No. AER1CSEE4 2019.11

This manual contains instructions for communication functions of the AER-102-SE.
To prevent accidents arising from the misuse of this instrument, please ensure the operator receives this manual.

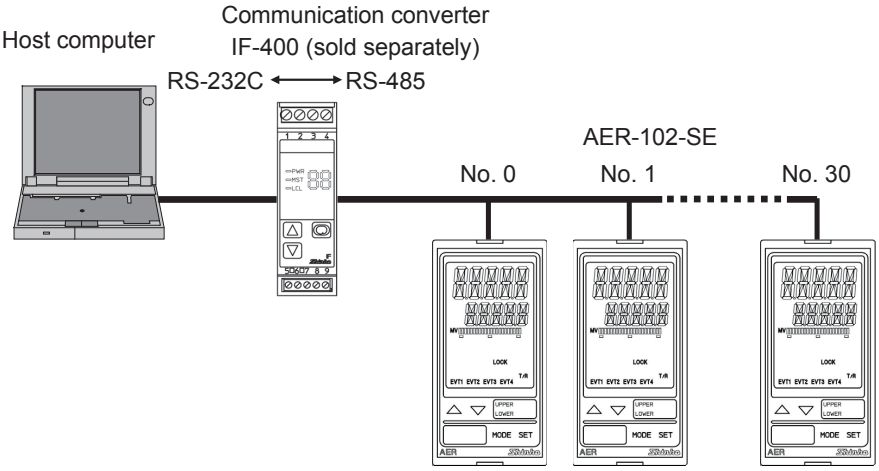
⚠ Warning

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

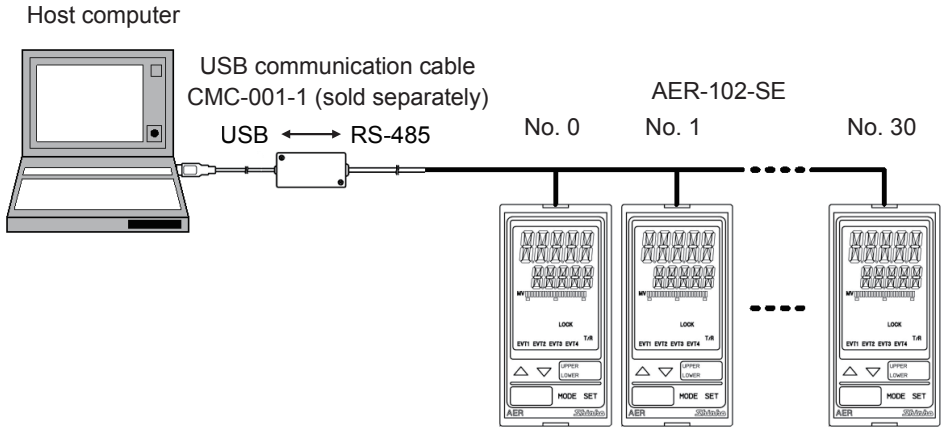
System configuration example using Communication converter IF-400 and USB communication cable CMC-001-1

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

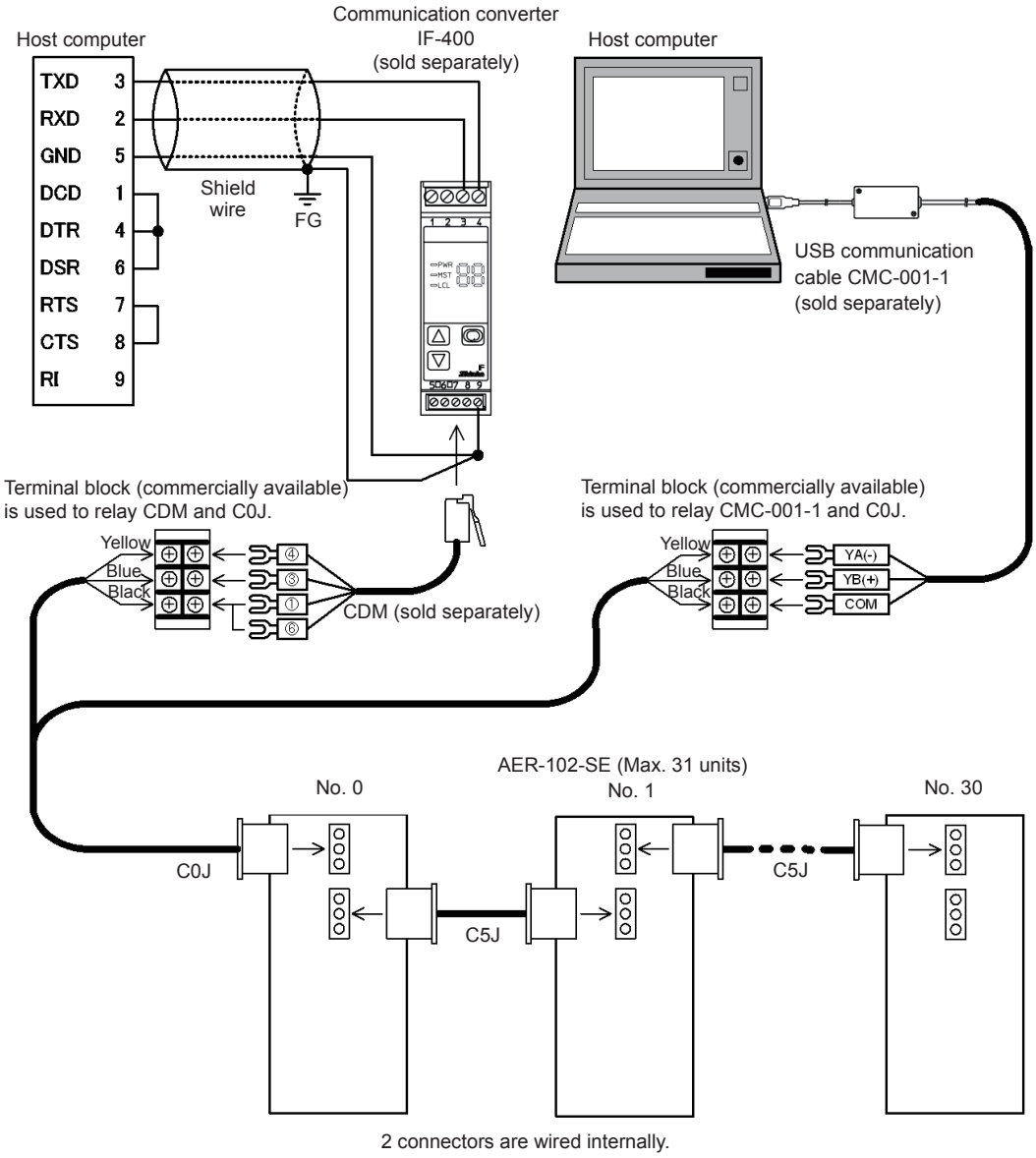
When using communication converter IF-400:

Use the provided wire harness (C0J: Between IF-400 and AER-102-SE, C5J: Between AER-102-SE 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-SE, C5J: Between AER-102-SE 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 or GND terminal to avoid a ground loop. If both ends of the shield wire are connected to the FG or GND terminal, the circuit will be closed, resulting in a ground loop. This may cause noise. Be sure to ground the FG or GND terminal.

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

Terminator (Terminal Resistor)

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

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

Do not connect a terminator to the communication line because each AER-102-SE has built-in pull-up and pull-down resistors.

3. Setting Communication Parameters

Communication parameters can be set in the Basic Function Group.

To enter the Basic Function Group, follow the procedure below.

(1) aT.ER Press the MODE key 5 times in Resistivity/Temperature Display Mode.
If EVT3, EVT4 outputs (EVT3 option) are/is ordered, press the MODE key 7 times in Resistivity/Temperature Display Mode.

(2) cMnL Press the SET key twice. "Communication protocol" will appear.

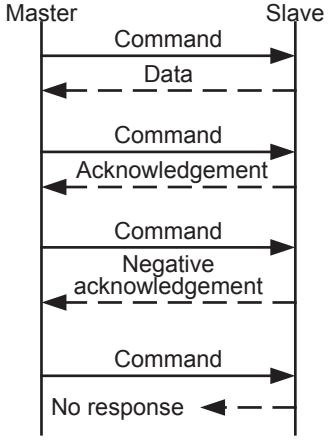
(3) Make a selection using the △ or ▽ key, and register the value with the SET key.

Character	Setting Item, Function, Setting range	Factory Default
cMnL NoML	**Communication protocol** • Selects communication protocol. • NoML : Shinko protocol ModA : MODBUS ASCII mode ModR : MODBUS RTU mode	Shinko protocol
cMNo 0	**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
cMnP 96	**Communication speed** • Selects a communication speed equal to that of the host computer. • 96 : 9600 bps 192 : 19200 bps 384 : 38400 bps	9600 bps
cMFT 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
cMnT 1	**Stop bit** • Selects the stop bit. • 1 : 1 bit 2 : 2 bits	1 bit

(4) Press the SET key multiple times. The unit will revert to Resistivity/Temperature Display Mode.

4. Communication Procedure

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

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. 12 to 21)

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. 12 to 21)

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 Resistivity calibration Span adjustment or Temperature 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.

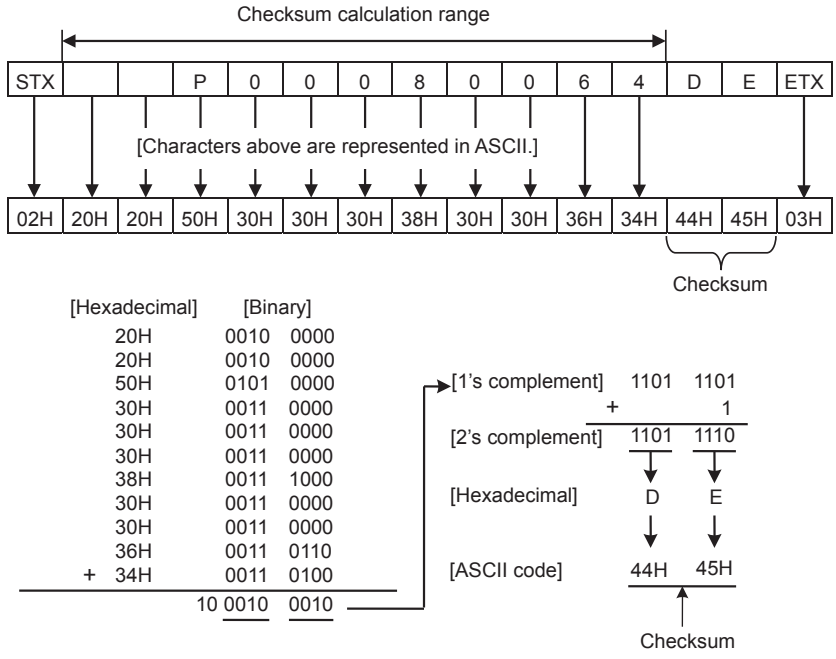
The ASCII code (hexadecimal) corresponding to the characters which range from the address (instrument number) to that before the checksum is converted to binary notation, and the total value is calculated.
The lower one byte of the total value is converted to 2’s complement, and then to hexadecimal numbers, 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 0008H (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 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 μs.

If an interval lasts longer than 1.5-character transmission times or 750 μs, the AER-102-SE 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)

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

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 Resistivity or Temperature calibration mode
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 (Resistivity)]**

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

• Response message from the slave in normal status [(e.g.) 1.00 MΩ•cm (0064H)]

The response byte count means the byte count of data which have been read. It is fixed as (30H 32H).

Header	Slave address	Function code	Response byte count [02H] (30H 32H)	Data [0064H]	Error check LRC	Delimiter
(3AH)	(30H 31H)	(30H 33H)		(30H 30H 36H 34H)	(39H 36H)	(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	Slave address	Function code	Exception code [02H]	Error check LRC	Delimiter
(3AH)	(30H 31H)	(38H 33H)	(30H 32H)	(37H 41H)	(0DH 0AH)
1	2	2	2	2	2

② **Setting [Slave address 1, Data item 0008H (EVT1 ON delay time)]**

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

Header	Slave address	Function code	Data item [0008H]	Data [0064H]	Error check LRC	Delimiter
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 38H)	(30H 30H 36H 34H)	(38H 44H)	(0DH 0AH)
1	2	2	4	4	2	2

• Response message from the slave in normal status

Header	Slave address	Function code	Data item [0008H]	Data [0064H]	Error check LRC	Delimiter
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 38H)	(30H 30H 36H 34H)	(38H 44H)	(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	Slave address	Function code	Exception code [03H]	Error check LRC	Delimiter
(3AH)	(30H 31H)	(38H 36H)	(30H 33H)	(37H 36H)	(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 (Resistivity)]**

• 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 [(e.g.) 1.00 MΩ•cm (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 0008H (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 (0008H)	Data (0064H)	Error check CRC-16 (D9E3H)	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 (0008H)	Data (0064H)	Error check CRC-16 (D9E3H)	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.
  A negative number is 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 (Sensor cell constant) as an example: Data item in the sending message is 0001H, however, MODBUS protocol Holding Register address is 40002 (1 + 40001).
- Even if options are not ordered, setting or reading via software communication will be possible.
  However, EVT3, EVT4 and Transmission output 2 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 communication. (If the value set via 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 – except Measurement unit, Measurement range, Resistivity calibration value, Temperature calibration value, Transmission output 1 Zero and Span adjustment values, Transmission output 2 Zero and Span adjustment 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 during selection of Data items 0005H (EVT1 type), 0050H (EVT2 type), 0051H (EVT3 type) and 0052H (EVT4 type), EVT1 to EVT4 values default to 0 (zero).
  Output status of EVT1 to 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.
- When sending a command using Global address [95 (7FH), Shinko protocol] or Broadcast address [00H, MODBUS protocol], the same command is sent to all the slaves connected. However, a 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
20H	03H	0001H	Sensor cell constant	0000H: 0.01/cm fixed.
50H/20H	06H/03H	0002H	Cell constant correction value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0003H	Measurement unit	0000H: Resistivity (MΩ•cm) 0001H: Resistivity (kΩ•cm)

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0004H	Measurement range	When Resistivity (MΩ•cm) is selected in [Measurement unit]: 0000H: 0.000 to 0.200 MΩ•cm 0001H: 0.00 to 2.00 MΩ•cm 0002H: 0.00 to 20.00 MΩ•cm 0003H: 0.0 to 100.0 MΩ•cm When Resistivity (kΩ•cm) is selected in [Measurement unit]: 0000H: 0.00 to 2.00 kΩ•cm 0001H: 0.0 to 20.0 kΩ•cm 0002H: 0.0 to 200.0 kΩ•cm 0003H: 0 to 1000 kΩ•cm
50H/20H	06H/03H	0005H	EVT1 type	0000H: No action 0001H: Resistivity input low limit action 0002H: Resistivity input high limit action 0003H: Temperature input low limit action 0004H: Temperature input high limit action 0005H: Error output 0006H: Fail output 0007H: Resistivity input error alarm output 0008H: Resistivity input High/Low limits independent action 0009H: Temperature input High/Low limits independent action
50H/20H	06H/03H	0006H	EVT1 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0007H	EVT1 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0008H	EVT1 ON delay time	Set value
50H/20H	06H/03H	0009H	EVT1 OFF delay time	Set value
50H/20H	06H/03H	000AH	Resistivity input filter time constant	Set value (Decimal point ignored.)
50H/20H	06H/03H	000CH	Ultrapure water value	When Resistivity (MΩ•cm) is selected in [Measurement unit]: 0000H: 18.18 0001H: 18.23 0002H: 18.24 When Resistivity (kΩ•cm) is selected in [Measurement unit]: 0000H: 181.8 0001H: 182.3 0002H: 182.4
50H/20H	06H/03H	000DH	Clip value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0010H	EVT1 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0011H	EVT1 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0012H	EVT1 proportional cycle	Set value
50H/20H	06H/03H	0013H	EVT2 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0014H	EVT2 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0015H	EVT2 proportional cycle	Set value
50H/20H	06H/03H	0016H	EVT3 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	0017H	EVT3 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	0018H	EVT3 proportional cycle	Set value
50H/20H	06H/03H	0019H	EVT4 proportional band	Set value (Decimal point ignored.)
50H/20H	06H/03H	001AH	EVT4 reset	Set value (Decimal point ignored.)
50H/20H	06H/03H	001BH	EVT4 proportional cycle	Set value

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0020H	Temperature compensation method	0000H: Temperature characteristics of deionized water 0001H: Temperature characteristics of deionized water and impure substance. 0002H: temperature coefficient (%/℃) and randomly selected reference temperature 0003H: No temperature compensation
50H/20H	06H/03H	0021H	Temperature coefficient	Set value (Decimal point ignored.)
50H/20H	06H/03H	0022H	Reference temperature	Set value (Decimal point ignored.)
50H/20H	06H/03H	0023H	Temperature input decimal point place	0000H: No decimal point 0001H: 1 digit after decimal point
50H/20H	06H/03H	0029H	Temperature input filter time constant	Set value (Decimal point ignored.)
50H/20H	06H/03H	0030H	Set value lock	0000H: Unlock 0001H: Lock 1 0002H: Lock 2 0003H: Lock 3
50H/20H	06H/03H	0031H	Transmission output 1 type	0000H: Resistivity transmission 0001H: Temperature transmission 0002H: EVT1 MV transmission (*1) 0003H: EVT2 MV transmission 0004H: EVT3 MV transmission (*2) 0005H: EVT4 MV transmission (*2)
50H/20H	06H/03H	0032H	Transmission output 1 high limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	0033H	Transmission output 1 low limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	0037H	Backlight time	Set value
50H	06H	0040H	Temperature calibration mode	0000H: Resistivity/Temperature Display Mode 0001H: Temperature calibration mode
50H/20H	06H/03H	0041H	Temperature calibration value	Set value (Decimal point ignored.)
50H	06H	0042H	Resistivity calibration Span adjustment mode	0000H: Resistivity/Temperature Display Mode 0001H: Resistivity calibration Span adjustment mode
50H/20H	06H/03H	0044H	Resistivity Span adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0045H	EVT output when input errors occur	0000H: Enabled 0001H: Disabled
50H/20H	06H/03H	0046H	Cable length correction	Set value (Decimal point ignored.)
50H/20H	06H/03H	0047H	Cable cross-section area	Set value (Decimal point ignored.)

(*1) If 'Setting' is executed while Transmission output 2 (TA2 option) is ordered, the following error code will be returned.
- Shinko protocol: Error code 3 (33H)
- MODBUS: Exception code 3 (03H)

(*2) 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	0048H	Output ON time when EVT1 output ON	Set value
50H/20H	06H/03H	0049H	Output OFF time when EVT1 output ON	Set value
50H/20H	06H/03H	004AH	Output ON time when EVT2 output ON	Set value
50H/20H	06H/03H	004BH	Output OFF time when EVT2 output ON	Set value
50H/20H	06H/03H	004CH	Output ON time when EVT3 output ON	Set value
50H/20H	06H/03H	004DH	Output OFF time when EVT3 output ON	Set value
50H/20H	06H/03H	004EH	Output ON time when EVT4 output ON	Set value
50H/20H	06H/03H	004FH	Output OFF time when EVT4 output ON	Set value
50H/20H	06H/03H	0050H	EVT2 type	0000H: No action 0001H: Resistivity input low limit action 0002H: Resistivity input high limit action 0003H: Temperature input low limit action 0004H: Temperature input high limit action 0005H: Error output 0006H: Fail output 0007H: Resistivity input error alarm output 0008H: Resistivity input High/Low limits independent action 0009H: Temperature input High/Low limits independent action
50H/20H	06H/03H	0051H	EVT3 type	0000H: No action 0001H: Resistivity input low limit action 0002H: Resistivity input high limit action 0003H: Temperature input low limit action 0004H: Temperature input high limit action 0005H: Error output 0006H: Fail output 0007H: Resistivity input error alarm output 0008H: Resistivity input High/Low limits independent action 0009H: Temperature input High/Low limits independent action
50H/20H	06H/03H	0052H	EVT4 type	0000H: No action 0001H: Resistivity input low limit action 0002H: Resistivity input high limit action 0003H: Temperature input low limit action 0004H: Temperature input high limit action 0005H: Error output 0006H: Fail output 0007H: Resistivity input error alarm output 0008H: Resistivity input High/Low limits independent action 0009H: Temperature input High/Low limits independent action
50H/20H	06H/03H	0053H	EVT2 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0054H	EVT3 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0055H	EVT4 value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0056H	EVT2 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0057H	EVT3 ON side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0058H	EVT4 ON side	Set value (Decimal point ignored.)

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0059H	EVT2 ON delay time	Set value
50H/20H	06H/03H	005AH	EVT3 ON delay time	Set value
50H/20H	06H/03H	005BH	EVT4 ON delay time	Set value
50H/20H	06H/03H	005CH	EVT2 OFF delay time	Set value
50H/20H	06H/03H	005DH	EVT3 OFF delay time	Set value
50H/20H	06H/03H	005EH	EVT4 OFF delay time	Set value
50H/20H	06H/03H	0063H	Backlight selection	0000H: All are backlit. 0001H: Resistivity Display is backlit. 0002H: Temperature Display is backlit 0003H: Action indicators are backlit. 0004H: Resistivity Display + Temperature Display are backlit. 0005H: Resistivity Display + Action indicators are backlit. 0006H: Temperature Display + Action indicators are backlit.
50H/20H	06H/03H	0064H	Resistivity color	0000H: Green 0001H: Red 0002H: Orange 0003H: Resistivity color changes continuously.
50H/20H	06H/03H	0065H	Resistivity color range	Set value (Decimal point ignored.)
50H/20H	06H/03H	0066H	Bar graph indication	0000H: No indication 0001H: Transmission output 1 0002H: Transmission output 2 (*)
50H/20H	06H/03H	0067H	Resistivity color reference value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0068H	Resistivity input sensor correction	Set value (Decimal point ignored.)
50H/20H	06H/03H	0069H	Temperature Display when no temperature compensation	0000H: Unlit 0001H: Reference temperature 0002H: Measured value
50H/20H	06H/03H	006FH	Pt100 input wire type	0000H: 2-wire type 0001H: 3-wire type
50H/20H	06H/03H	0070H	EVT1 output high limit	Set value
50H/20H	06H/03H	0071H	EVT1 output low limit	Set value
50H/20H	06H/03H	0072H	EVT2 output high limit	Set value
50H/20H	06H/03H	0073H	EVT2 output low limit	Set value
50H/20H	06H/03H	0074H	EVT3 output high limit	Set value
50H/20H	06H/03H	0075H	EVT3 output low limit	Set value
50H/20H	06H/03H	0076H	EVT4 output high limit	Set value
50H/20H	06H/03H	0077H	EVT4 output low limit	Set value
50H	06H	007FH	Key operation change flag clearing	0001H: Clear change flag.
50H/20H	06H/03H	0100H	EVT1 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0101H	EVT2 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0102H	EVT3 hysteresis type	0000H: Medium Value 0001H: Reference Value
50H/20H	06H/03H	0103H	EVT4 hysteresis type	0000H: Medium Value 0001H: Reference Value

(*) If 'Setting' is executed while Transmission output 2 (TA2 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	0104H	EVT1 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0105H	EVT2 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0106H	EVT3 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	0107H	EVT4 OFF side	Set value (Decimal point ignored.)
50H/20H	06H/03H	010FH	Transmission output 1 status when calibrating	0000H: Last value HOLD 0001H: Set value HOLD 0002H: Measured value
50H/20H	06H/03H	0110H	Transmission output 1 value HOLD when calibrating	Set value (Decimal point ignored.)
50H/20H	06H/03H	0111H	EVT1 resistivity input error alarm EVT□ type	0000H: No action 0001H: EVT2 type 0002H: EVT3 type (*1) 0003H: EVT4 type (*1)
50H/20H	06H/03H	0112H	EVT2 resistivity input error alarm EVT□ type	0000H: EVT1 type (*2) 0001H: No action 0002H: EVT3 type (*1) 0003H: EVT4 type (*1)
50H/20H	06H/03H	0113H	EVT3 resistivity input error alarm EVT□ type	0000H: EVT1 type (*2) 0001H: EVT2 type 0002H: No action 0003H: EVT4 type
50H/20H	06H/03H	0114H	EVT4 resistivity input error alarm EVT□ type	0000H: EVT1 type (*2) 0001H: EVT2 type 0002H: EVT3 type 0003H: No action
50H/20H	06H/03H	0115H	EVT1 resistivity input error alarm band when EVT□ output ON	Set value (Decimal point ignored.)
50H/20H	06H/03H	0116H	EVT1 resistivity input error alarm time when EVT□ output ON	Set value
50H/20H	06H/03H	0117H	EVT1 resistivity input error alarm band when EVT□ output OFF	Set value (Decimal point ignored.)
50H/20H	06H/03H	0118H	EVT1 resistivity input error alarm time when EVT□ output OFF	Set value
50H/20H	06H/03H	0119H	EVT2 resistivity input error alarm band when EVT□ output ON	Set value (Decimal point ignored.)
50H/20H	06H/03H	011AH	EVT2 resistivity input error alarm time when EVT□ output ON	Set value
50H/20H	06H/03H	011BH	EVT2 resistivity input error alarm band when EVT□ output OFF	Set value (Decimal point ignored.)
50H/20H	06H/03H	011CH	EVT2 resistivity input error alarm time when EVT□ output OFF	Set value

(*1) 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)

(*2) If 'Setting' is executed while Transmission output 2 (TA2 option) is 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	011DH	EVT3 resistivity input error alarm band when EVT□ output ON	Set value (Decimal point ignored.)
50H/20H	06H/03H	011EH	EVT3 resistivity input error alarm time when EVT□ output ON	Set value
50H/20H	06H/03H	011FH	EVT3 resistivity input error alarm band when EVT□ output OFF	Set value (Decimal point ignored.)
50H/20H	06H/03H	0120H	EVT3 resistivity input error alarm time when EVT□ output OFF	Set value
50H/20H	06H/03H	0121H	EVT4 resistivity input error alarm band when EVT□ output ON	Set value (Decimal point ignored.)
50H/20H	06H/03H	0122H	EVT4 resistivity input error alarm time when EVT□ output ON	Set value
50H/20H	06H/03H	0123H	EVT4 resistivity input error alarm band when EVT□ output OFF	Set value (Decimal point ignored.)
50H/20H	06H/03H	0124H	EVT4 resistivity input error alarm time when EVT□ output OFF	Set value
50H/20H	06H/03H	0125H	Resistivity input error alarm time unit	0000H: Seconds 0001H: Minutes
50H	06H	0126H	Transmission output 1 adjustment mode	0000H: Resistivity/Temperature Display Mode 0001H: Transmission output 1 Zero adjustment mode 0002H: Transmission output 1 Span adjustment mode
50H/20H	06H/03H	0127H	Transmission output 1 Zero adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0128H	Transmission output 1 Span adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0129H	EVT1 cycle variable range	Set value (Decimal point ignored.)
50H/20H	06H/03H	012AH	EVT2 cycle variable range	Set value (Decimal point ignored.)
50H/20H	06H/03H	012BH	EVT3 cycle variable range	Set value (Decimal point ignored.)
50H/20H	06H/03H	012CH	EVT4 cycle variable range	Set value (Decimal point ignored.)
50H/20H	06H/03H	012DH	EVT1 cycle extended time	Set value
50H/20H	06H/03H	012EH	EVT2 cycle extended time	Set value
50H/20H	06H/03H	012FH	EVT3 cycle extended time	Set value
50H/20H	06H/03H	0130H	EVT4 cycle extended time	Set value
50H/20H	06H/03H	0139H	EVT1 High/Low limits independent lower side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013AH	EVT2 High/Low limits independent lower side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013BH	EVT3 High/Low limits independent lower side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013CH	EVT4 High/Low limits independent lower side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013DH	EVT1 High/Low limits independent upper side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013EH	EVT2 High/Low limits independent upper side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	013FH	EVT3 High/Low limits independent upper side value	Set value (Decimal point ignored.)
50H/20H	06H/03H	0140H	EVT4 High/Low limits independent upper side value	Set value (Decimal point ignored.)

Shinko Command Type	MODBUS Function Code	Data Item		Data
50H/20H	06H/03H	0141H	EVT1 hysteresis	Set value (Decimal point ignored.)
50H/20H	06H/03H	0142H	EVT2 hysteresis	Set value (Decimal point ignored.)
50H/20H	06H/03H	0143H	EVT3 hysteresis	Set value (Decimal point ignored.)
50H/20H	06H/03H	0144H	EVT4 hysteresis	Set value (Decimal point ignored.)
50H/20H	06H/03H	0147H	Transmission output 2 type	0000H: Resistivity transmission 0001H: Temperature transmission 0002H: MV2 transmission 0003H: MV3 transmission (*1) 0004H: MV4 transmission (*1)
50H/20H	06H/03H	0148H	Transmission output 2 high limit	Set value (Decimal point ignored.)
50H/20H	06H/03H	0149H	Transmission output 2 low limit	Set value (Decimal point ignored.)
50H	06H	014AH	Transmission output 2 adjustment mode (*2)	0000H: Resistivity/Temperature Display Mode 0001H: Transmission output 2 Zero adjustment mode 0002H: Transmission output 2 Span adjustment mode
50H/20H	06H/03H	014BH	Transmission output 2 Zero adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	014CH	Transmission output 2 Span adjustment value	Set value (Decimal point ignored.)
50H/20H	06H/03H	014DH	Transmission output 2 status when calibrating	0000H: Last value HOLD 0001H: Set value HOLD 0002H: Measured value
50H/20H	06H/03H	014EH	Transmission output 2 value HOLD when calibrating	Set value (Decimal point ignored.)
50H/20H	06H/03H	0151H	Resistivity inputs for moving average	Set value
50H/20H	06H/03H	0152H	Temperature inputs for moving average	Set value
50H/20H	06H/03H	0153H	Measurement range cut function	0000H: Disabled 0001H: Enabled
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)

(*1) 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)

(*2) If 'Setting' is executed while Transmission output 2 (TA2 option) is not ordered, the following error code will be returned.
- Shinko protocol: Error code 4 (34H)
- MODBUS: Exception code 17 (11H)

7.3 Read Only Command

<table>
<tr><th>Shinko Command Type</th><th>MODBUS Function Code</th><th colspan="2">Data Item</th><th>Data</th></tr>
<tr><td>20H</td><td>03H</td><td>0080H</td><td>Resistivity</td><td>Resistivity (Decimal point ignored.)</td></tr>
<tr><td>20H</td><td>03H</td><td>0081H</td><td colspan="2">Status flag 1
0000 0000 0000 0000
2^{15} to 2^{0}
2^{0} digit: Not used (Always 0)
2^{1} digit: Not used (Always 0)
2^{2} digit: Not used (Always 0)
2^{3} digit: Not used (Always 0)
2^{4} digit: Not used (Always 0)
2^{5} digit: Temperature sensor burnout 0: Normal 1: Burnout
2^{6} digit: Temperature sensor short-circuited 0: Normal 1: Short-circuited
2^{7} digit: Outside temperature compensation range: Exceeding 110.0℃
0: Normal 1: Exceeding 110.0℃
2^{8} digit: Outside temperature compensation range: Less than 0.0℃
0: Normal 1: Less than 0.0℃
2^{9} digit: Resistivity input value is outside the measurement range (high limit)
0: Normal 1: Outside high limit
2^{10} digit: Resistivity input value is outside the measurement range (low limit)
0: Normal 1: Outside low limit
2^{11} digit: Unit status flag
0: Resistivity/Temperature Display Mode
1: Setting mode
2^{12}, 2^{13} digits: Resistivity calibration status flag
<table><tr><th>2^{13}</th><th>2^{12}</th><th>Status</th></tr><tr><td>0</td><td>0</td><td>Resistivity/Temperature Display Mode</td></tr><tr><td>0</td><td>1</td><td>During Resistivity calibration Span adjustment</td></tr></table>2^{14} digit: Not used (Always 0)
2^{15} digit: Change in key operation 0: No 1: Yes</td></tr>
<tr><td>20H</td><td>03H</td><td>0084H</td><td>EVT1 Manipulated Variable</td><td>MV (Decimal point ignored.)</td></tr>
<tr><td>20H</td><td>03H</td><td>0085H</td><td>EVT2 Manipulated Variable</td><td>MV (Decimal point ignored.)</td></tr>
<tr><td>20H</td><td>03H</td><td>0086H</td><td>EVT3 Manipulated Variable</td><td>MV (Decimal point ignored.)</td></tr>
<tr><td>20H</td><td>03H</td><td>0087H</td><td>EVT4 Manipulated Variable</td><td>MV (Decimal point ignored.)</td></tr>
<tr><td>20H</td><td>03H</td><td>0090H</td><td>Temperature</td><td>Temperature
(Decimal point ignored.)</td></tr>
</table>

<table>
<tr><th>Shinko Command Type</th><th>MODBUS Function Code</th><th colspan="2">Data Item</th><th>Data</th></tr>
<tr><td>20H</td><td>03H</td><td>0091H</td><td colspan="2">Status flag 2
0000 0000 0000 0000
2^{15} to 2^{0}
2^{0} digit: EVT1 output 0: OFF 1: ON
2^{1} digit: EVT2 output 0: OFF 1: ON
2^{2} digit: EVT3 output 0: OFF 1: ON
2^{3} digit: EVT4 output 0: OFF 1: ON

2^{4}, 2^{5} digits: Transmission output 1 adjustment status flag
<table>
<tr><th>2^{5}</th><th>2^{4}</th><th>Status</th></tr>
<tr><td>0</td><td>0</td><td>Resistivity/Temperature 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>
</table>
2^{6}, 2^{7} digits: Transmission output 2 adjustment status flag
<table>
<tr><th>2^{7}</th><th>2^{6}</th><th>Status</th></tr>
<tr><td>0</td><td>0</td><td>Resistivity/Temperature 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>
</table>
2^{8} to 2^{11} digits: Not used (Always 0)
2^{12}, 2^{13} digits: Temperature calibration status flag
<table>
<tr><th>2^{13}</th><th>2^{12}</th><th>Status</th></tr>
<tr><td>0</td><td>0</td><td>Resistivity/Temperature Display Mode</td></tr>
<tr><td>0</td><td>1</td><td>During Temperature calibration</td></tr>
</table>
2^{14}, 2^{15} digits: Not used (Always 0)</td></tr>
</table>

7.4 Resistivity and Temperature Calibrations, Transmission Output 1 and 2 Adjustments via Communication Command

7.4.1 Resistivity calibration Span adjustment

Cell constant may vary due to deterioration of 2-electrode resistivity sensor.
To correct the varied cell constant, calibration is required.
Adjust the correction value so that resistivity input value matches the reference resistivity meter.

The following outlines the procedure for Resistivity calibration Span adjustment.

① Set Data item 0042H (Resistivity calibration Span adjustment mode) to 0001H.
The unit moves to Resistivity calibration Span adjustment mode.
② Set the Resistivity Span adjustment value at Data item 0044H (Resistivity Span adjustment value), while checking the reference resistivity meter.
③ If 2^{13}, 2^{12} digits are read at Data item 0081H (Status flag 1), 01 (During Resistivity calibration Span adjustment) will be returned.
④ Set Data item 0042H (Resistivity calibration Span adjustment mode) to 0000H.
The Resistivity calibration Span adjustment is complete, and the unit will revert to Resistivity/Temperature Display Mode.

During Resistivity calibration Span adjustment, if Resistivity calibration Span adjustment cannot be performed due to reasons such as temperature compensation error, and if 2^5 to 2^{10} digits are read at Data item 0081H (Status flag 1), Error code 1 (Burnout, Short-circuited, Exceeding 110.0℃, Less than 0.0℃, Outside high limit, Outside low limit) will be returned.
To release the error code, set Data item 0042H to 0000H.
The unit will revert to Resistivity/Temperature Display Mode.

In Resistivity/Temperature Display Mode, if Resistivity Span adjustment value is set at Data item 0044H, the following error codes will be returned.
Shinko protocol: Error code 34H
MODBUS protocol: Exception code 11H

7.4.2 Temperature Calibration

Temperature calibration is performed by setting the temperature calibration value.

The following outlines the procedure for Temperature calibration.

① Set Data item 0040H (Temperature calibration mode) to 0001H.
The unit will move to Temperature calibration mode.
② Set the temperature calibration value at Data item 0041H (Temperature calibration value).
③ If 2^{13}, 2^{12} digits are read at Data item 0091H (Status flag 2), 01 (During temperature calibration) will be returned.
④ Set Data item 0040H (Temperature calibration mode) to 0000H.
The Temperature calibration is complete, and the unit will revert to Resistivity/Temperature Display Mode.

During temperature calibration, if temperature calibration cannot be performed due to reasons such as input error, calibration value error, and if 2^5 to 2^8 digits are read at Data item 0081H (Status flag 1), Error code 1 (Burnout, Short-circuited, Exceeding 110.0℃, Less than 0.0℃) will be returned.
To cancel the error code, set Data item 0040H (Temperature calibration mode) to 0000H.
The unit will revert to Resistivity/Temperature Display Mode.

In Resistivity/Temperature Display Mode, if Temperature calibration value is set at Data item 0041H (Temperature calibration value), the following error codes will be returned.
Shinko protocol: Error code 34H
MODBUS protocol: Exception code 11H

7.4.3 Transmission Output 1 Adjustment

Fine adjustment of Transmission output 1 is performed.
This instrument 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 0126H (Transmission output 1 adjustment mode) to 0001H.
The unit moves to Transmission output 1 Zero adjustment mode.
If 2^5, 2^4 digits are read at Data item 0091H (Status flag 2), 01 (During Transmission output 1 Zero adjustment in Transmission output 1 adjustment mode) will be returned.

② Set the Transmission output 1 Zero adjustment value at Data item 0127H (Transmission output 1 Zero adjustment value), while viewing the value indicated on the connected equipment (recorders, etc.).
Setting range: ±5.00% of Transmission output 1 span

③ Set Data item 0126H (Transmission output 1 adjustment mode) to 0002H.
The unit moves to Transmission output 1 Span adjustment mode.
If 2^5, 2^4 digits are read at Data item 0091H (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 0128H (Transmission output 1 Span adjustment value), while viewing the value indicated on the connected equipment (recorders, etc.).
Setting range: ±5.00% of Transmission output 1 span

⑤ Repeat steps ① to ④ if necessary.

⑥ To finish Transmission output 1 adjustment, set Data item 0126H (Transmission output 1 adjustment mode) to 0000H.
The unit reverts to Resistivity/Temperature Display Mode.

7.4.4 Transmission Output 2 Adjustment

Fine adjustment of Transmission output 2 is performed.
This instrument 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 014AH (Transmission output 2 adjustment mode) to 0001H.
The unit moves to Transmission output 2 Zero adjustment mode.
If 2^7, 2^6 digits are read at Data item 0091H (Status flag 2), 01 (During Transmission output 2 Zero adjustment in Transmission output 2 adjustment mode) will be returned.

② Set the Transmission output 2 Zero adjustment value at Data item 014BH (Transmission output 2 Zero adjustment value), while viewing the value indicated on the connected equipment (recorders, etc.).
Setting range: ±5.00% of Transmission output 2 span

③ Set Data item 014AH (Transmission output 2 adjustment mode) to 0002H.
The unit moves to Transmission output 2 Span adjustment mode.
If 2^7, 2^6 digits are read at Data item 0091H (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 014CH (Transmission output 2 Span adjustment value), while viewing the value indicated on the connected equipment (recorders, etc.).
Setting range: ±5.00% of Transmission output 2 span

⑤ Repeat steps ① to ④ if necessary.

⑥ To finish Transmission output 2 adjustment, set Data item 014AH (Transmission output 2 adjustment mode) to 0000H.
The unit reverts to Resistivity/Temperature Display Mode.

7.5 Notes on Programming Monitoring Software

7.5.1 How to Speed up the Scan Time

When monitoring multiple units of AER-102-SE, set the program so that the requisite minimum pieces of data such as Data item 0080H (Resistivity), Data item 0090H (Temperature), Data item 0081H (Status flag 1), Data item 0091H (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.

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

If any set value is changed by keypad operation, AER-102-SE will set [0081H (Status flag 1) 2^{15}: 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 [0081H (Status flag 1) 2^{15}: Change in key operation] has been set to 1 (Yes), then read all set values.

② Clear [0081H (Status flag 1) 2^{15}: Change in key operation], by setting Data item 007FH (Key operation change flag clearing) to 0001H (Clear change flag).

If 007FH (Key operation change flag clearing) is set to 0001H (Clear change flag) during setting mode of the instrument, Error code 5 (35H, Shinko protocol) or Exception Code 18 (12H, MODBUS protocol) will be returned as a negative acknowledgement. And [0081H (Status flag 1) 2^{15}: 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 [0081H (Status flag 1) 2^{15}: 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 the 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 (Resistivity), 0090H (Temperature), 0081H (Status flag 1), 0091H (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.

7.5.3 Note when Sending All Set Values Simultaneously

• When EVT type is changed at Data items 0005H (EVT1 type), 0050H (EVT2 type), 0051H (EVT3 type) or 0052H (EVT4 type), the EVT1, EVT2, EVT3 or EVT4 value will default to 0 (zero).
The EVT1, EVT2, EVT3 or EVT4 output status will also be initialized.

First, send the EVT1, EVT2, EVT3, EVT4 type, then send the EVT1, EVT2, EVT3, EVT4 value set at Data items 0006H (EVT1 value), 0053H (EVT2 value), 0054H (EVT3 value) and 0055H (EVT4 value).

8. Specifications

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

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.	Check the communication speed of the slave and master.
	The data bit, parity and stop bit of the master do not correspond to those of the slave.	Check the data bit, parity and stop bit of 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 command.
	The instrument numbers (addresses) are duplicated in multiple slaves.	Check the instrument numbers (addresses) of the slave.
	Make sure that the program is appropriate for the transmission timing.	Check the program.
Although communication is occurring, the response is a negative acknowledge-ment.	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-SE cannot be set during calibration mode. Refer to Sections '7.4.1 Resistivity Calibration Span Adjustment' and '7.4.2 Temperature Calibration'. (p.22)	Check the slave status.
	The AER-102- SE is in front keypad operation setting mode.	Return the unit to Resistivity/ Temperature Display Mode.

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

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