Digital Indicator

SD16A Series

COMMUNICATION INTERFACE (RS-232C/RS-485)

INSTRUCTION MANUAL

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

Contents

Preface

Thank you for purchasing Shimaden products.

Please check that the delivered product is the correct item you ordered.

This instruction manual describes the communication interface which is an optional function of the SD16A digital indicator. For details of its performance and parameters, please refer to the separate instruction manual.

Matters of attention concerning safety, damages on machines and equipment, additional explanations and precautions are described under the following headings.

⚠ WARNING	Items concerning matters that may lead to an accident involving human injury or death, if the warning is not observed.
⚠ CAUTION	Items concerning matters that may lead to an accident involving damages to machines or equipment, if the caution is neglected.

Note **Note** Additional explanations and commentaries.

1. Overview

The instrument supports one of the two communication interfaces, RS-232C and RS-485. These allow you to set or get various data of the instrument from/into a personal computer or the like.

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, that is, matters related to applicable hardware but not the data transmission procedure of software. Therefore, users need to have sufficient knowledge of specifications and transmission procedure.

2. Specification

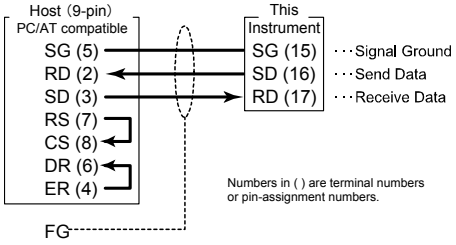
Communication type		EIA RS-232C, RS-485 compatible
Communication system		RS-232C, 3-line half duplex system RS-485, 2-line half duplex multi-drop (bus) system
Synchronization system		Half duplex start-stop synchronization system
Communication distance		RS-232C 15 m maximum RS-485 maximum total of 500 m (differs depending on conditions.)
Communication speed		1200, 2400, 4800, 9600, 19200 bps
Transmission procedure		No procedure
Communication address		1～100
Number of connectable devices		31 devices max. (for RS-485)
Delay		1~100 msec
Communication protocol		Shimaden protocol, MODBUS ASCII, MODBUS RTU
Shimaden	Data format	7E1, 7E2, 7N1, 7N2, 8E1, 8E2, 8N1, 8N2
	Control code	STX_ETX_CR, @_:_CR
	Checksum (BCC)	1 ADD operation from start character to text end character 2 2's complement after ADD operation from start character to text end character. 3 XOR operation from after start character to text end character. 4 BCC operation is not performed.
	Communication code	ASCII Code
MODBUS ASCII	Data format	7E1, 7E2, 7N1, 7N2
	Control code	_CRLF
	Error check	LRC check
	Communication code	ASCII Code
MODBUS RTU	Data format	8E1, 8E2, 8N1, 8N2
	Control code	None
	Error check	CRC check
	Communication code	Binary code
Isolation		Isolated between communication and input, between communication and alarm output, between communication and analog output (sensor power supply), or between communication and system.

3. Connecting with host computer

3-1. RS-232C

This indicator is provided with only 3 lines for input and output, i.e., for data transmission, data reception and grounding for signals, not with any other signal lines. Since the indicator has no control line, control signals should be handled on the host side. The following drawing shows an example of control signal processing methods. As the method depends on the system, however, please use this instrument with regard to the host computer's specifications.

Connection Example



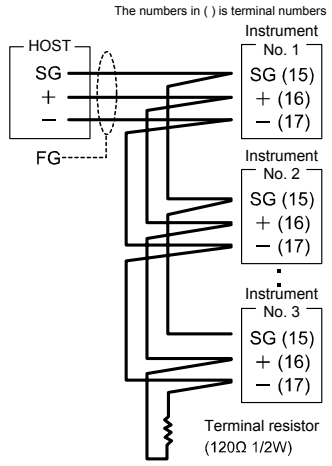
3-2. RS-485

Multiple indicators can be connected by introducing RS-485. In case of connecting via RS-485 on personal computers, please attach off-the-shelf "RS-485 converter."

When the RS-485 communication system is employed, the last indicator needs to be attached with a terminal resistor. The attached terminal resistor (1/2W 120Ω or so) should be inserted across the terminals (16) and (17). In case the terminal resistor cannot be attached to the last indicator, the internal terminal resistor of SD16A can be used. For more details, refer to "Using the internal terminal resistor."

The transmission output is held at high impedance until just before starting of sending data. For more details, refer to "Control of 3-state output."

Connection Example



Using the internal terminal resistor

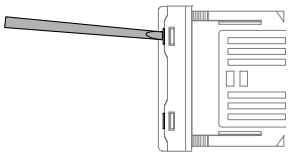
Please follow the steps below to use the internal terminal resistor. The terminal resistor is disabled at the factory default.

> **CAUTION**
>
> - Do not pull out the indicator inside from its case unless using the internal resistor. It may cause damages or failure to the instrument.

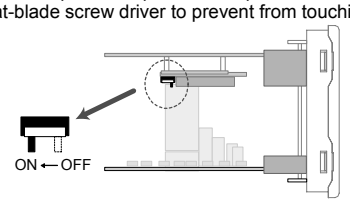
1. Turn off the power to the indicator.
   Confirm the power to the indicator is OFF because the inside of the indicator is pulled out of its case by the following steps.

> **WARNING**
>
> - When pulling an instrument out of its case, be sure to cut the power supply OFF. There is a risk of electric shock.
> - Do not touch the terminals and electrically charged parts while power is ON.

2. Pull the instrument out of its case.
   Attach a 2 to 4 mm-width flat-blade screw driver to a groove, insert it under the bezel on both sides of instruments, and gently pry it up. Grooves can be found on the left side and the right side of instrument. After the both sides of the front cover come out of its case, use fingers to catch hold on it, and pull it out.



3. Slide the switch of the terminal resistor to left.
   As the following illustration, slide the switch of internal terminal resistor from right to left, placing the instrument with its front pointed to right and with its top surface pointed to top. When sliding it, use a tool like flat-blade screw driver to prevent from touching nothing but the switch.

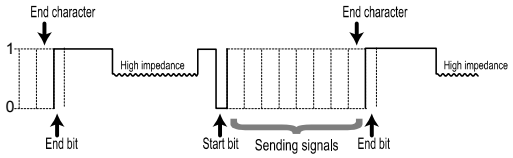


4. House the instrument in its case.
   Confirming the instrument and its case directions, push the instrument into the case gently. The top of the case, the terminal label is stuck.

> **CAUTION**
>
> - First confirm the direction of instrument, and then house it into the case. If it is housed upside down, the terminal part may be damaged, and the instrument's fault or damage might be caused.

Control of 3-state output

As the collision of sending signals should be avoided, in case of RS-485, transmission output is held at high impedance while communication is not carried out and during reception. Output is switched from high impedance to its ordinary state immediately before the start of sending data and is controlled to high impedance again when the communication ends. Note that the 3-state control delays by about 1msec (max) after the transmission of the end bit of the end characters. Therefore, a delay time of a few milliseconds or longer should be provided in case the host starts transmission upon termination of reception.



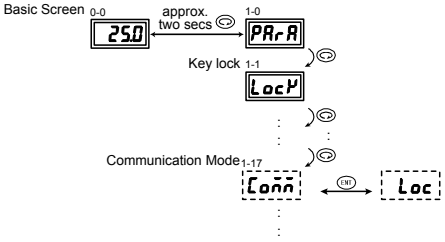
4. Communication parameters

The following is description about the instruments' communication parameters.

4-1. Display of communication screens

The communication parameters can be set or displayed on screen 1-17 to 1-24 in Mode 1 screen group. To shift from the Basic screen (0-0) to the initial screen of communication parameters (1-17), follow the steps below.

1. Hold the ⟲ key for approx. two seconds on the Basic (0-0) screen.
2. After the initial screen (1-0) of Mode 1 screens is displayed, press the ⟲ key several times. The numbers to press depend upon how many options are installed or what types of settings are implemented to the instrument you use.
3. After pressing the key some times, the initial screen (1-17, Communication mode screen) for communication parameters is displayed.
4. Press the ENT key to shift from a display screen to the setting screen.



4-2. Parameters

The following is the description about each communication parameter.

1-17 Communication mode

Conn

The communication mode is displayed or can be set.

LOC: Local mode. Data can be read out via communication.

COM: Data can be set and read out via communication.

Note	Once the communication mode is modified to COM via communication, the setting using front panel keys is not available. However, the modification from COM to LOC is available.

R LOC, COM Ini LOC

1-18 Communication protocol

Prot

The communication protocol is displayed or can be set.

SHIM: Shimaden protocol
ASC: MODBUS ASCII
RTU: MODBUS RTU

R SHIM, ASC, RTU Ini SHIM

1-19 Communication address

Addr

The communication address is displayed or can be set.

Max. of 31 SD16As can be connected via RS-485, however the communication is executed with peer-to-peer. Communication address is used for discrimination of each instrument.

R 1 ~ 100 Ini 1

1-20 Communication data format

dAtA

The communication data format is displayed or can be set.

The setting value is composed of three alphanumerical characters.

Left character: data length (bits) 7 or 8
Middle character: parity E (even) or N (none)
Right character: stop bit 1 or 2

Note	For MODBUS ASCII, specify one of the 7-bit format types. The default value is 7E1. For MODBUS ASCII, specify one of the 8-bit format types. The default value is 8E1.

R 7E1, 7E2, 7N1, 7N2, 8E1, 8E2, 8N1, 8N2 Ini 7E1

1-21 Communication start character

SchA

The start character of communication data is displayed or can be set.

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

Note	MODBUS ASCII/RTU doesn't use start character.

R STX, ATT Ini STX

1-22 BCC operation method

bcc

The BCC operation method is displayed or can be set.

1. ADD operation from start character to text end character
2. 2's complement after ADD operation from start character to text end character.
3. XOR operation from after start character to text end character.
4. BCC operation is not performed.

Note	MODBUS ASCII/RTU doesn't use BCC.

R 1 ~ 4 Ini 1

1-23 Communication speed

bPS

The communication speed is displayed or can be set.

Note	In case 19200 bps, "1920" is displayed on the screen.

R 1200, 2400, 4800, 9600, 19200 bps Ini 9600

1-24 Communication Delay

dELY

The delay time by communication, between time of receiving a command and transferring the reply, is displayed or can be set.
Delay time (msec) = Setting value (counts) * 1.0 (msec)

Note	In case of RS-485, some line converters expend a longer time to perform 3-state control, and signal collisions may occur. This can be avoided to set it longer delay time. Actual delay time from the reception of a communication command to transmission is a total of the above-described delay time and the time for software to process the command. Processing the Write command, in particular, may take about 400 msecs in some cases.

R 1 ~ 100 msecs Ini 20

5. Shimaden protocol

The following is description about Shimaden protocol.

5-1. Communication overview

Communication is performed per a data block. Personal computers or PLC (host) always roles a "master", and SD16A always roles a "slave", that is, the host starts a communication by sending a communication command and the slave terminates the communication by replying the command. Note, however, that there is no reply from the slave when data format error has occurred or when it is the broadcast command.

Note	When this instrument receives a start character and doesn't receive the end character in about one second, this command is processed as timeout, and the instruments shifting to the waiting state for the next command (start character). For this, if timeout is set on host, set it for more than one second. This instrument doesn't support the broadcast command.

5-2. Recommended communication format

The following parameter setting combination is recommended for convenience or avoiding confuse on settings, although this instrument supports various communication/data formats.

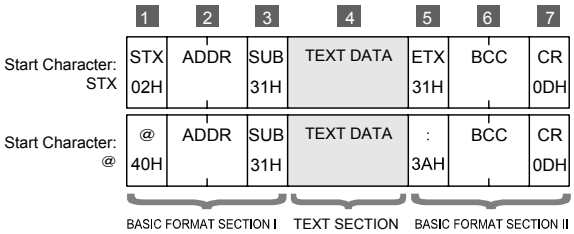
Data format	7E1 (Data length:7, parity: E, stop bit: 1)
Control code	STX (STX_ETX_CR)
Checksum (BCC)	1 (ADD operation)

5-3. Overview of protocol format

Shimaden protocol is composed of "Basic format section I", "Text section", and "Basic format section II." The protocol format send from host and the one respond from slave are common. Note that the format of Text section and BCC operation result is different.

5-4. Basic format section

The following is description about the Basic format section I and II.



1	Start character Indicates that the start of a data block. STX (02H) or @ (40H)
2	Communication address of the slave (destination address) The communication address of 1 to 100 (0000 0001 ~ 100: 0110 0100) are separated into high-order 4 bits and low-order 4 bits and converted to ASCII data. Ex: If the address is "100 (64H)", the high-order is "36H" and the low-order is "34H."
3	Sub address This is fixed to "1 (31H)."
4	Text data The data which is actually received/sent. Please refer to "5-5. Text section" for details.
5	Text end characters Indicates that the end of communication block. "ETX (03H)" or ": (34H)."

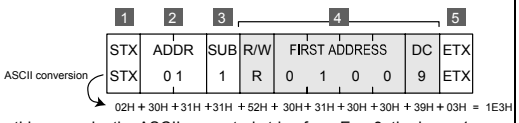
6 BCC operation result

Please refer to "5-5. Text section" for details about **4** (Text section) in the following illustration.

1. ADD operation

ADD operation from start character (**1**) to text end character (**5**) in unit of byte (one ASCII character).

Ex.:

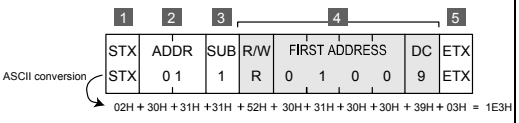


In this example, the ASCII converted string from E or 3, the lower 1 byte value of 1E3H, will be stored in the higher/the lower field of BCC respectively.

2. 2's complement after ADD operation

ADD operation from start character (**1**) to text end character (**5**) in unit of byte (one ASCII character), and 2's complement to the result of lower one byte will be stored.

Ex.:

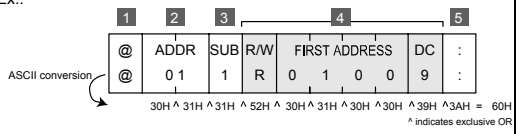


In this example, 2's complement of E3H, the lower one byte data of 1E3H, will be 1DH, and the ASCII converted string from 1 or D will be stored in the higher/the lower field of BCC respectively.

3. Exclusive OR operation

XOR operation from after the start character (**2**) to text end character (**5**) in unit of byte (one ASCII character).

Ex.:



In this example, the ASCII converted string from 6 or 0, the lower 1 byte value of 60H which is the result from XOR, will be stored in the higher/the lower field of BCC respectively.

4. No BCC operation

BCC operation is not executed. The data doesn't have BCC field (**6**).

7 End characters

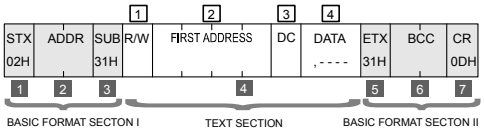
The end of the communication block. CR (0DH)

5-5. Text section

The following is description about the Text section. This is the **4** part described above. The Text section format differs between the data from the master and the data from the slave.

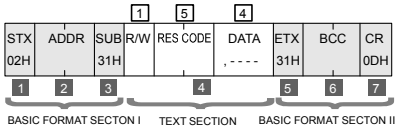
Command data format (from master)

The data format sent from the master (a host) is described below.



Reply data format (from slave)

The data format sent from the slave is described below.



1 Command

'R' (52H) or 'W' (57H)

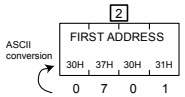
'R' (Read): Readout data from slave (Host retrieves data from slave).

'W' (Write): Write data to slave (Host sends data to slave).

2 The first address of the data

The first address of the data to be read/written from/to. Please refer to "7. Communication data address list" for the list of addresses.

Ex.:



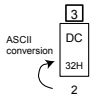
This example indicates the PV bias address.

3 The number of data

The data counts for reading/writing.

If multiple sequential data is processed, this range can be specified by this number. The valid value is 0 to 9 (1 to 10 data) for 'R' (Read), and 0 (1 data) for 'W' (Write), note that the actual number of data will be one-incremented value to the specified value.

Ex.:



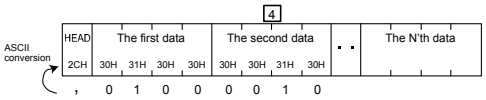
This example indicates that it specifies three data starting from the address specified in **2**.

4 Data

The data which is actually received/sent.

The data specified in the **3** field are sent as one data block. The block starts from "," (2CH), and this indicates that the block is actual data. Delimiters (special characters inserted between data to indicate start/end of data) are not inserted.

Ex.:

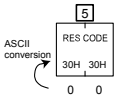


This example shows that the actual receive/sending data block contains "100H" in the first data field, "10H" in the second data field, until the data in the "N" th field.

5 Response code

The response code from the slave.

Ex.:

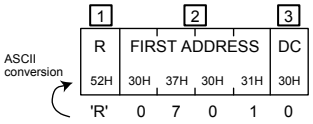


Please refer to "5-8. Response codes" for details.

5-6. Read command

The Read command 'R' is used by a master to read (take) various data in slave.

Command data format (from master)



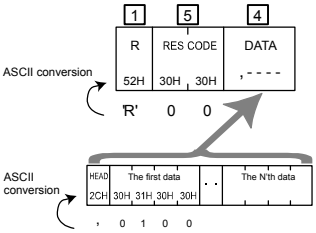
1 'R' (52H) indicates that this is the Read command.

2 The start data address of data to be read.

3 The number of data (words) to be read counting from the start data address. Valid value is 0 to 9. If multiple sequential data is read, the range can be specified by the number. The actual numbers of data is one incremented value specified to this field.

Reply data format (from slave)

When the communication ends successfully

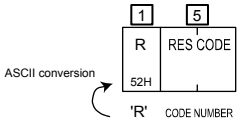


1 'R' (52H) indicates that this is the Read command.

5 Response code 00 (30H 30H) is returned when no error.

4 The data actually read. ',' (2CH, comma) is always added to the head of data.
One more data specified in the **3** field of command format from master will be actually read.

When the communication ends abnormally



1 'R' (52H) indicates that this is the Read command.

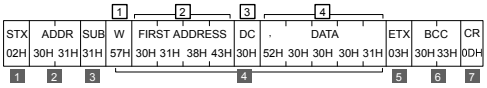
5 Response code
A code number is inserted to represent the situation. Please refer to "5-8. Response codes" for details.

5-7. Write command

The Write command 'W' is used by a master to write (input) various data to a slave.

Note

To use the Write command, the communication mode parameter should be set on COM. Note, however, the communication mode can be shifted from LOC to COM only with communication feature. Shift from LOC to COM by sending the following command.



1 Start character. In this example, STX (02H) is used. In case using '@', this value is 40H.

2 Communication address. In this example, 01 (30H 31H) is used.

3 Sub address. 01 (31H) is fixed for this instrument.

4 [1] 'W' (The Write command)

[2] 018C (30H 31H 38H 43H), the data address indicating communication mode.

[3] The number of data. Specify 0 (30H) here because there is only one data to be written.

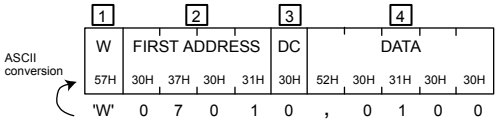
[4] The data to be written. The data will be a comma (, 52H) which indicates the head of data, and 0001 (30H 30H 30H 31H) which indicates COM.

5 Text end characters. Specify ETX (03H) in case STX is specified in 1 . Specify ':' (34H) in case '@' is specified in 1 .

6 Result of BCC operation.

7 End characters. CR (0DH) is fixed for this instrument.

Command data format (from master)



[1] 'W' (57H) indicates that this is the Write command.

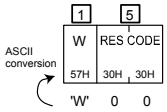
[2] The first address of writing data.

[3] The number of data to be written. The value is always 0 (the number of data which is able to be written is always one.

[4] The data actually written.
',' (2CH, comma) is always added to the head of data. The number of data to be written is only 1.

Reply data format (from slave)

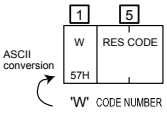
When the communication ends successfully



[1] 'W' (57H) indicates that this is the Write command.

[5] Response code 00 (30H 30H) is returned when no error.

When the communication ends abnormally



[1] 'W' (57H) indicates that this is the Write command.

[5] Response code
A code number is inserted to represent the situation. Please refer to "5-8. Response codes" for details.

5-8. Response codes

The following lists response codes of Shimaden protocol. Other than 00H (30H 30H) are error codes.

Response code	Condition	Description
00H (30H 30H)	Communication ends successfully.	The response code to a command indicating that the communication ends normally.
07H (30H 37H)	Format error	The data format of Text section differs from the defined one.
08H (30H 38H)	Error in address or number of data	The data address or the number of data differs from the defined one.
09H (30H 39H)	Data error	The address of data to be written is out of its setting range.
0AH (30H 41H)	Execution command error	The execution command cannot be accepted.
0BH (30H 42H)	Write mode error	Write command is issued with any data which is invalid to be written.
0CH (30H 43H)	Option error	Read/Write command is issued with option relating data although the option is not added.

Note

The smaller value of response code, the higher the priority. In case multiple errors have occurred, only the smallest value of response code is returned.

5-9. No response condition

If a slave found one of the errors listed below when the slave received a data block from a host, slave doesn't send response data, and waits for the next data from host instead.

- Hardware interface error has occurred (flaming, overrun, parity).
- Mismatch of communication address.
- Start character violation (other than STX or @ is specified).
- Sub address violation (other than 1 (31H) is specified).
- Other than 'R' or 'W' is specified in a command field.
- Text end character violation (other than ETX or : is specified).
- BCC operation result is different.
- End character violation (other than CR (0DH) is specified).

6. MODBUS protocol

The following is a description about MODBUS protocol.

6-1. Communication overview

MODBUS protocol is a communication protocol for PLCs which is developed by Modicon Inc. (AEG Schneider Automation International S.A.S).

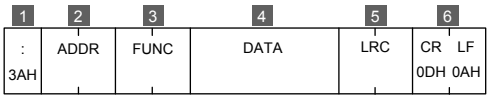
MODBUS protocol has ASCII mode and RTU mode. Under ASCII mode, 8-bit binary data is divided into two, 4-bit and 4-bit, and each 4-bit data is transmitted after ASCII conversion. Under RTU mode, 8-bit binary data is transmitted without ASCII conversion. Devices which belong to the network should be selected the same mode.

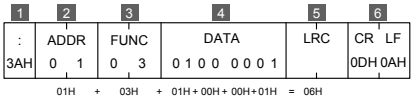
In case of MODBUS protocol, a host is the master and the SD16A is a slave, the host always starts a communication, and the communication terminates by the reply from the slave.

6-2. Message format

MODBUS ASCII mode

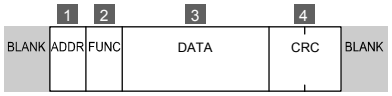
The following is a message format of MODBUS ASCII mode.

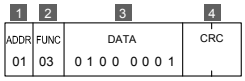


1	Header Indicates that the head of the message. : (3AH), fixed
2	Communication address of slave (destination address) The communication address value are separated into high-order 4-bit and low-order 4-bit and converted to ASCII data. For example, if the address is "100 (64H)", the high-order is "36H" and the low-order is "34H." The communication address setting range is 1 to 100 for this instrument.
3	Function code A command to slaves. Please refer to "6.5. Function codes" for details.
4	Data The data which is actually received/sent.
5	LRC check Result of LRC check (longitudinal redundancy check). Check by the result of 2's complement after ADD operation. 2's complement after ADD operation The message filed from communication address (2) to data (4) is converted into binary data (1-byte) by ASCII data 2-character (2-byte) unit, ADD each binary data, and take 2's complement of the lowest 1-byte. Ex.:  In this example, 2's complement of 0006H, the lower one byte data of 06H, will be FAH, and the ASCII converted string from F or A will be stored in the higher/the lower field of LRC respectively.
6	Trailer Indicates the end of the message. CR (0DH) and LF (0AH), fixed.

MODBUS RTU mode

The following is a message format of MODBUS RTU mode.



1	Communication address of slave (destination address) Set the communication address. For example, if the address is "100 (64H)", the valid value is "64H." The communication address setting range is 1 to 100 for this instrument.
2	Function code A command to slaves. Please refer to "6-5. Function codes" for details.
3	Data The data which is actually received/sent.
4	CRC check Result of CRC check (cyclic redundancy check). CRC-16 algorithm Ex.:  Explanatory, the following "CR" indicates a temporary value of CRC data (2-byte) for computation. 1. Initialize "CR" (FFFFH). 2. Perform XOR operation between "CR" and 1, and assign the result to "CR." 3. Check the LSB (least significant bit) value. If it is 0, shift "CR" value 1-bit right. If it is 1, perform XOR operation between the right shift 1-bit of "CR" value and A001H, and assign the result to "CR." 4. Repeat the Step 3 seven times. 5. After repeating the Step 3 eight times, perform XOR operation between the current "CR" and the value of the next field (2), and assign the result to "CR." 6. After repeating the Step 5 eight times, perform XOR operation using the value of the next field, until just before CRC field (the last field of 3). 7. Switch the upper 8-bit and the lower 8-bit of the finally gained "CR", and assign the result to CRC field.

Note

In case MODBUS RTU, there is no field that indicates the start of a message. Instead, if a silent time of 3.5 characters or more is detected after receiving the last data of a message, the host's communication state transits to the data waiting state. Then, a message is sent, the host start to receive it. After that, when a silent time of 3.5 character or more is detected, the host terminates receiving the data and waits for a next message.

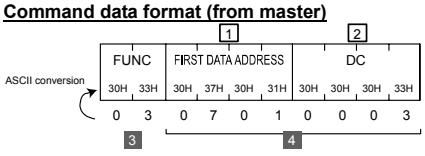
6-3. Commands of MODBUS ASCII mode

Under MODBUS ASCII mode, the Read command, the Write command and the Loop back command are offered.

Read command

The Read command is used by a master to read (take) various data in slave.

Command data format (from master)



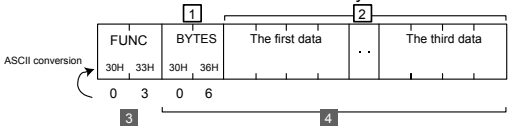
3 Function code. '03H' (30H 33H) indicates that this is a Read command.

4 1 The start data address of data to be read.

2 The number of data (words) to be read. The value of 1H to AH (ten, max.) can be assigned. If multiple sequential data is read, it can be specified by range.

Reply data format (from slave)

When the communication ends successfully

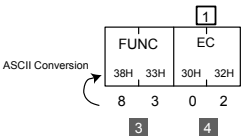


3 Function code. '03H' (30H 33H) indicates that this is the Read command.

4 1 The byte of data (words) to be read.

2 The data which is actually read.

When the communication ends abnormally



3 Function code
'83' (38H 33H) indicates that this is a error message to the Read command.

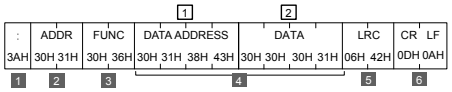
4 1 Error code
Please refer to "Error codes" in 6-5. for details.

Write command

The Write command is used by a master to write (input) various data to a slave.

Note

To use the Write command, communication mode parameter should be set on COM. Note, however, the communication mode can be shifted from LOC to COM only with communication feature. Shift from LOC to COM by sending the following command.



1 Start character. : (3AH)

2 Communication address. In this example, 01 (30H 31H) is used.

3 Function code. 06 (30H 36H)

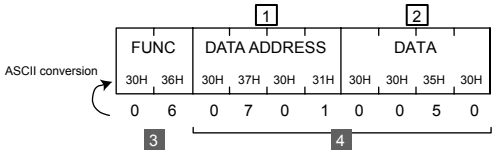
4 1 018C (30H 31H 38H 43H), the data address indicating communication mode.

2 The data to be written. 0001 (30H 30H 30H 31H) to specify the mode COM.

5 Result of LRC operation.

6 Trailer. CRLF (0DH 0AH)

Command data format (from master)



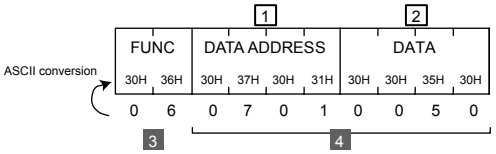
3 Function code. '06H' (30H 36H) indicates that this is the Write command.

4 1 The data address to be written.

2 The data to be written.

Reply data format (from slave)

When the communication ends successfully

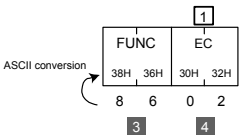


3 Function code. '06H' (30H 36H) indicates that this is the Write command.

4 1 The data address to be written.

2 The data to be written.

When the communication ends abnormally



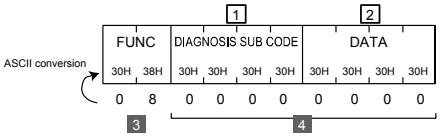
3 Function code
'86' (38H 36H) indicates that this is the error message to the Read command.

4 1 Error code
Please refer to "Error codes" in 6-5. for details.

Loop back command

The Loop back command is sent from a master to a slave, and replied from the slave. This is used for status check if the destination instrument (slave) is alive.

Command data format (from master)



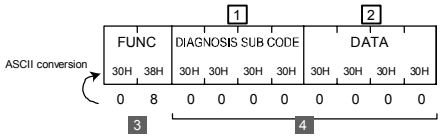
3 Function code. '08H' (30H 38H) indicates that this is a loop back command.

4 1 0000H (30H 30H 30H 30H) indicating this is a diagnosis sub code, fixed.

2 Data. This instrument ignores this field.

Reply data format (from slave)

When the communication ends successfully

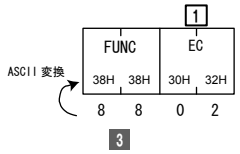


3 Function code. '08H' (30H 38H) indicates that this is a loop back command.

4 1 0000H (30H 30H 30H 30H) indicating this is a diagnosis sub code, fixed.

2 Data. This instrument ignores this field.

When the communication ends abnormally



3 Function code
'88H' (38H 38H) indicates that the communication has occurred an error to a loop back command.

4 1 Error code
Please refer to "Error codes" in 6-5. for details.

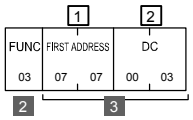
6-4. Commands of MODBUS RTU mode

Under MODBUS RTU mode, the Read command, the Write command and the Loop back command are offered.

Read command

The following is a description about the Read command. The Read command is used by a master to read (take) various data in slave.

Command data format (from master)



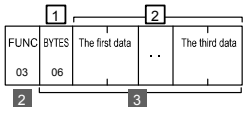
2 Function code
03H indicating that this is the Read command.

3 1 The start data address of data to be read.

2 The number of data (words) to be read. The value of 0001H to 000AH (ten, max.) can be assigned. If multiple sequential data is read, it can be specified by range.

Reply data format (from slave)

When the communication ends successfully

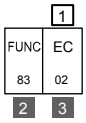


2 Function code
03H indicating that this is the Read command.

3 1 The number of data (words) to be read.

2 The data which is actually read.

When the communication ends abnormally



2 Function code
83H indicating that an error has occurred to the Read command.

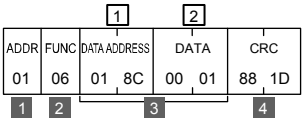
3 1 Error code
Please refer to "Error codes" in 6-5. for details.

Write command

The following is a description about the Write command. The Write command is used by a master to write (input) various data to a slave.

Note

To use the Write command, communication mode parameter should be set on COM. Note, however, the communication mode can be shifted from LOC to COM only with communication feature. Shift from LOC to COM by sending the following command.



1 Communication address. In this example, 01 is used

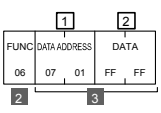
2 Function code. 06

3 1 018C, the data address indicating communication mode.

2 The data to be written. 0001 to specify the mode COM.

4 Result of CRC check.

Command data format (from master)



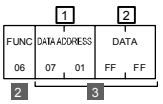
2 Function code
06H indicating that this is the Write command.

3 1 The data address to be written.

2 The data to be written.

Reply data format (from slave)

When the communication ends successfully

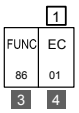


2 Function code
06H indicating that this is the Write command.

3 1 The data address to be written.

2 The data to be written.

When the communication ends abnormally



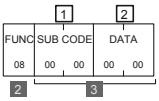
2 Function code
86H indicating that an error has occurred to the Write command.

3 1 Error code
Please refer to "Error codes" in 6-5. for details.

Loop back command

The following is a description about The Loop back command. The Loop back command is sent from a master to a slave, and replied from the slave. This is used for status check if the destination instrument (slave) is alive.

Command data format (from master)



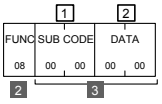
2 Function code
08H indicating that this is a loop back command.

3 1 0000H (fixed), indicates that this is diagnosis code.

2 Data This instrument ignores this field.

Reply data format (from slave)

When the communication ends successfully

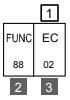


2 Function code
08H indicating that this is a loop back command.

3 1 0000H (fixed) indicating that this is diagnosis code.

2 Data This instrument ignores this field.

When the communication ends abnormally



2 Function code
88H indicating that this is a loop back error.

3 1 Error code
Please refer to "Error codes" in 6-5. for details.

6-5. Function codes

A function code indicates the command type for a slave. The same function code of the master is returned from a slave in case that the process terminates successfully. If the process is abnormally terminated, the MSB (Most Significant Bit) to the original function code is set to 1, and this revised function code is returned. The "Error codes" is also included in data field and returned.

Function codes

The instrument supports the following function codes.

Function codes	Description
03 (03H)	The Read command. Read setting values or information in a slave.
06 (06H)	The Write command. Write values to a slave.
08 (08H)	The Loop back command. Indicates to reply the sending data as it is. This is used for status check if the destination instrument (slave) is alive.

Error codes

The instrument supports the following error codes.

Error codes	Descriptions
1 (01H)	An error relating features (ex. unsupported features).
2 (02H)	An error relating data address or data counts (The data address or data counts violation).
3 (03H)	Data error (The data is out of its valid range).

6-6. No response condition

If a slave found one of the errors listed below when it received a data block from a host, it doesn't send response data, and waits for the next data from host instead.

MODBUS ASCII mode

- Hardware interface error has occurred (flaming, overrun, parity).

- Mismatch of communication address.
- Header is wrong (specified other than :).
- Function code is other than 03H, 06H, or 08H.
- LRC operation result is different.
- The trailer is other than CR and LF (0DH 0AH).

MODBUS RTU mode

- Hardware interface error has occurred (flaming, overrun, parity).
- Mismatch of communication address.
- Data length of a frame is not 8-byte.
- Function code is other than 03H, 06H, or 08H.
- CRC operation result is different.

7. Communication data address list

The supported data addresses are listed in the following table.

- For details about each parameter, refer to the Instruction Manual.
- In the R/W column, R indicates that the data is supported by the Read command, W indicates that it is supported by the Write command, and R/W indicates that it is supported by the Read or the Write command.
- In the OP column, the data is supported when the following option is installed.
  AL: Alarm output AOUT: Analog output

Address	Descriptions	R/W	OP	Note
0040H	Series code 1	R		SD, fixed
0041H	Series code 2	R		16, fixed
0042H	Series code 3	R		A0, fixed
0043H	Series code 4	R		00, fixed
0100H	PV (measured value)	R		Note 1
0101H	Reserved	R		
0102H	Reserved	R		
0103H	Reserved	R		
0104H	Action flag	R		Note 2
0105H	Alarm action flag	R	AL	Note 2
010DH	Alarm latching output flag	R	AL	Note 2
018CH	Communication code (0: LOC, 1: COM)	W		
0198H	Alarm latching release	W	AL	Note 2
0500H	Alarm 1 code (0: non, 1: HA, 2: LA, 3: HA_L, 4: LA_L, 5: SO)	R/W	AL	
0501H	Alarm1 setting value	R/W	AL	
0502H	Alarm1 hysterisis	R/W	AL	
0503H	Alarm1 inhibit (0: OFF, 1: ON)	R/W	AL	
0508H	Alarm 2 code (0: non, 1: HA, 2: LA, 3: HA_L, 4: LA_L, 5: SO)	R/W	AL	
0509H	Alarm2 setting value	R/W	AL	
050AH	Alarm2 hysterisis	R/W	AL	
050BH	Alarm2 inhibit (0: OFF, 1: ON)	R/W	AL	
05A1H	Analog output scaling lower-limit value	R/W	AOUT	
05A2H	Analog output scaling higher-limit value	R/W	AOUT	
0611H	Key lock (0: OFF, 1: ON)	R/W		
0701H	PV bias	R/W		
0702H	PV filter	R/W		
0703H	Reserved	R/W		
0704H	Input unit (0: °C, 1: °F)	R/W		
0705H	Measuring range	R/W		
0706H	Reserved	R/W		
0707H	Input scaling decimal places (0: without, 1: nnn.n, 2: nn.nn, 3:n.nnn)	R/W		
0708H	Input scaling lower-limit value	R/W		
0709H	Input scaling higher-limit value	R/W		
070AH	Decimal places (0: with, 1: without)	R/W		

Note 1 In case the abnormal measured value is detected:
If HHHH, CJHH, or b--- is displayed on the screen, 7FFFH is returned, and LLLL or CJLL is displayed, 8000H is returned.
- In case of Shimaden protocol or MODBUS ASCII mode, 7FFFH is converted into 37H 46H 46H 46H, and 8000H is converted into 38H 30H 30H 30H.
- In case of MODBUS RTU mode, 7FFFH is converted into 7FH FFH, and 8000H is converted into 80H 00H.

Note 2 Each data is treated as bit data. Refer to the table below to know each bit sequence of data (When active, the bit=1, and when inactive, the bit=0)

Address	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0104H								COM								
0105H															AL2	AL1
010DH															AL2	AL1
0198H															AL2	AL1

8. Appendix

8-1. ASCII code table

	b7~b5	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(S0H)	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

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

Temperature and Humidity Control Specialists

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