SR90 Series

Digital Controller

COMMUNICATION INTERFACE

(RS-232C/RS-485)

INSTRUCTION MANUAL

Thank you for purchasing the Shimaden SR90 series controller. Please check that the delivered product is the correct item you ordered. Please do not begin operating this product until you have read this instruction manual thoroughly and you understand its contents.

Notice

Please ensure that this instruction manual is given to the final user of the instrument.

Preface

This instruction manual describes the communication interface (RS-232C/RS-485) which is an optional function of the SR90 series (SR91, SR92, SR93 and SR94). For details of SR90 product's overview, performance, parameters, how to install, wiring, operation, and so on, please refer to the separate document "SR90 Series (SR91, SR92, SR93, SR94) Digital Controller Instruction Manual".

SHIMADEN CO., LTD.

SR90C-1EE
Sep. 2022

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1. Safety rules

For matters regarding safety, potential damage to equipment and/or facilities, additional instructions and notes are indicated by the following headings.

⚠**WARNING**: This heading indicates hazardous conditions that could cause injury or death of personnel unless extreme caution is exercised.
⚠**CAUTION**: This heading indicates hazardous conditions that could cause damage to equipment and/or facilities unless extreme caution is exercised.

⚠ WARNING

The SR90 Series digital controllers are control instruments designed for industrial use to control temperature, humidity and other physical values.

It must not be used in any way that may adversely affect the safety, health or working conditions of those who come into contact with the effects of its use. When used, adequate and effective safety countermeasures must be provided at all times by the user. No warranty, express or implied, is valid when this device is used without the proper safety countermeasures.

- When using this instrument, house it in a control box or the like to prevent terminals from coming into contact with personnel.
- Do not open this device's case, or touch the boards or the inside of the case with your hands or a conductor.
  The user should never repair or modify this device.
  Doing so might cause an accident that may result in death or serious bodily injury from electric shock.

⚠ CAUTION

To avoid damage to connected peripheral devices, facilities or the product itself due to malfunction of this device, safety countermeasures such as proper installation of the fuse or installation of overheating protection must be taken before use. No warranty, express or implied, is valid if usage results in an accident when the user has not taken the proper safety countermeasures.

Please operate this product safely after referring to and understanding the safety rules described in the separate Instruction Manual.

2. Outline

2-1. Communication interface

There are two types of communication systems, RS-232C and RS-485, employable in the SR90 series communication interface (however, only RS-485 applies to SR91). Each of them is capable of setting various data for the SR90 and reading through a personal computer or the like, using signals that comply with EIA standards.
RS-232C and RS-485 are data communication standards established by the Electronic Industries Association of the U.S. (EIA). The standards cover electrical and mechanical aspects, namely, matters related to applicable hardware but not the data transmission procedure for the software. Therefore, it is not possible to communicate unconditionally with an apparatus that has the same interface.
Hence, users need to have sufficient knowledge of product specifications and transmission procedures.

When RS-485 is used, two or more SR90 controllers can be connected to each other. There seems only a few computers, etc., that support this interface. Use a separately-purchased off-the-shelf line converter for RS-232C <---> RS-485 to support that interface.

2-2. Communication protocol and specifications

The SR90 Series supports the SHIMADEN standard protocol and MODBUS communication protocol.

■ Common to each protocol

Signal level	EIA RS-232C, RS-485 compliant
Communication system	RS-232C 3-line half-duplex system RS-485 2-line half-duplex multi-drop (bus) system
Synchronization system	Start-stop synchronization
Communication distance	RS-232C max. 15m RS-485 max. 500 m (depending on connection conditions)
Communication speed	1200, 2400, 4800, 9600, 19200 bps
Transmission procedure	Non-procedural
Communication delay time	1 to 100 x 0.512 msec
Number of connectable devices	RS-232C 1 RS-485 max. 31 (depending on connection conditions)
Communication address	1 to 255
Communication memory mode	EEP, RAM, R_E

■ Shimaden protocol

This is a SHIMADEN proprietary communication protocol. The table below lists the specifications of this protocol.

Data format Data length Parity Stop bit	Data length: 7 bits, Parity: Even, Stop bit: 1 bit Data length: 7 bits, Parity: Even, Stop bit: 2 bits Data length: 7 bits, Parity: None, Stop bit: 1 bit Data length: 7 bits, Parity: None, Stop bit: 2 bits Data length: 8 bits, Parity: Even, Stop bit: 1 bit Data length: 8 bits, Parity: Even, Stop bit: 2 bits Data length: 8 bits, Parity: None, Stop bit: 1 bit Data length: 8 bits, Parity: None, Stop bit: 2 bits
Communication code	ASCII code
Control code	STX_ETX_CR, @_:_CR
Communication BCC	ADD, ADD_two's cmp, XOR, None

■ MODBUS protocol

This is a communication protocol developed for PLCs by Modicon Inc. (AEG Schneider Automation International S.A.S.)
Though the specifications of this protocol are open, only the communication protocol is defined in this protocol, and physical layers, such as the communication medium, are not stipulated.
The table below shows the specifications of this protocol.

- ASCII mode

Data format Data length Parity Stop bit	Data length: 7 bits, Parity: Even, Stop bit: 1 bit Data length: 7 bits, Parity: Even, Stop bit: 2 bits Data length: 7 bits, Parity: None, Stop bit: 1 bit Data length: 7 bits, Parity: None, Stop bit: 2 bits
Communication code	ASCII code
Control code	CRLF
Error check	LRC

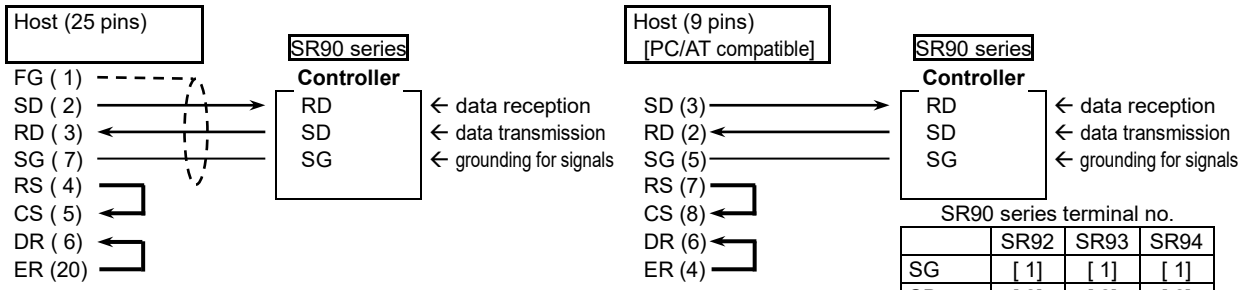
- RTU mode

Data format Data length Parity Stop bit	Data length: 8 bits, Parity: Even, Stop bit: 1 bit Data length: 8 bits, Parity: Even, Stop bit: 2 bits Data length: 8 bits, Parity: None, Stop bit: 1 bit Data length: 8 bits, Parity: None, Stop bit: 2 bits
Communication code	Binary data
Control code	None
Error check	CRC

3. Connecting controller with host computer

The SR90 series controller is only provided with 3 lines for input and output, i.e., for data transmission, data reception and grounding for signals, and not with any other signal lines.
In these instructions, the drawings give an example of control signal processing methods. Please refer to the documents that came with your host computer for further details.

3-1. RS-232C



SR90 series terminal no.

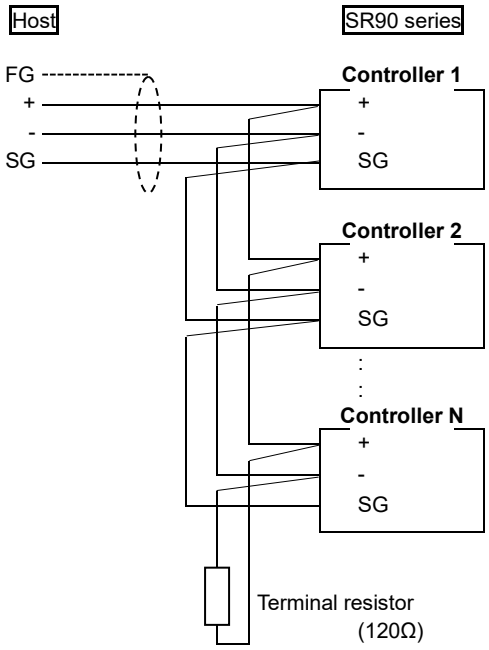
	SR92	SR93	SR94
SG	[1]	[1]	[1]
SD	[2]	[2]	[2]
RD	[3]	[3]	[3]

*1: Figures in ( ) represent pin numbers of connector.

3-2. RS-485

The input/output logical level of the SR90 controller is basically as follows:
In the mark state - terminal < + terminal
In the space state - terminal > + terminal

Until immediately before transmission, however, plus terminals and minus terminals of the controller have high impedance and outputs at the above levels are produced immediately before starting transmission. (See 3-3. 3-state output control.)



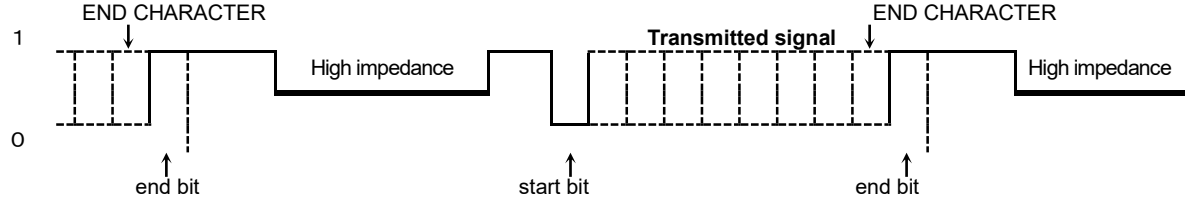
Note1: In the case of RS-485, provide it with the attached terminal resistor of 1/2W, 120Ω across terminals + and if necessary.
Nevertheless, it should be provided to only the last controller.
If two or more controllers are provided with terminal resistors, correct operation cannot be guaranteed.

SR90 series terminal no.

	SR91	SR92	SR93	SR94
SG	[1]	[1]	[1]	[1]
+	[11]	[2]	[2]	[2]
-	[12]	[3]	[3]	[3]

3-3. 3-state output control

Since RS-485 is of the multi-drop system, transmission output has high impedance always while communication is not carried out or signals are being received in order to avoid collision between transmission signals. It changes from high impedance to the normal output condition immediately before transmission and returns to high impedance control simultaneously when transmission terminates. As the 3-state control is delayed by about 1 msec (maximum) from the completion of transmission of an end character end bit, however, a few milliseconds' delay should be provided if the host side starts transmission immediately upon reception.

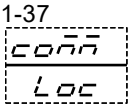


4. Setting of parameters

There are the following 9 communication-related parameters for the SR90 series controller. These parameters are unable to be set or changed by communication; use front key for setting and changing.
When parameters are set, see "6. Explanation of Screen Group and Setting" of the separate instruction manual for the controller and follow the described steps.

4-1. Communication mode setting

1-37



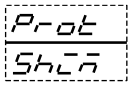
Initial value: Loc
Setting range: Loc, Com

Select communication mode. Front key operation allows only change from Com to Loc, though.

Code	Effective command	COM lamp
Loc	Read	Unlighted
Com	Read, write	Lighted

4-2. Communication protocol setting

1-38



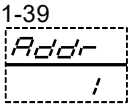
Initial value: shim
Setting range: shim, asc, rtu

Select communication protocol.

Code	Protocol
shim	Shimaden protocol
asc	MODBUS ASCII mode
rtu	MODBUS RTU mode

4-3. Communication address setting

1-39



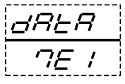
Initial value: 1
Setting range: 1 to 255

Select communication protocol.
While one host and one SR90 controller can be connected in the case of RS-232C, one host and 31 SR90 controllers (max.) can be connected in case of RS-485 by the multi-drop system.
Therefore, each instrument is assigned an address (machine No.) so that only the instrument with the designated address can answer.

Note 1: Although 1 to 255 addresses are available for setting, the number of connectable controllers is 31 maximum.

4-4. Communication data format setting

1-40



Initial value: Shimaden : 7E1, MODBUS ASCII : 7E1, MODBUS RTU : 8N2
Setting range: 8 types shown in the following table.

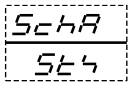
Select either one of the communication data formats shown below

Code	Data length	Parity	Stop bit	Shimaden	ASCII	RTU
7E1	7 bits	Even	1 bit	○	○	—
7E2	7 bits	Even	2 bits	○	○	—
7n1	7 bits	None	1 bit	○	○	—
7n2	7 bits	None	2 bits	○	○	—
8E1	8 bits	Even	1 bit	○	—	○
8E2	8 bits	Even	2 bits	○	—	○
8n1	8 bits	None	1 bit	○	—	○
8n2	8 bits	None	2 bits	○	—	○

○ Support
— Not Support

4-5. Start character setting

1-41



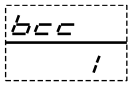
Initial value: STX
Setting range: STX, ATT

Select a control code to be used. This is used for Shimaden protocol only.

Code	Start character	Text end character	End character
STX	STX (02H)	ETX (03H)	CR (0DH)
ATT	"@" (40H)	":" (3AH)	CR (0DH)

4-6. BCC operation type setting

1-42



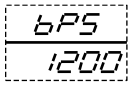
Initial value: 1
Setting range: 1, 2, 3, 4

Select a BCC operation method to be used in BCC checking. This is used for Shimaden protocol only.

Code	BCC operation method
1	Addition
2	Addition + 2's complement
3	XOR
4	None

4-7. Communication speed setting

1-43

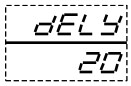


Initial value: 1200 bps
Setting range: 1200, 2400, 4800, 9600, 19200 bps

Select a rate at which data are transmitted to host computer.

4-8. Communication delay time setting

1-44



Initial value: 20
Setting range: 1 to 100

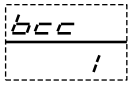
Set the length of delay time from receipt of a communication command to transmission.
Delay time (msec) = Set value (count) × 0.512 (msec)

Note 1: When RS-485 is used, some converters take longer time for 3-state control than others and it may lead to signal collision. This can be avoided by increasing delay time. Care should be taken particularly when the communication rate is slow (1200bps or 2400bps).

Note 2: Actual delay time from receipt of a communication command to transmission is a total of the above-mentioned delay time and command processing time by software. Particularly for writing commands, about 400 msecs maybe taken for processing.

4-9. Communication memory mode setting

1-45



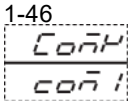
Initial value: EEP
Setting range: EEP, Ram, r_E

Since the volatile memory EEPROM used in SR90 series has its limits in number of writing cycles, the life of EEPROM is shortened if SV data or the like are rewritten frequently by communication. To prevent this, in case data are to be rewritten frequently by communication, set the RAM mode in which only RAM data are rewritten without rewriting EEPROM, thereby maintaining the life of EEPROM as long as possible.

Code	Description
EEP	In this mode EEPROM data are also rewritten every time data are changed by communication. Accordingly, data are maintained when power is turned off.
Ram	In this mode only RAM data are rewritten but EEPROM data are not when data are changed by communication. Therefore, RAM data are deleted when power is turned off. Upon applying power again, operation starts with data stored in EEPROM.
r_E	SV and OUT data are written in RAM. All other data are written in EEPROM.

4-10. Communication mode type setting

1-46



Initial value: COM1

Setting range: COM1, COM2

Selects type of communication mode.

Set to COM1 if you want to enable key operation while writing by communication.

Communication mode types	COM1		COM2	
Communication mode	COM	LOC	COM	LOC
Key operation	Possible	Possible	Not Possible	Possible
Communication writing	Possible	Possible	Possible	Not Possible

If "communication mode type" is modified by communication command, it becomes as follows.

Communication mode	LOC	COM
Communication writing	COM1 ⇒ COM2 Possible	COM1 ⇒ COM2 Possible
	COM2 ⇒ COM1 Not Possible	COM2 ⇒ COM1 Possible

5. Outline of Shimaden protocol

SR90 series support the Shimaden standard serial communication protocol.
This enables you to acquire and/or change data from instruments, which employ the Shimaden protocol, by using the same format.

5-1. Communication procedure

(1) Master/slave relation

- The master devices mean personal computer or PLC (host).
- The subordinate (slave) devices mean the SR90 series controller.
- A communication command from the master device starts communication and a response from the subordinate side terminates it.
  If abnormality such as a communication format error or a BCC error occurs, there will be no response.
  No response is sent, either, to broadcast instruction.

(2) Communication procedure

Communication goes on by transferring the transmission right to each other in the pattern that the subordinate device responds to the master device.

(3) Time-out

In case receipt of the end character does not complete within one second after receiving the start character, the controller figures it out as time-out and the controller automatically transits into waiting state for another command (a new start character).
Accordingly, the host device should set one second minimum as the time-out duration.

5-2. Communication format

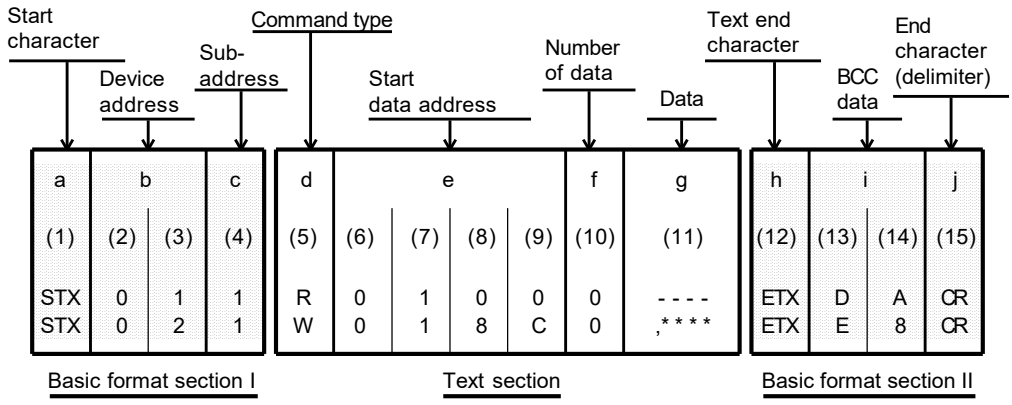
The SR90 Series allows for a variety of communication formats (control code and BCC operating method) and communication data formats (data bit length, parity/non-parity, and stop bit length) for easy compliance with other protocols.
However, the following settings are recommended as basic examples for your convenience:

	Settings	
Control code	STX_ETX_CR	
BCC operation	ADD	
Communication data format	7E1	8N1

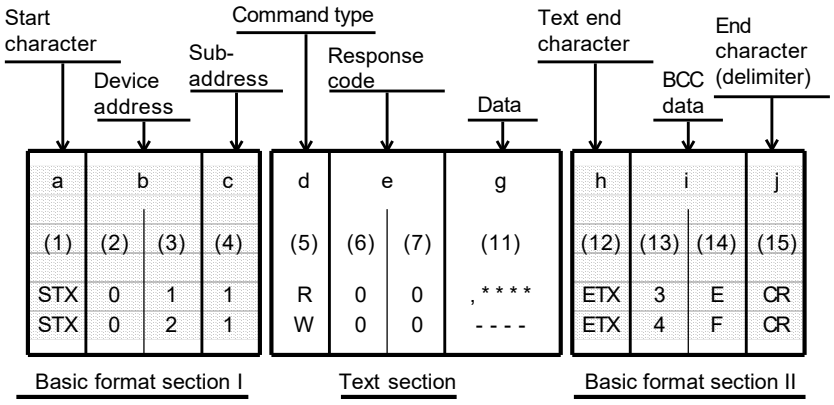
(1) Outline of communication format

The communication command formats sent from the master device or the communication response formats sent from the subordinate device consist of three blocks: basic format section I, text section and basic format section II.
Basic format sections I and II are common to the Read command (R), Write command (W) and during communication responses. Note, however, that the operation results each time are included in the BCC field ("i", (13) and (14)). The text section differs according to such factors as the command type, data address and communication response.

■ **Communication command format**



■ **Response format**



(2) Details of basic format section I

a: Start character [(1): 1 digit / STX (02H) or "@" (40H)]

- The start character indicates the start of the communication message.
- When the start character is received, it is judged to be the 1st character of a new communication message.
- Select a start character and a text end character as a pair.

STX (02H)·····Select by ETX (03H)
"@" (40H) ·····Select by ": " (3AH)

b: Device address [(2), (3): 2 digits]

- Specify the device to communicate with.
- Specify the address within the range from 1 to 255 (decimal).
- Binary 8-bit data (1: 0000 0001 to 255: 1111 1111) is divided into upper 4 bits and lower 4 bits, and converted to ASCII data.
  (2): Data obtained by converting the upper 4 bits to ASCII
  (3): Data obtained by converting the lower 4 bits to ASCII
- Device address 0 (30H, 30H) is used as the device address as it is used when the broadcast command is issued.

c: Subaddress [(4): 1 digit]

- As the SR90 series are single loop controllers, their sub-address is fixed to 1 (31H).
  If any other address is specified for a sub-address, there will be no response by sub-address error.

(3) Details of basic format section II

h: Text end character [(12): 1 digit / ETX (03H)] or ":" (3AH)]

- Indicates that the text section terminates right before this character.

i: BCC data [(13), (14): 2 digits]

- The BCC (Block Check Character) data is for checking if there is an error in the communication data.
- When BCC operation results in a BCC error, there will be no response.
- There are four types of BCC operation as shown below. These can be set on the front panel screen.
  (1) ADD
  Addition operation is performed from start character (1) through to text end character (12) in ASCII data single characters (1-byte).
  (2) ADD_two's cmp
  Addition operation is performed from start character (1) through to text end character (12) in ASCII data 1-character (1-byte) units, and the two's complement of the lower 1 byte of the operation result is taken.
  (3) XOR
  Exclusive OR is performed from after the start character (device address (2)) through to text end character (12) in ASCII data 1-character (1-byte) units.
  (4) None
  BCC operation is not performed. ((13) and (14) are omitted.)
- BCC data is operated in 1-byte (8-bit) units regardless of the data bit length (7 or 8).
- The lower 1-byte data of the result of the above operation is divided into upper 4 bits and lower 4 bits, and converted to ASCII data.
  (13): Data obtained by converting the upper 4 bits to ASCII
  (14): Data obtained by converting the lower 4 bits to ASCII

Example 1: Read command (R) at BCC i Add setting

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(14)	(15)
STX	0	1	1	R	0	1	0	0	0	ETX	D	A	CR

02H+30H+31H+31H+52H+30H+31H+30H+30H+30H+03H=1DAH

Lower 1 byte of add result (1DAH) = DAH

(13): "D" = 44H, (14): "A" = 41H

Example 2: Read command (R) at BCC i Add_two's cmp setting

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(14)	(15)
STX	0	1	1	R	0	1	0	0	0	ETX	2	6	CR

02H+30H+31H+31H+52H+30H+31H+30H+30H+30H+03H=1DAH

Lower 1 byte of add result (1DAH) = DAH
Two's complement of lower 1 byte (DAH) = 26H

(13): "2" = 32H, (14): "6" = 36H

Example 3: Read command (R) at BCC i XOR setting

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(14)	(15)
STX	0	1	1	R	0	1	0	0	0	ETX	5	0	CR

30H ⊕ 31H⊕31H⊕52H⊕30H⊕31H⊕30H ⊕30H⊕30H⊕03H = 50H

Note that ⊕ = XOR (exclusive OR)
Lower 1 byte of operation result (50H) = 50H

(13): "5" = 35H, (14): "0" = 30H

j: End character (delimiter) [(15): 1 digit / CR]

- Indicates that the end of the communication message.

Note

A response is not performed when errors such as those below are recognized in the basic format section:

- A hardware error has occurred.
- The device address and sub-address differ from the address of the specified device.
- The character specified by the previous communication format is not at the specified position.
- The BCC operation result differs from the BCC data.

Data are converted from binary data to ASCII data in 4-bit blocks.

Hex <A> to <F> are expressed in uppercase characters and are converted to ASCII data.

(4) Outline of text section

The text section differs according to the command type and communication response. For details, see "5-3 Details of Read command (R)" and "5-4 Details of Write command (W)".

d: Command type [(5): 1 digit]

- "R" (52H / uppercase character):
  Indicates a Read command or a Read command response.
  This is used to read (load) various SR90 data from a master personal computer or PLC.
- "W" (57H / uppercase character):
  Indicates a Write command or a Write command response.
  This is used to write (change) various SR90 data from a master personal computer or PLC.
- "B" (42H / uppercase character):
  Indicates a broadcast command. There is no broadcast command response.
- No response is made when a character other than "R" or "W" is recognized.

e: Start data address [(6), (7), (8), (9): 4 digits]

- Specifies the read start data address of the Read command (R) or the write start data address of the Write (W) command.
- The start data address is specified by binary 16-bit (1 word / 0 to 65535) data.
- The 16-bit data is divided into 4-bit blocks and then converted to ASCII data.

Binary	D15,D14,D13,D12	D11,D10,D9,D8	D7, D6, D5, D4	D3, D2, D1, D0
(16 bits)	0 0 0 0	0 0 0 1	1 0 0 0	1 1 0 0
Hex	0H	1H	8H	CH
	"0"	"1"	"8"	"C"
ASCII data	30H	31H	38H	43H
	(6)	(7)	(8)	(9)

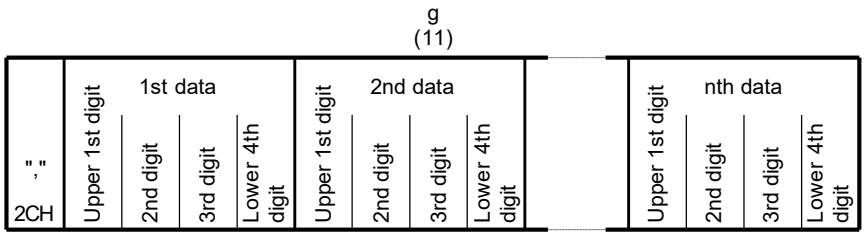
- For details on data addresses, see "7-2 Communication data addresses".

f: Number of data [(10): 1 digit]

- Specifies the number of read data in the Read command (R) or the number of write data in the Write command (W).
- The number of data is specified by converting binary 4-bit data to ASCII data.
- With the Read command (R), the number of data can be specified within the range 1: "0" (30H) to 10: "9" (39H). However, note that SR90 can read 8 data ("7" (37H)) maximally.
- With the Write command (W), the number of data is fixed at 1: "0" (30H).
- The actual number of data is "number of data = specified data numerical value + 1".

g: Data [(11): Number of digits determined by number of data]

- Specifies the number of write data (change data) of the Write command (W) or read data during a Read command (R) response.
- The following shows the data format:



- The data is always prefixed by a comma ("," 2CH) to indicate that what follows the comma is the data. Delimiters between data are not inserted.
- The number of data follows the number of data (f: (10)) in the communication command format.
- Each data is expressed in binary 16-bit (1 word) units without a decimal point. The position of the decimal point is determined by each data.
- 16-bit data is divided into 4-bit blocks, and each block is converted to ASCII data.
- For details of data, see "5-3 Details of Read command (R)" and "5-4 Details of Write command (W)".

e: Response code [(6), (7): 2 digits]

- Specifies the response code for the Read command (R) and Write command (W).
  Binary 8-bit data (0 to 255) is divided into upper 4 bits and lower 4 bits, and each is converted to ASCII data.
  (6): Data obtained by converting upper 4 bits to ASCII
  (7): Data obtained by converting lower 4 bits to ASCII
- In the case of a normal response, "0" (30H) and "0" (30H) are specified.
  In the case of an error response, the error code No. is specified after conversion to ASCII data.
  For details on response codes, see "5-6 Details of response codes".

5-3. Details of Read command (R)

The Read command (R) is used to read (load) various SR90 data from a master personal computer or PLC.

(1) Format of Read command (R)

- The following shows the format of the text section of the Read command (R).
  Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e				f
(5)	(6)	(7)	(8)	(9)	(10)
R	0	4	0	0	4
52H	30H	34H	30H	30H	34H

- d ((5)) : "R" (52H) indicates that this data is a Read command.
  It is fixed to "R" (52H).
- e ((6) to (7)) : The start data address of the data to read.
- f ((10)) : The number of data (words) to read.

- The above command is as follows:

Read start data address	= 0400H	(Hex)
	= 0000 0100 0000 0000	(Binary)
Number of read data	= 4H	(Hex)
	= 0100	(Binary)
	= 4	(Decimal)
(actual number of data)	= 5 (4 + 1)	

In other words, in this example, reading of 5 sequential data from data address 0400H is specified.

(2) Format of normal response to Read command (R)

- The following shows the format (text section) of a normal response to the Read command (R).
  Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e		g (11)													
(5)	(6)	(7)		1st data				2nd data					5th data			
R	0	0	,	0	0	1	E	0	0	7	8		0	0	0	3
52H	30H	30H	2CH	30H	30H	31H	45H	30H	30H	37H	38H		30H	30H	30H	33H

- d ((5)) : "R" (52H) is inserted to indicate that this data is a Read command response.
- e ((6) to (7)) : "0 0" (30H and 30H) is inserted to indicate that this is a normal response.
- g ((11)) : The actual response data to the Read command is inserted.
  1. "," (2CH) is added to indicate the actual data start.
  2. Actual data is inserted sequentially in order from <data of the read start data address> to the number of <read data number>.
  3. Nothing is inserted between each data items.
  4. Each data consists of binary 16-bit (1 word) data without a decimal point, and is converted to ASCII data in 4-bit blocks before it is inserted.
  5. The position of the decimal point is determined by each data.
  6. The number of characters of the response data is:
     "number of characters = 1 + 4 x number of read data".

- In actual terms, the following data is returned in order as the response data to the Read command (R).

Read start data address (0400H)

Number of read data (4H: 5 data)

	Data address 16 bits (1 word)	Data 16 bits (1 word)	
	Hex	Hex	Decimal
0	0400	001E	30
1	0401	0078	120
2	0402	001E	30
3	0403	0000	0
4	0404	0003	3

(3) Format of error response to Read command (R)

- The following shows the format (text section) of an error response to the Read command (R).
  Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e	
(5)	(6)	(7)
R	0	7
52H	30H	37H

- d ((5)) : "R" (52H) is inserted to indicate that this data is a Read command response.
- e ((6) to (7)) : Any response code is inserted to indicate that this is an error response.
- Response data is not inserted in the case of an error response.
- For details on error codes, see "5-6 Details of response codes".

5-4. Details of Write command (W)

The Write command (W) is used to write (change) various data on SR90 from a master personal computer or a PLC.

Caution

When the communication mode type is COM2, it is necessary to change the communication mode from LOC to COM when using the Write command.
The communication mode cannot be changed using the keys on the front panel.
To change the communication mode, send the following command from the master.

■ **Command format**

When ADDR=1, CTRL=STX_ETX_CR, BCC=ADD

STX	0	1	1	W	0	1	8	C	0	,	0	0	0	1	ETX	E	7	CR
02H	30H	31H	31H	57H	30H	31H	38H	43H	30H	2CH	30H	30H	30H	31H	03H	45H	37H	0DH

If a normal response is returned to the above command, the SB/COM LED on the front panel lights and the communication mode switches to COM.

(1) Format of Write command (W)

The following shows the format of the text section of the Write command (W).
Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e				f	g				
(5)	(6)	(7)	(8)	(9)	(10)	(11)				
						Write data				
W	0	4	0	0	0	,	0	0	2	8
57H	30H	34H	30H	30H	30H	2CH	30H	30H	32H	38H

- d ((5)) : "W" (57H) indicates that this data is a Write command.
  It is fixed to "W" (57H).
- e ((6) to (9)) : The start data address of the data to write (change).
- f (10) : The number of data to read (change).
  It is fixed to one, "0" (30H).
- g ((11)) : The actual data to the Write command is inserted.
  1. "," (2CH) is added to indicate the actual data start.
  2. Actual data is inserted.
  3. Each data consists of binary 16-bit (1 word) data without a decimal point, and is converted to ASCII data in 4-bit blocks before it is inserted.
  4. The position of the decimal point is determined by each data.

- The above command is as follows:

Write start data address	= 0400H	(Hex)
	= 0000 0100 0000 0000	(Binary)
Number of write data	= 0H	(Hex)
	= 0000	(Binary)
	= 0	(Decimal)
(actual number of data)	= 1 (0 + 1)	
Data to write	= 0028H	(Hex)
	= 0000 0000 0010 1000	(Binary)
	= 40	(Decimal)

In other words, in this example, writing of 1 data (40 in decimal) to data address 0400H is specified.

Write start data Address (0400H) → 0
Number of write data (one, 01)

Data address 16 bits (1 word)		Data 16 bits (1 word)	
Hex	Decimal	Hex	Decimal
0400	1024	0028	40
0401	1025	0078	120
0402	1026	001E	30

(2) Format of normal response to Write command (W)

- The following shows the format (text section) of a normal response to the Write command (W).
  Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e	
(5)	(6)	(7)
W	0	0
57H	30H	30H

- d ((5)) : "W" (57H) is inserted to indicate that this data is a Write command response.
- e ((6) to (7)) : "0 0" (30H and 30H) is inserted to indicate that this is a normal response.

(3) Format of error response to Write command (W)

- The following shows the format (text section) of an error response to the Write command (W).
  Basic format section I and basic format section II are common to all commands and command responses.

Text section

d	e	
(5)	(6)	(7)
W	0	9
57H	30H	39H

- d ((5)) : "W" (57H) is inserted to indicate that this data is a Write command response.
- e ((6) to (7)) : Any response code is inserted to indicate that this is an error response.
- For details on error codes, see "5-6 Details of response codes".

5-5. Broadcast command (B) details

The broadcast command (B) is used to write (change) all data for all machines that support the broadcast command from the master PC or PLC at once.
Broadcast command does not respond to communication.
Broadcast command corresponds with write (W) data address.

(1) Broadcast command format

The text portion format for the broadcast command is as follows.
The machine address of the basic format portion I is fixed to “00.”

Text portion

d	e				f	g				
(5)	(6)	(7)	(8)	(9)	(10)	(11)				
						write data				
R	0	4	0	0	0	,	0	0	2	8
42 H	30H	34H	30H	30H	30H	2CH	30H	30H	32H	38H

- d ((5)) : Indicates broadcast command.
  “B” (42H) fixed.
- e ((6) to (9)) : Specifies front data address of write data (change).
- f ((10)) : Specifies number of write data items (change).
  e number of write data items is fixed at 1: “0” (30H).
- g ((11)) : Specifies write data (change).
  1. <“,” (2CH)> that indicates beginning of data is inserted.
  2. Next, the write data is inserted.
  3. One item of data consists of binary 16-bit data (1 word) excluding the decimal point. Each 4 bits is converted into ASCII data and inserted.
  4. The position of the decimal point is determined by each item of data.

The command given above is as follows for all machines that support the broadcast command.

```
Write front data address = 0400H                    (hexadecimal)
                         = 0000 0100 0000 0000      (binary)
No. of write data items  = 0H                       (hexadecimal)
                         = 0000                     (binary)
                         = 0                        (decimal)
(Actual No. of data items) = 1 (0 + 1)

Write data items = 0028H                            (hexadecimal)
                 = 0000  0000  0010  1000           (binary)
                 = 40                               (decimal)
```

In other words, write (change) of 1 data item (40: decimal) is specified for data address 0400H.

Front data address for reading (400H) → 0

Number of write data items 1 (01)

Data address 16 bits (1 word)		Data 16 bits (1 word)	
Hexadecimal	Decimal	Hexadecimal	Decimal
0400	1024	0028	40
0401	1025	0078	120
0402	1026	001E	30

5-6. Details of response codes

(1) Type of response codes

Communication responses to the Read command (R) and Write command (W) must contain a response code.
There are two types of response codes: normal response code and error response code.
Response codes are expressed as binary 8-bit data (0 to 255). The table below shows the details of response codes.

Response Code List

Response Code		Code Type	Description
Binary	ASCII		
0000 0000	"0","0":30H,30H	Normal response	Normal response code for Read command (R) or Write command (W)
0000 0001	"0","1":30H,31H	Hardware error in text section	A hardware error such as framing overrun or parity has been detected in the data of the text section.
0000 0111	"0","7":30H,37H	Format error in text section	The format of the text section differs from the predetermined format.
0000 1000	"0","8":30H,38H	Data format data address, number of data error in text section	The format of the text section differs from the predetermined format, or the data address and number of data are other than specified.
0000 1001	"0","9":30H,39H	Data error	The write data exceeds the settable range of that data.
0000 1010	"0","A":30H,41H	Execution command error	An execution command (e.g. MAN) was received when it could not be accepted.
0000 1011	"0","B":30H,42H	Write mode error	When data that must not be rewritten depending on the data type, a write command containing that data was received.
0000 1100	"0","C":30H,43H	Specification, option error	A write command containing data of an unmounted specification or option was received.

(2) Order of priority of response codes

The smaller the value of the response code becomes, the higher the priority of the response code.
When multiple response codes have been issued, the response code having the higher or highest priority is returned.

6. Outline of MODBUS protocol

The MODBUS communication protocol has two transfer modes: ASCII mode and RTU mode.

6-1. Outline of transfer mode

(1) ASCII mode

The 8-bit binary data in commands are divided into groups of upper 4 bits (Hex) and lower 4 bits (Hex), each of which is sent as ASCII characters.

■ Data configuration

Data format	Selectable from 7E1, 7E2, 7N1, 7N2
Error check	LRC (Longitudinal Redundancy Check)
Data communication interval	1 sec or less

(2) RTU mode

The 8-bit binary data in commands are sent as is.

■ Data configuration

Data format	Selectable from 8E1, 8E2, 8N1, 8N2
Error check	CRC-16 (Cyclic Redundancy Check)
Data communication interval	3.5-character transmission time or less

6-2. Configuration of messages

(1) ASCII mode

In this mode, message formats begin with a start character (":" (colon, 3AH)), and end with an end character ("CR" (carriage return, ODH)) followed by an "LF" (line feed, 0AH)).

Header (:)	Slave address	Function code	Data	Error check LRC	Delimiter (CR)	Delimiter (LF)

(2) RTU mode

In this mode, messages begin after an idle time of 3.5-character transfer time or more, and end after an idle time of 3.5-character transfer time or more has elapsed.

Idle 3.5 characters	Slave address	Function code	Data	Error check CRC	Idle 3.5 characters

6-3. Slave address

The slave address is settable within the range 1 to 247 (SR90 series supports to 255).
The master device can specify the slave address in a request message to recognize each of the subordinate devices.
The subordinate device notifies the master which slave is responding by setting and returning its own slave address to the response message.
Slave address 0 is a broadcast address and can be broadcast to all slaves, but there is no response.

6-4. Function codes

A function code is a code to indicate the type of operation to the subordinate device.

Function Code	Details
03 (03H)	Reads setting values and information from subordinate devices
06 (06H)	Writes to subordinate devices

These function codes are also used to indicate whether the response message returned to the master by the slave is a normal response (positive response) or that some error has occurred (negative response).

In a positive response, the original function code is set and returned.
In a negative response, the MSB of the original function code is set to "1" and returned.
For example, when "10H" has been mistakenly set as the function code, and the request message has been sent to the subordinate device, "1" is set to the MSB and returned as "90H" as this function code is non-existent.
Also, in the case of a negative response, an error code is set to the response message and returned to notify the master which type of error has occurred.

Error Code	Details
1 (01H)	illegal Function (non-existent function)
2 (02H)	illegal data address (non-existent data address)
3 (03H)	illegal data value (value out of setting range)

6-5. Data

The data structure differs depending on the function code.
With request messages from the master device, the data consist of data item, number of data and setting data.
With response messages from a subordinate device, the data consist of number of bytes or data in response to the request, and in the case of a negative response, an error code.
The valid data range is -32768 to 32767.

6-6. Error check

The error check method differs depending on the transfer mode.

(1) ASCII mode

As the error check for the ASCII mode, calculate the LRC to the end of the data from the slave address, convert the resulting 8-bit data to two ASCII characters and append it to the data.

■ LRC calculation method

1. Create a message in the RTU mode.
2. Add to the end of the data from the slave address, and substitute with x.
3. Take the 2's complement (invert bits) of x, and substitute with x.
4. Add "1" to x, and substitute with x.
5. Append to the data taking x to be the LRC.
6. Convert the message to ASCII characters.

(2) RTU mode

As the error check for the RTU mode, calculate the CRC-16 to the end of the data from the slave address, and append the resulting 16-bit data to the data in the order of lower bits then upper bits.

■ CRC-16 calculation method

By the CRC method, the information to be sent is divided by a generating function, and the information is appended with the remainder and then sent.

Generating function: $X^{16} + X^{15} + X^2 + 1$

1. Initialize the data of CRC (taken to be x) to (FFFFH).
2. Exclusive-OR the 1st data with x, and substitute with x.
3. Shift x to the right by one bit, and substitute with x.
4. If the shift results in a carry, exclusive-OR the result of "***3.***" with a fixed value (A001H), and substitute with x. If the shift does not result in a carry, go to step "***5.***".
5. Repeat steps "***3.***" and "***4.***" until x is shifted eight times.
6. Exclusive-OR the next data with x, and substitute with x.
7. Repeat steps "***3.***" to "***5.***".
8. Repeat steps "***3.***" to "***5.***" until the last data.
9. Append the data to the message in order lower bits then upper bits taking x to be CRC-16.

6-7. Examples of messages

(1) ASCII mode

■ **Reading SV value from subordinate device No.1**

- **Request message from master device**

Header (:)	Slave address (01H)	Function code (03H)	Data address (0300H)	Number of data (0001H)	Error check LRC (F8H)	Delimiter (CR•LF)	
1	2	2	4	4	2	2	← Number of characters (17)

- **Response message from subordinate device in normal operation (SV = 10.0°C)**

Header (:)	Slave address (01H)	Function code (03H)	Response data length (02H)	Data (0064H)	Error check LRC (96H)	Delimiter (CR•LF)	
1	2	2	2	4	2	2	← Number of characters (15)

- **Subordinate device's response message in erroneous operation (when the data item has been mistaken)**

Header (:)	Slave address (01H)	Function code (83H)	Error code (02H)	Error check LRC (7AH)	Delimiter (CR•LF)	
1	2	2	2	2	2	← Number of characters (11)

In a response message when an error has occurred, "1" is set to the MSB of the function code (83H). An error code 02H (non-existent data address) is returned as the response message for the error content.

■ **Writing SV value (SV = 10.0°C) to subordinate device No.1**

- **Request message from master device**

Header (:)	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check LRC (92H)	Delimiter (CR•LF)	
1	2	2	4	4	2	2	← Number of characters (17)

- **Response message from subordinate device in normal operation (SV = 10.0°C)**

Header (:)	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check LRC (92H)	Delimiter (CR•LF)	
1	2	2	4	4	2	2	← Number of characters (17)

- **Subordinate device's response message in erroneous operation (when a value out of range is set)**

Header (:)	Slave address (01H)	Function code (86H)	Error code (03H)	Error check LRC (76H)	Delimiter (CR•LF)	
1	2	2	2	2	2	← Number of characters (11)

In a response message when an error has occurred, "1" is set to the MSB of the function code (86H). An error code 03H (value outside of setting range) is returned as the response message for the error content.

(2) RTU mode

■ **Reading SV value from subordinate device No.1**

- **Request message from master device**

Idle 3.5 characters	Slave address (01H)	Function code (03H)	Data address (0300H)	Number of data (0001H)	Error check CRC (844EH)	Idle 3.5 characters	
	1	1	2	2	2		← Number of characters (8)

- **Response message from subordinate device in normal operation (SV = 10.0°C)**

Idle 3.5 characters	Slave address (01H)	Function code (03H)	Response data length (02H)	Data (0064H)	Error check CRC (B9AFH)	Idle 3.5 characters	
	1	1	1	2	2		← Number of characters (7)

- **Subordinate device's response message in erroneous operation (when the data item has been mistaken)**

Idle 3.5 characters	Slave address (01H)	Function code (83H)	Error code (02H)	Error check CRC (C0F1H)	Idle 3.5 characters	
	1	1	1	2		← Number of characters (5)

In a response message when an error has occurred, "1" is set to the MSB of the function code (83H). An error code 02H (non-existent data address) is returned as the response message for the error content.

■ **Writing SV value (SV = 10.0°C) to subordinate device No.1**

- **Request message from master device**

Idle 3.5 characters	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 characters	
	1	1	2	2	2		← Number of characters (8)

- **Response message from subordinate device in normal operation (SV = 10.0°C)**

Idle 3.5 characters	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 characters	
	1	1	2	2	2		← Number of characters (8)

- **Subordinate device's response message in erroneous operation (when a value out of range is set)**

Idle 3.5 characters	Slave address (01H)	Function code (86H)	Error code (03H)	Error check CRC (0261H)	Idle 3.5 characters	
	1	1	1	2		← Number of characters (5)

In a response message when an error has occurred, "1" is set to the MSB of the function code (86H). An error code 03H (value outside of setting range) is returned as the response message for the error content.

7. Communication data address

7-1. Details of communication data addresses

Note: Error response codes here follow Shimaden protocol.

(1) Data address and read/write

- In a data address, binary numbers (16-bit data) are expressed by hexadecimal numbers, with 4 bits as a unit.
- R/W means that data are capable of being read and written.
- R means that data are only for reading.
- W means that data are only for writing.
- In case a data address only for writing is designated by a read command (R), or a data address only for reading is designated by a write command (W), it results in a data address error and the error response code "0", "8" (30H, 38H) "error in data format, data address or the number of data in text section" is returned.

(2) Data address and the number of data

- If a data address which is not included in the data addresses for SR90 is designated as the start data address, it results in a data address error, and the error response code "0", "8" (30H, 38H) "error in data format, data address or the number of data in text section" is returned.
- Even if a start data address belongs to the data address list, the actual data includes data which address is out of the data address list, it results in an error of the number of data, and error response code "0", "8" (30H, 38H) " is returned.

(3) Data

- Since data comprise binary numbers (16-bit data) without a decimal point, the data type or with/without decimal point, etc., have to be confirmed. (See the instruction manual of the instrument itself.)

Example: How to express data with a decimal point

				Hexadecimal data
20.0%	→	200	→	00C8
100.00°C	→	10000	→	2710
–40.00°C	→	–4000	→	F060

- In data of which the unit is digit, the position of decimal point depends on the measuring range.
- Otherwise, data is handled as signed binary numbers (16-bit data: –32768 to 32767).

Example) How to express 16-bit data

Signed number	
Decimal	Hexadecimal
0	0000
1	0001
:	:
32767	7FFF
–32768	8000
–32767	8001
:	:
–2	FFFE
–1	FFFF

(4) Read/Write of <Reserved> data

When <Reserved> data in the address list is read or written by a Read (R) or a Write (W) command, normal response code "0", "0" (30H, 30H) is returned.

(5) Option-related parameters

When parameter data for unmounted option is designated, error response code "0","C" (30H, 43H) "specification, option error" is returned to a Read command (R) as well as a Write command (W).

(6) Parameters not displayed on the front panel

Even parameter data which is not displayed on the front panel screen for its specifications or settings is able to Read/Write through communication.

7-2. Communication data address

Data address (hex)	Parameter	Setting range	R/W/B
0040		Series code 1	R
0041		Series code 2	R
0042		Series code 3	R
0043		Series code 4	R

- The address areas listed above become product ID data areas and data are ASCII data, 8 bits as a unit. Therefore, one address represents two data.
- A series code is expressed by 8 data maximum and a surplus area is filled with 00H data.

Example 1) SR91

Address	H	L	H	L
0040	"S"	"R"	53H	52H
0041	"9"	"1"	39H	31H
0042			00H	00H
0043			00H	00H

Example 2) SR92

Address	H	L	H	L
0040	"S"	"R"	53H	52H
0041	"9"	"2"	39H	32H
0042			00H	00H
0043			00H	00H

0100	PV	Measured value	R
0101	SV	Execution SV value	R
0102	OUT1	Control output 1 value	R
0103	OUT2	Control output 2 value (without option : 0000H)	R
0104	EXE_FLG	Action flag (bit without action : 0)	R
0105	EV_FLG	Event output flag (without option : 0000H)	R

0109	HB	HB current value (without option : 0000H)	R
010A	HL	HL current value (without option : 0000H)	R

- EXE_FLG, EV_FLG Details are shown below.

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
EXE_FLG :	0	0	0	0	0	0	0	COM	0	0	0	0	0	STBY	MAN	AT
EV_FLG :	0	0	0	0	0	0	0	0	0	0	0	0	0	0	EV2	EV1

- Higher limit side PV_SO, CJ_SO, b - - -, HB_SO : 7FFFH
- Lower limit side PV_SO, CJ_SO, HB_SO : 8000H
- Invalid data for HB and HL : 7FFEH

0182	OUT1	Control output 1, Set value in MAN operation	W/B
0183	OUT2	Control output 2, Set value in MAN operation (option)	W/B
0184	AT	0 : No execution, 1 : Execution	W/B
0185	MAN	0 : AUTO, 1 : MAN	W/B
0186	STBY	0 : No execution, 1 : Execution	W/B

018C	COM	0 : LOC, 1 : COM	W/B

0300	SV1	Target set value	R/W/B

030A	SV_L	Set value limiter on lower limit side	R/W/B
030B	SV_H	Set value limiter on higher limit side	R/W/B

0400	PB1	Control output 1 proportional band	R/W/B
0401	IT1	Control output 1 integral time	R/W/B
0402	DT1	Control output 1 derivative time	R/W/B
0403	MR1	Manual reset	R/W/B
0404	DF1	Hysteresis	R/W/B
0405	O11_L	Control output 1 lower output limiter	R/W/B
0406	O11_H	Control output 1 higher output limiter	R/W/B
0407	SF1	Control output 1 target value function	R/W/B

0460	PB21	Control output 2 proportional band (option)	R/W/B
0461	IT21	Control output 2 integral time (option)	R/W/B
0462	DT21	Control output 2 derivative time (option)	R/W/B
0463	DB21	Dead band (option)	R/W/B
0464	DF21	Hysteresis (option)	R/W/B
0465	O21_L	Control output 2 lower output limiter (option)	R/W/B
0466	O21_H	Control output 2 higher output limiter (option)	R/W/B
0467	SF21	Control output 2 target value function (option)	R/W/B

04DF	DFMD	Hysteresis mode 0 : CENT 1 : SVOF 2 : SVON	R/W/B

04FE	STBY EV	Event at STBY 0 : OFF, 1 : ON (option)	R/W/B

Data address (hex)	Parameter	Setting range	R/W/B
0500	EV1_MD	Event 1 mode See "8-2 Event type list." (option)	R/W/B
0501	EV1_SP	Event 1 set value See "8-2 Event type list." (option) A change through communication is also possible when oFF, So or Hb is set for the event mode but any change of event mode is followed by initialization. (Writable range : -1999 to 9999)	R/W/B
0502	EV1_DF	Event 1 hysteresis (option)	R/W/B
0503	EV1_STB	Event 1 standby actions (option) 1: Alarm action without standby 2: Alarm action with standby (when power is applied or when STBY -> execution) 3: Alarm action with standby (when power is applied, when STBY -> execution, or when SV is changed) 4: Control action without standby	R/W/B

0508	EV2_MD	Event 2 mode See "8-2 Event type list." (option)	R/W/B
0509	EV2_SP	Event 2 set value See "8-2 Event type list." (option) A change through communication is also possible when oFF, So or Hb is set for the event mode but any change of event mode is followed by initialization. (Writable range : -1999 to 9999)	R/W/B
050A	EV2_DF	Event 2 hysteresis (option)	R/W/B
050B	EV2_STB	Event 2 standby actions (option) 1: Alarm action without standby 2: Alarm action with standby (when power is applied or when STBY -> execution) 3: Alarm action with standby (when power is applied, when STBY -> execution, or when SV is changed) 4: Control action without standby	R/W/B

0590	HBS	Heater break alarm setting (option)	R/W/B
0591	HBL	Heater loop alarm setting (option)	R/W/B
0592	HB_MD	Setting of heater break alarm mode 0 : LC, 1 : RE (option)	R/W/B
0593	Reserved	(option)	R/W/B
0594	HB_STB	Heater break standby setting 0 : OFF, 1 : ON (option)	R/W/B

05A0	A01_MD	Analog output mode 0 : PV, 1 : SV, 2 : OUT1, 3 : OUT2 (option)	R/W/B
05A1	A01_L	Analog output scale on lower limit side (option)	R/W/B
05A2	A01_H	Analog output scale on higher limit side (option)	R/W/B

05B0	COM_MEM	Communication memory mode 0 : EEP, 1 : RAM, 2 : r_E (option)	R/W/B
05B1	COMK	Communication mode type 0 : COM1, 1 : COM2 (option)	R/W/B

0600	ACTMD	Output characteristics 0 : RA, 1 : DA	R/W/B
0601	01_CYC	SV1 proportional cycle 1 to 120	R/W/B

0604	02_CYC	SV2 proportional cycle 1 to 120 (option)	R/W/B

060A	SOFTD1	Set data for soft start 1 0 : OFF, 1 to 100	R/W/B

0611	KLOCK	Keylock 0 : OFF 1 : Lock except the screen group for user's setting and communication mode 2 : Lock except SV and communication mode 3 : Lock except communication mode	R/W/B

0701	PV_B	PV bias -1999 to 2000	R/W/B
0702	PV_F	PV filter 0 to 100	R/W/B

0704	UNIT	Unit of input data 0 : "°C" 1 : "°F"		R/W/B
0705	RANGE	Refer to 8-1. Table of measuring range codes		R/W/B
0706	CJ	Cold junction compensation 0 : Internal 1 : External		R/W/B
0707	DP	0: None 1: XXX.X 2: XX.XX 3: X.XXX	Unchangeable except linear input	R/W/B
0708	SC_L	Lower limit side of input scaling		R/W/B
0709	SC_H	Higher limit side of input scaling		R/W/B

8. Supplementary explanation

8-1. Table of measuring range codes

Input type				Code	Measuring range (°C)	Measuring range (°F)
Universal Input	Thermocouple	B *1		01	0 to 1800	0 to 3300
		R		02	0 to 1700	0 to 3100
		S		03	0 to 1700	0 to 3100
		K		04 *2	−199.9 to 400.0	−300 to 750
				05	0.0 to 800.0	0 to 1500
				06	0 to 1200	0 to 2200
		E		07	0 to 700	0 to 1300
		J		08	0 to 600	0 to 1100
		T		09 *2	−199.9 to 200.0	−300 to 400
		N		10	0 to 1300	0 to 2300
		PL II *3		11	0 to 1300	0 to 2300
		C(WRe5-26)		12	0 to 2300	0 to 4200
		U *4		13 *2	−199.9 to 200.0	−300 to 400
		L *4		14	0 to 600	0 to 1100
		Kelvin	K	15 *5	10.0 to 350.0 K	10.0 to 350.0 K
			AuFe-Cr	16 *6	0.0 to 350.0 K	0.0 to 350.0 K
			K	17 *5	10 to 350 K	10 to 350 K
			AuFe-Cr	18 *6	0 to 350 K	0 to 350 K
	R.T.D.	Pt100		31	−200 to 600	−300 to 1100
				32	−100.0 to 100.0	−150.0 to 200.0
				33	−50.0 to 50.0	−50.0 to 120.0
				34	0.0 to 200.0	0.0 to 400.0
		JPt100		35	−200 to 500	−300 to 1000
				36	−100.0 to 100.0	−150.0 to 200.0
				37	−50.0 to 50.0	−50.0 to 120.0
				38	0.0 to 200.0	0.0 to 400.0
	mV	−10 to 10mV		71	Initial value: 0.0 to 100.0 Input scaling setting range: −1999 to 9999 digit Span: 10 to 5000 digit Position of decimal point: None 1, 2 or 3 decimal places Lower limit value < higher limit value	
		0 to 10mV		72		
		0 to 20mV		73		
		0 to 50mV		74		
		10 to 50mV		75		
		0 to 100mV		76		
Voltage	V	−1 to 1V		81	Initial value: 0.0 to 100.0 Input scaling setting range: −1999 to 9999 digit Span: 10 to 5000 digit Position of decimal point: None 1, 2 or 3 decimal places Lower limit value < higher limit value	
		0 to 1V		82		
		0 to 2V		83		
		0 to 5V		84		
		1 to 5V		85		
		0 to 10V		86		
Current	mA	0 to 20mA		91		
		4 to 20mA		92		

Thermocouple: B, R, S, K, E, J, T, N, C: JIS/IEC
R.T.D.: Pt100: JIS/IEC, JPt100: Former JIS

*1 Thermocouple B: Accuracy guarantee not applicable to 400°C (752°F) and below.

*2 Thermocouple K, T, U: Accuracy of those whose readings are below −100°C is ± (0.7% FS+ 1digit)

*3 Thermocouple PLII: Platinel

*4 Thermocouple U, L: DIN 43710

*5 Thermocouple K: Accuracy is as follows;

Temperature range	External CJ	Internal CJ
10.0 to 30.0 K	±(2.0%FS +	40°C +1digit)
30.0 to 70.0 K	±(1.0%FS +	14°C +1digit)
70.0 to 170.0 K	±(0.7%FS +	6°C +1digit)
170.0 to 270.0 K	±(0.5%FS +	3°C +1digit)
270.0 to 350.0 K	±(0.3%FS +	2°C +1digit)

*6 Thermocouple AuFe-Cr: Accuracy is as follows;

Temperature range	External CJ	Internal CJ
0.0 to 30.0 K	±(0.7%FS +	6°C +1digit)
30.0 to 70.0 K	±(0.5%FS +	3°C +1digit)
70.0 to 170.0 K	±(0.3%FS +	3.6°C +1digit)
170.0 to 280.0 K	±(0.3%FS +	2°C +1digit)
280.0 to 350.0 K	±(0.5%FS +	2°C +1digit)

8-2. Table of event types

Alarm code	Event type	Number	Initial value	Setting range
oFF	None	0	— — — — — — — — —	— — — — — — —
Hd	Higher limit deviation	1	2000 digit	–1999 to 2000 digit
Ld	Lower limit deviation	2	–1999 digit	–1999 to 2000 digit
od	Outside higher/lower limit deviations	3	2000 digit	0 to 2000 digit
id	Within higher/lower limit deviations	4	2000 digit	0 to 2000 digit
HA	Higher limit absolute value	5	Higher limit vale of measuring range	Within measuring range
LA	Lower limit absolute value	6	Lower limit value of measuring range	Within measuring range
So	Scaleover	7	EV output to continue after scaleover	
Hb	Heater break/heater loop	8	EV output to continue after heater break alarm is output.	

8-3. ASCII code list

	b7b6b5	000	001	010	011	100	101	110	111
b4 ~ b1		0	1	2	3	4	5	6	7
0000	0	NUL	TC7 (DLE)	SP	0	@	P	`	p
0001	1	TC1 (SOH)	DC1	!	1	A	Q	a	q
0010	2	TC2 (STX)	DC2	”	2	B	R	b	r
0011	3	TC3 (ETX)	DC3	#	3	C	S	c	s
0100	4	TC4 (EOT)	DC4	$	4	D	T	d	t
0101	5	TC5 (ENQ)	TC8 (NAK)	%	5	E	U	e	u
0110	6	TC6 (ACK)	TC9 (SYN)	&	6	F	V	f	v
0111	7	BEL	TC10 (ETB)	’	7	G	W	g	w
1000	8	FE0 (BS)	CAN	(	8	H	X	h	x
1001	9	FE1 (HT)	EM	)	9	I	Y	i	y
1010	A	FE2 (LF)	SUB	*	:	J	Z	j	z
1011	B	FE3 (VT)	ESC	+	;	K	[	k	{
1100	C	FE4 (FF)	IS4 (FS)	,	<	L	\	l	|
1101	D	FE5 (CR)	IS3 (GS)	_	=	M	]	m	}
1110	E	SO	IS2 (RS)	.	>	N	^	n	~
1111	F	SI	IS1 (US)	/	?	O	_	o	DEL

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