SRS10 (SRS11/SRS13/SRS14) Series

Digital Controller

Communications Interface

(RS-485)

Instruction Manual

Thank you for purchasing a Shimaden Digital Controller. After making sure the product fits the desired description, you should carefully read the instructions and get a good understanding of the contents before attempting to operate the equipment.

Request

The instruction manual should be kept in a handy place where the end user can refer to it when necessary.

Preface

This instruction manual describes the basic functions and usage method of the communications interface (RS-485) for the SRS10 (SRS11/SRS13/SRS14) Series.
For product overview and details on product functions, or information on wiring, installation, operation or routine maintenance, see the “SRS10 (SRS11/SRS13/SRS14) Series Digital Controller Instruction Manual” (hereinafter referred to as “the instruction manual”).

SHIMADEN CO., LTD.

SRS10C-1AJ
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Contents

1. Safety rules

Safety rules, precautions concerning equipment damage, additional instructions and notes are written based on the following headings.

WARNING: Matters that could result in injury or death if instructions are not followed.
CAUTION: Matters that could result in equipment damage if instructions are not followed.

⚠ WARNING

The SRS10 Series digital controllers are manufactured and designed to control temperature, humidity and other physical amounts for general industrial equipment. You should therefore avoid using the devices for control that could have a serious effect on human life. It is the customer's responsibility to take measures to ensure safety. Shimaden shall not be liable for accidents resulting from failure to take proper safety measures.

- If the controller is mounted inside a control box, etc., be sure to take measures so the terminal element is not touched by any part of the human body.
- Do not open the case, touch the pc board, or stick your hands or any electrical conductor inside the case. Do dot attempt to repair or modify the equipment yourself. Doing so could result in electric shock accident involving death or serious injury.

⚠ CAUTION

If there is danger of damage to any peripheral device or equipment due to failure of the controller, you should take appropriate safety measures such as mounting a fuse or overheating prevention device. Shimaden shall not be liable for accidents resulting from failure to take proper safety measures.

Be sure to read the safety precautions in the instruction manual thoroughly and get a good understanding of the contents before attempting to use the equipment.

2. Overview

2-1. Communication interface

With the SRS10 Series, RS-485 communications is optionally available. With this option, you can set and read various types of data using the RS-485 interface.
RS-485 is the data communications standard established by the Electronic Industries Association of the U.S. (EIA). This standards stipulate the hardware. The data transmission procedure software is however not defined, so communication cannot be carried out unconditionally with another device equipped with the same interface. The customer must therefore get a good understanding of data transmission specifications and procedures prior to using the equipment.

Using the RS-485 interface enables you to connect multiple SRS10 Series controllers in parallel. Few PC models currently support the RS-485 interface, but if you equip your machine with a commercially available "RS-485 converter", you can use the RS-485 interface.

2-2. Communications protocol and specifications

The SRS10 Series supports Shimaden protocol and MODBUS (RTU/ASCII) communication protocol.

■ Shared by each protocol

Signal level	EIA RS-485-compliant
Communication system	RS-485 2-line half duplex multidrop system
Synchronization system	Half duplex start-stop synchronization system
Communication distance	RS-485 Total max. 500m (differs according to connection conditions)
Communication speed	1200／2400／4800／9600／19200／38400 bps
Transmission procedure	No procedure
Communication delay time	1 – 100 (x 0.512 msec)
No. of communication units	RS-485 Up to 31 units (differs according to connection conditions)
Communication address	1 – 255
Communication memory mode	EEP／RAM／R_E

■ Shimaden protocol

Shimaden's own original communication protocol. A list of specifications is provided below.

Data format Data length Parity Stop bits	Data length: 7 bits, parity: even, stop bits: 1 Data length: 7 bits, parity: even, stop bits: 2 Data length: 7 bits, parity: none, stop bits: 1 Data length: 7 bits, parity: none, stop bits: 2 Data length: 8 bits, parity: even, stop bits: 1 Data length: 8 bits, parity: even, stop bits: 2 Data length: 8 bits, parity: none, stop bits: 1 Data length: 8 bits, parity: none, stop bits: 2
Communication code	ASCII code
Control code	STX_ETX_CR, @_:_CR
BCC check	ADD／ADD_two's cmp／XOR／NONE

■ MODBUS (RTU/ASCⅡ) communication protocol

MODBUS (RTU/ASCII) communication protocol is communication protocol developed for PLC by Modicon Inc. The specifications have been discloded to the public, but only communication protocol is defined by MODBUS (RTU/ASCII) communication protocol, and physical layers such as communication media is not prescribed. A list of specifications is provided below.

▪ ASCⅡ mode

Data format Data length Parity Stop bits	Data length: 7 bits, parity: even, stop bits: 1 Data length: 7 bits, parity: even, stop bits: 2 Data length: 7 bits, parity: none, stop bits: 1 Data length: 7 bits, parity: none, stop bits: 2
Communication code	ASCII code
Control code	:_CRLF
Error check	LRC

▪ RTU mode

Data format Data length Parity Stop bits	Data length: 8 bits, parity: even, stop bits: 1 Data length: 8 bits, parity: even, stop bits: 2 Data length: 8 bits, parity: none, stop bits: 1 Data length: 8 bits, parity: none, stop bits: 2
Communication code	Binary data
Control code	None
Error check	CRC

3. Controller and host computer connection

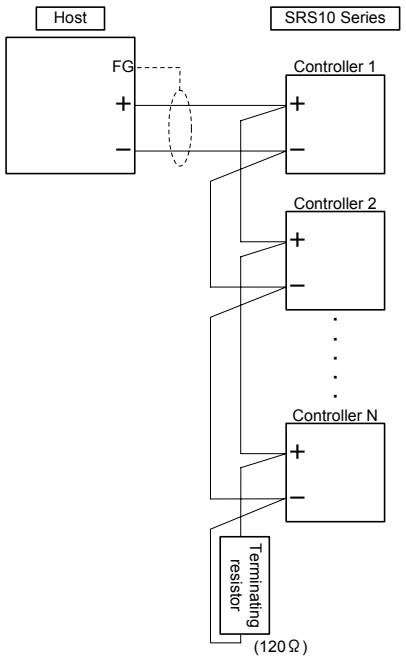
A transmission data line and a reception data line are connected between the SRS10 Series controller and host computer. A connection example is provided below. For details see the host computer manual.

3-1. RS-485

The input/output logic level of the SRS10 Series is basically as follows.

Mark	- terminal < + terminal
Space	- terminal > + terminal

The + and - terminals of the controller are however high impedance up until immediately before transmission begins and the level described above is output immediately before transmission starts. (See 3-2. 3-State output control.)



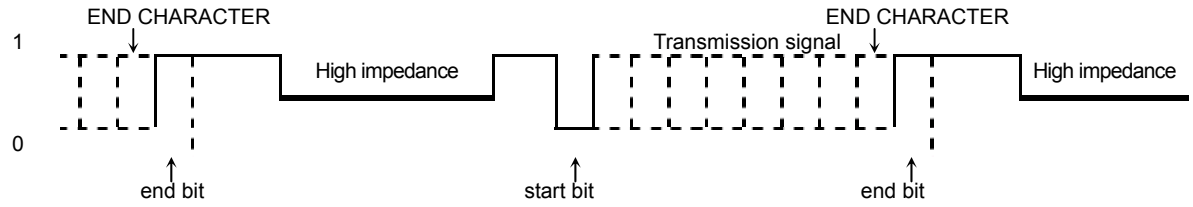
Note 1: With RS-485 specifications, you should mount the 1/2W 120Ω terminating resistor that comes with the terminal element (between + and -) if necessary.
The terminating resistor should however be ultimately mounted on a single controller only.
Operation cannot be guaranteed if a terminating resistor is mounted on more than one controller.

SRS10 Series terminal No.

	SRS11	SRS13/SRS14
+	17	23
−	18	24

3-2. 3-State output control

Because RS-485 is a multidrop system, in order to avoid collision of transmitted signals, transmission is always high impedance if communication is not conducted or during reception. Status changes from high impedance to communication output immediately prior to transmission, and is once again controlled to high impedance as soon as transmission is complete.
However, because 3-state control is delayed approximately 1 msec after end bit transmission of end character is finished, you should provide several msec of delay time when starting transmission immediately after the host receives the transmission.

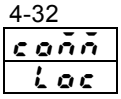


4. Settings related to communication

There are 12 types of parameters related to communication for the SRS10 Series as follows. The parameters cannot be set or modified by communication; use the keys on the front panel to set or modify the parameters.
When setting the parameters, you should follow the procedure as described in “Description and Settings for 6 screens” in the instruction manual.

4-1. Communication mode settings

4-32



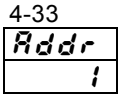
Initial value: Loc
Setting range: Loc, Com

The following selections can be made for communications. Can be changed only from Com to Loc with the front panel keys.

Selection	Valid command	COM lamp
Loc	Read	Off
Com	Read, write	On

4-2. Communication address settings

4-33



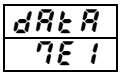
Initial value: 1
Setting range: MAST, 1 – 255

Because it is a multidrop system, connection up to 1 - 31 (max.) is possible.
With this system, each machine is provided with an address (machine No.) to distinguish it so only the machine of the specified address can be handled. When set to MAST, the machine operates as the master.

Note 1: Address can be set to 1 - 255. Up to 31 machines can be connected.

4-3. Communication data format settings

4-34



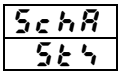
Initial value: 7E1
Setting range: 8 types in the following table

You can select format of communication data from among the following 8 selections.

Selection	Data length	Parity	Stop bits	Shimaden standard	MODBUS/ASCII mode	MODBUS/RTU mode
7E1	7 bits	EVEN	1bit	○	○	–
7E2	7 bits	EVEN	2bit	○	○	–
7N1	7 bits	None	1bit	○	○	–
7N2	7 bits	None	2bit	○	○	–
8E1	8 bits	EVEN	1bit	○	–	○
8E2	8 bits	EVEN	2bit	○	–	○
8N1	8 bits	None	1bit	○	–	○
8N2	8 bits	None	2bit	○	–	○

4-4. State character setting

4-35



Initial value: STX
Setting range: STX, ATT

Selects the control code to be used. This parameter is valid only when Shimaden standard protocol is used.

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

4-5. BCC operation/protocol type setting

4-36

ChY
Add

Initial value: ADD
Setting range: NON, ADD, ADD2, XOR, LRC, CR16

By selecting the BCC operating type, communication protocol is simultaneously selected.

Selection	Operation method	Communication protocol
NON	None	Shimaden protocol
ADD	Addition	
ADD2	Addition + 2's complement	
XOR	XOR (exclusive OR)	
LRC	LRC	MODBUS ASCII
CR16	CRC-16	MODBUS RTU

4-6. Communication speed setting

4-37

bPS
9600

Initial value: 9600 bps
Setting range: 1200, 2400, 4800, 9600, 19200, 38400 bps

Selects/sets communication speed to transmit data to the host.

4-7. Delay time setting

4-38

dELY
20

Initial value: 20
Setting range: 1 – 100

You can set delay time from when communication command is received until transmission.

Delay time (msec) = Setting value (count) x 0.512 (msec)

Note 1: In the case of RS-485, it may take a while for 3-state control by line converter and signal collision may occur in some cases. This can be avoided by increasing delay time. Caution is required particularly if communication speed is slow (1200/2400 bps, etc.).
Note 2: Actual delay time from when the communication command is received until transmission is the total of the delay time and time it takes software to process the command. Especially in the case of a write command, it may take about 400 msec to process the command.

4-8. Communication memory mode settings

4-39

nEn
EEP

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

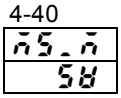
Because the write cycle of the non-volatile memory (EEPROM) used by the SRS10 Series is decided, the life of the EEPROM will be shortened if the SV data is frequently replaced by communications.
In order to prevent this, set to RAM mode when data is to be frequently replaced during communications, so that RAM data can be replaced rather than replacing the data in the EEPROM, thereby extending the life of the EEPROM.

Selection	Processing contents
EEP	Mode whereby EEPROM data is also replaced when data is changed by communications. Consequently data is preserved even if the power is turned off.
RAM	Mode whereby only RAM data is replaced instead of replacing EEPROM data if data is changed by communications. Consequently the data in the RAM is cleared when the power is turned off. When the power is turned back on, operation boots by the data stored in the EEPROM.
r_E	SV and OUT data is written in the RAM only; other data is written in the RAM or EEPROM.

* Caution when in communication memory mode "RAM"
If RAM is set for communication memory mode, all of the descriptions which are set by the communication function are only written for RAM.
Therefore, non-matching can result according to the setting description.
Example: if the measuring range is set to 05: K 0.0-800.0
1. Change event code from higher limit deviation alarm to higher limit absolute alarm by using the communication function, then change the communication mode from COM to LOC.
2. Change the event point from 800.0 to 700.0 by key operation. (Written to EEPROM as this is the key operation.)
3. Shut down the power, then restart.
4. 700.0 is the read-out as although the event code changes by communication function back to the higher limit deviation alarm, the event action point changed by key operation conducts writing to EEPROM.
5. The action point setting range of the higher limit deviation alarm is originally -199.9-200.0.
However, 700.0, abnormal value, is set as a value in this case. Therefore, it should be modified to the normal range of value.

4-9. Master mode setting

4-40



Initial value: SV
Setting range: SV, OUT1, 01SC, OUT2, 02SC

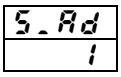
Selects data to be transmitted to slave when in master mode.
Displayed only when in master mode.

Selection	Processing contents
SV	Execution SV value transmitted to slave.
OUT1	Output percentage of output 1 is transmitted.
O1SC	Measuring range value relative to output percentage of output 1 is transmitted.
OUT2	Output percentage of output 2 is transmitted.
O2SC	Measuring range value relative to output percentage of output 2 is transmitted.

Note1: When O1SC/O2SC is selected, actual transmission data is "(measuring range x output percentage) + measuring range lower limit value."

4-10. Start slave machine address

4-41

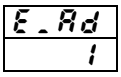


Initial value: 1
Setting range: bcas, 1 – 255

Selects start machine address of slave to transmit data when in master mode.
Displayed only when in master mode.
A broadcast command results when bcas is selected.

4-11. End slave machine address

4-42

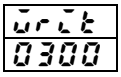


Initial value: 1
Setting range: 1 – 255

Selects start machine address of slave to transmit data when in master mode.
Displayed if start slave address is not bcas when in the master mode.
End slave address can be set in the range of start slave address + 30.

4-12. Write-in data address

4-43



Initial value: 0300H
Setting range: 0000H – FFFFH

Sets slave side communication address for which data is to be replaced when in the master mode.
Displayed when in the master mode.

5. Overview of shimaden communication protocol

The SRS10 Series uses Shimaden communication protocol.
For this reason, data acquisition can be changed by same communication format even if machine of different series using Shimaden communication protocol is connected.

5-1. Communication procedure

(1) Master-slave relationship

- PC and PLC (host) side are on the master side.
- The SRS10 Series is on the slave side.
- Communication is started by communications command from the master side and ends by communication response from the slave side.
  There is however no communication response if an error such as communication format error or BCC error is recognized.
  There is also no communication response for broadcast command as well.

(2) Communication procedure

Communication procedure calls for slave side responding to master side, with mutual transmission authority.

(3) Time out

The controller times out if end character reception is not completed within 1 second after receiving the start character, and begins waiting for another command (new start character).
Therefore set at least 1 second at the time out time on the host side.

5-2. Communication format

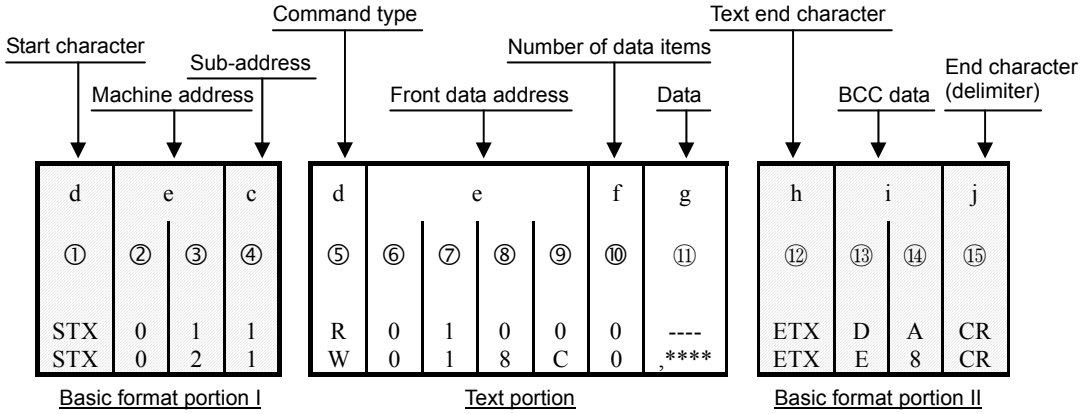
Because the SRS10 Series supports various types of protocol, you can make a wide range of selections by communication format (control code and BCC operating method) and communication data format (data bit length, parity or no parity, stop bit length).
But for the sake of convenience and in order to avoid confusion when making communication settings, we recommend using the following format.

	Recommended format	
Control code	STX_FTX_CR	
BCC operating method	ADD	
Communication data format	7E1	8N1

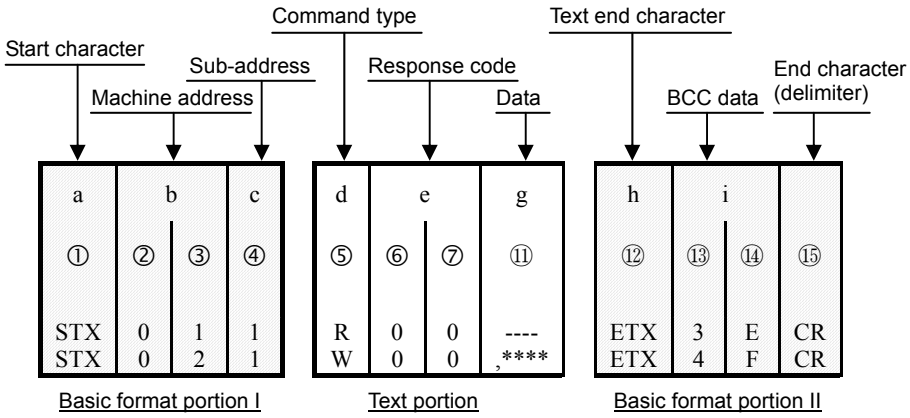
(1) Communication format overview

The communication command format sent from the master and communication response format sent from the slave consist of 3 blocks: basic format portion I, text portion, and basic format portion II.
Basic format portions I and II share read command (R) and write command (W) for communication response.
Operation results data is however inserted for BCC data of i (13 and 14) as it occurs.
Text portion differs according to command type, data address and communication response.

■ **Communication command format**



■ **Communication response format**



(2) Details of basic format portion I

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

- Indicates start character of communication string.
- When start character is received, it is judged to be the first character of a new communication string.
- Start character and text end character are selected as a pair.

Selected by STX (02H) - - - ETX (03H)
Selected by "@" (40H) - - - " : " (3AH)

b: Machine address [②, ③: 2 digits]

- Specifies machine to carry out communication.
- Address is specified in the range of 1 - 255 (decimal notation)
- Binary 8-bit data (1: 0000 0001 - 255: 1111 1111) is divided into top 4 bits and bottom 4 bits and converted to ASCII data.
  ②: Top 4 bits is data converted to ASCII.
  ③: Bottom 4 bits is data converted to ASCII.
- Machine address = 0 (30H, 30H) is used for broadcast command.
  The SRS10 Series supports broadcast command.
  There is however no response for broadcast command, regardless of whether it is normal or not.

c: Sub-address [④: 1 digit]

- The SRS10 Series is a single loop controller and is fixed to 1 (31H).
  If other sub-address is used, there is no response due to sub-address error.

(3) Details of basic format portion II

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

- Indicates text portion runs up to immediately preceding.

I : BCC data [⑬, ⑭: 2 digits]

- BCC (Block Check Character) data is for checking if there was an error in the communications data.
- In the case of BCC error, the result of BCC operation is no response.
- BCC operation includes the following 4 types. (BCC operation types can be set by the front screen.)
  (1) ADD
  Addition is performed by ASCII data 1 character (1 byte) unit from start character ① to text end character ⑫.
  (2) ADD_two's cmp
  Addition is performed by ASCII data 1 character (1 byte) unit from start character ① to text end character ⑫ and the 2's complement of the lower 1 byte of operation results is used.
  (3) XOR
  XOR (Exclusive OR) operation is performed by ASCII data 1 character (1 byte) unit from immediately following start character (machine address ②) to text end character ⑫.
  (4) None
  BCC operation is not performed. (⑬ and ⑭ omitted)
- Operation is performed by 1 byte (8 bits) unit regardless of data bit length (7 or 8).
- The lower 1 byte data of the results of the previously described operation are divided into top 4 bits and bottom 4 bits and converted to ASCII data.
  ⑬: Top 4 bits is data converted to ASCII.
  ⑭: Bottom 4 bits is data converted to ASCII.

Example 1: Read command (R) by BCC 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
Result of addition (1 DAH) lower 1 byte = DAH
⑬ : " D " = 44H, ⑭ : " D " = 41H

Example 2: Read command (R) by BCC 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
Result of addition (1 DAH) lower 1 byte = DAH
Complement of 2 of lower 1 byte (1DAH) = 26H
⑬ : " 2 " = 32H, ⑭ : " 6 " = 36H

Example 3: Read command (R) by 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

02H +30H +31H +31H +52H +30H +31H +30H +30H +30H +03H = 1DAH
(However + = XOR (exclusive OR)
Result of operation (50H) lower 1 byte = 50H
⑬ : " 5 " = 35H, ⑭ : " 0 " = 30H

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

- Indicates end of communication string.

Note

There is no response if an error such as the following is recognized in the basic format portion.

- If a hardware error occurs
- If the machine address or sub-address differs from that of the specified machine
- If character established by previously mentioned communication format is not in the established position
- If BCC operating results differ from BCC data

With data conversion, binary data is converted to ASCII data each 4 bits.
Hexidecimal A - F is converted to ASCII data using upper case letters.

(4) Overview of text portion

Text portion differs according to command type, data address and communication response. For details of the text portion, see "5-3. Read command (R) details" and "5-4. Write command (W) details."

d: Command type [⑤: 1 digit]

- "R" (52H / upper case letter)
  Indicates read command or read command response.
  Used to read various types of data of the SRS10 Series from master PC or PLC.

- "W" (57H / upper case letter)
  Indicates write command or write command response.
  Used to write various types of data from master PC or PLC to the SRS10 Series.

- "B" (42H / upper case letter)
  Indicates broadcast command.
  Used to write all data from the master PC or PLC to the SRS10 Series all at once.

- There is no response if any character other than "R", "W" or "B" is recognized.

e: Front data address [⑥, ⑦, ⑧, ⑨: 4 digits]

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

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

- For more information on data address, see "8-2. Communication Data Addresses."

f: No. of data items [⑩: 1 digit]

- Specifies the number read data items of the read command (R) or the number write data items of the write command (W) and broadcast command (B).
- Number of data items is specified by converting binary 4-bit data to ASCII data.
- With the read command (R), number of data items is specified within the range of 1 item: "0" (30H) - 10 items: "9" (39H). With the SRS10 Series, the maximum number of data items that can be read consecutively is 10 items: "9" (39H).
- The number of data items for the write command (W) is fixed at 1 item: "0" (30H).
- The number of data items for the broadcast command (B) is fixed at 1 item: "0" (30H).
- The actual number of data items is "No. of data items = specified No. of data items + 1."

g: Data [⑪: No. of digits is decided by the No. of data items]

- Specifies write data for write command (W) / broadcast command (B) or read data for read command (R) response.
- The data format is as follows.

g (⑪)

	No. 1 data				No. 2 data					No. n data			
"," 2CH	First digit	2 digits	3 digits	Last 4 digits	First digit	2 digits	3 digits	Last 4 digits		First digit	2 digits	3 digits	Last 4 digits

- A comma ("," 2CH) is always added to the beginning to indicate the following is data. Punctuation marks cannot be used to separate data items.
- The number of data items is in accordance with the number of data items of the communication command format (f: ⑩).
- One item of data is expressed in binary 16-bit units (1 word), excluding decimal point. The position of the decimal point is determined by each item of data.
- 16-bit data is divided into 4-bit segments and converted to ASCII data respectively.
- For details on data, see "5-3. Read command (R) details" and "5-4. write command (W) details."

e: Response code [⑥,⑦: 2 digits]

- Specifies response code for read command (R) and write command (W). Binary 8-bit data (0 - 255) is divided into top 4 bits and bottom 4 bits, and each 4 bits is converted to ASCII data respectively.
  - ⑥: Top 4 bits of data converted to ASCII
  - ⑦: Bottom 4 bits of data converted to ASCII

- "0" (30H), "0" (30H) is specified when response is normal. When response is abnormal, it is specified by converting the error code No. to ASCII data. For details on response code, see "5-5. Response code details."

5-3. Read command (R) details

Used to read various types of data of the SRS10 Series from master PC or PLC.

(1) Read command format

▪ The text portion format of the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

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

▪ d (⑤): Indicates read command.
"R" (52H) fixed.
▪ e (⑥ – ⑨): Specifies front data address of read data.
▪ f (⑩): Specifies number of read data items (words).

▪ The command is as follows:

Front data address for reading = 0400H (hexadecimal)
= 0000 0100 0000 0000 (binary)
Number of read data items = 4H (hexadecimal)
= 0100 (binary)
= 4 (decimal)
(Actual No. of data items) = 5 (4 + 1)

In other words, it specifies reading of 5 consecutive items of data beginning from 0400H.

(2) Normal response format for read command

▪ The normal response format (text portion) for the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e		g															
⑤	⑥	⑦	⑪															
				No. 1 data				No. 2 data					No. 5 data					
R	0	0	,	0	0	1	E	0	0	7	8		0	0	0	3		
52H	30H	30H	2H	30H	30H	31H	45H	30H	30H	37H	38H		30H	30H	30H	33H		

▪ d (⑤) : <R (52H)> that indicates it is response to read command is inserted.
▪ e (⑥ and ⑦): Response code <00 (30H and 30H)> that indicates it is a normal response to the read command is inserted.
▪ g: (⑪) : Response data to read command is inserted.
1. <"," (2CH)> that indicates beginning of data is inserted.
2. Next, the amount of data corresponding to <No. of read data items> is inserted in sequence from <data of front data address for reading>.
3. Nothing is inserted between items of data.
4. 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.
5. The position of the decimal point is determined by each item of data.
6. The number of characters of response data is "No. of characters = 1 + 4 x No. of read data items."

▪ In specific terms, the following data is returned as response data in sequence.

Front data address for reading (0400H)

Number of read data items (4H: 5)

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

(3) Abnormal response format for read command

▪ The abnormal response format (text portion) for the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
R 52H	0 30H	7 37H

▪ d (⑤): <R (52H)> that indicates it is response to read command is inserted.
▪ e (⑥ and ⑦): Response code that indicates it is an abnormal response to the read command is inserted.
▪ Response data is not inserted for abnormal response.
▪ For details of error code, see "5-5. Response code details."

5-4. Write command (W) details

The write command (W) is used to write (modify) various types of data from master PC or PLC to the SRS10 Series.

CAUTION

The communication mode must be changed from LOC to COM when using the write command.

The communication mode cannot be changed by the front panel keys.

Change by transmitting the following command from the master side.

■ **Command format**

For DDR=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

When a normal response is returned for the command given above, the COM LED on the front panel lights and communication mode changes to COM.

(1) Write command format

The text portion format of the write command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

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

- d (⑤) : Indicates write command.
  "W" (57H) fixed.
- e (⑥ – ⑨): Specifies front data address of write data (change).
- f (⑩) : Specifies number of write data items (change).
  The 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 is as follows:

```
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

(2) Normal response format for write command

- The normal response format (text portion) for the write command is as follows.
  Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
W	0	0
57H	30H	30H

- d (⑤) : <W (57H)> that indicates it is response to write command is inserted.
- e (⑥ and ⑦): Response code <00 (30H and 30H)> that indicates it is a normal response to the write command is inserted.

(3) Abnormal response format for write command

▪ The abnormal response format (text portion) for the write command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
W 57H	0 30H	9 39H

▪ d (⑤) : <W (57H)> that indicates it is response to write command is inserted.
▪ e (⑥ and ⑦): Response code that indicates it is an abnormal response to the write command is inserted.
▪ For details of error code, see "5-5. Response code details."

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.

(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 42 H	0 30H	4 34H	0 30H	0 30H	0 30H	, 2CH	0 30H	0 30H	2 32H	8 38H

▪ d (⑤) : Indicates broadcast command.
"B" (42H) fixed.
▪ e (⑥ – ⑨): Specifies front data address of write data (change).
▪ f (⑩) : Specifies number of write data items (change).
The 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	001E	40
0401	1025	0078	120
0402	1026	001E	30

5-6. Response code details

(1) Response code types

The response code is always included in the communication response to the read command (R) and write command (W).
The response code includes normal response code and abnormal response code.
Response code is binary 8-bit data (0 – 255). The details are given in the following table.

Response code list

Response code		Code type	Code contents
Binary	ASCII		
0000 0000	“0”, “0”:30H, 30H	Normal response	Normal response code for read command (R) and write command (W)
0000 0001	“0”, “1”:30H, 31H	Hardware error of text portion	If a hardware error such as framing overrun or parity is detected in the data of the text portion
0000 0111	“0”, “7”:30H, 37H	Format error of text portion	If the format of the text portion differs from the established format
0000 1000	“0”, “8”:30H, 38H	Text portion data format,data address, number of data items error	If data format of the text portion differs from the established format or data address or number of data items not specified
0000 1001	“0”, “9”:30H, 39H	Data error	If write data exceeds the data setting range
0000 1010	“0”, “A”:30H, 41H	Execution command error	When execution command is received when not in the state where an execution command (MAN command, etc.) can be received
0000 1011	“0”, “B”:30H, 42H	Write mode error	When write command including data that cannot be replaced due to type of data is received
0000 1100	“0”, “C”:30H, 43H	Specifications, optional item error	When write command containing data of optional items or specifications not added is received

(2) Response code priority ranking

With the response code, the lower the number the higher the priority ranking is.
If more than one response codes is generated, the one with the highest priority ranking is returned.

6. MODBUS protocol overview

MODBUS protocol includes ASCII and RTU transmission modes.

6-1. Transmission mode overview

(1) ASCII mode

Eight-bit binary data in the command is divided into top and bottom 4 bits and is transmitted as ASCII characters in hexadecimal notation.

■ Data configuration
Data format: Selection of 7E1, 7E2, 7N1 or 7N2
Error check: LRC (horizontal redundancy test)
Data communication standard: Max. 1 sec.

(2) RTU mode

Eight-bit binary data in the command is transmitted as is.

■ Data configuration
Data format: Selection of 8E1, 8E2, 8N1 or 8N2
Error check: CRC-16 (cycle redundancy test)
Data transmission interval: 3.5 character transmission time or less

6-2. Message configuration

(1) ASCII mode

Configured to begin with start character [: (colon) (3AH)] and end with end character [CR (carriage return) (0DH)] +[LF (line feed) (0AH)].

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

(2) RTU mode

Configures to begin after idling over the 3.5 character transmission time and ending when idling over the 3.5 character transmission time elapses.

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

6-3. Slave address

Slave addresses are slave machine numbers 1 – 247. (Up to 255 is possible for SRS10 Series.) Individual slaves are distinguished by specifying slave address by request message. The master is informed which slave is responding by setting slave address and returning it for the response message on the slave side.

6-4. Function code

The function code specifies the type of action to the slave.

Function code	Details
03 (03H)	Slave setting value and information read
06 (06H)	Slave write

The function code is also used to show if the response is normal (affirmative response) or what sort of error (negative response) is occurring when the slave returns a response message to the master.

With affirmative response, the original code is set and returned.

With a negative response, the highest bit of the original function code is set to “1” and returned.
If for instance the function code is mistakenly set to 10H and a request message is sent to the slave, because it is a nonexistent function code, the highest bit is set to “1” and returned as 90H.
Also for a negative response, in order to inform the master what sort of error has occurred, an abnormal code is set in the data of the response message and sent.

Abnormal code	Details
1 (01H)	Illegal function (nonexistent function)
2 (02H)	Illegal data address (nonexistent data address)
3 (03H)	Illegal data value (value outside setting range)

6-5. Data

Configuration of data differs according to the function code.
With request messages from master machines, it consists of data items, number of data items and set data.
With response messages from slave machines, it consists of number of bytes relative to the request, or abnormal code, etc., for negative response.
The valid range of data is -32768 to 32767.

6-6. Error check

The error check method differs according to transmission mode.

(1) ASCII mode

Error check in the ASCII mode calculates LRC from slave address to final data item; the 8-bit calculated data is converted to ASCII character 2 character and set following the data.

■ LRC calculation method

1. Prepare a message in RTU mode.
2. Add from slave address to final data item and substitute for X.
3. Take the complement of X (bit inverse) and substitute for X.
4. Add 1 to X and substitute for X.
5. Set X as LRC following data.
6. Convert message to ASCII characters.

(2) RTU mode

Error check in the RTU mode calculates CRC-16 from slave address to final data item; the 16-bit calculated data is set in bottom/top order following the data.

■ CRC-16 calculation method

CRC formula divides data to be sent by generating polynomial and the remainder is added to the end of the data and sent.

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

1. Initialize CRC data (X) (FFFFH)
2. Take the first data item and exclusive OR (XOR) and substitute for X.
3. Shift X 1 bit to the right and substitute for X.
4. If carry is enabled by shifting, take XOR by results X of (3) and fixed value (A001H) and substitute for X.
   If carry is enabled, proceed to 5.
5. Repeat steps 3 and 4 until shifted 8 times.
6. Take the next data item and XOR of X and substitute for X.
7. Repeat steps 3-5.
8. Repeat steps 3-5 up to the final data item.

X is set as CRC-16 in message following the data in bottom/top order.

6-7. Sample messages

(1) ASCII mode

■ **Machine No. 1, SV read**

▪ Request message from master machine

Header	Slave address	Function code	Data address	No. of data items	Error check LRC	Delimiter
(:)	(01H)	(03H)	(0300H)	(0001H)	(F8H)	(CR・LF)
1	2	2	4	4	2	2 ← No. of characters (17)

▪ Response message from slave when normal (SV = 10.0°C).

Header	Slave address	Function code	No. of response bytes	Data	Error check LRC	Delimiter
(:)	(01H)	(03H)	(02H)	(0064H)	(96H)	(CR・LF)
1	2	2	2	4	2	2 ← No. of characters (15)

▪ Response message from slave when abnormal (data item mistaken)

Header	Slave address	Function code	Abnormal code	Error check LRC	Delimiter
(:)	(01H)	(83H)	(02H)	(7AH)	(CR・LF)
1	2	2	2	2	2 ← No. of characters (11)

With response messages when an error occurs, “1” is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, SV = 10.0°C write**

▪ Request message from master machine

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

← No. of characters (17)

▪ Response message from slave when normal (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

← No. of characters (17)

▪ Slave side response message when abnormal (value set outside range)

Header (:)	Slave address (01H)	Function code (86H)	Abnormal code (03H)	Error check LRC (76H)	Delimiter (CR・LF)
1	2	2	2	2	2

← No. of characters (11)

With response messages when an error occurs, “1” is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

(2) RTU mode

■ **Machine No. 1, SV read**

▪ Request message from master machine

Idle 3.5 character	Slave address (01H)	Function code (03H)	Data address (0300H)	No. of data items (0001H)	Error check CRC (844EH)	Idle 3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal (SV = 10.0°C).

Idle 3.5 character	Slave address (01H)	Function code (03H)	No. of response bytes (02H)	Data (0064H)	Error check CRC (B9AFH)	Idle 3.5 character
	1	1	1	2	2	

← No. of characters (7)

▪ Response message from slave when abnormal (data item mistaken)

Idle 3.5 character	Slave address (01H)	Function code (83H)	Abnormal code (02H)	Error check LRC (C0F1H)	Idle 3.5 character
	1	1	1	2	

← No. of characters (5)

With response messages when an error occurs, “1” is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, SV = 10.0°C setting**

▪ Request message from master machine

Idle 3.5 character	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal (SV = 10.0°C)

Idle 3.5 character	Slave address (01H)	Function code (06H)	Data address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Slave response message when abnormal (value set outside range)

Idle 3.5 character	Slave address (01H)	Function code (86H)	Abnormal code (03H)	Error check CRC (0261H)	Idle 3.5 character
	1	1	1	2	

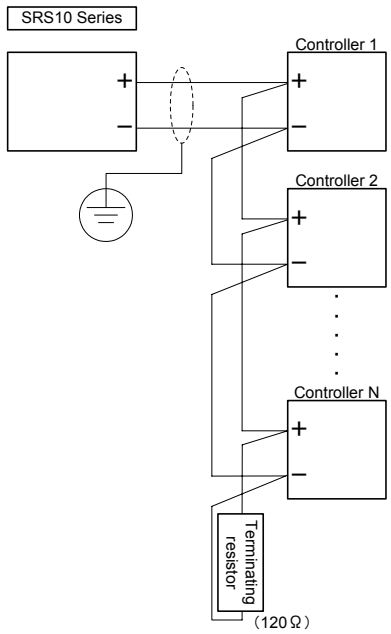
← No. of characters (5)

With response messages when an error occurs, “1” is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

7. Communication master function overview

By selecting "MASt" as the communication address setting, you can operate the machine as the master machine in various communication protocols.

7-1. Master/slave connection



Note 1: With RS-485 specifications, you should mount the 1/2W 120Ωt terminating resistor that comes with the terminal element (between + and -) if necessary.
The terminating resistor should however be ultimately mounted on a single controller only.
Operation cannot be guaranteed if a terminating resistor is mounted on more than one controller.

SRS10 Series terminal No.

	SRS11	SRS13/SRS14
+	17	23
−	18	24

Note 1: Only one master within one communications loop. Communication will not be normal if there is more than one master.

7-2. Transmission processing

A write command is sent to write address (slave side communication address) specified in sequence from start slave address to end slave address.
In reality however the slave side receives write commands only when the communication mode is COM mode, so the "0x018C: communication mode" is sent mutually as a command to switch to COM mode. Two commands at a time are therefore sent to each slave.

The write slave address is always "0" when the start slave address is "bcAS" (broadcast command). Thus data cannot be written if a machine that does not support broadcast command is connected as a slave.

7-3 Time out

If a response command is not received within 500 msec after transmission to a slave is complete, time out occurs and data is then transmitted to the next slave machine.

7-4. SV Value Write

If SV values executed such as program control are always changed and if there are multiple slave machines, processing is not in time for update cycle of SV values, and the SV values may differ among the various slave machines.
If more than one slave machine that supports broadcast command is connected, you can avoid such phenomena by using the broadcast command.

The SV values sent when the machine is on standby are as follows:

- FIX action: SV value of set SV No. is transmitted.
- PROG action: Start SV value of start pattern is transmitted.

* For FIX action, the same value is transmitted for both execution and standby.

8. Communication data address

8-1. Communication data address details

Note: The error response code is explained using the code when using Shimaden protocol.

(1) Data address and read/write

- Data address is expressed by expressing binary (16-bit) data in hexadecimal notation, 4 bits at a time.
- R/W is data that can be read and written.
- R is read only data.
- W is write only data.
- If a write-only data address is specified by read command (R), or if a read-only data address is specified by write command (W) or broadcast command (B), a data address error results and error response code “0” or “8” (30H, 38H) (text portion format, data address, No. of data items error) is returned.

(2) Data address and No. of data items

- If a data address not given in the data addresses for SRS10 is specified as the initial data address, a data address error results and error response code “0” or “8” (30H, 38H) (text portion format, data address, No. of data items error) is returned.
- For read command, if the front data address is among the given data addresses and the data address to which the number of data items is added makes it outside the given data addresses, read data is “0.”

(3) Data

- Because the various data items is binary (16-bit) data without decimal points, the data format, existence of decimal points, etc., must be checked. (Refer to the SRS10 Series Instruction Manual.)

Example: Expression of data with decimal point

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

- The decimal point position is decided by measuring range for data for which the unit is UNIT.
- Data is handled as coded binary (16-bit data: -32768 to 32767).

Example: Expression of 16-bit data

Coded data	
Decimal	Hexadecimal
0	0000
1	0001
≈	≈
32767	7FFF
-32768	8000
-32767	8001
≈	≈
-2	FFFE
-1	FFFF

(4) “Spare” of parameter portion

If the “Spare” portion is read by read command (R) or written by write command (W), normal response code “0”, “0” (30H, 30H) is returned.

(5) Parameters concerning optional items

If the data address of a parameter not added as an optional item is specified, abnormal response code “0”, “C” (30H, 43H) (Specification / optional item error) is returned for both the read command (R) and write command (W).

(6) Parameters not displayed on the front panel display due to action or setting specifications

Parameters not displayed (not used) on the front panel display depending on action or setting specifications can be read and written by communication.

8-2. Communication data addresses

Data Addr. (Hex)	Parameter	Setting range	R/W
0040		Series code 1	R
0041		Series code 2	R
0042		Series code 3	R
0043		Series code 4	R

▪ The address area given above is the product ID data, and is 8-bit unit ASCII data.
Two data items are therefore expressed as 1 address.

▪ The series code is expressed as a maximum of 8 data items. 00H data is inserted in surplus area.

Example: SRS11

address	H	L	H	L
0040	"S", "R"		53H,52H	
0041	"S", "1"		53H,31H	
0042	"1"		31H,00H	
0043			00H,00H	

Example: SRS13

address	H	L	H	L
0040	"S", "R"		53H,52H	
0041	"S", "1"		53H,32H	
0042	"3"		33H,00H	
0043			00H,00H	

0100	PV	Measurement value HHHH/CJHH/B---:7FFFH LLLL/CJLL:8000H	R
0101	SV	Execution SV value	R
0102	OUT1	Control output 1 value	R
0103	OUT2	Control output 2 value (no optional items = 0000H) (*See bit information)	R
0104	EXE_FLG	Action flag (no action bit = 0) (*See bit information)	R
0105	EV_FLG	Event output flag (no optional items = 0000H) (*See bit information)	R
0106	SV No.	Execution SV No.	R
0107	EXE PID	Execution PID No.	R

0109	HC1	Heater 1 current value No OP: 0000H HBHH:7FFFH HBLL:8000H Invalid data: 7FFEH	R
010A	HC2	Heater 2 current value No OP: 0000H HBHH:7FFFH HBLL:8000H Invalid data: 7FFEH	R
010B	DI_FLG	DI input status flag	R

010D	EV_LAC	Event latching output flag (*See bit information)	R
010E	EV_ACT	Event relay ON/OFF flag (*See bit information)	R

0120	E_PRG	Program action flag (*See bit information)	R
0121	E_PTN	Program execution pattern No. (Other than PROG RUN: 7FFEH)	R

0123	E_PRG	Number of patterns executed. (Other than PROG RUN: 7FFEH)	R
0124	E_PTN	Program execution step No. (Other than PROG RUN: 7FFEH)	R
0125	E_TIM	Program execution step remaining time (Other than PROG RUN: 7FFEH)	R
0126	E_PID	Program execution PID No. (Other than PROG RUN: 7FFEH)	R

▪ Bit information details are as follows:

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
EXE_FLG :	0	0	0	0	0	0	AT/W	COM	0	0	0	0	0	STBY	MAN	AT
EV_FLG :	0	0	0	0	0	0	0	0	0	0	0	0	0	EV3	EV2	EV1
DI_FLG :	0	0	0	0	0	0	0	0	0	0	0	0	DI4	DI3	DI2	DI1
EV_LAC :	0	0	0	0	0	0	0	0	0	0	0	0	0	EV3	EV2	EV1
EV_ACT :	0	0	0	0	0	0	0	0	0	0	0	0	0	EV3	EV2	EV1
E_PRG :	PRG	0	0	0	0	UP	LVL	DW	0	0	0	0	ADV	0	HLD	RUN

▪ E_TIM "program execution step remaining time" details are as follows:

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
E_TIM :	←	0-9 * 10h(m)		→	←	0-9 * 1h(m)		→	←	0-5 * 10m(s)		→	←	0-9 * 1m(s)		→

Example: if remaining time is 30 minutes 29 seconds

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
E_TIM :	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	1
HEX	←	3		→	←	0		→	←	2		→	←	9		→

0180	SV_NO	Execution SV No.	W

0182	OUT1	Control output 1 setting value for MAN setting value	W
0183	OUT2	Control output 2 setting value for MAN setting value (optional)	W
0184	AT	0 = No execution, 1 = Execution	W
0185	MAN	0 = AUTO, 1=MAN	W
0186	RUN	0 = STBY, 1 = Execution	W

018C	COM	0=Loc, 1=Com	W

0191	HLD	Hold: 0:HLF OFF, 1:HLD ON (optional)	W
0192	ADV	Advance 1: ADV ON (optional)	W

Data Addr. (Hex)	Parameter	Setting range	R/W
0198	RST_LACH	Latching alarm cancel	W

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
RST_LACH:	0	0	0	0	0	0	0	0	0	0	0	0	0	EV3	EV2	EV1

0300	FIX SV1	FIX SV value 1	R/W
0301	FIX SV2	FIX SV value 2	R/W
0302	FIX SV3	FIX SV value 3	R/W

030A	SV_L	Setting value limiter lower limit value	R/W
030B	SV_H	Setting value limiter higher limit value	R/W

0400	PB1	Control output 1, proportional band 1	R/W
0401	IT1	Control output 1, integral time1	R/W
0402	DT1	Control output 1, derivative time1	R/W
0403	MR1	Manual reset 1	R/W
0404	DF1	Control output 1, hysteresis1	R/W
0405	O11_L	Control output 1, lower limit output limiter 1	R/W
0406	O11_H	Control output 1, higher limit output limiter 1	R/W
0407	SF1	Control output 1, target value function 1	R/W
0408	PB2	Control output 1, proportional band 2	R/W
0409	IT2	Control output 1, integral time 2	R/W
040A	DT2	Control output 1, derivative time 2	R/W
040B	MR2	Manual reset 2	R/W
040C	DF2	Control output 1, hysteresis 2	R/W
040D	O12_L	Control output 1, lower limit output limiter 2	R/W
040E	O12_H	Control output 1, higher limit output limiter 2	R/W
040F	SF2	Control output 1, target value function 2	R/W
0410	PB3	Control output 1, proportional band 3	R/W
0411	IT3	Control output 1, integral time 3	R/W
0412	DT3	Control output 1, derivative time 3	R/W
0413	MR3	Manual reset 3	R/W
0414	DF3	Control output 1, hysteresis 3	R/W
0415	O13_L	Control output 1, lower limit output limiter 3	R/W
0416	O13_H	Control output 1, higher limit output limiter 3	R/W
0417	SF3	Control output 1, target value function 3	R/W

0460	PB21	Control output 2, proportional band 1 (optional)	R/W
0461	IT21	Control output 2, integral time 1 (optional)	R/W
0462	DT21	Control output 2, derivative time1 (optional)	R/W
0463	DB21	*Dead band 1 (optional)	R/W
0464	DF21	Control output 2, hysteresis1 (optional)	R/W
0465	O21_L	Control output 2, lower limit output limiter 1 (optional)	R/W
0466	O21_H	Control output 2, higher limit output limiter 1 (optional)	R/W
0467	SF22	Control output 2, target value function 1 (optional)	R/W
0468	PB22	Control output 2, proportional band 2 (optional)	R/W
0469	IT22	Control output 2, integral time 2 (optional)	R/W
046A	DT22	Control output 2, derivative time 2 (optional)	R/W
046B	DB22	*Dead band 2 (optional)	R/W
046C	DF22	Control output 2, hysteresis2 (optional)	R/W
046D	O22_L	Control output 2, lower limit output limiter 2 (optional)	R/W
046E	O22_H	Control output 2, higher limit output limiter 2 (optional)	R/W
046F	SF22	Control output 2, target value function 2 (optional)	R/W
0470	PB23	Control output 2, proportional band 3 (optional)	R/W
0471	IT23	Control output 2, integral time 3 (optional)	R/W
0472	DT23	Control output 2, derivative time 3 (optional)	R/W
0473	DB23	*Dead band 3 (optional)	R/W
0474	DF23	Control output 2, hysteresis 3 (optional)	R/W
0475	O23_L	Control output 2, lower limit output limiter 3 (optional)	R/W
0476	O23_H	Control output 2, higher limit output limiter 3 (optional)	R/W
0477	SF23	Control output 2, target value function 3 (optional)	R/W

Data Addr. (Hex)	Parameter	Setting range	R/W
0500	EV1_MD	Event 1 mode (see 9-2 Event types) (optional)	R/W
0501	EV1_SP	Event 1 setting value (see 9-2 Event types) (optional) The event mode can be changed by communicating settings other than alarm, but are initialized when event mode is changed. (Writing range is -1999 to 9999.)	R/W
0502	EV1_DF	Event 1, hysteresis (optional)	R/W
0503	EV1_STB	Event 1, standby action (optional) 1. Alarm action, no standby 2: Alarm action, standby (power ON, STBY -> EXE) 3: Alarm action, standby (power ON, STBY -> EXE, SV change) 4. Control action, no standby	R/W

0505	EV1_CHR	Event 1, latching / output characteristic (optional)	R/W

D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0

EV1_CHR: (Latching (OFF:00H, ON: 01H), Output characteristics (N.O: 00H, N.C: 01H)

0508	EV2_MD	Event 2 mode (see 9-2 Event types) (optional)	R/W
0509	EV2_SP	Event 2 setting value (see 9-2 Event types) (optional) The event mode can be changed by communicating settings other than alarm, but are initialized when event mode is changed. (Writing range is -1999 to 9999.)	R/W
050A	EV2_DF	Event 2, hysteresis (optional)	R/W
050B	EV2_STB	Event 2, standby action (optional) 1. Alarm action, no standby 2: Alarm action, standby (power ON, STBY -> EXE) 3: Alarm action, standby (power ON, STBY -> EXE, SV change) 4. Control action, no standby	R/W

050D	EV2_CHR	Event 2, latching / output characteristic (optional)	R/W

D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0

EV2_CHR: (Latching (OFF:00H, ON: 01H), Output characteristics (N.O: 00H, N.C: 01H)

0510	EV3_MD	Event 3 mode (see 9-2 Event types) (optional)	R/W
0511	EV3_SP	Event 3 setting value (see 9-2 Event types) (optional) The event mode can be changed by communicating settings other than alarm, but are initialized when event mode is changed. (Writing range is -1999 to 9999.)	R/W
0512	EV3_DF	Event 3, hysteresis (optional)	R/W
0513	EV3_STB	Event 3, standby action (optional) 1. Alarm action, no standby 2: Alarm action, standby (power ON, STBY -> EXE) 3: Alarm action, standby (power ON, STBY -> EXE, SV change) 4. Control action, no standby	R/W

0515	EV3_CHR	Event 3, latching / output characteristic (optional)	R/W

D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0

EV2_CHR: (Latching (OFF:00H, ON: 01H), Output characteristics (N.O: 00H, N.C: 01H)

0580	DI1	DI1 type (optional)	R/W
0581	DI2	DI2 type (optional)	R/W
0582	DI3	DI3 type (optional)	R/W
0583	DI4	DI4 type (optional)	R/W

0590	CT1_HBS	Heater 1 burnout alarm setting (optional)	R/W
0591	CT1_HBL	Heater 1 loop alarm setting (optional)	R/W
0592	CT1_MD	Heater 1 mode setting, 0=OUT1, 1=OUT2 (optional)	R/W

0598	CT2_HBS	Heater 2 burnout alarm setting (optional)	R/W
0599	CT2_HBL	Heater 2 loop alarm setting (optional)	R/W
059A	CT"_MD	Heater 2 mode setting, 0=OUT1, 1=OUT2 (optional)	R/W

Data Addr. (Hex)	Parameter	Setting range	R/W
05A0	AO1_MD	Analog output mode, 0=PV, 1=SV, 2=OUT1 3=OUT2 (optional)	R/W
05A1	AO1_L	Analog output scale lower limit value (optional)	R/W
05A2	AO1_H	Analog output scale higher limit value (optional)	R/W
05B0	COM_MEM	Communication memory mode, 0=EEP, 1=RAM 2=r_E (optional)	R/W
05B4	AO_LL	Analog output limiter lower limit value (optional)	R/W
05B5	AO_HH	Analog output limiter higher limit value (optional)	R/W
0600	ACTMD	Control output 1, output characteristics, 0=RA, 1=DA	R/W
0601	O1_CYC	Control output 1, proportional cycle	R/W
0604	O2_CYC	Control output 2, proportional cycle (optional)	R/W
0607	ACTMD2	Control output 2, output characteristics, 0=RA, 1=DA (optional)	R/W
060A	SOFTD1	Output 1, soft start setting data	R/W
060B	SOFTD2	Output 2, soft start setting data (optional)	R/W
0611	KLOCK	Key lock, 0 = OFF 1 = User setting screen group, other than communication locked 2 = SV value, other than communication locked 3 = Other than communication locked	R/W
0700	PV_G	PV gain compensation	R/W
0701	PV_B	*PV bias	R/W
0702	PV_F	*PV filter	R/W
0704	UNIT	Input unit 0: "°C" 1: "°F" 2: "K"	R/W
0705	RANGE	See 9-1. Measuring range codes	R/W
0707	DP	0:None 1:XXX.X 2:XX.XX 3:X.XXX	R/W
0708	SC_L	Input scaling lower limit value	R/W
0709	SC_H	Input scaling higher limit value	R/W
0800	PRG_MD	Program mode, 0: PROG, 1: FIX (optional)	R/W
0802	ST_PTN	Start pattern No. (optional)	R/W
0818	PTN_CNT	Number of patterns, 1, 2, 4 (optional)	R/W
0819	TIM_MOD	Time unit, 0: HM (hours, minutes), 1: MS (milliseconds) (optional)	R/W

Only linear input can be changed.

■ Pattern No. and step No. should be assigned when conducting read/write processing on "0903: pattern end step" address or later.
Read/write processing of data "0903" or later should be conducted after assigning pattern No. on address "0900" and step No. on address "0901."

0900	PTN_NO	Pattern No. for communication setting (optional)	R/W
0901	STP_NO	Step No. for communication setting (optional)	R/W
0903	P_ED_STP	Pattern end step (optional)	R/W
0905	P_RTP	Number of pattern repeat executions (optional)	R/W
0906	P_ST_SV	Pattern start SV value (optional)	R/W
0909	P_PV_ST	Start mode (optional)	R/W
0912	P_EV1	Pattern event 1 setting (see 9-2 Event Types) (optional)	R/W
0913	P_EV2	Pattern event 2 setting (see 9-2 Event Types) (optional)	R/W
0914	P_EV3	Pattern event 3 setting (see 9-2 Event Types) (optional)	R/W
0950	STEP_SV	Step SV value (optional)	R/W
0951	STEP_TM	Step time (optional)	R/W
0952	STEP_PID	Step PID No. (optional)	R/W

▪ STEP_TM "step time" details are as follows:

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
STEP_TM:	←	0-9 * 10h(m)		→	←	0-9 * 1h(m)		→	←	0-5 * 10m(s)		→	←	0-9 * 1m(s)		→

Example: if setting 55 minutes 39 seconds

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
STEP_TM:	0	1	0	1	0	1	0	1	0	0	1	1	1	0	0	1
HEX	←	5		→	←	5		→	←	3		→	←	9		→

9. Supplementary explanation

9-1. Measuring range codes

Input type			Code	Measuring range	Measuring range
Universal input	Thermocouple	B *1	01	0 ~ 1800 °C	0 ~ 3300 °F
		R	02	0 ~ 1700 °C	0 ~ 3100 °F
		S	03	0 ~ 1700 °C	0 ~ 3100 °F
		K	04 *2	-199.9 ~ 400.0 °C	-300 ~ 750 °F
			05	0.0 ~ 800.0 °C	0 ~ 1500 °F
			06	0 ~ 1200 °C	0 ~ 2200 °F
		E	07	0 ~ 700 °C	0 ~ 1300 °F
		J	08	0 ~ 600 °C	0 ~ 1100 °F
		T	09 *2	-199.9 ~ 200.0 °C	-300 ~ 400 °F
		N	10	0 ~ 1300 °C	0 ~ 2300 °F
		PL Ⅱ *3	11	0 ~ 1300 °C	0 ~ 2300 °F
		WRe5-26 *4	12	0 ~ 2300 °C	0 ~ 4200 °F
		U *5	13 *2	-199.9 ~ 200.0 °C	-300 ~ 400 °F
		L *5	14	0 ~ 600 °C	0 ~ 1100 °F
	Thermocouple Kelvin	K	15 *6	10.0 ~ 350.0 K	10.0 ~ 350.0 K
		AuFe-Cr	16 *7	0.0 ~ 350.0 K	0.0 ~ 350.0 K
		K	17 *6	10 ~ 350 K	10 ~ 350 K
		AuFe-Cr	18 *7	0 ~ 350 K	0 ~ 350 K
	*R.T.D.	Pt100	31	-200 ~ 600 °C	-300 ~ 1100 °F
			32	-100.0 ~ 100.0 °C	-150.0 ~ 200.0 °F
			33	-50.0 ~ 50.0 °C	- 50.0 ~ 120.0 °F
			34	0.0 ~ 200.0 °C	0.0 ~ 400.0 °F
		JPt100	35	-200 ~ 500 °C	-300 ~ 1000 °F
			36	-100.0 ~ 100.0 °C	-150.0 ~ 200.0 °F
			37	- 50.0 ~ 50.0 °C	- 50.0 ~ 120.0 °F
			38	0.0 ~ 200.0 °C	0.0 ~ 400.0 °F
	mV	-10~10mV	71	Initial value: 0.0 – 100.0 Input scaling setting range: -1999 – 9999 Span: 10 – 10,000 count Decimal point position: None, 1/2/3 digits following decimal point Lower limit value is less than higher limit value.	
		0~10mV	72		
		0~20mV	73		
		0~50mV	74		
		10~50mV	75		
		0~100mV	76		
Voltage	V	-1~ 1V	81	Initial value: 0.0 – 100.0 Input scaling setting range: -1999 – 9999 Span: 10 – 10,000 count Decimal point position: None, 1/2/3 digits following decimal point Lower limit value is less than higher limit value.	
		0~ 1V	82		
		0~ 2V	83		
		0~ 5V	84		
		1~ 5V	85		
		0~10V	86		

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

*1. Thermocouple B: Accuracy guarantee not applicable to 400°C (752°F) or below.
*2. Thermocouple K, T, U: Accuracy of those readings below -100°C is ±0.7% FS.
*3. Thermocouple PLII: Platinel
*4. Thermocouple WRe5-26: A product of Hoskins
*5. Thermocouple U, L: DIN 43710
*6. Thermocouple K (Kelvin) accuracy

Temperature Range	
10.0 – 30.0 K	± (2.0% FS + [CJ error × 20] K + 1K)
30.0 – 70.0 K	± (1.0% FS + [CJ error × 7] K + 1K)
70.0 – 170.0 K	± (0.7% FS + [CJ error × 3] K + 1K)
170.0 – 270.0 K	± (0.5% FS + [CJ error × 1.5] K + 1K)
270.0 – 350.0 K	± (0.3% FS + [CJ error × 1] K + 1K)

*7. Thermocouple Metal-chromel (AuFe-Cr) (Kelvin) accuracy

Temperature Range	
0.0 – 30.0 K	± (0.7% FS + [CJ error × 3] K + 1K)
30.0 – 70.0 K	± (0.5% FS + [CJ error × 1.5] K + 1K)
70.0 – 170.0 K	± (0.3% FS + [CJ error × 1.2] K + 1K)
170.0 – 280.0 K	± (0.3% FS + [CJ error × 1] K + 1K)
280.0 – 350.0 K	± (0.5% FS + [CJ error × 1] K + 1K)

9-2. Types of event

Alarm code	Types of event	Value	Initial value	Setting range
non	None	0	–––––––	–––––––––––
Hd	Higher limit deviation	1	2000 (unit)	-1999 – 2000 (unit)
Ld	Lower limit deviation	2	-1999 (unit)	-1999 – 2000 (unit)
od	Outside higher/lower limit deviation	3	2000 (unit)	0 – 2000 (unit)
id	Inside higher/lower limit deviation	4	2000 (unit)	0 – 2000 (unit)
HA	Higher limit absolute value	5	Measuring range higher limit value	Within measuring range
LA	Lower limit absolute value	6	Measuring range lower limit value	Within measuring range
So	Scaleover	7	EV output continues for scaleover.	
run	RUN signal	8	EV output continues for execution.	
HC1	Heater 1 break/loop	9	EV output continues for heater 1 break/loop trouble.	
HC2	Heater 2 break/loop	10	EV output continues for heater 1 break/loop trouble.	
StPS	Step signal	11	EV output for 1 second for step switch.	
PtnS	Pattern signal	12	Ev output for 1 second each time pattern ends.	
EndS	Program end signal	13	Ev output for 1 second each time program ends.	
Hold	Hold signal	14	EV output continues for hold.	
ProG	Program signal	15	EV output continues for program mode.	
u.SL	Up slope signal	16	EV output continues for up slope execution.	
d.SL	Down slope signal	17	EV output continues for down slope execution.	

9-3. Table of DI types

DI code	DI type	Value	Action
non	None	0	No allocation
run1	RUN/RST toggle	1	Toggles RUN/RST (level designation)
run2	RUN/RST toggle	2	Toggles RUN/RST (edge designation)
mAn	MAN	3	Switches manual output.
At	AT	4	AT start instruction
ESb2	SV external selection	5	Designates execution SV No. by 2 bits.
ProG	Program	6	Toggles between program mode and FIX mode.
Hold	Hold	7	Temporarily stops step time.
Adv	Advance	8	Moves on to next step.
Ptn2	Start pattern No. designation 2	9	Designates start pattern No. by 2 bits.
Ptn3	Start pattern No. designation 3	10	Designates start pattern No. by 3 bits.
L.rS	Latching release	11	Releases latching for event.

9-4. ASCII codes table

	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	C6(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

The contents of this manual are subject to change without notice.

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