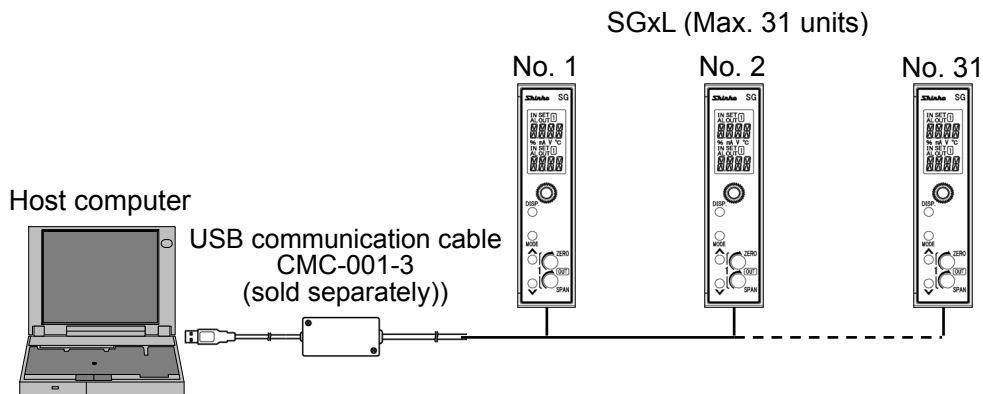


This manual contains instructions for communication functions of the SGxL (except SGFL and SGJL).
 SGxL: SGBL, SGCL, SGDL, SGIL, SGLL, SGML, SGPL, SGRL, SGSL, SGTL, SGUL

Serial communication and Console communication cannot be used together.
 When performing Serial communication, remove the Tool Cable (CME-001) from the USB port of the PC and console connector of the SGxL.
 When performing Console communication, it is not required to remove the Serial communication cables.
 However, do not send a command from the master side.

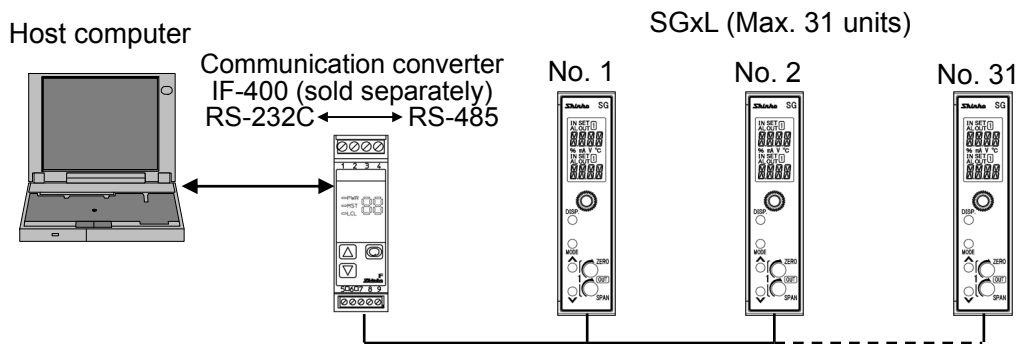
1. System Configuration

1.1 When Using USB Communication Cable CMC-001-3 (sold separately)



(Fig. 1.1-1)

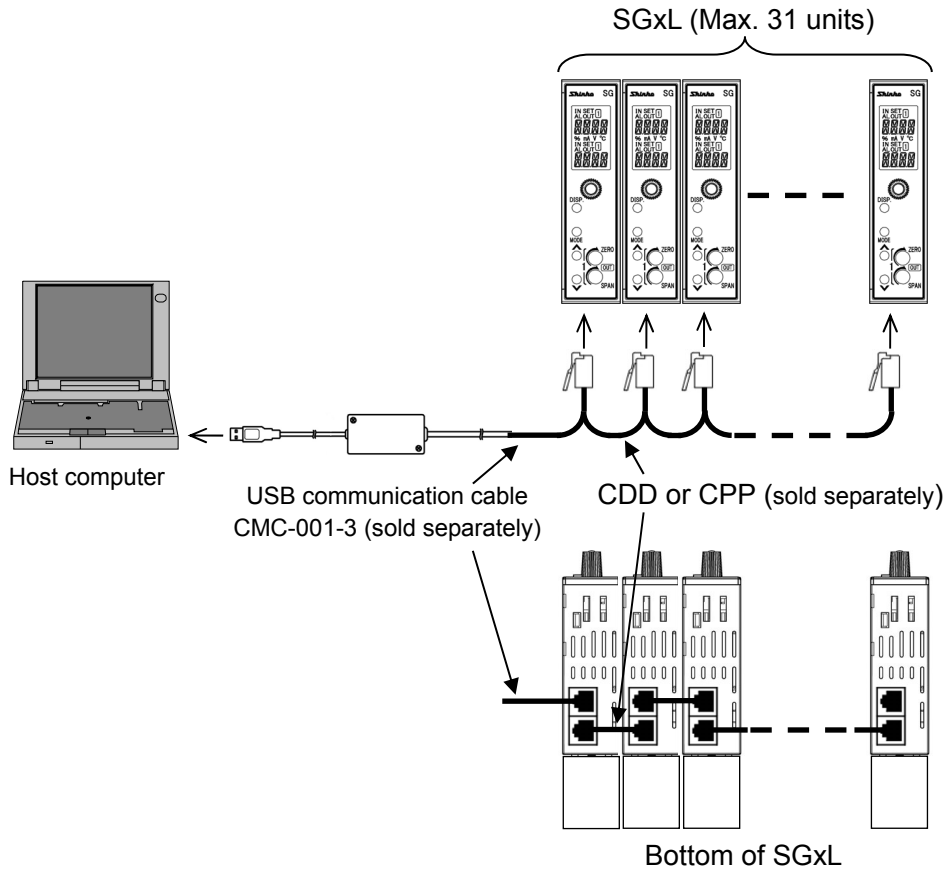
1.2 When Using Communication Converter IF-400 (sold separately)



(Fig. 1.2-1)

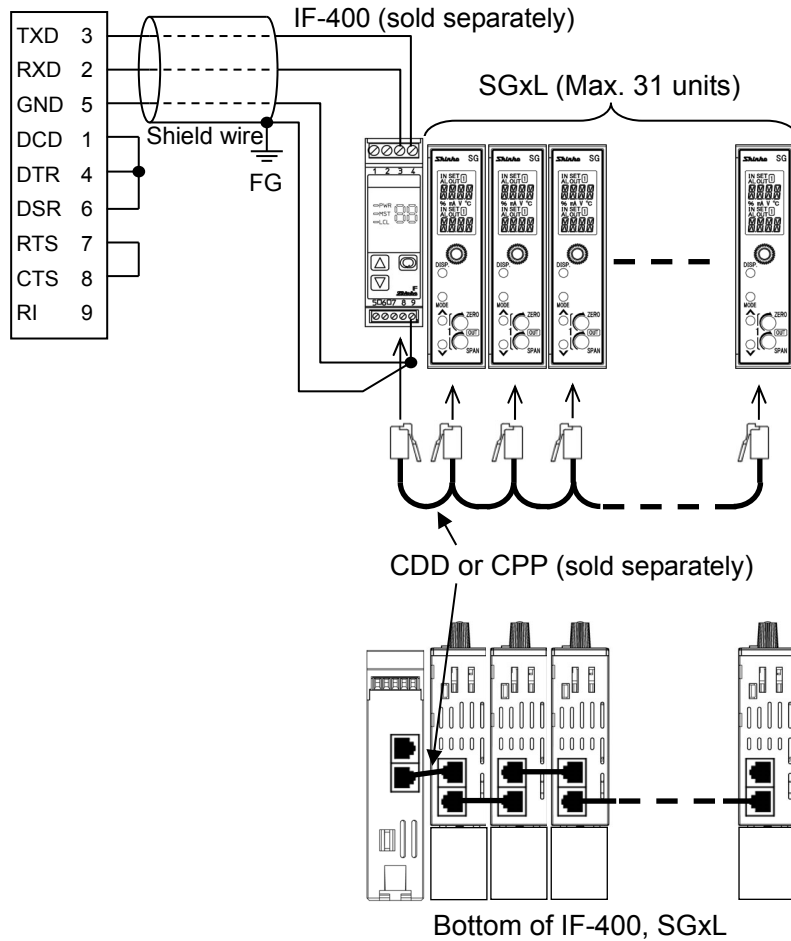
2. Wiring

2.1 When Using USB Communication Cable CMC-001-3 (sold separately)



(Fig. 2.1-1)

2.2 When Using Communication Converter IF-400 (sold separately)



(Fig. 2.2-1)

Shield wire

Connect only one end of the shield to the FG terminal to avoid a ground loop. If both ends of the shield wire are connected to the FG terminal, the circuit will be closed, resulting in a ground loop. This may cause noise. Be sure to ground the FG terminal.

Recommended cable: OTSC-VB 2PX0.5SQ (made by Onamba Co., Ltd.) or equivalent (Use a twisted pair cable.)

Terminator (Terminal resistor)

Communication converter IF-400 (sold separately) has a built-in terminator.

The terminator is mounted at the end of the wire when connecting multiple peripheral devices to a personal computer. The terminator prevents signal reflection and disturbance.

Do not connect a terminator to the communication line because each SGxL has built-in pull-up and pull-down resistors.

3. Setting Communication Parameters

Set communication parameters in Communication setting mode.

Press and hold the MODE key for approx. 5 seconds in the Default Display.

The unit will enter Input setting mode.

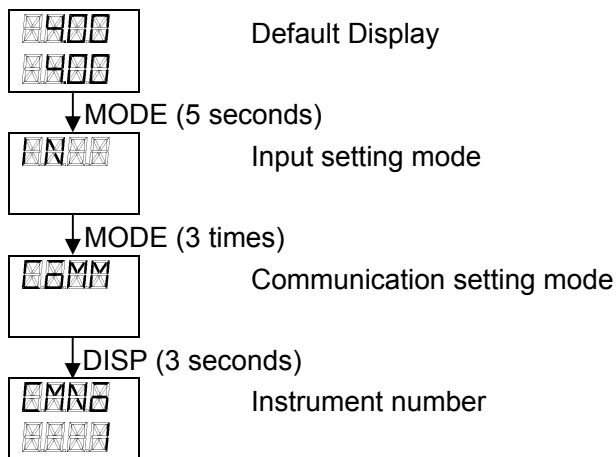
Press the MODE key 3 times. The unit will enter Communication setting mode.

Press and hold the DISP key for approx. 3 seconds. The unit will enter [Instrument number].

To set (or select) each setting item, use the UP or DOWN key.

To register each setting item, use the DISP key.

Set each communication parameter following the procedure below.



Instrument number

Sets the instrument number.

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
1 to 247		Set value	1

Communication speed

Selects the communication speed,

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
9600 bps	9600	9600	38400 bps 38400
19200 bps		19200	
38400 bps		38400	

Data bit/Parity

Selects data bit and parity.

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
8 bits/No parity	8N0	8N0	8 bits/Odd 8O0
8 bits/Even		8E0	
8 bits/Odd		8O0	

Stop bit

Selects the stop bit.

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
1 bit	1	1	1 bit 1
2 bits		2	

Response Delay Time

Response from the instrument can be delayed after receiving command from the host computer.

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
0 to 1000 ms	0000	Set value	10 ms 0010

Save Settings

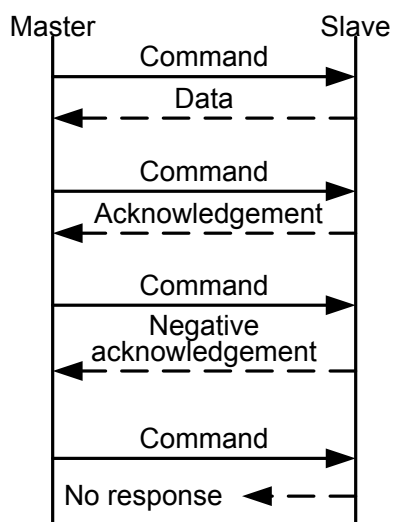
Selects whether the settings are saved (registered) or not.

Setting Range	Indication		Factory Default
	Multi-Display A	Multi-Display B	
Save	SAVE	SAVE	Save SAVE
Not save		NO	

By pressing the DISP key, the unit reverts to the Default Display.
At this stage, settings are complete.

4. Communication Procedure

Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the SGxL (hereafter Slave).



(Fig. 4-1)

• Response with data

When the master sends the Read command, the slave responds with the corresponding set value or current status.

• Acknowledgement

When the master sends the Write command, the slave responds by sending the acknowledgement after processing is terminated.

• Negative acknowledgement

When the master sends a non-existent command or a value out of the setting range, the slave returns a negative acknowledgement.

• No response

The slave will not respond to the master in the following cases:

- Broadcast address is set.
- Communication error (framing error, parity error)
- CRC-16 discrepancy

Communication timing of the RS-485

Master Side (Take note while programming)

When the master starts transmission through the RS-485 communication line, the master is arranged so as to provide an idle status (mark status) transmission period of 1 or more characters before sending the command to ensure synchronization on the receiving side.

Set the program so that the master can disconnect the transmitter from the communication line within a 1 character transmission period after sending the command in preparation for reception of the response from the slave.

To avoid collision of transmissions between the master and the slave, send the next command after carefully checking that the master has received the response.

If a response to the command is not returned due to communication errors, set the Retry Processing to send the command again. (It is recommended to execute Retry twice or more.)

Slave Side

When the slave starts transmission through the RS-485 communication line, the slave is arranged so as to provide an idle status (mark status) transmission period of 1 ms or more (*) before sending the response to ensure synchronization on the receiving side.

The slave is arranged so as to disconnect the transmitter from the communication line within a 1 character transmission period after sending the response.

(*) Can be set in [Response delay time] within a range of 0 to 1000 ms. (See p.4.)

5. Modbus Protocol

5.1 Transmission Mode

Modbus protocol transmission mode is RTU mode.

8-bit binary data in command is transmitted as it is.

Data format Start bit: 1 bit

Data bit: 8 bits

Parity: Odd (No parity, Even) (Selectable)

Stop bit: 1 bit (2 bits) (Selectable)

Error detection: CRC-16 (Cyclic Redundancy Check)

5.2 Data Communication Interval

For communication speed 9600 bps, 19200 bps: To transmit continuously, an interval between characters which consist of one message, must be within 1.5 character transmission times.

For communication speed 38400 bps: To transmit continuously, an interval between characters which consist of one message, must be within 750 μ s.

If an interval lasts longer than the above, the instrument assumes that transmission from the master is finished, which results in a communication error, and will not return a response.

5.3 Message Configuration

For communication speed 9600 bps, 19200 bps: RTU mode message is configured to start after idle time is processed for more than 3.5 character transmissions, and end after idle time is processed for more than 3.5 character transmissions.

For communication speed 38400 bps: RTU mode message is configured to start after idle time is processed for more than 1.75 ms, and end after idle time is processed for more than 1.75 ms.

Data section: Max. 252 bytes

3.5 idle characters	Slave address	Function code	Data	Error check CRC-16	3.5 idle characters
---------------------	---------------	---------------	------	--------------------	---------------------

(1) Slave Address

Slave address is an individual instrument number on the slave side, and is set within the range 1 to 247 (01H to F7H). The master identifies slaves by the slave address of the requested message. The slave informs the master which slave is responding to the master by placing its own address in the response message.

Slave address 0 (00H, Broadcast address) can identify all the slaves connected. However, slaves do not respond.

(2) Function Code

The function code is the command code for the slave to undertake one of the following actions.

Type	Function Code	Sub-Function Code	Contents
Data access	03 (03H)		Reads a single or multiple piece(s) of data from slave(s). (Max. 25 pieces of data)
	04 (04H)		Reads information from slave(s).
	06 (06H)		Writes a single piece of data to slave(s).
	16 (10H)		Writes multiple pieces of data to slave(s). (Max. 25 pieces of data)
Diagnostics	08 (08H)	00	Echoes back the request message.
	43 (2BH)	14	Reads device identification information.

The function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.

When acknowledgement is returned, the slave simply returns the original function code.

When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.

For example, if the master sends request message setting 13H to the function code by mistake, slave returns 93H by setting the MSB to 1, because the former is an illegal function.

For negative acknowledgement, the exception codes below are set to the data of the response message, and returned to the master in order to inform it of what kind of error has occurred.

Exception Code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Status unable to be written.
18 (12H)	During setting mode by keypad operation

(3) Data

Data differs depending on the function code.

A request message from the master is composed of a data item, amount of data and setting data.

A response message from the slave is composed of the byte count, data and exception codes in negative acknowledgements, corresponding to the request message.

The effective range of data is -32768 to 32767 (8000H to 7FFFH).

Refer to Section “6. Communication Command Table” (pp.15 to 20).

(4) Error Check

After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of the data, the calculated 16-bit data is appended to the end of message in sequence from low order to high order.

How to calculate CRC-16

In the CRC-16 system, the information is divided by the polynomial series. The remainder is added to the end of the information and transmitted. The generation of a polynomial series is as follows.

(Generation of polynomial series: $X^{16} + X^{15} + X^2 + 1$)

- ① Initialize the CRC-16 data (assumed as X) (FFFFH).
- ② Calculate exclusive OR (XOR) with the 1st data and X. This is assumed as X.
- ③ Shift X one bit to the right. This is assumed as X.
- ④ When a carry is generated as a result of the shift, XOR is calculated by X of ③ and the fixed value (A001H). This is assumed as X. If a carry is not generated, go to step ⑤.
- ⑤ Repeat steps ③ and ④ until shifting 8 times.
- ⑥ XOR is calculated with the next data and X. This is assumed as X.
- ⑦ Repeat steps ③ to ⑤.
- ⑧ Repeat steps ③ to ⑤ up to the final data.
- ⑨ Set X as CRC-16 to the end of message in sequence from low order to high order.

5.4 Message Example

Numerals written below the command represent the number of characters.

(1) Read [Slave address 1, input value (00B0H)]

- A request message from the master

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (00B0H)	Amount of data (0001H)	Error check CRC-16 (85EDH)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in normal status [When input value is 1200 (04B0H)]

3.5 idle characters	Slave address (01H)	Function code (03H)	Response byte count (02H)	Data (04B0H)	Error check CRC-16 (BB30H)	3.5 idle characters
	1	1	1	2	2	

(2) Write [Slave address 1, Default Display/Manual mode (0001H)]

- A request message from the master [When Manual mode (0001H) is written]

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0001H)	Data (0001H)	Error check CRC-16 (19CAH)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0001H)	Data (0001H)	Error check CRC-16 (19CAH)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in exception (error) status (When a value out of the setting range is set)
The function code MSB is set to 1 for the response message in exception (error) status, and 86H is returned.

The Exception code 03H (Value out of the setting range) is returned (error).

3.5 idle characters	Slave address (01H)	Function code (86H)	Exception code (03H)	Error check CRC-16 (0261H)	3.5 idle characters
	1	1	1	2	

(3) Read [Slave address 1, Default Display/Manual mode (0001H)]

- A request message from the master

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0001H)	Amount of data (0001H)	Error check CRC-16 (D5CAH)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in normal status [for Manual mode (0001H)]

3.5 idle characters	Slave address (01H)	Function code (03H)	Response byte count (02H)	Data (0001H)	Error check CRC-16 (7984H)	3.5 idle characters
	1	1	1	2	2	

- Response message from the slave in exception (error) status (When data item is incorrect)

The function code MSB is set to 1 for the response message in exception (error) status, and 83H is returned. The Exception code 02H (Non-existent data address) is returned (error).

3.5 idle characters	Slave address (01H)	Function code (83H)	Exception code (02H)	Error check CRC-16 (C0F1H)	3.5 idle characters
	1	1	1	2	

(4) Write [Slave address 1, 7 commands (multiple pieces of data) from Input group (0010H)]

Data Item		Data
0010H	Input group	DC signal input
0011H	Input type	4 to 20 mA Built-in 50 Ω shunt resistor
0012H	Input unit	°C
0013H	Decimal point place	2 digits after decimal point
0014H	Output 0% value	4.00
0015H	Output 100% value	20.00
0016H	Indication unit	mA

When writing the above data, Data in the message becomes as follows.

Amount of data: 7 (0007H)

Byte count: 14 (0EH)

Data: The following Data is converted to hexadecimal.

Data Item		Data	Data (Converted to Hexadecimal)
0010H	Input group	DC signal input	0002H
0011H	Input type	4 to 20 mA Built-in 50 Ω shunt resistor	0000H
0012H	Input unit	°C	0000H
0013H	Decimal point place	2 digits after decimal point	0002H
0014H	Output 0% value	4.00	0190H
0015H	Output 100% value	20.00	07D0H
0016H	Indication unit	mA	0002H

- A request message from the master (When writing the above data)

3.5 idle characters	Slave address (01H)	Function code (10H)	Data item (0010H)
	1	1	2

3.5 idle characters	Data (00070E0002000000000002019007D00002H)	Error check CRC-16 (13EEH)	3.5 idle characters
	17	2	

- Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (10H)	Data item (0010H)	Data (0007H)	Error check CRC-16 (800EH)	3.5 idle characters
	1	1	2	2	2	

(5) Read [Slave address 1, 7 commands (multiple pieces of data) from Input group (0010H)]

- A request message from the master (When reading the data on p.9)

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0010H)	Amount of data (0007H)	Error check CRC-16 (05CDH)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (03H)	Response byte count (0EH)
	1	1	1

3.5 idle characters	Data (00020000000000002019007D00002H)	Error check CRC-16 (8B17H)
	14	2

Data in the response message becomes as follows.

	Data Item	Data	Data (Converted to Hexadecimal)
0010H	Input group	DC signal input	0002H
0011H	Input type	4 to 20 mA Built-in 50 Ω shunt resistor	0000H
0012H	Input unit	°C	0000H
0013H	Decimal point place	2 digits after decimal point	0002H
0014H	Output 0% value	4.00	0190H
0015H	Output 100% value	20.00	07D0H
0016H	Indication unit	mA	0002H

5.5 Diagnostics Function

Modbus protocol has the following diagnostics functions.

- Echoes back the request message.
- Reads device identification information.

5.5.1 Message Configuration

3.5 idle characters	Slave address	Function code	Data	Error check CRC-16	3.5 idle characters
---------------------	---------------	---------------	------	--------------------	---------------------

(1) Slave address

Slave address is an individual instrument number on the slave side, and is set within the range 1 to 247 (01H to F7H).

The master identifies slaves by the slave address of the requested message.

The slave informs the master which slave is responding to the master by placing its own address in the response message.

Diagnostics function is disabled for the Broadcast address [0 (00H)].

(2) Function code

The function code is the command code for the slave to undertake the following action types.

Type	Function Code	Sub-Function Code	Contents
Diagnostics	08 (08H)	00 (0000H)	Echoes back the request message.
	43 (2BH)	14 (0EH)	Reads device identification information.

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master. When acknowledgement is returned, the slave simply returns the original function code.

When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.

For example, when the master sends request message setting 0FH to the sub-function code by mistake, slave returns ABH by setting the MSB to 1, because the former is a non-existent sub-function code.

For negative acknowledgement, the exception codes below are set to the data of the response message, and returned to the master in order to inform it of what kind of error has occurred.

Exception Code	Contents
1 (01H)	Illegal function (Non-existent function) Sub-function code is not correct.
2 (02H)	Illegal data address (Non-existent data address) For function code 43: Object ID is any value other than 00, 01, 02.
3 (03H)	Illegal data value (Value out of the setting range) For function code 08: Data is less than 1, or has exceeded 100. For function code 43: Read Device ID code is any value other than 01, 04.

(3) Data

Data differs depending on the function code.

For Function code 08 (08H), a request message from the master is composed of 'Sub-function code 2 bytes (0000H)' and 'Data n x 2 bytes'.

[n: Amount of data (Max. 25)]

In normal status, a response message from the slave is the same as the request message.

Function code	1 byte	08H
Sub-function code	1 byte	0000H fixed
Data	n x 2 bytes	Random value (Max. 25)

For Function code 43 (2BH), the request message from the master is composed of Sub-function code 14 (0EH), Read Device ID code and Object ID.

Function code	1 byte	2BH	
Sub-function code (MEI type)	1 byte	0EH	
Read Device ID code (Corresponds to Basic category)	1 byte	01/04H	
Object ID	1 byte	00	Vendor name SHINKO TECHNOS CO., LTD.
		01	Product code (model) (e.g.) SGSL-A01 -0-0
		02	Version number (D, T, MP) (e.g.) D15-011-02-00MP3202-00

Response message from the slave is composed of Sub-function code 14 (0EH) (for request), Read Device ID code and Object ID.

Function code	1 byte	2BH	
Sub-function code (MEI type)	1 byte	0EH	
Data	Read Device ID code	1 byte	01/04H
	Conformity level	1 byte	01/81H
	More Follows	1 byte	00/FFH
	Next Object ID	1 byte	Object ID number
	Number of Objects	1 byte	
	List of Object ID	1 byte	
	List of Object length	1 byte	
	List of Object value	Object length	

For the response message (negative acknowledgement), an exception code is set and returned.

Function code	1 byte	ABH
Exception code	1 byte	01/02/03H

(4) Error check

16-bit data to detect communication errors.

Refer to Section '5.3 Message Configuration (4) Error Check (p.7).

5.5.2 Message Example

Numerals written below the command represent the number of characters.

(1) Echo back Slave address 1, Request message

- A request message from the master [Test data 200 (00C8H), 60 (003CH), 10 (000AH)]

3.5 idle characters	Slave address (01H)	Function code (08H)	Sub-function code (0000H)	Data (00C8003C000AH)	Error check CRC-16 (E7D9H)	3.5 idle characters
	1	1	2	6	2	

- Response message from the slave in normal status (Echoes back the same message.)

3.5 idle characters	Slave address (01H)	Function code (08H)	Sub-function code (0000H)	Data (00C8003C000AH)	Error check CRC-16 (E7D9H)	3.5 idle characters
	1	1	2	6	2	

(2) Read [Slave address 1, Device identification information (Vendor name)]

- A request message from the master

3.5 idle characters	Slave address (01H)	Function code (2BH)	Sub-function code (0EH)	Data (0400H)	Error check CRC-16 (7327H)	3.5 idle characters
	1	1	1	2	2	

- Response message from the slave in normal status (SHINKO TECHNOS CO., LTD.)

3.5 idle characters	Slave address (01H)	Function code (2BH)	Sub-function code (0EH)	
	1	1	1	

Data
(048100000100185348494E4B4F20544543484E4F5320434F2E2C204C54442EH)
31

Error check CRC-16 (1C54H)	3.5 idle characters
2	

Data in the response message becomes as follows.

Data	Read Device ID code	1 byte	04H
	Conformity level	1 byte	81H
	More Follows	1 byte	00H
	Next Object ID	1 byte	00H
	Number of Objects	1 byte	01H
	List of Object ID	1 byte	00H
	List of Object length	1 byte	24(18H)
	List of Object value	Object length	S(53H)
			H(48H)
			I(49H)
			N(4EH)
			K(4BH)
			O(4FH)
			(20H)
			T(54H)
			E(45H)
			C(43H)
			H(48H)
			N(4EH)
			O(4FH)
			S(53H)
			(20H)
			C(43H)
			O(4FH)
			.(2EH)
			.(2CH)
			(20H)
		L(4CH)	
		T(54H)	
		D(44H)	
		.(2EH)	

(3) Read [Slave address 1, Device identification information (Product code)]

- A request message from the master

3.5 idle characters	Slave address (01H)	Function code (2BH)	Sub-function code (0EH)	Data (0401H)	Error check CRC-16 (B2E7H)	3.5 idle characters
	1	1	1	2	2	

- Response message from the slave in normal status (SGSL-A01 -0-0)

3.5 idle characters	Slave address (01H)	Function code (2BH)	Sub-function code (0EH)			
	1	1	1			
	Data (0481000001010D5347534C2D413031202D302D30H)				Error check CRC-16 (01BDH)	3.5 idle characters
	20				2	

Data in the response message becomes as follows.

Data	Read Device ID code	1 byte	04H
	Conformity level	1 byte	81H
	More Follows	1 byte	00H
	Next Object ID	1 byte	00H
	Number of Objects	1 byte	01H
	List of Object ID	1 byte	01H
	List of Object length	1 byte	13(0DH)
	List of Object value	Object length	S(53H)
			G(47H)
			S(53H)
			L(4CH)
			-(2DH)
			A(41H)
			0(30H)
			1(31H)
			Space (20H)
			-(2DH)
		0(30H)	
		-(2DH)	
		0(30H)	

- Response message from the slave in exception (error) status [when Sub-function code (MEI type) is incorrect]

The function code MSB is set to 1 for the response message in exception (error) status, and ABH is returned.

Exception code 01H (Non-existent function) is returned (error).

3.5 idle characters	Slave address (01H)	Function code (ABH)	Exception code (01H)	Error check CRC-16 (9EF0H)	3.5 idle characters
	1	1	1	2	

6. Communication Command Table

6.1 Communication Command Table

6.1.1 A Single Piece of Data Read/Write Command

Function Code	Data Item		Data
03/06H	0001H	Default Display/Manual mode (*1)	0000H: Default Display 0001H: Manual mode
03/06H	0002H	Output 1 output value	Set value
	0003H	Reserved (*2)	
	0004H	Reserved (*3)	
	:	:	
	000FH	Reserved (*3)	

6.1.2 A Single/Multiple Piece(s) of Data Read/Write Command

Function Code	Data Item		Data
03/06/10H	0010H	Input group (*4)	0000H: DC signal input 0001H: Thermocouple input 0002H: RTD input
03/06/10H	0011H	Input type	<p>SGU (DC signal input), SGS</p> <p>0000H: 4 to 20 mA (Built-in 50 Ω shunt resistor)</p> <p>0001H: 4 to 20 mA (Externally mounted 250 Ω shunt resistor)</p> <p>0002H: 4 to 20 mA (Externally mounted 50 Ω shunt resistor)</p> <p>0003H: 0 to 20 mA</p> <p>0004H: 0 to 16 mA</p> <p>0005H: 2 to 10 mA</p> <p>0006H: 0 to 10 mA</p> <p>0007H: 1 to 5 mA</p> <p>0008H: 0 to 1 mA</p> <p>0009H: 10 to 50 mA</p> <p>000AH: 0 to 10 mV</p> <p>000BH: 0 to 50 mV</p> <p>000CH: 0 to 60 mV</p> <p>000DH: 0 to 100 mV</p> <p>000EH: 0 to 1 V</p> <p>000FH: 0 to 5 V</p> <p>0010H: 1 to 5 V</p> <p>0011H: -5 to 5 V</p> <p>0012H: 0 to 10 V</p> <p>0013H: -10 to 10 V</p> <p>S GI</p> <p>0000H: 4 to 20 mA (Built-in 50 Ω shunt resistor)</p> <p>0001H: 4 to 20 mA (Externally mounted 250 Ω shunt resistor)</p> <p>0002H: 4 to 20 mA (Externally mounted 50 Ω shunt resistor)</p> <p>0003H: 1 to 5 V</p> <p>SGU (Thermocouple input), SGT</p> <p>0000H: K -200 to 1370°C</p> <p>0001H: K -200 to 200°C</p> <p>0002H: K 0 to 400°C</p> <p>0003H: J -200 to 1000°C</p> <p>0004H: J -200 to 200°C</p> <p>0005H: J 0 to 400°C</p> <p>0006H: R -50 to 1760°C</p> <p>0007H: S -50 to 1760°C</p> <p>0008H: B 0 to 1820°C</p> <p>(Continued on next page)</p>

Function Code	Data Item		Data
03/06/10H	0011H	Input type (Continued from the previous page)	0009H: E -200 to 800°C 000AH: T -200 to 400°C 000BH: T -100 to 100°C 000CH: N -200 to 1300°C 000DH: PL-Ⅱ 0 to 1390°C 000EH: W5Re/W26Re 0 to 2315°C 000FH: W3Re/W25Re 0 to 2315°C SGU (RTD input), SGR 0000H: Pt100 -200 to 650°C 0001H: Pt100 -100 to 100°C 0002H: JPt100 -200 to 500°C 0003H: JPt100 -100 to 100°C
03/06/10H	0012H	Input unit (*4)	0000H: °C 0001H: °F
03/06/10H	0013H	Decimal point place	SGU (Thermocouple, RTD input), SGT, SGR 0000H: No decimal point 0001H: 1 digit after decimal point SGxL except SGU (Thermocouple, RTD input), SGT, SGR 0000H: No decimal point 0001H: 1 digit after decimal point 0002H: 2 digits after decimal point 0003H: 3 digits after decimal point
03/06/10H	0014H	Output 0% value	Set value
03/06/10H	0015H	Output 100% value	Set value
03/06/10H	0016H	Indication unit	0000H: No unit 0001H: % 0002H: mA 0003H: V 0004H: °C
03/06/10H	0017H	Square root function (*4)	0000H: Disabled 0001H: Enabled
03/06/10H	0018H	Low level cutoff (*4)	Set value
	0019H	Reserved (*3)	
	:	:	
	001FH	Reserved (*3)	
03/06/10H	0020H	Output 1 type	SGxL except SGI 0000H: 4 to 20 mA 0001H: 0 to 20 mA 0002H: 0 to 16 mA 0003H: 2 to 10 mA 0004H: 0 to 10 mA 0005H: 0 to 10 mV 0006H: 0 to 100 mV 0007H: 0 to 1 V 0008H: 0 to 5 V 0009H: 1 to 5 V 000AH: 0 to 10 V 000BH: -5 to 5 V SGI 0000H: 4 to 20 mA 0001H: 1 to 5 V

Function Code	Data Item		Data
03/06/10H	0021H	Output 1 decimal point place	0000H: No decimal point 0001H: 1 digit after decimal point 0002H: 2 digits after decimal point 0003H: 3 digits after decimal point
03/06/10H	0022H	Output 1 indication value at output 0%	Set value
03/06/10H	0023H	Output 1 indication value at output 100%	Set value
03/06/10H	0024H	Output 1 low limit (*4)	Set value
03/06/10H	0025H	Output 1 high limit (*4)	Set value
03/06/10H	0026H	Output 1 low limit (outside rating) (*4)	Set value
03/06/10H	0027H	Output 1 high limit (outside rating) (*4)	Set value
03/06/10H	0028H	I/O characteristics (*4)	0000H: V characteristics 0001H: Parallel characteristics
03/06/10H	0029H	Output 1 split value (*4)	Set value
03/06/10H	002AH	Output 1 Normal/Reverse	0000H: Normal 0001H: Reverse
03/06/10H	002BH	Output 1 ratio (*4)	Set value
03/06/10H	002CH	Output 1 bias (*4)	Set value
03/06/10H	002DH	Input point 1 (*4)	Set value
03/06/10H	002EH	Output 1 output value 1(*4)	Set value
03/06/10H	002FH	Input point 2 (*4)	Set value
03/06/10H	0030H	Output 1 output value 2(*4)	Set value
	0031H	Reserved (*3)	
	:	:	
	003FH	Reserved (*3)	
03/06/10H	0040H	Output 2 type (*2)	SGxL except SGI 0000H: 4 to 20 mA 0001H: 0 to 20 mA 0002H: 0 to 16 mA 0003H: 2 to 10 mA 0004H: 0 to 10 mA 0005H: 0 to 10 mV 0006H: 0 to 100 mV 0007H: 0 to 1 V 0008H: 0 to 5 V 0009H: 1 to 5 V 000AH: 0 to 10 V SGI 0000H: 4 to 20 mA 0001H: 1 to 5 V
03/06/10H	0041H	Output 2 decimal point place (*2)	0000H: No decimal point 0001H: 1 digit after decimal point 0002H: 2 digits after decimal point 0003H: 3 digits after decimal point
03/06/10H	0042H	Output 2 indication value at output 0% (*2)	Set value
03/06/10H	0043H	Output 2 indication value at output 100% (*2)	Set value
03/06/10H	0044H	Output 2 low limit (*2)(*4)	Set value
03/06/10H	0045H	Output 2 high limit (*2)(*4)	Set value
03/06/10H	0046H	Output 2 low limit (outside rating) (*2)(*4)	Set value
03/06/10H	0047H	Output 2 high limit (outside rating) (*2)(*4)	Set value
	0048H	Reserved (*3)	
03/06/10H	0049H	Output 2 split value (*2)(*4)	Set value
03/06/10H	004AH	Output 2 Normal/Reverse (*2)	0000H: Normal 0001H: Reverse

Function Code	Data Item		Data
03/06/10H	004BH	Output 2 ratio (*2)(*4)	Set value
03/06/10H	004CH	Output 2 bias (*2)(*4)	Set value
03/06/10H	004DH	Input point 1 (*2)(*4)	Set value
03/06/10H	004EH	Output 2 output value 1 (*2)(*4)	Set value
03/06/10H	004FH	Input point 2 (*2)	Set value
03/06/10H	0050H	Output 2 output value 2 (*2)	Set value
	0051H	Reserved (*3)	
	:	:	
	005FH	Reserved (*3)	
03/06/10H	0060H	Filter time constant	Set value
03/06/10H	0061H	Sensor correction	Set value
03/06/10H	0062H	Input disconnection status (*4)	0000H: Overscale 0001H: Underscale
03/06/10H	0063H	Indication time	Set value
03/06/10H	0064H	Auto/Manual	0000H: Auto 0001H: Manual
03/06/10H	0065H	Ratio setting method (*4)	0000H: Ratio setting 0001H: Output value setting
	0066H	Reserved (*3)	
	:	:	
	0068H	Reserved (*3)	
03/06/10H	0069H	Manual mode auto return time	Set value
	006AH	Reserved (*3)	
	:	:	
	006FH	Reserved (*3)	
03/06/10H	0070H	Multi-Display A 1st digit	0000H: A 0001H: B 0002H: C 0003H: D 0004H: E 0005H: F 0006H: G 0007H: H 0008H: I 0009H: J 000AH: K 000BH: L 000CH: M 000DH: N 000EH: O 000FH: P 0010H: Q 0011H: R 0012H: S 0013H: T 0014H: U 0015H: V 0016H: W 0017H: X 0018H: Y 0019H: Z 001AH: 0 001BH: 1
			(Continued on next page)

Function Code	Data Item		Data
03/06/10H	0070H	Multi-Display A 1st digit (Continued from the previous page)	001CH: 2 001DH: 3 001EH: 4 001FH: 5 0020H: 6 0021H: 7 0022H: 8 0023H: 9 0024H: / (Slash) 0025H: - (Hyphen) 0026H: . (Period) 0027H: (Blank)
03/06/10H	0071H	Multi-Display A 2nd digit	Same as Multi-Display A 1st digit data
03/06/10H	0072H	Multi-Display A 3rd digit	Same as Multi-Display A 1st digit data
03/06/10H	0073H	Multi-Display A 4th digit	Same as Multi-Display A 1st digit data
03/06/10H	0074H	Multi-Display B 1st digit	Same as Multi-Display A 1st digit data
03/06/10H	0075H	Multi-Display B 2nd digit	Same as Multi-Display A 1st digit data
03/06/10H	0076H	Multi-Display B 3rd digit	Same as Multi-Display A 1st digit data
03/06/10H	0077H	Multi-Display B 4th digit	Same as Multi-Display A 1st digit data
	0078H	Reserved (*3)	
	:	:	
	007FH	Reserved (*3)	
03/06/10H	0080H	Instrument number (*5)	Set value
03/06/10H	0081H	Communication speed (*5)	0000H: 9600 bps 0001H: 19200 bps 0002H: 38400 bps
03/06/10H	0082H	Data bit/Parity (*5)	0000H: 8 bits/No parity 0001H: 8 bits/Even 0002H: 8 bits/Odd
03/06/10H	0083H	Stop bit (*5)	0000H: 1 bit 0001H: 2 bits
03/06/10H	0084H	Response delay time	Set value
	0085H	Reserved (*3)	
	:	:	
	009FH	Reserved (*3)	

6.1.3 A Single Piece of Data Write Command

Function Code	Data Item		Data
06H	00A0H	Key operation change flag clearing (*6)	0001H: Clear key operation change flag
	00A1H	Reserved (*3)	
	:	:	
	00AFH	Reserved (*3)	

6.1.4 Read Command

Function Code	Data Item		Data
03/04H	00B0H	Input value	Read value, Decimal point ignored
03/04H	00B1H	Output 1 output value	Read value, Decimal point ignored
03/04H	00B2H	Status flag	B0: Input error (High limit) 0: Normal 1: Error (Overscale) B1: Input error (Low limit) 0: Normal 1: Error (Underscale) B2: Not used : B10: Not used B11: USB connection 0: Standard connection 1: USB connection B12: Unit status 1 0: Default Display 1: Setting mode B13: Unit status 2 0: Default Display 1: Manual mode B14: Lock status 0: Unlock 1: Lock B15: Change in key operation 0: No 1: Yes
	00B3H	Reserved (*3)	
	:	:	
	00C0H	Reserved (*3)	
03/04H	00C1H	Output 2 output value	Read value, Decimal point ignored
	00C2H	Reserved (*3)	
	:	:	
	00CFH	Reserved (*3)	
03/04H	00D0H	Software version	Read value
	00D1H	Reserved (*3)	
03/04H	00D2H	Key operation changed item	Data item changed by key operation
	00D3H	Reserved (*3)	
	:	:	
	0138H	Reserved (*3)	

(*1) If Auto is selected in [Auto/Manual (0064H)], and if Manual mode is selected in [Default Display/Manual mode (0001H)], Exception code 17 (11H) will be returned as a negative acknowledgement.

(*2) This item (Reserved) cannot be used as it is console software data area.

If a single/multiple piece(s) of data Read is executed, 0 (zero) will be returned (acknowledgement).

If a single/multiple piece(s) of data Write is executed, acknowledgement will be returned, and data will be discarded.

If a value out of the setting range is written, Exception code 3 (03H) will be returned as a negative acknowledgement.

(*3) This item (Reserved) cannot be used as it is data area for extension.

If a single/multiple piece(s) of data Read is executed, 0 (zero) will be returned (acknowledgement).

If a single/multiple piece(s) of data Write is executed, acknowledgement will be returned, and data will be discarded.

(*4) Available or unavailable depending on model.

For unavailable items,

if a single/multiple piece(s) of data Read is executed, 0 (zero) will be returned (acknowledgement).

if a single/multiple piece(s) of data Write is executed, acknowledgement will be returned, and data will be discarded.

(*5) If communication conditions are changed, please change communication conditions on the host side as well.

(*6) If a single/multiple piece(s) of data Read is executed, 0 (zero) will be returned (acknowledgement).

For a single/multiple piece(s) of data Write, and if data except 0001H is written, Exception code 3 (03H) will be returned as a negative acknowledgement.

6.2 Data

6.2.1 Notes about Write/Read Command

- The data (set value, decimal) is converted to a hexadecimal number. Negative numbers are represented in 2's complement.
- When connecting multiple slaves, the address (instrument number) must not be duplicated.
- Do not use undefined Data items. If they are used, negative acknowledgement will be returned or a random value will be written or read, resulting in malfunction.
- Modbus protocol uses Holding Register addresses. The Holding Register addresses are created as follows. A data item is converted to decimal number, and the offset of 40001 is added. The result is the Holding Register address.
Using Data item 0001H (Default Display/Manual mode) as an example: Data item in the sending message is 0001H, however, Modbus protocol Holding Register address is 40002 (1 + 40001).

6.2.2 Write Command

- Up to 1,000,000 (one million) entries can be stored in non-volatile IC memory. If the number of settings exceeds the limit, the data will not be saved. So, do not change the set values frequently via software communication. (If a value set via software communication is the same as the value before the setting, the value will not be written in non-volatile IC memory.)
- Setting range of each item is the same as that of keypad operation.
- When data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used.
- Writings via software communication are possible while in Set value lock status.
- Even if options are not equipped, writing or reading via software communication will be possible. However, their command contents will not function.
- When Write is executed using the Broadcast address (00H) command, the command is sent to all the connected slaves. However, a response is not returned.

6.2.3 Read Command

- When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used for a response.

6.3 Negative Acknowledgement

6.3.1 Exception code 2 (02H)

The slave will return Exception code 2 (02H) in the following cases.

- When non-existent data address is read or written
- When "Not used" item is read or written.

6.3.2 Exception code 3 (03H)

The slave will return Exception code 3 (03H) in the following case.

- When a value out of the setting range is written.

6.3.3 Exception code 17 (11H)

The slave will return Exception code 17 (11H) in the following case.

- When Auto is selected in [Auto/Manual (0064H)], and if Manual mode is selected in [Default Display/Manual mode]

6.3.4 Exception code 18 (12H)

The slave will return Exception code 18 (12H) in the following case.

- During setting mode by keypad operation

6.4 Notes on Programming Monitoring Software

6.4.1 How to Speed up the Scan Time

When monitoring multiple units of the instrument, set the program so that the requisite minimum pieces of data such as Data item 00B0H (Input value), Data item 00B1H (Output 1 output value), Data item 00B2H (Status flag), can be read.

For other data, set the program so that they can be read only when their set value has changed.

This will speed up the scan time.

6.4.2 How to Read the Set Value Changes Made by Front Keypad Operation

If any set value is changed by the keypad operation, the instrument sets the [00B2H (Status flag) B15: Change in key operation] to 1 (Yes).

There are 2 methods of reading the set value changes made by front keypad.

(1) Reading method 1

① On the monitoring software side, check that [00B2H (Status flag) B15: Change in key operation] has been set to 1 (Yes), then read all set values.

② Clear [00B2H (Status flag) B15: Change in key operation], by writing Data item 00A0H (Key operation change flag clearing) to 0001H (Clear key operation change flag).

If 00A0H (Key operation change flag clearing) is written to 0001H (Clear key operation change flag) during setting mode of the instrument, Exception Code 18 (12H) will be returned as a negative acknowledgement. And [00B2H (Status flag) B15: Change in key operation] cannot be cleared.

Set a program so that all set values can be read when a negative acknowledgement is returned.

③ Read all set values again after acknowledgement is returned.

(2) Reading method 2

① On the monitoring software side, check that [00B2H (Status flag) B15: Change in key operation] has been set to 1 (Yes), then write the 00A0H (Key operation change flag clearing) to 0001H (Clear key operation change flag).

② Set the program depending on the acknowledgement or negative acknowledgement as follows.

When acknowledgement is returned;

Consider it as settings completed, and read all set values.

When Exception code 18 (12H) is returned as a negative acknowledgement;

Consider it as still in setting mode, and read the requisite minimum pieces of data such as 00B0H (Input value), 00B1H (Output 1 output value), 00B2H (Status flag), then return to Step ①.

Thus, programs which do not affect the scan time can be created using the methods described above, even if set values on the monitoring software will not be updated until settings are complete.

6.5 When Communicating with a PLC

To communicate with a PLC, use a Shinko PLC Interface Unit SIF-600-S3.

No programming is needed for connection.

PLCs corresponding to the SIF-600-S3, its manufacturer and host link units:

PLC Manufacturer	PLC Model, Series Name	Host Link Unit Model
Mitsubishi Electric Corp.	MELSEC Q, QnA series (*)	AJ71UC24, A1SJ71UC24-R2/R4/PRF A1SJ71C24-R2/R4/PRF, QJ71C24
	MELSEC FX series (*)	
Omron Corp.	SYSMAC CJ/CS/CP series	CS1W-SCU21-V1 CJ1W-SCU21, CJ1W-SCU41
Keyence Corp.	KV series	KV-L20V
Yokogawa Electric Corp.	FA-M3 series	F3LC11-2N, F3LC11-1F, F3LC12-1F
Fuji Electric Co., Ltd.	MICREX-SX series	NP1L-RS1, NP1L-RS2, NP1L-RS3 NP1L-RS4

(*) Models with compatible QR/QW communication commands

7. Specifications

Cable length	1.2 km (Max.), Cable resistance: Within 50 Ω (Terminators are not necessary, but if used, use 120 Ω or more on both sides.)
Communication line	EIA RS-485
Communication method	Half-duplex communication
Communication speed	38400 bps (9600, 19200 bps) Selectable by keypad
Synchronization method	Start-stop synchronization
Code form	Binary
Error detection	Parity checking, CRC-16
Error correction	Command request repeat system
Communication protocol	Modbus RTU
Data format	Start bit: 1 bit Data bit: 8 bits Parity: Odd (No parity, Even) (Selectable by keypad) Stop bit: 1 bit (2 bits) (Selectable by keypad)
Number of connectable units	Max 31 units to 1 host computer

8. Troubleshooting

Check that power is being supplied to the master and slave that customers use. If communication failure still occurs, check the following.

Problem	Possible Cause	Solution
Communication failure	Communication cable is not securely connected, or is disconnected/defective.	Check the communication cable and connector.
	Incorrect wiring of the communication cable and/or connector	Check the communication cable and connector. Refer to Section '2. Wiring' (pp. 2, 3).
	Imperfect contact between the communication cable and the connector, or between the communication connector and instrument port	Check the communication cable and connector.
	Communication speed of the slave does not match that of the master.	Set the same communication speed on the master and the slave. Refer to Section '3. Setting Communication Parameters' (pp. 3, 4).
	The data bit, parity and stop bit of the master do not correspond to those of the slave.	Set the same data bit, parity and stop bit on the master and the slave. Refer to Section '3. Setting Communication Parameters' (pp. 3, 4).
	The instrument number (address) of the slave does not correspond to that of the command.	Check the instrument number (address) of the slave and the command. Refer to Section '3. Setting Communication Parameters' (pp. 3, 4).
	The instrument numbers (addresses) are duplicated in multiple slaves.	Check that each slave has a different instrument number (address). Refer to Section '3. Setting Communication Parameters' (pp. 3, 4).
	Make sure that the program is appropriate for the transmission timing.	Check the program. Refer to Section '4. Communication Procedure' (p.5).
Although communication is occurring, the response is negative acknowledgement.	A non-existent command code has been sent.	Check the command code.
	The Write command data exceeds the setting range of the slave.	Check the setting range of the slave.
	No command can be written to the slave.	Check the slave status.
	The instrument is in front keypad operation setting mode.	Return the instrument to the Default Display.

For all other malfunctions, please contact our main office or dealers.

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