PS-7-M Communication Specifications Guide

Keep this guide for easy reference.
Carefully read this guide prior to use or maintenance for safe operation.

Instruction Manual No.
GAE-159-01
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Revision History

Revision	Document No.	Date	Contents of change
00	GAE-159-00	June 2020	Initial issue.
01	GAE-159-01	April 2024	6.5 Register Address Map

Table of Contents

1 Introduction

Thank you for purchasing the New Cosmos PS-7-M series extractive pump gas detector (hereinafter “detector” or “product”).

This detector consists of a main unit and a base unit. A main unit includes a display, a pump and a sensor, while a base unit has external communication terminals to connect to external devices.

This product supports RS-485 and Ethernet communications.

1.1 Related Publications

The following documents have been prepared to guide your installation and use of this product.

1. PS-7-M series gas detector's instruction manual (Doc.No.GAE-138-xx)

This manual provides the following information to ensure safe use of the product.

- Safety precautions
- Installation and wiring
- Basic configuration, block diagram, unit dimensions and components
- Operation and mode setting
- Maintenance, parts replacement, and action to take in the event of a failure

One manual is provided per system, not per unit.

2. PS-7 gas detector's operation manual for administrators (Doc.No.GAE-019-xx)

This manual is intended for your system administrators/supervisors.

- Password
- Changing settings

All the items set for this product (e.g. alarm set values) are password-protected.

One manual is provided per system, not per unit.

3. PS-7 pyrolyzer's operation manual (Doc.No.GAE-020-xx)

This manual describes installation and replacement procedure for a pyrolyzer (sold separately).

A manual is provided per system if the unit includes a sensor unit with pyrolyzer.

4. PS-7-M communication specifications guide (Doc.No.GAE-159-xx)

This guide provides the communication specifications and procedure to establish communication with external devices.

One guide is provided per system, not per unit.

5. PS-7-M IP address setting guide

This guide describes how to set/change the IP address by using a web browser to establish communication with external devices.

One guide is provided per system, not per unit.

1.2 Overview

This product uses the Modbus RTU (RS-485) and Modbus TCP (Ethernet) communication protocols. This guide describes the Modbus interface communication specifications for exterior communication of this product.

This guide is intended for administrators/supervisors who perform device setups and data collection from the Modbus master, by connecting the master and the PS-7-M series gas detectors (Modbus slaves) and using the Modbus protocol function codes and their functions.

For the basic operation of the product, refer to the PS-7-M series gas detector's instruction manual.

This guide describes the communication specifications and connection method for using the product's Modbus communication functions. For the operation and handling of the external Modbus devices that send/receive data to/from this product, refer to each device's instruction manual.

1.3 Trademark Registration

Modbus® is a registered trademark of Modicon Inc. (AEG Schneider Automation International S.A.S).
Their company name and product name are also their trademarks and are used in this guide with no TM or "®" symbol.

1.4 Remarks

Prior to use, carefully read this guide for correct use.
Unauthorized copying and replication of the contents of this guide, in whole or in part, are strictly prohibited.
The contents of this guide are subject to change without notice.
This guide has been prepared with the utmost care. If any incorrect description comes to your notice, please contact us for correction.

1.5 Symbols Used in this Instruction Manual

Operators' safety has been put first in designing this product. However, there exist some unavoidable risks due to the system characteristics. In this guide, safety symbols are divided into three categories, Danger, Warning and Caution, depending on the severity and magnitude of the risks. Carefully read the contents related to the precautions before starting operation or maintenance work.

This guide uses DANGER, WARNING, CAUTION and NOTE symbols to draw attention to procedures, materials, methods and processes that require particular attention.

DANGER

Indicates an imminently hazardous situation that can result in death or serious injury.

WARNING

Indicates a potentially hazardous situation that may result in death or serious injury.

CAUTION

Indicates a hazardous situation that may result in minor injury or property damage.

NOTE Provides supplemental or useful information on product handling.

2 Precautions

Carefully read the following precautions for correct use.
Use this product in accordance with the applicable laws and regulations.
Wiring and installation should only be performed by a qualified electrician with knowledge of wiring/installation procedures in accordance with the applicable technical standards.

DANGER

- This product is not explosion-proof and should not be installed in a hazardous area.

WARNING

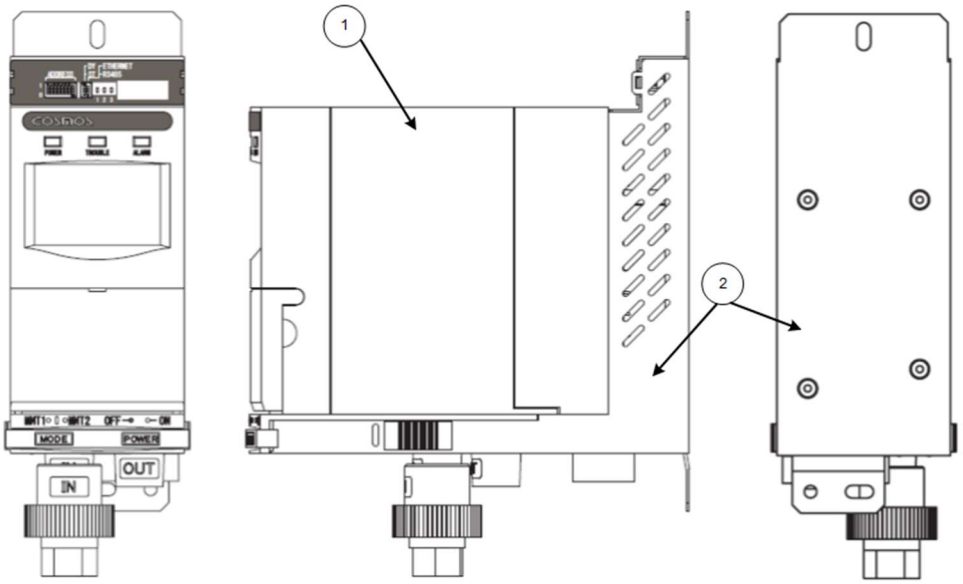
- Ground the product to prevent electric shocks.
- In the event of a gas leak alarm, follow safety procedures in accordance with your company's regulations.

CAUTION

- Do not disassemble, modify, or alter the structure of the product or its electrical circuits; doing so may compromise product performance.
- This product is not drip-proof and should be kept away from splashing water or rain.

3 Unit Structure

The PS-7-M gas detector consists of a main unit and a base unit.
For the details on the main and base units and other parts of the detector, refer to the PS-7-M series gas detector's instruction manual.



Item	Component	Description/Function
1	Main unit	Includes a display, a pump and a sensor.
2	Base unit	Used for wiring and tubing. Includes two terminal blocks for exterior communication.

4 Communication Specifications

This chapter describes the communication specifications for this product.
Single-master-multiple-slave (SMMS) communication method is used for a system configuration in which Modbus slaves (PS-7-M series gas detectors) can send/receive data to/from the Modbus master.
It is assumed that the Modbus master (high-order device) is a personal computer, a programmable logic controller (PLC), or a fieldbus controller in case of Modbus TCP.

4.1 Modbus RTU (RS-485) Communication Specifications

Modbus RTU (RS-485) communication specifications

Item	Specifications
Communication protocol	Modbus
Communication specifications	RS-485 interface
Communication method	Two-wire half-duplex asynchronous
System configuration	Single-Master-Multiple-Slave (SMMS) Multi-drop
Data format	Modbus RTU mode (hexadecimal number (hex code)) Start bit: 1 bit Data length: 8 bits (fixed) (LSB first) Stop bit: 1 bit (fixed) Parity bit: No parity (fixed)
Communication speed	Fixed at 9600 bps
Physical layer protocol	ANSI/EIA/TIA RS-485
Number of connected devices	Up to 32 units including master
Maximum transmission distance	1.2km when the communication speed is 9600 bps
Terminal resistance	120 Ohm Can be set to on/off with switch
Error checking method	CRC-16

4.2 Modbus TCP (Ethernet) Communication Specifications

Modbus TCP (Ethernet) communication specifications.

Item	Specifications
Communication protocol	Modbus (TCP/IP)
Communication specifications	Ethernet
Communication interface	RJ-45 Ethernet IEEE 802.3af/ANSI X3.263
System configuration	Single-Master-Multiple-Slave (SMMS)
Port No.	No.502 (fixed: Modbus)
Communication speed	Max. 10 Mbps/100 Mbps
Physical layer protocol	100BASE-TX
Number of connected devices	Up to 254 units
Maximum transmission distance	100 m (distance up to the switching hub)
Applicable cable	Unshielded Twisted Pair (UTP) cable (Category: 5e or higher)
IP address	192.168.100.1 (by default when shipped out) Can be changed from the base unit or web browser.

5 Connection Specifications

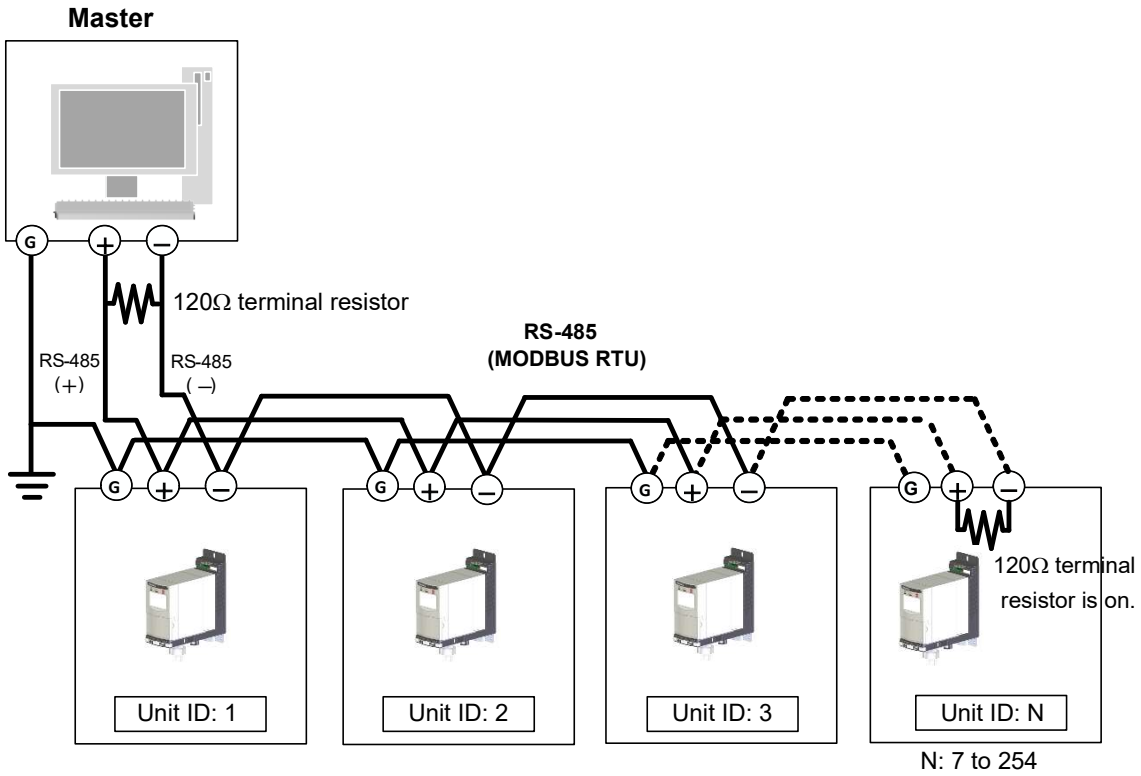
This chapter describes the connection specifications for this product.

5.1 System Configuration

Typical communication system configurations are given below as examples.

(1) Typical Modbus RTU (RS-485) configuration

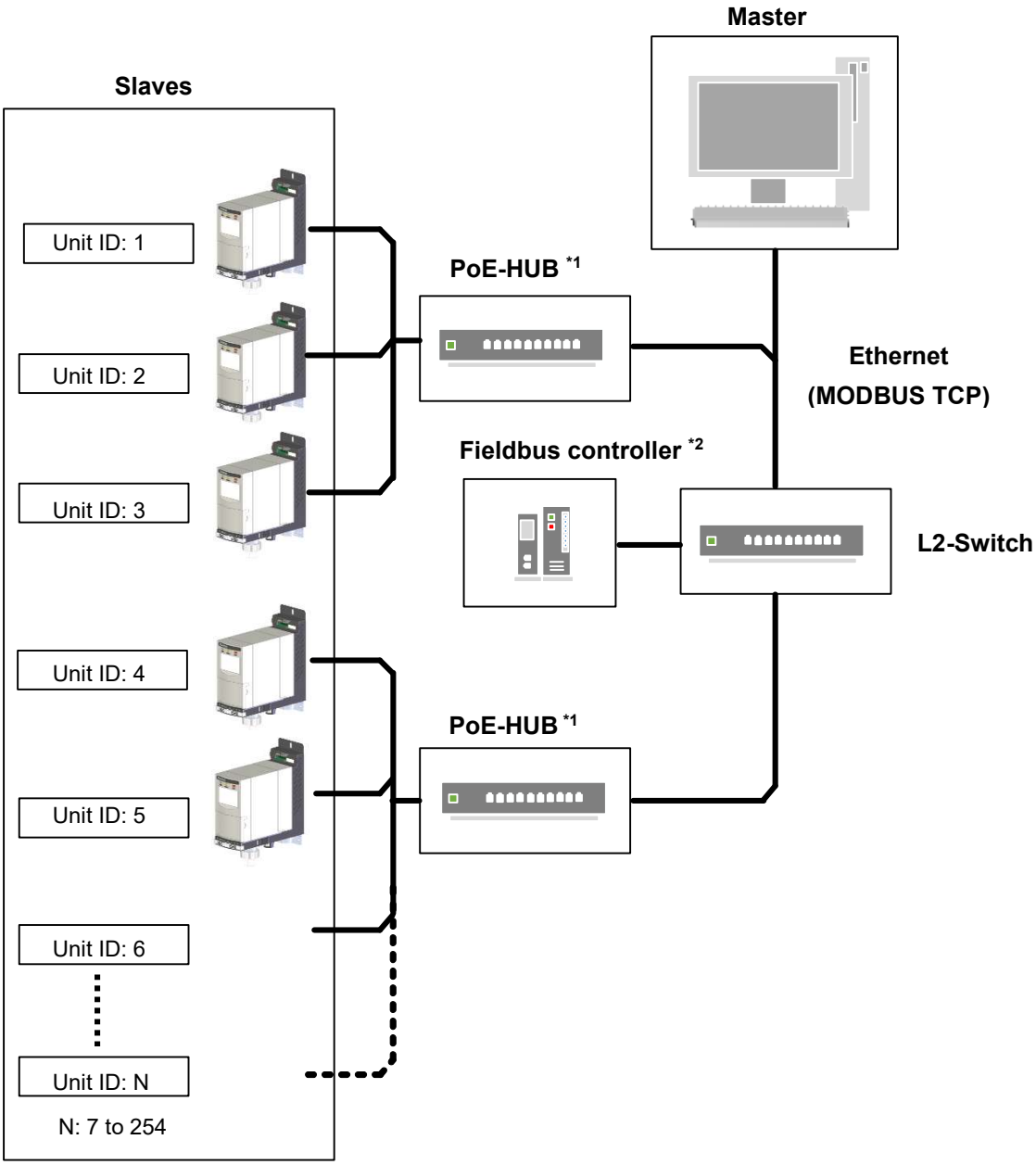
Wire multiple slaves in series (multi-drop wiring).



Use a 120 Ohm terminal resistor at each end of the communication line.

There is a terminal resistor switch on the base unit. Set the switch to the ON position when the terminal resistors are used at both ends of the line (one resistor at each end).

(2) Typical Modbus TCP (Ethernet) configuration



NOTE

*1. If the switching hub is not PoE-compliant, provide 24 VDC to PS-7-M units.
*2. In case of using a fieldbus controller as a Modbus TCP master.

5.2 Wiring Procedure

This section explains how to establish a Modbus (RS-485 or Ethernet) network.
For detailed wiring procedure, refer to the PS-7-M series gas detector's instruction manual.

⚠ WARNING

Turn off the gas detector before wiring to prevent electric shocks.

⚠ CAUTION

- For precautions to be taken while wiring other than the Modbus terminals wiring, refer to 6. "Installation and Wiring" of the PS-7-M series gas detector's instruction manual.
- Before powering on the unit, ensure the wiring is correct by referring to 6-1. "Wiring Procedure" of the PS-7-M series gas detector's instruction manual and the delivery specifications if any.
- The analog output line and power line of the gas detector are not isolated from each other. When using with external devices, provide isolation to prevent noise from other power lines from interfering with the analog output of the detector.
- When wiring, place wires to avoid potential noise sources (e.g. large power transformers, motors, and powers supply units).
- Keep the connection cables (power and signal lines from the detector) away from other power lines.
- When wiring, place wires to avoid mechanical stress on the wiring.

5.2.1 Modbus RTU (RS-485) Wiring Procedure

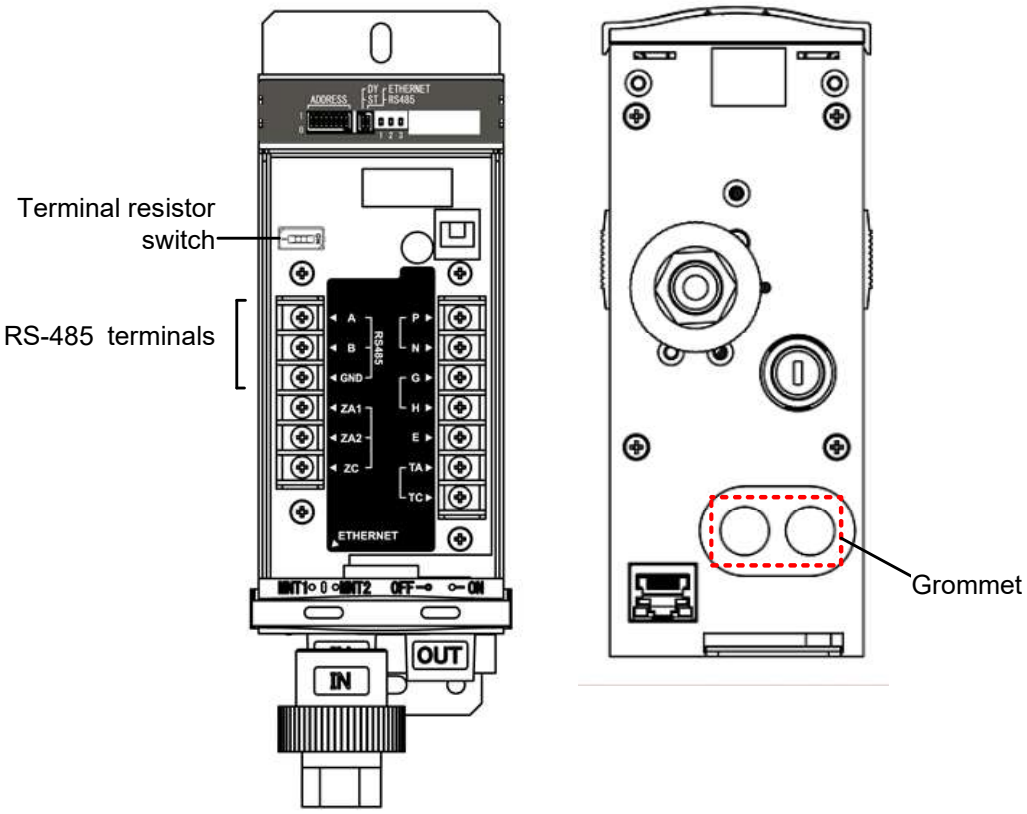
Establish the Modbus RTU (RS-485) communication by taking the following steps.

⚠ WARNING

When using the 24 VDC power supply, ensure that the power supply is 24 VDC ±10%.

⚠ CAUTION

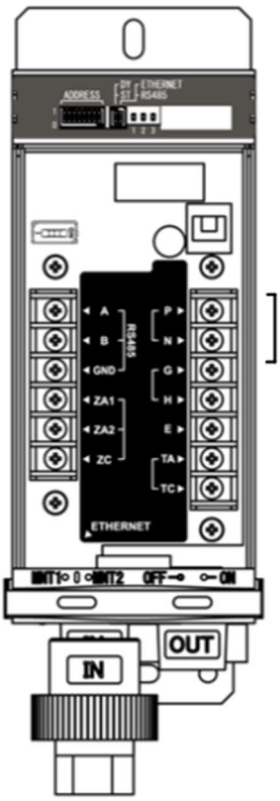
Applicable cables: Dia.8–11mm x 2pcs. Use appropriate cables for the installation environment.



1) Run a RS-485 digital signal cable thru the grommet (located at the bottom of the base unit), and connect the cable wires to their corresponding RS-485 terminals.

Component	Marking on board	Function	Recommended cable
RS-485 terminals	A	RS-485 (+) IN/OUT	2-core shielded twisted pair cable
	B	RS-485 (−) IN/OUT	
	GND	Shielded	

2) Run a power cable thru the grommet (located at the bottom of the base unit), and connect the cable wires to their corresponding power terminals



Power terminals

Component	Marking on board	Function	Recommended cable
Power terminals (Thread size: M3)	P	Polarity: ＋ Power input (24 VDC)	2-core CVV cable
	N	Polarity: － Power input (24 VDC)	

NOTE

- Single-point grounding (grounding at a single point) is mandatory. When the cable shield from the gas detector is grounded on the power supply side, DO NOT ground the shielded cable to the Earth terminal located inside the gas detector (on the terminal block for power cable) to avoid 2-point grounding.
- If used in a place exposed to electrical noises, use a shielded twisted pair (STP) cable. When using STP cable, provide signal grounding so that all the connected devices are ground-looped (ground continuity) to avoid noise interference due to ground discontinuity.
- Set the terminal resistor switch (located on the base unit) to the ON position when terminal resistors are used at both ends of the circuit.

3) Perform the communication setup (select the “RS485” mode and set the unit ID with the DIP switches (mode change switch and address setting switches). Refer to pages 19 and 20 for the procedure).

4) Set the base unit power switch to the ON position.

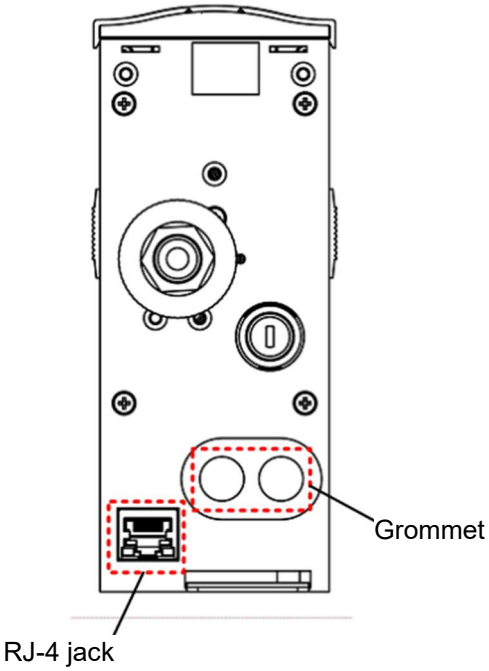
5.2.2 Modbus TCP (Ethernet) Wiring Procedure

Establish the Modbus TCP (Ethernet) communication by taking the following steps.

⚠ WARNING

- When using the 24 VDC power supply, ensure that the power is 24 VDC ±10%.
- When using the PoE power supply, ensure that the LAN cable is securely connected.

Bottom view of base unit



1) Connect the LAN cable to the RJ-45 jack on the bottom of the base unit.

Component	Function	Applicable cables
RJ-45 jack	8P8C Ethernet and PoE ＋Power Device port	100BASE-TX unshielded twisted pair (UTP) cable Category: 5e or greater Cable length: Max.100 m (distance to HUB)

When using a PoE-compliant switching hub (PoE HUB)

Go to step 2).

⚠ CAUTION

Turn off the PoE before disconnecting the LAN cable from the RJ-45 jack.

When using a non-PoE-compliant switching hub (PoE HUB)

24 VDC power supply is required.
Run the power cable thru the grommet and connect the cable wires to their corresponding power terminals (located on the base unit).

NOTE

- Single-point grounding (grounding at a single point) is mandatory. When the cable shield from the gas detector is grounded on the power supply side, DO NOT ground the shielded cable to the Earth terminal located inside the gas detector (on the terminal block for power cable) to avoid 2-point grounding.
- If used in a place exposed to electrical noises, use a shielded twisted pair (STP) cable.

2) Perform the communication setup (select “DY” or “ST”, select the “ETHERNET” mode, and set the 4th value of the IP address with the DIP switches. Refer to pages 19 to 21 for the procedure.)

3) Set the base unit power switch to the ON position.

5.3 Communication Setup

This section explains how to set the Modbus (RS-485 or Ethernet) communication.

⚠ CAUTION

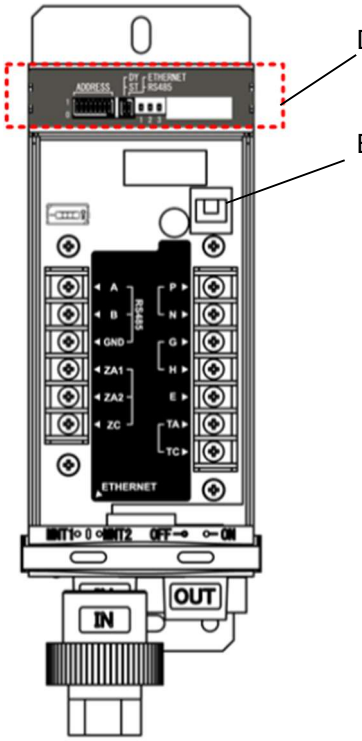
- Set the base unit power switch to the OFF position before using the DIP switches to avoid incorrect operation or device failure.
- When the specifications of the connected Modbus master and those of this product do not match, it may cause incorrect operation (e.g. communication becomes disabled).

5.3.1 DIP Switches

This section explains how to operate the DIP switches.

⚠ CAUTION

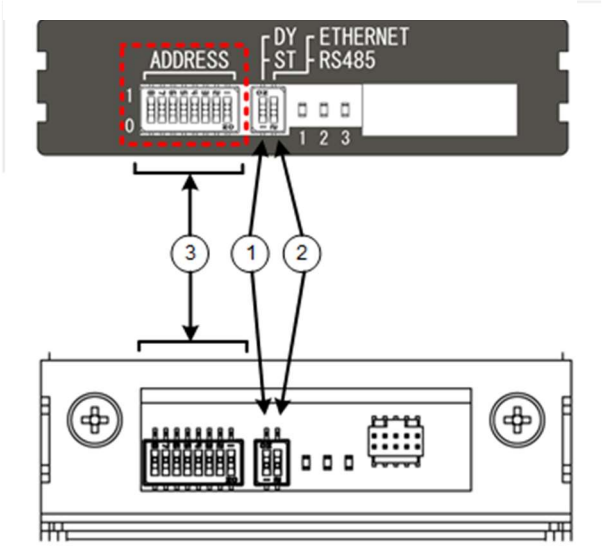
- Set the base unit power switch to the OFF position before using the DIP switches to avoid incorrect operation or device failure.
- Set the DIP switches in accordance with your selected communication method.
- Ensure that each switch is clearly set to the 1/0, DY/ST, and Ethernet/RS485 positions. Unclear setting may result in incorrect operation or communication.



DIP switches are located in the upper part of the base unit

Base unit power switch

Address plate



With address plate removed

DIP Switches

Item	Component	Description/function
1	IP address type switch	Switches the IP address type between “DY” and “ST”. DY: Dynamic IP address (DHCP) ST: Static IP address
2	Mode change switch	Switches the communication mode between “ETHERNET” and “RS485”. ETHERNET: Modbus TCP (Ethernet) RS485: Modbus RTU (RS-485)
3	Address setting switches (8 places)	Sets the address (unit ID) for this product. Settable range: 1 (0000 0001) to 254 (1111 1110). The unit ID set here will also serve as the 4th value of the IP address when Modbus TCP (Ethernet) is selected with the mode change switch.*

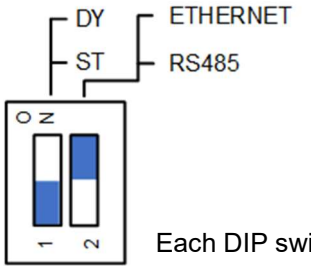
* If the 4th value is set to 0 (0000 0000) with the address setting switches, it will be superseded by the value set by a web browser.

NOTE The DIP switches are accessible when the address plate is removed. To remove the address plate, refer to 7-1. “Operation Procedure” of the PS-7-M series gas detector’s instruction manual.

(1) Set the IP address type: “DY” or “ST”

Select the IP address type between “Dynamic” and “Static” by using the IP address type switch. When “Dynamic” is selected, IP address will be automatically assigned to the detector.

The setting here is active when the “ETHERNET (Modbus TCP)” is selected with the mode change switch.

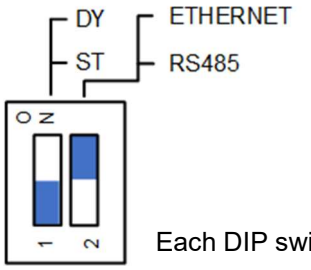


Each DIP switch enters the ON status when it is set to the ON position.

IP address type	DIP switch position (Switch No.1)
DY: Dynamic IP address (DHCP)	ON
ST: Static IP address	OFF (by default when shipped out)

(2) Set the communication mode: “ETHERNET” or “RS485”

Select the Modbus communication mode between “ETHERNET” and “RS485” by using the mode change switch.



Each DIP switch enters the ON status when it is set to the ON position.

Communication mode	DIP switch position (Switch No. 2)
ETHERNET: Modbus TCP	ON (by default when shipped out)
RS485: Modbus RTU (RS-485)	OFF

(3) Set the address (Unit ID)

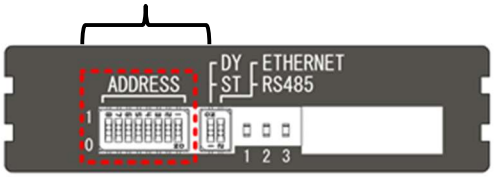
The address set using the address setting switches is the unit ID. In case of Modbus TCP (Ethernet), the unit ID also serves as the 4th value of the IP address.

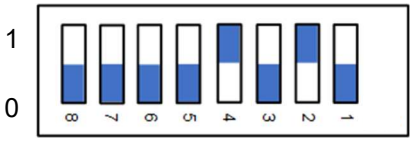
Set the address by taking the following steps.

⚠ CAUTION

- Do not use the address “255 (1111 1111)”, because the communication will be disabled.
- The address can be set to any value within the settable range, but if the same address is used by more than one unit (detector), the relevant units cannot communicate.

Address setting switches (left eight DIP switches)





Set the address by sliding the eight address setting switches to the “1” or “0” positions.
The 8-digit number is an 8-bit binary number representing the address.
The address settable range is 1 (0000 0001) to 254 (1111 1110).

Set value	Description
0 (0000 0000)	Invalid address Modbus RTU (RS-485): Do not use the address “0 (0000 0000)”, because the relevant units cannot communicate. Modbus TCP (Ethernet): If the address is set to “0 (0000 0000)” with the address setting switches, it will be superseded by the value set by a web browser.
1 (0000 0001) to 254 (1111 11110)	Valid address Modbus RTU (RS-485): The address represents the unit ID. Modbus TCP (Ethernet): The address represents the 4th value of the IP address.

NOTE Refer to the PS-7-M IP address setting guide (separate document) for how to change the IP address with a web browser.

A. Modbus RTU (RS-485) communication address setting

When the mode change switch is in the “RS485” position, the address set for Modbus RTU (RS-485) communication will supersede. The set address represents the unit ID.

Set the Unit ID with the address setting switches.

NOTE Up to 32 units, including a master, can be connected on a Modbus RTU (RS-485) network. Set the unit IDs (from 1 to 254) for a maximum of 31 slaves (detectors).

For example, if you want to set the unit ID to “100”, set the address setting switches to the “0110 0100” positions. “0110 0100” is an 8-bit binary number equivalent to “100” in decimal.

B. Modbus TCP (Ethernet) communication address setting

When the mode change switch is in the “ETHERNET” position and the IP address type switch is in the “ST (static IP address)” position, the address set for Modbus TCP (Ethernet) communication will supersede. The set address represents the 4th value of IP address.

Set the 4th value of IP address with the address setting switches.
The default IP address when shipped out is “192.168.100.1”.

For example, if you want to set the IP address of the detector to “192.123.45.**10**”, take the following steps.

(1) Set the first three values of the IP address to “192.123.45” from a web browser.

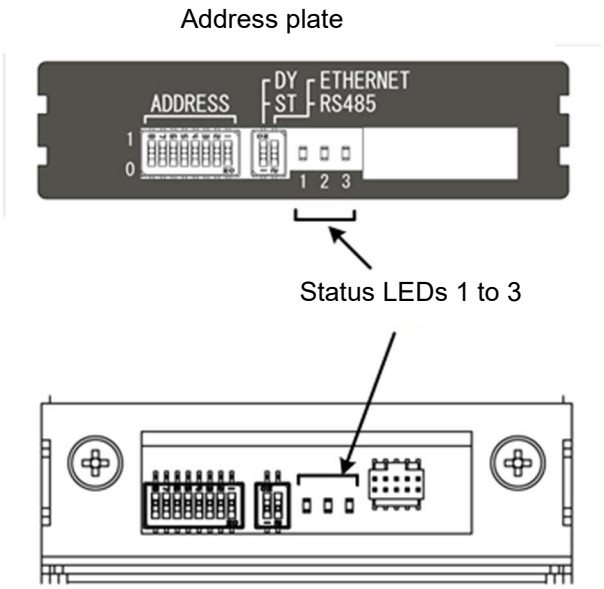
(2) Set the address setting switches to the “0000 1010” positions. The 4th value of the IP address will be set to “**10**”. “0000 1010” is an 8-bit binary number representing “**10**”.

NOTE

- If the address is set to “0 (0000 0000)” with the address setting switches, it will be superseded by the value set by a web browser.
- Refer to the PS-7-M IP address setting guide (separate document) for how to change the IP address with a web browser.

5.3.2 Status LEDs

The status LEDs located on the base unit indicate the LAN cable and communication statuses.



Component	LED No.	Description
Green Status LEDs	1	When lit, a LAN cable is securely connected to the RJ-45 jack and a switching hub
	2	When flashing, Ethernet or RS-485 communication is in progress
	3	Communication status between the base unit and main unit • When flashing, communication is normal (transmitting and receiving are in progress) • When steady, no response from the main unit (no receiving) • When not lit, no request from the base unit (no transmitting)

6 Communication Protocol

This chapter describes the communication protocol.

1. Modbus communication protocol overview
2. Function codes and their functions
3. Response in the event of an error
4. Message examples
5. Register address map

6.1 Modbus Communication Protocol Overview

Modbus communication uses a single-master-multiple-slave configuration.
In Modbus communication, a transaction is always initiated by a master, in which the master sends a request message then a slave returns a response message.

6.1.1 Message Configuration

A Modbus message frame consists of the following four items: unit ID (IP address), function code, data and error check code. They are transmitted in the following sequence.

Item	Message data	Data size
(1) Address	Unit ID (IP address)	1 byte
(2) Function	Function code	1 byte
(3) Data	Data	Variable length of up to125 words (250 bytes)
(4) CRC	Error check code	2 bytes

NOTE Error check code is not included in Modbus TCP (Ethernet) message frame.

(1) Unit ID (IP address)

Only when the slave's unit ID (IP address) and the one specified by the master match, the slave will process the relevant request message. If they do not match, the slave will not respond to the master.

In the Modbus RTU (RS-485) communication, the address set using the address setting switches represents the Unit ID. In the Modbus TCP (Ethernet) communication, the address set using the address setting switches represents the 4th value of the IP address.

NOTE For how to set the address setting switches, refer to (3) "Set the address" of 5.3.1 "DIP Switches".

⚠ CAUTION

- Do not use the address "255 (1111 1111)", because the communication will be disabled.
- The address can be set to any value within the settable range, but if the same address is used by more than one unit (detector), the relevant units cannot communicate.

(2) Function code

The function code tells the slave what kind of action to perform. The slave (this detector) will take action specified by the function code it supports. After the slave performs the specified action normally, it will return a response message including the same function code.

NOTE

- Refer to 6.2 "Function Codes" for the function codes supported by this product.
- A register address to read from/write to will be assigned per function code.
- There are four types of registers: coil, input status, input register, and holding register. The address range to read from/write to differs depending on the register type.
- All Modbus registers where this detector's data items are saved per function code supported by this detector, are holding registers.
- Holding register address range is from 40001 to 49999 on the Modbus protocol. This detector's data (e.g. gas concentrations, device setup details) will be allocated in this range.

(3) Data

This is necessary data for a slave to take action based on the function code. The data configuration differs depending on the function code. It consists of a starting register address, quantity of data, or write data, etc.
Data is variable length of up to 125 words (250 bytes).

NOTE

- Refer to 6.2 “Function Codes” for the function codes supported by this product.
- The maximum data size differs depending on the function code.

(4) Error check code (for Modbus RTU only)

A Modbus RTU (RS-485) message contains an error check code (CRC value) calculated by the CRC-16 method to detect a request/response message error.

The data size of a CRC value is 2 bytes, and they are sent by the byte in the sequence of low-order byte followed by high-order byte.

CRC-16 calculation uses data items from unit ID through the one before the error check code (the end of the Data).
The slave calculates a CRC value based on a received request message, then compares it with the CRC value (error check code) contained in the message. If they do not match, no response is returned and no action taken.

NOTE Refer to 6.1.2 “CRC-16 Calculation” for CRC-16.

6.1.2 CRC-16 Calculation (for Modbus RTU only)

This section describes the CRC-16 calculation method for Modbus RTU (RS-485).

CRC-16 generation method (polynomial: X16＋X15＋X2＋1)

1. Initialize the CRC register (2-byte error check code) to FFFF in hex.
2. XOR the 1st letter (1 byte) of the received data with the lower-order byte of the CRC register and store the XOR-result in the CRC register.
3. Save the LSb (0th bit) value of the CRC register.
4. Right-shift the CRC register by one bit (toward the LSb).
5. If the value saved at step 3 above is “1”, XOR the CRC register with the generator polynomial “A001 (hex)” (1010 0000 0000 0001), then store the result in the CRC register.
6. Repeat the process (steps 3 to 5) 7 times.
7. Repeat the process (steps 2 to 6) on the 2nd letter of the received data or later until the end of the received data (CRC is excluded).
8. The value that remains in the CRC register is the final CRC value.

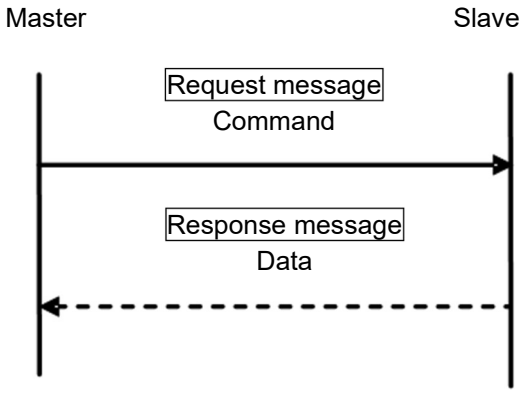
The generated CRC value is compared with the CRC value (error check code) contained in the request message from the master. If they match, the slave will take action according to the request and create a response message. If they do not match, the slave will not take any action or send a response message.
The slave includes the generated CRC value (2-byte error check code) in a response message then sends it by the byte in the sequence of low-order byte followed by high-order byte.

NOTE In the Modbus RTU (RS-485) communication, if no response is returned from the slave (this detector), the master must check that the error check code (CRC value) contained in the request message is correct.

6.1.3 Communication Procedure

This section describes the Modbus communication procedure.

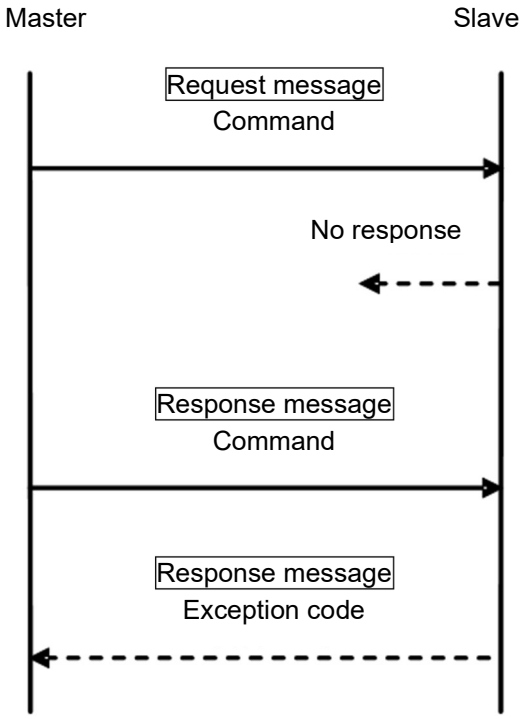
(1) The master sends a request message to the slave (this detector).
(2) The slave checks if the unit ID (4th value of the IP address in case of Modbus TCP) contained in the request message matches its own unit ID ((4th value of the IP address). The master can start Modbus communication individually with individual slaves which exist on the same network by specifying the unit ID (4th value of the IP address in case of Modbus TCP).



(3) If there is a match, the slave takes action according to the contents of the request message and creates a response message. If the slave detects an error, it creates an exception response message including an exception code.

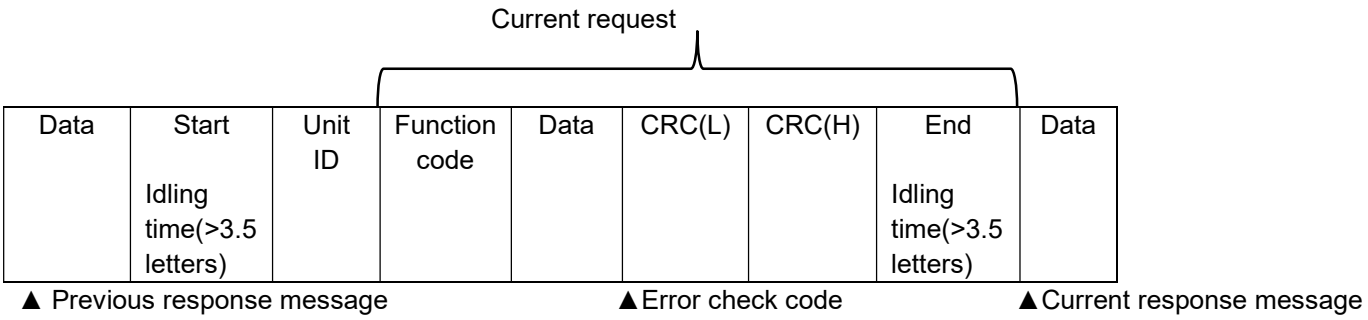
NOTE Refer to 6.4.5 “Exception Response” for the message configuration in the event of an error.

(4) If there is no match, the slave discards the request message, then waits for a next request message (non-response status).
(5) After sending a request message, the master checks if it receives a response from the slave.
If there is no response or exception response message (exception code), the master will perform a communication error process.



6.1.4 Modbus RTU Communication Interval

This section describes the Modbus RTU (RS-485) communication interval.



Provide a non-communication interval (idling time of more than 3.5-letter) between message frames, to identify the end and start of each message.

The slave returns a response message after non-communication interval (idling time of more than 3.5-letter) from its receipt of a request message.

If a space of more than 3.5 letters is detected within a message frame, the slave judges that the message frame ends then discards the message, then judges the next received data to be the start of the request message.

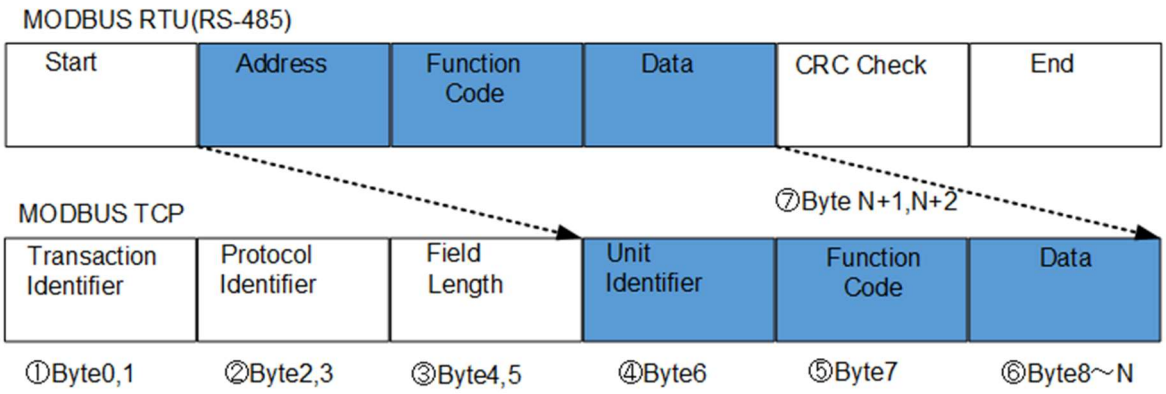
NOTE

Idling time calculation method
For example, when the communication speed is 9600bps and 1 letter is 11-bit long (Modbus RTU communication data),
Interval per letter = 1 /9600 x 11 x 1000 ≈ 1.15 msec.
If converted to 3.5 letters, 1.15 x 3.5 ≈ 4.01 msec.

6.1.5 Differences between Modbus TCP and Modbus RTU Protocols

This section describes the differences between Modbus TCP (Ethernet) and Modbus RTU (RS-485) communication protocols.

① Transaction identifier = TRXN ID (data size: 2 bytes)
In Modbus TCP communication, the exact value set in the request message (arbitrary) will be included in a response message.
② Protocol identifier = Protocol ID (data size: 2 bytes)
Fixed at “0”.
③ Field length (data size: 2 bytes)
Quantity of transferred data from ④ to ⑦
④ Address/Unit identifier (data size: 1 byte)
This is unit ID for Modbus RTU and the 4th value of IP address for Modbus TCP.
⑤ Function code (data size: 1 byte)
Function code supported by this detector.
⑥ Data (data size: variable length)
Message (data) corresponding to the function code.
⑦ Error check code (CRC) (data size: 2 bytes)
CRC value calculated by the CRC-16 method.



NOTE Message configurations from ④ to ⑥ are common between Modbus TCP and Modbus RTU.

6.2 Function Codes

The following table lists the function codes supported by this product.

Function code		Function	Maximum data size (words)	Remarks
Code	Hex			
03	0x03	Read single/multiple holding registers	125	- Holding register address range: 40001-49999 - Gas concentrations, status information, and device setup details including gas/trouble alarm related setups
06	0x06	Write single holding register	125	
16	0x10	Write multiple holding registers	123	
23	0x17	Read and write multiple holding registers	125 (read) 121 (write)	

NOTE

- Register data access unit is 16 bits data length (1 word).
- Function code 23 (0x17) applies to Modbus TCP (Ethernet) only.
- Register address range used by this detector to save its data: 40001 to 41321.

6.3 Response in the Event of an Error

This section describes the response in the event of a Modbus communication error.

If the slave (this detector) judges that there is an error with a request from the master, the slave will create an exception response message and send it to the master without processing the request.

If an exception response message is returned from the slave, the master should be capable of checking its contents.

In the Modbus RTU (RS-485) communication, if a communication error, listed in the table below, occurs, the slave will not return an exception response message and wait for the next request.

Error	Description
Framing error	The stop bit of the received data cannot be detected
Overrun error	In the RS-485 communication, before reading the received data from the received data register, the next one frame of data was received
Parity error	The parity bit of the received data cannot be detected
CRC error	The error check codes (CRC values) do not match

6.3.1 Error Codes (Exception Codes)

The following table lists error codes (exception codes) supported by this detector.

Code	Error name	Cause
0x01	Illegal function code	A received function code is not the one supported by this detector
0x02	Illegal address error	- A received Modbus register address is not the one defined by this detector - Writing was performed to a read-only register
0x03	Illegal data error	Invalid data (data not defined by the detector) was written
0x04	Slave device error	A communication timeout error occurred between the main unit and base unit, including the main unit's power-off
0x06	Slave device busy	The slave received a request, while it is still processing a previous request (slave is in a busy state)
0x07	Negative acknowledge (NACK)	The read/write data size of a request message is 0 or exceeds the maximum limit (125 words)

NOTE

- Refer to 6.2 "Function Codes" for the function codes supported by this product.
- The maximum data size differs depending on the function code.
- If the specified read/write starting register address falls in the reserved area, an illegal address error occurs. However, even if reserved area is included in the specified addresses to read from/write to, excluding the read/write starting register address, an Illegal address error does not occur.
  If data is read from/written from/to register address 41321 and after, an illegal address error occurs. Writing to the reserved area or read-only register is invalid.

  *Reserved area: registers not defined by the detector
- Data read from the reserved area or write-only registers is "0xFFFF" (word size).

6.4 Message Examples

This section provides examples of request/response messages per function code supported by this detector, and an example of exception response message in the event of an error.

6.4.1 Function Code 03 (Read Single/Multiple Holding Registers)

Function code 03 (0x03) is used to read the data from the specified register addresses.

Example of request message

The master sends function code 03 (0x03) to the slave (unit ID = 01) in order to read two words of data from register address 41039 (relative address = 1038 (0x040E)). The current gas concentration and F.S. code will be read from register addresses 41039 and 41040.

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	6	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x06	–	–	–	
Unit ID		1	(7)	1	0x01	(1)	1	0x01	
Function code		1	(8)	3	0x03	(2)	3	0x03	
Starting address	Hi	2	(9)	1038	0x04	(3)	1038	0x04	Read starting register address
	Lo		(10)		0x0E	(4)		0x0E	
Quantity of registers to be read	Hi	2	(11)	0	0x00	(5)	0	0x00	Read by the word Range: 1–125
	Lo		(12)	2	0x02	(6)	2	0x02	
Error check data	Lo	2	–	–	–	(7)		0xA4	Modbus RTU only
	Hi		–	–	–	(8)		0xF8	

Common to both Modbus TCP and Modbus RTU.

Example of response message

The slave returns a response message including the “current gas concentration = 25%F.S. (0x0019) and F.S. code = 101 (0x0065)” to the master.

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	13	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x0D	–	–	–	
Unit ID		1	(7)	1	0x01	(1)	1	0x01	
Function code		1	(8)	3	0x03	(2)	3	0x03	
Quantity of data		1	(9)	4	0x04	(3)	4	0x04	Quantity of response data = N x 2 bytes N: Quantity of registers N range =1–125
Data1	Hi	2	(10)	25	0x00	(4)	25	0x00	Sent by the byte in the sequence of high-order byte followed by low-order byte: Data 1, 2, 3, 4….
	Lo		(11)		0x19	(5)		0x19	
Data2	Hi	2	(12)	101	0x00	(6)	101	0x00	
	Lo		(13)		0x65	(7)		0x65	
Error check data	Lo	2	–	–	–	(8)		0x2B	Modbus RTU only
	Hi		–	–	–	(9)		0x4A	

Common to both Modbus TCP and Modbus RTU.

6.4.2 Function Code 06 (Write Single Holding Register)

Function code 06 (0x06) is used to write one word of data to the specified single register.

Example of request message

The master sends function code = 06 (0x06) to the slave (unit ID = 03). One word (2 bytes) of data for “Host maintenance mode ON command” will be written to register address 40050 (relative address = 49 (0x0031)).

Host maintenance mode ON command (with self-resetting) = ON (0x0011)

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	6	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x06	–	–	–	
Unit ID		1	(7)	3	0x03	(1)	3	0x03	
Function code		1	(8)	6	0x06	(2)	6	0x06	
Starting address	Hi	2	(9)	49	0x00	(3)	49	0x00	Write starting register address
	Lo		(10)		0x31	(4)		0x31	
Data	Hi	2	(11)	17	0x00	(5)	17	0x00	Write by the word.
	Lo		(12)		0x11	(6)		0x11	
Error check data	Lo	2	–	–	–	(7)		0x19	Modbus RTU only
	Hi		–	–	–	(8)		0xEB	

Common to both Modbus TCP and Modbus RTU.

Example of response message

The slave returns a response message (result) informing that “Host maintenance mode ON command” (one word of data) has been written, to the master.

Host maintenance mode ON command (with self-resetting) = ON (0x0011)

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	13	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x0D	–	–	–	
Unit ID		1	(7)	3	0x03	(1)	3	0x03	
Function code		1	(8)	6	0x06	(2)	6	0x06	
Starting address	Hi	2	(9)	49	0x00	(3)	49	0x00	
	Lo		(10)		0x31	(4)		0x31	
Data	Hi	2	(11)	17	0x00	(5)	17	0x00	Write by the word.
	Lo		(12)		0x11	(6)		0x11	
Error check data	Lo	2	–	–	–	(7)		0x19	Modbus RTU only
	Hi		–	–	–	(8)		0xEB	

Common to both Modbus TCP and Modbus RTU.

6.4.3 Function Code 16 (Write Multiple Holding Registers)

Function code 16 (0x10) is used to write a block of contiguous data to the specified multiple registers.

Example of request message

The master sends function code = 16 (0x10) to the slave (unit ID = 03). “Test mode ON command” and “test gas concentration” will be written to register addresses 40048 (relative address = 47 (0x002F)) and 40049 (relative address = 48 (0x0030)) respectively.

Test mode ON command = ON (0x0001)
Test gas concentration = 25%F.S. (0x0019)

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	11	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x0B	–	–	–	
Unit ID		1	(7)	3	0x03	(1)	3	0x03	
Function code		1	(8)	16	0x10	(2)	16	0x10	
Starting address	Hi	2	(9)	47	0x00	(3)	47	0x00	Write starting register address
	Lo		(10)		0x2F	(4)		0x2F	
Quantity of registers	Hi	2	(11)	2	0x00	(5)	2	0x00	Quantity of registers to be written Range: 1–123
	Lo		(12)		0x02	(6)		0x02	
Quantity of data		1	(13)	4	0x04	(7)	4	0x04	Quantity of data = N x 2 bytes N: Quantity of registers
Data1	Hi	2	(14)	1	0x00	(8)	1	0x00	Write data by the word
	Lo		(15)		0x01	(9)		0x01	
Data2	Hi	2	(16)	25	0x00	(10)	25	0x00	
	Lo		(17)		0x19	(11)		0x19	
Error check data	Lo	2	–	–	–	(12)		0x2A	Modbus RTU only
	Hi		–	–	–	(13)		0x45	

Common to both Modbus TCP and Modbus RTU.

Example of response message

The slave returns a response message (result) informing that contiguous data has been written to multiple registers, to the master.

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	13	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x0D	–	–	–	
unit ID		1	(7)	3	0x03	(1)	3	0x03	
Function code		1	(8)	16	0x10	(2)	16	0x10	
Starting address	Hi	2	(9)	47	0x00	(3)	47	0x00	Write starting register address
	Lo		(10)		0x2F	(4)		0x2F	
Quantity of registers	Hi	2	(11)	2	0x00	(5)	2	0x00	Quantity of registers to be written Range: 1–123
	Lo		(12)		0x02	(6)		0x02	
Error check data	Lo	2	–	–	–	(7)		0x71	Modbus RTU only
	Hi		–	–	–	(8)		0xE3	

Common to both Modbus TCP and Modbus RTU.

6.4.4 Function Code 23 (Read and Write Multiple Holding Registers)

Function code 23 (0x17) is used to perform a combination of one read operation and one write operation. A block of contiguous data will be written to specified multiple registers, then a block of contiguous data will be read from specified multiple registers. The write operation is performed before the read.

NOTE Function code 23 (0x17) applies only to Modbus TCP (Ethernet) and it does not apply to Modbus RTU (RS-485)

Example of request message

The master sends function code = 23 (0x17) to the slave (unit ID = 05). Two words of data (current gas concentration and F.S. code) starting from register address 41039 (relative address = 1038 (0x040E)) will be read, then two words of data (Test mode ON command and test gas concentration) will be written to register addresses 40048 (relative address = 47 (0x002F)) and 40049 (relative address = 48 (0x0030)) respectively.

Test mode ON command = ON (0x0001)
Test gas concentration = 25%F.S. (0x0019)

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	11	0x00	–	–	–	Number of data which follows unit ID
	Lo		(6)		0x0B	–	–	–	
Unit ID		1	(7)	3	0x03	–	–	–	
Function code		1	(8)	16	0x10	–	–	–	
Read starting address	Hi	2	(9)	1038	0x00	–	–	–	
	Lo		(10)		0x2F	–		–	
Quantity of registers to be read	Hi	2	(11)	2	0x00	–	–	–	Range: 1–125
	Lo		(12)		0x02	–	–	–	
Write starting address	Hi	2	(13)	47	0x00	–	–	–	
	Lo		(14)		0x2F	–	–	–	
Quantity of registers to be written	Hi	2	(15)	2	0x00	–	–	–	Range: 1–121
	Lo		(16)		0x02	–	–	–	
Quantity of data		1	(17)	4	0x04	–	–	–	Quantity of data = N x 2 bytes N: Quantity of registers

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
Data1	Hi	2	(18)	1	0x00	–	–	–	Write by the word
	Lo		(19)		0x01	–		–	
Data2	Hi	2	(20)	25	0x00	–	–	–	
	Lo		(21)		0x19	–		–	
Error check data	Lo	2	–	–	–	–	–	–	
	Hi		–	–	–	–	–	–	

Example of response message

The slave returns a response message including the “current gas concentration = 25%F.S. (0x0019) and F.S. code = 101 (0x0065)” to the master.

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Fixed at “00”.
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	13	0x00	–	–	–	Number of data which follows unit ID
	Lo		(6)		0x0D	–	–	–	
Unit ID		1	(7)	1	0x01	–	–	–	
Function code		1	(8)	3	0x03	–	–	–	
Quantity of data		1	(9)	4	0x04	–	–	–	Quantity of response data = N x 2 bytes N: Quantity of registers N range= 1–125
Data1	Hi	2	(10)	25	0x00	–	–	–	Sent by the byte in the sequence of high-order byte followed by low-order byte: Data 1, 2, 3, 4….
	Lo		(11)		0x19	–		–	
Data2	Hi	2	(12)	101	0x00	–	–	–	
	Lo		(13)		0x65	–		–	
Error check data	Lo	2	–	–	–	–	–	–	
	Hi		–	–	–	–	–	–	

6.4.5 Exception Response (Response in the event of an error)

When an error (e.g. communication error. Refer to 6.3.1 Error Code for details of errors) occurs, the slave sends an exception response to the master in the following configuration. In an exception response, the slave sets the most-significant bit (MSb) of the function code to "1 (generated by adding 0x80 to the received function code)" and uses it as an error function code.

(1) Unit ID: 1 byte
(2) Error function code: 1 byte
(3) Exception code (error code): 1 byte
(4) Error check code: 2 bytes

Example of error function code generation

When an error occurs while receiving a request message whose function code is "0x06", 0x80 will be added to the function code to form an error function code: 0x80 + 0x06 = 0x86.
The generated error function code will be added to an exception response.

NOTE Refer to 6.1.2 "CRC-16 Calculation" for error check codes.

Example of transactions in the event of an error is as follows.

Example of request message

The master sends function code = 16 (0x10) to the slave (unit ID = 03).
The request specifies the non-existent register address 40100 (relative address = 99 (0x0063)) and number of registers to be written.

Example of response message

The slave returns the following exception response message to the master.

Message frame			Modbus TCP			Modbus RTU			Remarks
Data item		Data size (byte)	No.	Byte data	Hex	No.	Byte data	Hex	
TRXN ID	Hi	2	(1)	0	0x00	–	–	–	Modbus TCP only
	Lo		(2)	0	0x00	–	–	–	
Protocol ID	Hi	2	(3)	0	0x00	–	–	–	Modbus TCP only Fixed at "00".
	Lo		(4)	0	0x00	–	–	–	
Quantity of comm. data	Hi	2	(5)	3	0x00	–	–	–	Modbus TCP only Number of data which follows unit ID
	Lo		(6)		0x03	–	–	–	
Unit ID		1	(7)	3	0x03	(1)	3	0x03	
Error function code		1	(8)	144	0x90	(2)	144	0x90	"0x80" is added to the received function code"0x10"
Error code (Exception code)		1	(9)	2	0x02	(3)	2	0x02	Illegal address error
Error check data	Lo	2	–	–	–	(8)		0x6C	Modbus RTU only
	Hi		–	–	–	(9)		0x01	

Common to both Modbus TCP and Modbus RTU.

6.5 Register Address Map

This section describes the register address map for the data used by this detector.
The detector assigns its data (e.g. gas concentrations, status information, device setup details) to its holding registers. A request message from the master specifies the register addresses to read from/write to.

Modbus Register Address Map

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
40001	0	Flow rate	R	Word	Read current flow rate Response example: 0x01F4 when flow rate is measured at 500ml
40002	1	AL1 set value	R	Word	Read AL1 set value Response example: 0x0019 when AL1 set value is 25%F.S.
40003	2	AL2 set value	R	Word	Read AL2 set value Response example: 0x0028 when AL2 set value is 40%F.S.
40004	3	Alarm mode combination	R	Word	Read alarm mode combination 0: High-High limit 0x0000 1: Low-Low limit 0x0001 2: High-Low limit 0x0002
40005	4	AL1 delay time	R	Word	Read AL1 delay time Response example: 0x0005 when delay time is 5 sec
40006	5	AL2 delay time	R	Word	Read AL2 delay time Response example: 0x0005 when delay time is 5 sec
40007	6	Zero suppression value (21vol% suppression value for oxygen)	R	Word	Read zero suppression value Response example: 0x0019 when suppression value is 25%
40009	8	Target gas (1st and 2nd letters)	R	Word	Read target gas Target gas (max. 4 letters) are set in hex ASCII code. Response example: When target gas is CO_2, 1st letter “C”, 2nd letter “O” and 3rd letter “2” are returned in hex ASCII code “C”: 0x43 (high-order byte of word data) “O”: 0x4F (low-order byte of word data) “2”= 0x32 (high-order byte of word data) “(space)” = 0x20 (low-order byte of word data) When gas name exceeds 5 letters, first 4 letters will be returned.
40010	9	Target gas (3rd and 4th letters)	R	Word	
40011	A	Measurement unit code	R	Word	Read unit code for sensor unit 0: (None), 10: ppm, 20: ppb, 30: %

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
					40: %LEL
40013	C	Sensor unit Mfg. No.(1st and 2nd letters)	R	Word	Read sensor unit Mfg. No. (8-letter ASCII code) Response example: When Mfg. No. is ”C302026”, 1st letter is “C”, 2nd is “3”, 3rd is “0, …. 7th is “6” and 8th is “(space)” “C”=0x43 (high-order byte of word data) “3”= 0x33 (low-order byte of word data) “0”= 0x30 (high-order byte of word data) “2”= 0x32 (low-order byte of word data) “0”= 0x30 (high-order byte of word data) “2”= 0x32 (low-order byte of word data) “6”= 0x36 (high-order byte of word data) “(space)”= 0x20 (low-order byte of word data)
40014	D	Sensor unit Mfg. No.(3rd and 4th letters)	R	Word	
40015	E	Sensor unit Mfg. No. (5th and 6th letters)	R	Word	
40016	F	Sensor unit Mfg. No.(7th and 8th letter)	R	Word	
40017	10	Test mode on/off	R	Word	Read current test mode status ON: 0x0001 OFF: 0x0000
40018	11	Test gas concentration	R	Word	Read test gas concentration value Response example: 0x0019 when test gas concentration is 25%
40019	12	Sensor current value	R	Word	Read sensor current value Range: 2.00 to 6.00 mA Multiplied by 100, then converted to hex to create the data to send. Response example: 0x00C8 in case of 200 (2.00 mA)
40020	13	f-value	R	Word	Read sensor unit f-value (4 letter hex ASCII) Multiplied by 100, then converted to hex to create the data to send. Response example: 0x064 in case of 100 (f-value is 01.00)
40021	14	Calibration gas code (1st and 2nd letters)	R	Word	Read calibration gas code (3-letter ASCII code) Response example: “0x2D”, “0x2D”, “0x2D” and “0x20” when code is - - - plus space.
40022	15	Calibration gas code (3rd and 4th letters)	R	Word	
40023	16	Calibration gas concentration	R	Word	Read calibration gas concentration value Response example: 0x004B when the gas concentration value is 75%
40025	18	Linear table X1Y1	R	Word	Read linear table (X1,Y1) Response example: When X1 = 20%, 0x0014 (high-order byte of word data)

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
					When Y1 = 20%, 0x0014 (low-order byte of word data)
40026	19	Linear table X2Y2	R	Word	Read linear table (X2,Y2) Response example: When X2 = 40%, 0x0028 (high-order byte of word data) When Y2 = 40%, 0x0028 (low-order byte of word data)
40027	1A	Linear table X3Y3	R	Word	Read linear table (X3,Y3) Response example: When X3 = 50%, 0x0032 (high-order byte of word data) When Y3 = 50%, 0x0032 (low-order byte of word data)
40028	1B	Linear table X4Y4	R	Word	Read linear table (X4,Y4) Response example: When X4 = 60%, 0x003C (high-order byte of word data) When Y4 = 60%, 0x003C (low-order byte of word data)
40029	1C	Linear table X5Y5	R	Word	Read linear table (X5,Y5) Response example: When X5 = 80%, 0x0050 (high-order byte of word data) When Y5 = 80%, 0x0050 (low-order byte of word data)
40030	1D	Linear table X6Y6	R	Word	Read linear table (X6,Y6) Response example: When X6 = 90%, 0x005A (high-order byte of word data) When Y6 = 90%, 0x005A (low-order byte of word data)
40031	1E	Main unit software version	R	Word	Read PS-7-M main unit software version Response example: In case of ver.1.12, 112 = 0x0070
40032	1F	Base unit software version	R	Word	Read PS-7-M base unit software version Response example: In case of ver.1.10, 110 = 0x006E
40048	2F	Test mode on/off	W	Word	Set test mode to on/off ON: 0x0001 OFF: 0x0000
40049	30	Test gas concentration	W	Word	Set test gas concentration value Write example: 0x0019 to set to 25%
40050	31	Host maintenance mode on/off	W	Word	Set host maintenance mode to on/off OFF: 0x0000 ON: 0x0001 (without self-resetting) ON: 0x0011 (with 10-min self-resetting)

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
					Host maintenance mode is equivalent to maintenance mode 1, and maintenance mode 2 is prioritized
40051	32	AL1 set value	W	Word	Set AL1 set value Write example: 0x0019 to set to 25%F.S. Always %F.S. is used
40052	33	AL2 set value	W	Word	Set AL2 set value Write example: 0x0028 to set to 40 %F.S. Always %F.S. is used
40053	34	Alarm mode combination	W	Word	Set alarm mode combination 0: High-High limit 0x0000 1: Low-Low limit 0x0001 2: High-Low limit 0x0002
40054	35	AL1 delay time	W	Word	Set AL1 delay time Write example: 0x0005 to set to 5 sec
40055	36	AL2 delay time	W	Word	Set AL2 delay time Write example: 0x0005 to set to 5 sec
40056	37	Zero suppression value (21vol% suppression value)	W	Word	Set zero suppression value Write example: 0x0005 to set to 5%
40057	38	Calibration gas concentration	W	Word	Set calibration gas concentration value Write example: 0x004B to set to 75%
40516	203	Current value (device status information)	R	Word	Read current device status information and gas/trouble alarms <u>Status byte 1</u> b7: Symbol for gas concentration value (0:＋/1:－) b6: (Reserved) b5: Low flow rate 1 (0:Good/1:Not good) b4: Low flow rate 2 (0:Good/1:Not good) b3: Broken pyrolyzer wire (0: Good/1: Not good) b2: Sensor fault (0: Good/1: Not good) b1: AL1 (0: OFF/1: ON) b0: AL2 (0: OFF/1: ON) <u>Status byte 2</u> b7: Device setup change (0: No change/ 1: Change) b6: (Reserved) b5: (Reserved) b4: Host maintenance mode (0: OFF/1: ON) b3: (Reserved) b2: Test mode (0: OFF/1: ON) b1: Maintenance mode 2 (0:OFF/1:ON) b0: Maintenance mode 1 (0:OFF/1:ON)

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
					Response example: When AL1 and AL2 activate while in MNT2, Status byte 1: 0x03 (high-order byte of word data) Status byte 2: 0x02 (low-order byte of word data)
41039	40E	Current value (gas concentration)	R	Word	Read current gas concentration value Response example 1: 0x000A when the gas concentration is 10%. Response example 2: 0x0005 with 1 being assigned to bit7 of status byte 1, when gas concentration is –5%
41040	40F	F.S. code	R	Word	Read F.S. code F.S. code is returned in hex Response example: 0x0065 when F.S. code is 101 Master will then convert received code to F.S. value by referring to full scale code table (refer to 7.5 Full Scale Codes)
41284	503	Modbus setting change permit	R/W	Word	Permission for Modbus setting change
41291	50A	Dynamic IP address (high-order)	R	Word	Read currently-set IP address (high-order) Dynamic IP address (high-order) assigned to DHCP
41292	50B	Dynamic IP address (low-order)	R	Word	Read currently-set IP address (low-order) Dynamic IP address (low-order) assigned to DHCP
41293	50C	DHCP subnet mask (high-order)	R	Word	Read currently-set subnet mask (high-order), which is assigned to DHCP
41294	50D	DHCP subnet mask (low-order)	R	Word	Read currently-set subnet mask (low-order), which is assigned to DHCP
41295	50E	DHCP default gateway (high-order)	R	Word	Read currently-set default gateway (high-order), which is assigned to DHCP
41296	50F	DHCP default gateway (low-order)	R	Word	Read currently-set default gateway (low-order), which is assigned to DHCP
41297	510	TCP/IP port No.	R	Word	Read TCP port number Example: 0x01F6 when Modbus/TCP port No. is 502 (static)
41298	511	Static IP address (high-order)	R	Word	Read 1st and 2nd values of static IP address (high-order)
41299	512	Static IP address	R	Word	Read 3rd and 4tth values of static IP

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
		(low-order)			address (low-order) 4th value of IP address is Unit ID, too The 4th value of IP address is set with address setting switches (DIP switches). It is valid if set to 1 to 254, but invalid if set to 255. If set to 0 with the switches, it will be superseded by the one set by high-order device (web browser)
41300	513	Subnet mask (high-order)	R	Word	Read subnet mask (high-order)
41301	514	Subnet mask (low-order)	R	Word	Read subnet mask (low-order)
41302	515	Default gateway (high-order)	R	Word	Read default gateway (high-order)
41303	516	Default gateway (low-order)	R	Word	Read default gateway (low-order)
41304	517	IP address type (DY/ST)	R	Word	Read IP address type (dynamic or static), which is set with IP address type switch. 0x0000: Dynamic IP address 0x0001: Static IP address
41305	518	MAC address (1st and 2nd bytes)	R	Word	Read MAC address (1st and 2nd bytes) of PS-7-M base unit
41306	519	MAC address (3rd and 4th bytes)	R	Word	Read MAC address (3rd and 4th bytes) of PS-7-M base unit
41307	51A	MAC address (5th and 6th bytes)	R	Word	Read MAC address (5th and 6th bytes) of PS-7-M base unit
41308	51B	Communication speed	R	Word	Read Modbus RTU (RS-485) communication speed (bps) Response example: 0x2580 in case of 9600 bps
41309	51C	Data length	R	Word	Read Modbus RTU (RS-485) data length Response example: 0x0008 in case of 8 data bit length
41310	51D	Stop bit	R	Word	Read Modbus RTU (RS-485) data length Response example: 0x0001 in case of 1 stop bit
41311	51E	Parity bit	R	Word	Read Modbus RTU (RS-485) data length Response example: 0x0000: No parity 0x0001: Even parity 0x0010: Odd parity
41312	51F	Unit ID	R	Word	Read unit ID set with address setting switches (DIP switches)

Register address	Relative address (hex)	Register name	Read (R) or Write (W)	Data type	Data contents
41316	523	Static IP address (high-order)	W	Word	Set 1st and 2nd values of static IP address (high-order) Valid when “0x0001 (static IP)” is set at register address 41304. The first three values of IP address are written to this register from high-order device (web browser)
41317	524	Static IP address (low-order)	W	Word	Set 3rd and 4tth values of static IP address (low-order) Valid when “0x0001 (static IP)” is set at register address 41304. The first three values of IP address are written to this register from high-order device (web browser) The 4th value of IP address is set with address setting switches (DIP switches). It is valid if set to 1 to 254, but invalid if set to 255. If set to 0 with the switches, it will be superseded by the one set by high-order device (web browser)
41318	525	Subnet mask (high-order)	W	Word	Set subnet mask (high-order) Valid when “0x0001 (static IP)” is set at register address 41304 Invalid if bits are set to 1, 0, 1 from high to low bit
41319	526	Subnet mask (low-order)	W	Word	Set subnet mask (low-order) Valid when “0x0001 (static IP)” is set at register address 41304 Invalid if bits are set to 1, 0, 1 from high to low bit
41320	527	Default gateway (high-order)	W	Word	Set default gateway (high-order) Valid when “0x0001 (static IP)” is set at register address 41304
41321	528	Default gateway (low-order)	W	Word	Set default gateway (low-order) Valid when “0x0001 (static IP)” is set at register address 41304

NOTE Data newly written to the registers addresses from 41316 to 41321 will not be reflected in the register address map until the detector is restarted.

7 Device Status Information

This chapter describes the device operation statuses during gas alarm, trouble alarm, test mode, and maintenance mode.

7.1 Gas Alarm Operation

If the gas concentration exceeds the gas alarm set value, the alarm contacts will activate after the alarm delay time, and the gas detector will enter the gas alarm status.

The master can detect a gas alarm by reading the device status information located at register address 40516.

When the gas concentration falls below the gas alarm set value, the gas detector will automatically return to its normal status (self-resetting).

NOTE For gas alarm operation of the main unit, refer to 7-2 “Operation – Gas Alarm” of the PS-7-M series gas detector’s instruction manual.

The device status information (register address: 40516) is one word consisting of two bytes, Status byte 1 (high-order byte) and Status byte 2 (low-order byte).
The 1st stage gas alarm (AL1) is assigned to bit1 1 of Status byte 1 and the 2nd stage gas alarm (AL2) is assigned to bit 0 of Status byte 1, as shown below.

Bit assignment (gas alarms status)

Gas alarm	Register name	Register address	Data contents
1st stage gas alarm (AL1)	Current value (device status information)	40516	0: OFF / 1: ON (alarm is activated) Status byte 1 bit7 bit0 [ ][ ][ ][ ][ ][ ][1][ ] bit1: AL1
2nd stage gas alarm (AL2)			0: Alarm is absent / 1: Alarm is present Status byte 1 bit7 bit0 [ ][ ][ ][ ][ ][ ][ ][1] bit0:AL2

7.2 Trouble Alarm Operation (Fault Alarm Operation)

When this detector detects an internal failure, it will activate a trouble alarm.
The master can detect a trouble alarm of a slave (this detector) by reading the device status information at register address 40516.
Trouble alarm will be automatically cleared, when a problem is removed (self-resetting).

NOTE For the trouble alarm operation of the main unit, refer to 7-3 “Operation – Trouble Alarm” of the PS-7-M series gas detector's instruction manual.

(1) Low flow rate
A minimum flow rate is not present.
There are two low flow rate patterns. When the flow rate is reduced due to a clogged filter or excessive negative pressure, etc., the flow rate icon spins slowly (low flow rate 1). When the flow rate is too low, the icon stops spinning, “FLOW” is shown on the LCD and a low flow rate alarm activates (low flow rate 2).

NOTE For the information on the LCD, refer to 5-6 “LCD Indicator Icons” of the PS-7-M series gas detector's instruction manual.

(2) Broken pyrolyzer wire (when detector uses a pyrolyzer)
A broken wire occurs.

(3) Sensor fault
The sensor’s zero level output is extremely low, or
A broken sensor wire occurs (applies to CHS-7 combustible gas sensor only).

The device status information (register address: 40516) is one word consisting of two bytes, Status byte 1 (high-order byte) and Status byte 2 (low-order byte).
The trouble alarms are assigned to bits 2 to 5 of Status byte 1 as shown below.

Bit assignment (trouble alarms)

Trouble alarm	Register name	Register address	Data contents
Low flow rate	Current value (device status information)	40516	0: Good /1: Not good Status byte 1 bit7 bit0 [ ][ ][1][ ][ ][ ][ ][ ] bit5: Low flow rate 1 Status byte 1 bit7 bit0 [ ][ ][ ][1][ ][ ][ ][ ] bit4: Low flow rate 2
Broken pyrolyzer wire			0: Good /1: Not good Status byte 1 bit7 bit0 [ ][ ][ ][ ][1][ ][ ][ ] bit3: Broken pyrolyzer wire
Sensor fault			0: Good /1: Not good Status byte 1 bit7 bit0 [ ][ ][ ][ ][ ][1][ ][ ] bit2: Sensor fault

7.3 Test Mode Setup and Operation

Press the TEST switch on the main unit with the test stick to enter the test mode. Each press of the recessed TEST switch will turn on and off the test mode. The test mode can be also turned on/off from the master by setting the test mode register to on/off via Modbus communication.

"TEST" appears on the LCD of this detector while in the test mode. The test mode will automatically turn off 10 minutes later.

NOTE To enter the test mode from the main unit, refer to 7-4 "Operation – Test Mode" of the PS-7-M series gas detector's instruction manual

Registers for test mode setting

Register name	Register address	Data type	Data contents
Test mode on/off	40048	Word	Set test mode to on/off ON: 0x0001 OFF: 0x0000
Test gas concentration	40049	Word	Set test gas concentration value Example: "0x0019" to set the value to 25% Settable range: 1 to 100%

The master can check the test mode on/off status and the test gas concentration value by reading the device status information located at register address 40516. It can also check them by reading register address 40017 for test mode and register address 40018 for test gas concentration respectively.

The device status information (register address: 40516) is one word consisting of two bytes, Status byte 1 (high-order byte) and Status byte 2 (low-order byte).
The test mode is assigned to bit 2 of Status byte 2 as shown below.

Bit assignment (test mode)

Mode	Register name	Register address	Data contents
Test mode	Current value (device status information)	40516	0: OFF 1: ON Status byte 2 bit7 bit0 0 0 0 0 0 1 0 0 bit 2: Test mode

⚠ CAUTION

While in test mode, the gas alarm contacts activate. If the gas alarm contacts are used to operate the interlocks of the external devices, release the interlocks beforehand, as needed to prevent a possible activation of the interlocks during the test mode, or enter the maintenance mode before entering the test mode. (Refer to 7-5. "Operation – Maintenance Mode" for more information).
Notify those concerned before starting the gas alarm test.

7.4 Maintenance Mode Setup and Operation

The maintenance switch on the front of the base unit can switch between two maintenance modes, maintenance mode 1 (MNT1) and maintenance mode 2 (MNT2).

There are three maintenance modes in total, maintenance mode 1 (MNT1), maintenance mode 2 (MNT2), plus host maintenance mode.
The operation of the host maintenance mode is the same as maintenance mode 1.

NOTE For the setup and operation for maintenance modes 1/2, refer to 7-5 “Operation – Maintenance Mode” of the PS-7-M series gas detector’s instruction manual.

The host maintenance mode can be turned on/off from the master by setting the test mode register to on/off via Modbus communication.

“MNT1” or “MNT2” appears on the LCD while in maintenance mode, and “MNT1” appears while in host maintenance mode.

The host maintenance mode will automatically turn off 10 minutes later.

Register for host maintenance mode setting

Register name	Register address	Data type	Data contents
Host maintenance mode on/off	40050	Word	Set host maintenance mode to on/off OFF: 0x0000 ON: 0x0001 (without self-resetting) ON: 0x0011 (with 10-min self-resetting)

The master can check the current maintenance mode status by reading the device status information at register address 40516.

The device status information (register address: 40516) is one word consisting of two bytes, Status byte 1 (high-order byte) and Status byte 2 (low-order byte).
The maintenance mode is assigned to bits 0, 1 and 4 of Status byte 2 as shown in the following table.

Bit assignment (maintenance mode)

Mode	Register name	Register address	Data contents	Gas alarm contacts	Trouble alarm open collector
MNT1	Current value (device status information)	40516	0: OFF /1: ON Status byte 2 bit7 bit0 [ ][ ][ ][ ][ ][ ][ ][1] bit0: MNT 1	Disabled (Fixed at OFF)	Disabled (Fixed at ON)
MNT2			0: OFF /1: ON Status byte 2 bit7 bit0 [ ][ ][ ][ ][ ][ ][1][ ] bit1: MNT2	Disabled (Fixed at OFF)	Disabled (Fixed at ON)
Host maintenance mode			0: OFF /1: ON Status byte 2 bit7 bit0 [ ][ ][ ][1][ ][ ][ ][ ] bit4: Host maintenance mode	Disabled (Fixed at OFF)	Disabled (Fixed at ON)

⚠ CAUTION

- While in maintenance mode, the status information of gas/trouble alarms is sent to the master digitally. If the status information is used to operate the interlocks of the external devices, release the interlocks beforehand, as needed to prevent a possible activation of the interlocks during the maintenance mode.
- Trouble alarm will activate if the main unit power switch is set to the OFF position while in any maintenance mode.
- The analog output may change when the main unit power switch is set to the OFF position.

⚠ WARNING

- During normal operation (gas monitoring mode), ensure the maintenance switch is set to the center position and the host maintenance mode is off. Gas alarm contacts and trouble alarm open collector will not activate if the switch is set to right/left (MNT1/MNT2) position or host maintenance mode is on.
- During MNT2, the analog output is fixed at 4.0 mA (or 17.4 mA for oxygen).

NOTE For the gas alarm contacts and trouble alarm open collector, refer to 7-5 “Operation – Maintenance Mode” of the PS-7-M series gas detector’s instruction manual.

7.5 Full Scale Codes

Full scale information is read in a form of 3-digit full scale code (F.S. code).
Convert the read F.S. code to the corresponding full scale value by referring to the table blow.

Full scale code table

F.S. code	F.S. value	F.S. code	F.S. value	F.S. code	F.S. value
010	1	030	3	079	0.7
100	10	300	30	070	7
101	100	301	300	700	70
102	1000	302	3000	701	700
				702	7000
159	1.5	049	0.4	759	7.5
150	15	040	4	750	75
151	150	400	40	751	750
152	1500	401	400	752	7500
		402	4000		
020	2	050	5	089	0.8
200	20	500	50	080	8
201	200	501	500	800	80
202	2000	502	5000	801	800
				802	8000
259	2.5	069	0.6	099	0.9
250	25	060	6	090	9
251	250	600	60	900	90
252	2500	601	600	901	900
		602	6000	902	9000

8 Troubleshooting

Before requesting repair, please refer to the table below. If the detector does not return to normal operation after performing the corresponding steps in the table, or if your issue is not found in the table, consult New Cosmos or its authorized representative.

Symptom	Cause	Action	Reference
Modbus TCP (Ethernet) communication error	LAN cable incorrectly connected Poor LAN cable connection	• Check that the status LED 1 is lit, which indicates that LAN cable is correctly connected). • Connect the LAN cable. • Check and rewire.	5.2.2 Modbus TCP (Ethernet) Wiring Procedure 5.3.2 Status LEDs
	Not all devices are on.	• Turn on all the external devices that communicate with this product.	5.1 System Configuration
	Incorrectly set DIP switch for communication mode	• Set the mode change switch to “ETHERNET”. * Restart the unit after setting with the DIP switch.	5.3.1 DIP Switches
	The number of connected units and transmission distance exceed the specified limit.	• Check and rewire so that the number of connected units and transmission distance are within the limit.	4.2 Modbus TCP (Ethernet) Communication Specifications
	Incorrect conditions	• Check and reconnect the IP address, subnet mask, and default gateway.	6.5 Register Address Map
	Incorrectly set DIP switches for unit ID	• Check that the unit ID (4th value of the IP address) set with the DIP switches is correct. • Check that the unit ID is not set to “255”. * Restart the unit after setting with the DIP switches.	5.3.1 DIP Switches
	Same unit ID is used for more than one unit.	• Check the IP addresses on the same communication line. • Check that the unit ID (4th value of IP address) is correct. * Restart the unit after setting with the DIP switches.	6.5 Register Address Map 5.3.1 DIP Switches
Modbus RTU (RS-485) communication error	Incorrect wiring	• Check and rewire. • Securely connect wires to terminals.	5.2.1 Modbus RTU (RS-485) Wiring Procedure
	Not all devices are on	• Turn on all the external devices that communicate with this product.	5.1 System Configuration
	Incorrectly set DIP switch for communication mode	• Set the mode change switch to “RS485”. * Restart the unit after setting with the DIP switch.	5.3.1 DIP Switches
	The number of connected units and	Check and rewire so that the number of connected units and	4.1 Modbus RTU Communication

Symptom	Cause	Action	Reference
	transmission distance exceed the specified limit.	transmission distance are within the limit.	Specifications
	Incorrect conditions	• Check that the RS-485 setting of the master and that of this product match, then rewire.	4.1 Modbus RTU Communication Specifications
	Incorrectly set DIP switches for unit ID	• Check that the unit ID set with the DIP switches is correct. • Check that the unit ID is not set to “255”. * Restart the unit after setting with the DIP switches.	5.3.1 DIP Switches
	Same unit ID is used for more than one unit.	• Check the unit IDs on the same communication line. • Check that the unit ID is correct. * Restart the unit after setting with the DIP switches.	6.5 Register Address Map 5.3.1 DIP Switches
	Modbus RTU (RS-485) communication interval is not good.	• Check the Modbus RTU protocol communication interval, then rewire.	6.1.4 Modbus RTU Communication Interval
	No terminal resistors installed	• Check that the terminal resistors are used at both ends of the communication line. Install them if they are not installed. • Set the terminal resistor switch to the on position.	5.1 System Configuration
Received data incorrect	Communication error between main unit and base unit Poor connection of main unit	• Check that the status LED-3 flashes, which indicates that the communication status between main and base units is normal. If lit, it means that there is no response from main unit, and if not lit, it means that there is no request from base unit. • Remove and reinstall the main unit.	5.3.2 Status LEDs
	Incorrect function code	• Check that the function code is correct.	6.2 Function Codes
	Incorrect register address	• Check the register addresses specified are correct.	6.5 Register Address Map

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