RIKEN KEIKI

PT2E-3640

SD-3 Series

RS-485 (Modbus-RTU)

Communication Function Operating Manual

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Introduction

- Introduction

  Thank you for purchasing the SD-3 Series.

  Communication Function Operating Manual is a guide to using the SD-3 Series communication functions.
  We recommend that both first-time users and those with previous experience with the product carefully read this manual to confirm their understanding of specific information and to refresh their familiarity with the product.

  Note that the SD-3 Series communication functions are part of the communication equipment that makes up a network system in the field. Be sure to also read the operating manuals for the associated equipment.

- Disclaimer

  RIKEN KEIKI rejects all liability for the consequences of the use of device software that communicates with the product.

- Notations

  Notations used for numbers
  Base 10: Numbers only (e.g., 1, 100, 1,000)
  Base 16: Numbers prefixed with “0x” (e.g., 0x00, 0x64, 0x3EB)

Contents

1. Basic Information

This section describes basic information for using SD-3 Series RS-485 (Modbus-RTU) communication functions.

- Address setting
  The SD-3 Series Modbus address can be set to between 1 and 128.

- Number of simultaneous connections
  Up to 127 devices can be connected simultaneously (when connected to one upstream master device).

- Transmission mode
  Modbus is available in ASCII mode for ASCII text communication and RTU mode for binary communication. The SD-3 Series supports only RTU mode.

- Supported functions
  The following Modbus function is supported:
  0x03: Read Holding Register

- Exception responses
  The SD-3 Series will return a Modbus exception response in the following cases:

  1) When an unsupported function is specified
  (The only function supported by the SD-3 Series is 0x03.)

  Example data
  Query: 010500000000**** ← Function code = 0x05
  Response: 018500000000**** ← Exception response: Invalid function
  (0x80 or is returned for the received function.)

  2) When a non-existent data field is specified
  (SD-3 Series data fields are 40001 to 40032.)

  Example data
  Query: 010300870001**** ← Data field = 40136
  Response: 018300870001**** ← Exception response: Invalid data field
  (0x80 or is returned for the received function.)

2. Register Map

● SD-3 Series Modbus register map

Address	Item	Description
40001	Status data (See subsequent table for details.) *1	Bits 0 to 1: Magnification (0: same; 1: 1/10; 2: 1/100; 3: 1/1,000) Bits 2 to 3: Units (0: vol%; 1: %LEL; 2: ppm; 3: ppb) Bit 4: Double range measurement information (1: L side; 0: H side and single range) Bit 5: Not used Bit 6: Not used Bit 7: Sensor fault flag Bit 8: 1st alarm flag Bit 9: 2nd alarm flag Bit 10: Not used Bit 11: Full scale over flag Bit 12: Initialization flag Bit 13: INHIBIT flag Bit 14: Alarm test flag Bit 15: Maintenance mode flag
40002	4 to 20 mA output information	800 to 4000 Note: The 4 to 20 mA output will have a fixed value of “800” for negative concentrations. The upper limit is normally F.S. + 1 resolution. During maintenance, the upper limit will be up to F.S. × 1.2. (F.S. equivalent = “4000”).
40003	Concentration data *2, *3	Signed integer The significant figure of the concentration value rounded to the nearest integer. The actual concentration value is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018 (or address 40028).
40004 to 40011	Reserved	
40012	Full scale value	Signed integer The significant figure of the full scale rounded to the nearest integer. The actual full scale is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018.
40013	1st alarm setpoint	Signed integer The significant figure of the first alarm setpoint rounded to the nearest integer. The actual first alarm setpoint is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018 (or address 40028).
40014	2nd alarm setpoint	Signed integer The significant figure of the second alarm setpoint rounded to the nearest integer. The actual second alarm setpoint is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018 (or address 40028).
40015	Reserved	
40016	Alarm/fault new flag	Bit 0 = 1st alarm new flag Bit 1 = 2nd alarm new flag Bit 2 = Fault new flag

Address	Item	Description
40017	Resolution	Signed integer The significant figure of the resolution rounded to the nearest integer. The actual resolution is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018.
40018	Decimal point	0: same; 1: 1/10; 2: 1/100; 3: 1/1,000
40019	Units	0: vol%; 1: %LEL; 2: ppm; 3: ppb
40020	Reserved	
40021 to 40025	Gas name	Gas name = ASCII code, 10 characters
40026	L side full scale value	Signed integer: L side full scale with double range set The significant figure of the L side full scale rounded to the nearest integer. The actual L side full scale is obtained by multiplying this value by bits 0 to 1 of address 40028 (magnification).
40027	L side resolution	Signed integer: L side resolution with double range set The significant figure of the L side resolution rounded to the nearest integer. The actual L side resolution is obtained by multiplying this value by bits 0 to 1 of address 40028 (magnification).
40028	L side decimal point position	L side decimal point position with double range set 0: same; 1: 1/10; 2: 1/100; 3: 1/1,000
40029	L side units	L side units with double range set 0: vol%; 1: %LEL; 2: ppm; 3: ppb
40030	Reserved	
40031	Changeover range H side concentration	Signed integer: H side changeover concentration with double range set The significant figure of the H side changeover concentration rounded to the nearest integer. The actual H side changeover concentration is obtained by multiplying this value by bits 0 to 1 of address 40001 (magnification) or by the value at address 40018.
40032	AMP type	0: NONE, 1: NC, 2: Reserved, 3: IR, 4: SG, 5: SH, 6: EC

*1: In maintenance mode, the alarm flag will not be set even when the concentration value exceeds the alarm setpoint.
However, both the maintenance flag and alarm flag will be set while performing [2-0 GAS TEST] on the main unit in maintenance mode.

*2: During maintenance, the concentration reading may sometimes be negative. Design should take into account the possibility of negative values (complement representation of 2) for alarm processing based on concentration data.

*3: The value is converted to an integer with its significant digits retained.
Example:
① With full scale 25.0, concentration value 20.9 → 209
② With full scale 50.0, concentration value 0.2 → 2
③ With full scale 5.00, concentration value 0.20 → 20

● Status data operation table (address 40001)

Status	15	14	13	12	11	10	9	8	7	6	5	4	3, 2	1, 0
	Maintenance	Test	Inhibit	Initialization	RANGE OVER	Not used	2nd alarm	1st alarm	Abnormal: Sensor	Not used	Not used	Double range information	Concentration units code	Decimal point code
Normal: Measurement	○	○	○	○	○	○	○	○	○	○	○	○	-	-
Alarm: 1st	○	○	○	○	○	○	○	●	○	○	○	○	-	-
Alarm: 2nd	○	○	○	○	○	○	●	*	○	○	○	○	-	-
F.S. exceeded	○	○	○	○	●	○	-	-	○	○	○	○	-	-
Preset time after power on (or restart)	○	○	○	●	○	○	○	○	○	○	○	○	-	-
Maintenance	●	○	○	○	-	○	-	-	○	○	○	○	-	-
Alarm test	●	●	○	○	-	○	-	-	○	○	○	○	-	-
Abnormal: Sensor	○	○	○	○	○	○	○	○	●	○	○	○	-	-
Double range L side measurement	○	○	○	○	○	○	○	○	○	○	○	●	-	-
Inhibit	●	○	●	○	○	○	○	○	○	○	○	○	-	-

●: Bit on ○: Bit off -: Undetermined

* ● for H-HH/L-LL alarm pattern; ○ for L-H alarm pattern

3. Communication Specifications

● SD-3 Series communication specifications

Item	Specifications
Electrical specifications	Complies with EIA RS-485 standard.
Communication method	2-wire half-duplex
Synchronization method	Asynchronous
Connection form	1:N
Maximum number of connected devices	127 devices (with one upstream device connected)
Protocol	Modbus-RTU Supported functions: 03 Read Holding Register
Communication speed	19,200 bps/38,400 bps*
Data length	8 bits
Parity	None/odd/even*
Stop bit	1 bit*/2 bits
Error checking	CRC-16

* indicates the default value.

NOTE

The maximum transmission distance is 1.2 km.

● Modbus protocol communication specifications

The Modbus communication method allows communication with multiple slave devices using master/slave communication.
A communication start message is sent from the master, and the slave returns a reply message in response.

Modbus-RTU mode message frame

Address	Function	Data	Error checking
8 bits (0 to 128)	8 bits	N*8 bits (depending on function)	16 bits (CRC-16)

Address
Sets the recipient (slave) address.

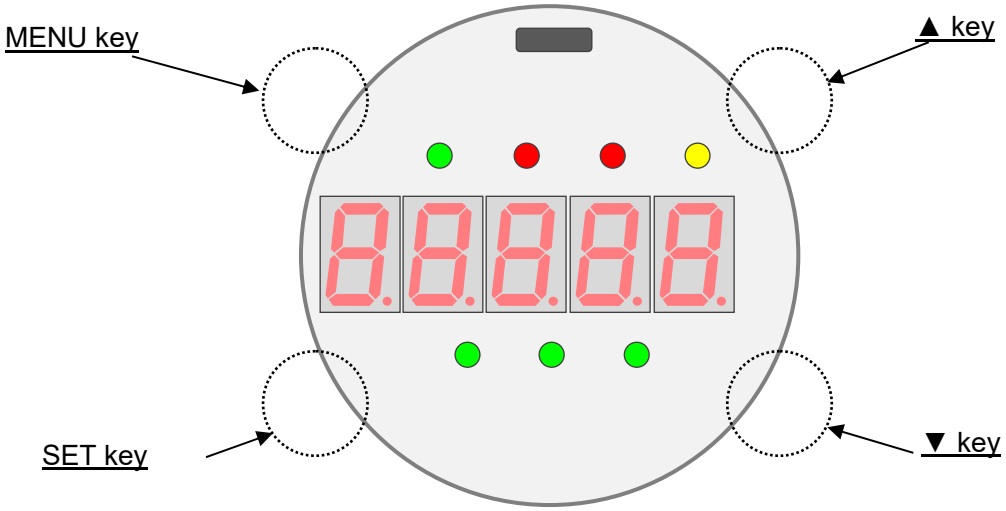
Function
Sets the function code to be executed.

Error checking (CRC-16)
CRC-16 is a 16-bit binary value calculated by the transmitting side and appended to the message. The receiving side must verify that the error check value appended to the received message matches the value calculated from the received message. If they do not match, the received message is considered to be in error.

CRC-16 calculation method
- Perform an XOR operation on the register initialized with FFFF (Hex) and the message byte data.
- Shift the result by 1 bit to the right (right 1-bit shift).
- If the least significant digit is 1, perform an XOR operation on the register and A001 (Hex).
- Repeat this process eight times (for 8 bits).
- The register value after performing this calculation on the message byte data is the CRC value.

4. Appendix

● Address setting method



Setting procedure

① Press and hold the MENU key to switch to maintenance mode.
(The display changes to [1-0].)

② Press the ▲ or ▼ key to display [1-3], then press the SET key.
(The display changes to [-----].)

③ Press and hold the SET key again.
(The display changes to [2-0].)

④ Press the ▲ or ▼ key to display [2-7], then press the SET key.
(The display changes to [2-7.0].)

⑤ Press the SET key.
(The display changes to [2-7.0.0].)

⑥ Press the SET key.
(The display changes to [0].)

⑦ Press the ▲ or ▼ key to set the address, then press the SET key.
(The display changes to [2-7.00].)

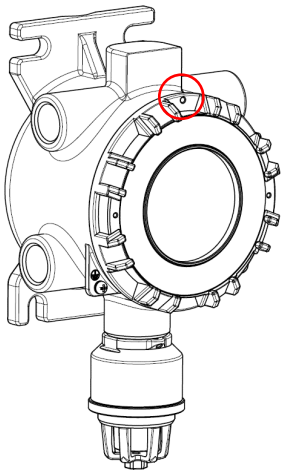
⑧ Press the MENU key to return to [2-7].

⑨ Press and hold the MENU key to exit maintenance mode.

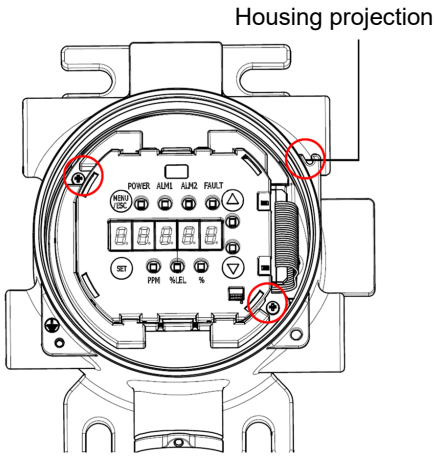
● Wiring method and terminating resistor setting method

1 Unscrew the single M4 hex socket set screw on the main unit cover, then rotate the cover counterclockwise to remove.

Use a hex key wrench (2 across flats) to unscrew the M4 hex socket set screw.
Be careful to avoid dropping the cover while unscrewing and removing it.

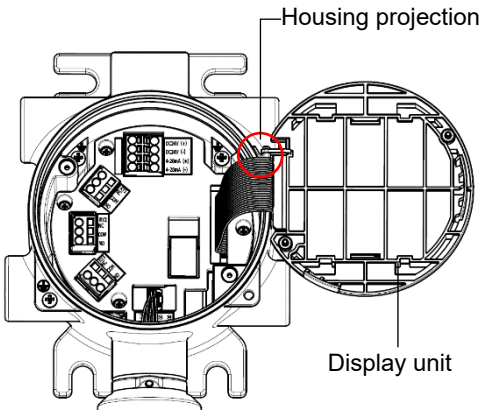


2 Unscrew the two M3 screws securing the display unit.



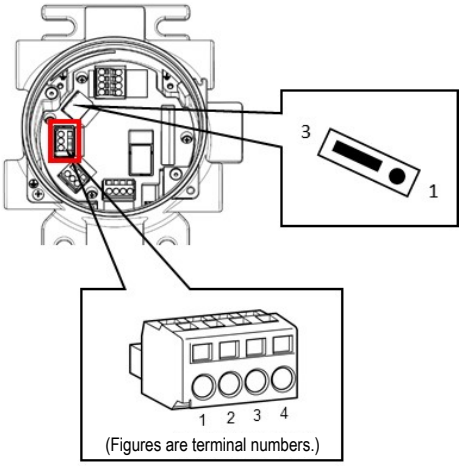
3 Take out the display unit and hook onto the housing projection.

The display unit is connected to the terminal plate unit by a flat cable. Pulling with excessive force may disconnect the cable.
During the removal process, avoid pulling on the display unit with excessive force.



4 Pull out the terminal plate (TN2 (RS-485)) from the terminal plate board.

5 Set the terminating resistor to ON only for the device connected at the furthest position on the bus. Do not set the terminating resistors to ON for any other devices.



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Terminal No.	Terminating resistor
1-2 (standard)	OFF
3-2	ON (120 Ω)

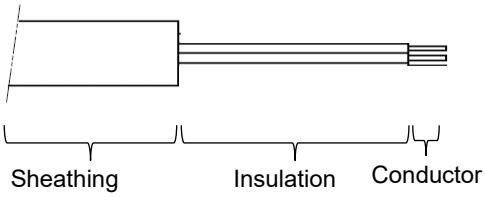
6 Connect the RS-485 communication wires to the corresponding terminals on the detached terminal plates.

TN2 (RS-485)

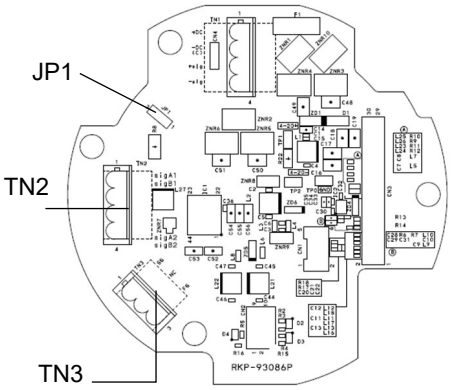
Terminal No.	Cable connection
1	RS-485 (A1)
2	RS-485 (B1)
3	RS-485 (A2)
4	RS-485 (B2)

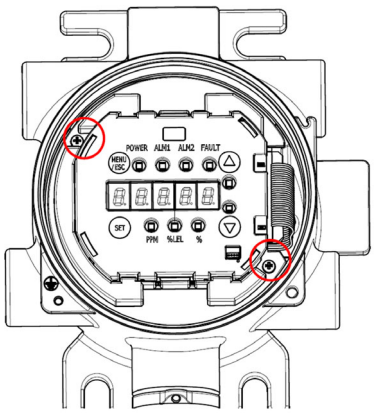
TN3 (Reconsider the connection if communication is unstable.)

Terminal No.	Cable connection
1	Signal ground
2	N.C.
3	Frame ground



Recommended insulation length: 120 to 130 mm

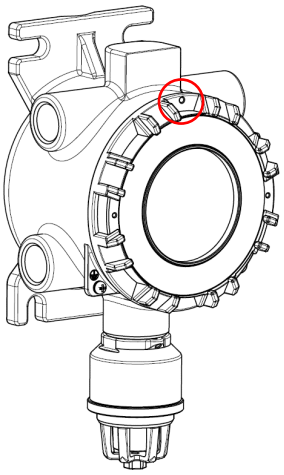




6 Attach the terminal plate (TN2 (RS-485)) to the terminal plate PCB.
Adjust the cable position so that no load is applied to the terminal plates.

7 Return the display unit to its original position and secure with the two M3 screws.
Take care not to trap the cable here.

8 Rotate the cover clockwise to attach, and secure with the single M4 hex socket set screw.
Use a hex key wrench (2 across flats) to tighten the M4 hex socket set screw.
Take care not to trap the cable when attaching the cover. Rotate the cover clockwise until it moves no further to securely fasten in place.

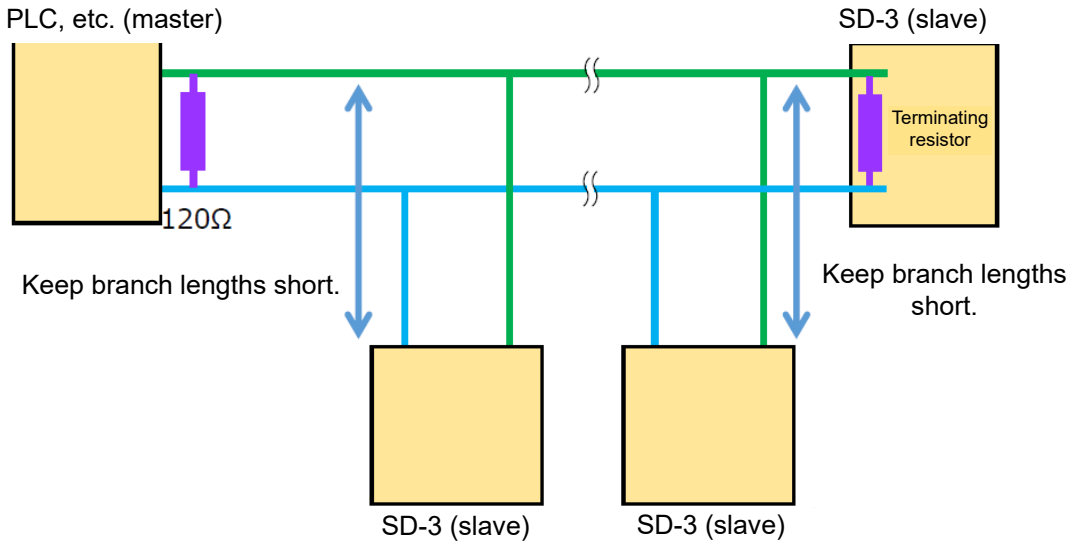


* The diagram illustrates the SD-3. The SD-3SC is connected in the same way.

NOTE

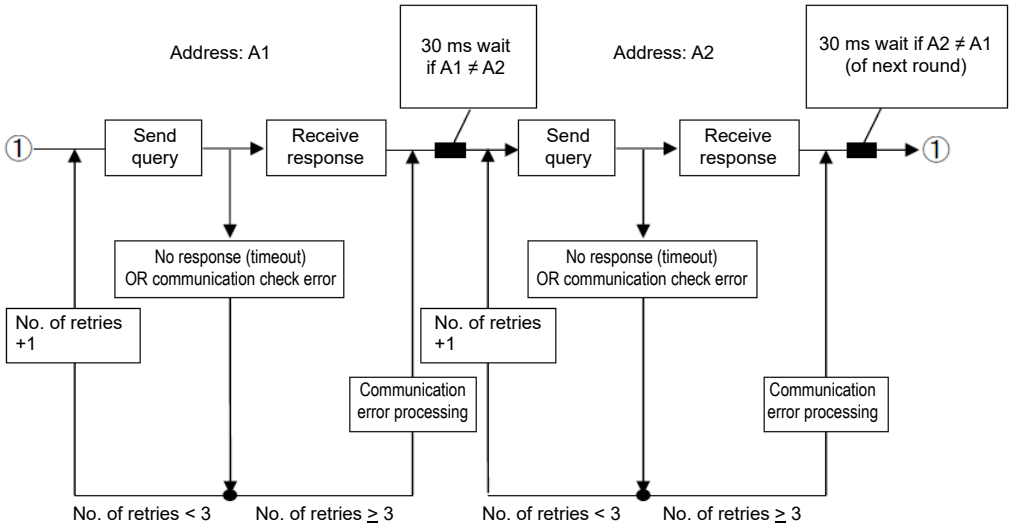
When branching the RS-485 communication wiring, keep the branches short.

Long branches may lead to communication failure.



● Example communication procedure

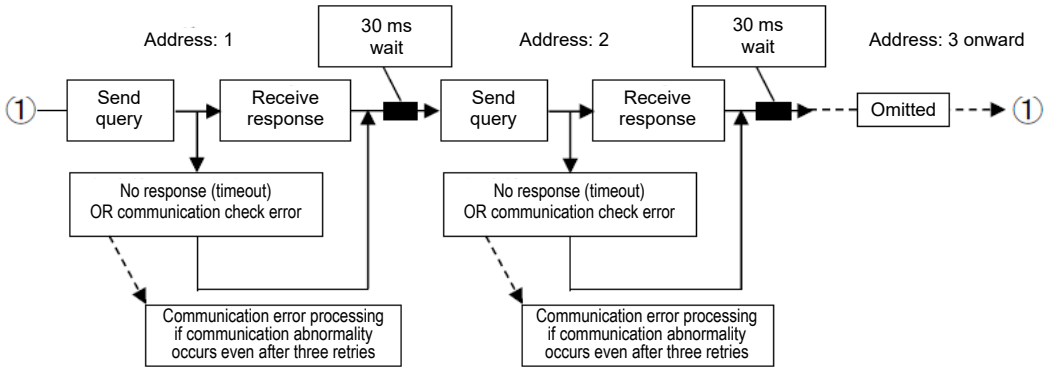
Example control station (e.g., PLC) communication procedure



• Normal processing
The control station sends a query to the product and waits for a response.
On receiving a response from the product, it performs receive processing, then performs send processing of the next query.
Once communication is completed for one device, it proceeds in sequence to perform send and receive processing to the subsequent addresses.
A 30 ms wait is inserted before sending a query to the next address.

• Abnormal processing
If the product does not respond (no response) and a communication timeout occurs or if there is a reception error for the response, the query is resent (retry).
These errors are handled by performing retry processing up to three times. If a valid response is not received even after retry processing, communication error processing is performed.

If communication errors persist even after continuous retry processing, wait (by adding more wait time, such as increasing from 30 ms to 50 ms) while performing communication for other addresses before resending the query. This may resolve the issue.



Revision history

Issue	Revision details	Issue date
0	First issue	Mar 3, 2025