

This manual contains instructions for communication functions of the AER-102-DO.

To prevent accidents arising from the misuse of this instrument, please ensure the operator receives this manual.

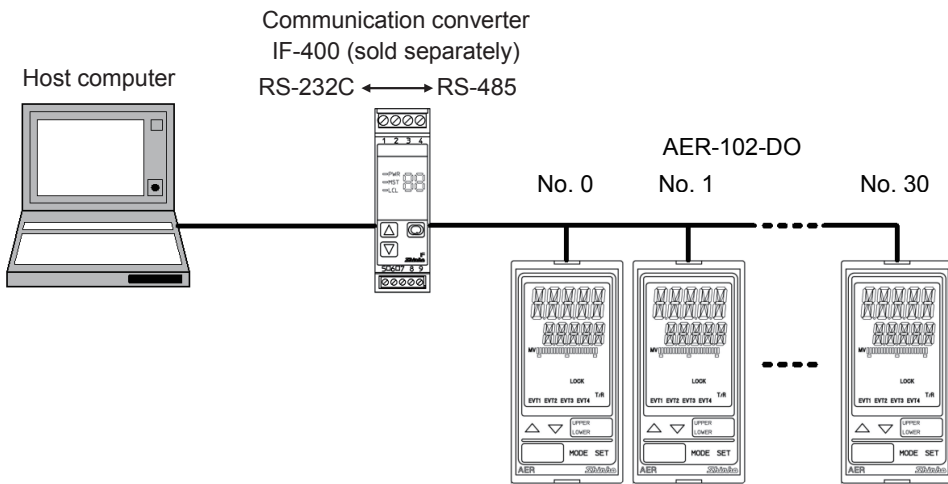
Warning

Turn the power supply to the instrument off before wiring or checking.
 Working on or touching the terminal with the power switched on may result in severe injury or death due to electrical shock.

1. System Configuration

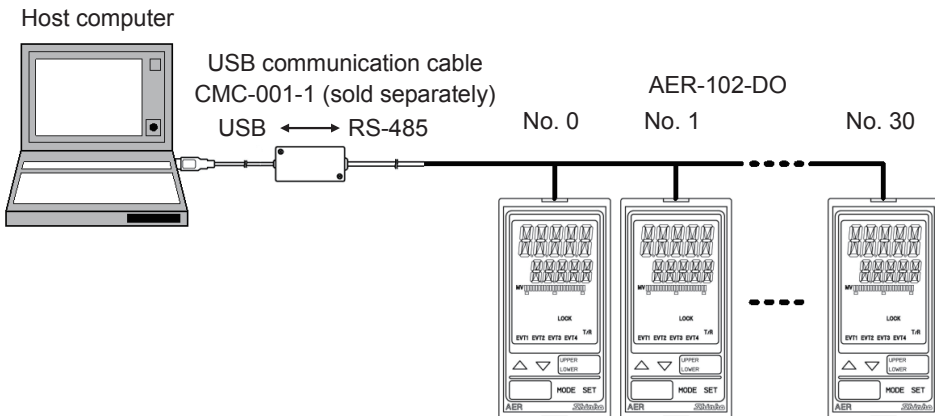
System configuration example using Communication converter IF-400 and USB communication cable CMC-001-1

When using Communication converter IF-400



(Fig. 1-1)

When using USB communication cable CMC-001-1



(Fig. 1-2)

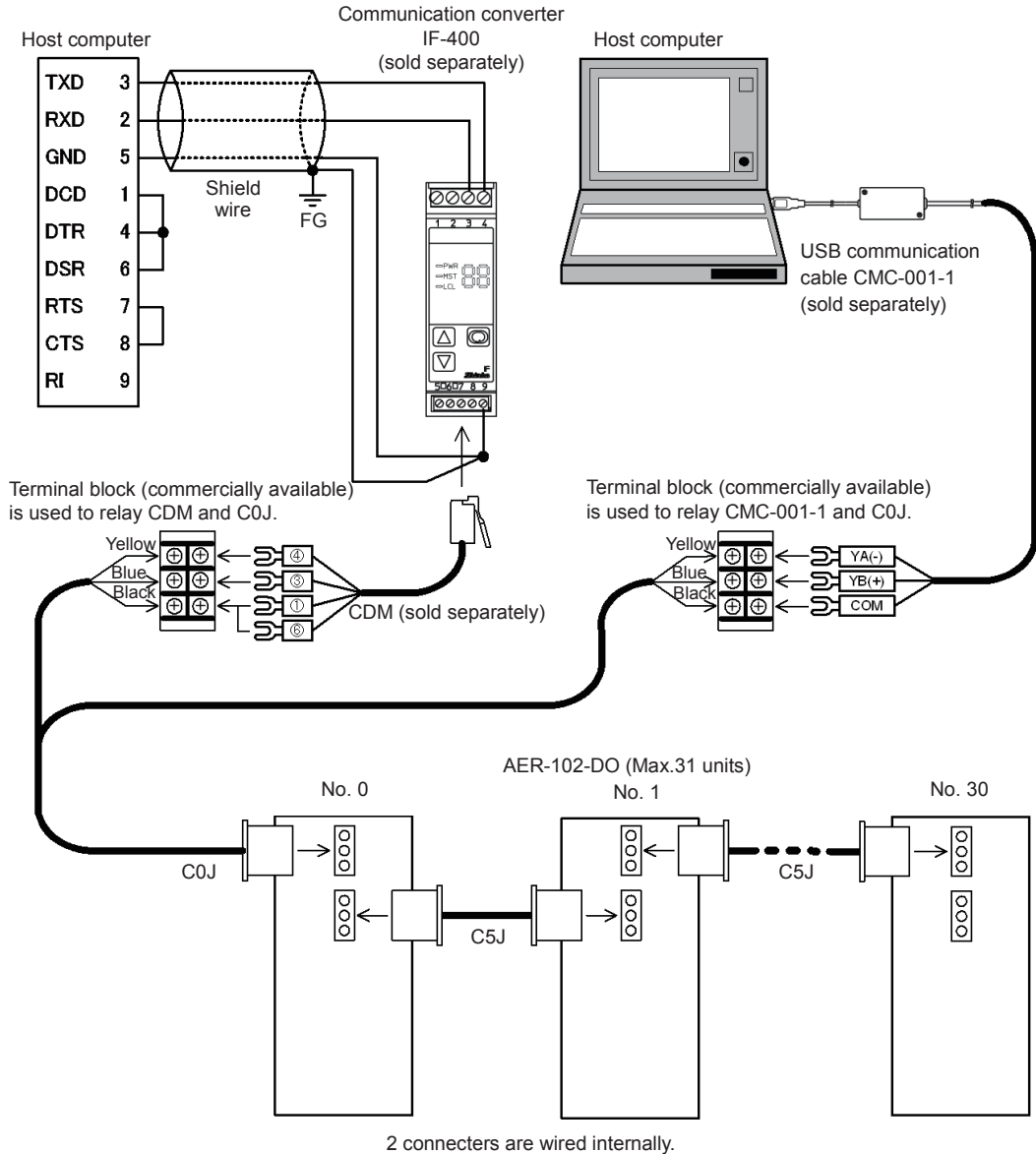
2. Wiring

Wiring example using Communication converter IF-400 and USB communication cable CMC-001-1

When using communication converter IF-400, use the provided wire harness (C0J: Between IF-400 and AER-102-DO, C5J: Between AER-102-DO units), shield wire and CDM (sold separately).

When using USB communication cable CMC-001-1, use the provided wire harness (C0J: Between IF-400 and AER-102-DO, C5J: Between AER-102-DO units).

- When using communication converter IF-400
- When using USB communication cable CMC-001-1



(Fig. 2-1)

Shield Wire

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

Be sure to ground the FG.

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 AER-102-DO has built-in pull-up and pull-down resistors.

3. Setting Communication Parameters

Communication parameters can be set in the Communication Group.

To enter the Communication Group, follow the procedure below.

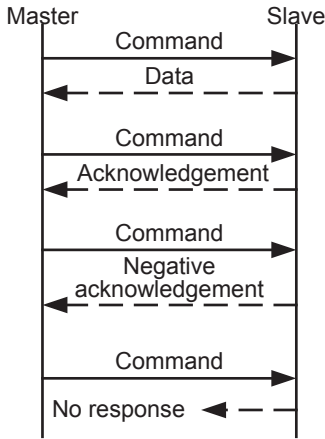
- (1) $cMNM$ Press the **MODE** key 6 times in Display Mode or Cleansing Output Mode.
If EVT3, EVT4 outputs (EVT3 option) are ordered, press the **MODE** key 8 times in Display Mode or Cleansing Output Mode.
- (2) $cMHL$ Press the **SET** key.
The unit enters the Communication Group, and "Communication protocol" will appear.
- (3) Set each item. (Use the Δ or ∇ key for settings, and register the value with the **SET** key.)

Character	Setting Item, Function, Setting Range	Factory Default
$cMHL$ $NdML$	Communication protocol • Selects communication protocol. • $NdML$: Shinko protocol $ModR$: MODBUS ASCII mode $ModR$: MODBUS RTU mode	Shinko protocol
$cMNo$ 0000	Instrument number • Sets the instrument number of this unit. (The instrument numbers should be set one by one when multiple instruments are connected in Serial communication, otherwise communication is impossible.) • Setting range: 0 to 95	0
$cMHP$ 0096	Communication speed • Selects a communication speed equal to that of the host computer. • 0096 : 9600 bps 0192 : 19200 bps 0384 : 38400 bps	9600 bps
$cMFF$ $7EVN$	Data bit/Parity • Selects data bit and parity. • $8NoN$: 8 bits/No parity $7NoN$: 7 bits/No parity $8EVN$: 8 bits/Even $7EVN$: 7 bits/Even $8odd$: 8 bits/Odd $7odd$: 7 bits/Odd	7 bits/Even
$cMHI$ 0001	Stop bit • Selects the stop bit. • 0001 : 1 bit 0002 : 2 bits	1 bit

- (4) Press the **SET** key. The unit will revert to Display Mode or Cleansing Output Mode.

4. Communication Procedure

Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the AER-102-DO (hereafter Slave).



(Fig. 4-1)

- **Response with data**

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

- **Acknowledgement**

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

- **Negative acknowledgement**

When the master sends a non-existent command or 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:

- Global address (Shinko protocol) is set.
- Broadcast address (MODBUS protocol) is set.
- Communication error (framing error, parity error)
- Checksum error (Shinko protocol), LRC discrepancy (MODBUS ASCII mode), CRC-16 discrepancy (MODBUS RTU mode)

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 or more characters 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.

5. Shinko Protocol

5.1 Transmission Mode

Shinko protocol is composed of ASCII codes.

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format Start bit: 1 bit
 Data bit: 7 bits
 Parity: Even
 Stop bit: 1 bit

Error detection: Checksum

5.2 Command Configuration

All commands are composed of ASCII.

The data (set value, decimal number) is represented by hexadecimal numbers.

Negative numbers are represented in 2's complement.

Numerals written below the command represent number of characters.

(1) Setting Command

Header (02H)	Address	Sub address (20H)	Command type (50H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(2) Reading Command

Header (02H)	Address	Sub address (20H)	Command type (20H)	Data item	Checksum	Delimiter (03H)
1	1	1	1	4	2	1

(3) Response with Data

Header (06H)	Address	Sub address (20H)	Command type (20H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(4) Acknowledgement

Header (06H)	Address	Checksum	Delimiter (03H)
1	1	2	1

(5) Negative Acknowledgement

Header (15H)	Address	Error code	Checksum	Delimiter (03H)
1	1	1	2	1

Header: Control code to represent the beginning of the command or the response. ASCII codes are used.

Setting command, Reading command: STX (02H) fixed

Response with data, Acknowledgement: ACK (06H) fixed

Negative acknowledgement: NAK (15H) fixed

Instrument number (Address): Numbers by which the master discerns each slave.

Instrument numbers 0 to 94 and Global address 95.

ASCII codes (20H to 7FH) are used by adding 20H to instrument numbers 0 to 95 (00H to 5FH).

95 (7FH) is called the Global address, which is used when the same command is sent to all the slaves connected. However, a response is not returned.

Sub address: 20H fixed.

Command type: Code to discern Setting command (50H) and Reading command (20H)

- Data item:** Classification of the command object.
Composed of 4-digit hexadecimal numbers, using ASCII.
Refer to "7. Communication Command Table". (pp.11 to 20)
- Data:** The contents of data (set value) differ depending on the setting command.
Composed of 4-digit hexadecimal numbers, using ASCII.
Refer to "7. Communication Command Table". (pp.11 to 20)
- Checksum:** 2-character data to detect communication errors.
Refer to "5.3 Checksum Calculation".
- Delimiter:** Control code to represent the end of command.
ASCII code ETX (03H) fixed.
- Error code:** Represents an error type using ASCII.
1 (31H)----Non-existent command
2 (32H)----Not used
3 (33H)----Value outside the setting range
4 (34H)----Status unable to be set (e.g. During calibration)
5 (35H)----During setting mode by keypad operation

5.3 Checksum Calculation

Checksum is used to detect receiving errors in the command or data.

Set the program for the master side as well to calculate the checksum of the response data from the slaves so that communication errors can be checked.

The ASCII code (hexadecimal) corresponding to the characters which range from the address (instrument number) to that before the checksum is converted to binary notation, and the total value is calculated.

The lower one byte of the total value is converted to 2's complement, and then to hexadecimal numbers, that is, ASCII code for the checksum.

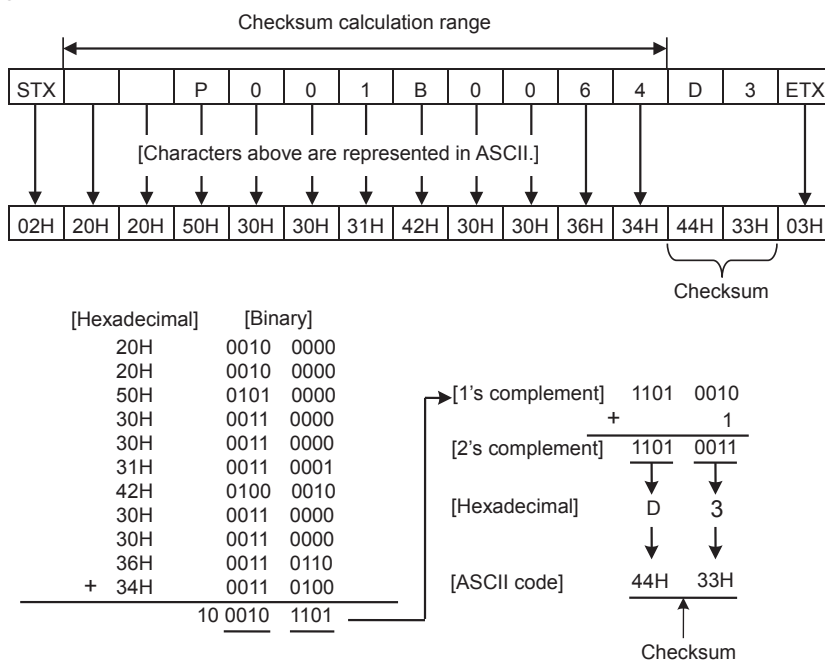
- 1's complement: Reverse each binary bit. 0 will become 1 and vice versa.
- 2's complement: Add 1 to 1's complement.

Checksum Calculation Example

Data item 001BH (EVT1 ON delay time): 100 seconds (0064H)

Address (instrument number): 0 (20H)

[e.g.]



(Fig. 5.3-1)

6. MODBUS Protocol

6.1 Transmission Mode

There are 2 transmission modes (ASCII and RTU) in MODBUS protocol.

ASCII Mode

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format Start bit: 1 bit
 Data bit: 7 bits (8 bits) (Selectable)
 Parity: Even (No parity, Odd) (Selectable)
 Stop bit: 1 bit (2 bits) (Selectable)

Error detection: LRC (Longitudinal Redundancy Check)

RTU Mode

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

Data format Start bit: 1 bit
 Data bit: 8 bits
 Parity: No parity (Even, Odd) (Selectable)
 Stop bit: 1 bit (2 bits) (Selectable)

Error detection: CRC-16 (Cyclic Redundancy Check)

6.2 Data Communication Interval

ASCII Mode

Max.1 second of interval between ASCII mode characters

RTU Mode

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.

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 1.5-character transmission times or 750 μ s, the AER-102-DO assumes that transmission from the master is finished, which results in a communication error, and will not return a response.

6.3 Message Configuration

ASCII Mode

ASCII mode message is configured to start by Header [: (colon) (3AH)] and end by Delimiter [CR (carriage return) (0DH) + LF (Line feed) (0AH)].

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

Communication speed 9600 bps, 19200 bps: RTU mode 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.

Communication speed 38400 bps: RTU mode 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.

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

Slave address is an individual instrument number on the slave side, and is set within the range 0 to 95 (00H to 5FH).

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

6.3.2 Function Code

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

(Table 6.3.2-1)

Function Code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

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 10H to the function code by mistake, slave returns 90H 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. (Table 6.3.2-2)

(Table 6.3.2-2)

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)	Shinko protocol error code 4 [Status unable to be set. (e.g.) During calibration]
18 (12H)	Shinko protocol error code 5 (During setting mode by keypad operation)

6.3.3 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.

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

6.3.4 Error Check

ASCII Mode

After calculating LRC (Longitudinal Redundancy Check) from the slave address to the end of data, the calculated 8-bit data is converted to two ASCII characters, and are appended to the end of message.

How to calculate LRC

- ① Create a message in RTU mode.
- ② Add all the values from the slave address to the end of data. This is assumed as X.
- ③ Make a complement for X (bit reverse). This is assumed as X.
- ④ Add a value of 1 to X. This is assumed as X.
- ⑤ Set X as an LRC to the end of the message.
- ⑥ Convert the whole message to ASCII characters.

RTU Mode

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.

6.4 Message Example

ASCII Mode

Numerals written below the command represent the number of characters.

① Reading [Slave address 1, Data item 0080H (DO concentration)]

- A request message from the master

Amount of data means how many data items are to be read. It is fixed as (30H 30H 30H 31H).

Header (3AH)	Slave address (30H 31H)	Function code (30H 33H)	Data item [0080H] (30H 30H 38H 30H)	Amount of data [0001H] (30H 30H 30H 31H)	Error check LRC (37H 42H)	Delimiter (0DH 0AH)
1	2	2	4	4	2	2

- Response message from the slave in normal status [When DO concentration is 1.00 mg/L (0064H)]
The response byte count means the byte count of data which have been read. It is fixed as (30H 32H).

Header (3AH)	Slave address (30H 31H)	Function code (30H 33H)	Response byte count [02H] (30H 32H)	Data [0064H] (30H 30H 36H 34H)	Error check LRC (39H 36H)	Delimiter (0DH 0AH)
1	2	2	2	4	2	2

- Response message from the slave in exception (error) status (When a data item is incorrect)
The function code MSB is set to 1 for the response message in exception (error) status (83H is returned).

The exception code 02H (Non-existent data address) is returned (error).

Header (3AH)	Slave address (30H 31H)	Function code (38H 33H)	Exception code [02H] (30H 32H)	Error check LRC (37H 41H)	Delimiter (0DH 0AH)
1	2	2	2	2	2

② Setting [Slave address 1, Data item 001BH (EVT1 ON delay time)]

- A request message from the master [When EVT1 ON delay time is set to 100 seconds (0064H)]

Header (3AH)	Slave address (30H 31H)	Function code (30H 36H)	Data item [001BH] (30H 30H 31H 42H)	Data [0064H] (30H 30H 36H 34H)	Error check LRC (44H 45H)	Delimiter (0DH 0AH)
1	2	2	4	4	2	2

- Response message from the slave in normal status

Header (3AH)	Slave address (30H 31H)	Function code (30H 36H)	Data item [001BH] (30H 30H 31H 42H)	Data [0064H] (30H 30H 36H 34H)	Error check LRC (44H 45H)	Delimiter (0DH 0AH)
1	2	2	4	4	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 (86H is returned.).

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

Header (3AH)	Slave address (30H 31H)	Function code (38H 36H)	Exception code [03H] (30H 33H)	Error check LRC (37H 36H)	Delimiter (0DH 0AH)
1	2	2	2	2	2

RTU Mode

Numerals written below the command represent number of characters.

① Reading [Slave address 1, Data item 0080H (DO concentration)]

- A request message from the master

Amount of data means how many data items are to be read. It is fixed as (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0080H)	Amount of data (0001H)	Error check CRC-16 (85E2H)	3.5 idle characters
	1	1	2	2	2	

- Response message from the slave in normal status [When DO concentration is 1.00 mg/L (0064H)]

The response byte count means the byte count of data which has been read. It is fixed as (02H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Response byte count (02H)	Data (0064H)	Error check CRC-16 (B9AFH)	3.5 idle characters
	1	1	1	2	2	

- Response message from the slave in exception (error) status (When a data item is incorrect)
The function code MSB is set to 1 for the response message in exception (error) status (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	

② Setting (Slave address 1, Data item 001BH (EVT1 ON delay time))

- A request message from the master [When EVT1 ON delay time is set to 100 seconds (0064H)]

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (001BH)	Data (0064H)	Error check CRC-16 (F826H)	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 (001BH)	Data (0064H)	Error check CRC-16 (F826H)	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 (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	

7. Communication Command Table

7.1 Note on Setting/Reading Commands

- The data (set value, decimal) is converted to hexadecimal numbers.
Negative numbers are represented in 2's complement.
- When connecting multiple slaves, the address (instrument number) must not be duplicated.
- Data items 0200H to 0209H (User save area 1 to 10) can be read or set in 1 word units.
Effective range of data is -32768 to 32767 (8000H to 7FFFH).
- MODBUS protocol uses Holding Register addresses. The Holding Register addresses are created as follows. A Shinko command 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 (Signal output response time) as an example: Data item in the sending message is 0001H, however, MODBUS protocol Holding Register address is 40002 (1 + 40001).
- Even if EVT3, EVT4 outputs (EVT3 option) are/is not ordered, setting or reading via software communication will be possible. However, EVT3 and EVT4 command contents will not function.

(1) Setting 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.)
- Be sure to select Lock 3 when changing the set value frequently via software communication. If Lock 3 is selected, all set values can be temporarily changed. However, they revert to their previous value after the power is turned off because they are not saved in the non-volatile IC memory.
Do not change setting items (EVT1, EVT2, EVT3, EVT4 types). If they are changed, they will affect other setting items.
- Setting range of each item is the same as that of keypad operation.
- When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used.
- If EVT type is changed at [0014H (EVT1 type), 0022H (EVT2 type), 0030H (EVT3 type), 003FH (EVT4 type)], EVT1, EVT2, EVT3 or EVT4 value will default to 0 (zero).
The output status of EVT1, EVT2, EVT3 or EVT4 will also be initialized.
- Settings via software communication are possible while in Set value lock status.
- Communication parameters such as Instrument Number, Communication Speed of the slave cannot be set by software communication. They can only be set via the keypad. (p.3)
- When sending a command by Global address [95 (7FH), Shinko protocol] or Broadcast address [(00H), MODBUS protocol], the same command is sent to all the slaves connected. However, the response is not returned.

(2) Reading Command

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

7.2 Setting/Reading Command

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0001H	Signal output response time	Set value (1 to 120) '1' corresponds to 5 seconds, and '120' corresponds to 600 seconds.
50H/20H	06H/03H	0003H	Salinity correction	Set value
50H/20H	06H/03H	0004H	Altitude correction	Set value
50H	06H	0005H	DO concentration calibration mode	0000H: Display Mode 0001H: DO concentration 1-point calibration mode 0002H: DO concentration 2-point calibration mode 0003H: Concentration option calibration mode
50H	06H	0006H	DO concentration calibration start	DO concentration 1-point calibration: 0000H: DO concentration 1-point calibration mode 0001H: 1-point calibration (100% saturation calibration) start 0003H: Measured value fixed DO concentration 2-point calibration: 0000H: DO concentration 2-point calibration mode 0001H: 1 st -point calibration (100% saturation calibration) start 0002H: 2 nd -point calibration (0-point calibration) start 0003H: Measured value fixed Concentration option calibration: 0000H: Concentration option calibration mode 0001H: Concentration option calibration start 0003H: Measured value fixed
50H/20H	06H/03H	0007H	Concentration desired value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0008H	Transmission output 1 type	0000H: DO concentration transmission 0001H: Water temperature transmission 0002H: DO % saturation transmission 0003H: Oxygen partial pressure transmission 0004H: EVT1 MV transmission 0005H: EVT2 MV transmission 0006H: EVT3 MV transmission (*) 0007H: EVT4 MV transmission (*)
50H/20H	06H/03H	0009H	Transmission output 1 high limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	000AH	Transmission output 1 low limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	000BH	Transmission output 2 type	0000H: DO concentration transmission 0001H: Water temperature transmission 0002H: DO % saturation transmission 0003H: Oxygen partial pressure transmission 0004H: EVT1 MV transmission 0005H: EVT2 MV transmission 0006H: EVT3 MV transmission (*) 0007H: EVT4 MV transmission (*)

(*) If 'Setting' is executed while EVT3, EVT4 outputs (EVT3 option) is not ordered, the following error code will be returned.

- Shinko protocol: Error code 3 (33H)
- MODBUS: Exception code 3 (03H)

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	000CH	Transmission output 2 high limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	000DH	Transmission output 2 low limit	Set value (Decimal point ignored.)
50H	06H	000EH	Transmission output 1 adjustment mode	0000H: Display Mode 0001H: Transmission output 1 Zero adjustment mode 0002H: Transmission output 1 Span adjustment mode
50H/20H	06H/03H	000FH	Transmission output 1 Zero adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0010H	Transmission output 1 Span adjustment value	Set value (Decimal point ignored.)
50H	06H	0011H	Transmission output 2 adjustment mode	0000H: Display Mode 0001H: Transmission output 2 Zero adjustment mode 0002H: Transmission output 2 Span adjustment mode
50H/20H	06H/03H	0012H	Transmission output 2 Zero adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0013H	Transmission output 2 Span adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0014H	EVT1 type	0000H: No action 0001H: DO concentration input high limit action 0002H: DO concentration input low limit action 0003H: Water temperature input high limit action 0004H: Water temperature input low limit action 0005H: DO % saturation input high limit action 0006H: DO % saturation input low limit action 0007H: Oxygen partial pressure input high limit action 0008H: Oxygen partial pressure input low limit action 0009H: Sensor cap replacement timer 000AH: Cleansing output 000BH: DO concentration input High/Low limits independent action 000CH: Water temperature input High/Low limits independent action 000DH: DO % saturation input High/Low limits independent action 000EH: Oxygen partial pressure input High/Low limits independent action
50H/20H	06H/03H	0015H	EVT1 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0016H	EVT1 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0017H	EVT1 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0018H	EVT1 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0019H	EVT1 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	001AH	EVT1 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	001BH	EVT1 ON delay time	Set value
50H/20H	06H/03H	001CH	EVT1 OFF delay time	Set value
50H/20H	06H/03H	001DH	EVT1 proportional cycle	Set value
50H/20H	06H/03H	001EH	EVT1 output high limit	Set value
50H/20H	06H/03H	001FH	EVT1 output low limit	Set value
50H/20H	06H/03H	0020H	Output ON time when EVT1 output ON	Set value
50H/20H	06H/03H	0021H	Output OFF time when EVT1 output ON	Set value

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0022H	EVT2 type	0000H: No action 0001H: DO concentration input high limit action 0002H: DO concentration input low limit action 0003H: Water temperature input high limit action 0004H: Water temperature input low limit action 0005H: DO % saturation input high limit action 0006H: DO % saturation input low limit action 0007H: Oxygen partial pressure input high limit action 0008H: Oxygen partial pressure input low limit action 0009H: Sensor cap replacement timer 000AH: Cleansing output 000BH: DO concentration input High/Low limits independent action 000CH: Water temperature input High/Low limits independent action 000DH: DO % saturation input High/Low limits independent action 000EH: Oxygen partial pressure input High/Low limits independent action
50H/20H	06H/03H	0023H	EVT2 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0024H	EVT2 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0025H	EVT2 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0026H	EVT2 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0027H	EVT2 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0028H	EVT2 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0029H	EVT2 ON delay time	Set value
50H/20H	06H/03H	002AH	EVT2 OFF delay time	Set value
50H/20H	06H/03H	002BH	EVT2 proportional cycle	Set value
50H/20H	06H/03H	002CH	EVT2 output high limit	Set value
50H/20H	06H/03H	002DH	EVT2 output low limit	Set value
50H/20H	06H/03H	002EH	Output ON time when EVT2 output ON	Set value
50H/20H	06H/03H	002FH	Output OFF time when EVT2 output ON	Set value,

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0030H	EVT3 type	0000H: No action 0001H: DO concentration input high limit action 0002H: DO concentration input low limit action 0003H: Water temperature input high limit action 0004H: Water temperature input low limit action 0005H: DO % saturation input high limit action 0006H: DO % saturation input low limit action 0007H: Oxygen partial pressure input high limit action 0008H: Oxygen partial pressure input low limit action 0009H: Sensor cap replacement timer 000AH: Cleansing output 000BH: DO concentration input High/Low limits independent action 000CH: Water temperature input High/Low limits independent action 000DH: DO % saturation input High/Low limits independent action 000EH: Oxygen partial pressure input High/Low limits independent action
50H/20H	06H/03H	0031H	EVT3 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0032H	EVT3 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0033H	EVT3 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0034H	EVT3 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0035H	EVT3 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0036H	EVT3 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0037H	EVT3 ON delay time	Set value
50H/20H	06H/03H	0038H	EVT3 OFF delay time	Set value
50H/20H	06H/03H	0039H	EVT3 proportional cycle	Set value
50H/20H	06H/03H	003AH	EVT3 output high limit	Set value
50H/20H	06H/03H	003BH	EVT3 output low limit	Set value
50H/20H	06H/03H	003CH	Output ON time when EVT3 output ON	Set value
50H/20H	06H/03H	003DH	Output OFF time when EVT3 output ON	Set value,

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	003EH	EVT4 type	0000H: No action 0001H: DO concentration input high limit action 0002H: DO concentration input low limit action 0003H: Water temperature input high limit action 0004H: Water temperature input low limit action 0005H: DO % saturation input high limit action 0006H: DO % saturation input low limit action 0007H: Oxygen partial pressure input high limit action 0008H: Oxygen partial pressure input low limit action 0009H: Sensor cap replacement timer 000AH: Cleansing output 000BH: DO concentration input High/Low limits independent action 000CH: Water temperature input High/Low limits independent action 000DH: DO % saturation input High/Low limits independent action 000EH: Oxygen partial pressure input High/Low limits independent action
50H/20H	06H/03H	003FH	EVT4 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0040H	EVT4 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0041H	EVT4 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0042H	EVT4 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0043H	EVT4 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0044H	EVT4 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0045H	EVT4 ON delay time	Set value
50H/20H	06H/03H	0046H	EVT4 OFF delay time	Set value
50H/20H	06H/03H	0047H	EVT4 proportional cycle	Set value
50H/20H	06H/03H	0048H	EVT4 output high limit	Set value
50H/20H	06H/03H	0049H	EVT4 output low limit	Set value
50H/20H	06H/03H	004AH	Output ON time when EVT4 output ON	Set value
50H/20H	06H/03H	004BH	Output OFF time when EVT4 output ON	Set value,

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0068H	Cleansing time	Set value
50H/20H	06H/03H	0069H	Cleansing inactive interval	Set value
50H	06H	006AH	Forced cleansing mode	0001H: Forced cleansing mode
50H/20H	06H/03H	006BH	Set value lock	0000H: Unlock 0001H: Lock 1 0002H: Lock 2 0003H: Lock 3
50H/20H	06H/03H	006EH	Backlight selection	0000H: All are backlit. 0001H: DO Display is backlit. 0002H: Temperature Display is backlit. 0003H: Action indicators are backlit. 0004H: DO Display + Temperature Display are backlit. 0005H: DO Display + Action indicators are backlit. 0006H: Temperature Display + Action indicators are backlit.
50H/20H	06H/03H	006FH	DO color	0000H: Green 0001H: Red 0002H: Orange 0003H: DO color changes continuously.
50H/20H	06H/03H	0070H	DO color reference value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0071H	DO color range	Set value (Decimal point ignored.)
50H/20H	06H/03H	0072H	Backlight time	Set value
50H/20H	06H/03H	0073H	Bar graph indication	0000H: No indication 0001H: Transmission output 1 0002H: Transmission output 2
50H/20H	06H/03H	0074H	EVT output when input errors occur	0000H: Enabled 0001H: Disabled
50H/20H	06H/03H	0075H	Data clear selection	0000H: Calibration value 0001H: Set value
50H	06H	0076H	Data clear Stop/Perform	0000H: Data clear Stop 0001H: Data clear Perform
50H/20H	06H/03H	0077H	Standby after cleansing	Set value
50H	06H	007FH	Key operation change flag clearing	0001H: Clear change flag

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0100H	EVT1 High/Low limits independent lower side value	
50H/20H	06H/03H	0101H	EVT2 High/Low limits independent lower side value	
50H/20H	06H/03H	0102H	EVT3 High/Low limits independent lower side value	
50H/20H	06H/03H	0103H	EVT4 High/Low limits independent lower side value	
50H/20H	06H/03H	0106H	EVT1 High/Low limits independent upper side value	
50H/20H	06H/03H	0107H	EVT2 High/Low limits independent upper side value	
50H/20H	06H/03H	0108H	EVT3 High/Low limits independent upper side value	
50H/20H	06H/03H	0109H	EVT4 High/Low limits independent upper side value	
50H/20H	06H/03H	010CH	EVT1 hysteresis	
50H/20H	06H/03H	010DH	EVT2 hysteresis	
50H/20H	06H/03H	010EH	EVT3 hysteresis	
50H/20H	06H/03H	010FH	EVT4 hysteresis	
50H/20H	06H/03H	0112H	Transmission output 1 status when calibrating	0000H: Last value HOLD 0001H: Set value HOLD 0002H: Measured value
50H/20H	06H/03H	0113H	Transmission output 1 value HOLD when calibrating	Set value (Decimal point ignored.)
50H/20H	06H/03H	0114H	Transmission output 2 status when calibrating	0000H: Last value HOLD 0001H: Set value HOLD 0002H: Measured value
50H/20H	06H/03H	0115H	Transmission output 2 value HOLD when calibrating	Set value (Decimal point ignored.)
50H/20H	06H/03H	0200H	User save area 1	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0201H	User save area 2	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0202H	User save area 3	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0203H	User save area 4	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0204H	User save area 5	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0205H	User save area 6	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0206H	User save area 7	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0207H	User save area 8	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0208H	User save area 9	-32768 to 32767 (8000H to 7FFFH)
50H/20H	06H/03H	0209H	User save area 10	-32768 to 32767 (8000H to 7FFFH)

7.3 Read Only Command

Shinko Command Type	MODBUS Function Code	Data Item	Data																															
20H	03H	0080H	DO concentration	DO concentration (Decimal point ignored.)																														
20H	03H	0081H	DO % saturation	DO % saturation (Decimal point ignored.)																														
20H	03H	0082H	Oxygen partial pressure	Oxygen partial pressure (Decimal point ignored.)																														
20H	03H	0083H	Status flag 1 0000 0000 0000 0000 2 ¹⁵ to 2 ⁰ 2 ⁰ digit: Outside measurement range of DO concentration (high limit) 0: Normal 1: Error 2 ¹ digit: Outside measurement range of DO concentration (low limit) 0: Normal 1: Error 2 ² digit: Outside measurement range of DO % saturation (high limit) 0: Normal 1: Error 2 ³ digit: Outside measurement range of DO % saturation (low limit) 0: Normal 1: Error 2 ⁴ digit: Outside measurement range of Oxygen partial pressure (high limit) 0: Normal 1: Error 2 ⁵ digit: Outside measurement range of Oxygen partial pressure (low limit) 0: Normal 1: Error 2 ⁶ digit: Communication errors have occurred or DO Sensor is not connected. 0: Normal 1: Error 2 ⁷ digit: Sensor cap of DO Sensor is not attached, or it is incorrectly attached. 0: Normal 1: Error 2 ⁸ digit: Calibration error 0: Normal 1: Error 2 ⁹ digit: Unit status flag 0: Display Mode 1: Setting mode 2 ¹⁰ , 2 ¹¹ digits: Calibration mode status flag <table border="1" data-bbox="467 948 1193 1111"> <thead> <tr> <th>2¹¹</th> <th>2¹⁰</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Display Mode</td> </tr> <tr> <td>0</td> <td>1</td> <td>DO concentration 1-point calibration mode</td> </tr> <tr> <td>1</td> <td>0</td> <td>DO concentration 2-point calibration mode</td> </tr> <tr> <td>1</td> <td>1</td> <td>Concentration option calibration mode</td> </tr> </tbody> </table> 2 ¹² , 2 ¹³ digits: Calibration status flag <table border="1" data-bbox="467 1153 1193 1348"> <thead> <tr> <th>2¹³</th> <th>2¹²</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Standby</td> </tr> <tr> <td>0</td> <td>1</td> <td>During 1st-point calibration (100% saturation calibration)</td> </tr> <tr> <td>1</td> <td>0</td> <td>During 2nd-point calibration (0-point calibration)</td> </tr> <tr> <td>1</td> <td>1</td> <td>During concentration option calibration</td> </tr> </tbody> </table> 2 ¹⁴ digit: Normal measurement value cannot be obtained from the DO Sensor. 0: Normal 1: Error 2 ¹⁵ digit: Change in key operation 0: No 1: Yes	2 ¹¹	2 ¹⁰	Status	0	0	Display Mode	0	1	DO concentration 1-point calibration mode	1	0	DO concentration 2-point calibration mode	1	1	Concentration option calibration mode	2 ¹³	2 ¹²	Status	0	0	Standby	0	1	During 1 st -point calibration (100% saturation calibration)	1	0	During 2 nd -point calibration (0-point calibration)	1	1	During concentration option calibration	
2 ¹¹	2 ¹⁰	Status																																
0	0	Display Mode																																
0	1	DO concentration 1-point calibration mode																																
1	0	DO concentration 2-point calibration mode																																
1	1	Concentration option calibration mode																																
2 ¹³	2 ¹²	Status																																
0	0	Standby																																
0	1	During 1 st -point calibration (100% saturation calibration)																																
1	0	During 2 nd -point calibration (0-point calibration)																																
1	1	During concentration option calibration																																
20H	03H	0084H	EVT1 Manipulated Variable	MV (Decimal point ignored.)																														
20H	03H	0085H	EVT2 Manipulated Variable	MV (Decimal point ignored.)																														
20H	03H	0086H	EVT3 Manipulated Variable	MV (Decimal point ignored.)																														
20H	03H	0087H	EVT4 Manipulated Variable	MV (Decimal point ignored.)																														

Shinko Command Type	MODBUS Function Code	Data Item	Data																																							
20H	03H	0090H	Temperature																																							
			Temperature (Decimal point ignored.)																																							
20H	03H	0091H	Sensor cap replacement timer remainder																																							
			Sensor cap replacement timer remaining time																																							
20H	03H	0093H	<p>Status flag 2</p> <p>0000 0000 0000 0000</p> <p>2¹⁵ to 2⁰</p> <p>2⁰ digit: Outside temperature measurement range (high limit) 0: Normal 1: Error</p> <p>2¹ digit: Outside temperature measurement range (low limit) 0: Normal 1: Error</p> <p>2² digit: EVT1 output 0: OFF 1: ON</p> <p>2³ digit: EVT2 output 0: OFF 1: ON</p> <p>2⁴ digit: EVT3 output 0: OFF 1: ON</p> <p>2⁵ digit: EVT4 output 0: OFF 1: ON</p> <p>2⁶, 2⁷ digits: Not used (Always 0)</p> <p>2⁸, 2⁹ digits: Transmission output 1 adjustment status flag</p> <table border="1"> <thead> <tr> <th>2⁹</th> <th>2⁸</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Display Mode</td> </tr> <tr> <td>0</td> <td>1</td> <td>During Transmission output 1 Zero adjustment in Transmission output 1 adjustment mode</td> </tr> <tr> <td>1</td> <td>0</td> <td>During Transmission output 1 Span adjustment in Transmission output 1 adjustment mode</td> </tr> </tbody> </table> <p>2¹⁰, 2¹¹ digits: Transmission output 2 adjustment status flag</p> <table border="1"> <thead> <tr> <th>2¹¹</th> <th>2¹⁰</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Display Mode</td> </tr> <tr> <td>0</td> <td>1</td> <td>During Transmission output 2 Zero adjustment in Transmission output 2 adjustment mode</td> </tr> <tr> <td>1</td> <td>0</td> <td>During Transmission output 2 Span adjustment in Transmission output 2 adjustment mode</td> </tr> </tbody> </table> <p>2¹², 2¹³ digits: Cleansing status flag</p> <table border="1"> <thead> <tr> <th>2¹³</th> <th>2¹²</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Display Mode</td> </tr> <tr> <td>0</td> <td>1</td> <td>During Cleansing inactive interval</td> </tr> <tr> <td>1</td> <td>0</td> <td>During Cleansing time</td> </tr> <tr> <td>1</td> <td>1</td> <td>During Standby after cleansing</td> </tr> </tbody> </table> <p>2¹⁴ digit: Self-check output 0: OFF 1: ON</p> <p>2¹⁵ digit: Not used (Always 0)</p>	2 ⁹	2 ⁸	Status	0	0	Display Mode	0	1	During Transmission output 1 Zero adjustment in Transmission output 1 adjustment mode	1	0	During Transmission output 1 Span adjustment in Transmission output 1 adjustment mode	2 ¹¹	2 ¹⁰	Status	0	0	Display Mode	0	1	During Transmission output 2 Zero adjustment in Transmission output 2 adjustment mode	1	0	During Transmission output 2 Span adjustment in Transmission output 2 adjustment mode	2 ¹³	2 ¹²	Status	0	0	Display Mode	0	1	During Cleansing inactive interval	1	0	During Cleansing time	1	1	During Standby after cleansing
2 ⁹	2 ⁸	Status																																								
0	0	Display Mode																																								
0	1	During Transmission output 1 Zero adjustment in Transmission output 1 adjustment mode																																								
1	0	During Transmission output 1 Span adjustment in Transmission output 1 adjustment mode																																								
2 ¹¹	2 ¹⁰	Status																																								
0	0	Display Mode																																								
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2 ¹³	2 ¹²	Status																																								
0	0	Display Mode																																								
0	1	During Cleansing inactive interval																																								
1	0	During Cleansing time																																								
1	1	During Standby after cleansing																																								

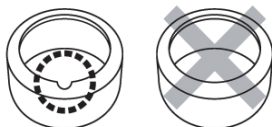
7.4 DO Concentration Calibration via Communication Command

For DO concentration calibration, there are 3 calibration methods (like a key operation) via software communication:

DO concentration 1-point calibration mode, DO concentration 2-point calibration mode, Concentration option calibration mode

7.4.1 Preparation

- (1) Clean the DO Sensor body and measurement section, and remove all moisture.
- (2) Remove the storage cap of the calibration container, and replace with a calibration cap (ventilating cap).



Calibration cap Storage cap

(Fig. 7.4.1-1)

- (3) Keep the water, used for DO Sensor and calibration, at room temperature for approx. 30 minutes.
- (4) Select a mode from Sections 7.4.2 (DO Concentration 1-point Calibration Mode), 7.4.3 (DO Concentration 2-point Calibration Mode), and 7.4.4 (Concentration Option Calibration Mode), and perform calibration.

7.4.2 DO Concentration 1-point Calibration Mode

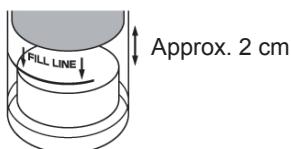


Caution

- If salinity concentration has been previously corrected, return the salinity concentration correction value to 0 PSU, then start calibration.
[Data item 0003H: Salinity correction].
If calibration is performed with salinity concentration being corrected, an error will occur, or calibration will not be performed normally.
- When using a sensor in geographically high elevation sites, perform altitude correction for accurate calibration, then start calibration.
[Data item 0004H: Altitude correction].

The following outlines the calibration procedure.

- (1) Pour approx. 10 mL of ion-exchanged water into the calibration container sponge.
- (2) Insert the DO Sensor into the calibration container until the measurement section of the sensor is situated approximately 2 cm away from the sponge.



(Fig. 7.4.2-1)

- (3) Allow it to settle, undisturbed, for 5 to 10 minutes.



Caution

- Do not leave the sensor attached to the calibration container for more than 30 minutes. This will result in dew condensation in measurement section, which will affect measurement value.
If dew condensation has occurred, remove the moisture from the measurement section, then start calibration again.

- (4) Set Data item 0005H (DO concentration calibration mode) to 0001H.
The unit moves to DO concentration 1-point calibration mode.
If 2¹¹, 2¹⁰ digits are read at Data item 0083H (Status flag 1), 01 (DO concentration 1-point calibration mode) will be returned.

- (5) Set Data item 0006H (DO concentration calibration start) to 0001H.
 1-point calibration (100% saturation calibration) starts.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 01 [During 1st-point calibration (100% saturation calibration)] will be returned.
- (6) Set Data item 0006H (DO concentration calibration start) to 0003H.
 The measured value will be fixed, and automatic calibration will be performed.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 00 (Standby) will be returned.
 1-point calibration (100% saturation calibration) is completed.
- (7) Set Data item 0006H (DO concentration calibration start) to 0000H.
 The unit reverts to DO concentration 1-point calibration mode.
- (8) Set Data item 0005H (DO concentration calibration mode) to 0000H.
 The unit reverts to Display Mode or Cleansing Output Mode.

If calibration cannot be performed during 1-point calibration (100% saturation calibration) due to unstable DO concentration input or temperature correction error, etc., and if 2⁸ digit is read at Data item 0083H (Status flag 1), 1 (Error) will be returned.

To release the error, set Data item 0005H (DO concentration calibration mode) to 0000H.
 The unit reverts to Display Mode or Cleansing Output Mode.

7.4.3 DO Concentration 2-point Calibration Mode

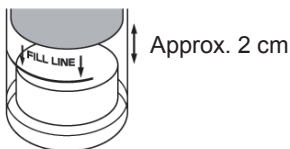


Caution

- When using a sensor in geographically high elevation sites, perform altitude correction for accurate calibration, then start calibration.
 [Data item 0004H: Altitude correction]

The following outlines the calibration procedure.

- (1) Pour approx. 10 mL of ion-exchanged water into the calibration container sponge.
- (2) Insert the DO Sensor into the calibration container until the measurement section of the sensor is situated approximately 2 cm away from the sponge.



(Fig. 7.4.3-1)

- (3) Allow it to settle, undisturbed, for 5 to 10 minutes.

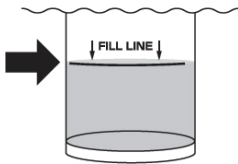


Caution

- Do not leave the sensor attached to the calibration container for more than 30 minutes. This will result in dew condensation in measurement section, which will affect measurement value.
 If dew condensation has occurred, remove the moisture from the measurement section, then start calibration again.

- (4) Set Data item 0005H (DO concentration calibration mode) to 0002H.
 The unit moves to DO concentration 2-point calibration mode.
 If 2¹¹, 2¹⁰ digits are read at Data item 0083H (Status flag 1), 10 (DO concentration 2-point calibration mode) will be returned.

- (5) Set Data item 0006H (DO concentration calibration start) to 0001H.
 1st-point calibration (100% saturation calibration) starts.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 01 [During 1st-point calibration (100% saturation calibration)] will be returned.
- (6) Set Data item 0006H (DO concentration calibration start) to 0003H.
 The measured value will be fixed, and automatic calibration will be performed.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 00 (Standby) will be returned.
 1st-point calibration (100% saturation calibration) is completed.
- (7) Prepare a zero standard solution.
 Zero standard solution is 100 mL of ion-exchanged water into which 5 g or more of sodium sulfite has been added and completely dissolved.
- (8) Take out the calibration container sponge used for 1st-point calibration, and pour the zero standard solution into the calibration container up to the Fill Line.



(Fig. 7.4.3-2)

- (9) Insert the temperature sensor of the DO Sensor until it is immersed in the prepared zero standard solution.



Caution

- Insert the measurement section so that approximately 1 cm of gap is left between it and the bottom of the calibration container.
- Insert the measurement section so that air bubbles cannot attach to it.

- (10) Allow it to settle, undisturbed, for at least 5 minutes to stabilize the temperature.
- (11) Set Data item 0006H (DO concentration calibration start) to 0002H.
 2nd-point calibration (0-point calibration) starts.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 10 [During 2nd-point calibration (0-point calibration)] will be returned.
- (12) Set Data item 0006H (DO concentration calibration start) to 0003H.
 The measured value will be fixed, and automatic calibration will be performed.
 If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 00 (Standby) will be returned.
 2nd-point calibration (0-point calibration) is completed.
 2-point calibration (both 100% saturation calibration and 0-point calibration) is completed.
- (13) Set Data item 0006H (DO concentration calibration start) to 0000H.
 The unit reverts to DO concentration 2-point calibration mode.
- (14) Set Data item 0005H (DO concentration calibration mode) to 0000H.
 The unit reverts to Display Mode or Cleansing Output Mode.

If calibration cannot be performed during DO concentration 2-point calibration due to unstable DO concentration input or temperature correction error, etc., and if 2⁸ digit is read at Data item 0083H (Status flag 1), 1 (Error) will be returned.

To release the error, set Data item 0005H (DO concentration calibration mode) to 0000H.

The unit reverts to Display Mode or Cleansing Output Mode.

7.4.4 Concentration Option Calibration Mode

Immerse the DO Sensor in an aqueous solution (of known concentration), then the measurement value can be matched to the concentration.

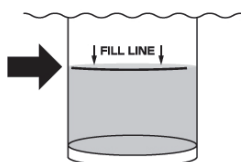
Factory default value: 0.00 mg/L

DO concentration can be set within a range of 0.00 to 20.00 mg/L.

The following outlines the calibration procedure.

(e.g.) Setting to the (already-known) concentration of 7.77 mg/L

(1) Pour the already-known concentration solution into the calibration container up to the Fill Line.



(Fig. 7.4.4-1)

(2) Insert the temperature sensor of the DO Sensor until it is immersed in the poured solution.



Caution

- Insert the measurement section so that approximately 1 cm of gap is left between it and the bottom of the calibration container.
- Insert the measurement section so that air bubbles cannot attach to it.

(3) Allow it to settle, undisturbed, for at least 5 minutes to stabilize the temperature.

(4) Set Data item 0005H (DO concentration calibration mode) to 0003H.

The unit moves to Concentration option calibration mode.

If 2¹¹, 2¹⁰ digits are read at Data item 0083H (Status flag 1), 11 (Concentration option calibration mode) will be returned.

(5) Set Data item 0007H (Concentration desired value) to the desired value (7.77).

(6) Set Data item 0006H (DO concentration calibration start) to 0001H.

Concentration option calibration starts.

If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 11 (During concentration option calibration) will be returned.

(7) Set Data item 0006H (DO concentration calibration start) to 0003H.

The measured value will be fixed, and calibration will be performed.

If 2¹³, 2¹² digits are read at Data item 0083H (Status flag 1), 00 (Standby) will be returned. Concentration option calibration is completed.

(8) Set Data item 0006H (DO concentration calibration start) to 0000H.

The unit reverts to Concentration option calibration mode.

(9) Set Data item 0005H (DO concentration calibration mode) to 0000H.

The unit reverts to Display Mode or Cleansing Output Mode.

If errors occur during concentration option calibration, and if 2⁸ digit is read at Data item 0083H (Status flag 1), 1 (Error) will be returned.

To release the error, set Data item 0005H (DO concentration calibration mode) to 0000H.

The unit reverts to Display Mode or Cleansing Output Mode.

7.5 Transmission output 1 and 2 Adjustments

7.5.1 Transmission output 1 Adjustment Mode

Fine adjustment of Transmission output 1 is performed.

This DO meter (AER-102-DO) is adjusted at the factory, however, differences may occur between the indication value of the connected equipment (recorders, etc.) and the output value of this instrument. In this case, perform Transmission output 1 Zero adjustment and Span adjustment.

The following outlines the procedure for Transmission output 1 adjustment.

- (1) Set Data item 000EH (Transmission output 1 adjustment mode) to 0001H.
The unit moves to Transmission output 1 Zero adjustment mode.
If 2⁹, 2⁸ digits are read at Data item 0093H (Status flag 2), 01 (During Transmission output 1 Zero adjustment in Transmission output 1 adjustment mode) will be returned.
- (2) Set Transmission output 1 Zero adjustment value at Data item 000FH (Transmission output 1 Zero adjustment value), while checking the value indicated on the connected equipment (recorders, etc.).
Setting range: $\pm 5.00\%$ of Transmission output 1 span
- (3) Set Data item 000EH (Transmission output 1 adjustment mode) to 0002H.
The unit moves to Transmission output 1 Span adjustment mode.
If 2⁹, 2⁸ digits are read at Data item 0093H (Status flag 2), 10 (During Transmission output 1 Span adjustment in Transmission output 1 adjustment mode) will be returned.
- (4) Set Transmission output 1 Span adjustment value at Data item 0010H (Transmission output 1 Span adjustment value), while checking the value indicated on the connected equipment (recorders, etc.).
Setting range: $\pm 5.00\%$ of Transmission output 1 span
- (5) Repeat steps (1) to (4) if necessary.
- (6) Set Data item 000EH (Transmission output 1 adjustment mode) to 0000H.
The unit reverts to Display Mode or Cleansing Output Mode.

7.5.2 Transmission output 2 Adjustment Mode

Fine adjustment of Transmission output 2 is performed.

This DO meter (AER-102-DO) is adjusted at the factory, however, differences may occur between the indication value of the connected equipment (recorders, etc.) and the output value of this instrument. In this case, perform Transmission output 2 Zero adjustment and Span adjustment.

The following outlines the procedure for Transmission output 2 adjustment.

- (1) Set Data item 0011H (Transmission output 2 adjustment mode) to 0001H.
The unit moves to Transmission output 2 Zero adjustment mode.
If 2¹¹, 2¹⁰ digits are read at Data item 0093H (Status flag 2), 01 (During Transmission output 2 Zero adjustment in Transmission output 2 adjustment mode) will be returned.
- (2) Set Transmission output 2 Zero adjustment value at Data item 0012H (Transmission output 2 Zero adjustment value), while checking the value indicated on the connected equipment (recorders, etc.).
Setting range: $\pm 5.00\%$ of Transmission output 2 span
- (3) Set Data item 0011H (Transmission output 2 adjustment mode) to 0002H.
The unit moves to Transmission output 2 Span adjustment mode.
If 2¹¹, 2¹⁰ digits are read at Data item 0093H (Status flag 2), 10 (During Transmission output 2 Span adjustment in Transmission output 2 adjustment mode) will be returned.
- (4) Set Transmission output 2 Span adjustment value at Data item 0013H (Transmission output 2 Span adjustment value), while checking the value indicated on the connected equipment (recorders, etc.).
Setting range: $\pm 5.00\%$ of Transmission output 2 span
- (5) Repeat steps (1) to (4) if necessary.
- (6) Set Data item 0011H (Transmission output 2 adjustment mode) to 0000H.
The unit reverts to Display Mode or Cleansing Output Mode.

7.6 Notes on Programming Monitoring Software

7.6.1 How to speed up the scan time

When monitoring multiple units of AER-102-DO, set the program so that the requisite minimum pieces of data such as Data item 0080H (DO concentration), Data item 0090H (Temperature), Data item 0083H (Status flag 1), Data item 0093H (Status flag 2) can be read. For other data, set the program so that they can be read only when their set value has been changed. This will speed up the scan time.

7.6.2 How to read the set value changes made by the front keypad operation

If any set value is changed by keypad operation, the AER-102-DO will set [0083H (Status flag 1) ^{2¹⁵}: Change in key operation] to 1 (Yes).

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

(1) Reading method 1

- ① On the monitoring software side, check that [0083H (Status flag 1) ^{2¹⁵}: Change in key operation] has been set to 1 (Yes), then read all set values.
- ② Clear the [0083H (Status flag 1) ^{2¹⁵}: Change in key operation], by setting Data item 007FH (Key operation change flag clearing) to 0001H (Clear change flag).
If Data item 007FH (Key operation change flag clearing) is set to 0001H (Clear change flag) during setting mode of this instrument, Error code 5 (35H, Shinko protocol) or Exception Code 18 (12H, MODBUS protocol) will be returned as a negative acknowledgement. And [0083H (Status flag 1) ^{2¹⁵}: 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 [0083H (Status flag 1) ^{2¹⁵}: Change in key operation] has been set to 1 (Yes), then set 007FH (Key operation change flag clearing) to 0001H (Clear change flag).
- ② Set the program depending on acknowledgement or negative acknowledgement as follows.
When acknowledgement is returned:
Consider it as settings completed, and read all set values.
When Error code 5 (35H, Shinko protocol) or Exception code 18 (12H, MODBUS protocol) is returned as a negative acknowledgement:
Consider it as still in setting mode, and read the requisite minimum pieces of data such as 0080H (DO concentration), 0090H (Temperature), 0083H (Status flag 1), 0093H (Status flag 2), 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.

7.6.3 Note when sending all set values at one time

- When EVT type is changed at Data items 0014H (EVT1 type), 0022H (EVT2 type), 0030H (EVT3 type) or 003EH (EVT4 type), EVT1, EVT2, EVT3 or EVT4 value will default to 0 (zero).
The output status of EVT1, EVT2, EVT3 or EVT4 will also be initialized.

First, send the EVT1, EVT2, EVT3, EVT4 type, then send the EVT1, EVT2, EVT3, EVT4 value set at Data items 0015H (EVT1 value), 0023H (EVT2 value), 0031H (EVT3 value) and 003FH (EVT4 value).

8. Specifications

Serial communication	The following operations can be carried out from an external computer. (1) Reading and setting of various set values (2) Reading of the DO concentration, DO % saturation, Oxygen partial pressure, temperature and status (3) Function change, Adjustment (4) Reading and setting of user save area			
Cable length	1.2 km (Max.), Cable resistance: Within 50 Ω (Terminators are not necessary, but if used, use 120 Ω minimum on both sides.)			
Communication line	EIA RS-485			
Communication method	Half-duplex communication			
Communication speed	9600, 19200, 38400 bps (Selectable by keypad.)			
Synchronization	Start-stop synchronization			
Code form	ASCII, Binary			
Communication protocol	Shinko protocol, MODBUS ASCII, MODBUS RTU (Selectable by keypad.)			
Data bit/Parity	8 bits/No parity, 7 bits/No parity, 8 bits/Even, 7 bits/Even, 8 bits/Odd, 7 bits/Odd (Selectable by keypad.)			
Stop bit	1 bit, 2 bits (Selectable by keypad.)			
Error correction	Command request repeat system			
Error detection	Parity check, Checksum (Shinko protocol), LRC (MODBUS protocol ASCII), CRC-16 (MODBUS protocol RTU)			
Data format	Communication protocol	Shinko Protocol	MODBUS ASCII	MODBUS RTU
	Start bit	1	1	1
	Data bit	7	7 (8) Selectable	8
	Parity	Even	Even (No parity, Odd) Selectable	No parity (Even, Odd) Selectable
	Stop bit	1	1 (2) Selectable	1 (2) Selectable

9. 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.
	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.
	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.
	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.
	The instrument numbers (addresses) are duplicated in multiple slaves.	Check that each slave has a different instrument number (address).
	Make sure that the program is appropriate for the transmission timing.	Check the program.
Although communication is occurring, the response is negative acknowledgement.	A non-existent command code has been sent.	Check the command code.
	The setting command data exceeds the setting range of the slave.	Check the setting range of the slave.
	The AER-102-DO cannot be set while calibration is being performed.	Check the slave status.
	The AER-102-DO is in front keypad operation setting mode.	Return the unit to Display Mode or Cleansing Output Mode.

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

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