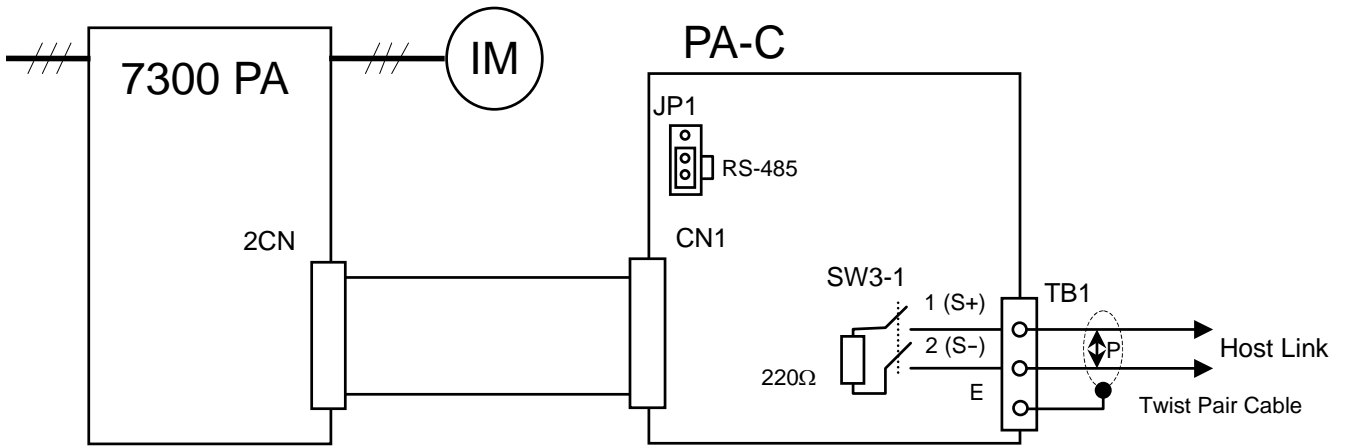
This manual describes feature of PA-C communication card and the communication methods between TECO frequency inverter 7300PA and host controllers (PC, PLC...) with Modbus Protocol ASCII mode or MetaSys N2 Protocol.

2. Specification

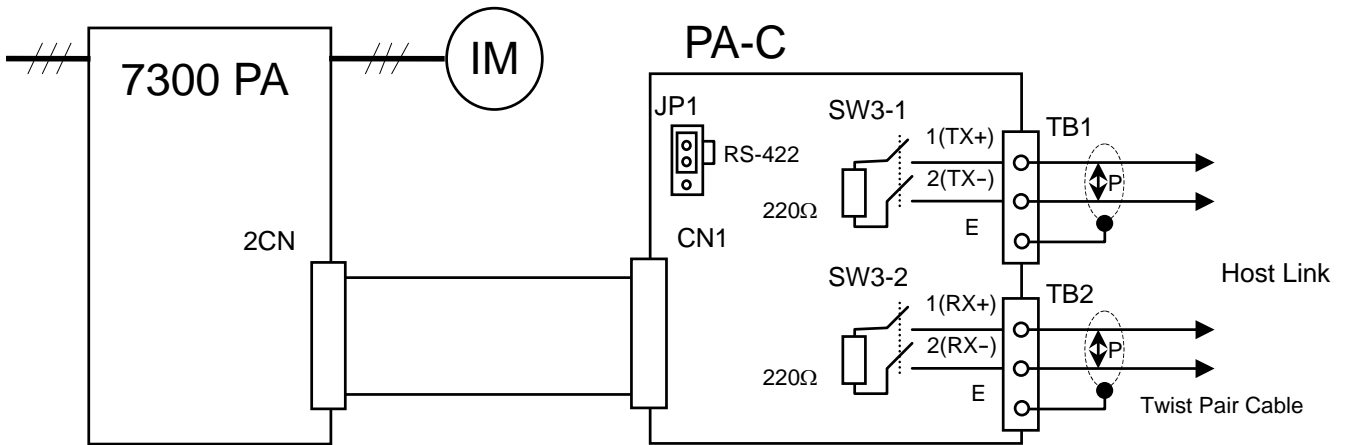
Product Feature	Connection Medium	Shielded Twisted Pair Cable
	RTS Repeater	TTL Level
	Photocoupler Isolation	Common Mode Rejection $V_{CM} = 50V$, $dV/dt = 5000V/\mu\text{sec}$
	Terminal Resistors	Onboard Switch Setting
	Communication Status	4 LED Indications
	Distance	(Max.) 100m
	Mode	Half-Duplex
	Mechanical Size	110mm x 112mm
Modbus ASCII Spec.	Serial Interface	RS-422/RS-485
	Maximum Connection	31 MODBUS (ASCII mode) slave standard
	Baud Rate	2400/4800/9600/19200 (BPS)
	Data Bit	7 Bit
	Parity	No Parity/Odd Parity /Even Parity
	Stop Bit	1 Bit (Odd Parity, Even Parity)/2 Bit (No Parity)
	Error Check	Longitudinal Redundancy Check (LRC)
	Access Data	All Parameters of 7300PA
MetaSys N2 Spec.	Serial Interface	RS-485
	Maximum Connection	255 MetaSys N2 slave standard
	Baud Rate	9600 (BPS)
	Data Format	8-bit data, 1 stop bit, no parity check
	Error Check	Checksum
	Access Data	10 analog inputs, 24 binary inputs, 22 analog outputs and 12 binary outputs
	Command	<p>Commands supported:</p> <p>0/4, 0/5: Poll Command 0/8 : Warm Reset Command</p> <p>1: Read Command 2: Write Command</p> <p>F: Identify Device Command</p> <p>Following Override Commands valid, but the data will not return to original one while override is released</p> <p>7/2/3: AO Override Command 7/2/4 : BO Override Command</p> <p>The PA-C will response following normally, but no action be taken.</p> <p>0/0 : Synch Time Command 7/3: Override Release Command</p> <p>7/2/1: AI Override Command 7/2/2 : BI Override Command</p>

3. Wiring Diagram

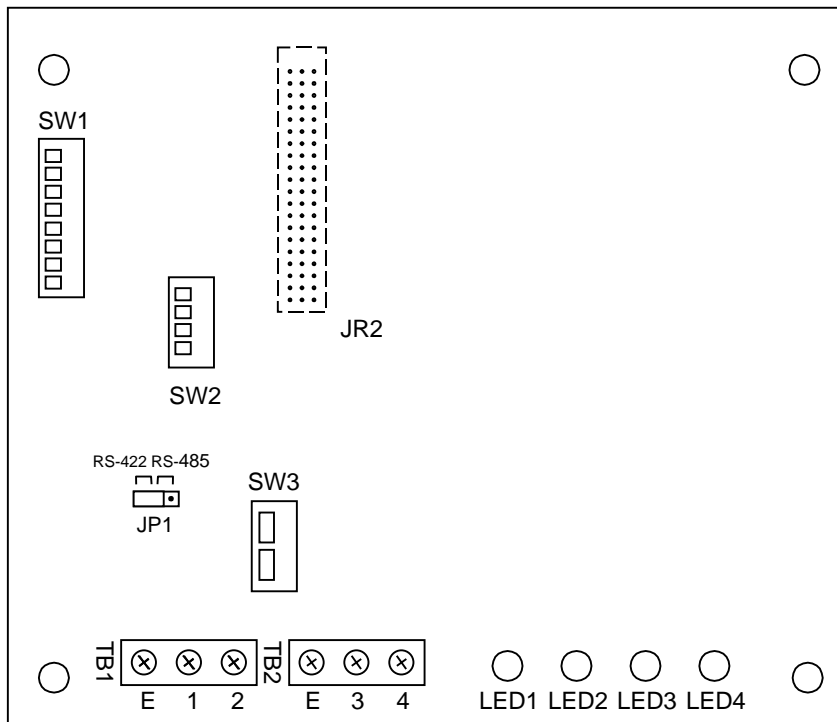
(1) RS-485 interface (Set JP1 to "RS-485")



(2) RS-422 interface (Set JP1 to "RS-422")



4. Description of Terminal, LED, DIP Switch and Jumper



(1) Terminal

Terminal		Function	
		RS-485	RS-422
TB1	1	S+	TX+
	2	S-	TX-
	E	Shield	Shield
TB2	3	————	RX+
	4	————	RX-
	E	————	Shield
CN1		Connect to 2CN in 7300PA Control Board	

(2) LED

LED	Function	Description
LED1	Receive	light while data are being received from inverter
LED2	Transmit	light while data are being transmitted to inverter
LED3	Transmit	light while data are being received from PLC
LED4	Receive	light while data are being transmitted to PLC

(3) DIP SWITCH

1. Protocol Setting

Protocol Setting	SW 2-3	SW 2-4	Comments
Modbus ASCII	OFF	OFF	Set SW 1-8 to OFF
MetaSys N2	ON	OFF	Set SW 2-1 to OFF
RESERVED	—	ON	

2. DIP Switch (ON : enable terminal resistor, OFF : disable terminal resistor)

DIP Switch	Description	
	RS-485	RS-422
SW3-1	Control terminal resistor between S+ and S-.	Control terminal resistor between TX+ and TX -.
SW3-2	—————	Control terminal resistor between RX+ and RX-.

3. Address, Baud Rate & Parity Check

Below are the setting for Modbus ASCII protocol and MetaSys N2 protocol.

1. MetaSys N2 Protocol:

Address	SW1-5	SW1-4	SW1-3	SW1-2	SW1-1
1	OFF	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	OFF	ON
...	...				
30	ON	ON	ON	OFF	ON
31	ON	ON	ON	ON	OFF

Baud Rate	SW2-2	SW2-1
19200	OFF	OFF
9600	ON	OFF
4800	OFF	ON
2400	ON	ON

Parity Check	SW1-7	SW1-6
No Parity	OFF	OFF
Odd Parity	ON	OFF
Even Parity	OFF	ON
RESERVED	ON	ON

2. MetaSys N2 Protocol:

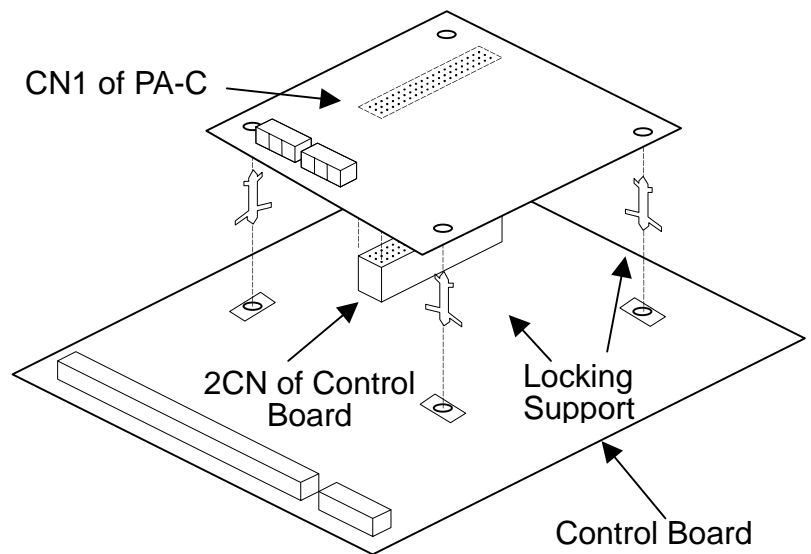
Baud Rate: 9600 BPS Parity Check: NO Stop Bit:: 1 STOP bit

Address	SW1-8	SW1-7	SW1-6	SW1-5	SW1-4	SW1-3	SW1-2	SW1-1
1	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
...	...							
254	ON	ON	ON	ON	ON	ON	OFF	ON
255	ON	ON	ON	ON	ON	ON	ON	OFF

- Be sure to set the protocol setting, address, baud rate and parity before power on.

5. Installation

- (1) Turn off the inverter.
- (2) Insert attached 2 locking supports into the 7300PA control board.
- (3) Mount the PA-C communication interface to the control board, with the holes in the right side aligned to the locking supports, and the connector CN1 aligned to 2CN of control board.
- (4) Connect the wire to TB1 (or TB2) terminal in PA-C communication interface.



6. Inverter Setting

1. Set method

Start inverter 7300PA, and switch to PRGM mode, then set the following parameters.

Sn-08 = 1100 (Frequency and RUN/STOP command provided by RS-485, continuously running in communication error.)

Sn-23 = 1 (Inverter Address: 1)

Sn-24 = 1100 (Baud Rate 19200 BPS, without parity check)

Cn-31 = 01.0 s (communication checkout time: 1s)

Restarting power supply after setting the parameters ensures normally communication between Inverter 7300PA and PA-C interface card.

(The setting of Sn-23, Sn-24 is for communication between inverter and PA-C only)

2. Inverter Communication Status

The PA-C card will send data to 7300PA after data from PLC is transmitted to PA-C card. If there is error in communication between PA-C card and 7300PA, the digital operator will show the warning message. Follow is the description:

- (1) Digital operator will blink 'RS-485 comm Ready' or 'CALL' while receiving no data in 1s after inverter starts. Such message will disappear in receiving data.
- (2) The digital operator will display warning 'RS-485 comm Fault 1' or 'CPF21' if receiving no data in 1s after communication succeed.
- (3) If the baud rate, data bits, stop bit or parity of data received by the inverter is not correct, the digital operator will blink 'RS-485 comm Fault 2' or 'CPF22'.

7. Modbus ASCII Protocol

1. Modbus ASCII Protocol Format

- (1) A message of Modbus ASCII mode contains 6 parts: start character, slave address, function, data, Longitudinal Redundancy Check (LRC) and end characters.

Start ' : '	Slave Address	Function Code	Data	LRC	End CR, LF
----------------	------------------	------------------	------	-----	---------------

The start character is a colon (:) character (ASCII 3Ah), and the end the characters are the carriage return character (CR) and line feed character (LF). The allowable characters are hexadecimal 0...9, A...F.

Every byte will be transformed into 2 hexadecimals. For example, the 03h will be transformed into '03' (30h, 33h)

- (2) Following is the data bit format for MODBUS RTU mode. (LSB will be sent first)

	LSB							MSB		
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7	Bit8	Bit9
Even/Odd Parity	Start	1	2	3	4	5	6	7	Parity	Stop
No Parity	Start	1	2	3	4	5	6	7	Stop	Stop

- (3) Slave Address

The DIP switch SW1 can set the node address of each inverter (1~31). Every slave stand can receive the message sent from host controller. Only the corresponding one returns the message to master.

If the slave address of receiving message is 0, all slave stands will execute this command and do not return the message to master. This message can only use for Register 0001H and 0002H.

- (4) Function Code

Code	Function	Note
03H	Read Data of Holding Register	-----
06H	Write Data to Single Register	the Slave Address can be 0
08H	Loop Test	-----
10H	Write Data to Holding Register	the Slave Address can be 0

- (5) Data Characters

Detail descriptions will be discussed in "Message Format" section (p.9-12) because it depends on the function code.

(6) Longitudinal Redundancy Check (LRC)

The procedures of calculating LRC are listed as below:

A. Add the bytes of slave address, the function code and the data and save the low byte of sum only.

B. Take the 2's complement of low byte of sum. It is the LRC

Ex: The LRC of Modbus Message :01080000AA55 is calculated as below

$01H + 08H + 00H + 00H + AAH + 55H = 108H$. Low byte of $108H = 08H$.

The 2's complement of $08H$ is $F8H$.

The LRC is $F8H$, The complete message is :01080000AA55F8 CR LF

(7) Inverter return messages

A. Please refer to the "Message Format" in next page about inverter returning messages for more detail descriptions.

B. It needs 15ms to return messages after inverter had received normal message from host controller.

C. In the next two cases, inverter does not return any message :

(a) There is any error detected in received data message (parity error, framing error, overrun error or CRC-16 error).

(b) Slave address is different from the slave address set by SW1

2. Message Format

PA-C supports 4 MODBUS Function codes: Read, Loop Test and Write (write single hold register and write multiple hold registers)

Table 1 Message Length

Function	Code	Function	Host Query		Inverter Return	
			Byte (Min.)	Byte (Max.)	Byte (Min.)	Byte (Max.)
Data Read	03H	Read Data from Holding Register	17	17	15	75
Data Write	06H	Write Data to Single Holding Register	17	17	17	17
Loop Test	08H	Loop Test	17	17	17	17
Data Write	10H	Write Data to Holding Register	23	83	17	17

(1) Read Command : Read data of Holding Register

Start Character		' : '
Slave Address		' 0 ' ' 1 '
Function Code		' 0 ' ' 3 '
Head Address (*1)	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 2 '
Access Count (*2)	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
LRC		' F ' ' 9 '
End Characters		CR LF

Start Character		' : '
Slave Address		' 0 ' ' 1 '
Function Code		' 0 ' ' 3 '
Data Byte Count		' 0 ' ' 2 '
Data Value	High Byte	' 1 ' ' 7 '
	Low Byte	' 7 ' ' 0 '
LRC		' 7 ' ' 3 '
End Characters		CR LF

*1 Refer to p.13-23 to see the holding register tag list.

*2 Host controller can read 16 registers at most in each transferring message.

*3 Refer to p.24 to see the error response.

(2) Write Command : Write Data to Single Holding Register

Host Query			Inverter Return (Normal)		
Start Character		' : '	Start Character		' : '
Slave Address (*1)		' 0 ' ' 1 '	Slave Address		' 0 ' ' 1 '
Function Code		' 0 ' ' 6 '	Function Code		' 0 ' ' 6 '
Head Address (*2)	High Byte	' 0 ' ' 0 '	Head Address	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 2 '		Low Byte	' 0 ' ' 2 '
Data Value	High Byte	' 1 ' ' 7 '	Data Value	High Byte	' 1 ' ' 7 '
	Low Byte	' 7 ' ' 0 '		Low Byte	' 7 ' ' 0 '
LRC		' 7 ' ' 0 '	LRC		' 7 ' ' 0 '
End Characters		CR LF	End Characters		CR LF

- *1 If slave address is 0 (valid for address 0001H and 0002H only), all slave inverters will execute this command but do not return message to master.
- *2 Refer to p.13-23 to see the holding register tag list.
- *3 Refer to p.24 to see the error response.
- Parameters modified will not be saved to EEPROM automatically. We can save parameters to EEPROM by writing data to address 0900H while the inverter is not running.

(3) Loop Test Command (test inverter communication status)

Host Query			Inverter Return (Normal)		
Start Character		' : '	Start Character		' : '
Slave Address		' 0 ' ' 1 '	Slave Address		' 0 ' ' 1 '
Function Code		' 0 ' ' 8 '	Function Code		' 0 ' ' 8 '
Test Code (*1)	High Byte	' 0 ' ' 0 '	Test Code	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 0 '		Low Byte	' 0 ' ' 0 '
Test Data (*2)	High Byte	' A ' ' A '	Test Data	High Byte	' A ' ' A '
	Low Byte	' 5 ' ' 5 '		Low Byte	' 5 ' ' 5 '
LRC		' F ' ' 8 '	LRC		' F ' ' 8 '
End Characters		CR LF	End Characters		CR LF

*1 The test code is fixed to be 00H.

*2 The test data is arbitrary.

*3 Refer to p.24 to see the error response.

(4) Write Holding Register Command

Host Query

Start Character		' : '
Slave Address (*1)		' 0 ' ' 1 '
Function Code		' 1 ' ' 0 '
Head Address (*2)	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
Access Count (*3)	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
Data Byte Count (*4)		' 0 ' ' 2 '
Data Value	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
LRC		' E ' ' A '
End Characters		CR LF

Inverter Return (Normal)

Start Character		' : '
Slave Address		' 0 ' ' 1 '
Function Code		' 1 ' ' 0 '
Head Address	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
Access Count	High Byte	' 0 ' ' 0 '
	Low Byte	' 0 ' ' 1 '
LRC		' E ' ' D '
End Characters		CR LF

- *1 If the slave address of host query message is 0, all slave inverters will execute this command but do not return message to master.
- *2 Refer to p.13-23 to see the holding register tag list.
- *3 Host controller can write 16 registers at most in each transferring message.
- *4 Data Byte Count = 2 * Access Count.
- *5 Refer to p.24 to see the error response.
- Parameters modified will not be saved to EEPROM automatically. We can save parameters to EEPROM by writing data 0000H to address 0900H while the inverter is not running.

3. Holding Register Tag List

(1) Control Data Register (Read / Write)

Address		Function Description			Ref. Page
HEX	DEC				
0001H	1	Operation Signals	0	RUN Command	p.14
			1	REV Command	
			2	External Fault	
			3	Fault Reset	
			4	Multifunction Ref 1	
			5	Multifunction Ref 2	
			6	Multifunction Ref 3	
			7	Multifunction Ref 4	
		8-15	Reserved		
0002H	2	Frequency Reference (100/1Hz)			p.15
0003H	3	Reserved			
0004H	4	Reserved			
0005H	5	Reserved			
0006H	6	Reserved			
0007H	7	Reserved			
0008H	8	Reserved			
0009H	9	Multifunction Output Command	0	Relay Output (R2A-R2C) Output	p.15
			1	Digital Output (DO1) Output	
			2	Relay Output (R1A-R1C) Output	
			3-15	Reserved	
000AH	10	Analog Output 1 Command (255/10V)			p.15
000BH	11	Analog Output 2 Command (255/10V)			p.15
000CH	12	Reserved			
000DH	13	Reserved			
000EH	14	Reserved			
000FH	15	Reserved			

*1 Control Data Register can be used for Salve Address '0' write-in message.

Address		Function Description
HEX	DEC	
0001H	1	Operation Signals

BIT	Function Description
2 (*1)	1 : Run (RUN), 0 : Stop (STOP)
2 (*1)	1 : Reverse Run (REV), 0 : Forward Run (FWD)
2 (*2)	External Fault (EB) : Invert output OFF, Fault Output ON
3	Fault Reset (RESET)
4 (*3)	Multifunction Ref. 1 (By Sn-15 setting, Initial setting : multi-step speed ref. 1)
5 (*3)	Multifunction Ref. 2 (By Sn-16 setting, Initial setting : multi-step speed ref. 2)
6 (*3)	Multifunction Ref. 3 (By Sn-17 setting, Initial setting : jogging frequency)
7 (*3)	Multifunction Ref. 4 (By Sn-18 setting, Initial setting : external baseblock)
8-15	Reserved

- *1 This register becomes effective by setting Sn-08 (run mode selection 5) to --0-.
- *2 External baseblock function is OR operation of command from bit 2 (EB) and command by inverter external terminal ③. "Emergency stop" is possible by external terminal ③ even while inverter is running by MODBUS.
- *3 Multifunction Ref. 1-4 are OR operation of command from bit 4-7 and command by inverter external terminals ⑤-⑧.

Address		Function Description
HEX	DEC	
0001H	1	Frequency Reference (100/1Hz)

- This register becomes effective by setting Sn-08 (run mode selection 5) to ---0.

Address		Function Description
HEX	DEC	
0009H	9	Multifunction Output Command

BIT	Function Description
0	1 : R2A-R2C ON, 0 : R2A-R2C OFF
1	1 : DO1 ON, 0 : DO1 OFF
2	1 : R1A-R1C ON, 0 : R1A-R1C OFF
4-15	Reserved

- These bits become effective by setting Sn-20-22 (Sn-20 for bit 0, Sn-21 for bit 1 and Sn-22 for bit 2) to 0F.

Address		Function Description
HEX	DEC	
000AH	10	Analog Output 1 Command (255/10V)
000BH	11	Analog Output 2 Command (255/10V)

- These registers become effective by setting Sn-26-27 (Sn-26 for register 000A, Sn-27 for register 000B) to 10.

(2) Monitor Data Register (Read Only)

Address		Function Description		Ref. Page	
HEX	DEC				
0020H	32	Status Signals	0	Running	p.18
			1	Reverse Running	
			2	Inverter Ready	
			3	Major Fault	
			4	Reserved	
			5	Relay Output (R2A-R2C) Output	
			6	Digital Output (DO1) Output	
			7	Relay Output (R1A-R1C) Output	
			8-15	Reserved	
0021H	33	Fault Contents	0	Overcurrent or Ground Fault (OC, GF)	p.18
			1	Overvoltage (OV)	
			2	Inverter Overload (OL1, OL2)	
			3	Inverter Overheat (OH)	
			4	Reserved	
			5	Reserved	
			6	Reserved	
			7	External Fault (EFxx)	
			8	Control Circuit Fault (CPFxx)	
			9	Motor Overload (OL3)	
			10	Reserved	
			11	Reserved	
			12	Power Loss or MC defective (UVx)	
13-15	Reserved				
0022H	34	Reserved			
0023H	35	Frequency Reference (100/1Hz)			
0024H	36	Output Frequency (100/1Hz)			
0025H	37	Reserved			
0026H	38	Reserved			
0027H	39	Output Current (10/1A)			
0028H	40	Output Voltage (1/1V)			
0029H	41	Main Speed (VIN+AIN) A/D Converted Value (1023/10V)			
002AH	42	AUX. Speed A/D Converted Value (1023/10V)			
002BH	43	Digital Input Terminal Value	0	1 : Terminal ① is close	
			1	1 : Terminal ② is close	
			2	1 : Terminal ③ is close	
			3	1 : Terminal ④ is close	
			4	1 : Terminal ⑤ is close	
			5	1 : Terminal ⑥ is close	
			6	1 : Terminal ⑦ is close	
			7	1 : Terminal ⑧ is close	
			8-15	Reserved	

Address		Function Description	Ref. Page		
HEX	DEC				
002CH	44	Inverter Status	0	Running	p.19
			1	During Zero Speed	
			2	During Frequency Coincidence	
			3	Arbitrary Frequency Coincidence	
			4	Frequency Detection 1	
			5	Frequency Detection 2	
			6	Inverter Ready	
			7	Undervoltage Detecting	
			8	Output Baseblock	
			9	Frequency Reference Mode	
			10	Run Command Mode	
			11	Overtorque Detection	
			12	Frequency Reference Missing	
			13	Reserved	
			14	Major Fault	
15	Reserved				
002DH	45	Digital Output Terminal Value	0	1 : R2A-R2C ON	
			1	1 : DO1-DCOM ON	
			2	1 : R1A-R1C ON	
			3-15	Reserved	
002EH	46	Reserved			
002FH	47	Reserved			
0030H	48	Reserved			
0031H	49	Main Circuit DC Voltage (1/1V)			
0032H	50	Reserved			
0033H	51	Reserved			
0034H	52	Reserved			
0035H	53	Reserved			
0036H	54	Reserved			
0037H	55	Reserved			
0038H	56	Reserved			
0039H	57	Reserved			
003AH	58	Reserved			
003BH	59	Reserved			
003CH	60	Reserved			
003DH	61	Reserved			
0040H	64	PA-C Software Version (10 for version 1.0)			

Address		Function Description
HEX	DEC	
0020H	32	Status Signals

BIT	Function Description
0	1 : Running, 0 : Stop
1	1 : Reverse Run, 0 : Forward Run
2	1 : Inverter Operation Ready (*1)
3	1 : Major Fault (Except CPF00, CPF01)
4	Reserved
5	Multifunction Output 1 (R2A-R2C) (By Sn-20 setting. Default setting : during running)
6	Multifunction Output 2 (DO1-DCOM) (By Sn-21 setting, Default setting : zero speed)
7	Multifunction Output 3 (R1A-R1C) (By Sn-22 setting, Default setting : agreed frequency)
8-15	Reserved

*1 This bit will be set to 1 when the inverter is in the DRIVE mode and there is no alarm, fault or baseblock.

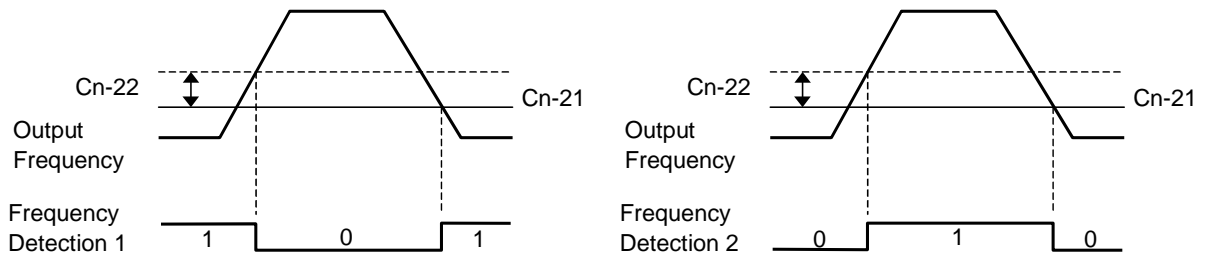
Address		Function Description
HEX	DEC	
0021H	33	Fault Contents

BIT	Function Description
0	Overcurrent (OC) or Ground Fault (GF)
1	Overvoltage (OV)
2	Inverter Overload (OL1, OL2)
3	Inverter Overheat (OH)
4-6	Reserved
7	External Fault (EF3, EF5, EF6, EF7, EF8)
8	Control Circuit Fault (CPF02) EEPROM fault (CPF03) EEPROM BCC CODE Error (CPF04) CPU ADC Fault (CPF05)
9	Motor Overload (OL3)
10-11	Reserved
12	Main circuit low voltage or momentary power loss protection (UV1) Control circuit low voltage (UV2) Main circuit soft charge contactor defective (UV3)
13-15	Reserved

Address		Function Description
HEX	DEC	
002CH	44	Inverter Status

BIT	Function Description
0	1 : Running
1	1 : During Zero Speed
2	1 : During Frequency Coincidence $\left(\text{Freq. Ref} - \frac{\text{Cn-22}}{\text{Cn-22}} \right) \leq \text{Output Freq.} \leq \left(\text{Freq. Ref} + \frac{\text{Cn-22}}{\text{Cn-22}} \right)$
3	1 : Arbitrary Frequency Coincidence Frequency Coincidence and $(\text{Cn-21} - \text{Cn-22}) \leq \text{Output Freq.} \leq (\text{Cn-21} + \text{Cn-22})$
4	1 : Frequency Detection 1 Output Freq. \geq Cn-21 (*1)
5	1 : Frequency Detection 2 Output Freq. \leq Cn-21 (*1)
6	1 : Inverter Operation Ready (*2)
7	1 : Undervoltage Detecting
8	1 : Output Baseblock
9	0 : Frequency Reference is from RS-485. 1 : Frequency Reference is from Operator or terminal.
10	0 : RUN/STOP Command is from RS-485. 1 : RUN/STOP Command is from Operator or terminal.
11	1 : Overtorque Detection (Detection Level : Cn-26, Detection Time : Cn-27)
12	1 : Frequency Reference is Missing
13	Reserved
14	1 : Major Fault (Except CPF00, CPF01)
15	Reserved

*1



*2 This bit will be set to 1 when the inverter is in the DRIVE mode and there is no alarm, fault or baseblock.

(3) Inverter Parameter Register

(An, Bn : Read/Write, Others : Read Only in DRIVE Mode, Read/Write in PRGM Mode)

Address		Parameter			Notes
HEX	DEC	No.	Description	Unit	
System Parameters Sn					
0101H	257	Sn-01	Inverter Capacity Selection	-	
0102H	258	Sn-02	V/f Curve Selection	-	
0103H	259	Sn-03	Operation Status	-	
0104H	260	Sn-04	Operation Mode Select 1	-	
0105H	261	Sn-05	Operation Mode Selection 2	-	
0106H	262	Sn-06	Operation Mode Selection 3	-	
0107H	263	Sn-07	Operation Mode Selection 4	-	
0108H	264	Sn-08	Operation Mode Selection 5	-	
0109H	265	Sn-09	Operation Mode Selection 6	-	
010AH	266	Sn-10	Protective Characteristic Selection 1	-	
010BH	267	Sn-11	Protective Characteristic Selection 2	-	
010CH	268	Sn-12	Protective Characteristic Selection 3	-	
010DH	269	Sn-13	Protective Characteristic Selection 4	-	
010EH	270	Sn-14	Protective Characteristic Selection 5	-	
010FH	271	Sn-15	Terminal ⑤ Function	-	
0110H	272	Sn-16	Terminal ⑥ Function	-	
0111H	273	Sn-17	Terminal ⑦ Function	-	
0112H	274	Sn-18	Terminal ⑧ Function	-	
0113H	275	Sn-19	Terminal AUX Function	-	
0114H	276	Sn-20	Terminal R2A-R2C Function	-	
0115H	277	Sn-21	Terminal D01 Function	-	
0116H	278	Sn-22	Terminal R1A Function	-	
0117H	279	Sn-23	Inverter station address	-	
0118H	280	Sn-24	RS-485 communication protocol setting	-	
0119H	281	Sn-25	LCD Language displayed selection	-	
011AH	282	Sn-26	Multi-Function Analog Output A01 Function Selection	-	
011BH	283	Sn-27	Multi-Function Analog Output A02 Function Selection	-	
011CH	284	-	Reserved	-	
011DH	285	-	Reserved	-	
011EH	286	Sn-30	Pump Operation Mode Selection	-	
011FH	287	Sn-31	PA-PID Card Relay 2 Control	-	
0120H	288	Sn-32	PA-PID Card Relay 3 Control	-	
0121H	289	Sn-33	PA-PID Card Relay 4 Control	-	
0122H	290	Sn-34	PA-PID Card Relay 5 Control	-	
0123H	291	Sn-35	PA-PID Card Relay 6 Control	-	
0124H	292	Sn-36	PA-PID Card Relay 7 Control	-	
0125H	293	Sn-37	PA-PID Card Relay 8 Control	-	
0126H	294	Sn-38	Parameter copy	-	

Address		Parameter			Notes
HEX	DEC	No.	Description	Unit	
Control Parameters Cn					
0200H	512	Cn-01	Input Voltage	0.1V	
0201H	513	Cn-02	Max. Output Frequency	0.1Hz	
0202H	514	Cn-03	Max. Output Voltage	0.1V	
0203H	515	Cn-04	Max. Voltage Frequency	0.1Hz	
0204H	516	Cn-05	Middle Output Frequency	0.1Hz	
0205H	517	Cn-06	Voltage At Middle Output Frequency	0.1V	
0206H	518	Cn-07	Min Output Frequency	0.1Hz	
0207H	519	Cn-08	Voltage At Min. Output Frequency	0.1V	
0208H	520	Cn-09	Motor Rated Current	0.1A	
0209H	521	Cn-10	DC Injection Braking Starting Frequency	0.1Hz	
020AH	522	Cn-11	DC Braking Current	1%	
020BH	523	Cn-12	DC Injection Braking Time At Stop	0.1s	
020CH	524	Cn-13	DC Injection Braking Time At Start	0.1s	
020DH	525	Cn-14	Frequency Command Upper Bound	1%	
020EH	526	Cn-15	Frequency Command Lower Bound	1%	
020FH	527	Cn-16	Frequency Jump Point 1	0.1Hz	
0210H	528	Cn-17	Frequency Jump Point 2	0.1Hz	
0211H	529	Cn-18	Frequency Jump Point 3	0.1Hz	
0212H	530	Cn-19	Jump Frequency Width	0.1Hz	
0213H	531	Cn-20	Digital Operator Display Unit	1	
0214H	532	Cn-21	Frequency Agree Detection Level	0.1Hz	
0215H	533	Cn-22	Frequency Agree Detection Width	0.1Hz	
0216H	534	Cn-23	Carrier Frequency Upper Limit	0.1KHz	
0217H	535	Cn-24	Carrier Frequency Lower Limit	0.1KHz	
0218H	536	Cn-25	Carrier Frequency proportion Gain	1	
0219H	537	Cn-26	Overtorque Detection Level	1%	
021AH	538	Cn-27	Overtorque Detection Time	0.1s	
021BH	539	Cn-28	Stall Prevention Level During Acceleration	1%	
021CH	540	-	Reserved	-	
021DH	541	Cn-30	Stall Prevention Level During Running	1%	
021EH	542	Cn-31	Communication Fault Detection Time	0.1s	
021FH	543	Cn-32	Frequency Detection 1 Level	0.1Hz	
0220H	544	Cn-32	Frequency Detection 2 Level	0.1Hz	
0221H	545	-	Reserved	-	
0222H	546	-	Reserved	-	
0223H	547	Cn-36	Number of Auto Restart Attempt	1	
0224H	548	Cn-37	Power Loss Ride-through Time	0.1s	
0225H	549	Cn-38	Speed Search Detection Level	1%	
0226H	550	Cn-39	Speed Search Time	0.1s	
0227H	551	Cn-40	Min. Baseblock Time	0.1s	
0228H	552	Cn-41	V/F Curve in Speed Search	1%	
0229H	553	Cn-42	Voltage Recovery Time	0.1s	
022AH	554	Cn-43	PID Integral Upper Bound	1%	

Address		Parameter			Notes
HEX	DEC	No.	Description	Unit	
022BH	555	Cn-44	PID Primary Delay Time Constant	0.1s	
022CH	556	Cn-45	Energy-Saving Volt. Upper Limit (60Hz)	1%	
022DH	557	Cn-46	Energy-Saving Volt. Upper Limit (6Hz)	1%	
022EH	558	Cn-47	Energy-Saving Volt. Lower Limit (60Hz)	1%	
022FH	559	Cn-48	Energy-Saving Volt. Lower Limit (6Hz)	1%	
0230H	560	Cn-49	Tuning Operation Voltage Limit	1%	
0231H	561	Cn-50	Tuning Operation Control Cycle	0.1s	
0232H	562	Cn-51	Tuning Operation Volt. Step (100% output Volt)	0.10%	
0233H	563	Cn-52	Tuning Operation Volt. Step (5% output Volt)	0.10%	
0234H	564	-	Reserved	-	
0235H	565	-	Reserved	-	
0236H	566	-	Reserved	-	
0237H	567	-	Reserved	-	
0238H	568	-	Reserved	-	
0239H	569	Cn-58	Energy-Saving Coefficient K2 (60Hz)	0.01	
023AH	570	Cn-59	Energy-Saving Coefficient Reduction ratio (6Hz)	1%	
023BH	571	Cn-60	Motor Code	-	
023CH	572	-	Reserved	-	
023DH	573	Cn-62	Auto Restart Time Interval	1s	
023EH	574	Cn-63	Motor Overheat protection time	1s	
Order Parameters On					
0300H	768	On-01	Control Status 1	-	
0301H	769	On-02	Control Status 2	-	
0302H	770	On-03	Control Status 3	-	
0303H	771	-	Reserved	-	
0304H	772	-	Reserved	-	
0305H	773	-	Reserved	-	
0306H	774	On-07	Hunting Prevention gain	0.01	
0307H	775	On-08	Hunting Prevention limit	1%	
0308H	776	On-09	Effective current detection filter time constant	1(3.5ms)	
0309H	777	-	Reserved	-	
030AH	778	On-11	ON-DELAY TIME	1(0.25 μ s)	
030BH	779	On-12	ON-DELAY Compensated value	1(0.25 μ s)	
030CH	780	-	Reserved	-	
030DH	781	-	Reserved	-	
030EH	782	On-15	Power detection filter changing width	1%	
030FH	783	On-16	Power detection filter time constant	1(7ms)	
0310H	784	On-17	Motor phase to phase resistance	0.001 Ω	
0311H	785	On-18	Torque Compensation of care loss	1W	
0312H	786	On-19	Torque Compensation limit	1V	
0313H	787	On-20	Motor Constant R1	0.001 Ω	*1
0314H	788	On-21	Motor Constant R2	0.001 Ω	*1
0315H	789	On-22	Motor Constant L	0.001mH	*1
0316H	790	On-23	Motor Constant Rm	0.001m Ω / ω	*1
0317H	791	On-24	Motor Constant Lm	0.01mH	*1

Address		Parameter			Notes	
HEX	DEC	No.	Description	Unit		
Frequency Command An						
0400H	1024	An-01	Frequency Command 1	0.01Hz	*2	
0401H	1025	An-02	Frequency Command 2	0.01Hz	*2	
0402H	1026	An-03	Frequency Command 3	0.01Hz	*2	
0403H	1027	An-04	Frequency Command 4	0.01Hz	*2	
0404H	1028	An-05	Frequency Command 5	0.01Hz	*2	
0405H	1029	An-06	Frequency Command 6	0.01Hz	*2	
0406H	1030	An-07	Frequency Command 7	0.01Hz	*2	
0407H	1031	An-08	Frequency Command 8	0.01Hz	*2	
0408H	1032	An-09	Jog Frequency Command	0.01Hz	*2	
Parameters Groups Can Be Changed during Running Bn						
0500H	1280	Bn-01	Acceleration Time 1	0.1s	*2	
0501H	1281	Bn-02	Deceleration Time 1	0.1s	*2	
0502H	1282	Bn-03	Acceleration Time 2	0.1s	*2	
0503H	1283	Bn-04	Deceleration Time 2	0.1s	*2	
0504H	1284	Bn-05	Analog Frequency Cmd. Gain	0.10%	*2	
0505H	1285	Bn-06	Analog Frequency Cmd. Bias	0.10%	*2	
0506H	1286	Bn-07	Auto torque Boost Gain	0.1	*2	
0507H	1287	Bn-08	Multi-Function Analog Output A01 Bias	0%	*2	
0508H	1288	Bn-09	Multi-Function Analog Output A02 Bias	0.10%	*2	
0509H	1289	Bn-10	Monitor No. After power ON	-	*2	
050AH	1290	Bn-11	Multi-Function Analog Output A01 Gain	1%	*2	
050BH	1291	Bn-12	Multi-Function Analog Output A02 Gain	0.01	*2	
050CH	1292	Bn-13	PID Detection Gain	0.01	*2	
050DH	1293	Bn-14	PID Proportional Gain	10%	*2	
050EH	1294	Bn-15	PID Integral Gain	0.1s	*2	
050FH	1295	Bn-16	PID Differential Time	0.01s	*2	
0510H	1296	Bn-17	PID Bias	1%	*2	
0511H	1297	Bn-18	PID sleep Frequency	0.01Hz	*2	
0512H	1298	Bn-19	PID sleep/Wake-up Delay Time	0.1s	*2	
0513H	1299	Bn-20	PID Wake Up Frequency	0.01Hz	*2	
0514H	1300	Bn-21	PID Detected Value Display Bias	0.001	*2	
0515H	1301	Bn-22	PID Detected Value Display Gain	0.001	*2	
0516H	1302	Bn-23	Freq. Command Upper-Bound Delay Time	1s	*2	
0517H	1303	Bn-24	Freq. Command Lower-Bound Delay Time	1s	*2	
0518H	1304	Bn-25	MC ON/OFF Delay Time	0.01s	*2	
0519H	1305	Bn-26	Pump ON/OFF Detection Level	0.1%	*2	
Enter Command						
0900H	2304	Save An, Bn, Sn and Cn to EEPROM.			-	*2 *3

*1 These parameters can not be saved to EEPROM.

*2 These parameters can be written in DRV mode or PRG mode.

*3 Writing data to this address while the inverter is not running can save parameter (except On-20 - 24) to EEPROM.

- All parameters can be read in PRG mode or DRV mode, and parameters without note *2 can be written in PRG mode only.

4. Error Response

Following is the format of error response.

Inverter Return (Error Detected)

Start Code	' : '
Slave Address	' 0 '
	' 1 '
80H+Function Code	' 8 '
	' 3 '
Error Code	' 0 '
	' 1 '
LRC	' 7 '
	' B '
End Code	CR
	LF

Following is the list of the error code and description.

Code	Description	Possible Cause
00H	CRC Code Error	CRC Word (High or Low Byte) Error
01H	Function Code Error	Function code is not 03H, 06H, 08H or 10H.
02H	Register Address Error	Register address is not in the range that can be accessed.
03H	Access Count Error	The Access Count is more than 16. The Access Count in writing command (10H) does not match the amount of actual data.
21H	Data Value Error	Data value is out of range in writing message. Write parameters which not be written through Modbus command.
22H	Register Write Error	Write Cn ,Sn or On parameters during DRIVE mode
Not Response	UART Error	Parity, Overrun, Frame error.
Not Response	Data Format Error	Data string is not correct. (Incomplete Message, "Data Byte Count" in writing command (10H) does not match the amount of actual data.)
Not Response	CRC Error	The CRC of data string is not correct.

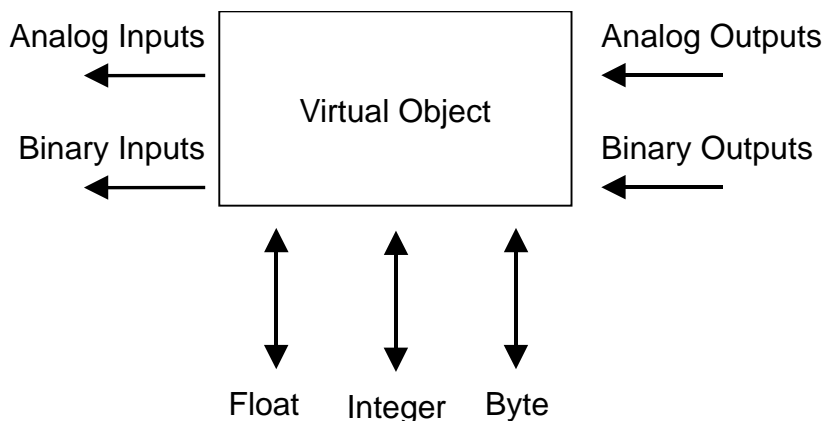
8. MetaSys N2 Protocol

1. Introduction of MetaSys N2 Protocol

MetaSys N2 protocol (Designed by Johnson Control) is a master/slave control network. N2 devices can have addresses in the range from 1 - 255. Full address range is supported.

A MetaSys N2 node may contain up to 256 data points in each of its seven different Data Point Types (NPT). The types are defined in list below.

No.	NPT name	Short Name	Comment
1	Analog Input	AI	32-bit, IEEE-standard floats
2	Binary Input	BI	1-bit
3	Analog Output	AO	32-bit, IEEE-standard floats
4	Binary Output	BO	1-bit
5	Internal Float	ADF	32-bit, IEEE-standard floats
6	Internal Integer	ADI	16-bit
7	Internal Byte	DB	8-bit



Every data point in N2 node has its address (Network Point Address, NPA), whose range is 0-255.

Every data point in N2 node have its attributes, like object configuration, object status, data value (Analog Input/ Analog Output), alarm/warning limit level. Most attributes allow Read/Write commands. However, data Value in Analog Input or Analog Output objects can be modified by Override command only.

N2 objects support COS (Chang of State) function. If COS function is enabled, the Binary Input/Output objects will record automatically while data is modified, and the Analog Input/Output objects will record automatically while warning/alarm level changes. All record data are reported if a Poll command is received.

After power on, the N2 device will wait for Identify command. The communication will work properly after Identify command is received.

2. MetaSys N2 protocol supported in PA-C card.

PA-C card supports Analog Input/Output, Binary Input/Output and corresponding functions. Note the following exceptions.

- PA-C card does not support attributes or fields for JCI only.
- PA-C card does not support analog alarm or analog warning of Analog Input object.
- PA-C card does not support override function of Analog Input and Binary Input objects. Those commands are received, but there is no action taken.
- PA-C card supports override function of Analog Output, Binary Output object but it is not possible to return the previous value by releasing the override.

Following are the lists of AI, AO BI and BO supported in PA-C card:

(1) AI Attribute List

No.	Type	Description	Comment
1	Byte	Object Configuration	Both R/W is allowed
2	Byte	Object Status	Read Only
3	Float	Analog Input Value	Read Only

(2) BI Attribute List

No.	Type	Description	Comment
1	Byte	Object Configuration	Both R/W is allowed
2	Byte	Object Status	Read Only

(1) AO Attribute List

No.	Type	Description	Comment
1	Byte	Object Configuration	Both R/W is allowed
2	Byte	Object Status	Read Only
3	Float	Current Value	Read and Override is allowed

(4) BO Attribute List

No.	Type	Description	Comment
1	Byte	Object Configuration	Both R/W is allowed
2	Byte	Object Status	Read Only (Override current state is allowed)
3	Integer	Minimum On-time	Both R/W is allowed
4	Integer	Minimum On-time	Both R/W is allowed
5	Integer	Maximum Cycles/Hour	Both R/W is allowed

3. PA-C Card Point Map

NPT	NPA	Unit	Description	Range/Value	Notes
AI	1	Hz	Frequency Command	0 - 180.00	
AI	2	Hz	Output Frequency	0 - 180.00	
AI	3	A	Output Current	0 - 300.00	
AI	4	V	Output Voltage	0 - 765.0	
AI	5	%	Terminal VIN (or AIN) Status	0 - 100.0	= VIN + AIN
AI	6	%	Terminal AUX Status	0 - 100.0	
AI	7	V	DC Bus Voltage	0 - 1200.0	
AI	8	-	Fault Content	0 - 65535	Refer to "Analog Input 8 format"
AI	9	%	PID Feedback Signal	0 - 100.0	Valid while PID Function enabled
AI	10	-	PA-C Software Version	0.0 - 9.9	
BI	1	-	Running Status	0: STOP, 1: RUN	
BI	2	-	Running Direction	0: FWD, 1: REV	
BI	3	-	Inverter Ready	0: OFF, 1: ON	
BI	4	-	Fault	0: OK, 1: FAULT	
BI	5	-	Zero Speed	0: OFF, 1: ON	
BI	6	-	Frequency Coincidence	0: OFF, 1: ON	
BI	7	-	Arbitrary Freq. Coincidence	0: OFF, 1: ON	
BI	8	-	Freq. Detection 1	0: OFF, 1: ON	
BI	9	-	Freq. Detection 2	0: OFF, 1: ON	
BI	10	-	Undervoltage Detecting	0: OFF, 1: ON	
BI	11	-	Output Baseblock	0: OFF, 1: ON	
BI	12	-	Overtorque Detection	0: OFF, 1: ON	
BI	13	-	Frequency Command Missing	0: OFF, 1: ON	
BI	14	-	Terminal 1 Status	0: Open, 1: Close	
BI	15	-	Terminal 2 Status	0: Open, 1: Close	
BI	16	-	Terminal 3 Status	0: Open, 1: Close	
BI	17	-	Terminal 4 Status	0: Open, 1: Close	
BI	18	-	Terminal 5 Status	0: Open, 1: Close	
BI	19	-	Terminal 6 Status	0: Open, 1: Close	
BI	20	-	Terminal 7 Status	0: Open, 1: Close	
BI	21	-	Terminal 8 Status	0: Open, 1: Close	
BI	22	-	Terminal DO1 Status	0: Open, 1: Close	
BI	23	-	Terminal R1A-R1C Status	0: Open, 1: Close	
BI	24	-	Terminal R2A-R2C Status	0: Open, 1: Close	
AO	1	Hz	Frequency Command	0 - 180.00	
AO	2	%	Terminal AO1 Command	0 - 100	Valid while parameter Sn-26 = 0A
AO	3	%	Terminal AO2 Command	0 - 100	Valid while parameter Sn-27 = 0A
AO	4	Hz	JOG Frequency	0 - 180.00	Parameter An-09

NPT	NPA	Unit	Description	Range/Value	Notes
AO	5	s	Acceleration Time 1	0 - 6000.0	Parameter Bn-01
AO	6	s	Deceleration Time 1	0 - 6000.0	Parameter Bn-02
AO	7	s	Acceleration Time 2	0 - 6000.0	Parameter Bn-03
AO	8	s	Deceleration Time 2	0 - 6000.0	Parameter Bn-04
AO	9	-	PID Detection Gain	0.01 - 10.00	Parameter Bn-13
AO	10	-	PID Proportional Gain	0.01 - 10.0	Parameter Bn-14
AO	11	s	PID Integral Time	0.0 - 100.0	Parameter Bn-15
AO	12	s	PID Differential Time	0.0 - 1.0	Parameter Bn-16
AO	13	%	Frequency Command Upper Bound	0 - 109	Parameter Cn-14 *1
AO	14	%	Frequency Command Lower Bound	0 - 109	Parameter Cn-15 *1
AO	15	Hz	Frequency Jump Point 1	0 - 180.0	Parameter Cn-16 *1
AO	16	Hz	Frequency Jump Point 2	0 - 180.0	Parameter Cn-17 *1
AO	17	Hz	Frequency Jump Point 3	0 - 180.0	Parameter Cn-18 *1
AO	18	Hz	Jump Frequency Width	0 - 25.5	Parameter Cn-19 *1
AO	19	%	Stall Prevention Level During Acceleration	30 - 170	Parameter Cn-28 *1
AO	20	%	Stall Prevention Level During Running	30 - 170	Parameter Cn-30 *1
AO	21	-	Number of Auto Restart Attempt	0-10	Parameter Cn-36 *1
AO	22	-	Terminal AUX Function	0-12	Parameter Sn-19 *1
BO	1	-	RUN Command	0: STOP, 1: RUN	
BO	2	-	REV Command	0: FWD, 1: REV	
BO	3	-	External Fault	0: OFF, 1: ON	
BO	4	-	Fault Reset	0: OFF, 1: ON	
BO	5	-	Multi-function Command 1	0: OFF, 1: ON	It depends on Sn-15 setting
BO	6	-	Multi-function Command 2	0: OFF, 1: ON	It depends on Sn-16 setting
BO	7	-	Multi-function Command 3	0: OFF, 1: ON	It depends on Sn-17 setting
BO	8	-	Multi-function Command 4	0: OFF, 1: ON	It depends on Sn-18 setting
BO	9	-	Terminal DO1 Command	0: OFF, 1: ON	Valid while parameter Sn-21 = 0F
BO	10	-	Terminal R1A-R1C Command	0: OFF, 1: ON	Valid while parameter Sn-22 = 0F
BO	11	-	Terminal R2A-R2C Command	0: OFF, 1: ON	Valid while parameter Sn-20 = 0F
BO	12	-	Energy-saving Function	0: OFF, 1: ON	Parameter Sn-09 *1

*1 These parameter can be written in PRGM mode only.

Following is the format of Analog Input 8

BIT	Function
0	Overcurrent (OC) or Ground Fault (GF)
1	Overvoltage (OV)
2	Inverter Overload (OL1, OL2)
3	Inverter Overheat (OH)
4-6	Reserved
7	External Fault (EF3, EF5, EF6, EF7, EF8)
8	Control Circuit Fault (CPF02) EEPROM fault (CPF03) EEPROM BCC CODE Error (CPF04) CPU ADC Fault (CPF05)
9	Motor Overload (OL3)
10-11	Reserved
12	Main circuit low voltage or momentary power loss protection (UV1) Control circuit low voltage (UV2) Main circuit soft charge contactor defective (UV3)
13-15	Reserved

4. Error Code List

Error Code	Description
00	Device has reset and is waiting for the "Identify Yourself" command.
01	Undefined Command: command not understood by addressed device.
02	Checksum error.
03	Input buffer overrun: message longer than maximum device expects to receive.
05	Data field error: size of message is not correct for command type.
10	Invalid Data: one of the fields contains a value that is out of the expected range.
11	Invalid command for data type: command not appropriate for this field or record. Analog Output or Binary Output corresponding to parameter Cn., Sn is overridden during DRIVE mode