Serial Communication Protocol [Modbus Version]

Operation Manual, First Edition

IAI America, Inc.

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Chapter 1 Overview

1. Instruction

This manual describes the specifications of the Modbus protocol (Protocol M) applied to ROBO Cylinder Series controllers (ERC2, PCON, ACON and SCON). The specifications described herein do not apply to other controllers adopting IAI's original Termibus protocol (Protocol T).
Among the Modbus protocol specifications, this manual only covers those relating to serial communication. For other items specific to each controller, refer to the operation manual that comes with the applicable controller.
The Modbus protocol can be used to perform the following operations:

[1] Reference the current position, various statuses and other conditions of the controller
[2] Move the actuator by specifying position numbers
[3] Move the actuator by directly specifying target positions
[4] Rewrite the position table
[5] Start multiple axes simultaneously via broadcast addressing

For details on [5], contact IAI's Sales.

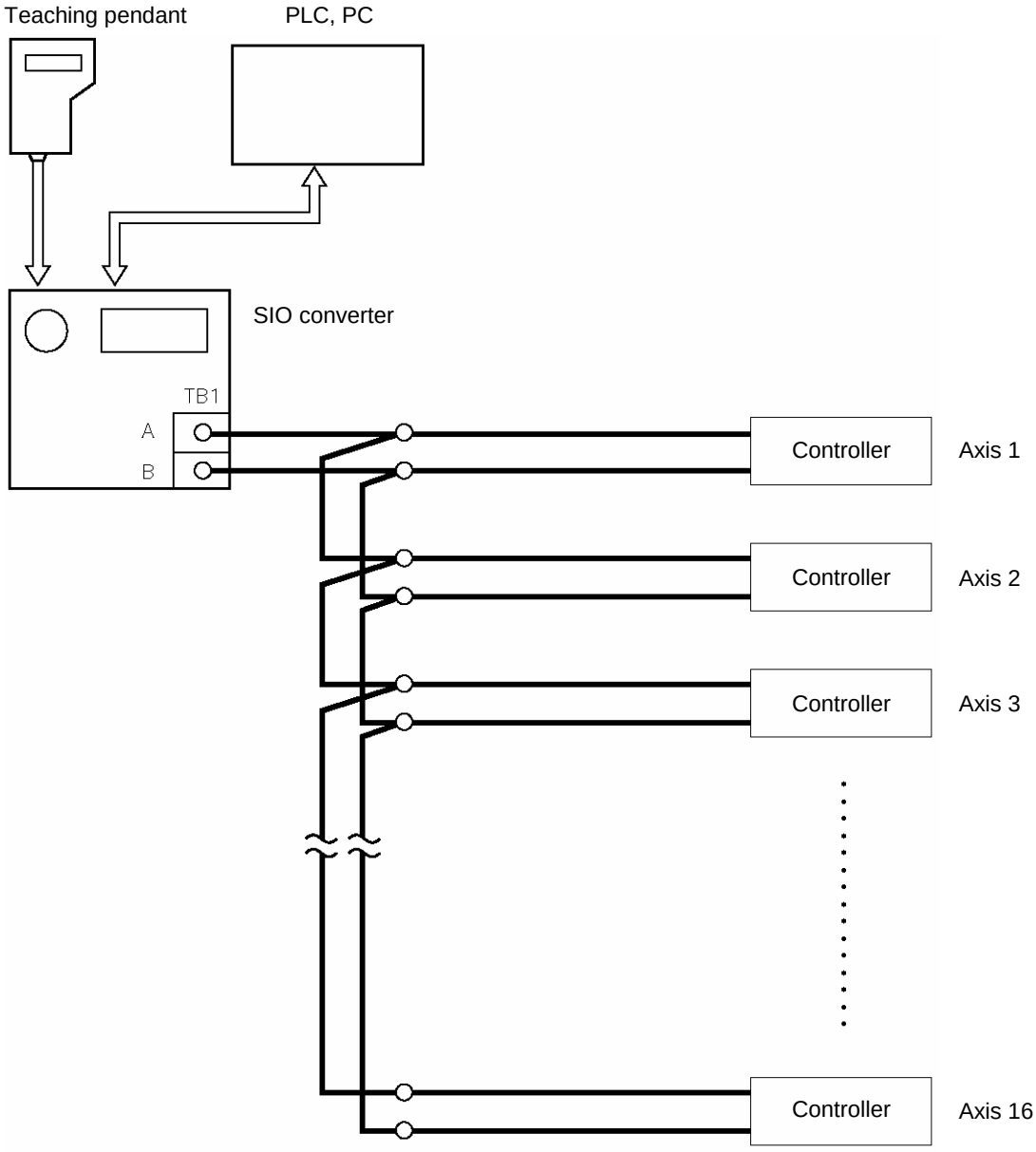
2. Connection Configuration

A maximum of 16 controllers can be connected serially with a host PLC, etc., via a SIO converter, as shown on the next page.
If you wish to use your system over DeviceNet, CC-Link, Profibus or other field network, refer to the operation manual that comes with the gateway unit for the desired field network.

⚠ Caution

(1) If any address or function not defined in this specification is sent to the controller, the controller may not operate properly or it may implement unintended movements. Exercise due caution. Do not send any function or address not specified herein.
(2) RC Series controllers are designed in such a way that once the controller detects a break (space) signal of 150 msec or longer via its SIO port, it will automatically switch the baud rate to 9600 bps. On some PCs, the transmission line remains in the break (space) signal transmission mode while the communication port is closed. Exercise caution if one of these PCs is used as the host device, because the baud rate in your RC Series controller may have been changed to 9600 bps.
(3) Set the communication speed and other parameters using IAI's tool (teaching pendant or PC software), and then transfer the specified parameters to the controller.
(4) If the controller is used in a place meeting any of the following conditions, provide sufficient shielding measures. If sufficient actions are not taken, the controller may malfunction:
    [1] Where large current or high magnetic field generates
    [2] Where arc discharge occurs due to welding, etc.
    [3] Where noise generates due to electrostatic, etc.
    [4] Where the controller may be exposed to radiation

Connection Configuration



Chapter 2 Modbus Protocol Specifications

RC Series controllers have a built-in asynchronous serial-bus interface conforming to EIA RS485 as their host interface. This interface can be connected to up to 16 slave axes using controller link cables, etc. Note, however, that connecting dedicated controllers and other equipment to the same line may cause the controllers to malfunction.

The Modbus protocol is a PLC communication protocol developed by Modicon Inc. (AEG Schneider Automation International S.A.S.), and its specifications are disclosed globally.

For the detailed specifications of this protocol, refer to the specification document (MODBUS Application Protocol Specification V1.1a) published by Modbus-IDA (http://www.modbus-ida.org/). Refer to the above specification document together with this specification.

1. Basic Specifications

The table below summarizes the basic specifications of the Modbus protocol.

Item	Method/condition
Interface	Conforming to EIA RS485
Communication method	Half-duplex communication
Synchronization method	Start-stop synchronization
Connection pattern	1-to-N unbalanced bus connection ($1 \leq N \leq 16$)
Transmission mode	RTU/ASCII (auto-detect)
Baud rate (bps)	Selectable from the following speeds via parameter setting: 9600, 14400, 19200, 28800, 38400 57600, 76800, 115200, 230400
Bit length	8 bits
Stop bit	1 bit
Parity	None

1.1 Communication Mode

Under the Modbus protocol, communication is implemented based on the single-master/multiple-slave mode. In this mode, only the master can issue a query (to start communication). The applicable slave receives this query, executes the function specified in the query, and then returns a response message.

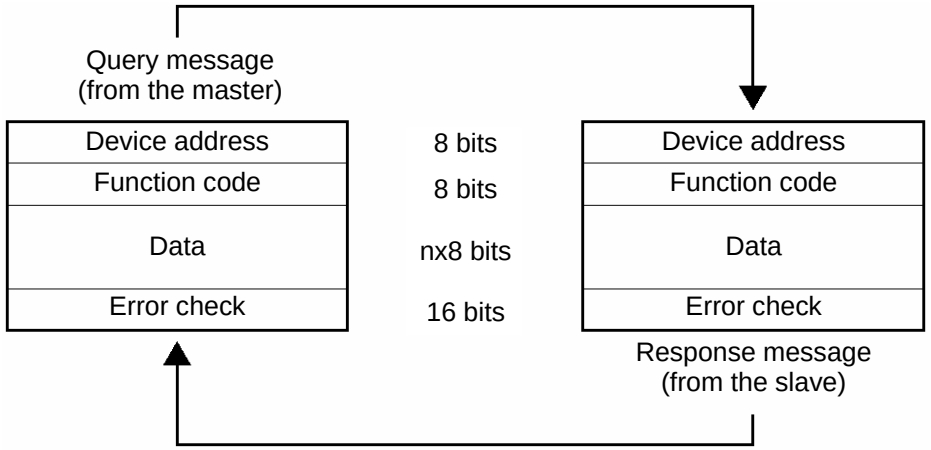
The master can issue a query to a specified slave, or issue a broadcast query to all slaves.

In the case of a broadcast query, all slaves only execute the specified function without returning a response message. Each slave returns a response message only when it has received a query specifically addressed to the slave.

The query message format consists of the slave address (or broadcast) field, function code field defining the content of request, data field, and error check field.

The response message format consists of the request check field, data field, and error check field. Following figure shows the query message format and response message format.

Query/response communication cycles



1.2 Serial Transmission Mode

Serial transmission is implemented in two modes: ASCII (American Standard Code for Information Interchange) mode and RTU (Remote Terminal Unit) mode.

In the ASCII mode, one byte (eight bits) of data is transmitted as two ASCII code characters. In the RTU mode, on the other hand, one byte (eight bits) of data is transmitted directly. Therefore, transmission efficiency is higher in the RTU mode than in the ASCII mode. All devices on a given network must operate under the same mode.

RC Series controllers determine the transmission mode applicable to each packet, which means that data can be received in either mode.

1.3 Message Frames

In the RTU mode, the message frame conforms to the format shown below.

START	Address	Function	Data	CRC Check	End
T1-T2-T3-T4	8 bits	8 bits	n x 8 bits	16 bits	T1-T2-T3-T4

* "T1-T2-T3-T4" indicates a silent interval.

In the ASCII mode, the message frame conforms to the format shown below.

START	Address	Function	Data	LRC Check	End
1 character	2 characters	2 characters	n characters	2 characters	2 characters

* Data that can be specified between START and End are a character string consisting of '0' to '9' and 'A' to 'F.'

(1) Header Field

In the RTU mode, a message starts with a silent interval consisting of at least 3.5 characters.
In the ASCII mode, a message starts with the ASCII character ':' (3Ah).

(2) Address Field

The table below summarizes the addresses in the message frame.

Address	Function	Details
0	Broadcast	All slaves receive the message as a query addressed to them. They do not return a response. Some functions cannot be broadcast. (Refer to the function list.)
1 to 16	Slave address	These addresses are used to specify slave addresses. With RC Series controllers, a slave address is assigned in a range of 1 to 16, which is larger by one than the range of 0 to 15 corresponding to axis numbers that can be set internally in the controller.
17 to 255	(Reserved)	These addresses cannot be set in RC Series controllers.

* For the procedure to set axis numbers, refer to the operation manual for each controller.

(3) Function Field

The table below summarizes the function codes and functions that can be used with RC Series controllers.

Code (Hex)	Name	Function	Broadcast
01H	Read Coil Status	Read coils/DOs.	
02H	Read Input Status	Read input statuses/DIs.	
03H	Read Holding Registers	Read holding registers.	
04H	Read Input Registers	Read input registers.	
05H	Force Single Coil	Write one coil/DO.	○
06H	Preset Single Register	Write holding register.	○
07H	Read Exception Status	Read exception statuses.	
0FH	Force Multiple Coils	Write multiple coils/DOs at once.	○
10H	Preset Multiple Registers	Write multiple holding registers at once.	○
11H	Report Slave ID	Query a slave's ID.	
17H	Read / Write Registers	Read/write registers.	

(4) Data Field

This field is used to append data associated with the function code. The data field has a variable length and need not be always specified.

(5) Error Check Field

The content of the error check field varies depending on the transmission mode.
In the RTU mode, 16-bit data is indicated by two sets of 8-bit byte data. The result of error check is calculated using the method called CRC (Cyclical Redundancy Check calculation).
In the ASCII mode, data is checked via LRC (Longitudinal Redundancy Check), where the result is indicated by two characters representing the sum of all characters excluding the Start character ':' and End character "CR/LF."

(6) Trailer Field

In the RTU mode, a message ends with a silent interval consisting of at least 3.5 characters.
In the ASCII mode, a message ends with "CR/LF" (0DH/0AH).

1.4 Error Check

CRC Check

In the RTU mode, an error check field conforming to the CRC method is included in each message. The CRC field is used to check the content of the entire message. CRC is performed independently of parity check, which checks the individual characters in the message.

The CRC field consists of two bytes containing a 16-bit binary value. The CRC value is calculated by the sender that appends the CRC field to the message. The recipient recalculates the CRC value while receiving the message, and compares the calculation result against the actual value received in the CRC field. If the two values do not match, an error will generate.

In CRC calculation, a register whose 16 bits all contain 1 is preloaded first. Next, the message bytes, each consisting of successive eight bits, are applied to the current registers one by one. A CRC value is generated using only eight bits per character. Start, stop and parity bits are not used to generate a CRC value.

During CRC generation, each 8-bit character is exclusive ORed with the current register content. The result is then shifted to the direction of the least significant bit (LSB), after which 0 is filled into the most significant bit (MSB). The value in the LSB is then extracted and checked. If the value in the LSB is 1, the register is exclusive ORed with a predefined fixed value (0xA001). If the value in the LSB is 0, no exclusive OR takes place.

This process is repeated until the eighth shift. After the last (eighth) shift, the next 8-bit character is exclusive ORed with the current register content. This process is then repeated another eight times in the same manner mentioned above. After all bytes in the message have been applied, the final content of the register becomes the CRC value.

The CRC generation polynomial is as follows: (CRC-16 method)
x16 + x15 + x2 + 1

When a CRC value is appended to a message, its lower byte is appended first, followed by the upper byte.

LRC Check

In the ASCII mode, an error check field conforming to the LRC method is included in each message. The LRC field is used to check the message content excluding the first colon and CR/LF.

The LRC field consists of two bytes corresponding to two ASCII code characters. The LRC value is calculated by the sender that appends the LRC field to the message. The recipient recalculates the LRC value while receiving the message, and compares the calculation result against the actual value received in the LRC field. If the two values do not match, an error will generate.

In LRC calculation, the successive two ASCII code bytes in the message, starting from the address field, are converted to binary values, and the converted binary values are added up until the end of the data field. Next, a 2's complement (binary value) is calculated for the lower eight bits of the result, and this 2's complement is converted to two ASCII code characters that are then appended to the LRC field.

1.5 Send/Receive Buffers

The send/receive buffer sizes of controllers are 256 bytes, respectively. Messages sent by the host must not exceed the receive buffer size, while data requests must not exceed the send buffer size.

1.6 Message Transmission Timings

The basic transmission control procedure consists of the host sending a query, and the controller that received the query sending a response, where these query and response transmissions constitute one transmission cycle. The timings at which send/receive transmission is switched between the host and controller are explained below.

The delay time after a query message is received until a response message is sent is calculated as the total sum of the “Min delay for activating local transmitter” effective during operation, and the internal processing time.

After receiving a query message, the controller waits for the “min. delay for activating local transmitter.” Once this delay time elapses, the controller will activate the transmitter and start sending a response message. The host must enable the receive function of its own station within the aforementioned delay time after sending a query message.

After sending a response message, the controller immediately inactivates the transmitter and prepares to receive the next packet.

In the Modbus/RTU mode, packet separation is managed using a silent interval (non-communication time). If the host cannot send data successively through its own processing, change the “Silent interval multiplier” parameter on the controller side.

1.7 Timeout and Retry

After sending a query, the host waits for a response from the controller (except when the query that has been sent is a broadcast query).

If the elapsed time after sending a command until a response is received exceeds the timeout value (Tout), the host may send the command again to reestablish communication. If the number of retries exceeds the maximum limit (Nrt), it means that an irremediable communication error has occurred.

The methods to calculate the timeout value (Tout) and maximum retry limit (Nrt) are explained below.

(1) Timeout value (Tout)

Tout = To + α + (10 x Bprt/Kbr) [msec]

To: Internal processing time* x Safety factor (3)
α: Min. delay for activating local transmitter [msec]
Kbr: Baud rate [kbps]
Bprt Response message bytes + 8

* The internal processing time varies depending on the category of the register to be accessed. Reading/writing of position table information registers, which are stored in the low-speed memory area, requires accessing the EEPROM. Accordingly, with registers the processing time varies in accordance with the number of positions read/written. The processing time required for each action is listed in the table below.

Item	Time
Read/write a register other than those in the low-speed memory area	1 msec max.
Position data (1 position) Read	4 msec max.
Position data (1 position) Write	15 msec max.
Position data (1 position) Read/write	18 msec max.
Position data (9 positions) Read	9 msec max.
Position data (9 positions) Write	90 msec max.
Position data (9 positions) Read/write	98 msec max.

(2) Maximum retry limit (Nrt)

Nrt = 0 to 3 (Selected in accordance with the system)

2. Modbus Functions

2.1 Read Coil Status (01)

- Function
  Read the ON/OFF statuses of DOs (Discrete Outputs) in a slave.
  This function cannot be broadcast.

- Query
  In a query message, specify the DO address from which to start reading data, and number of DOs to be read.

  Sample query message
  (The statuses of 37 DOs in slave address 3 will be read, starting from data address 20.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	01H	'0,' '1'	01H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	13H	'1,' '3'	13H
DO count (H)	00H	'0,' '0'	00H
DO count (L)	25H	'2,' '5'	25H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  In a response message, coil status data is set in the data field, with each coil represented by one bit. Bit 1 indicates ON, while bit 0 indicates OFF. The LSB of the first data represents the status of the coil in the first address. If the statuses of coils 20 to 27 are ON – ON – OFF – OFF – ON – OFF – ON – OFF, the statuses are expressed as 01010011 (53H) in binary notation. One byte indicates eight coil statuses. If the last data contains less than eight coils, the remaining digits are filled with 0.
  A sample response to the query message shown above is given below.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	01H	'0,' '1'	01H
Data byte count	05H	'0,' '5'	05H
Data 1	53H	'5,' '3'	53H
Data 2	6BH	'6,' 'B'	6BH
Data 3	01H	'0,' '1'	01H
Data 4	F4H	'F,' '4'	F4H
Data 5	1BH	'1,' 'B'	1BH
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	21	10

2.2 Read Input Status (02)

- Function
  Read the ON/OFF statuses of DIs (Discrete Inputs) in a slave.
  This function cannot be broadcast.

- Query
  In a query message, specify the DI address from which to start reading data, and number of DIs to be read.

  Sample query message
  (The statuses of 20 DIs at DI addresses 100 to 119 in slave address 3 will be read.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	02H	'0,' '2'	02H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	64H	'6,' '4'	64H
DI count (H)	00H	'0,' '0'	00H
DI count (L)	14H	'1,' '4'	14H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  The structure and meaning of data in a response message are the same as those explained for Read Coil Status (01).

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	02H	'0,' '2'	02H
Data byte count	03H	'0,' '3'	03H
Data 1	53H	'5,' '3'	53H
Data 2	6BH	'6,' 'B'	6BH
Data 3	01H	'0,' '1'	01H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

2.3 Read Holding Registers (03)

- Function
  Read the contents of holding registers in a slave.
  This function cannot be broadcast.

- Query
  In a query message, specify the holding register address from which to start reading data, and number of holding registers to be read.

  Sample query message
  (The contents of three holding registers in slave address 7 will be read, starting from holding register address 200.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	07H	'0,' '7'	07H
Function code	03H	'0,' '3'	03H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	C8H	'C,' '8'	C8H
Register count (H)	00H	'0,' '0'	00H
Register count (L)	03H	'0,' '3'	03H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  In a response message, the content corresponding to each holding address is represented by 16-bit data.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	07H	'0,' '7'	07H
Function code	03H	'0,' '3'	03H
Data byte count	06H	'0,' '6'	06H
Data 1 (H)	00H	'0,' '0'	00H
Data 1 (L)	01H	'0,' '1'	01H
Data 2 (H)	FFH	'F,' 'F'	FFH
Data 2 (L)	FFH	'F,' 'F'	FFH
Data 3 (H)	00H	'0,' '0'	00H
Data 3 (L)	0AH	'0,' 'A'	0AH
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	23	11

2.4 Read Input Registers (04)

- Function
  Read the contents of input registers in a slave.
  This function cannot be broadcast.

- Query
  In a query message, specify the input register address from which to start reading data, and number of input registers to be read.

  Sample query message
  (The contents of three input registers in slave address 7 will be read, starting from input register address 200.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	07H	'0,' '7'	07H
Function code	04H	'0,' '4'	04H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	C8H	'C,' '8'	C8H
Register count (H)	00H	'0,' '0'	00H
Register count (L)	03H	'0,' '3'	03H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  In a response message, the content corresponding to each input address is represented by 16-bit data.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	07H	'0,' '7'	07H
Function code	04H	'0,' '4'	04H
Data byte count	06H	'0,' '6'	06H
Data 1 (H)	00H	'0,' '0'	00H
Data 1 (L)	01H	'0,' '1'	01H
Data 2 (H)	FFH	'F,' 'F'	FFH
Data 2 (L)	FFH	'F,' 'F'	FFH
Data 3 (H)	00H	'0,' '0'	00H
Data 3 (L)	0AH	'0,' 'A'	0AH
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	23	11

2.5 Force Single Coil (05)

- Function
  Change the status of a given DO (Discrete Output) in a slave to ON or OFF (= write ON/OFF to the DO). If this function is broadcast, the coil at the same address will be rewritten in all slaves.

- Query
  In a query message, specify the address of the coil to be changed, and the new status (ON/OFF). When specifying the new data, use FFH and 00H to specify ON, or use 00H and 00H to specify OFF. Any other data will be deemed invalid and the controller will not change the existing status.

  Sample query message
  (The DO at address 150 in slave address 3 will be changed to ON.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	05H	'0,' '5'	05H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	96H	'9,' '6'	96H
New data (H)	FFH	'F,' 'F'	FFH
New data (L)	00H	'0,' '0'	00H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  A response message to be issued when the change was successful is the same as the query message.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	05H	'0,' '5'	05H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	96H	'9,' '6'	96H
New data (H)	FFH	'F,' 'F'	FFH
New data (L)	00H	'0,' '0'	00H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

2.6 Preset Single Register (06)

- Function
  Change (write) the content of a given holding register in a slave.
  If this function is broadcast, the content of the holding register at the same address will be changed in all slaves.

- Query
  Specify the address of the holding register to be changed, and the new data.
  Specify the new data using 16-bit data in the data area of the query message.

  Sample query message
  (The content of the holding register at address 150 in slave address 3 will be changed to 1000.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	06H	'0,' '6'	06H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	96H	'9,' '6'	96H
New data (H)	03H	'0,' '3'	03H
New data (L)	E8H	'E,' '8'	E8H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

- Response
  A response message to be issued when the change was successful is the same as the query message.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	06H	'0,' '6'	06H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	96H	'9,' '6'	96H
New data (H)	03H	'0,' '3'	03H
New data (L)	E8H	'E,' '8'	E8H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

2.7 Read Exception Status (07)

- Function
  Read exception statuses in a slave.
  This function cannot be broadcast.
  The controller returns the alarm codes corresponding to alarms presently detected.

- Query
  Sample query message
  (Exception statuses will be read from slave address 3.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	07H	'0,' '7'	07H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	9	4

- Response
  A "successful" response will contain one byte of exception status (alarm code) data.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	07H	'0,' '7'	07H
Exception status	00H	'0,' '0'	00H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes		

2.8 Force Multiple Coils (15)

- Function
  Change the statuses of multiple successive DOs (Discrete Outputs) in a slave to ON or OFF (= write ON/OFF to the DOs).
  If this function is broadcast, the coils at the same addresses will be rewritten in all slaves.

- Query
  In a query message, specify the address of the first coil to be changed, number of coils to be changed, number of bytes corresponding to new data (status (ON/OFF) specification data), and new data.
  In the new coil status data, each coil status is set by one bit. Bit 1 indicates ON, while bit 0 indicates OFF. The LSB of the first data becomes the status of the coil at the first address.
  If the statuses of coils 20 to 27 are ON – ON – OFF – OFF – ON – OFF – ON – OFF, the statuses are expressed as 01010011 (53H) in binary notation. One byte indicates eight coil statuses. If the last data contains less than eight coils, the remaining digits are filled with 0.

  An example of setting the coils at addresses 20 to 30 in slave 5 as follows is given below.

Bit	1	1	0	1	0	0	0	1	0	0	0	0	0	1	0	1
Coil	27	26	25	24	23	22	21	20	• • • • • • • • • • • • • • • •					30	29	28

  Sample query message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		‘:’	None
Slave address	05H	‘0,’ ‘5’	05H
Function code	0FH	‘0,’ ‘F’	0FH
Start address (H)	00H	‘0,’ ‘0’	00H
Start address (L)	14H	‘1,’ ‘4’	14H
DO count (H)	00H	‘0,’ ‘0’	00H
DO count (L)	0BH	‘0,’ ‘B’	0BH
Byte count	02H	‘0,’ ‘2’	02H
New data 1	D1H	‘D,’ ‘1’	D1H
New data 2	05H	‘0,’ ‘5’	05H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	23	11

- Response
  If the change was successful, a response message that is effectively a copy of the query message, except for the byte count and new data, will be returned.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	05H	'0,' '5'	05H
Function code	0FH	'0,' 'F'	0FH
Start address (H)	00H	'0,' '0'	00H
Start address (L)	14H	'1,' '4'	14H
DO count (H)	00H	'0,' '0'	00H
DO count (L)	0BH	'0,' 'B'	0BH
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

2.9 Preset Multiple Registers (16)

- Function
  Change (write) the contents of multiple successive holding registers in a slave.
  If this function is broadcast, the contents of holding registers at the same addresses will be rewritten in all slaves.

- Query
  In a query message, specify the address of the first holding register to be changed, number of holding registers to be changed, number of bytes corresponding to new data, and new data.
  An example of setting the following values in the holding registers at addresses 20 to 22 in slave 5 is given below.

  Data in address 20 0164H
  Data in address 21 0165H
  Data in address 22 0166H

  Sample query message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	05H	'0,' '5'	05H
Function code	10H	'1,' '0'	10H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	14H	'1,' '4'	14H
Register count (H)	00H	'0,' '0'	00H
Register count (L)	03H	'0,' '3'	03H
Byte count	06H	'0,' '6'	06H
New data 1 (H)	01H	'0,' '1'	01H
New data 1 (L)	64H	'6,' '4'	64H
New data 2 (H)	01H	'0,' '1'	01H
New data 2 (L)	65H	'6,' '5'	65H
New data 3 (H)	01H	'0,' '1'	01H
New data 3 (L)	66H	'6,' '6'	66H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	31	15

- Response
  If the change was successful, a response message that is effectively a copy of the query message, except for the byte count and new data, will be returned.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	05H	'0,' '5'	05H
Function code	10H	'1,' '0'	10H
Start address (H)	00H	'0,' '0'	00H
Start address (L)	14H	'1,' '4'	14H
Register count (H)	00H	'0,' '0'	00H
Register count (L)	03H	'0,' '3'	03H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

2.10 Report Slave ID (17)

- Function
  Read the controller type, operation mode and other slave information from a slave.
  This function cannot be broadcast.
  With IAI's controllers, the slave ID is the same as the controller model code. Additional information includes the controller unit code and firmware version.
  The run status is indicated as either 00H (OFF) or FFH (ON). If the controller is ready for communication, it will return ON.

- Query
  Sample query message
  (The slave ID will be read from slave address 3.)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	11H	'1,' '1'	11H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	9	4

- Response
  A "successful" response will contain a byte count indicating the length of slave ID data.

  Sample response message (When IAI's controller is used)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	11H	'1,' '1'	11H
Byte count	05H	'0,' '5'	05H
Slave ID	AEH	'A,' 'E'	AEH
Run status	FFH	'F,' 'F'	FFH
Controller unit code	03H	'0,' '3'	03H
FW version (H)	00H	'0,' '0'	00H
FW version (L)	01H	'0,' '1'	01H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	21	10

2.11 Read/Write Registers (23)

- Function
  Write multiple successive holding registers in a slave, and then read the contents of holding registers.
  This function cannot be broadcast.
  Although the Specification (PI-MBUS-300 Rev. J) does not define whether write or read occurs first, the basic rule for RC Series controllers is that writing of registers occurs first, followed by reading of registers.

- Query
  In a query message, specify the address of the first register to be read, number of registers to be read, address of the first register to be written, number of registers to be written, number of bytes corresponding to data to be written, and new data.
  An example of setting the following values in the holding registers at addresses 20 and 21 in slave 5, and then reading three register values starting from address 2, is given below.
  Data in address 20 0164H
  Data in address 21 0165H

  Sample query message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	05H	'0,' '5'	05H
Function code	17H	'1,' '7'	17H
Read start address (H)	00H	'0,' '0'	00H
Read start address (L)	02H	'0,' '2'	02H
Read register count (H)	00H	'0,' '0'	00H
Read register count (L)	03H	'0,' '3'	03H
Write start address (H)	00H	'0,' '0'	00H
Write start address (L)	14H	'1,' '4'	14H
Write register count (H)	00H	'0,' '0'	00H
Write register count (L)	02H	'0,' '2'	02H
Byte count	04H	'0,' '4'	04H
New data 1 (H)	01H	'0,' '1'	01H
New data 1 (L)	64H	'6,' '4'	64H
New data 2 (H)	01H	'0,' '1'	01H
New data 2 (L)	65H	'6,' '5'	65H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	35	17

- Response
  If the read/write was successful, the response message will return the number of bytes corresponding to the register data read as well as the data values read.

  Sample response message

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	05H	'0,' '5'	05H
Function code	17H	'1,' '7'	17H
Data byte count	06H	'0,' '6'	06H
Data 1 (H)	00H	'0,' '0'	00H
Data 1 (L)	01H	'0,' '1'	01H
Data 2 (H)	FFH	'F,' 'F'	FFH
Data 2 (L)	FFH	'F,' 'F'	FFH
Data 3 (H)	00H	'0,' '0'	00H
Data 3 (L)	0AH	'0,' 'A'	0AH
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	23	11

3. Modbus Exceptions

3.1 Exception Responses

In each query, except for a broadcast query message, the master issues a query by expecting a “successful” response, and the applicable slave must return a response to the query. If the query was processed successfully, the slave returns a “successful” response. If an error occurred, however, the slave returns an exception response.

The slave responds to a query in one of the following four ways:

(1) The slave receives the query successfully, processes it successfully, and then returns a “successful” response.
(2) The slave returns no response because the query could not be received due to a communication error, etc. The master generates a timeout error.
(3) The slave also returns no response if the query was received but was found invalid because a parity, CRC or LRC error was detected. In this case, the master also generates a timeout.
(4) If the query was received properly without generating errors but it cannot be processed for some reason (such as when the applicable register does not exist), the slave returns an exception response that contains an exception code indicating the content of exception.

The exception response consists of the slave address field, function code field, and data field. In the slave address field, the applicable slave address is set as in the slave address field of a “successful” response. In the function code field, the function code in the query is set, and then the MSB of this field is set to 1. This allows the master to recognize that the message is not a “successful” response, but an exception response. An exception code indicating the content of exception is set in the data field.

Sample query that generates an exception response
(Sample query message using Read Input Status)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	02H	'0,' '2'	02H
Start address (H)	04H	'0,' '4'	04H
Start address (L)	A1H	'A,' '1'	A1H
DI count (H)	00H	'0,' '0'	00H
DI count (L)	14H	'1,' '4'	14H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

If input status 04A1H does not exist, the following exception response will be returned.

Sample exception response from a slave

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	82H	'8,' '2'	82H
Exception code	02H	'0,' '2'	02H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	11	5

3.2 Exception Codes

The table below lists the exception codes that may generate in the controller, as well as the contents of respective codes.

Code (Hex)	Exception code	Function	Remarks
01H	Illegal Function	Invalid function	The function cannot be executed because a major error is present.
02H	Illegal Data Address	Invalid data address	The data address does not permit the specified function.
03H	Illegal Data Value	Invalid data	The data value does not permit the specified function.
04H	Slave Device Failure	Execution not possible due to irremediable slave error	The function cannot be executed because a major error is present.

4. Data Structure in Internal Memory

4.1 Registers and Statuses

(1) Modbus registers

The controller can directly read and write virtual registers using the Modbus protocol. Read-only input registers (input registers) and read/write holding registers (holding registers) are available, and these registers are collectively referred to as “Modbus registers.” The functions used with Modbus registers are listed in the table below.

As for the handling of values, internally Modbus registers are defined as registers handling two words consisting of 32 bits. The Modbus Specification does not define the endian (arrangement of the upper word and lower word) for this 2-word data. However, RC Series controllers adopt the big endian method (the upper word occupies the lower addresses, while the lower word occupies the upper addresses).

(2) Modbus statuses

As explained in (1), the bit access (coil) fields mapped in virtual registers can be read and written directly using the Modbus protocol.

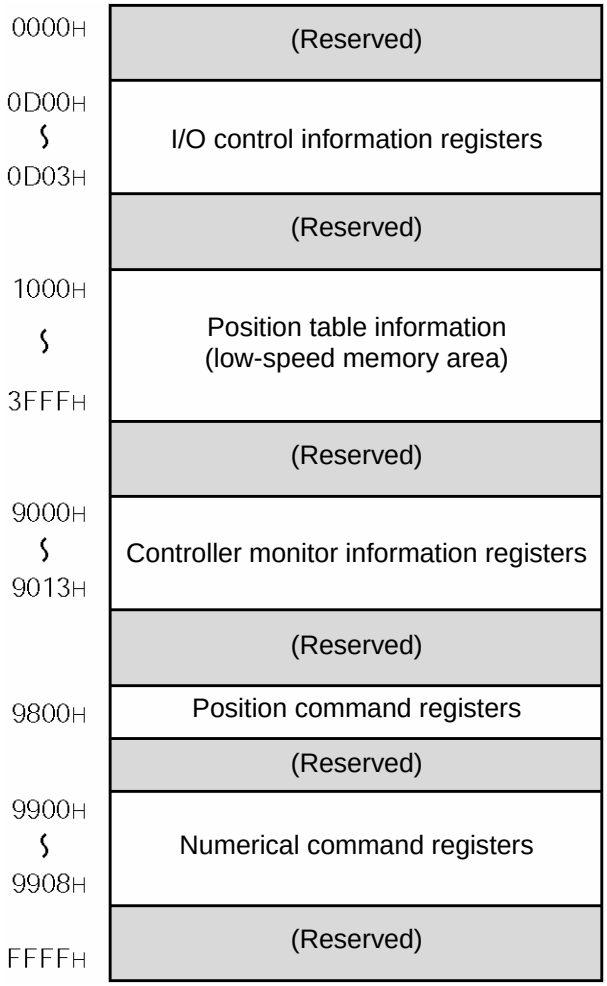
There are read-only discrete inputs (input statuses) and read/write coils (coil statuses), and these are collectively referred to as “Modbus statuses.” The functions used with Modbus statuses are listed in the table below.

Register				Function		
				Code	Name	Description
Virtual register	Modbus register	Input Register	Read	04H	Read Input Registers	Read input registers
				03H	Read Holding Registers	Read holding registers
		Holding Register	Read / write	06H	Preset Single Registers	Write holding registers
				10H	Preset Multiple Registers	Write multiple holding registers at once
				17H	Read/Write Registers	Read/write registers
	Modbus status	Input Status	Read	01H	Read Coil Status	Read coils/DOs
				02H	Read Input Status	Read input statuses/DIs
		Coil Status	Read / write	01H	Read Coil Status	Read coils/DOs
				02H	Read Input Status	Read input statuses/DIs
				05H	Force Single Coil	Write a single coil/DO
				0FH	Force Multiple Coils	Write multiple coils/DOs at once

Note 1: 03H and 04H are the same and interchangeable.
Note 2: 01H and 02H are the same and interchangeable.
Note 3: An attempt to write a read-only input register or input status will generate an exception (address error).

4.2 Register Address Map

Registers are assigned according to the map shown below.



4.3 Status Address Map

Statuses are assigned according to the map shown below.

0000H	(Reserved)
0100H ~ 010FH	Device status register 1 [DSS1]
0110H ~ 011FH	Device status register 2 [DSS2]
0120H ~ 012FH	Expansion device status register [DSSE]
0130H ~ 013FH	Position number status register [POSS]
0140H ~ 014FH	Zone status register [ZONS]
0150H ~ 015FH	Input port monitor register [DIPM]
0160H ~ 016FH	Output port monitor register [DOPM]
0170H ~ 017FH	Special input port register [SIPM]
	(Reserved)
0400H ~ 040FH	Device control register 1 [DRG1]
0410H ~ 041FH	Device control register 2 [DRG2]
0420H ~ 042FH	Expansion device control register [DRGE]
0430H ~ 043FH	Position number specification register [POSR]
FFFFH	(Reserved)

4.4 Data Structures of Controller Monitor Information Registers

These registers indicate the various conditions of the controller.

Address	Symbol	Name	Sign	Size	R/W	Unit
9000	PNOW	Current absolute position counter position	Signed	32	R	0.01 mm
9002	ALMC	Present alarm code	Unsigned	16	R	
9003	DIPM	Input port monitor register	Unsigned	16	R	
9004	DOPM	Output port monitor register	Unsigned	16	R	
9005	DSS1	Device status register 1	Unsigned	16	R	
9006	DSS2	Device status register 2	Unsigned	16	R	
9007	DSSE	Expansion device status register	Unsigned	16	R	
9008	STAT	System status	Unsigned	32	R	
900A	VNOW	Current speed monitor	Signed	32	R	0.01 mm/sec
900C	CNOW	Current ampere monitor	Signed	32	R	mA
900E	DEVI	Deviation monitor	Signed	32	R	pulse
9010	STIM	System timer	Unsigned	32	R	msec
9012	SIPM	Special input port monitor	Unsigned	16	R	
9013	ZONS	Zone status register	Unsigned	16	R	
9014	POSS	Position number status register	Unsigned	16	R	
9016	PNWP	Current position monitor (pulses)	Unsigned	32	R	
9018	VNWP	Current speed monitor (pulses)	Unsigned	32	R	

4.4.1 Current Position Monitor (PNOW) (9000H)

This register is an absolute coordinate position counter that indicates the current position. It counts position feedback pulses and constantly refreshes the count. This register stores the pulses indicated by the driver after converting them to a value in units of 0.01 mm.

4.4.2 Present Alarm Code (ALMC) (9002H)

This register indicates whether the controller is normal or any alarm is present. If the controller has no alarm, 00H is stored.
For details on alarm codes, refer to the operation manual that comes with each controller.

4.4.3 Input Port Monitor Register (DIPM) (9003H)

This register stores the DI input values directly regardless of the PIO pattern. Take note, however, that the values stored are those after the hardware filter delay and software filter delay.
The number of input bits varies depending on the controller model.

4.4.4 Output Monitor Register (DOPM) (9004H)

This register stores the DO output values assigned to output ports in accordance with the applicable PIO pattern.
The number of output bits varies depending on the controller model.

4.4.5 Device Status Register 1 (DSS1) (9005H)

This register indicates the internal statuses of the controller. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0100	EMGS	EMG status	0: Emergency stop not actuated 1: Emergency stop actuated This bit indicates whether or not the controller is currently in the emergency stop mode due to an emergency stop input, cutoff of the drive source, etc.
14	0101	SFTY	Safety speed enabled status	0: Safety status disabled 1: Safety status enabled This bit indicates whether the safety speed of the controls is enabled or disabled by the “Safety speed command bit” in device control register 1.
13	0102	PWR	Controller ready status	0: Controller busy 1: Controller ready This bit indicates whether or not the controller can be controlled externally. Normally this bit does not become 0 (busy).
12	0103	SV	Servo ON status	0: Servo OFF 1: Servo ON This bit indicates the ON status of the actual servo. This bit will remain 0 after a servo ON command is received until the time specified by the “Servo ON delay time” parameter elapses. If the servo cannot be turned ON for some reason after a servo ON command is received, this bit will remain 0. The controller does not accept any movement command while this bit is 0.
11	0104	PSFL	Missed work in push-motion operation	0: Normal 1: Missed work in push-motion operation This bit will be output when the actuator reaches the push-motion band in accordance with a push-motion operation command. Normal operation commands do not change this bit.
10	0105	ALMH	Major failure status	0: Normal 1: Major failure alarm present This bit will turn 1 if any alarm generates that inhibits continuation of operation. Alarms of this type can be reset using an alarm reset command, but some alarms cannot be reset with a reset command.
9	0106	ALML	Minor failure status	0: Normal 1: Minor failure alarm present This bit will turn 1 if a minor failure generates that permits continuation of operation.
8	0107	ABER	Absolute error status	0: Normal 1: Absolute error present This bit indicates, on a model equipped with an absolute encoder, that an error relating to the absolute encoder has generated.

Bit	Status address	Symbol	Name	Function
7	0108	BKRL	Brake forced-release status	0: Brake actuated 1: Brake released This bit indicates the status of brake operation. Normally the bit remains 1 while the servo is ON. Even when the servo is OFF, changing the “brake forced-release command bit” in device control register 1 to 1 will change this bit to 1.
6	0109	TRQM	Torque limited	0: Normal 1: Torque limited
5	010A	STP	Pause status	0: Normal 1: Pause command active This bit indicates the read-back status of a pause command, not a pause condition during movement.
4	010B	HEND	Homing completion status	0: Homing not yet complete 1: Homing complete This bit indicates the homing completion status. Normally this bit is 0 when the controller is started. On a model equipped with an absolute encoder, the bit is 1 when the controller is started, if an absolute reset has already completed. If an absolute position command is issued while this bit is 0, an alarm will generate.
3	010C	PEND	Positioning completion status	0: Positioning not yet complete 1: Positioning complete This bit will turn 1 when the actuator reaches the target position and enter the in-position band. When the servo is turned OFF and then ON again, the current position will become the target position, and therefore this bit will become 1. This bit will also turn 1 when the push-motion judgment signal turns ON during push-motion operation.
2	010D	---	Reserved	
1	010E	---	Reserved	
0	010F	---	Reserved	

4.4.6 Device Status Register 2 (DSS2) (9006H)

This register indicates the internal statuses of the controller. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0110	ENBS	Enable status	0: Disabled 1: Enabled This bit indicates the status of the enable-switch installed tool connected to a model equipped with an enable function. On a model equipped with an operation mode switch, this bit is always 1 while the AUTO mode is selected. This bit is always 1 on a model not equipped with an enable function.
14	0111	---	Reserved	
13	0112	LOAD	Load output judgment status	0: Normal 1: Load output judgment If a load current threshold or check range (individual zone boundaries) is set when a movement command is issued, this bit indicates whether or not the motor current has reached the threshold inside the check range. The status of this bit is held, which means that after switching, the new bit status will be held until the next command is received.
12	0113	TRQS	Torque level status	0: Normal 1: Torque level achieved If a load current threshold is set when a movement command is issued, this bit indicates whether or not the motor current has reached the threshold. Since this bit indicates a level, its status will change when the current level changes.
11	0114	MODS	Teaching mode status	0: Normal operation mode 1: Teaching mode This bit indicates whether the controller has switched to the teaching mode in accordance with the “teaching mode command bit” in device control register 2.
10	0115	TEAC	Position-data load command status	0: Normal 1: Position data load complete Setting the “position-data load command bit” in device control register 2 to 1 will change this bit to 0. This bit will turn 1 once position data has been written to the EEPROM successfully.

Bit	Status address	Symbol	Name	Function
9	0116	JOG+	Jog+ status	0: Normal 1: Jog+ command active This bit indicates the read-back status of the “jog+ command bit” in device control register 2.
8	0117	JOG-	Jog- status	0: Normal 1: Jog- command active This bit indicates the read-back status of the “jog- command bit” in device control register 2.
7	0118	PE7	Completed position 7	Each bit indicates a completed position. When the actuator moves to the target position and enters the in-position band as a result of positioning operation initiated by a positioning command, the applicable bit will turn 1. Although the bit that has turned 1 will change to 0 once the servo turns OFF, the bit will turn 1 again if the actuator is still inside the in-position band of the applicable command position data when the servo is turned ON subsequently. This bit will also turn 1 if the push judgment signal turns ON, or the actuator misses the work, during push-motion operation.
6	0119	PE6	Completed position 6	
5	011A	PE5	Completed position 5	
4	011B	PE4	Completed position 4	
3	011C	PE3	Completed position 3	
2	011D	PE2	Completed position 2	
1	011E	PE1	Completed position 1	
0	011F	PE0	Completed position 0	

4.4.7 Expansion Device Status Register (DSSE) (9007H)

This register indicates the internal statuses of the controller. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0120	EMGP	Emergency stop status	0: Emergency stop input OFF 1: Emergency stop input ON This bit indicates the status of the dedicated emergency stop port.
14	0121	MPUV	Motor voltage low status	0: Normal 1: Motor drive source cut off This bit will turn 1 when the motor drive-source cutoff terminal is released, upon which the controller will switch to the emergency stop mode.
13	0122	RMDS	Operation mode status	0: AUTO mode 1: MANU mode This bit is 1 (MANU) when the operation mode switch is set to MANU on a model equipped with an operation mode switch or the “operation mode bit” in the expansion device control register is set to MANU. It will become 0 (AUTO) only when both the operation mode switch and operation mode bit are set to AUTO. On a model not equipped with an operation mode switch, this bit is always 1 (MANU).
12	0123	---	Reserved	
11	0124	GHMS	Homing status	0: Normal 1: Homing This bit remains 1 while homing is in progress following a homing command. When the homing is completed or interrupted in the middle, this bit will turn 0.
10	0125	PUSH	Push-motion operation in progress	0: Normal 1: Push-motion operation in progress This bit remains 1 while push-motion operation is in progress (the actuator is inside the push-motion range, excluding the approach range) following a push-motion operation command. This bit will turn 0 in any of the following conditions: 1. The actuator has missed the work. 2. The actuator has paused. 3. The next movement command has been issued. 4. The servo has turned OFF.

Bit	Status address	Symbol	Name	Function
9	0126	PSNS	Excitation detection status	0: Excitation detection not yet complete 1: Excitation detection complete PCON Series controllers perform excitation detection at the first servo ON command received after the controller has started. This bit remains 0 if the excitation detection has failed. Even after a successful detection, the bit will return to 0 when a software reset is performed. ACON Series controllers perform pole sensing at the first servo ON command received after the controller has started. On SCON Series controllers, this bit is always 0.
8	0127	PMSS	PIO/Modbus switching status	0: PIO commands enabled 1: PIO command disabled This bit indicates the read-back status of the “PIO/Modbus switching specification bit” in the expansion device control register.
7	0128	---	Reserved	
6	0129	POSW	Position-data static memory write completion status	0: Writing 1: Writing complete This bit will turn 0 when a position-data write command is issued via the “position-data static memory write command bit” in the expansion device control register. Once the writing is completed, the bit will turn 1. This bit is 1 when the controller is first started.
5	012A	MOVE	Moving signal	0: Stopped 1: Moving This bit indicates whether or not the actuator is moving (conditions during homing and push-motion operation included). This bit remains 0 while the actuator is paused.
4	012B	---	Reserved	
3	012C	---	Reserved	
2	012D	---	Reserved	
1	012E	---	Reserved	
0	012F	---	Reserved	

4.4.8 System Status (STAT) (9008H)

The internal operating statuses of the controller are indicated by the bit patterns shown below. The bits whose details are not explained are reserved.

Bit	Symbol	Name	Function
17	ASOF	Auto servo OFF	0: Normal 1: Auto servo OFF If the “Auto servo OFF delay time” parameter is set, this bit will turn 1 when the servo is turned OFF automatically after elapse of the specified time following the completion of positioning.
16	AEEP	EEPROM accessed	0: Normal 1: EEPROM being accessed This bit will turn 1 when the controller accesses the EEPROM to read or write the parameter position table, etc. The bit will turn 0 when the access is completed or a timeout error occurs.
4	RMDS	Operation mode status	0: AUTO mode 1: MANU mode This bit is 1 (MANU) when the operation mode switch is set to MANU on a model equipped with an operation mode switch or the “operation mode bit” in the expansion device control register is set to MANU. It will become 0 (AUTO) only when both the operation mode switch and operation mode bit are set to AUTO. On a model not equipped with an operation mode switch, this bit is always 1 (MANU).
3	HEND	Homing completion status	0: Homing not yet complete 1: Homing complete This bit indicates the homing completion status. Normally this bit is 0 when the controller is started. On a model equipped with an absolute encoder, the bit is 1 when the controller is started, if an absolute reset has already completed. If an absolute position command is issued while this bit is 0, an alarm will generate.
2	SV	Servo status	0: Servo OFF 1: Servo ON This bit indicates the ON status of the actual servo. This bit will remain 0 after a servo ON command is received until the time specified by the “Servo ON delay time” parameter elapses. If the servo cannot be turned ON for some reason after a servo ON command is received, this bit will remain 0. The controller does not accept any movement command while this bit is 0.
1	SON	Servo command status	0: Servo OFF 1: Servo ON This bit indicates the servo ON/OFF command status. This bit will turn 1 when the following conditions are met: • The EMG status bit in device status register 1 is 0. • The major failure status bit in device status register 1 is 0. • The enable status bit in device status register 2 is 1. • The auto servo OFF status in the system status register is 0.
0	MPOW	Drive source ON	0: Drive source cut off 1: Normal This bit will turn 0 when the motor drive-source cutoff terminal is released.

4.4.9 Current Speed Monitor (VNOW) (900AH)

This register monitors the actual motor speed based on encoder feedback. The value becomes positive or negative depending on the operating direction of the motor. The value of this register is indicated in units of 0.01 mm/sec.

4.4.10 Current Ampere Monitor (CNOW) (900CH)

This register indicates the monitored data of motor current in mA. It stores the torque current command value.

4.4.11 Deviation Monitor (DEVI) (900EH)

This register stores the deviation over a 1-ms period between the position command value and the feedback value (actual position), in pulses. The number of pulses per one motor revolution in mechanical angle varies depending on the encoder used.

4.4.12 System Timer (STIM) (9010H)

The indicated status corresponds to the total time since the control power was turned on unit: msec. This system timer is not cleared after a software reset.

4.4.13 Special Input Port Monitor Register (SIPM) (9012H)

This register can be used to monitor input ports other than normal DI inputs. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0170	---	Reserved	
14	0171	NP	Command pulse NP signal status	This bit indicates the status of the command pulse NP signal.
13	0172	---	Reserved	
12	0173	PP	Command pulse PP signal status	This bit indicates the status of the command pulse PP signal.
11	0174	---	Reserved	
10	0175	---	Reserved	
9	0176	PTSW	Port switch monitor	0: OFF 1: ON On a model equipped with a port switch, this bit indicates the status of this switch. On a model equipped with a SIO-connector installation/removal detection function, this bit indicates the installation/removal status of a tool. This bit is always 0 on any other model.
8	0177	MDSW	Mode switch status	0: AUTO mode 1: MANU mode On a model equipped with an operation mode switch, this bit indicates the status of this switch. It is always 1 on any other model.
7	0178	ENBL	Enable switch monitor	0: DISABLE 1: ENABLE On a model equipped with an enable function, this bit indicates the status of this switch if an enable-switch installed tool is connected. It is always 1 on any other model.
6	0179	---	Reserved	
5	017A	---	Reserved	
4	017B	---	Reserved	
3	017C	HMCK	Home-check sensor monitor	0: Sensor OFF 1: Sensor ON On a model equipped with a home-check sensor function, this bit indicates the status of sensor input. It is always 0 on any other model.
2	017D	OT	Overtravel sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the overtravel sensor signal in the encoder connector. It is always 0 on a model not equipped with an overtravel sensor.
1	017E	CREP	Creep sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the creep sensor signal in the encoder connector. It is always 0 on a model not equipped with a creep sensor.

Bit	Status address	Symbol	Name	Function
0	017F	LS	Limit sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the limit sensor signal in the encoder connector. It is always 0 on a model not equipped with a limit sensor.

4.4.14 Zone Status Register (ZONS) (9013H)

This register can be used to monitor zone output statuses. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0140	---	Reserved	
14	0141	LS2	Limit sensor output monitor 2	0: Out of range 1: In range The position away from the target position for position No. 2 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
13	0142	LS1	Limit sensor output monitor 1	0: Out of range 1: In range The position away from the target position for position No. 1 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
12	0143	LS0	Limit sensor output monitor 0	0: Out of range 1: In range The position away from the target position for position No. 0 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
11	0144	---	Reserved	
10	0145	---	Reserved	
9	0146	---	Reserved	

Bit	Status address	Symbol	Name	Function
8	0147	ZP	Position zone output monitor	0: Out of range 1: In range If individual zone boundaries are set for a position command, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range. The zone will be reset when the next movement command is issued.
7	0148	---	Reserved	
6	0149	---	Reserved	
5	014A	---	Reserved	
4	014B	---	Reserved	
3	014C	---	Reserved	
2	014D	---	Reserved	
1	014E	Z2	Zone output monitor 2	0: Out of range 1: In range If the zone boundary 2 parameters are set, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
0	014F	Z1	Zone output monitor 1	0: Out of range 1: In range If the zone boundary 1 parameters are set, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.

4.4.15 Position Number Status Register (POSS) (9014H)

This register can be used to monitor the completed position number. It can also be referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Status address	Symbol	Name	Function
15	0130	---	Reserved	
14	0131	---	Reserved	
13	0132	---	Reserved	
12	0133	---	Reserved	
11	0134	---	Reserved	
10	0135	---	Reserved	
9	0136	---	Reserved	
8	0137	PM256	Completed position number status bit 256	These bits indicate completed positions in binary codes. When the actuator moves to the target position and enters the in-position band as a result of a positioning command, the applicable bit will turn 1. Although the bit that has turned 1 will change to 0 once the servo turns OFF, the bit will turn 1 again if the actuator is still inside the in-position band of the applicable command position data when the servo is turned ON subsequently. These bits will also turn 1 if the push judgment signal turns ON, or the actuator misses the work, during push-motion operation.
7	0138	PM128	Completed position number status bit 128	
6	0139	PM64	Completed position number status bit 64	
5	013A	PM32	Completed position number status bit 32	
4	013B	PM16	Completed position number status bit 16	
3	013C	PM8	Completed position number status bit 8	
2	013D	PM4	Completed position number status bit 4	
1	013E	PM2	Completed position number status bit 2	
0	013F	PM1	Completed position number status bit 1	

4.4.16 Current Position Monitor [Pulses] (PNWP) (9016H)

This register is an absolute coordinate position counter of a resolution corresponding to the encoder division unit, and indicates the current motor position. It counts position feedback pulses and constantly refreshes the count. This register directly stores the pulses indicated by the driver.

4.4.17 Current Speed Monitor [Pulses] (VNWP) (9018H)

This register monitors the actual motor speed based on encoder feedback. It stores the motor speed indicated by the driver after converting it to a value in units of pulses/sec.

4.5 Data Structures of Position Command Registers

These registers are used to execute position commands via position number specification.

Address	Symbol	Name	Sign	Size	R/W	Unit
9800	POSR	Position movement command register	Unsigned	16	R/W	

To move the actuator via position number specification, write applicable data in the position movement command register (POSR). The actuator will start moving the moment this register is written, so there is no need to operate the positioning start specification bit (CSTR) in the device control register.

If a command is issued when the actuator has not yet completed homing, the actuator will complete homing first, and then start moving to the specified position.

The maximum position number that can be specified varies depending on the controller model and the PIO pattern currently specified.

4.6 Data Structures of Numerical Command Registers

These registers are used to move the actuator by numerically specifying the target position, speed, acceleration/deceleration, etc.

Address	Symbol	Name	Sign	Size	R/W	Unit
9900	PCMD	Target position specification register	Signed	32	R/W	0.01 mm
9902	INP	In-position band specification register	Unsigned	32	R/W	0.01 mm
9904	VCMD	Speed specification register	Unsigned	32	R/W	0.01 mm/sec
9906	ACMD	Acceleration/deceleration specification register	Unsigned	16	R/W	0.01 G
9907	PPOW	Push-current limiting value specification register	Unsigned	16	R/W	
9908	CTLF	Control flag specification register	Unsigned	16	R/W	

4.6.1 Target Position Coordinate Specification Register (PCMD) (9900H)

This register specifies the target position in PTP positioning operation using absolute coordinates. The value of this register is set in units of 0.01 mm in a range of –999999 to 999999. When a position is specified using absolute coordinates and the specified value exceeds the soft limit set by a parameter, an alarm will generate the moment a movement start command is issued. The actuator will start moving when the lower word of this register is rewritten. In other words, a numerical movement command can be issued simply by writing a target position in this register.

To specify a speed, etc., at the same time, rewrite the necessary number of registers in one message using the Modbus function Preset Multiple Registers, etc.

4.6.2 In-position Band Specification Register (INP) (9902H)

This register is used in two different ways depending on the type of operation.
In normal positioning operation, it specifies the allowable difference between the target position and current position to be used in the detection of positioning completion. In push-motion operation, it specifies the push-motion band. The value of this register is set in units of 0.01 mm in a range of 0 to 999999. Whether the normal operation or push-motion operation is specified by the applicable bit in the control flag specification register as explained later.

Changing this register alone will not start actuator movement.

4.6.3 Speed Specification Register (VCMD) (9904H)

This register specifies the moving speed. The value of this register is set in units of 0.01 mm/sec in a range of 0 to 999999. If the specified value exceeds the maximum speed set by a parameter, an alarm will generate the moment a movement start command is issued.

The actuator will start moving when the lower word of this register is rewritten. In other words, the speed can be changed while the actuator is moving, simply by rewriting this register.

4.6.4 Acceleration/Deceleration Specification Register (ACMD) (9906H)

This register specifies the acceleration or deceleration. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum acceleration or deceleration set by a parameter, an alarm will generate the moment a movement start command is issued.

The actuator will start moving when this register is rewritten. In other words, the acceleration/deceleration can be changed while the actuator is moving, simply by rewriting this register.

4.6.5 Push-current Limiting Value (PPOW) (9907H)

This register sets the current limit during push-motion operation. The current limiting value is set as one of 256 levels, with FFH representing the maximum current. Due to the actuator limitations, the push-current limiting value should be set in range of 20% to 70% (33H to B3H).

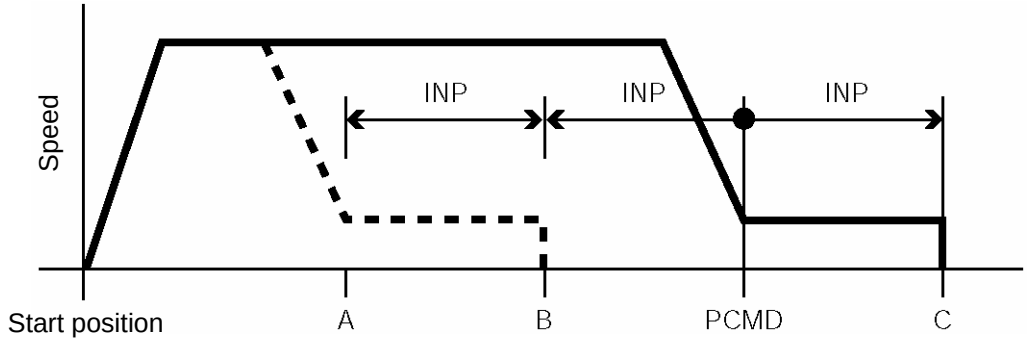
The actuator will start moving when this register is rewritten. In other words, the current limiting value can be changed during push-motion operation simply by rewriting this register.

4.6.6 Control Flag Specification Register (CTLF) (9908H)

This parameter consists of the following bit pattern that sets the respective operations.
This register will be overwritten by the default parameter value once the actuator starts moving.

Bit 1 = 0: Normal operation
1: Push-motion operation

Bit 2 = 0: The direction of push-motion operation after completion of approach is defined as the forward direction.
1: The direction of push-motion operation after completion of approach is defined as the reverse direction.
This bit is used to calculate the direction of final stop position from PCMD. If this bit is set incorrectly, therefore, the target position will deviate from the specified position by a distance corresponding to “2 x INP,” as shown below.
If bit 1 is set to 0, the setting of this bit is invalid.



Direction of push-motion operation

Bit 3 = 0: Normal operation
1: Incremental operation
Setting this bit to 1 will enable incremental operation.
In incremental operation, the actuator behaves differently between normal operation and push-motion operation (CTLF bit 1).
While the travel is calculated with respect to the target position (PCMD) in normal operation, it is calculated relative to the current position in push-motion operation (when bit 1 = 1).

Here, since relative coordinate calculation involves adding up pulses in mm, followed by conversion, unlike a calculation method involving addition after pulse conversion, “repeated relative movements will not cause position deviation as a result of cumulative errors corresponding to fraction pulses that are not divisible with certain lead settings”.

* All bits whose details are not explained are reserved.

4.7 Data Structures of Position Table Information Registers

These registers indicate position data and are located in the low-speed memory area. Each time a register of this category is accessed, the applicable member data will be read from the EEPROM in units of position data. When a positioning command is issued, the data of the applicable position number will be transferred to each position command information register, and then specified to the driver. Member data is rewritable, and will be stored in the EEPROM when written to a register of this category.

The address of each member can be calculated using the formula below:

1000H + (16 x Position number) + Address (Offset)

* The maximum position number varies depending on the controller model and the PIO pattern currently specified.

Address	Symbol	Name	Sign	Size	R/W	Unit
+0000	PCMD	Target position	Signed	32	R/W	0.01 mm
+0002	INP	In-position band	Unsigned	32	R/W	0.01 mm
+0004	VCMD	Speed command	Unsigned	32	R/W	0.01 mm/sec
+0006	ZNMP	Individual zone boundary +	Signed	32	R/W	0.01 mm
+0008	ZNLP	Individual zone boundary -	Signed	32	R/W	0.01 mm
+000A	ACMD	Acceleration command	Unsigned	16	R/W	0.01 G
+000B	DCMD	Deceleration command	Unsigned	16	R/W	0.01 G
+000C	PPOW	Push-current limiting value	Unsigned	16	R/W	
+000D	LPOW	Load current threshold	Unsigned	16	R/W	
+000E	CTLF	Control flag specification	Unsigned	16	R/W	

* Addresses starting with “+” indicate offsets.

4.7.1 Target Position (PCMD)

This register specifies the target position using absolute coordinates or by an incremental distance. The value of this register is set in units of 0.01 mm in a range of –999999 to 999999. When a position is specified using absolute coordinates and the specified value exceeds the soft limit set by a parameter, an alarm will generate the moment a movement start command is issued. Specify whether to use absolute coordinates or incremental distance using the applicable bit in the control flag specification register as explained later.

4.7.2 In-position Band Specification Register (INP)

This register is used in two different ways depending on the type of operation.
In normal positioning operation, it specifies the allowable difference between the target position and current position to be used in the detection of positioning completion. In push-motion operation, it specifies the push-motion band. The value of this register is set in units of 0.01 mm in a range of 0 to 999999. Whether the normal operation or push-motion operation is specified by the applicable bit in the control flag specification register as explained later.

4.7.3 Speed Specification Register (VCMD)

This register specifies the moving speed in positioning. The value of this register is set in units of 0.01 mm/sec in a range of 0 to 999999. If the specified value exceeds the maximum speed set by a parameter, an alarm will generate the moment a movement start command is issued.

4.7.4 Individual Zone Boundaries ± (ZNMP, ZNLP)

These registers output zone signals that are effective only during positioning, separately from the zone boundaries set by parameters.

Set in ZNMP the positive zone signal output boundary expressed using absolute coordinates, and set the negative zone signal output boundary in ZNLP. The corresponding bit in the zone register remains ON while the current position is within these positive and negative boundaries. The value of this register is set in units of 0.01 mm, and in a range of –999999 to 999999 for both registers. However, ZNMP must be greater than ZNLP.

Set the same value in both ZNMP and ZNLP to disable the individual zone output.

4.7.5 Acceleration Specification Register (ACMD)

This register specifies the acceleration during positioning. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum acceleration set by a parameter, an alarm will generate the moment a movement start command is issued.

4.7.6 Deceleration Specification Register (DCMD)

This register specifies the deceleration during positioning. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum deceleration set by a parameter, an alarm will generate the moment a movement start command is issued.

4.7.7 Push-current Limiting Value (PPOW)

Set the current limit in push-motion operation in PPOW. The current limiting value is set as one of 256 levels, with FFH representing the maximum current. Due to the actuator limitations, the push-current limiting value should be set in range of 20% to 70% (33H to B3H).

4.7.8 Load Output Current Threshold (LPOW)

To perform load output judgment, set the current threshold in LPOW. Set a desired value as one of 256 levels, with FFH representing the maximum current. If load output judgment is not performed, set 0.

4.7.9 Control Flag Specification Register (CTLF)

This parameter consists of the following bit pattern that sets the respective operations.

Bit 1 = 0: Normal operation
1: Push-motion operation

Bit 2 = 0: The direction of push-motion operation after completion of approach operation represents the forward direction.
1: The direction of push-motion operation after completion of approach operation represents the reverse direction.

Bit 3 = 0: Normal operation
1: Incremental operation

* All bits whose details are not explained are reserved.

4.8 Data Structures of I/O Control Information Registers

Address	Symbol	Name	Sign	Size	R/W	Unit
0D00	DRG1	Device control register 1	Unsigned	16	R/W	
0D01	DRG2	Device control register 2	Unsigned	16	R/W	
0D02	DRGE	Expansion device control register	Unsigned	16	R	
0D03	POSR	Position number specification register	Unsigned	16	R/W	

4.8.1 Device Control Register 1 (DRG1) (0D00H)

These bits are used for control commands. The bits in this register are assigned to input ports in accordance with the PIO pattern when the “PIO/Modbus switching status (PMSS)” bit in the expansion device status register is 0 (Enable PIO commands). This register can also be rewritten/referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Coil address	Symbol	Name	Function
15	0400	EMG	EMG operation specification	0: Emergency stop not actuated 1: Emergency stop actuated Changing this bit to 1 will switch the controller to the emergency stop mode. Take note that the drive source will not be cut off. (The ALM LED on the controller will not illuminate.)
14	0401	SFTY	Safety speed command	0: Disable safety speed 1: Enable safety speed Changing this bit to 1 will limit the speeds of all movement commands to the speed specified by the “Safety speed” parameter.
13	0402	RSV	Reserved	
12	0403	SON	Servo ON command	0: Servo OFF 1: Servo ON Changing this bit to 1 will turn the servo ON after elapse of the time specified by the “Servo ON delay time” parameter. However, the following conditions must be satisfied: • The EMG status bit in device status register 1 is 0. • The major failure status bit in device status register 1 is 0. • The enable status bit in device status register 2 is 1. • The auto servo OFF status in the system status register is 0.
11	0404	RSV	Reserved	
10	0405	RSV	Reserved	
9	0406	RSV	Reserved	
8	0407	ALRS	Alarm reset command	0: Normal 1: Execute alarm reset Present alarms will be reset upon detection of the 0 $\rightarrow$ 1 edge of this bit. If any alarm remains unresolved (its cause has not been removed), the same alarm will generate again. If this command is detected while the actuator is paused, the remaining travel will be cancelled.

Bit	Coil address	Symbol	Name	Function
7	0408	BKRL	Brake forced-release command	0: Normal 1: Forcibly release brake Brake control is linked to servo ON/OFF. However, changing this bit to 1 will forcibly release the brake even when the servo is ON.
6	0409	RSV	Reserved	
5	040A	STP	Pause command	0: Normal 1: Pause command All motor movement is inhibited while this bit is 1. If this bit turns 1 while the actuator is moving, the actuator will decelerate to a stop. When the bit is set to 0 again thereafter, the actuator will resume the remaining travel. If the alarm reset command bit is set while the actuator is paused, the remaining travel will be cancelled. The current limiting value during pause corresponds to the value set by the positioning-current limiting value (DPOW) parameter during normal positioning operation or during approach operation as part of push-motion operation. (*1) During push-motion operation inside the push range, the push-current limiting value (PPOW) is used. If this bit is set during homing, the movement command will be held if the actuator has not yet reversed after contacting the mechanical end. If the actuator has already reversed after contacting the mechanical end, homing will be repeated from the beginning.
4	040B	HOME	Homing command	0: Normal 1: Homing command Homing will start upon detection of the 0 → 1 edge of this bit. Once the homing is completed, the HEND bit will turn 1. This bit can be input as many times as desired even after homing has been completed once.
3	040C	CSTR	Positioning start command	0: Normal 1: Position start command Upon detection of the 0 → 1 edge of this bit, the target position number will be read by the position number specification register and the actuator will move to the target position of the corresponding position data. If this bit remains 1, a completed position will not be output even when the actuator enters the in-position band. If this command is executed when homing has never been performed after the power was turned on (when the HEND bit is 0), the actuator will perform homing and then start moving to the target position. The target position, speed and other operation parameters must be already set in the position table (nonvolatile memory) of the controller before this command is issued.
2	040D	RSV	Reserved	
1	040E	RSV	Reserved	
0	040F	RSV	Reserved	

*1 On PCON and ERC2 controllers, the current limiting value during pause corresponds to the standstill-current limiting value (SPOW) if the stationary mode is set to a value other than 4 (full servo control).

4.8.2 Device Control Register 2 (DRG2) (0D01H)

These bits are used for control commands. The bits in this register are assigned to input ports in accordance with the PIO pattern when the “PIO/Modbus switching status (PMSS)” bit in the expansion device status register is 0 (Enable PIO commands). This register can also be rewritten/referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Coil address	Symbol	Name	Function
15	0410	RSV	Reserved	
14	0411	JISL	Jog/inch switching	0: Jog 1: Inch When this bit is 0, the actuator jogs in accordance with the JOG+/JOG- bits. When this bit is 1, the actuator inches in accordance with the JOG+/JOG- bits. If this bit switches while the actuator is jogging, the actuator will decelerate to a stop. If this bit switches while the actuator is inching, the inching movement will continue. Jog/inch switching by this bit is not reflected in the jogging/inching operation initiated by a tool.
13	0412	RSV	Reserved	
12	0413	RSV	Reserved	
11	0414	MOD	Teaching mode command	0: Normal operation mode 1: Teaching mode Changing this bit to 1 will switch the controller to the teaching mode.
10	0415	TEAC	Position data load command	0: Normal 1: Position data load command If this bit has remained 1 continuously for 20 msec or more in the teaching mode (while MOD in this register is 1), the current position data will be written in the target position field under the position number specified by the position number specification register when the aforementioned condition was detected. If other position data fields are empty, the default parameter values will be written at the same time in the empty fields other than the target position (VCMD, ACMD, INP and CTLF).

Bit	Coil address	Symbol	Name	Function
9	0416	JOG+	Jog+ command	0: Normal 1: Jog+ command In the jog mode (when JISL in this register is 0), the actuator jogs in the direction opposite home while this bit is 1. The speed and acceleration/deceleration conform to the PIO jog speed (IOJV) parameter and PIO jog acceleration/deceleration (IOJA) parameter, respectively. If this bit is turned 0 or the jog- command bit is changed to 1 while the actuator is moving, the actuator will decelerate to a stop. Switching this bit from 0 to 1 in the inching mode (when JISL in this register is 1) will cause the actuator to inch in the direction opposite home. The speed, acceleration/deceleration and travel conform to the PIO jog speed (IOJV) parameter, PIO jog acceleration/deceleration (IOJA) parameter, and PIO inching distance (IOID) parameter, respectively.
8	0417	JOG-	Jog- command	0: Normal 1: Jog- command In the jog mode (when JISL in this register is 0), the actuator jogs in the direction of home while this bit is 1. The speed and acceleration/deceleration conform to the PIO jog speed (IOJV) parameter and PIO jog acceleration/deceleration (IOJA) parameter, respectively. If this bit is turned 0 or the jog+ command bit is changed to 1 while the actuator is moving, the actuator will decelerate to a stop. Switching this bit from 0 to 1 in the inching mode (when JISL in this register is 1) will cause the actuator to inch in the direction of home. The speed, acceleration/deceleration and travel conform to the PIO jog speed (IOJV) parameter, PIO jog acceleration/deceleration (IOJA) parameter, and PIO inching distance (IOID) parameter, respectively.
7	0418	ST7	Start position 7	These bits are effective only when the air cylinder mode is selected as the PIO pattern. Each bit indicates a start position command. Either level operation or edge operation can be selected as the command type of these bits. In level operation, the actuator will decelerate to a stop once the specified bit turns 0 while the actuator is operating. The priorities in which the respective bits are received can be selected using parameters. If two or more bits are input simultaneously, the bit of the youngest number will be given priority.
6	0419	ST6	Start position 6	
5	041A	ST5	Start position 5	
4	041B	ST4	Start position 4	
3	041C	ST3	Start position 3	
2	041D	ST2	Start position 2	
1	041E	ST1	Start position 1	
0	041F	ST0	Start position 0	

4.8.3 Expansion Device Control Register (DRGE) (0D02H)

These bits are used for control commands. This register can be rewritten only if changed using the Modbus function code 05H (Force Single Coil). Write operation is inhibited while this register is being accessed. The details of bits are explained below. Never rewrite the reserved bits in this register.

Bit	Coil address	Symbol	Name	Function
15	0420	RSV	Reserved	
14	0421	RSV	Reserved	
13	0422	RSV	Reserved	
12	0423	RSV	Reserved	
11	0424	RSV	Reserved	
10	0425	RSV	Reserved	
9	0426	RSV	Reserved	
8	0427	PMSL	PIO/Modbus switching specification	0: Enable PIO commands 1: Disable PIO commands This bit switches the right to the position number specification register and device control register 1/2. When this bit is 0, PIOs are given the right to change. When it is 1, Modbus is given the right to change. The bit is set to 0 (PIO) when a PIO controller is started. On a non-PIO controller, it is set to 1 (Modbus). On a controller equipped with an operation mode switch, this bit will change to 0 when the switch is set to the AUTO mode, and will change to 1 when the switch is set to the MANU mode. If the right to change is switched from PIOs to Modbus, the aforementioned registers will take over the PIO values. If the right to change is switched from Modbus to PIOs, the registers will be refreshed with the PIO values, but edge detection will not occur at the time of switching.
7	0428	RSV	Reserved	
6	0429	RSV	Reserved	
5	042A	RSV	Reserved	
4	042B	RSV	Reserved	

Bit	Coil address	Symbol	Name	Function
3	042C	STOP	Deceleration stop	0: Normal 1: Deceleration stop command The actuator will start decelerating to a stop upon detection of the 0 → 1 edge of this bit. Once the actuator starts decelerating, this bit will be reset to 0 by the controller.
2	042D	RSV	Reserved	
1	042E	RSV	Reserved	
0	042F	RSV	Reserved	

4.8.4 Position Number Specification Register (POSR) (0D03H)

When a positioning command is issued, the specified position number is stored in this register. The bits in this register are assigned to input ports in accordance with the PIO pattern when the “PIO/Modbus switching status (PMSS)” bit in the expansion device status register is 0 (Enable PIO commands). This register can also be rewritten/referenced based on bit access addresses corresponding to applicable Modbus statuses. The details of bits are explained below.

Bit	Coil address	Symbol	Name	Function
15	0430	RSV	Reserved	
14	0431	RSV	Reserved	
13	0432	RSV	Reserved	
12	0433	RSV	Reserved	
11	0434	RSV	Reserved	
10	0435	RSV	Reserved	
9	0436	RSV	Reserved	
8	0437	PC256	Position command bit 256	These bits specify command position numbers in binary codes. Specifying a position number using the applicable bit and then turning ON the CSTR bit in device control register 1 will start a positioning operation to the specified position. The maximum position number varies depending on the controller model and the PIO pattern currently specified.
7	0438	PC128	Position command bit 128	
6	0439	PC64	Position command bit 64	
5	043A	PC32	Position command bit 32	
4	043B	PC16	Position command bit 16	
3	043C	PC8	Position command bit 8	
2	043D	PC4	Position command bit 4	
1	043E	PC2	Position command bit 2	
0	043F	PC1	Position command bit 1	

4.9 Exception Status

A function is supported whereby the Modbus function Exception Status is used to notify an error encountered by the controller (alarm code) to the host.

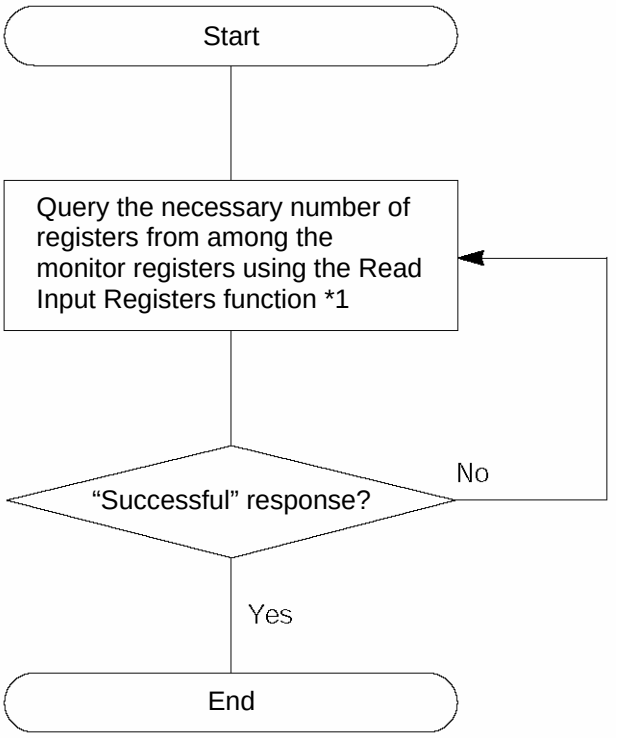
When a query is issued with the Modbus function code 07H (Read Exception Status), byte data indicating the alarm code currently generated by the controller will be returned as the exception status in the response.

If no alarm is present, the exception status will become 00H.

5. Communication Procedures

5.1 Controller Status Monitoring Procedure

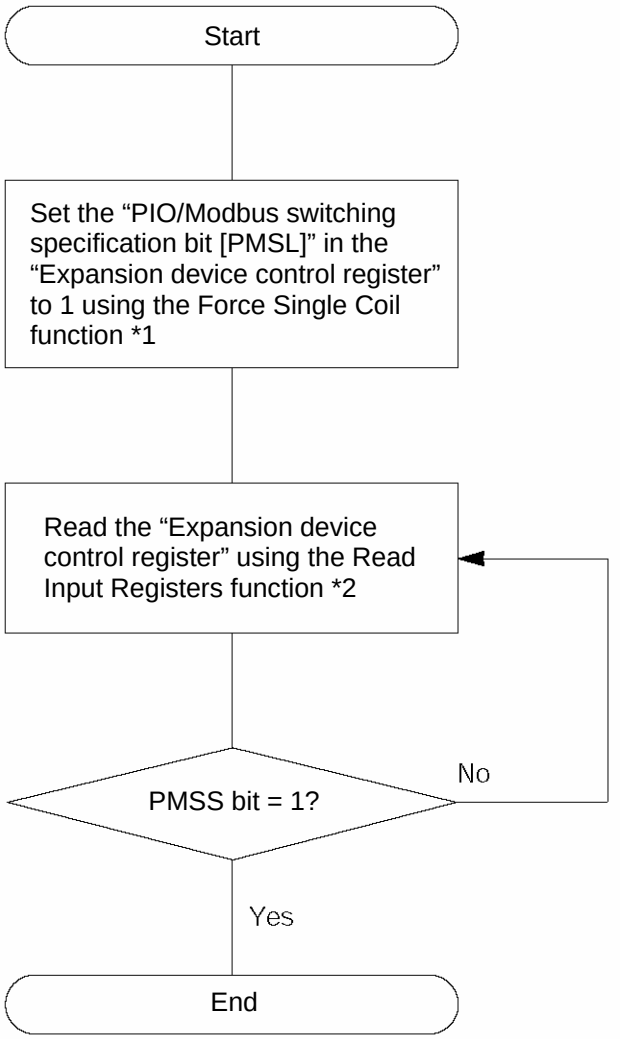
The procedure to monitor the internal statuses of the controller, such as the current position and presence of alarms, is shown below. All monitor registers can be read at once, but it is also possible to read only the necessary registers individually.



*1 The Read Holding Registers function can also be used.

5.2 PIO Command Disable Specification Procedure

When the controller is started, PIOs are enabled. To perform control using the Modbus protocol, PIO activation must be disabled. (This operation is not necessary if the controller will only perform monitoring operations.)
When PIOs are disabled, the input statuses of DIs corresponding to the PIO pattern are retained in the respective bits of the device control register.
On a non-PIO model, PIOs are disabled when the controller is started.
To resume PIO command operation, the PMSL bit must be reset to 0.

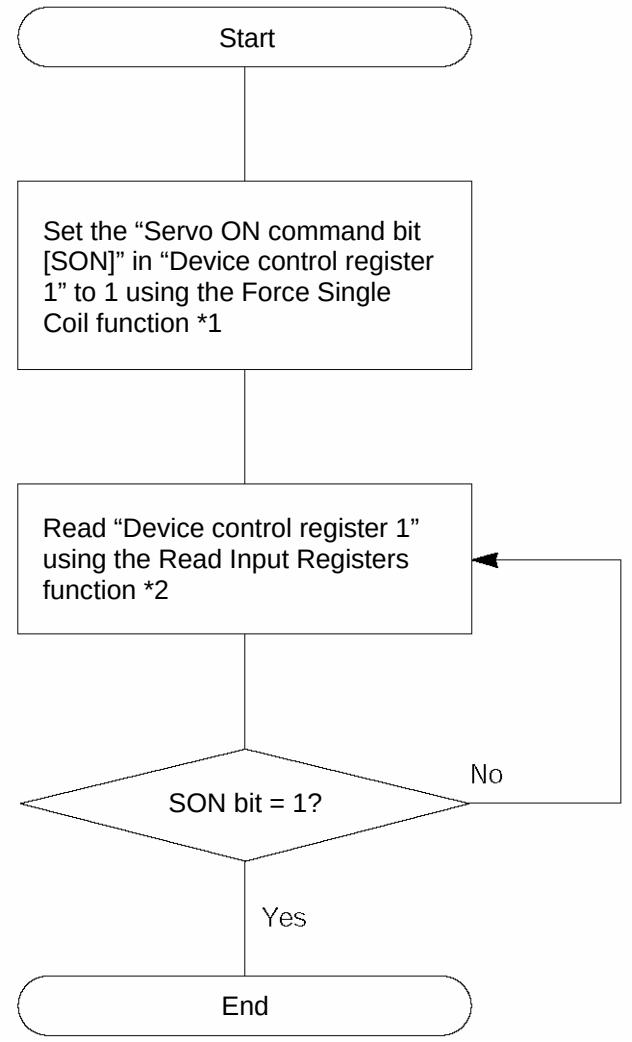


*1 This bit cannot be changed by any other function but Force Single Coil.

*2 The PMSS bit can be read directly using Read Input Status.

5.3 Servo ON Command Procedure

The servo must be turned ON before a movement command is issued. Turn the servo ON by following the procedure below. This operation is not necessary if the “Servo ON input” parameter is set to “Disable.”

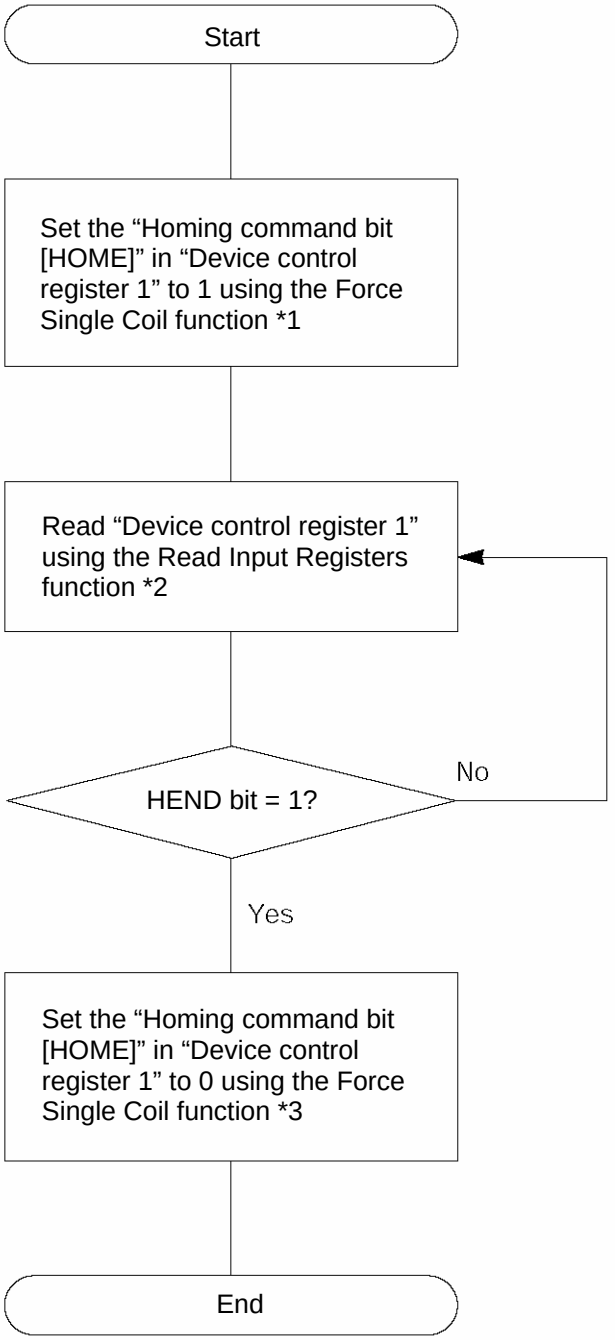


*1 Force Multiple Coils can also be used.

*2 The SON bit can be read directly using Read Input Status.

5.4 Homing Procedure

Homing must be completed before a movement command is issued. Perform homing by following the procedure below. In the position number specification mode, the actuator will automatically perform homing if it is not yet completed.



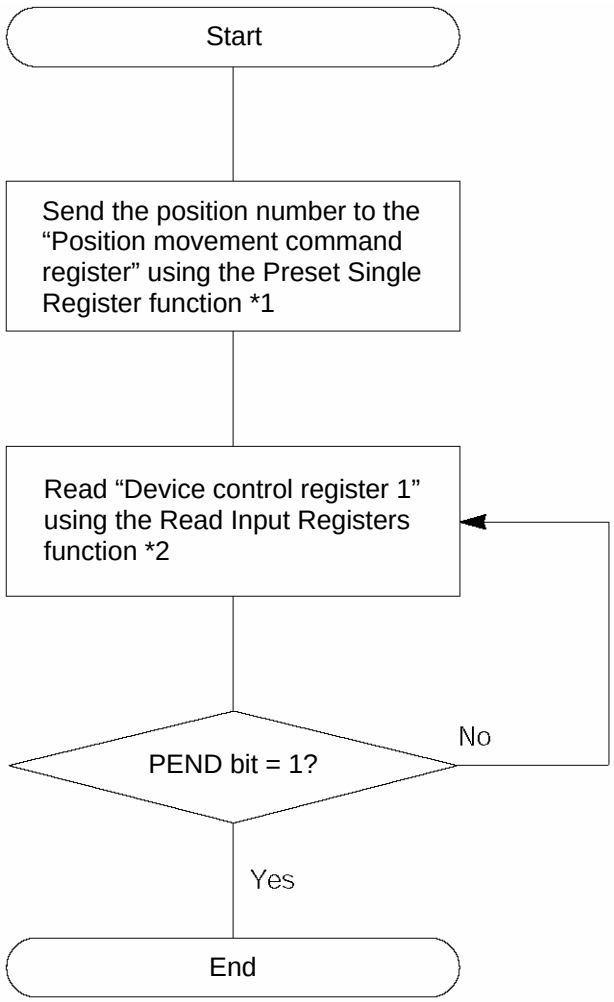
*1 Force Multiple Coils can also be used.

*2 The HEND can be read directly using Read Input Status.

*3 After homing, reset the command bit to 0. Force Multiple Coils can also be used.

5.5 Movement Procedure by Position Number Specification

The procedure to issue a movement command using data registered in the position table is shown below. The servo must be turned ON before a movement command is issued.

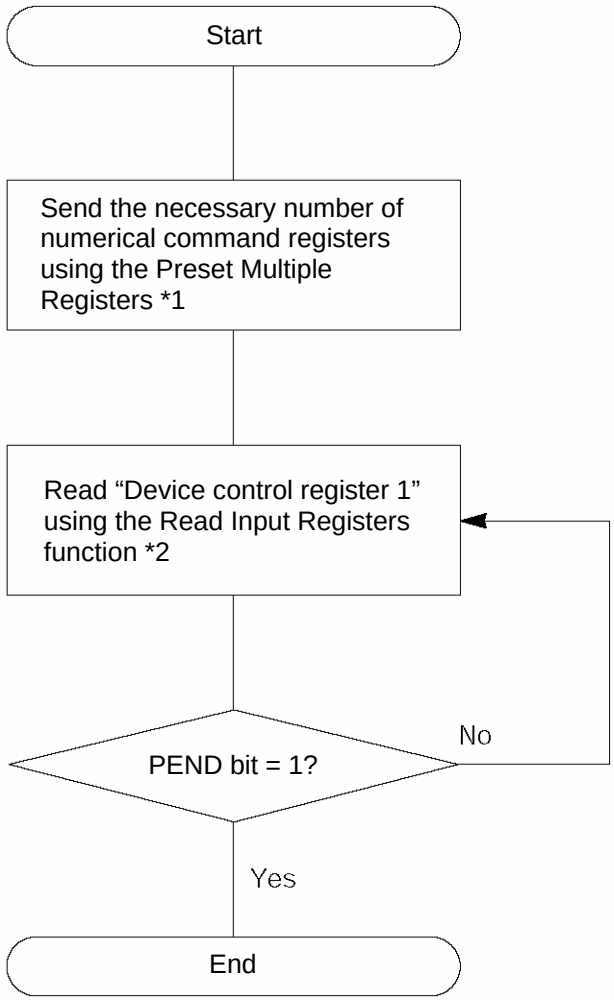


*1 Preset Multiple Registers can also be used.

*2 The PEND can be read directly using Read Input Status.

5.6 Movement Procedure by Position Coordinate Specification

The procedure to issue a movement command via numerical specification is shown below. The servo must be turned ON and homing completed before a movement command is issued.

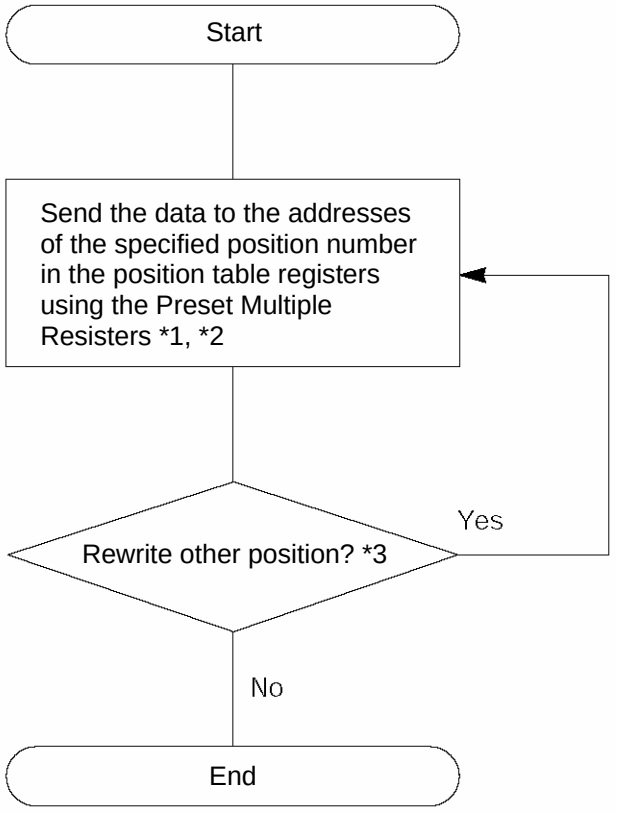


*1 To specify only the target position, send only the PCMD 2 register. To also specify the in-position band and speed, specify the six registers up to INP and VCMD.

*2 The PEND can be read directly using Read Input Status.

5.7 Position Data Write Procedure

The procedure to register data in the position table is shown below.



*1 Rewrite the PCMD through CTLF registers.

*2 Writing a position table register requires accessing the EEPROM, and thus it may take a longer time before a response is received. When writing these registers, therefore, set the timeout period sufficiently long.

*3 Repeat the same step for the number of positions that must be rewritten.

5.8 Notes

- When referencing registers using Modbus functions, registers belonging to multiple categories cannot be read simultaneously using a single message. To reference registers belonging to multiple categories, read them using multiple messages by classifying the corresponding addresses by category.
- The explanations in this specification apply commonly to RC Series controller models supporting “Protocol M.” For the specifications and other items specific to each model, refer to the operation manual that comes with the applicable controller.
- This specification is subject to change without notice for the purpose of improving product functions.

5.9 CRC Calculation

Sample C functions used for CRC calculation are shown below.
They are equivalent to the CRC calculation functions stated in the published Modbus Protocol Specification (PI-MBUS-300 Rev. J).

```
unsigned short CalcCRC16swap(
    unsigned char*  puchMsg,                    /* message to calculate */
    unsigned short  usDataLen)                  /* quantity of bytes in message */
{
    unsigned char   uchCRCHi = 0xFF;            /* high byte of CRC initialized */
    unsigned char   uchCRCLo = 0xFF;            /* low byte of CRC initialized */
    unsigned int    uIndex;                     /* will index into CRC lookup table */

    while(usDataLen--)                          /* pass through message buffer */
    {                                           /* calculate the CRC */
        uIndex = uchCRCHi ^ *puchMsg++;
        uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex];
        uchCRCLo = auchCRCLo[uIndex];
    }
    return (uchCRCHi << 8 | uchCRCLo);
}

const unsigned char auchCRCHi[] =
{/*  Table of CRC values for high-order byte */
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
};
```

```
const unsigned char auchCRCLo[] =
{/* Table of CRC values for low-order byte */
    0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4, 0x04,
    0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8,
    0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
    0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3, 0x11, 0xD1, 0xD0, 0x10,
    0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4,
    0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
    0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C,
    0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26, 0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0,
    0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
    0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68,
    0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C,
    0xB4, 0x74, 0x75, 0xB5, 0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
    0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54,
    0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98,
    0x88, 0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
    0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80, 0x40,
};
```

5.10 LRC Calculation

A sample C function used for LRC calculation is shown below.
When creating a query message, store the address, function and data fields of the created message in the input buffer of this function after converting them to binary values. The binary return value will be converted to an ASCII code and then stored in the error check field.
When performing error check on a response message, store all fields of the received response message, except for the header, error check and trailer, in the input buffer of this value after converting them to binary values. The converted binary value in the error check field of the response message will be compared against the return value of this function.

```
unsigned char LRC(
    unsigned char *auchMsg,                    /* message to calculate */
    unsigned short usDataLen)                  /* LRC upon quantity of bytes in message */
{
    unsigned char uchLRC = 0;                  /* LRC char initialized */

    while(usDataLen--)                         /* pass through message */
    {
        uchLRC += *auchMsg++;                  /* buffer add buffer byte without carry */
    }
    return ((unsigned char)(-((char_uchLRC)));  /* return twos complemen */
}
```

Chapter 3 Modbus Protocol Formats

This chapter explains the protocol formats (ASCII mode) that have been created based on the protocol specifications explained in Chapter 2.

1. Message Frame

The message frame in the ASCII mode is shown once again.

Header	Address	Function	Data	LRC Check	Trailer
':'	2 characters	n characters	n characters	2 characters	'CR,' 'LF'

* Only character strings consisting of "0" through "9" and "A" through "F" can be specified between the header and the trailer.

1.1 Header Field

In the ASCII mode, a message starts with the ASCII character ':' (3AH).

1.2 Address Field

The table below summarizes the addresses in the message frame.

Address	Function	Details
0	Broadcast	All slaves receive the message as a query addressed to them. They do not return a response. Some functions cannot be broadcast. (Refer to the function list.)
1 to 16	Slave address	These addresses are used to specify slave addresses. With RC Series controllers, a slave address is assigned in a range of 1 to 16, which is larger by one than the range of 0 to 15 corresponding to axis numbers that can be set internally in the controller.
17 to 255	(Reserved)	These addresses cannot be set in RC Series controllers.

* For the procedure to set axis numbers, refer to the operation manual for each controller.

1.3 Function Field

The table below summarizes the function codes and functions that can be used with RC Series controllers.

Code (Hex)	Name	Function	Combination with PIO	Broadcast	Page
01H	Read Coil Status	Read coils/DOs.	○		---
02H	Read Input Status	Read input statuses/DIs.	○		---
03H	Read Holding Registers	Read holding registers.	○		
04H	Read Input Registers	Read input registers.	○		---
05H	Force Single Coil	Write one coil/DO.		○	
06H	Preset Single Register	Write holding register.		○	
07H	Read Exception Status	Read exception statuses.	○		---
0FH	Force Multiple Coils	Write multiple coils/DOs at once.		○	---
10H	Preset Multiple Registers	Write multiple holding registers at once.		○	
11H	Report Slave ID	Query a slave's ID.	○		---
17H	Read / Write Registers	Read/write registers.			---

* In this chapter, only the queries that use the shaded function codes are explained.

1.4 Data Field

This field is used to append data associated with the function code. The data field has a variable length and need not be always specified.

1.5 LRC Check Field

In the ASCII mode, an error check field conforming to the LRC method is included in each message. The LRC field is used to check the message content excluding the first colon and CR/LF.

The LRC field consists of two bytes corresponding to two ASCII code characters. The LRC value is calculated by the sender that appends the LRC field to the message. The recipient recalculates the LRC value while receiving the message, and compares the calculation result against the actual value received in the LRC field. If the two values do not match, an error will generate.

In LRC calculation, the successive bits in the query message, starting from the address field, are divided into units of two bytes, and the values of all 2-byte data are added up until the end of the data field (before LRC). Finally, the lower eight bits of the calculated result is converted to a 2's complement. This binary value is converted to two ASCII code characters that are then appended to the LRC field.

- <Sample LRC check calculation> The shaded fields relate to the Modbus PDU (Protocol Data Unit).

Assume the following query message:
[':'] ["01"] ["05"] ["040B"] ["0000"] [LRC] [CR] [LF]
LRC calculation on this message produces a total sum of 01H + 05H + 04H + 0BH + 00H + 00H = 15H.
When the 8-bit length is applied, the 2's complement of this value is EBH.
In other words, LRC = "EB."

Accordingly, this query message is converted to 0105040B0000EB [CR] [LF].

- Tip: LRC stands for Longitudinal Redundancy Check, which is a horizontal parity check.

1.6 Trailer Field

In the ASCII mode, "CR/LF" (0DH, 0AH) is the last field.

1.7 Send/Receive Buffers

The send/receive buffer sizes of controllers are 256 bytes, respectively. Messages sent by the host must not exceed the receive buffer size, while data requests must not exceed the send buffer size.

2. Query List (Functional Comparison)

Chapter 3 describes the query/response formats under the Modbus protocol that are used for executing the functions listed below.

FC	Function	Symbol	Broad-cast	Remarks	Reference page
03H	Multiple FC03 register read	None		This function can be used to successively read multiple registers that use function 03.	
03H	Current position monitor	PNOW		This function reads the current actuator position in units of 0.01 mm.	
03H	Present alarm code query	ALMC		This function reads alarm codes that are presently detected.	
03H	Input port query	DIPM		This function reads the ON/OFF statuses of PIO input ports.	
03H	Output port query	DOPM		This function reads the ON/OFF statuses of PIO output ports.	
03H	Device status query 1	DSS1		This function reads the following 12 statuses: [1] Emergency stop [2] Safety speed enabled/disabled [3] Controller ready [4] Servo ON/OFF [5] Missed work in push-motion operation [6] Major failure [7] Minor failure [8] Absolute error [9] Brake [10] Pause [11] Homing completion [12] Positioning completion	

* FC stands for “Function Code.”
* The function code 03H represents the “Read Holding Resisters” function.

FC	Function	Symbol	Broad-cast	Remarks	Reference page
03H	Device status query 2	DSS2		This function reads the following 15 statuses: [1] Enable [2] Load output judgment (check-range load current threshold) [3] Torque level (load current threshold) [4] Teaching mode (normal/teaching) [5] Position data load (normal/complete) [6] Jog+ (normal/command active) [7] Jog- (normal/command active) [8] Completed position 7 [9] Completed position 6 [10] Completed position 5 [11] Completed position 4 [12] Completed position 3 [13] Completed position 2 [14] Completed position 1 [15] Completed position 0	
03H	Expansion device status query	DSSE		This function reads the following 9 statuses: [1] Emergency stop (emergency stop input port) [2] Motor voltage low [3] Operation mode (AUTO/MANU) [4] Homing [5] Push-motion operation in progress [6] Excitation detection [7] PIO/Modbus switching [8] Position-data write completion status [9] Moving	
03H	System status query	STAT		This function reads the following 7 statuses: [1] Automatic servo OFF [2] EEPROM accessed [3] Operation mode (AUTO/MANU) [4] Homing completion [5] Servo ON/OFF [6] Servo command [7] Drive source ON (normal/cut off)	

FC	Function	Symbol	Broad-cast	Remarks	Reference page
03H	Current speed monitor	VNOW		This function reads the current actuator speed in units of 0.01 mm/sec.	
03H	Current ampere monitor	CNOW		This function reads the motor-torque current command value of the actuator in mA.	
03H	Deviation monitor	DEVI		This function reads the deviation over a 1-ms period in pulses.	
03H	System timer monitor	STIM		This function reads the total time in msec since the controller power was turned on.	
03H	Special input port query	SIPM		This function reads the following 9 statuses: [1] Command pulse NP [2] Command pulse PP [3] Port switch [4] Mode switch [5] Enable switch [6] Home check sensor [7] Overtravel sensor [8] Creep sensor [9] Limit sensor	
03H	Zone status query	ZONS		This function reads the following 6 statuses: [1] LS2 (PIO pattern: Solenoid valve mode) [2] LS1 (PIO pattern: Solenoid valve mode) [3] LS0 (PIO pattern: Solenoid valve mode) [4] Position zone [5] Zone 2 [6] Zone 1	

FC	Function	Symbol	Broad-cast	Remarks	Reference page
03H	Completed position number query	POSS		This function reads the following 9 statuses: [1] Completed position number bit 256 [2] Completed position number bit 128 [3] Completed position number bit 64 [4] Completed position number bit 32 [5] Completed position number bit 16 [6] Completed position number bit 8 [7] Completed position number bit 4 [8] Completed position number bit 2 [9] Completed position number bit 1	
05H	Safety speed mode switching	SFTY	O	This function issues a command to enable/disable the safety speed.	
05H	Servo ON/OFF	SON	O	This function issues a command to turn the servo ON/OFF.	
05H	Alarm reset	ALRS	O	This function issues a command to reset alarms/cancel the remaining travel.	
05H	Brake release	BKRL	O	This function issues a command to forcibly release the brake.	
05H	Pause	STP	O	This function issues a pause command.	
05H	Homing	HOME	O	This function issues a homing operation command.	
05H	Positioning start	CSTR	O	This function turns the start signal ON/OFF for movement by position number specification. (This function is not used in this manual.)	
05H	Jog/inch switching	JISL	O	This function switches between the jogging mode and the inching mode	
05H	Teaching mode command	MOD	O	This function switches between the normal mode and the teaching mode	
05H	Position data load	TEAC	O	This function issues a current position load command in the teaching mode.	
05H	Jog+	JOG+	O	This function issues a jogging/inching command in the direction opposite home.	
05H	Jog-	JOG-	O	This function issues a jogging/inching command in the direction of home.	
05H	Position number specification 0 to 7	ST0 to ST7	O	This function specifies position numbers effective only in the solenoid valve mode. The actuator can be operated with this command alone.	
05H	PIO/Modbus switching setting	PMSL	O	This function issues a command to enable/disable PIO external command signals.	
05H	Deceleration stop	STOP	O	This function can decelerate the actuator to a stop.	
06H	Movement by position number specification	POSR	O	Normal movement, relative movement and push-motion operation can be performed by position number specification using this command alone.	

FC	Function	Symbol	Broad-cast	Remarks	Reference page
10	Numerical movement command	None	○	This function can be used to send the target position, in-position band, speed, acceleration/deceleration, push, and control setting in a single message to operate the actuator. Normal movement, relative movement and push-motion operation are supported.	
10	Position data table write	None	○	This function can be used to change all data of the specified position number for the specified axis.	
Indeter-minable	Exception response	None		This response will be returned when the message contains invalid data.	

* The function code 05H represents the “Force Single Coil” function.
* The function code 06H represents the “Preset Single Registers” function.
* The function code 10H represents the “Preset Multiple Registers” function.

3. Queries Using Function Code 03H (Read Holding Registers)

3.1 Basic Query/Response Structures

3.1.1 Function

Read the contents of holding registers in a slave.
Broadcast is not supported.

3.1.2 Query Format

In a query message, specify the holding register address from which to start reading data, and number of holding registers to be read.
1 holding register = 2 bytes = 16-bit data

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	':'	1	
Slave address (H)	Arbitrary	2	Axis number + 1 (01H to 10H)
Function code (H)	'0,' '3'	2	"Read Holding Registers" code
Start address (H)	Arbitrary	4	Refer to "Start Address List."
Number of registers (H)	Arbitrary	4	Refer to "Start Address List."
Error check (H)	LRC (2 characters)	2	
Trailer	CR/LF	2	
Total bytes	17	17	

3.1.3 Start Address List

With RC Series controllers, the sizes of send/receive buffers are set to 256 bytes, respectively, in the ASCII mode. Accordingly, a maximum of 61 registers' worth of data consisting of 247 bytes (one register uses four bytes in the ASCII mode), which is 11 bytes (header + slave address + function code + error check + trailer) less than the above 256 bytes, can be queried. In other words, all of the data listed below (total 21 registers) can be queried in a single transmission.

Address (H)	Symbol	Name	Sign	Register size	Byte
9000	PNOW	Current position monitor	○	2	4
9002	ALMC	Present alarm code query		1	2
9003	DIPM	Input port query		1	2
9004	DOPM	Output port monitor query		1	2
9005	DSS1	Device status query 1		1	2
9006	DSS2	Device status query 2		1	2
9007	DSSE	Expansion device status query		1	2
9008	STAT	System status query		2	4
900A	VNOW	Current speed monitor	○	2	4
900C	CNOW	Current ampere monitor	○	2	4
900E	DEVI	Deviation monitor	○	2	4
9010	STIM	System timer query		2	4
9012	SIPM	Special input port query		1	2
9013	ZONS	Zone status query		1	2
9014	POSS	Completed position number status query		1	2

■ A sample query that queries addresses 9000 to 9009 in a controller of axis No. 0 is shown below:
■ Query: 01039000000A62 [CR] [LF]

Field	ASCII mode character string (fixed)
Header	':'
Slave address	'0,' '1'
Function code	'0,' '3'
Start address	'9,' '0,' '0,' '0'
Number of registers	'0,' '0,' '0,' 'A'
Error check	'6,' '2'
Trailer	'CR,' 'LF'

3.1.4 Response Format

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	':'	1	
Slave address (H)	Arbitrary	2	Axis number + 1 (01H to 10H)
Function code (H)	'0,' '3'	2	"Read Holding Registers" code
Number of data bytes (H)		2	Number of registers specified in the query format x 2
Data 1 (H)		4	
Data 2 (H)		4	
Data 3 (H)		4	
Data 4 (H)		4	
:		:	
:		:	
Error check (H)	LRC (2 characters)	2	
Trailer	CR/LF	2	
Total bytes		256 max.	

The response to the query shown on the preceding page is as follows:

■ Response: 0103140000000000000B80162002000800031C7000800111C [CR] [LF]

The following pages explain the query/response formats based on single queries targeting respective addresses, as well as the data functions/specifications and other items corresponding to these addresses.

MEMO

3.2 Current Position Monitor (Unit: 0.01 mm) <<PNOW>>

3.2.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '0'	Current position monitor
Number of registers (H)	4	'0,' '0,' '0,' '2'	Call register Nos. 9000 and 9001.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Store the current position after converting it to a value in units of 0.01 mm. The sign is effective.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.2.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '4'	Call two registers (four bytes).
Data 1 (H)	4	Depending on the current value	Current value data (hex)
Data 2 (H)	4	Depending on the current value	Current value data (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

3.2.3 Sample Query/Response Messages (Axis No. 0)

- Query sent: 0103900000026A [CR] [LF]
- Response received: 010304000013885D [CR] [LF]

The current position is "00001388" → Converted to a decimal value → 5000 (x 0.01 mm)
The current position is 50 mm.

3.3 Present Alarm Code Query <<ALMC>>

3.3.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '2,'	Alarm codes presently detected
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9002 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Whether the controller is normal or any alarm presently detected is indicated by a code.
If no alarm is present, 00H is stored.
For details on alarm codes, refer to the operation manual that comes with each controller.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.3.2 Response Format

A response message contains 16 bits of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data 1 (H)	4	Alarm code	Alarm code (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

3.3.3 Sample Query/Response Messages (Axis No. 0)

- Query sent: 01039002000169 [CR] [LF]
- Response received: 01030200E812 [CR] [LF]

The most important alarm presently detected is "0E8"H, which is a phase A/B open alarm.
For details on alarm codes, refer to the operation manual that comes with each controller.

3.4 Input Port Query <<DIPM>>

3.4.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '3,'	Input port monitor register
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9003 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
DI input values are stored directly regardless of the PIO pattern. Note that the stored values are those that have been processed through the hardware filter and software filter.
The number of input bits varies depending on the controller model.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.4.2 Response Format

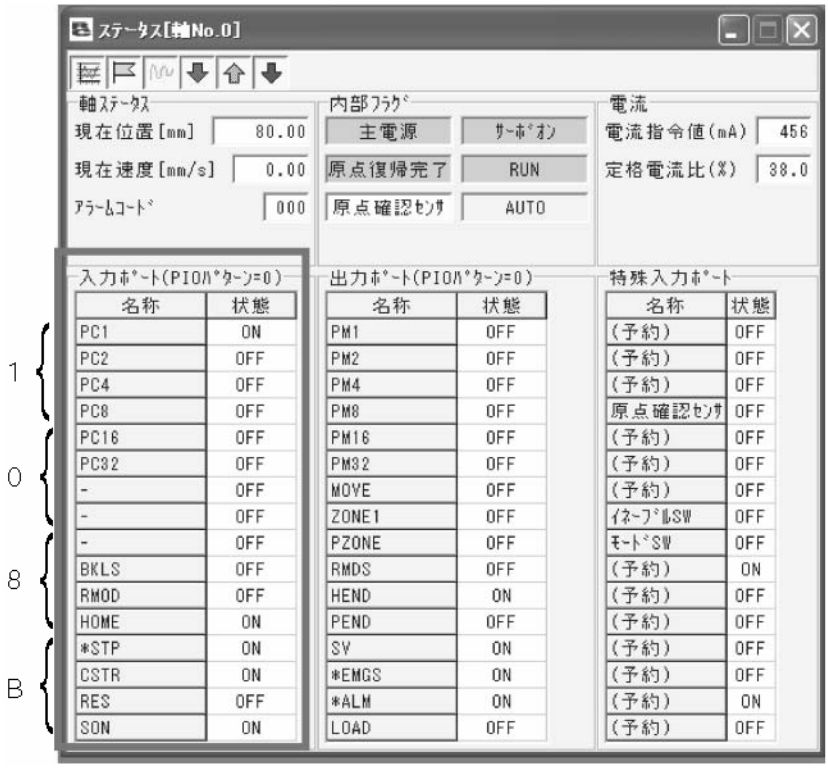
A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data 1 (H)	4	DI input value	DI input value (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

3.4.3 Sample Query/Response Messages (Axis No. 0)

- Query sent: 01039003000168 [CR] [LF]
- Response received: 010302B80141 [CR] [LF]

The DI data is "B801"H → Converted to the binary value "1011100000000001"



3.5 Output Port Query <<DOPM>>

3.5.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '4,'	Output port monitor register
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9004 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
The DO output values assigned to output ports in accordance with the PIO pattern are stored. The number of output bits varies depending on the controller model.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.5.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data 1 (H)	4	DO output value	DO output value (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

3.5.3 Sample Query/Response Messages (Axis No. 0)

- Query sent: 01039004000167 [CR] [LF]
- Response received: 010302740086 [CR] [LF]

The DO data is "7400"H → Converted to the binary value "0111010000000000"

3.6 Device Status Query 1 <<DSS1>>

3.6.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '5,'	Device status register 1
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9005 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Internal statuses of the controller are indicted.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.6.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Status 1	Status 1 (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Status 1 = 16 bits)

Bit	Status address (H)	Symbol	Name	Function
15	0100	EMGS	EMG status	0: Emergency stop not actuated 1: Emergency stop actuated This bit indicates whether or not the controller is currently in the emergency stop mode due to an emergency stop input, cutoff of the drive source, etc.
14	0101	SFTY	Safety speed enabled status	0: Safety status disabled 1: Safety status enabled This bit indicates whether the safety speed of the controls is enabled or disabled by the "Safety speed command bit" in device control register 1.
13	0102	PWR	Controller ready status	0: Controller busy 1: Controller ready This bit indicates whether or not the controller can be controlled externally. Normally this bit does not become 0 (busy).
12	0103	SV	Servo ON status	0: Servo OFF 1: Servo ON This bit indicates the ON status of the actual servo. This bit will remain 0 after a servo ON command is received until the time specified by the "Servo ON delay time" parameter elapses. If the servo cannot be turned ON for some reason after a servo ON command is received, this bit will remain 0. The controller does not accept any movement command while this bit is 0.

Bit	Status address (H)	Symbol	Name	Function
11	0104	PSFL	Missed work in push-motion operation	0: Normal 1: Missed work in push-motion operation This bit will be output when the actuator reaches the push-motion band in accordance with a push-motion operation command. Normal operation commands do not change this bit.
10	0105	ALMH	Major failure status	0: Normal 1: Major failure alarm present This bit will turn 1 if any alarm generates that inhibits continuation of operation. Alarms of this type can be reset using an alarm reset command, but some alarms cannot be reset with a reset command.
9	0106	ALML	Minor failure status	0: Normal 1: Minor failure alarm present This bit will turn 1 if a minor failure generates that permits continuation of operation.
8	0107	ABER	Absolute error status	0: Normal 1: Absolute error present This bit indicates, on a model equipped with an absolute encoder, that an error relating to the absolute encoder has generated.
7	0108	BKRL	Brake forced-release status	0: Brake actuated 1: Brake released This bit indicates the status of brake operation. Normally the bit remains 1 while the servo is ON. Even when the servo is OFF, changing the “brake forced-release command bit” in device control register 1 to 1 will change this bit to 1.
5	010A	STP	Pause status	0: Normal 1: Pause command active This bit indicates the read-back status of a pause command, not a pause condition during movement.
4	010B	HEND	Homing completion status	0: Homing not yet complete 1: Homing complete This bit indicates the homing completion status. Normally this bit is 0 when the controller is started. On a model equipped with an absolute encoder, the bit is 1 when the controller is started, if an absolute reset has already completed. If an absolute position command is issued while this bit is 0, an alarm will generate.
3	010C	PEND	Positioning completion status	0: Positioning not yet complete 1: Positioning complete This bit will turn 1 when the actuator reaches the target position and enter the in-position band. When the servo is turned OFF and then ON again, the current position will become the target position, and therefore this bit will become 1. This bit will also turn 1 when the push-motion judgment signal turns ON during push-motion operation.
2	010D	---	Reserved	
1	010E	---	Reserved	
0	010F	---	Reserved	

3.7 Device Status Query 2 <<DSS2>>

3.7.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '6,'	Device status register 2
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9006 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Internal status 2 of the controller are indicted.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.7.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Internal controller status
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Status 2	Status 2 (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Status 2 = 16 bits)

Bit	Status address (H)	Symbol	Name	Function
15	0110	ENBS	Enable status	0: Disabled 1: Enabled This bit indicates the status of the enable-switch installed tool connected to a model equipped with an enable function. On a model equipped with an operation mode switch, this bit is always 1 while the AUTO mode is selected. This bit is always 1 on a model not equipped with an enable function.
14	0111	---	Reserved	
13	0112	LOAD	Load output judgment status	0: Normal 1: Load output judgment If a load current threshold or check range (individual zone boundaries) is set when a movement command is issued, this bit indicates whether or not the motor current has reached the threshold inside the check range. The status of this bit is held, which means that after switching, the new bit status will be held until the next command is received.

Bit	Status address (H)	Symbol	Name	Function
12	0113	TRQS	Torque level	0: Normal 1: Torque level achieved If a load current threshold is set when a movement command is issued, this bit indicates whether or not the motor current has reached the threshold. Since this bit indicates a level, its status will change when the current level changes.
11	0114	MODS	Teaching mode status	0: Normal operation mode 1: Teaching mode This bit indicates whether the controller has switched to the teaching mode in accordance with the “teaching mode command bit” in device control register 2.
10	0115	TEAC	Position-data load command status	0: Normal 1: Position data load complete Setting the “position-data load command bit” in device control register 2 to 1 will change this bit to 0. This bit will turn 1 once position data has been written to the EEPROM successfully.
9	0116	JOG+	Jog+ status	0: Normal 1: Jog+ command active This bit indicates the read-back status of the “jog+ command bit” in device control register 2.
8	0117	JOG-	Jog- status	0: Normal 1: Jog- command active This bit indicates the read-back status of the “jog+ command bit” in device control register 2.
7	0118	PE7	Completed position 7	Each bit indicates a completed position. When the actuator moves to the target position and enters the in-position band as a result of positioning operation initiated by a positioning command, the applicable bit will turn 1. Although the bit that has turned 1 will change to 0 once the servo turns OFF, the bit will turn 1 again if the actuator is still inside the in-position band of the applicable command position data when the servo is turned ON subsequently. This bit will also turn 1 if the push judgment signal turns ON, or the actuator misses the work, during push-motion operation.
6	0119	PE6	Completed position 6	
5	011A	PE5	Completed position 5	
4	011B	PE4	Completed position 4	
3	011C	PE3	Completed position 3	
2	011D	PE2	Completed position 2	
1	011E	PE1	Completed position 1	
0	011F	PE0	Completed position 0	

3.8 Expansion Device Status Query <<DSSE>>

3.8.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '7,'	Expansion device status register
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9007 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Internal statuses (expansion device) of the controller are indicated.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.8.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Expansion status	Expansion status (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Expansion status = 16 bits)

Bit	Status address (H)	Symbol	Name	Function
15	0120	EMGP	Emergency stop status	0: Emergency stop input OFF 1: Emergency stop input ON This bit indicates the status of the dedicated emergency stop port.
14	0121	MPUV	Motor voltage low status	0: Normal 1: Motor drive source cut off This bit will turn 1 when the motor drive-source cutoff terminal is released, upon which the controller will switch to the emergency stop mode.
13	0122	RMDS	Operation mode status	0: AUTO mode 1: MANU mode This bit is 1 (MANU) when the operation mode switch is set to MANU on a model equipped with an operation mode switch or the "operation mode bit" in the expansion device control register is set to MANU. It will become 0 (AUTO) only when both the operation mode switch and operation mode bit are set to AUTO. On a model not equipped with an operation mode switch, this bit is always 1 (MANU).
12	0123	---	Reserved	
11	0124	GHMS	Homing status	0: Normal 1: Homing This bit remains 1 while homing is in progress following a homing command. When the homing is completed or interrupted in the middle, this bit will turn 0.

Bit	Status address (H)	Symbol	Name	Function
10	0125	PUSH	Push-motion operation in progress	0: Normal 1: Push-motion operation in progress This bit remains 1 while push-motion operation is in progress (the actuator is inside the push-motion range, excluding the approach range) following a push-motion operation command. This bit will turn 0 in any of the following conditions: 1. The actuator has missed the work. 2. The actuator has paused. 3. The next movement command has been issued. 4. The servo has turned OFF.
9	0126	PSNS	Excitation detection status	0: Excitation detection not yet complete 1: Excitation detection complete PCON, ERC 2 Series controllers perform excitation detection at the first servo ON command received after the controller has started. This bit remains 0 if the excitation detection has failed. Even after a successful detection, the bit will return to 0 when a software reset is performed. ACON Series controllers perform pole sensing at the first servo ON command received after the controller has started. On SCON Series controllers, this bit is always 0.
8	0127	PMSS	PIO/Modbus switching status	0: PIO commands enabled 1: PIO command disabled This bit indicates the read-back status of the “PIO/Modbus switching specification bit” in the expansion device control register.
7	0128	---	Reserved	
6	0129	POSW	Position-data static memory write completion status	0: Writing 1: Writing complete This bit will turn 0 when a position-data write command is issued via the “position-data static memory write command bit” in the expansion device control register. Once the writing is completed, the bit will turn 1. This bit is 1 when the controller is first started.
5	012A	MOVE	Moving signal	0: Stopped 1: Moving This bit indicates whether or not the actuator is moving (conditions during homing and push-motion operation included). This bit remains 0 while the actuator is paused.
4	012B	---	Reserved	
3	012C	---	Reserved	
2	012D	---	Reserved	
1	012E	---	Reserved	
0	012F	---	Reserved	

3.9 System Status Query <<STAT>>

3.9.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' '8,'	System status register
Number of registers (H)	4	'0,' '0,' '0,' '2,'	Call register Nos. 9008 and 9009.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Internal operating statuses of the controller are called using a bit pattern.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.9.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Internal controller status
Number of data bytes (H)	2	'0,' '4'	Call two registers (Four bytes).
Data (H)	8	System status	System status (hex)
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

Details of data (System status = 32-bit area)

Bit	Status address	Name	Function
17	ASOF	Auto servo OFF	0: Normal 1: Auto servo OFF If the "Auto servo OFF delay time" parameter is set, this bit will turn 1 when the servo is turned OFF automatically after elapse of the specified time following the completion of positioning.
16	AEEP	EEPROM accessed	0: Normal 1: EEPROM being accessed This bit will turn 1 when the controller accesses the EEPROM to read or write the parameter position table, etc. This bit will turn 0 when the access is completed or a timeout error occurs.
4	RMDS	Operation mode status	0: AUTO mode 1: MANU mode This bit is 1 (MANU) when the operation mode switch is set to MANU on a model equipped with an operation mode switch or the "operation mode bit" in the expansion device control register is set to MANU. It will become 0 (AUTO) only when both the operation mode switch and operation mode bit are set to AUTO. On a model not equipped with an operation mode switch, this bit is always 1 (MANU).
3	HEND	Homing completion status	0: Homing not yet complete 1: Homing complete This bit indicates the homing completion status. Normally this bit is 0 when the controller is started. On a model equipped with an absolute encoder, the bit is 1 when the controller is started, if an absolute reset has already completed. If an absolute position command is issued while this bit is 0, an alarm will generate.

Bit	Status address	Name	Function
2	SV	Servo status	0: Servo OFF 1: Servo ON This bit indicates the ON status of the actual servo. This bit will remain 0 after a servo ON command is received until the time specified by the “Servo ON delay time” parameter elapses. If the servo cannot be turned ON for some reason after a servo ON command is received, this bit will remain 0. The controller does not accept any movement command while this bit is 0.
1	SON	Servo command status	0: Servo OFF 1: Servo ON This bit indicates the servo ON/OFF command status. This bit will turn 1 when the following conditions are met: • The EMG status bit in device status register 1 is 0. • The major failure status bit in device status register 1 is 0. • The enable status bit in device status register 2 is 1. • The auto servo OFF status in the system status register is 0.
0	MPOW	Drive source ON	0: Drive source cut off 1: Normal This bit will turn 0 when the motor drive-source cutoff terminal is released.

3.10 Current Speed Monitor <<VNOW>>

3.10.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' 'A,'	Current speed monitor
Number of registers (H)	4	'0,' '0,' '0,' '2,'	Call register Nos. 900A and 900B.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
This monitored data of actual motor speed is indicated. The value becomes positive or negative depending on the operating direction of the motor, and is indicated in units of 0.01 mm/sec.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.10.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '4'	Call two registers (four bytes).
Data (H)	8	Current speed	Current speed (hex) Indicated in units of 0.01 mm/sec.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

Sample response message (Axis No. 0)

: 010304000026FCD6 [CR] [LF]

The current position is "000026FC" → Converted to a decimal value → 9980 (x 0.01 mm)

The value of the current speed monitor register is 99.8 mm/sec.

3.11 Current Ampere Monitor <<CNOW>>

3.11.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' 'C,'	Current ampere monitor
Number of registers (H)	4	'0,' '0,' '0,' '2,'	Call register Nos. 900C and 900D.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
The motored data of motor current is indicated in mA.
The torque current command value is stored.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.11.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '4'	Call two registers (four bytes).
Data (H)	8	Motor current monitor	Motor current monitor (hex) Indicated in mA.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

Sample response message (Axis No. 0)
: 010304000001C82F [CR] [LF]
The motor current is "000001C8" → Converted to a decimal value → 456 (mA)
The value of the current ampere monitor register is 456 mA.

3.12 Deviation Monitor <<DEVI>>

3.12.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '0,' 'E,'	Deviation monitor
Number of registers (H)	4	'0,' '0,' '0,' '2,'	Call register Nos. 900E and 900F.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
The deviation over a 1-ms period between the position command value and the feedback value (actual position), is stored in pulses. The number of pulses per one motor revolution in mechanical angle varies depending on the encoder used.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.12.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '4'	Call two registers (four bytes).
Data (H)	8	Deviation monitor	Deviation monitor (hex) Indicated in pulses.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

Sample response message (Axis No. 0)

: 0103040000008375 [CR] [LF]

The motor current is "00000083" → Converted to a decimal value → 131 (pulse)

The deviation over a 1-ms period between the position command value and the feedback value (actual position) is 131 pulses.

3.13 System Timer Query <<STIM>>

3.13.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '1,' '0,'	System timer
Number of registers (H)	4	'0,' '0,' '0,' '2,'	Call register Nos. 9010 and 9011.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
The total time since the controller power was turned on is stored in msec. This value is not cleared after a software reset.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.13.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '4'	Call two registers (four bytes).
Data (H)	8	System timer	System timer (hex) Indicated in msec.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	19		

Sample response message (Axis No. 0)

: 0103040238C0946A [CR] [LF]

The system timer value is "0238C094" → Converted to a decimal value → 37273748 (msec)

The total time since the controller power was turned on is 10.3538 hours.

3.14 Special Input Port Query <<SIPM>>

3.14.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '1,' '2,'	Special input port monitor
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9012 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Input ports other than normal DI inputs can be monitored.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.14.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Special port monitor	Refer to the list below.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Special port register = 16-bit area)

Bit	Status address (H)	Symbol	Name	Function
15	0170	---	Reserved	
14	0171	NP	Command pulse NP signal status	This bit indicates the status of the command pulse NP signal.
13	0172	---	Reserved	
12	0173	PP	Command pulse PP signal status	This bit indicates the status of the command pulse PP signal.
11	0174	---	Reserved	
10	0175	---	Reserved	
9	0176	PTSW	Port switch monitor	0: OFF 1: ON On a model equipped with a port switch, this bit indicates the status of this switch. On a model equipped with a SIO-connector installation/removal detection function, this bit indicates the installation/removal status of a tool. This bit is always 0 on any other model.
8	0177	MDSW	Mode switch status	0: AUTO mode 1: MANU mode On a model equipped with an operation mode switch, this bit indicates the status of this switch. It is always 1 on any other model.
7	0178	ENBL	Enable switch monitor	0: DISABLE 1: ENABLE On a model equipped with an enable function, this bit indicates the status of this switch if an enable-switch installed tool is connected. It is always 1 on any other model.

Bit	Status address (H)	Symbol	Name	Function
6	0179	---	Reserved	
5	017A	---	Reserved	
4	017B	---	Reserved	
3	017C	HMCK	Home-check sensor monitor	0: Sensor OFF 1: Sensor ON On a model equipped with a home-check sensor function, this bit indicates the status of sensor input. It is always 0 on any other model.
2	017D	OT	Overtravel sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the overtravel sensor signal in the encoder connector. It is always 0 on a model not equipped with an overtravel sensor.
1	017E	CREP	Creep sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the creep sensor signal in the encoder connector. It is always 0 on a model not equipped with a creep sensor.
0	017F	LS	Limit sensor	0: Sensor OFF 1: Sensor ON This bit indicates the status of the limit sensor signal in the encoder connector. It is always 0 on a model not equipped with a limit sensor.

3.15 Zone Status Query <<ZONS>>

3.15.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '1,' '3,'	Zone status query
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9013 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Zone output statuses can be monitored.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.15.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Zone status	Refer to the list below.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Zone status register = 16-bit area)

Bit	Status address (H)	Symbol	Name	Function
15	0140	---	Reserved	
14	0141	LS2	Limit sensor output monitor 2	0: Out of range 1: In range The position away from the target position for position No. 2 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
13	0142	LS1	Limit sensor output monitor 1	0: Out of range 1: In range The position away from the target position for position No. 1 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.

Bit	Status address (H)	Symbol	Name	Function
12	0143	LS0	Limit sensor output monitor 0	0: Out of range 1: In range The position away from the target position for position No. 0 by the in-position band in the negative direction represents the negative boundary, while the position away from the target position by the in-position band in the positive direction represents the negative boundary. This bit remains 1 while the current position is within these boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
11	0144	---	Reserved	
10	0145	---	Reserved	
9	0146	---	Reserved	
8	0147	ZP	Position zone output monitor	0: Out of range 1: In range If individual zone boundaries are set for a position command, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range. The zone will be reset when the next movement command is issued.
7	0148	---	Reserved	
6	0149	---	Reserved	
5	014A	---	Reserved	
4	014B	---	Reserved	
3	014C	---	Reserved	
2	014D	---	Reserved	
1	014E	Z2	Zone output monitor 2	0: Out of range 1: In range If the zone boundary 2 parameters are set, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.
0	014F	Z1	Zone output monitor 1	0: Out of range 1: In range If the zone boundary 1 parameters are set, this bit remains 1 while the current position is within the specified boundaries. This bit becomes effective upon completion of homing. It remains effective even while the servo is OFF, and will turn 0 once the current position exits the range.

3.16 Completed Position Number Query <<POSS>>

3.16.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Start address (H)	4	'9,' '0,' '1,' '4,'	Position number status
Number of registers (H)	4	'0,' '0,' '0,' '1,'	Call register No. 9014 only.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Completed position numbers can be monitored.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

3.16.2 Response Format

A response message contains 16 bits (2 bytes) of data per holding register.

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [Slave address].
Function code (H)	2	'0,' '3'	Read Holding Registers
Number of data bytes (H)	2	'0,' '2'	Call one register (two bytes).
Data (H)	4	Position number status	Refer to the list below.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	15		

Details of data (Completed position number status register = 16-bit area)

Bit	Status address (H)	Symbol	Name	Function
15	0130	---	Reserved	
14	0131	---	Reserved	
13	0132	---	Reserved	
12	0133	---	Reserved	
11	0134	---	Reserved	
10	0135	---	Reserved	
9	0136	---	Reserved	
8	0137	PM256	Completed position number status bit 256	These bits indicate completed positions in binary codes. When the actuator moves to the target position and enters the in-position band as a result of a positioning command, the applicable bit will turn 1. Although the bit that has turned 1 will change to 0 once the servo turns OFF, the bit will turn 1 again if the actuator is still inside the in-position band of the applicable command position data when the servo is turned ON subsequently. These bits will also turn 1 if the push judgment signal turns ON, or the actuator misses the work, during push-motion operation.
7	0138	PM128	Completed position number status bit 128	
6	0139	PM64	Completed position number status bit 64	
5	013A	PM32	Completed position number status bit 32	
4	013B	PM16	Completed position number status bit 16	
3	013C	PM8	Completed position number status bit 8	
2	013D	PM4	Completed position number status bit 4	
1	013E	PM2	Completed position number status bit 2	
0	013F	PM1	Completed position number status bit 1	

4. Queries Using Function Code 05H (Force Single Coil)

4.1 Basic Query/Response Structures

4.1.1 Function

Change the status of a given DO (Discrete Output) in a slave to ON or OFF (= write ON/OFF to the DO). If this function is broadcast, the coil at the same address will be rewritten in all slaves.

4.1.2 Query Format

In a query message, specify the address of the coil to be changed, and new status (ON/OFF). If the new data is FFH, 00H, the ON status is specified. If the new data is 00H, 00H, the OFF status is specified. Any other data is invalid and does not initiate a change operation.

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	':'	1	
Slave address (H)	Arbitrary	2	[1] Axis number + 1 (01H to 10H) [2] 00H, if broadcast.
Function code (H)	'0,' '5'	2	Force Single Coil
Start address (H)	Arbitrary	4	Refer to "Start address List."
New data (H)	Arbitrary	4	[1] ON specification: FFH, 00H [2] OFF specification: 00H, 00H
Error check (H)	LRC calculation result	2	
Trailer	CR/LF	2	
Total bytes		17	

4.1.3 Start Address List

Start address (H)	Symbol	Function
0401	SFTY	Safety speed command
0403	SON	Servo ON command
0407	ALRS	Alarm reset command
0408	BKRL	Brake forced-release command
040A	STP	Pause command
040B	HOME	Homing command
040C	CSTR	Positioning start command
0411	JISL	Jog/inch switching
0414	MOD	Teaching mode command
0415	TEAC	Position data load command
0416	JOG+	Jog+ command
0417	JOG-	Jog- command
0418	ST7	Start position 7 (solenoid valve mode)
0419	ST6	Start position 6 (solenoid valve mode)
041A	ST5	Start position 5 (solenoid valve mode)
041B	ST4	Start position 4 (solenoid valve mode)
041C	ST3	Start position 3 (solenoid valve mode)
041D	ST2	Start position 2 (solenoid valve mode)
041E	ST1	Start position 1 (solenoid valve mode)
041F	ST0	Start position 0 (solenoid valve mode)
0427	PMSL	PIO/Modbus switching specification
042C	STOP	Deceleration stop

All addresses indicate coil addresses of the following Modbus status registers that can be accessed at the bit level.

0400H to 040FH: Device control register 1
(DRG1)
0410H to 041FH: Device control register 2
(DRG2)
0420H to 042FH: Expansion device register
(DRGE)

4.1.4 Response

If the change was successful, the response message will be the same as the query.

The following pages explain the query/response formats based on respective addresses, as well as the applicable data functions/specifications and other items.

4.2 Safety Speed Enable/Disable Switching <<SFTY>>

4.2.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' '1,'	Safety speed command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Enable/disable the speed specified by user parameter No. 35, "Safety speed." Enabling the safety speed in the MANU mode will limit the speeds of all movement commands.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Specify whether to enable or disable the safety speed.
Enable safety speed: 'F,' 'F,' '0,' '0'
Disable safety speed: '0,' '0,' '0,' '0'

4.2.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.3 Servo ON/OFF (Old q Command) <<SON>>

4.3.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' '3,'	Servo ON/OFF command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Control ON/OFF of the servo.
When "Servo ON" is specified by the new data, the servo will turn ON after elapse of the manufacturer parameter "Servo ON delay time." However, the following conditions must be satisfied:
- The EMG status bit in device status register 1 is 0.
- The major failure status bit in device status register 1 is 0.
- The enable status bit in device status register 2 is 1.
- The auto servo OFF status in the system status register is 0.

[2] [Slave address]
Axis number + 1 (01H to 10H)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Specify whether to turn the servo ON or OFF.
Servo ON: 'F,' 'F,' '0,' '0'
Servo OFF: '0,' '0,' '0,' '0'

[4] [Other note]
If a teaching pendant or PC software is connected, the servo is turned OFF, and then the teaching pendant/PC software is removed, all before the control establishes communication with the host, the servo cannot be turned ON/OFF via commands received from with the host.
In this case, restore the controller power, or make sure the connected tool is removed while the servo is ON.

4.3.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.4 Alarm Reset (Similar to Old r, d Commands) <<ALRS>>

4.4.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' '7,'	Alarm reset command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
When the "Normal" → "Execute alarm reset" edge of the new data is detected, alarms that are presently detected will be reset. If any alarm remains unresolved (its cause has not been removed), the same alarm will generate again. If this command is detected while the actuator is paused, the remaining travel will be cancelled.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Execute alarm reset: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

4.4.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.4.3 Sample "Alarm Reset" Query/Response (Sent to Axis No. 0 Controller)

- Query sent: 01050407FF00F0 [CR] [LF]
- Response received: 01050407FF00F0 [CR] [LF]

4.5 Brake Forced Release <<BKRL>>

4.5.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' '8,'	Brake forced-release command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Brake control is linked to servo ON/OFF. When "Forcibly release brake" is specified by the new data, the brake will be forcibly released even when the servo is ON.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Forcibly release brake: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

[4] [Other note]
If a teaching pendant or PC software is connected, the servo is turned OFF, and then the teaching pendant/PC software is removed, all before the control establishes communication with the host, the servo cannot be turned ON/OFF via commands received from with the host.
In this case, restore the controller power, or make sure the connected tool is removed while the servo is ON.

4.5.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.6 Pause <<STP>>

4.6.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' 'A,'	Pause command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]

- While "Pause command" is specified in the new data, all motor movement is inhibited.
- If the data is changed to "Pause command" while the actuator is moving, the actuator will decelerate to a stop. When the data is set to "Normal" again thereafter, the actuator will resume the remaining travel.
- If the alarm reset command bit is set while the actuator is paused, the remaining travel will be cancelled.
- The current limiting value during pause corresponds to the value set by the moving-current limiting value (DPOW) parameter during normal positioning operation or during approach operation as part of push-motion operation. (*1) During operation inside the push range, the push-current limiting value (PPOW) is used.
- If this bit is set during homing, the movement command will be held if the actuator has not yet reversed after contacting the mechanical end. If the actuator has already reversed after contacting the mechanical end, homing will be repeated from the beginning.

  *1 On PCON and ERC2 controllers, the current limiting value during pause corresponds to the standstill-current limiting value (SPOW) if the stationary mode is set to a value other than 4 (full servo control).

[2] [Slave address]

Axis number + 1 (01H to 10H; 00H if this function is broadcast)

Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]

Pause command: 'F,' 'F,' '0,' '0'

Normal: '0,' '0,' '0,' '0'

4.6.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.7 Homing (Old o Command) <<HOME>>

4.7.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' 'B,'	Homing command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Homing operation will start upon detection of the "Normal" → "Homing command" edge of the new data. Once the homing is completed, the HEND bit will turn 1. This command can be input as many times as desired even after homing has been completed once.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Homing operation will start upon detection of the "Normal" → "Homing command" edge of this data.
Homing command: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

[4] [Other note]
The servo must be ON before a homing command is issued.
If a teaching pendant or PC software is connected, the servo is turned OFF, and then the teaching pendant/PC software is removed, all before the control establishes communication with the host, the servo cannot be turned ON/OFF via commands received from with the host.
In this case, restore the controller power, or make sure the connected tool is removed while the servo is ON.

4.7.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.7.3 Sample "Homing" Query/Response (Sent to Axis No. 0 Controller)

Query sent: 0105040BFF00EC [CR] [LF]
Response received: 0105040BFF00EC [CR] [LF]

4.8 Positioning Start Command <<CSTR>>

4.8.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '0,' 'C,'	Positioning Start Command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
Upon detection of "Normal" → "Position start command" edge of the new data, the target position number will be read by the position number specification register and the actuator will move to the target position of the corresponding position data. If the new data remains "Position start command," a completed position will not be output even when the actuator enters the in-position band.
If this command is executed when homing has never been performed after the power was turned on (when the HEND bit is 0), the actuator will perform homing and then start moving to the target position. The target position, speed and other operation parameters must be already set in the position table (nonvolatile memory) of the controller before this command is issued.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Position start command: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

4.8.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.9 Jog/Inch Switching <<JISL>>

4.9.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '1,' '1,'	Jog/Inch Switching
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
If this bit switches while the actuator is jogging, the actuator will decelerate to a stop.
If this bit switches while the actuator is inching, the inching movement will continue.
Jog/inch switching by this bit is not reflected in the jogging/inching operation initiated by a tool.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Inching in accordance with JOG+/JOG- bits: 'F,' 'F,' '0,' '0'
Jogging in accordance with JOG+/JOG- bits: '0,' '0,' '0,' '0'

4.9.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.10 Teaching Mode Command <<MOD>>

4.10.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '1,' '4,'	Switch between the normal mode and the teaching mode
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
When the new data is set to 'F,' 'F,' '0,' '0' (ON), the controller will switch to the teaching mode.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Teaching mode (ON): 'F,' 'F,' '0,' '0'
Normal operation mode (OFF): '0,' '0,' '0,' '0'

4.10.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.11 Position Data Load Command <<TEAC>>

4.11.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '1,' '5,'	Position data load command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
If this command was sent with the new data set to 'F,' 'F,' '0,' '0' when the teaching mode command (MOD: Address No. 0414) in 4.10 was set to 'F,' 'F,' '0,' '0' (teaching mode), and thereafter the controller has recognized the command continuously for 20 msec or more, the current position data will be written in the target position field under the position number specified by the position number specification register when the aforementioned condition was detected.
If other position data fields are empty, the default parameter values will be written at the same time in the empty fields other than the target position (in-position band INP, speed VCMD, acceleration/deceleration ACMD, and control flag CTLF).

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Position data load command: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

4.11.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.12 Jog+ Command <<JOG+>>

4.12.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '1,' '6,'	Jog+ command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]

- Jog+ operation command (direction opposite home)
  If this query is sent with the new data set to 'F,' 'F,' '0,' '0' when the jog/inch switching command (JISL: Address No. 0411) in 4.9 is set to '0,' '0,' '0,' '0' (jog), the actuator will jog in the direction opposite home. The speed and acceleration/deceleration conform to the PIO jog speed set by user parameter No. 26 and rated acceleration/deceleration (varies depending on the actuator), respectively.
- How to stop jog+ operation
  While the actuator is moving, send this query with the new data set to '0,' '0,' '0,' '0' or send the jog- command (JOG-: Address No. 0417) in 4.13 with the new data set to 'F,' 'F,' '0,' '0,' and the actuator will decelerate to a stop.
- Inching
  If this query is sent by switching the data from '0,' '0,' '0,' '0' to 'F,' 'F,' '0,' '0' while the jog/inch switching command (JISL: Address No. 0411) in 4.9 is 'F,' 'F,' '0,' '0' (inch), the actuator will inch in the direction opposite home. The speed, travel and acceleration/deceleration conform to the PIO jog speed set by user parameter No. 26, user parameter No. 48 (PIO inching distance), and rated acceleration/deceleration (varies depending on the actuator), respectively.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Jog+ command: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

4.12.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.13 Jog- Command <<JOG->>

4.13.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '1,' '7,'	Jog- command
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]

- Jog- operation command (direction of home)
  When this query is sent with the new data set to 'F,' 'F,' '0,' '0' when the jog/inch switching command (JISL: Address No. 0411) in 4.9 is set to '0,' '0,' '0,' '0' (jog), the actuator will jog in the direction of home. The speed and acceleration/deceleration conform to the PIO jog speed set by user parameter No. 26 and rated acceleration/deceleration (varies depending on the actuator), respectively.
- How to stop jog- operation
  While the actuator is moving, send this query with the new data set to '0,' '0,' '0,' '0' or send the jog+ command (JOG+: Address No. 0416) in 4.12 with the new data set to 'F,' 'F,' '0,' '0,' and the actuator will decelerate to a stop.
- Inching
  When this query is sent by switching the data from '0,' '0,' '0,' '0' to 'F,' 'F,' '0,' '0' while the jog/inch switching command (JISL: Address No. 0411) in 4.9 is 'F,' 'F,' '0,' '0' (inch), the actuator will inch in the direction of home. The speed, travel and acceleration/deceleration conform to the PIO jog speed set by user parameter No. 26, user parameter No. 48 (PIO inching distance), and rated acceleration/deceleration (varies depending on the actuator), respectively.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
Jog- command: 'F,' 'F,' '0,' '0'
Normal: '0,' '0,' '0,' '0'

4.13.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.14 Start Position 0 to 7 <<ST0 to ST7>> (Limited to PIO Pattern: Solenoid Valve Mode)

4.14.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	Arbitrary	Refer to [3], [Start code].
New data (H)	4	Arbitrary	Refer to [4], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]

- Condition for this query to become effective
  This query is effective only when the solenoid valve mode is selected as the PIO pattern (parameter No. 25).
  Position number specification uses ST0 to ST7 (refer to "Start address"). Since the available positions depend on the number of positions provided in the solenoid valve mode selected by the PIO pattern in each controller, performing any operation involving a non-specifiable position will generate a "085: Moving position number error" will generate.
- Operation types of this query
  Either level operation or edge operation can be selected using user parameter No. 27, "Movement command type."

[2] [Slave address]

Axis number + 1 (01H to 10H; 00H if this function is broadcast)

Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [Start address]

Address	Symbol	Name	Function
0418	ST7	Start position 7	Move to position 7.
0419	ST6	Start position 6	Move to position 6.
041A	ST5	Start position 5	Move to position 5.
041B	ST4	Start position 4	Move to position 4.
041C	ST3	Start position 3	Move to position 3.
041D	ST2	Start position 2	Move to position 2.
041E	ST1	Start position 1	Move to position 1.
041F	ST0	Start position 0	Move to position 0.

[4] [New data]

- Actuator operation command ON: 'F,' 'F,' '0,' '0'
- Actuator operation command OFF: '0,' '0,' '0,' '0'
- Operation will start upon operation command OFF → ON.
- When user parameter No. 27, "Movement command type" is set to "Level operation," the actuator will decelerate to a stop upon ON → OFF.

4.14.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.14.3 Example of Operation

- Controller: PCON-C (Axis No. 0)
- Parameter No. 25 (PIO pattern 5: Solenoid valve mode 2; Number of positions 3) setting
- Position data settings

No	位置 [mm]	速度 [mm/s]	加速度 [G]	減速度 [G]
0	0.00	533.00	0.30	0.30
1	25.00	533.00	0.30	0.30
2	50.00	533.00	0.30	0.30

- Addresses (Refer to the start codes ST0 to ST7)

- Sample command to move to position No. 2
  Query sent: 0105041DFF00DA [CR] [LF]
  Response received: 0105041DFF00DA [CR] [LF]
- Sample command to move to position No. 1
  Query sent: 0105041EFF00D9 [CR] [LF]
  Response received: 0105041EFF00D9 [CR] [LF]
- Sample command to move to position No. 0
  Query sent: 0105041FFF00D8 [CR] [LF]
  Response received: 0105041FFF00D8 [CR] [LF]
  (Operation will start when the ON/OFF specification data changes from ‘0,’ ‘0,’ ‘0,’ ‘0’ to ‘F,’ ‘F,’ ‘0,’ ‘0.’)

4.15 PIO/Modbus Switching Setting <<PMSL>>

4.15.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '2,' '7,'	PIO/Modbus switching setting
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
PIO external command signals can be enabled or disabled.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
- Enable PIO commands (ON): 'F,' 'F,' '0,' '0'
  External PIO signals are given the right to change the I/O signals (inputs) selected by parameter No. 25, "PIO pattern."
- Disable PIO commands (OFF): '0,' '0,' '0,' '0'
  The right to change the I/O signal data selected by parameter No. 25, "PIO pattern" returns to Modbus.

Tip If the right to change is switched from PIOs to Modbus, the aforementioned registers will take over the PIO values.
If the right to change is switched from Modbus to PIOs, the registers will be refreshed with the PIO values, but edge detection will not occur at the time of switching.

[4] [Note]

- On a model equipped with an operation mode switch, “Enable PIO commands” will be specified when the switch is set to the AUTO mode, or “Disable PIO commands” will be specified when the switch is set to the MANU mode.
- On a non-PIO model, the default setting is “Disable PIO commands.”
- If IAI’s tool (teaching pendant or PC software) is connected, “Teaching modes 1, 2” and “Monitor modes 1, 2” are available as tool modes. The correspondence of these modes and PIO enable/disable specifications are as follows:

  “Monitor modes 1, 2” → “Enable PIO commands”
  “Teaching modes 1, 2” → “Disable PIO commands”

4.15.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

4.16 Deceleration Stop <<STOP>>

4.16.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '5'	Force Single Coil
Start address (H)	4	'0,' '4,' '2,' 'C,'	Deceleration stop setting
New data (H)	4	Arbitrary	Refer to [3], [New data].
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
The actuator will start decelerating to a stop upon detection of the "Normal" → "Deceleration stop command" edge of the new data.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

[3] [New data]
- Deceleration stop command (ON): 'F,' 'F,' '0,' '0'
  Tip Once the actuator starts decelerating, these bits will be reset to 0 by the controller.
- Normal (OFF): '0,' '0,' '0,' '0'

4.16.2 Response

If the change was successful, the response message will be the same as the query.
If invalid data was sent, an exception response (refer to p. 156) will be returned, or no response will be returned.

5. Queries Using Function Code 06H (Preset Single Register)

5.1 Movement by Position Number Specification <<POSR>>

5.1.1 Query Format

Field	Number of characters	ASCII mode character string (fixed)	Remarks
Header	1	':'	
Slave address (H)	2	Arbitrary	Refer to [2], [Slave address].
Function code (H)	2	'0,' '6'	Preset Single Registers
Start address (H)	4	'9,' '8,' '0,' '0,'	Position command number status
New data (H)	4	Arbitrary	A position number is input as a hexadecimal value.
Error check (H) LRC	2	In accordance with the calculation result	
Trailer	2	'CR,' 'LF'	
Total bytes	17		

[1] [Function]
To move the actuator via position number specification, write applicable data in this register. The actuator will start moving the moment this register is written, so there is no need to operate the positioning start specification bit (CSTR) in the device control register.
If a command is issued when the actuator has not yet completed homing, the actuator will complete homing first, and then start moving to the specified position. The maximum position number that can be specified varies depending on the controller model and the PIO pattern currently specified.
If this query is broadcast, all slave axes can be moved to the same position number.

[2] [Slave address]
Axis number + 1 (01H to 10H; 00H if this function is broadcast)
Example) If the axis number of the sender is 09H, the slave address becomes 09H + 01H = 0AH, where the input value is '0,' 'A.'

5.1.2 Response Format

If the change was successful, the response message will be the same as the query.
If invalid data was sent, no response message will be returned.

5.1.3 Sample Response Message (Sent to Axis No. 0 Controller)

- Query: 01069800000160 [CR] [LF] (Command to move to position No. 1)
- Response: 01069800000160 [CR] [LF]

6. Queries Using Function Code 10H (Preset Multiple Registers)

This chapter explains numerical commands where values are input directly to Modbus register addresses 9900H to 9908H, as well as writing of data to position table information addresses 1000H to 3FFFH.

6.1 Basic Query/Response Structures of Numerical Movement Commands

6.1.1 Function

Specify the target position in PTP positioning operation using absolute coordinates. A numerical movement command can be issued to the actuator by rewriting the registers shown in 6.1.4, “Start Address List” (addresses 9900H to 9908EH) (all registers can be sent in one message).
Values of all registers, other than the control flag specification register (address: 9908H), will become effective once the values are sent. If there is no need to change the target position, in-position band, speed, acceleration/deceleration, push-current limiting value and control specification, therefore, each subsequent numerical movement command can be issued simply by writing a desired register that can effect an actual movement command based on changing of the applicable register alone (refer to “Start Address List”).

6.1.2 Query Format

In the query format, specify the address of the first holding register to be changed (refer to “Start Address List”), number of holding registers to be changed, number of bytes corresponding to new data, and new data.
1 holding register = 2 bytes = 16-bit data

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	‘:’	1	
Slave address (H)	Arbitrary	2	1) Axis number + 1 (01H to 10H) 2) 00H, if broadcast
Function code (H)	‘1,’ ‘0’	2	
Start address (H)	Arbitrary	4	Refer to “Start Address List.”
Number of registers (H)	Arbitrary	4	Refer to “Start Address List.”
Number of bytes (H)	In accordance with the above registers	2	A value corresponding to twice the number of registers specified above is input.
New data 1 (H)		4	Refer to “Start Address List.”
New data 2 (H)		4	Refer to “Start Address List.”
New data 3 (H)		4	Refer to “Start Address List.”
: :		: :	
Error check (H)	LRC check calculation result	2	
Trailer	‘CR,’ ’LF’	2	
Total bytes		256 max.	

6.1.3 Response format

If the change was successful, a response message that is effectively a copy of the query message, except for the byte count and new data, will be returned.

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	‘:’	1	
Slave address (H)	Arbitrary	2	1) Axis number + 1 (01H to 10H) 2) 00H, if broadcast
Function code (H)	‘1,’ ‘0’	2	
Start address (H)	Arbitrary	4	Refer to [4], “Start Address List.”
Number of registers (H)	Arbitrary	4	Refer to [4], “Start Address List.”
Error check (H)	LRC check calculation result	2	
Trailer	‘CR,’ ’LF’	2	
Total bytes		256 max.	

6.1.4 Start Address List

The address list below shows a group of registers that are used to move the actuator by numerically specifying the target position coordinates, in-position band, speed, acceleration/deceleration, push-current limiting vale, control specification flag, etc.
With RC Series controllers, the sizes of send/receive buffers are set to 256 bytes, respectively, in the ASCII mode. Accordingly, a maximum of 61 registers' worth of data consisting of 247 bytes (one register uses four bytes in the ASCII mode), which is 11 bytes (header + slave address + function code + error check + trailer) less than the above 256 bytes, can be queried. In other words, all of the data listed below (total nine registers) can be queried in a single transmission.

Address (H)	Symbol	Name	Sign	Able to effect an actual movement command by changing the applicable register alone	Register size	Byte size	Unit
9900	PCMD	Target position specification register	○	○	2	4	0.01 mm
9902	INP	In-position band specification register	x	x	2	4	0.01 mm
9904	VCMD	Speed specification register	x	○	2	4	0.01 mm/sec
9906	ACMD	Acceleration/deceleration specification register	x	○	1	2	0.01 G
9907	PPOW	Push-current limiting value specification register	x	○	1	2	---
9908	CTLF	Control flag specification register	x	x Initialization after each movement	1	2	---

■ Input value

Value indicated in specified units (decimal value) and bit data

↓

Conversion to hexadecimal

↓

Input value in the query format

■ Target position specification register (PCMD)
This register specifies the target position in PTP positioning operation using absolute coordinates. The value of this register is set in units of 0.01 mm in a range of –999999 to 999999. When a position is specified using absolute coordinates and the specified value exceeds the soft limit set by a parameter, an alarm will generate the moment a movement start command is issued. The actuator will start moving when the lower word of this register (symbol: PCMD, address: 9900H) is rewritten. In other words, a numerical movement command can be issued simply by writing a target position in this register.

■ In-position band register (INP)
This register has two meanings depending on the type of operation. In normal positioning operation, this register specifies the allowable difference between the target position and the current position, which will be used in detecting a completion of positioning operation. In push-motion operation, this register specifies a push-motion band. The value of this register is set in units of 0.01 mm in a range of 0 to 999999. Specify normal operation or push-motion operation using the applicable bit in the control flag specification register as explained later.
Changing this register alone will not start actuator movement.

■ Speed specification register (VCMD)
This register specifies the moving speed. The value of this register is set in units of 0.01 mm/sec in a range of 0 to 999999. If the specified value exceeds the maximum speed set by a parameter, an alarm will generate the moment a movement start command is issued.
The actuator will start moving when this lower word of this register is rewritten. In other words, the speed can be changed while the actuator is moving, simply by rewriting this register.

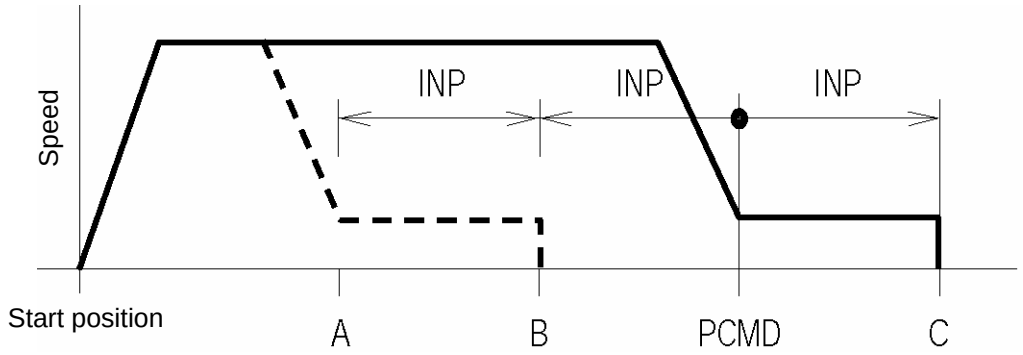
■ Acceleration/deceleration specification register (ACMD)
This register specifies the acceleration or deceleration. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum acceleration or deceleration set by a parameter, an alarm will generate the moment a movement start command is issued.
The actuator will start moving when this register is rewritten. In other words, the acceleration/deceleration can be changed while the actuator is moving, simply by rewriting this register.

■ Push-current limiting value (PPOW)
Set the current limit during push-motion operation in PPOW. The current limiting value is set as one of 256 levels, with FFH representing the maximum current. Due to the actuator limitations, the push-current limiting value should be set in range of 20% to 70% * (33H to B3H). The specific range varies depending on the actuator, so refer to the IAI catalog or operation manual for your actuator.
The actuator will start moving when this register is rewritten. In other words, the current limiting value can be changed during push-motion operation simply by rewriting this register.
Sample push-motion current setting
* When setting the current to 20%
  256 x 0.2 = 51.2 → 33H (converted to a hexadecimal value)

■ Control Flag Specification Register (CTLF)
This parameter consists of the following bit pattern that sets the respective operations.
This register will be overwritten by the default parameter value once the actuator starts moving.

Bit 0 = 0: Fixed
Bit 1 = 0: Normal operation
1: Push-motion operation
Bit 2 = 0: The direction of push-motion operation after completion of approach is defined as the forward direction.
1: The direction of push-motion operation after completion of approach is defined as the reverse direction.

This bit is used to calculate the direction of final stop position from PCMD. If this bit is set incorrectly, therefore, the target position will deviate from the specified position by a distance corresponding to "2 x INP," as shown below.
If bit 1 is set to 0, the setting of this bit is invalid.



Direction of push-motion operation

Bit 3 = 0: Normal operation
1: Incremental operation

Setting this bit to 1 will enable incremental operation.
In incremental operation, the actuator behaves differently between normal operation and push-motion operation (CTLF bit 1).
While the travel is calculated with respect to the target position (PCMD) in normal operation, it is calculated relative to the current position in push-motion operation (when bit 1 = 1).
Here, since relative coordinate calculation involves adding up pulses in mm, followed by conversion, unlike a calculation method involving addition after pulse conversion, "repeated relative movements will not cause position deviation as a result of cumulative errors corresponding to fraction pulses that are not divisible with certain lead settings".

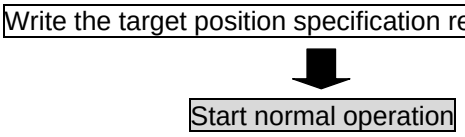
■ Sample register input flow

a) Flow of normal operation 1

Conditions: The operation conditions conform to the default speed, default acceleration/deceleration and default in-position band set by the controller's user parameters. Only the target position is changed to move the actuator.

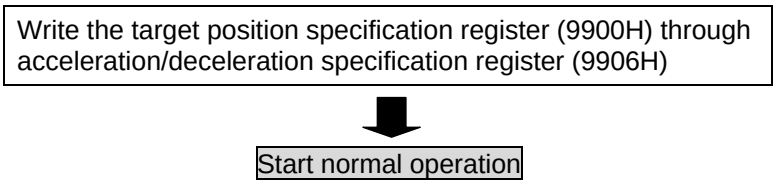
Tip: Controller's user parameters

- Default speed (parameter No. 8) → Maximum speed stated in the IAI's catalog for each actuator
- Default acceleration/deceleration (parameter No. 9) → Rated acceleration/deceleration stated in the IAI's catalog for each actuator
- Default in-position band (parameter No. 10) → Default value = 0.1 mm



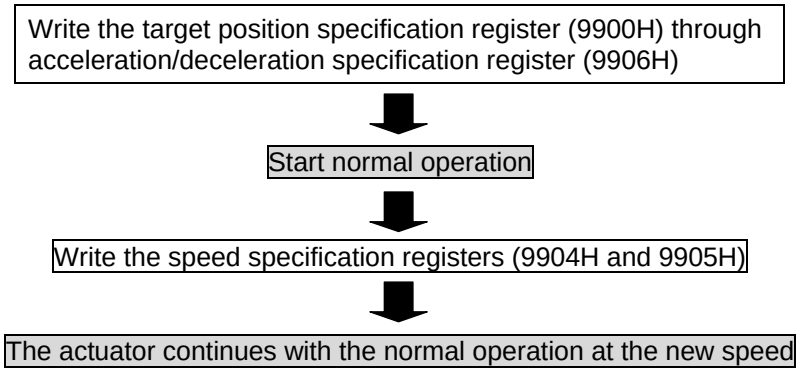
b) Flow of normal operation 2

Conditions: Change the target position, speed and acceleration/deceleration each time the actuator is moved.



c) Flow of normal operation 3

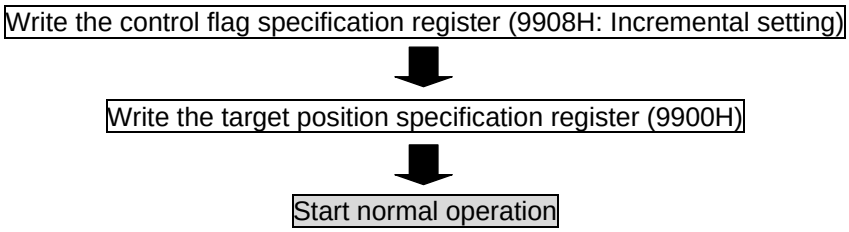
Conditions: Change the target position, speed and acceleration/deceleration each time the actuator is moved, with the actuator speed changed at a given timing during movement.



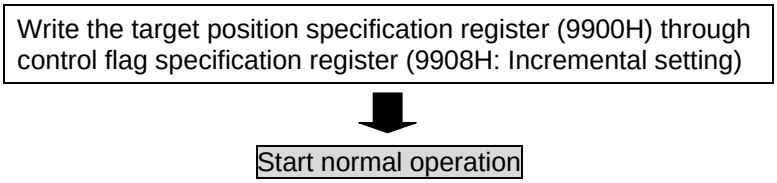
d) Flow of incremental positioning operation 1 (incremental move)

Conditions: The operation conditions conform to the default speed, default acceleration/deceleration and default in-position band set by the controller's user parameters. Only the pitch is changed to move the actuator.

Method 1



Method 2

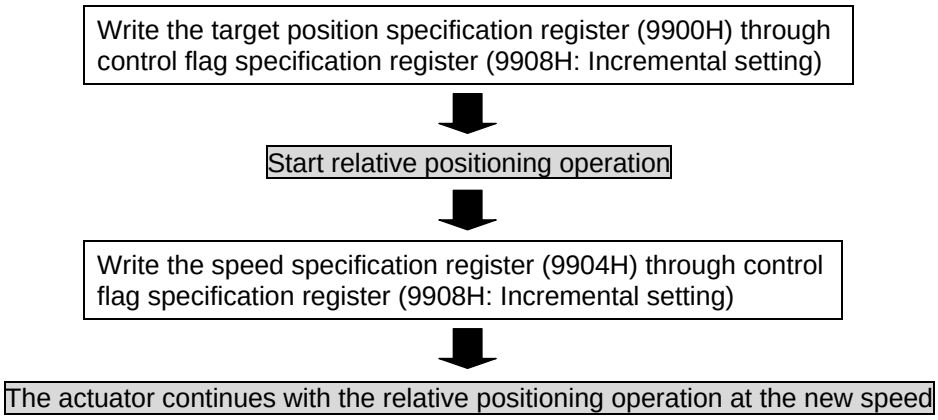


Tip: Addresses 9900H and 9908H alone cannot be changed in a single data transmission. Since addresses must be continuous, you must send two messages to change 9900H and 9908H (method 1), or if you want to change them in a single message transmission, all addresses from 9900H through 9908H must be written (method 2).

If method 2 is to be used, the speed, acceleration/deceleration and in-position band will also be written, which means that the values of user parameter Nos. 8, 9 and 10 will become invalid.

e) Flow of incremental positioning operation 2 (incremental move)

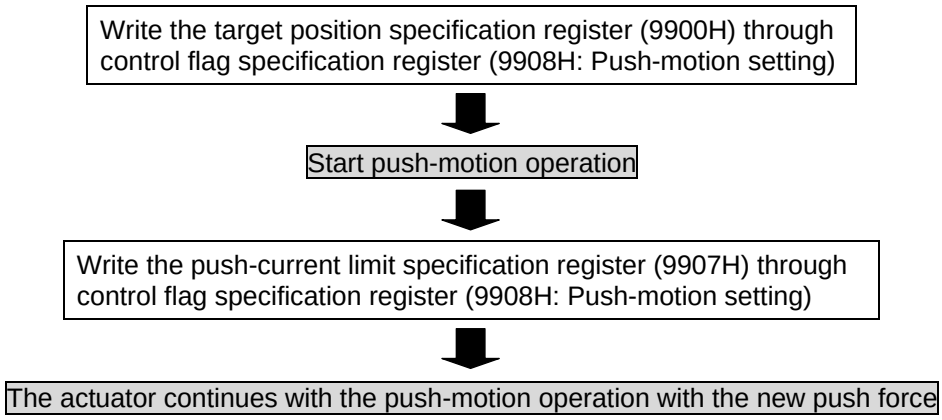
Conditions: Change the target position, speed and acceleration/deceleration each time the actuator is moved, with the actuator speed changed at a given timing during movement.



Tip: Once the actuator starts moving after the control flag specification register (9908H: Incremental setting) has been changed, the register will be reset (the setting will change to 0H: Normal movement). In other words, the control flag specification register (9908H) must be set to the incremental setting and sent again, even if you only wish to change the speed.

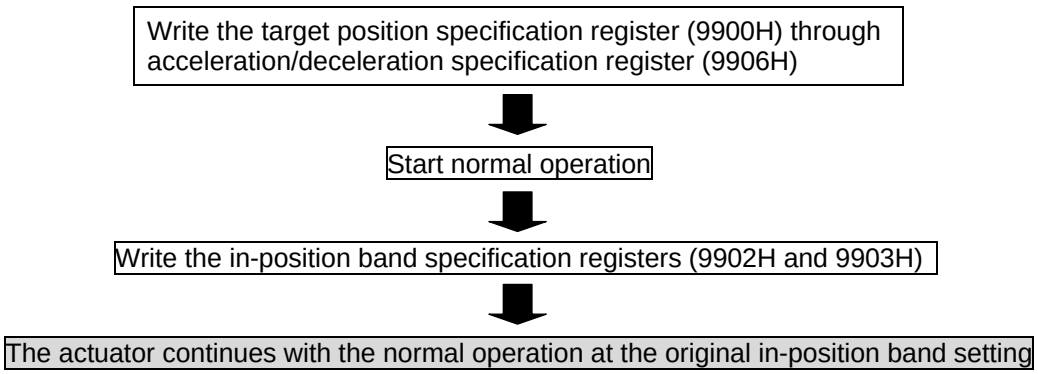
f) Flow of push-motion operation

Conditions: Perform push-motion operation by changing the push force at a desired timing while the actuator is pushing the work.



g) Note

Conditions: Change the target position, speed and acceleration/deceleration each time the actuator is moved, with the in-position band changed at a given timing during movement.



Tip: Changing the in-position band specification registers alone cannot effect an actual movement command.
Therefore, the data changed by writing the in-position band specification registers (9902H and 9903H) will become effective when the next movement command is executed.

6.1.5 Sample Query/Response Formats 1 (Normal Movement)

Axis No. 0

Target position (mm)	In-position band (mm)	Speed (mm/sec)	Acceleration/deceleration (G)	Push (%)	Movement control
50	0.1	100	0.3	0	Normal movement

■ Query sent: 01109900000912000013880000000A00002710001E0000000041 [CR] [LF]
■ Response sent: 0110990000094D [CR] [LF]

■ Details of query message

Field	ASCII mode character string (fixed)	Remarks
Header	':'	
Slave address	'0,' '1'	Axis No. 0 + 1
Function code	'1,' '0'	
Start address	'9,' '9,' '0,' '0'	The start address is the target position specification register 9900H.
Number of registers	'0,' '0,' '0,' '9'	Specify 9900H through 9908H as the addresses to be written.
Number of bytes	'1,' '2'	9 (registers) x 2 = 18 (bytes) → 12H
New data 1, 2 (target position)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'1,' '3,' '8,' '8'	50 (mm) x 100 = 5000 → 1388H
New data 3, 4 (in-position band)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'0,' '0,' '0,' 'A'	0.1 (mm) x 100 = 10 → 000AH
New data 5, 6 (speed)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'2,' '7,' '1,' '0'	100 (mm/sec) x 100 = 10000 → 2710H
New data 7 (acceleration/deceleration)	'0,' '0,' '1,' 'E'	0.3 (G) x 100 = 30 → 001EH
New data 8 (push)	'0,' '0,' '0,' '0'	0 (%) → 0H
New data 9 (control flag)	'0,' '0,' '0,' '0'	All bits are 0, because normal operation is specified. 0000b → 0000H
Error check	'4,' '1'	LRC check calculation result → 41H
Trailer	'CR,' 'LF'	
Total bytes	55	

6.1.6 Sample Query/Response Formats 2 (Incremental Move)

Axis No. 0

Target position (mm)	In-position band (mm)	Speed (mm/sec)	Acceleration/deceleration (G)	Push (%)	Movement control
10	0.1	100	0.3	0	Incremental

■ Query sent: 01109900000912000003E80000000A00002710001E00000008E9 [CR] [LF]
■ Response sent: 0110990000094D [CR] [LF]

■ Details of query message

Field	ASCII mode character string (fixed)	Remarks
Header	':'	
Slave address	'0,' '1'	Axis No. 0 + 1
Function code	'1,' '0'	
Start address	'9,' '9,' '0,' '0'	The start address is the target position specification register 9900H.
Number of registers	'0,' '0,' '0,' '9'	Specify 9900H through 9908H as the addresses to be written.
Number of bytes	'1,' '2'	9 (registers) x 2 = 18 (bytes) → 12H
New data 1, 2 (target position)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'0,' '3,' 'E,' '8'	10 (mm) x 100 = 1000 → 03E8H
New data 3, 4 (in-position band)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'0,' '0,' '0,' 'A'	0.1 (mm) x 100 = 10 → 000AH
New data 5, 6 (speed)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'2,' '7,' '1,' '0'	100 (mm/sec) x 100 = 10000 → 2710H
New data 7 (acceleration/deceleration)	'0,' '0,' '1,' 'E'	0.3 (G) x 100 = 30 → 001EH
New data 8 (push)	'0,' '0,' '0,' '0'	0 (%) → 0H
New data 9 (control flag)	'0,' '0,' '0,' '0'	Bit 3 is 1, because incremental move is specified (incremental setting). 10000b → 0008H
Error check	'E,' '9'	LRC check calculation result → E9H
Trailer	'CR,' 'LF'	
Total bytes	55	

6.2 Basic Query/Response Structures for Writing Position Table Data

6.2.1 Function

Position table data can be changed using this query.
Each time an address specified in “Start Address List” (addresses +0000H through +000EH) is accessed, the applicable data will be read from the EEPROM in units of position data. After having been written, the data will be stored in the EEPROM again.

6.2.2 Query Format

In the query format, specify the address of the first holding register to be changed (refer to “Start Address List”), number of holding registers to be changed, number of bytes corresponding to new data, and new data.
1 holding register = 2 bytes = 16-bit data

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	‘:’	1	
Slave address (H)	Arbitrary	2	1) Axis number + 1 (01H to 10H) 2) 00H, if broadcast
Function code (H)	‘1,’ ‘0’	2	
Start address (H)	Arbitrary	4	Refer to “Start Address List.”
Number of registers (H)	Arbitrary	4	Refer to “Start Address List.”
Number of bytes (H)	In accordance with the above registers	2	A value corresponding to twice the number of registers specified above is input.
New data 1 (H)		4	Refer to “Start Address List.”
New data 2 (H)		4	Refer to “Start Address List.”
New data 3 (H)		4	Refer to “Start Address List.”
: :		: :	
Error check (H)	LRC check calculation result	2	
Trailer	‘CR,’ ’LF’	2	
Total bytes		256 max.	

6.2.3 Response format

If the change was successful, a response message that is effectively a copy of the query message, except for the byte count and new data, will be returned.

Field	ASCII mode character string (fixed)	Number of characters (bytes)	Remarks
Header	':'	1	
Slave address (H)	Arbitrary	2	Axis number + 1 (01H to 10H)
Function code (H)	'1,' '0'	2	
Start address (H)	Arbitrary	4	Refer to "Start Address List."
Number of registers (H)	Arbitrary	4	Refer to "Start Address List."
Error check (H)	LRC check calculation result	2	
Trailer	'CR,' 'LF'	2	
Total bytes		256 max.	

6.2.4 Start Address List

In a query input, each address is calculated using the formula below:

1000H + (16 x Position number) H + Address (Offset) H

Example Change the speed command register for position No. 200
1000H + (16 x 200 = 3200) H + 4H
= 1000H + C80H + 4H
= 1C84H
"1C84" becomes the input value for the start address field of this query.

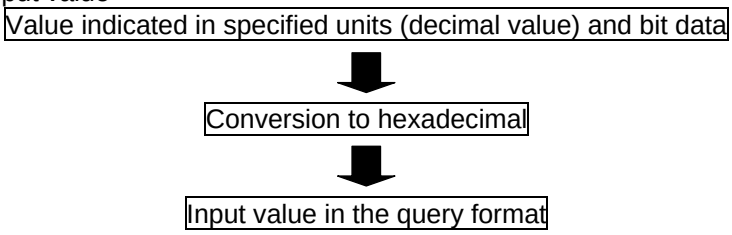
* The maximum position number varies depending on the controller model and the PIO pattern currently specified.

■ Position data change resisters

Address	Symbol	Name	Sign	Register size	Byte size	Input unit
+0000	PCMD	Target position	○	2	4	0.01 mm
+0002	INP	In-position band		2	4	0.01 mm
+0004	VCMD	Speed command		2	4	0.01 mm/sec
+0006	ZNMP	Individual zone boundary +	○	2	4	0.01 mm
+0008	ZNLP	Individual zone boundary -	○	2	4	0.01 mm
+000A	ACMD	Acceleration command		1	2	0.01 G
+000B	DCMD	Deceleration command		1	2	0.01 G
+000C	PPOW	Push-current limiting value		1	2	%
+000D	LPOW	Load current threshold		1	2	%
+000E	CTLF	Control flag specification		1	2	

* Addresses starting with "+" indicate offsets.

■ Input value



The specifications of the above registers are described on the following pages.

■ Target Position (PCMD)
This register specifies the target position using absolute coordinates or by an incremental distance. The value of this register is set in units of 0.01 mm in a range of –999999 to 999999. When a position is specified using absolute coordinates and the specified value exceeds the soft limit set by a parameter, an alarm will generate the moment a movement start command is issued. Specify whether to use absolute coordinates or incremental distance using the applicable bit in the control flag specification register as explained later.

■ In-position Band Specification Register (INP)
This register is used in two different ways depending on the type of operation.
In normal positioning operation, it specifies the allowable difference between the target position and current position to be used in the detection of positioning completion. In push-motion operation, it specifies the push-motion band. The value of this register is set in units of 0.01 mm in a range of 0 to 999999.
Whether the normal operation or push-motion operation is specified by the applicable bit in the control flag specification register as explained later.

■ Speed Specification Register (VCMD)
This register specifies the moving speed in positioning. The value of this register is set in units of 0.01 mm/sec in a range of 0 to 999999. If the specified value exceeds the maximum speed set by a parameter, an alarm will generate the moment a movement start command is issued.

■ Individual Zone Boundaries ± (ZNMP, ZNLP)
These registers output zone signals that are effective only during positioning, separately from the zone boundaries set by parameters.
Set in ZNMP the positive zone signal output boundary expressed using absolute coordinates, and set the negative zone signal output boundary in ZNLP. The corresponding bit in the zone register remains ON while the current position is within these positive and negative boundaries. The value of this register is set in units of 0.01 mm, and in a range of –999999 to 999999 for both registers. However, ZNMP must be greater than ZNLP.
Set the same value in both ZNMP and ZNLP to disable the individual zone output.

■ Acceleration Specification Register (ACMD)
This register specifies the acceleration during positioning. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum acceleration set by a parameter, an alarm will generate the moment a movement start command is issued.

■ Deceleration Specification Register (DCMD)
This register specifies the deceleration during positioning. The value of this register is set in units of 0.01 G in a range of 0 to 300. If the specified value exceeds the maximum deceleration set by a parameter, an alarm will generate the moment a movement start command is issued.

■ Push-current Limiting Value (PPOW)
Set the current limit in push-motion operation in PPOW. The current limiting value is set as one of 256 levels, with FFH representing the maximum current. Due to the actuator limitations, the push-current limiting value should be set in range of 20% to 70% (33H to B3H).

■ Load Output Current Threshold (LPOW)
To perform load output judgment, set the current threshold in LPOW. Set a desired value as one of 256 levels, with FFH representing the maximum current. If load output judgment is not performed, set 0.

■ Control Flag Specification Register (CTLF)

This parameter consists of the following bit pattern that sets the respective operations.

Bit 1 = 0: Normal operation
1: Push-motion operation
Bit 2 = 0: The direction of push-motion operation after completion of approach operation represents the forward direction.
1: The direction of push-motion operation after completion of approach operation represents the reverse direction.
Bit 3 = 0: Normal operation
1: Incremental operation

* All bits whose details are not explained are reserved.

6.2.5 Sample Query/Response Formats 1

Write all data of position No. 12 for axis No. 0 as follows.

Target position (mm)	In-position band (mm)	Speed (mm/sec)	Individual zone boundary+ (mm)	Individual zone boundary- (mm)	Acceleration (G)	Deceleration (G)	Push (%)	Threshold	Movement control
100	0.1	200	60	40	0.01	0.3	0	0	Normal movement

■ Query sent: 011010C0000F1E000027100000000A00004E2000001770
00000FA00001001E000000000000EE [CR] [LF]
■ Response received: 011010C0000F10 [CR] [LF]
■ Details of query message

Field	ASCII mode character string (fixed)	Remarks
Header	':'	
Slave address	'0,' '1'	Axis No. 0 + 1
Function code	'1,' '0'	
Start address	'1,' '0,' 'C,' '0'	The start address is the target position specification register 10C0H for position No. 12. *1
Number of registers	'0,' '0,' '0,' 'F'	Total 15 registers from PCMD to CTLF in register symbols are specified for writing.
Number of bytes	'1,' 'E'	15 (registers) x 2 = 30 (bytes) → 1EH
New data 1, 2 (target position)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'2,' '7,' '1,' '0'	100 (mm) x 100 = 10000 → 2710H
New data 3, 4 (in-position band)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'0,' '0,' '0,' 'A'	0.1 (mm) x 100 = 10 → 000AH
New data 5, 6 (speed)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'4,' 'E,' '2,' '0'	200 (mm/sec) x 100 = 20000 → 4E20H
New data 7, 8 (individual zone boundary+)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'1,' '7,' '7,' '0'	60 (mm) x 100 = 6000 → 1770H
New data 9, 10 (individual zone boundary-)	'0,' '0,' '0,' '0'	32-bit data, where the upper bits are all 0
	'0,' 'F,' 'A,' '0'	40 (mm) x 100 = 4000 → 0FA0H
New data 11 (acceleration)	'0,' '0,' '0,' '1'	0.01 (G) x 100 = 1 → 0010H
New data 12 (deceleration)	'0,' '0,' '1,' 'E'	0.3 (G) x 100 = 30 → 001EH

Continued to the next page

Continued from the previous page

Field	ASCII mode character string (fixed)	Remarks
New data 13 (push)	'0,' '0,' '0,' '0'	0 (%) → 0H
New data 14 (threshold)	'0,' '0,' '0,' '0'	0 (%) → 0H
New data 15 (control flag)	'0,' '0,' '0,' '0'	All bits are 0, because normal operation is specified. 0000b → 0000H
Error check	'E,' 'E'	LRC check calculation result → EEH
Trailer	'CR,' 'LF'	
Total bytes	79	

*1) Calculation of start address
In the example, all data of position No. 12 is changed. Accordingly, the target position address of position No. 12 is set in the start address field of this query.

1000H + (16 x 12 =192) H + 0H
= 1000H + C0H + 0H
= 10C0H

"10C0" becomes the input value for the start address field of this query.

Shown below are the screens of IAI's PC software for RC Series, indicating how position data changes after a query message is sent.

■ Before a query is sent

No	位置 [mm]	速度 [mm/s]	加速度 [G]	減速度 [G]	押付け [%]	しきい [%]	位置決め幅 [mm]	ゾーン + [mm]	ゾーン - [mm]	加減速モード	インクリメンタル
10											
11											
12											
13											

■ After a query is sent

No	位置 [mm]	速度 [mm/s]	加速度 [G]	減速度 [G]	押付け [%]	しきい [%]	位置決め幅 [mm]	ゾーン + [mm]	ゾーン - [mm]	加減速モード	インクリメンタル
10											
11											
12	100.00	200.00	0.01	0.30	0	0	0.10	60.00	40.00	0	0

7. Exception Response

In each query, except for a broadcast query message, the master issues a query by expecting a “successful” response, and the applicable slave must return a response to the query. If the query was processed successfully, the slave returns a “successful” response. If an error occurred, however, the slave returns an exception response.

The slave responds to a query in one of the following four ways:

(1) The slave receives the query successfully, processes it successfully, and then returns a “successful” response.
(2) The slave returns no response because the query could not be received due to a communication error, etc. The master generates a timeout error.
(3) The slave also returns no response if the query was received but was found invalid because a LRC error was detected. In this case, the master also generates a timeout.
(4) If the query was received properly without generating errors but it cannot be processed for some reason (such as when the applicable register does not exist), the slave returns an exception response that contains an exception code indicating the content of exception.

Example of exception response generation
(Sample query message using Read Input Status)

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	02H	'0,' '2'	02H
Start address (H)	04H	'0,' '4'	04H
Start address (L)	A1H	'A,' '1'	A1H
Number of DIs (H)	00H	'0,' '0'	00H
Number of DIs (L)	14H	'1,' '4'	14H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	17	8

If input status 04A1H does not exist, the following exception response will be returned.

Sample exception response from a slave

Field	Sample value (Hex)	ASCII mode character string	RTU mode 8 bits (Hex)
Header		':'	None
Slave address	03H	'0,' '3'	03H
Function code	82H	'8,' '2'	82H
Exception code	02H	'0,' '2'	02H
Error check		LRC (2 characters)	CRC (16 bits)
Trailer		CR/LF	None
	Total bytes	11	5

The exception response consists of the slave address field, function code field, and data field. In the slave address field, the applicable slave address is set as in the slave address field of a "successful" response. In the function code field, the function code in the query is set, and then the MSB (most significant bit of the function code) of this field is set to 1. This allows the master to recognize that the message is not a "successful" response, but an exception response. An exception code indicating the content of exception is set in the data field.

Example) Query function code "02H" (00000010b)
→ Exception response function code "82H" (10000010b)

■ Exception codes

The table below lists the exception codes that may generate in RC Series controllers, as well as the contents of respective codes.

Code (Hex)	Exception code	Function	Remarks
01H	Illegal Function	Indicates that the function is invalid.	The query cannot be executed because a major error occurred.
02H	Illegal Data Address	Indicates that the data address is invalid.	Use of the data address value is not permitted.
03H	Illegal Data Value	Indicates that the data is invalid.	Use of the data value is not permitted.
04H	Slave Device Failure	Indicates that the query cannot be executed because an irremediable error occurred in the slave.	The query cannot be executed because a major error occurred.

Catalog No.: MJ****-1A (* 2006)

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