Back Pressure Type Indicator

LE100A/LE110A

[Z-1021]

Modbus Communication Instruction Manual

RKC INSTRUMENT INC.

IMR01C27-E1

NOTICE

This manual assumes that the reader has a fundamental knowledge of the principles of electricity, process control, computer technology and communications.

- The figures, diagrams and numeric values used in this manual are only for explanation purpose.
- RKC is not responsible for any damage or injury that is caused as a result of using this instrument, instrument failure or indirect damage.
- RKC is not responsible for any damage and/or injury resulting from the use of instruments made by imitating this instrument.
- Periodic maintenance is required for safe and proper operation of this instrument. Some components have a limited service life, or characteristics that change over time.
- Every effort has been made to ensure accuracy of all information contained herein. RKC makes no warranty, expressed or implied, with respect to the accuracy of the information. The information in this manual is subject to change without prior notice.
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Safety Precautions

■ Pictorial Symbols (safety symbols)

Various pictorial symbols are used in this manual to ensure safe use of the product, to protect you and other people from harm, and to prevent damage to property. The symbols are described below.
Be sure you thoroughly understand the meaning of the symbols before reading this manual.

⚠ WARNING : This mark indicates precautions that must be taken if there is danger of electric shock, fire, etc., which could result in loss of life or injury.

⚠ CAUTION : This mark indicates that if these precautions and operating procedures are not taken, damage to the instrument may result.

⚠ : This mark indicates that all precautions should be taken for safe usage.

⚠ WARNING

- To prevent injury to persons, damage to the instrument and the equipment, a suitable external protection device shall be required.
- All wiring must be completed before power is turned on to prevent electric shock, fire or damage to the instrument and the equipment.
- This instrument must be used in accordance with the specifications to prevent fire or damage to the instrument and the equipment.
- This instrument is not intended for use in locations subject to flammable or explosive gases.
- Do not touch high-voltage connections such as power supply terminals, etc. to avoid electric shock.
- RKC is not responsible if this instrument is repaired, modified or disassembled by other than factory-approved personnel. Malfunction may occur and warranty is void under these conditions.

⚠ CAUTION

- This product is intended for use with industrial machines, test and measuring equipment. (It is not designed for use with medical equipment and nuclear energy plant.)
- This is a Class A instrument. In a domestic environment, this instrument may cause radio interference, in which case the user may be required to take additional measures.
- Be sure to provide an appropriate surge control circuit respectively for the following:
  - If input/output or signal lines within the building are longer than 30 meters.
  - If input/output or signal lines leave the building, regardless the length.
- This instrument is designed for installation in an enclosed instrumentation panel. All high-voltage connections such as power supply terminals must be enclosed in the instrumentation panel to avoid electric shock to operating personnel.
- All precautions described in this manual should be taken to avoid damage to the instrument or equipment.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- All wiring must be in accordance with local codes and regulations.
- To prevent instrument damage as a result of failure, protect the power line and the input/output lines from high currents with a suitable overcurrent protection device with adequate breaking capacity such as a fuse, circuit breaker, etc.
- A malfunction in this product may occasionally make control operations impossible or prevent alarm outputs, resulting in a possible hazard. Take appropriate measures in the end use to prevent hazards in the event of malfunction.
- Prevent metal fragments or lead wire scraps from falling inside instrument case to avoid electric shock, fire or malfunction.
- Tighten each terminal screw to the specified torque found in the manual to avoid electric shock, fire or malfunction.
- For proper operation of this instrument, provide adequate ventilation for heat dissipation.
- Do not connect wires to unused terminals as this will interfere with proper operation of the instrument.
- Turn off the power supply before cleaning the instrument.
- Do not use a volatile solvent such as paint thinner to clean the instrument. Deformation or discoloration may occur. Use a soft, dry cloth to remove stains from the instrument.
- To avoid damage to the instrument display, do not rub with an abrasive material or push the front panel with a hard object.

For Proper Disposal

When disposing of each part used for this instrument, always follows the procedure for disposing of industrial wastes stipulated by the respective local community.

Symbols

■ Pictorial Symbols (safety symbols)

NOTE : This mark indicates important information on installation, handling and operating procedures.

: This mark indicates supplemental information on installation, handling and operating procedures.

: This mark indicates where additional information may be located.

■ Character Symbols

7-segment character

0	1	2	3	4	5	6	7	8	9	Minus	Period
											

A	B (b)	C	c	D (d)	E	F	G	H	I	J	K
											

L	M	N (n)	O (o)	P	Q	R	S	T	t	U	u
											

V	W	X	Y	Z	Degree	／	Prime	＊ (Asterisk)
								

About This Manual

There are six manuals pertaining to this product. Please be sure to read all manuals specific to your application requirements.

The following manuals can be downloaded from the official RKC website:
https://www.rkcinst.co.jp/english/download-center/

Manual	Manual Number	Remarks
LE100A-D Installation Manual	IMR01C20-X☐	This manual is enclosed with instrument. This manual explains the mounting and wiring.
LE110A-D Installation Manual	IMR01C23-X☐	
LE100A-D Instruction Manual	IMR01C21-E☐	This manual describes installation, wiring, troubleshooting, and product specification.
LE110A-D Instruction Manual	IMR01C24-E☐	
LE100A/ LE110A Communication Instruction Manual	IMR01C22-E☐	This manual explain communication protocol (ANSI X3.28-1976) relating to communication parameters setting.
LE100A/ LE110A [Z-1021] Modbus Communication Instruction Manual	**IMR01C27-E1**	This manual you are reading now. This manual explain Modbus communication protocol relating to communication parameters setting.

Read this manual carefully before operating the instrument. Please place the manual in a convenient location for easy reference.

Document Configuration

This manual consists of 7 chapters and an appendix. If you are looking for topics concerning the Modbus communication, you may be able to find one in the following table.

	What do you want to do?	See the following section for more details
☐	I want to know the features of the Modbus communication	1. OUTLINE
☐	I want to know the specification of the Modbus communication	2. SPECIFICATIONS
☐	I want to know how to connect to the host computer	3. WIRING
☐	I want to know how to set up the communication parameters	4. PARAMETER SETTING
☐	I want to know the content of Modbus protocol	5. MODBUS PROTOCOL
☐	I want to check communication [register address, data attribute, data range, and factory set values]	6. COMMUNICATION DATA LIST
☐	I want to know how to cope with errors	7. TROUBLESHOOTING

Contents

MEMO

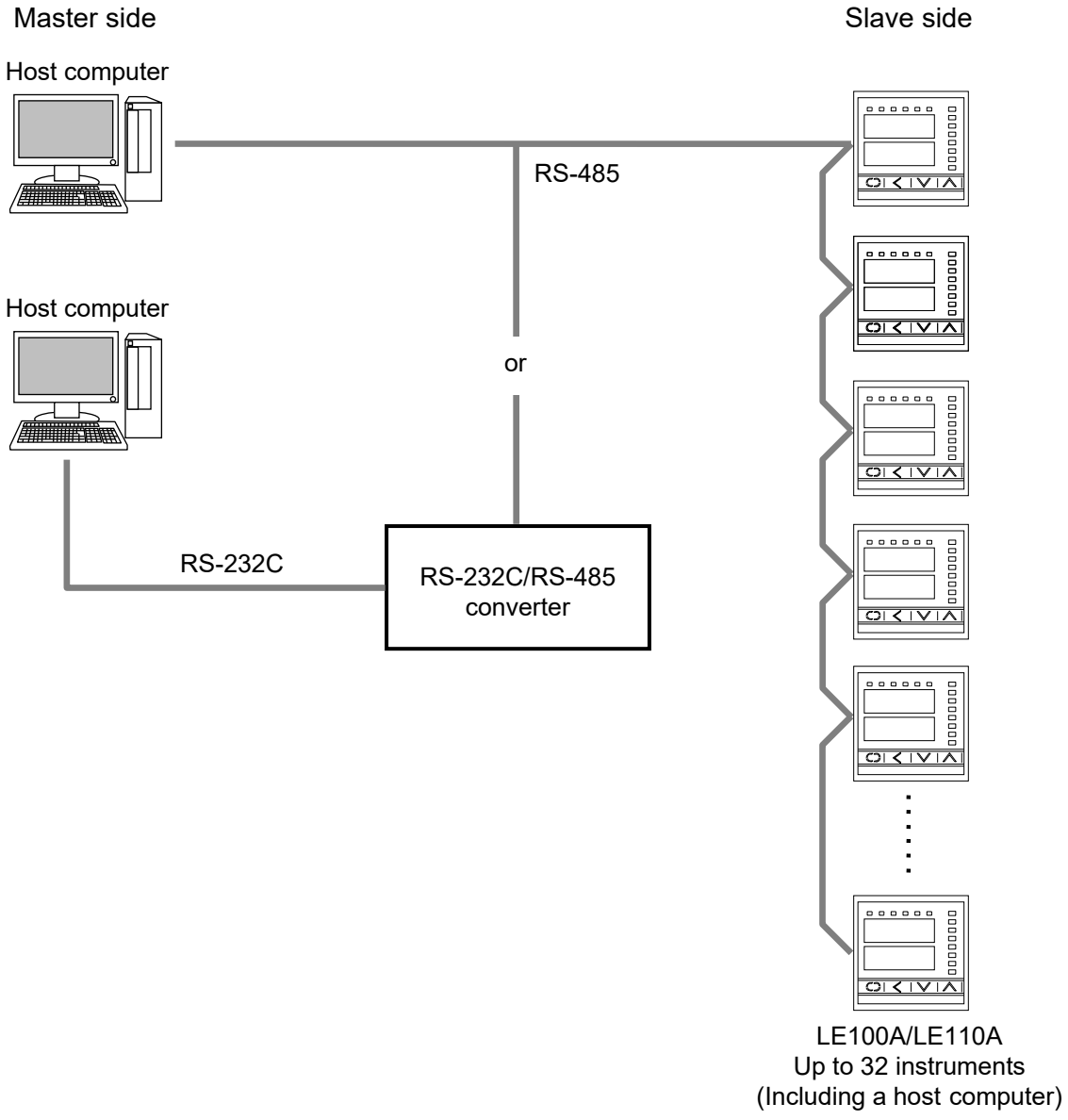
1. OUTLINE

This manual describes the communication functions between the back pressure type indicator LE100A/LE110A * [Z-1021] and the host computer.

* LE110A: Differential Pressure Type

The back pressure type indicator LE100A/LE110A [Z-1021] interfaces with the host computer via Modbus communication protocol.

For reference purposes, the Modbus protocol identifies the host computer as master, the LE100A/LE110A as slave.



2. SPECIFICATIONS

Interface: Based on RS-485, EIA standard

Connection method: 2-wire system, half-duplex multi-drop connection

Communication distance: 1 km max.
(The maximum communication distance will be affected by the surrounding conditions.)

Synchronous method: Start/Stop synchronous type

Communication speed: 2400 bps, 4800 bps, 9600 bps, 19200 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1 or 2

Protocol: Modbus

Signal transmission mode: Remote Terminal Unit (RTU) mode

Function code:
03H (Read holding registers)
06H (Preset single register)
08H (Diagnostics: loopback test)

Error check method: CRC-16

Error code:
1: Function code error
2: When the mismatched address is specified.
3: When the specified number of data items in the query message exceeds the maximum number of data items available

Termination resistor: Externally terminal connected

Maximum connections: 32 instruments maximum including a host computer

Signal logic: RS-485

Signal voltage	Logic
V (A) – V (B) ≥ 2 V	0 (SPACE)
V (A) – V (B) ≤ –2 V	1 (MARK)

Voltage between V (A) and V (B) is the voltage of (A) terminal for the (B) terminal.

3. WIRING

⚠ WARNING

- To prevent electric shock or instrument failure, do not turn on the power until all wiring is completed. Make sure that the wiring is correct before applying power to the instrument.
- To prevent electric shock or instrument failure, turn off the power before connecting or disconnecting the instrument and peripheral equipment.

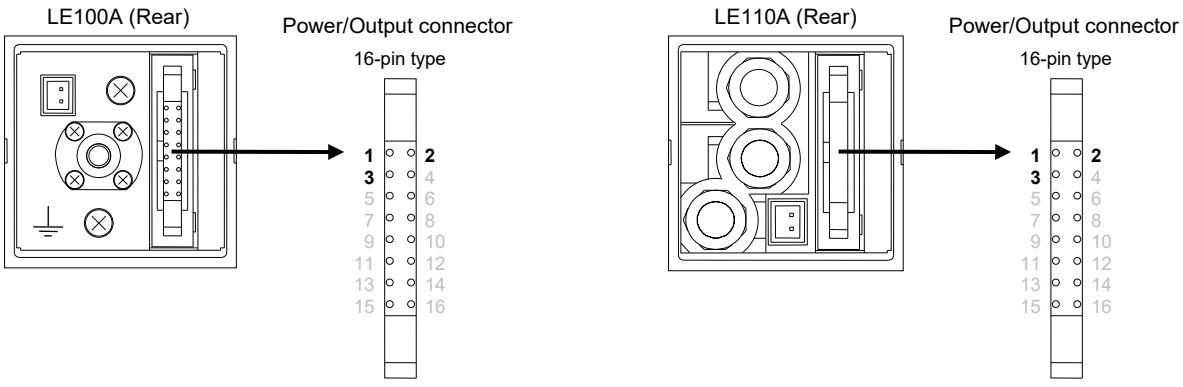
3.1 Wiring Cautions

- To avoid noise induction, keep communication wire away from instrument power line, load lines and power lines of other electric equipment.
- Connect connectors correctly in the right position. If it is forcibly pushed in with pins in the wrong positions, the pins may be bent resulting in instrument failure.
- In order to prevent the instrument from malfunctioning, firmly connect the connector. Check that the Power/Output connector is locked with the lock lever.

3.2 Wiring for Modbus Communication

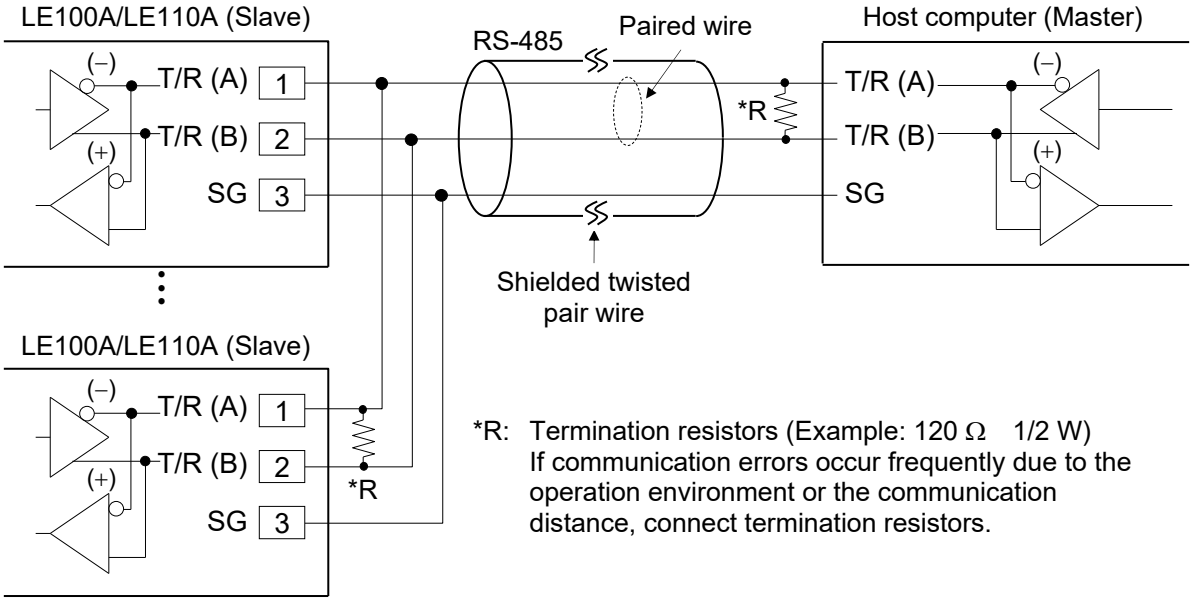
■ Connector pin number and signal details

Pin No.	Signal name	Symbol
1	Send data/Receive data	T/R (A)
2	Send data/Receive data	T/R (B)
3	Signal ground	SG



■ Connection to the RS-485 port of the host computer (master)

● Connection example



*R: Termination resistors (Example: 120 Ω 1/2 W)
If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors.

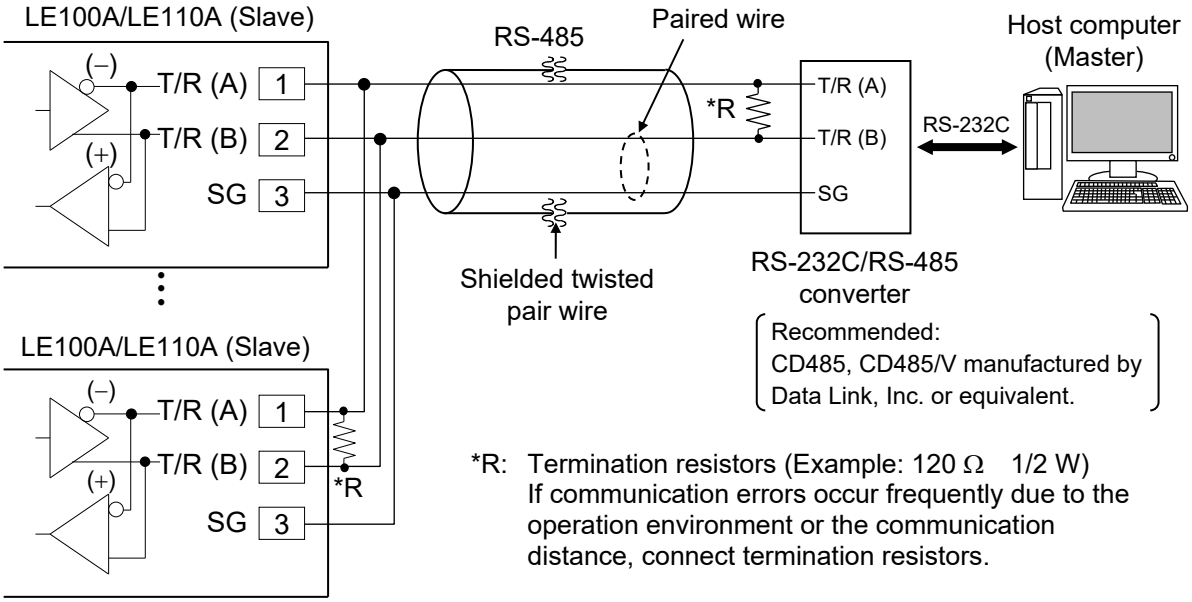
Maximum connections:
32 instruments (including a host computer)

The communication cable and termination resistor(s) must be provided by the customer.

■ Connection to the RS-232C port of the host computer (master)

Use a RS-232C/RS-485 converter with an automatic send/receive transfer function.

● Connection example



*R: Termination resistors (Example: 120 Ω 1/2 W)
If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors.

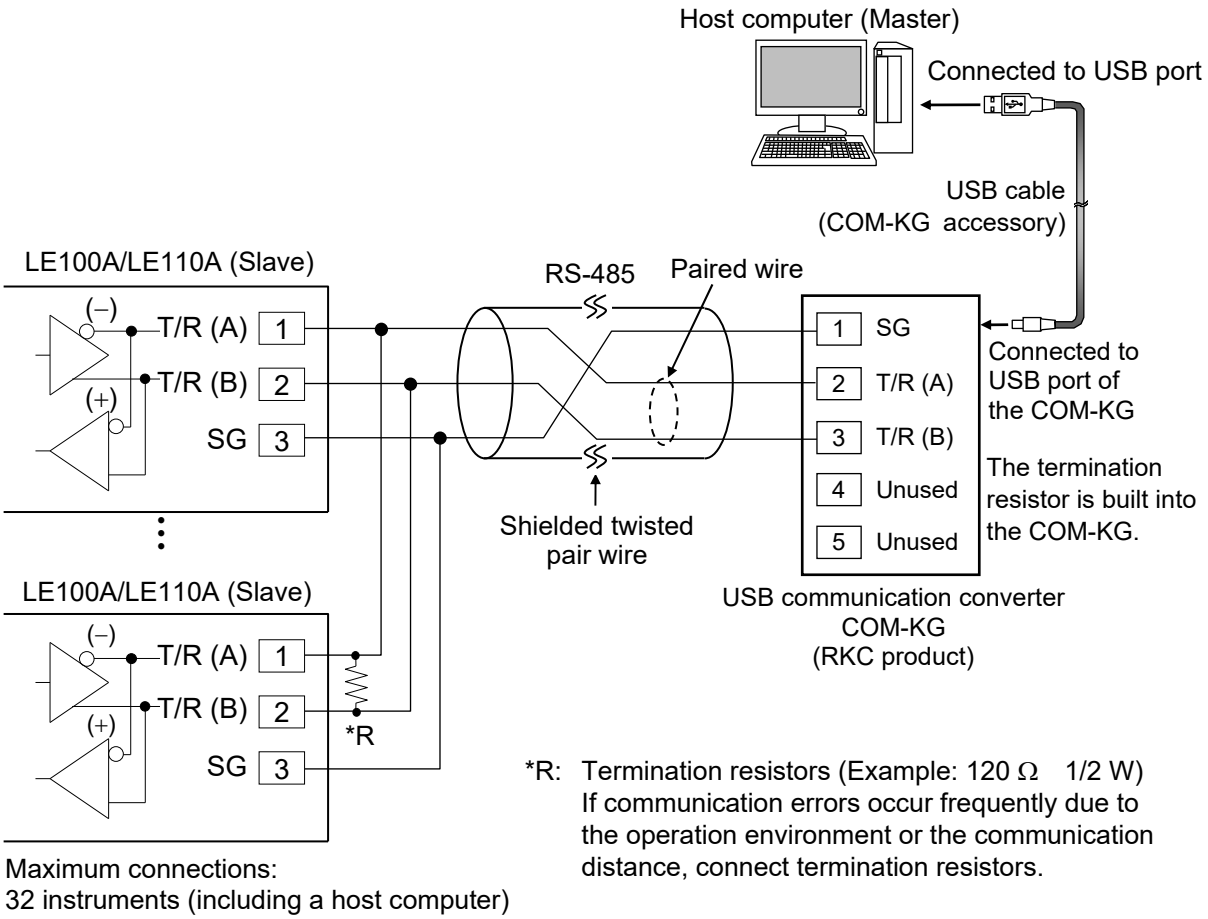
Maximum connections:
32 instruments (including a host computer)

The communication cable and termination resistor(s) must be provided by the customer.

■ Connection to the USB of the host computer (master)

Connect the USB communication converter between the host computer and the LE100A/LE110A.

● Connection example

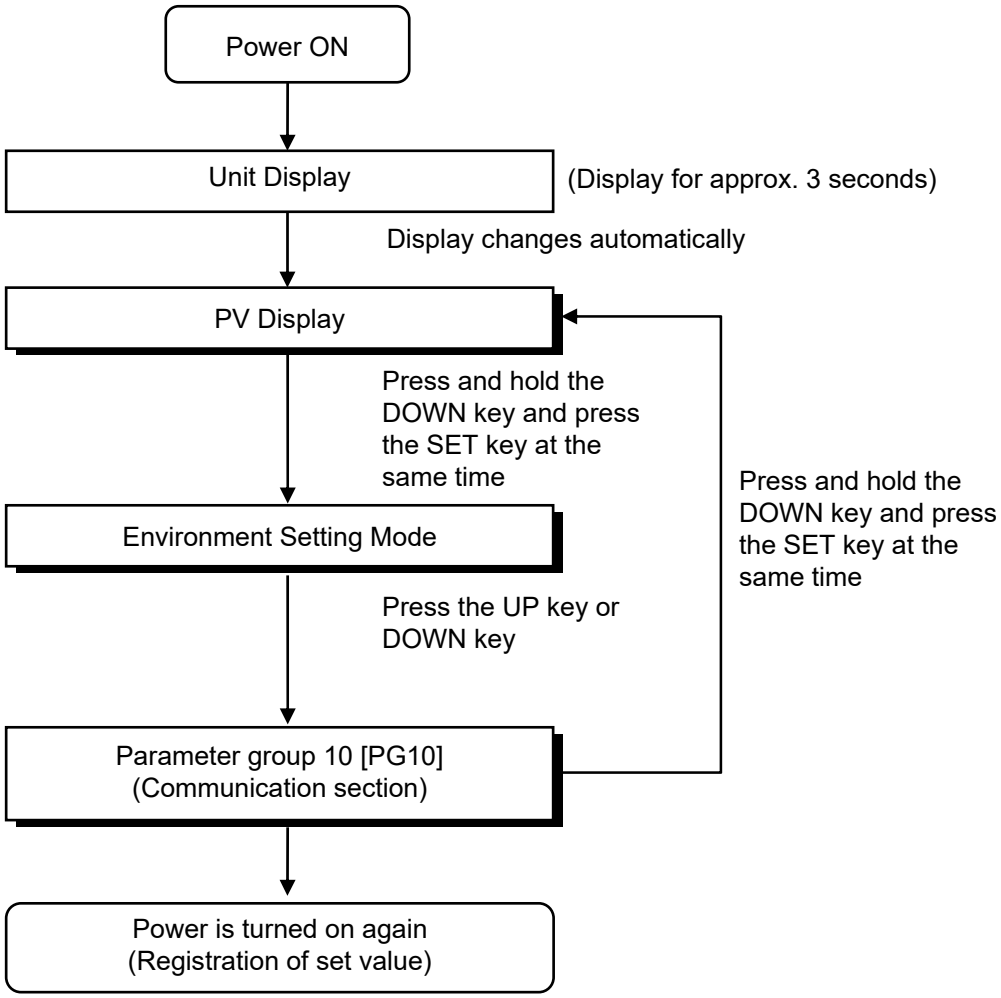


The communication cable and termination resistor(s) must be provided by the customer.

For the COM-KG, refer to the **COM-KG Instruction Manual**.
You can also use our USB communication converter COM-K2.

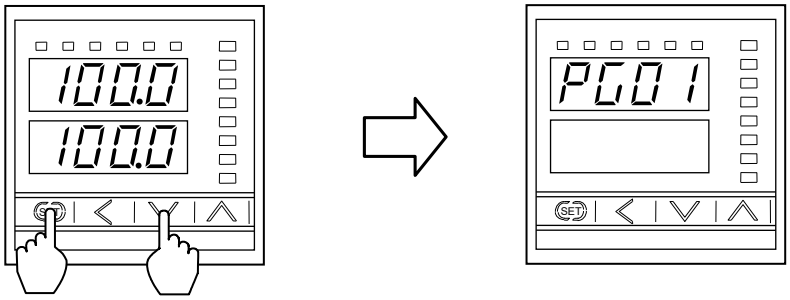
4. PARAMETER SETTING

To establish communication parameters between host computer and LE100A/LE110A, it is necessary to set the slave address, communication speed, data bit configuration and interval time on each LE100A/LE110A in the Parameter group 10 (Communication section).

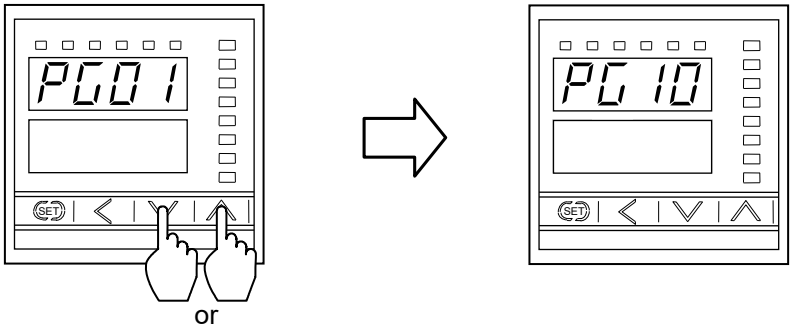


4.1 Transfer to Parameter Group 10 (PG10)

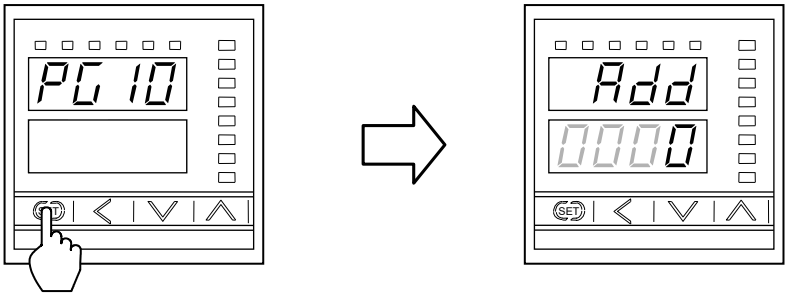
1. To go to the environment setting mode, you must be in PV display. Press and hold the DOWN key and press the SET key at the same time to initiate environment setting mode. The first parameter to be displayed will be the Parameter Group 1 [PG01].



2. Press the UP key or DOWN key to change the present display to the Parameter Group 10 [PG10] (Communication section).



3. Press the SET key. The first parameter to be displayed will be the slave address [Add].

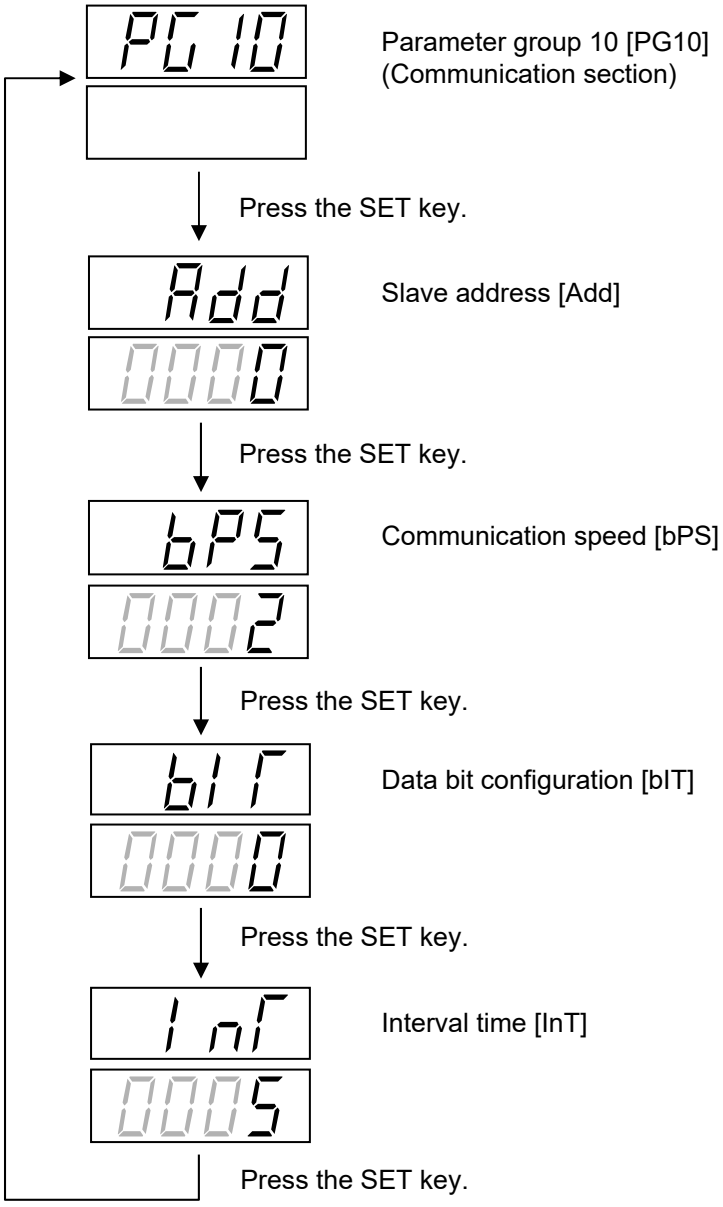


When let Parameter Group 10 [PG10] (Communication section) finish, press and hold the DOWN key and press the SET key at the same time. The display changes to the PV display.

4.2 Setting the Communication Parameters

To select parameters in Parameter Group 10 [PG10] (Communication section), press the SET key. The parameters are displayed and sequenced in the order of slave address [Add], communication speed [bPS], data bit configuration [bIT] and interval time set value [InT].

■ Setting procedure



■ Registration of set value

After completing all communication parameter settings, turn on the power again, and register the set value which changed.

■ Description of each parameters

Symbol	Name	Setting range	Description	Factory set value
PG 10 (PG10)	Parameter Group 10	—	This is the first parameter symbol of parameter group 10.	—
Add (Add)	Slave address	0 to 99	Please set it not to duplication in multi-drop connection. Master does not communicate with the slave when the address is set to "0."	0
bPS (bPS)	Communication speed	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps	Set the same communication speed for both the LE100A/LE110A and the host computer (master).	2
bIT (bIT)	Data bit configuration	☞ See **Data bit configuration table**	Set the same data bit configuration for both the LE100A/LE110A and the host computer (master).	0
InT (InT)	Interval time *	0 to 250 ms	The LE100A/LE110A's interval time must match the specifications of the host computer (master).	5

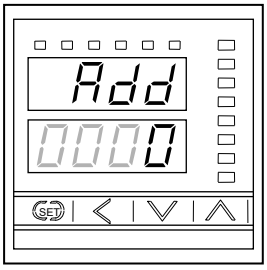
Data bit configuration table

Set value	Data bit	Parity bit	Stop bit
0	8	None	1
1	8	None	2
2 to 5	Do not set this one.		

* The interval time for the LE100A/LE110A should be set to provide a time for host computer to finish sending all data including stop bit and to switch the line to receive data. If the interval time between the two is too short, the LE100A/LE110A may send data before the host computer is ready to receive it. In this case, communication transmission cannot be conducted correctly. For a successful communication sequence to occur, the LE100A/LE110A's interval time must match the specifications of the host computer.

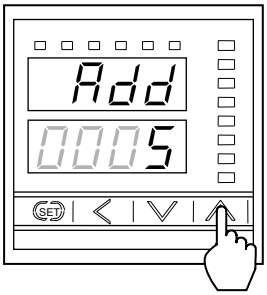
■ Setting procedure example

1. Go to the Parameter Group 10 [PG10] (Communication section) so that slave address [Add], is displayed.
Present set value is displayed, and the least significant digit brightly lit.

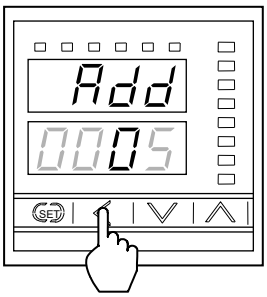


Slave address

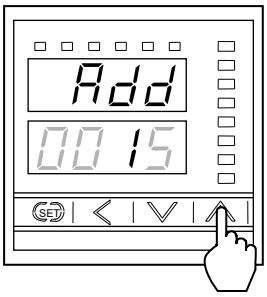
2. Set the slave address. Press the UP key to enter “5” at the least significant digit.
Example: Setting the slave address to “15”.



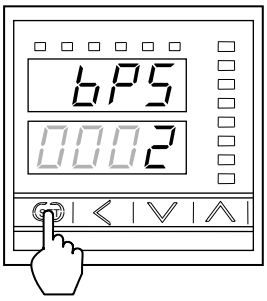
3. Press the <R/S key to brightly lit the tens digit.



4. Press the UP key to enter “1” at the tens digit.



5. Press the SET key to set the value thus set. The display changes to the next communication parameter. It the SET key is not pressed within 1 minute, the present display returns to the PV display and the value set here returns to that before the setting is changed.



Communication speed

6. After completing all communication parameter settings, turn on the power again, and register the set value which changed.

4.3 Communication Requirements

■ Processing times during data send/receive

The LE100A/LE110A requires the following processing times during data send/receive.

The sending and receiving of LE100A/LE110A is conducted through two wires; consequently, the transmission and reception of data requires precise timing.

Response send time is time at having set interval time in 0 ms.

[Unit: ms]

Procedure details	Maximum processing times	Average processing times
Read holding registers [03H] Response transmission time after the slave receives the query message (When 1 register is read)	4	4
Read holding registers [03H] Response transmission time after the slave receives the query message (When 100 registers are collectively read)	24	48
Preset single register [06H] Response transmission time after the slave receives the query message	4	4
Diagnostics (loopback test) [08H] Response transmission time after the slave receives the query message	4	4

■ Fail-safe

A transmission error may occur with the transmission line disconnected, shorted or set to the high-impedance state. In order to prevent the above error, it is recommended that the fail-safe function be provided on the receiver side of the host computer. The fail-safe function can prevent a framing error from its occurrence by making the receiver output stable to the MARK (1) when the transmission line is in the high-impedance state.

■ Data backup

The nonvolatile memory (EEP-ROM) for data backup has limitations on the number of memory rewrite times (approx. 100,000 times). Avoid using the memory to frequently change the set value via communication.

5. MODBUS PROTOCOL

In this chapter a host computer is called Master and LE100A/LE110A is called Slave.

The master controls communication between master and slave. A typical message consists of a request (query message) sent from the master followed by an answer (response message) from the slave. When master begins data transmission, a set of data is sent to the slave in a fixed sequence. When it is received, the slave decodes it, takes the necessary action, and returns data to the master.

5.1 Message Format

The message consists of four parts: slave address, function code, data, and error check code which are always transmitted in the same sequence.

Slave address
Function code
Data
Error check CRC-16

Message format

■ Slave address

The slave address is a number from 1 to 99 manually set at the front key panel of the LE100A/LE110A.

📖 Master does not communicate with the slave when the address is set to "0."

☞ For details, see **4. PARAMETER SETTING (P. 7)**.

Although all connected slave units receive the query message sent from the master, only the slave with the slave address coinciding with the query message will accept the message.

■ Function code

The function codes are the instructions set at the master and sent to the slave describing the action to be executed. The function codes are included when the slave responds to the master.

☞ For details, see **5.2 Function Code (P. 15)**.

■ Data

The data to execute the function specified by the function code is sent to the slave and corresponding data returned to the master from the slave.

☞ For details, see **5.6 Register Read and Write (P. 20)**, **5.7 Data Configuration (P. 23)** and **6. COMMUNICATION DATA LIST (P. 25)**.

■ Error check

An error checking code (CRC-16: Cyclic Redundancy Check) is used to detect an error in the signal transmission.

☞ For details, see **5.5 Calculating CRC-16 (P. 17)**.

5.2 Function Code

Function code contents

Function code (Hexadecimal)	Function	Contents
03H	Read holding registers	Measured value, Alarm status, etc.
06H	Preset single register	Set value, Alarm set value, etc. (For each word)
08H	Diagnostics (loopback test)	Loopback test

Message length of each function (Unit: byte)

Function code (Hexadecimal)	Function	Query message		Response message	
		Min	Max	Min	Max
03H	Read holding registers	8	8	7 *	215
06H	Preset single register	8	8	8 *	8
08H	Diagnostics (loopback test)	8	8	8 *	8

* Error response: 5 bytes

5.3 Communication Mode

Signal transmission between the master and slaves is conducted in Remote Terminal Unit (RTU) mode.

Items	Contents
Data bit length	8-bit (Binary)
Start mark of message	Unused
End mark of message	Unused
Message length	See **5.2 Function code**
Data time interval	Less than 24-bit time *
Error check	CRC-16 (Cyclic Redundancy Check)

* When sending a command message from the master, set intervals of data configuring one message to time shorter than the 24-bit time. If time intervals become time longer than the 24-bit time the relevant slave assumes that message sending from the master is terminated to deform the message format. As a result, the slave does not make a response.

5.4 Slave Responses

(1) Normal response

- In the response message of the Read Holding Registers, the slave returns the read out data and the number of data items with the same slave address and function code as the query message.
- In the response message of the Preset Single Register, the slave returns the same message as the query message.
- In the response message of the Diagnostics (Loopback test), the slave returns the same message as the query message.

(2) Defective message response

- If the query message from the master is defective, except for transmission error, the slave returns the error response message without any action.

Slave address
Function code
Error code
Error check CRC-16

Error response message

- If the self-diagnostic function of the slave detects an error, the slave will return an error response message to all query messages.
- The function code of each error response message is obtained by adding 80H to the function code of the query message.

Error code	Contents
1	Function code error (An unsupported function code was specified)
2	When the mismatched address is specified.
3	• When the data written exceeds the setting range • When the specified number of data items in the query message exceeds the maximum number of data items available

- Order of determination of error
  Error code 1 > Error code 3 > Error code 2

(3) No response

The slave ignores the query message and does not respond when:

- The slave address in the query message does not coincide with any slave address settings.
- The CRC code of the master does not coincide with that of the slave.
- Transmission error such as overrun, framing, parity and etc., is found in the query message.
- Data time interval in the query message from the master exceeds 24-bit time.
- There is length of query message exceeds set range.

5.5 Calculating CRC-16

The Cyclic Redundancy Check (CRC) is a 2 byte (16-bit) error check code. After constructing the data message, not including start, stop, or parity bit, the master calculates a CRC code and appends this to the end of the message. The slave will calculate a CRC code from the received message, and compare it with the CRC code from the master. If they do not coincide, a communication error has occurred and the slave does not respond.

The CRC code is formed in the following sequence:

1. Load a 16-bit CRC register with FFFFH.

2. *Exclusive OR* (⊕) the first byte (8 bits) of the message with the CRC register. Return the result to the CRC register.

3. Shift the CRC register 1 bit to the right.

4. If the carry flag is 1, *exclusive OR* the CRC register with A001 hexadecimal and return the result to the CRC register. If the carry flag is 0, repeat step ***3***.

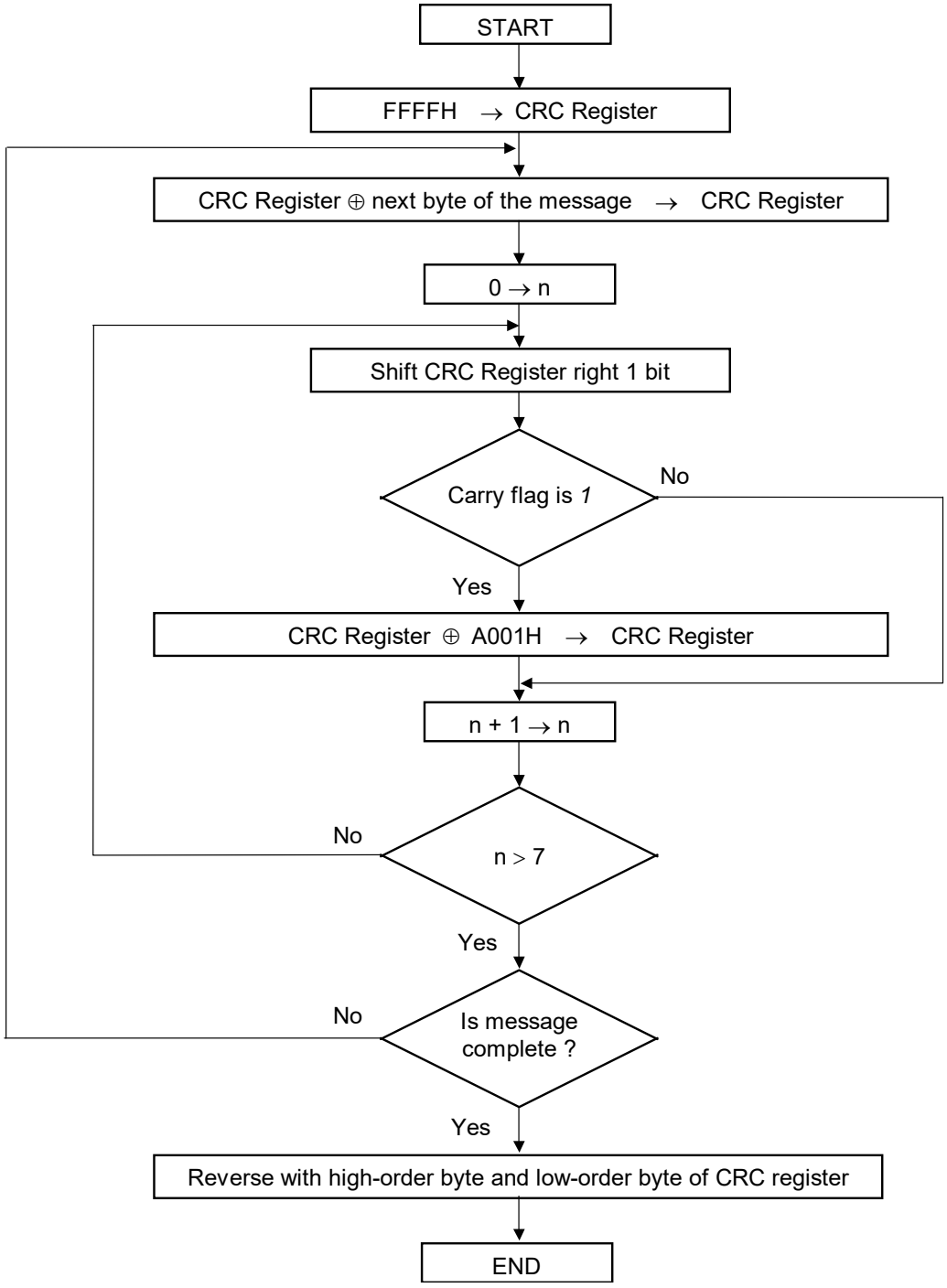
5. Repeat step ***3*** and ***4*** until there have been 8 shifts.

6. *Exclusive OR* the next byte (8 bits) of the message with the CRC register.

7. Repeat step ***3*** through ***6*** for all bytes of the message (except the CRC).

8. The CRC register contains the 2 byte CRC error code. When they are appended to the message, the low-order byte is appended first, followed by the high-order byte.

■ The flow chart of CRC-16



The ⊕ symbol indicates an *exclusive OR* operation. The symbol for the number of data bits is *n*.

■ Example of a CRC calculation in the 'C' language

This routine assumes that the data types 'uint16' and 'uint8' exists. Theses are unsigned 16-bit integer (usually an 'unsigned short int' for most compiler types) and unsigned 8-bit integer (unsigned char). 'z_p' is a pointer to a Modbus message, and 'z_messaage_length' is its length, excluding the CRC. Note that the Modbus message will probably contain NULL characters and so normal C string handling techniques will not work.

uint16 calculate_crc （byte *z_p, unit16 z_message_length）

```
/* CRC runs cyclic Redundancy Check Algorithm on input z_p    */
/* Returns value of 16 bit CRC after completion and           */
/* always adds 2 crc bytes to message                         */
/* returns 0 if incoming message has correct CRC              */

{
    uint16 CRC= 0xffff;
    uint16 next;
    uint16 carry;
    uint16 n;
    uint8 crch, crcl;

    while (z_messaage_length--) {
        next = (uint16) *z_p;
        CRC ^= next;
        for (n = 0; n < 8; n++) {
            carry = CRC & 1;
            CRC >>= 1;
            if (carry) {
              CRC ^= 0xA001;
            }
        }
        z_p++;
    }
    crch = CRC / 256;
    crcl = CRC % 256
    z_p [z_messaage_length++] = crcl;
    z_p [z_messaage_length] = crch;
    return CRC;
}
```

5.6 Register Read and Write

5.6.1 Read holding registers [03H]

The query message specifies the starting register address and quantity of registers to be read.
The contents of the holding registers are entered in the response message as data, divided into two parts: the high-order 8-bit and the low-order 8-bit, arranged in the order of the register numbers.

Example: The contents of the three holding registers from 0000H to 0002H are the read out from slave address 2.

Query message

Slave address		02H	
Function code		03H	
Starting number	High	00H	First holding register address
	Low	00H	
Quantity	High	00H	The setting must be between 1 and 105 (0001H and 0069H)
	Low	03H	
CRC-16	High	05H	
	Low	F8H	

Normal response message

Slave address		02H	
Function code		03H	
Number of data		06H	→ Number of holding registers × 2
First holding register contents	High	00H	
	Low	64H	
Next holding register contents	High	00H	
	Low	00H	
Next holding register contents	High	00H	
	Low	00H	
CRC-16	High	44H	
	Low	4DH	

Error response message

Slave address		02H
80H + Function code		83H
Error code		03H
CRC-16	High	F1H
	Low	31H

5.6.2 Preset single register [06H]

The query message specifies data to be written into the designated holding register. The write data is arranged in the query message with high-order 8-bit first and low-order 8-bit next. Only R/W holding registers can be specified.

Example: Data is written into the holding register 000AH of slave address 1.

Query message

Slave address		01H	
Function code		06H	
Holding register number	High	00H	
	Low	0AH	
Write data	High	00H	Any data within the range
	Low	C8H	
CRC-16	High	A8H	
	Low	5EH	

Normal response message

Slave address		01H	
Function code		06H	
Holding register number	High	00H	
	Low	0AH	
Write data	High	00H	Contents will be the same as query message data.
	Low	C8H	
CRC-16	High	A8H	
	Low	5EH	

Error response message

Slave address		01H
80H + Function code		86H
Error code		02H
CRC-16	High	C3H
	Low	A1H

5.6.3 Diagnostics (Loopback test) [08H]

The master's query message will be returned as the response message from the slave.
This function checks the communication system between the master and slave.

Example: Loopback test for slave address 1

Query message

Slave address		01H	
Function code		08H	
Test code	High	00H	Test code must be set to "00"
	Low	00H	
Data	High	1FH	Any pertinent data
	Low	34H	
CRC-16	High	E9H	
	Low	ECH	

Normal response message

Slave address		01H	Contents will be the same as query message data.
Function code		08H	
Test code	High	00H	
	Low	00H	
Data	High	1FH	
	Low	34H	
CRC-16	High	E9H	
	Low	ECH	

Error response message

Slave address		01H
80H + Function code		88H
Error code		03H
CRC-16	High	06H
	Low	01H

5.7 Data Configuration

5.7.1 Data scale

The numeric range of data used in Modbus protocol is 0000H to FFFFH. Only the set value within the setting range is effective.

FFFFH represents −1.

■ Data processing with decimal points

The Modbus protocol does not recognize data with decimal points during communication.

- **Data with one decimal place**

  Output 1 to 8 differential gap

- **Data with two decimal places**

  Amount of emptiness correction monitor

- **Data with three decimal places**

  Specific gravity monitor End specific gravity setting Specific gravity setting

- **Data whose decimal point's presence and/or position depends on input range and decimal point position (001BH) selection**

The position of the decimal point changes depending on the input range type and the decimal point position selection type, because the Modbus protocol does not recognize data with decimal points during communication.

[Type of decimal points position]

No decimal place, One decimal place, Two decimal places, Three decimal places, Four decimal places

Measured value (PV)
Scale high monitor
Bottom hold monitor
Linearizing table setting 0 to 10
Monitor output low
Scale low monitor
Peak hold monitor
Output 1 to 8 set value
Monitor output high

Example: When Output 1 set value is 20.0 %, 20.0 is processed as 200,
200 = 00C8H

Output 1 set value	High	00H
	Low	C8H

- **Data with no decimal place**

Status monitor	Error code
Number of wafer processing times monitor	Actual liquid output setting
Emptiness adjustment	Number of wafer processing times
Initializing the number of wafer processing times	Hold reset
Interlock release	Set data lock
Default setting	Error release
Decimal point position selection	Number of linearizing table setting
Digital filter	Number of empty adjustment decision times
Output 1 to 8 type selection	Output 1 to 8 deviation value setting
Output 1 to 8 interlock function selection	Output 1 to 8 action selection
Output 1 to 8 timer setting	Number of wafer processing times setting
Scale low	Scale 1 actual liquid setting
Scale 2 actual liquid setting	Correction on the low limit side by actual liquid 2
Correction on the high limit side by actual liquid 2	Unit setting
Specific gravity setting transfer	Specific gravity correction function selection
DI function selection	Volume/Level display selection

Example: When Digital filter is 50 seconds,
50 = 0032H

Digital filter	High	00H
	Low	32H

5.7.2 Caution for handling communication data

- If data (holding register) exceeding the accessible address range is accessed, an error response message is returned.
- Read data of undefined address is “0”. If write to an undefined address, an error response message is returned.
- If data range or address error occurs during data writing, the data written before error is in effect.
- Send the next command message at time intervals of 60 bits after the master receives the response message.

6. COMMUNICATION DATA LIST

■ Reference to communication data list

(1) (2) (3) (4) (5)

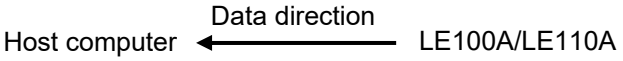
No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV)	0000	0	RO	Within input range ☞ See **Input range table (P. 32)**.	—
2	Status monitor	0001	1	RO	Bit 0: Burnout Bit 1: Output 1 status [a] Bit 2: Output 2 status [a]	—

(1) Name: Communication data name is written.

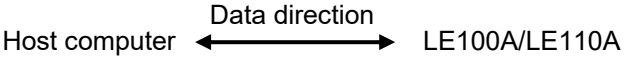
(2) Register address: Modbus communication data register addresses are written for each channel.
HEX: Hexadecimal
DEC: Decimal

(3) Attribute: A method of how communication data items are read or written when viewed from the host computer is described.

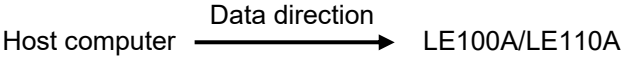
RO: Only reading data is possible.



R/W: Reading and writing data is possible.

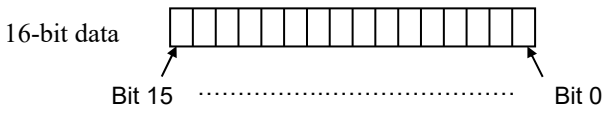


WO: Only writing data is possible.



(4) Data range: The reading range or the writing range of communication data is written.

📖 Bit image of bit data is as follows.



(5) Factory set value: The factory set value of communication data is written.

■ Communication data

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV)	0000	0	RO	Within input range ☞ See **Input range table (P. 32)**.	—
2	Status monitor	0001	1	RO	Bit 0: Burnout Bit 1: Output 1 status [a] Bit 2: Output 2 status [a] Bit 3: Output 3 status [a] Bit 4: Output 4 status [a] Bit 5: Output 5 status [a] Bit 6: Output 6 status [a] Bit 7: Output 7 status [b] Bit 8: Output 8 status [b] Bit 9 to Bit 15: Unused (0 fixed) Data 0: OFF 1: ON [Decimal number: 0 to 511] [a] This is the data enabled when Output type selection other than OFF is selected. [b] This is the data enabled when Output type selection is set to other than OFF on the 8-output type.	—
3	Error code	0002	2	RO	0: No error 1: Adjusted data destruction error 2: EEP-ROM write error 4: EEP-ROM time out error 8: Input capture hardware error 16: Emptiness adjustment execution error 32: Span setting by actual liquid error 64: Span adjustment execution error 128: Number of wafer processing times error 256: Output setting by actual liquid error 512: Linearizing table creation error If two or more errors occur simultaneously, the error values are summed up.	—
4	Specific gravity monitor	0003	3	RO	0.800 to 2.500	—
5	Scale low monitor	0004	4	RO	Scale low to Scale high	—
6	Scale high monitor	0005	5	RO	Scale low to Scale high	—
7	Peak hold monitor	0006	6	RO	Scale low to Scale high	—
8	Bottom hold monitor	0007	7	RO	Scale low to Scale high	—
9	Number of wafer processing times monitor [1]	0008	8	RO	1 to Number of wafer processing times setting	—
10	Amount of emptiness correction monitor	0009	9	RO	−5.00 to +5.00 of span	—
11	Output 1 set value [2]	000A	10	R/W	Scale low to Scale high	Input range high

[1] This is the data enabled when the presence of the specific gravity correction function is selected.
[2] This is the data enabled when Output type selection other than OFF is selected.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
12	Output 2 set value [1]	000B	11	R/W	Scale low to Scale high	Input range high
13	Output 3 set value [1]	000C	12	R/W	Scale low to Scale high	Input range high
14	Output 4 set value [1]	000D	13	R/W	Scale low to Scale high	Input range high
15	Output 5 set value [1]	000E	14	R/W	Scale low to Scale high	Input range high
16	Output 6 set value [1]	000F	15	R/W	Scale low to Scale high	Input range high
17	Output 7 set value [2]	0010	16	R/W	Scale low to Scale high	Input range high
18	Output 8 set value [2]	0011	17	R/W	Scale low to Scale high	Input range high
19	Actual liquid output setting	0012	18	WO	0: Not executed 1 to 8: Each output is executed	—
20	Emptiness adjustment	0013	19	R/W	0: Not executed 1: Executed	0
21	Number of wafer processing times [3]	0014	20	WO	1: Executed	—
22	Initializing the number of wafer processing times [3]	0015	21	WO	0: Executed	—
23	Hold reset	0016	22	WO	1: Executed	—
24	Interlock release [4]	0017	23	WO	0: Executed	—
25	Set data lock	0018	24	R/W	0: Set data lock not provided. 1: Only output set value can be set. 2: All parameter cannot be set.	0
26	Default setting	0019	25	WO	1: Executed	—
27	Error release	001A	26	WO	0: Executed	—
28	Decimal point position selection [5]	001B	27	R/W	0: No decimal place 1: One decimal place 2: Two decimal places 3: Three decimal places	1
29	Number of linearizing table setting [5]	001C	28	R/W	2 to 11	11
30	Linearizing table setting 0 [5]	001D	29	R/W	Scale low to Scale high	0.0
31	Linearizing table setting 1 [5]	001E	30	R/W	Linearizing table setting 0 to Scale high	3.6
32	Linearizing table setting 2 [5]	001F	31	R/W	Linearizing table setting 1 to Scale high	7.2

[1] This is the data enabled when Output type selection other than OFF is selected.
[2] This is the data enabled when Output type selection is set to other than OFF on the 8-output type.
[3] This is the data enabled when the presence of the specific gravity correction function is selected.
[4] This is the data enabled when Interlock is set for any of Outputs 1 to 8.
[5] This is the data enabled when the engineering unit is set to L (liter) or mL.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
33	Linearizing table setting 3 [1]	0020	32	R/W	Linearizing table setting 2 to Scale high	10.8
34	Linearizing table setting 4 [1]	0021	33	R/W	Linearizing table setting 3 to Scale high	14.4
35	Linearizing table setting 5 [1]	0022	34	R/W	Linearizing table setting 4 to Scale high	18.0
36	Linearizing table setting 6 [1]	0023	35	R/W	Linearizing table setting 5 to Scale high	21.6
37	Linearizing table setting 7 [1]	0024	36	R/W	Linearizing table setting 6 to Scale high	25.2
38	Linearizing table setting 8 [1]	0025	37	R/W	Linearizing table setting 7 to Scale high	28.8
39	Linearizing table setting 9 [1]	0026	38	R/W	Linearizing table setting 8 to Scale high	32.4
40	Linearizing table setting 10 [1]	0027	39	R/W	Linearizing table setting 9 to Scale high	36.0
41	Digital filter	0028	40	R/W	0 to 100 seconds (0: Filter OFF)	3
42	Number of empty adjustment decision times	0029	41	R/W	1 to 20 times This is the data enabled for LE100A Z-1106 specification or LE110A.	10
43	Output 1 type selection [2]	002A	42	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
44	Output 1 deviation value setting [3]	002B	43	R/W	−50 to +50 mm	0
45	Output 1 interlock function selection	002C	44	R/W	0: Without interlock function 1: With interlock function	0
46	Output 1 action selection	002D	45	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
47	Output 1 differential gap	002E	46	R/W	0.0 to 10.0 % of span	0.3
48	Output 1 timer setting	002F	47	R/W	0 to 600 seconds	0
49	Output 2 type selection [2]	0030	48	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
50	Output 2 deviation value setting [4]	0031	49	R/W	−50 to +50 mm	0

[1] This is the data enabled when the engineering unit is set to L (liter) or mL.
[2] The high limit or low limit deviation output can be set only when the engineering unit is set to mm.
[3] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 1 type selection.
[4] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 2 type selection.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
51	Output 2 interlock function selection	0032	50	R/W	0: Without interlock function 1: With interlock function	0
52	Output 2 action selection	0033	51	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
53	Output 2 differential gap	0034	52	R/W	0.0 to 10.0 % of span	0.3
54	Output 2 timer setting	0035	53	R/W	0 to 600 seconds	0
55	Output 3 type selection [1]	0036	54	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
56	Output 3 deviation value setting [2]	0037	55	R/W	−50 to +50 mm	0
57	Output 3 interlock function selection	0038	56	R/W	0: Without interlock function 1: With interlock function	0
58	Output 3 action selection	0039	57	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
59	Output 3 differential gap	003A	58	R/W	0.0 to 10.0 % of span	0.3
60	Output 3 timer setting	003B	59	R/W	0 to 600 seconds	0
61	Output 4 type selection [1]	003C	60	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
62	Output 4 deviation value setting [3]	003D	61	R/W	−50 to +50 mm	0
63	Output 4 interlock function selection	003E	62	R/W	0: Without interlock function 1: With interlock function	0
64	Output 4 action selection	003F	63	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
65	Output 4 differential gap	0040	64	R/W	0.0 to 10.0 % of span	0.3
66	Output 4 timer setting	0041	65	R/W	0 to 600 seconds	0
67	Output 5 type selection [1]	0042	66	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1

[1] The high limit or low limit deviation output can be set only when the engineering unit is set to mm.
[2] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 3 type selection.
[3] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 4 type selection.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
68	Output 5 deviation value setting [1]	0043	67	R/W	–50 to +50 mm	0
69	Output 5 interlock function selection	0044	68	R/W	0: Without interlock function 1: With interlock function	0
70	Output 5 action selection	0045	69	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
71	Output 5 differential gap	0046	70	R/W	0.0 to 10.0 % of span	0.3
72	Output 5 timer setting	0047	71	R/W	0 to 600 seconds	0
73	Output 6 type selection [2]	0048	72	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
74	Output 6 deviation value setting [3]	0049	73	R/W	–50 to +50 mm	0
75	Output 6 interlock function selection	004A	74	R/W	0: Without interlock function 1: With interlock function	0
76	Output 6 action selection	004B	75	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
77	Output 6 differential gap	004C	76	R/W	0.0 to 10.0 % of span	0.3
78	Output 6 timer setting	004D	77	R/W	0 to 600 seconds	0
79	Output 7 type selection [2, 5]	004E	78	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
80	Output 7 deviation value setting [4, 5]	004F	79	R/W	–50 to +50 mm	0
81	Output 7 interlock function selection [5]	0050	80	R/W	0: Without interlock function 1: With interlock function	0
82	Output 7 action selection [5]	0051	81	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
83	Output 7 differential gap [5]	0052	82	R/W	0.0 to 10.0 % of span	0.3
84	Output 7 timer setting [5]	0053	83	R/W	0 to 600 seconds	0

[1] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 5 type selection.
[2] The high limit or low limit deviation output can be set only when the engineering unit is set to mm.
[3] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 6 type selection.
[4] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 7 type selection.
[5] This is the data enabled when the 8-output specification is selected.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
85	Output 8 type selection [1, 2]	0054	84	R/W	0: OFF 1: Process high output 2: Process low output 3: Deviation high output 4: Deviation low output	1
86	Output 8 deviation value setting [1, 3]	0055	85	R/W	−50 to +50 mm	0
87	Output 8 interlock function selection [1]	0056	86	R/W	0: Without interlock function 1: With interlock function	0
88	Output 8 action selection [1]	0057	87	R/W	0: Transistor turned on in the output activating state 1: Transistor turned off in the output activating state	0
89	Output 8 differential gap [1]	0058	88	R/W	0.0 to 10.0 % of span	0.3
90	Output 8 timer setting [1]	0059	89	R/W	0 to 600 seconds	0
91	Monitor output high [4]	005A	90	R/W	Monitor output low to Scale high	1000
92	Monitor output low [4]	005B	91	R/W	Scale low to Monitor output high	0
93	End specific gravity setting [5]	005C	92	R/W	0.800 to 2.500	1.000
94	Number of wafer processing times setting [5]	005D	93	R/W	1 to 20	10
95	Scale low [6]	005E	94	R/W	0 to 50 mm	0
96	Specific gravity setting [7]	005F	95	R/W	0.800 to 2.500	1.000
97	Scale 1 actual liquid setting [8]	0060	96	R/W	0 to 1250 mm	0
98	Scale 2 actual liquid setting [8]	0061	97	R/W	1 to 1250 mm	1250
99	Correction on the low limit side by actual liquid 2 [9]	0062	98	WO	1: Executed	—
100	Correction on the high limit side by actual liquid 2 [9]	0063	99	WO	1: Executed	—

[1] This is the data enabled when the 8-output specification is selected.
[2] The high limit or low limit deviation output can be set only when the engineering unit is set to mm.
[3] This is the data enabled when 3 (deviation high output) or 4 (deviation low output) is selected in the Output 8 type selection.
[4] This is the data enabled when the monitor output is selected.
[5] This is the data enabled when the specific gravity correction function is selected.
[6] This is the data enabled when the engineering unit is set to mm, L (liter) or mL.
[7] This is the data enabled when the engineering unit is set to mm, % (liquid level displayed in %), L (liter) or mL and the specific gravity setting transfer is set to the manual setting.
[8] This is the data enabled when the specific gravity setting transfer is set to the actual liquid setting.
[9] This is the data enabled when the engineering unit is set to % (pressure displayed in %)

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
101	Unit setting	0064	100	R/W	0: mm 1: % (% display of liquid level) 2: % (% display of pressure) 3: L (liter) 4: mL 5: kPa 6: Pa ☞ See **Input range table** below	0
102	Specific gravity setting transfer [1]	0065	101	R/W	0: Manual setting 1: Actual liquid setting	0
103	Specific gravity correction function selection [2]	0066	102	R/W	0: Without specific gravity correction function 1: With specific gravity correction function	0
104	DI function selection [3]	0067	103	R/W	0: For conducting the emptiness adjustment 1: For counting the number of wafer processing times	0
105	Volume/Level display selection [4]	0068	104	R/W	0: Volume display 1: Level display	0

[1] This is the data enabled when the engineering unit is set to mm, % (liquid level displayed in %), L (liter) or mL.
[2] This is the data enabled when the engineering unit is set to mm and the specific gravity setting transfer is set to the manual setting.
[3] This is the data enabled when the contact input and the specific gravity correction function are selected.
[4] This is the data enabled when the engineering unit is set to L (liter) or mL.

Input range table

Unit setting	Unit	Range	Notes
0	mm	0 to 1250	The high limit is determined by the specific gravity setting. At specific gravity 2.5: 0 to 400 mm At specific gravity 1: 0 to 1000 mm At specific gravity 0.8: 0 to 1250 mm
1	%	0.0 to 100.0	Liquid level displayed in %
2	%	0.0 to 100.0	Pressure displayed in %
3	L (liter)	0 to 360	The decimal point position depends on the decimal point position selection.
4	mL	0 to 360	The decimal point position depends on the decimal point position selection.
5	kPa	0 to 9.807	—
6	Pa	0 to 9807	—

7. TROUBLESHOOTING

⚠ WARNING

- To prevent electric shock or instrument failure, always turn off the system power before replacing the instrument.
- To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.
- To prevent electric shock or instrument failure, do not turn on the power until all wiring is completed. Make sure that the wiring is correct before applying power to the instrument.
- To prevent electric shock or instrument failure, do not touch the inside of the instrument.
- All wiring must be performed by authorized personnel with electrical experience in this type of work.

⚠ CAUTION

All wiring must be completed before power is turned on to prevent electric shock, instrument failure, or incorrect action. The power must be turned off before repairing work for input break and output failure including replacement of sensor, contactor or SSR, and all wiring must be completed before power is turned on again.

This section lists some of the main causes and solutions for communication problems.
If you cannot solve a problem, please contact RKC sales office or the agent, on confirming the type name and specifications of the product.

Problem	Probable cause	Solution
No response	Wrong connection, no connection or disconnection of the communication cable	Confirm the connection method or condition and connect correctly
	Breakage, wrong wiring, or imperfect contact of the communication cable	Confirm the wiring or connector and repair or replace the wrong one
	Mismatch of the setting data of communication speed and data bit configuration with those of the host computer	Confirm the settings and set them correctly
	Wrong address setting	
	There is length of query message exceeds set range	
	A transmission error (overrun error, framing error, parity error or CRC-16 error) is found in the query message	Re-transmit after time-out occurs or verify communication program
	The time interval between adjacent data in the query message is too long, 24-bit time or more	• Re-transmit after time-out occurs • Verify communication program
Error code 1	Function cod error (Specifying nonexistent function code)	Confirm the function code
Error code 2	When the mismatched address is specified	Confirm the address of holding register
Error code 3	When the data written exceeds the setting range	Confirm the setting data
	When the specified number of data items in the query message exceeds the maximum number of data items available	

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