MITSUBISHI ELECTRIC

Numerical Relay
MELPRO™-S Series

MODEL

CBV2 - A02S1
COC4 - A02S1

MODBUS INSTRUCTION MANUAL

- Safety precautions -

Before installation, operation, maintenance, and inspection, please be sure to read this instruction manual and all other attached documents thoroughly in order to work safely with the equipment. Please ensure that you fully understand the equipment, safety information, and precautions that need to be taken before working with the equipment.
Safety precautions are classified as “Danger” and “Caution.”

 Danger	The case where a dangerous situation can arise and there is the possibility that death or seriously injury can occur if the equipment is handled incorrectly.
 Caution	The case where a dangerous situation can arise and there is the possibility that moderate or minor injuries canl occur, or property damage can take place if the equipment is handled incorrectly.

Furthermore, even with items described as ⚠Caution, there is the possibility of serious consequences depending on the situation. All of the described contents are important. Therefore, be sure to comply with them.

[Transportation]

⚠Caution
●Transport the equipment in the correct orientation. ●Do not apply excessive shock and/or vibration as this could affect the performance and life of the product.

[Storage]

⚠Caution
●The storage environment shall comply with the following conditions. Otherwise, there is a risk of reducing the performance and life of the product. - Ambient temperature -25 to +70°C The state where dew condensation or freezing does not occur. • Frequency variation Within ±5% of the rated frequency - Altitude 2000 m or lower - The equipment must not be exposed to abnormal vibration, shock, inclination, or magnetic fields. - The equipment must not be exposed to harmful smoke/gas, saline gas, water droplets or vapour, excessive dust or fine powder, explosive gas or fine powder, wind & rain.

[Installation, wiring work]

Danger

- The equipment must be correctly grounded using the designated grounding terminals where they exist. Failure to do so may lead to the risk of electric shock, equipment failure, malfunction or failure to operate.
- Be sure to return all terminal covers, protection covers to their original positions once any work is complete. If they remain uncovered there is a risk of electrical shock.

Caution

- Ensure that the equipment is mounted and connected correctly. Otherwise, there are risks of failure, burning, or mal-operation.
- Securely tighten the terminal connection screws. Otherwise, there are risks of failure and burning.
- Ensure that the equipment is connected correctly in accordance with the details shown on the connection terminals. Otherwise, there is the risk of failure, burning, malfunction, or maloperation.
- Ensure that the equipment is connected correctly in accordance with the phase sequence details shown on the connection terminals. Otherwise, there is the risk of failure, burning, malfunction, or maloperation.
- All power supplies to the equipment must be of suitable capacity and rated load to avoid the risk of malfunction and maloperation.
- The appropriate connectors must be used to ensure compatibility with the connector terminals to avoid the risks of failure or fire.

[Operating and Setting the equipment]

Danger

- The equipment must only be operated and handled by qualified personnel. Otherwise, there are risks of electric shock, injury, failure, malfunction, and maloperation.
- Handling and maintenance of the equipment must only be carried out after gaining a thorough understanding of the instruction manual. Otherwise, there is the risk of electric shock, injury, failure, malfunction, or maloperation.

Caution

- The equipment must be used within the following range limits. Otherwise, there is a risk of reducing the performance and life of the product.
  - Variation range of control power supply voltage — Within –15% to +10% of the rated voltage
  - Frequency variation — Within ±5% of the rated frequency
  - Ambient temperature — -10 to +55°C (-10 to 50°C is allowable temporarily within few hours a day, but use under the state where dew condensation or freezing does not occur.)
  - Altitude — 2000 m or lower
  - The state where abnormal vibration, shock, inclination, magnetic field are not applied
  - The state where it is not exposed to harmful smoke/gas, saline gas, water droplet or vapor, excessive dust or fine powder, explosive gas or fine powder, wind & rain.
- While energized, do not tamper with or remove any components other than those which have been designated. Otherwise, there is a risk of failure, malfunction, or maloperation.
- When changing the setting value during the energized state, ensure that all trip circuits are locked in order not to operate. Otherwise, there is a risk of malfunction.

[Maintenance and Inspection]

Danger

- ●The equipment must only be operated and handled by qualified personnel. Otherwise, there are risks of electric shock, injury, failure, malfunction, and maloperation.
- ●Handling and maintenance of the equipment must only be carried out after gaining a thorough understanding of the instruction manual. Otherwise, there is the risk of electric shock, injury, failure, malfunction, or maloperation.
- ●Do not touch any live parts, such as terminals, etc. Otherwise, there is a risk of electric shock.

Caution

- ●When replacing the equipment, use a product of same model, rating, and specifications. Otherwise, there is the risk of failure or fire. If any other product is to be used, the manufacturer must be consulted.
- ●We recommend that any tests or inspections are carried out under the following conditions, as well as any additional conditions described in the instruction manual.

• Ambient temperature	20 ± 10°C
• Relative humidity	90% or less
• External magnetic field	80 A/m or less
• Atmospheric pressure	86 to 106 × 10^3 Pa
• Mounting angle	Regular direction ±2°
• Frequency	Rated frequency ±1%
• Waveform (in the case of AC)	Distortion factor 2% or less

$$\text{Distortion factor} = \frac{\text{Effective value of higher harmonics only}}{\text{Effective value of fundamental wave}} \times 100\ (\%)$$

• AC component (in the case of DC)	Ripple factor 3% or less

$$\text{Ripple factor} = \frac{\text{Max. value} - \text{Min. value}}{\text{Average value of DC}} \times 100\ (\%)$$

• Control power supply voltage	Rated voltage ±2%

- ●Do not exceed the overload capacity for voltage and current. Otherwise,equipment failure or fire could occur.
- ●Do not clean the equipment while energised. When the cover needs to be cleaned, make use of a damp cloth.

[Repair and modification]

Caution

- ●When carrying out repair and/or modification, please consult with the manufacturer in advance.of carrying out the work. We will not take any responsibility for any repair and/or modification (including software) which has been carried out without prior consent.

[Disposal]

Caution

- ●Disposal must take place in accordance with the applicable legislation

- Guarantee -

1. Guarantee period

The guarantee period of this product should be one year after delivery, unless otherwise specified by both parties.

2. Scope of guarantee

When any fault or defect is detected during the period of guarantee and such fault or defect is proved to be caused apparently at the responsibility of MITSUBISHI ELECTRIC CORPORATION, the defective unit concerned will be repaired or replaced with substitute with free of charge.
However, the fee for our engineer dispatching to site has to be covered by the user.
Also, site retesting or trial operation caused along with replacing the defect units should be out of scope of our responsibilities.
It is to be acknowledged that the following faults and defects should be out of this guarantee.
(1) When the faults or defects are resulted from the use of the equipment at the range exceeding the condition/environment requirements stated in the catalogue and manual.
(2) When the faults or defects are resulted from the reason concerning without our products.
(3) When the faults or defects are resulted from the modification or repair carried out by any other entity than MITSUBISHI ELECTRIC CORPORATION.
(4) When the faults or defects are resulted from a phenomenon which cannot be predicted with the science and technology put into practical use at the time of purchase or contract
(5) In case of integrating our products into your equipment, when damages can be hedged by the proper function or structure in the possession of your equipment which should be completed according to the concept of the de fact standard of industry.
(6) In case of that the faults or defects are resulted from un-proper application being out of instruction of MITSUBISHI ELECTRIC CORPORATION.
(7) In case that the faults or defects are resulted from force majeure such a fire or abnormal voltage and as an act of God such as natural calamity or disaster.

3. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, MITSUBISHI ELECTRIC CORPORATION shall not be liable for compensation of damages caused by any cause found not be the responsibility of MITSUBISHI ELECTRIC CORPORATION, loss in opportunity, lost profits incurred to the user by failures of MITSUBISHI ELECTRIC CORPORATION products, special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than MITSUBISHI ELECTRIC CORPORATION products and other tasks.

4. Applications of products

(1) The user is requested to confirm the standards, the regulations and the restrictions which should be applied, in case of utilizing products described in this catalogue and another one in combination.
Also, the user is requested to confirm the suitability of our products to your applied system or equipment or apparatus by yourself.
MITSUBISHI ELECTRIC CORPORATION shall not be liable for any suitability of our products to your utilization.
(2) This MITSUBISHI ELECTRIC CORPORATION products described in the catalogue have been designed and manufactured for application in general industries, etc. Thus, application in which the life or an asset could be affected by special application such as medical system for life-sustaining, in nuclear power plants, power plants, aerospace, transportation devices(automobile, train, ship, etc.) shall be excluded from the application. In addition to above, application in which the life or an asset could be affected by potentially chemical contamination or electrical interference and also in which the circumstances and condition are not mentioned in this catalogue shall be excluded from the application.
Note even if the user wants to use for these applications with user's responsibility, the user to be requested to approve the specification of MITSUBISHI ELECTRIC CORPORATION products and to contact to the technical section of MITSUBISHI ELECTRIC CORPORATION prior to such applications.
If the user applies MITSUBISHI ELECTRIC CORPORATION products to such applications without any contact to our technical section, MITSUBISHI ELECTRIC CORPORATION shall not be liable for any items and not be insured, independently from mentioned in this clause.
(3) In using MITSUBISHI ELECTRIC CORPORATION product, the working conditions shall be that the application will not lead to a major accident even if any problem or fault occur, and that backup or duplicate system built in externally which should be decided depend on the importance of facility, is recommended.
(4) The application examples given in this catalogue are reference only and you are requested to confirm function and precaution for equipment and apparatus and then, use our products.
(5) The user is requested to understand and to respect completely all warning and caution items so that unexpected damages of the user or the third party arising out of un-correct application of our products would

not be resulted.

5. Onerous repair term after discontinuation of product

(1) MITSUBISHI ELECTRIC CORPORATION shall accept onerous product repairs for 7 (seven) years after production of the product is discontinued. (However, please consider the replacement of products after 15 years have been passed from ex-work of products.)
(2)Product supply (including repair parts) is not available after production is discontinued.

6. Changes in product specification

The specification given in the catalogue, manuals or technical documents are subject to change without prior to notice.

7. Scope of service

The technical service fee such as engineer dispatching fee is excluded in the price of our products.
Please contact to our agents if you have such a requirement.

- Introduction -

Thank for your purchasing MITSUBISHI ELECTRIC ***MELPRO***™ – S Series Digital Protection Relay.
Please read this instruction manual carefully to be familiar with the functions and performances enough to use the product properly.
It is necessary to forward this instruction manual to end users and a person in charge of maintenance.

This “MODBUS Instruction Manual” explains MODBUS communication and how to use it.
The main function of the MELPRO-S series–such as protection function overview, operation method– are shown in the each instruction manuals.

- Table of contents -

1. Features

Flexible and reliable protection functions

- Fine setting step of protection elements enables flexible use for various applications.
- 16 kinds of operation time characteristics and wide setting range of time multiplier is available for overcurrent protection element.
- Fault record function (10 records at a maximum) is provided for fault analysis.
- Modbus interface using RS-485 is provided for remote communication.
- Password-protected human-machine interface enables secured operation.

Highly Accurate Digital Computation

- The digital computation using high-speed sampling minimizes the effect of harmonics, etc., and provides highly accurate protection.

Self-diagnosis

- The continuously monitoring of electronic circuits from input to output can detect internal failure before the failure causes damage on the power system.

Compact size

- The compact relay designed for space-saving is suitable for replacement of existing ones.

Energy saving

- Low power consumption of the relay is effective in miniaturization of CT and VT as well as energy saving.

Fig. 1-1 Front view of MELPRO-S Series

2. Hardware specification

2.1. System configuration

The system configuration of MODBUS communication is shown in Fig. 2-1.

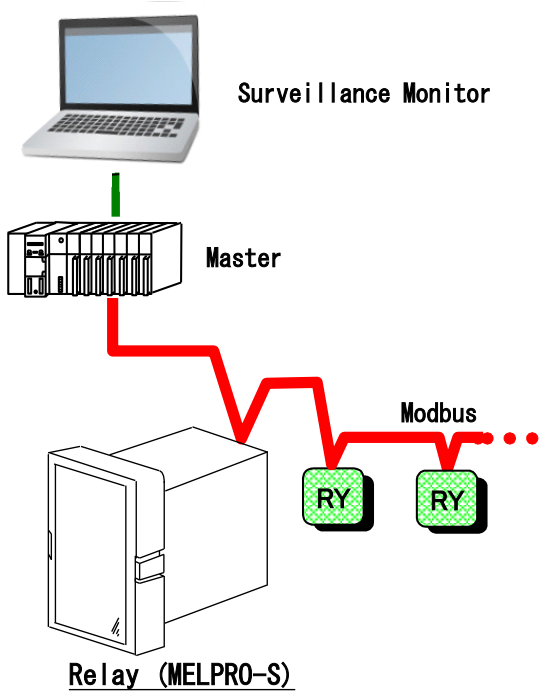


Fig. 2-1 MODBUS system configuration

2.2. Wiring diagram and terminals

The twisted pair cables are recommended to connect between the master and slave units.
Fig. 2-2 shows overview of Modbus wiring diagram between master and slave devices.

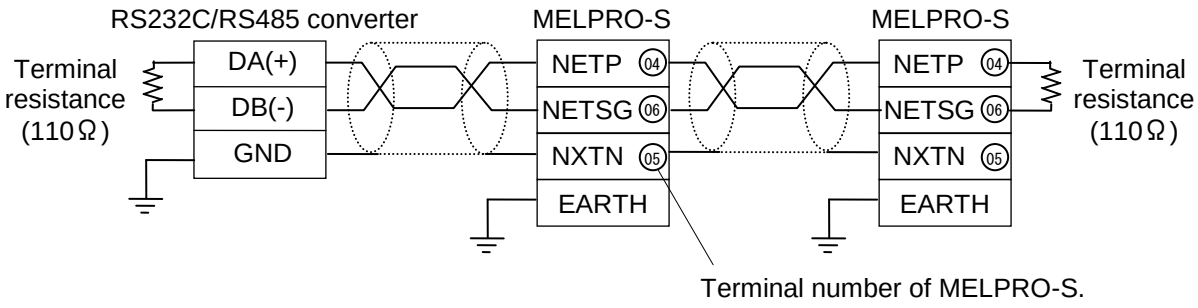


Fig. 2-2 Wiring diagram

Table 2-1 and Fig. 2-3 show the signal assign for Modus connection terminal.

Table 2-1 Signal assign, signal details and terminal no.

Detail	Signal Name	Terminal No	Terminal No	Signal Name	Detail
	−	02	01	AUX (+)	
Modbus RS485 Data (+)	NETP	04	03	AUX (-)	
Modbus RS485 Data (−)	NETSG	06	05	NXTN	Modbus RS485 Communication cable GND.
Digital output for alarm signal by b-contact. In healthy condition, this contact keeps opening.	ALARM	08	07	ALARM	Digital output for alarm signal by b-contact. In healthy condition, this contact keeps opening.
(Note 1)	Annunciator contact	10	09	Annunciator contact	(Note 1)
		12	11		
(Note 1)	Trip Contact	14	13	Trip Contact	(Note 1)
(Note 1)	Negative (−) side of analogue input	16	15	Positive (+) side of analogue input	(Note 1)
		18	17		
		20	19		
		22	21		

Note 1: The functions of these terminals are depending on each protection device. Please refer to instruction manual of each the relay model.

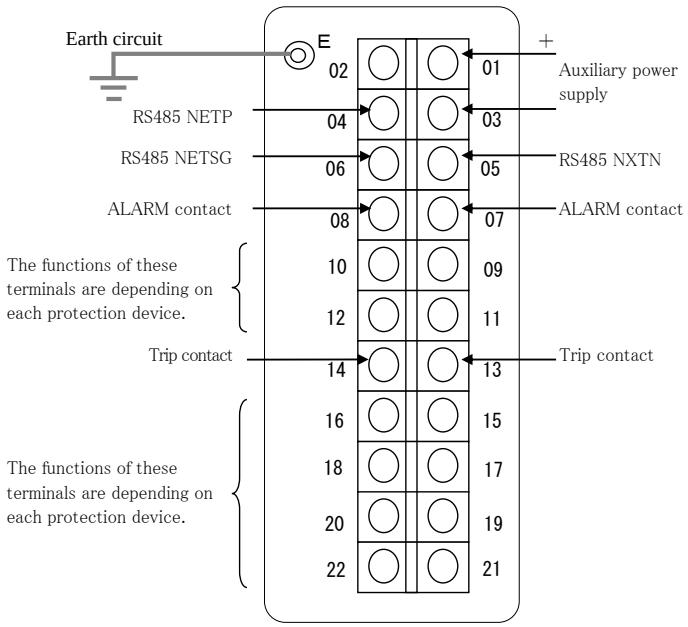


Fig. 2-3 Back view and terminal assign

2.3. Communication cable specification

A general specification of the communication cable is shown in Table 2-2.

Table 2-2 Communication cable specification

Items	Specifications
Cable type	Twist pair cable
Conductor size	0.5 mm^2 or smaller
Conductor resistance	38 Ω/km or less
Insulation resistance	10000 MΩ-km or less
Withstand voltage	DC 500 V, 1 min.
Static capacity	60 nF/km or less
Characteristic impedance	110 Ω

3. Communication specification

3.1. Transmission specification

Table 3-1 Transmission specification

Item		Specifications
Interface		RS-485
Transmission method		Half duplex transmission
Communication speed		19200 bps
Data form	Transmission mode	RTU
	Start bit	1
	Data bit	8
	Parity bit	None
	Stop bit	1
Error detection		CRC
DTR/DSR(ER/DR) control		None
Number of slave connection		31 (Slave address can set 1 ~ 31)
Transmission distance		1200m
Topology		Multi-drop system
Cable		Twisted pair cable
Terminal resistance		110 Ω

3.2. MODBUS Protocol and Frame Data

The transmission frame is composed as follows.

Table 3-2 Data frame

#1	Slave No.	Function Code	Byte Counter	Data	CRC Check	#1
	8 bits	8 bits	1 byte	8 bits * N	16 bits	

		N: Maximum data size is 251 bytes
	Slave (station) number can be set between 1 and 31.	
	A slave number 0 (broadcast frame) is NOT supported in this relay.	

This frame (#1) indicates 3.5 character times.
This frame is inserted at the head and the end of the message.

3.3. Function Code (FC)

This protection relay supports the following function codes.

Table 3-3 Function Code (FC) and Modbus Address table

FC	Contents	Accessible data quantities per one message (Note 1)	MODBUS Address (Note 2)
2	Read Input Status. (A binary information such as LED status, DI status, etc.)	1 – 2000	10001-19999
3	Read Holding Registers. Read the slave (relay) data (fixed value) (Setting of word-unit information, etc.)	1 – 125	40001-49999
4	Read Input Registers. Read the slave (relay) data (input value) (Analog information of word-unit information, etc.)	1 – 125	30001-39999
5	Force Single Coils. Change the slave (relay) ON/OFF (1 address). (e.g. Forced operation to change the value that becomes a binary information)	1	00001-09999
6	Preset Single Registers. (Setting to change the value that serves as the word unit)	1	40001-49999

Note 1: Accessible data quantities per one message

This figure shows the maximum number of points in each function code on the Modbus protocol. But, in actual situation, the number of accessible points per message in this relay varies depending on the address to access, etc. For further details, see sub-clause 3.2.

Note 2: MODBUS address

Addresses that can be used for the function code on the Modbus protocol. For the addresses that can be actually used in this relay, see Modbus Address Map.

3.4. Diagnostic Sub-function and Exception Response

This protection relay does NOT support the diagnostic sub-function and the exception response.
When this relay receives exception message (e.g.: undefined function, undefined address, undefined data value, and value outside the setting range), the protection relay discards the received data.
In this case, the relay does NOT return any response to the master device.
Therefore, in the master device, operate the retry after the elapse of a time-out period.

3.5. Communication abnormality

In case of the received data under the abnormal condition (communication abnormality or communication failure), the relay discards the received data.
The protection relay does NOT return any response to the master device.
Therefore, in the master device, operate the retry after the elapse of a time-out period.

Example case of assuming abnormal condition is as follows:

- CRS check error (CRC-16)
- RS485 communication error (overrun error or framing error)
- Oversize error (in case of receiving data beyond 256 bytes)
- Short frame error
- Receive timing error

3.6. Polling Intervals

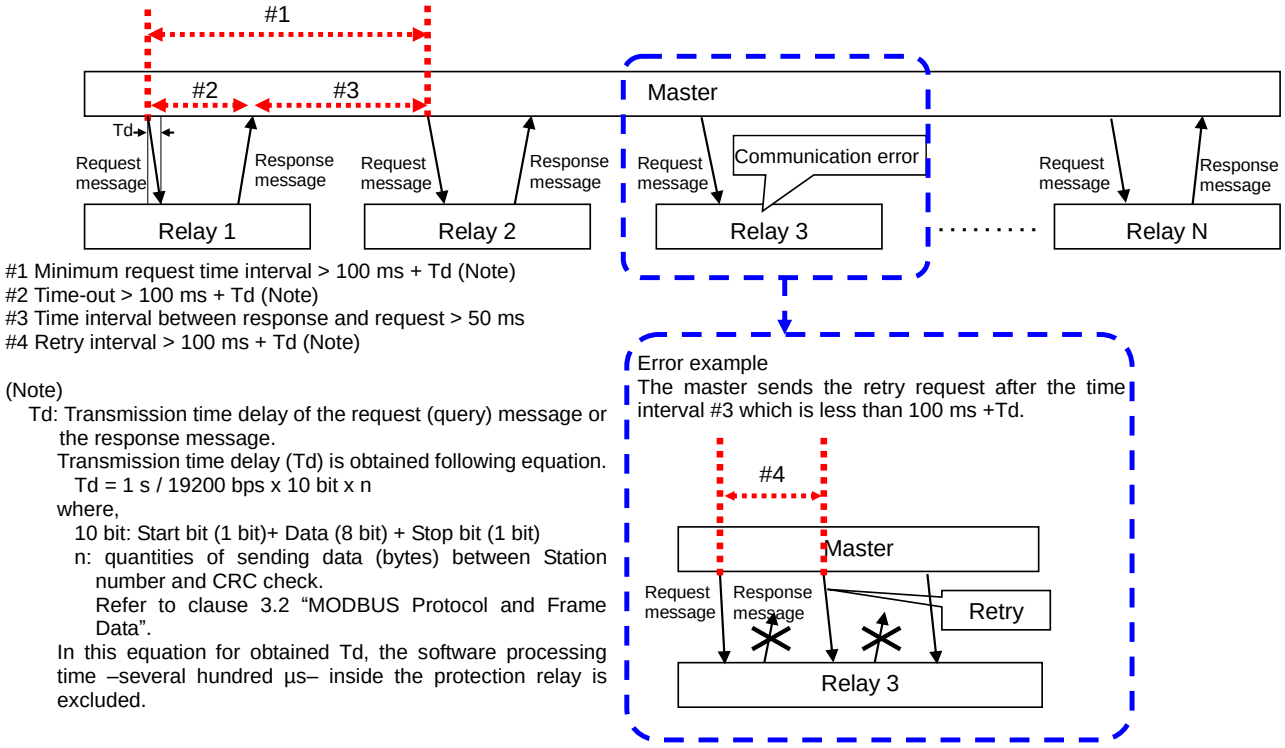


Fig. 3-1 Polling interval timing chart

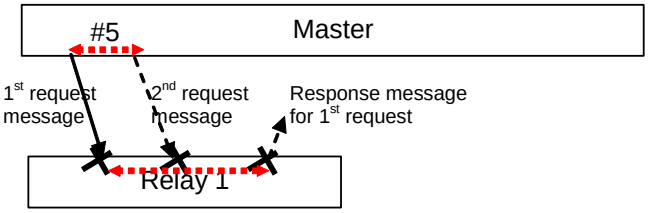
Important
For this protection relay DON'T break rule both (1) and (2).
The request (query) is NOT accepted even if received data deviates either (1) or (2).

(Rule 1) Request time interval from master should be set greater than 100 ms + Transmission time delay (Td), at least.
→ Refer to the time interval #1 in Fig. 3-1.

(Rule 2) Request time interval between the response message from relay and request message from master should be set greater than 50 ms, at least.
→ Refer to the time interval #3 in Fig. 3-1.

When the requests send with the time interval less than 100 ms, the protection relay may not process the request normally. Some examples are as follows.

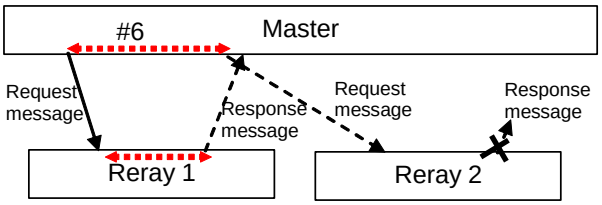
(1) When the retry time interval is less than 100 ms, not only first and second requests are discarded, but also the response message for first request is discarded.



#5 Retry request time interval < 100 ms

Fig. 3-2 Error example of the short request time interval
The protection relay cannot send response for all request.

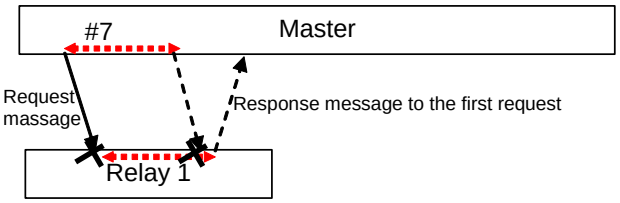
(2) When the response message overlaps request message for another slave relay, the Sending and receiving process may not succeed.



#6 Request time interval < 100 ms + Td
Td: Transmission time delay of the request (query) message or the response message.

Fig. 3-3 Error example of message overlap

(3) When the retry time interval is less than 100 ms + Td, second request may be discarded and the response message to the “first” request may be returned in some cases.
Therefore, the master device would be difficult to associates the received message with the first request.



#7: Retry time interval < 100 ms + Td
Td: Transmission time delay of the request (query) message or the response message.

Fig. 3-4 Error example of the short request interval
The protection relay send response for “first” request.

3.7. Update cycle in the protection relay

Following items are always updated in the relay, even if no request from a master.

3.7.1. All data in the relay are updated once

The items as mentioned update cycle include the real time measuring value and the front panel LED conditions.

COC Series approx. 130s
CBV Series approx. 100s

3.7.2. The real-time measurement value

The items as mentioned update cycle include the digital inputs and the self-diagnosis results.

COC Series approx. 2.3s
CBV Series approx. 2.0s

3.7.3. State of LED on the front side of the relay

All relays approx. 100ms

3.7.4. Initialized condition

After this protection relay starting up, the waiting time until the master can collect each data in the relay is shown above sub-clause 3.7.1.

3.8. Time-out

3.8.1. Setting

For the following communication items, time-out is set forth between when the relay receives the setting request and when the relay receives the operation request.
If the interval prolongs over the time-out, the master should once again repeat from the setting request.

Table 3-4 Time-out duration

Communication item	Time-out duration
Enable new setting value	About 60 sec
Forced operation execute	About 60 sec

3.9. Communication Item with Long Processing Duration

For the following communication items, the time is required after the master has sent a request to the relay until the relay completes processing.

Table 3-5 Time until activated new setting

Communication item	Time until activated new setting
Setting value operation	About 5 sec.

3.10. Modbus Address Map

The following table shows the contents assigned to the Modbus Address Map. For the detailed contents of assignment, see each protection relay type's address map.

Table 3-6 Modbus address map

Modbus address	Number of data	Function Code (FC)	Detail
00001	1	5	Reset LED
00002	1	5	Delete fault record
00003	1	5	Delete self-diagnosis
00004	1	5	Spare Note: when read this address, return data is zero.
00005	1	5	Execute setting operation
0006～00026	1	5	Set forced operation
00027	1	5	Execute forced operation
10001	1	2	Self-diagnosis results
10002	Spare	—	— Note: when read this address, return data is zero.
10003～10015	13	2	Read LED
10016	Spare	—	— Note: when read this address, return data is zero.
10017～10176	160	2	Read fault (operation element) record
10177～10208	32	2	Read self-diagnosis item
10209～10216	—	—	— Note: when read this address, return data is zero.
30001～30048	48	4	Read real-time measurement
30049～30138	—	—	— Note: when read this address, return data is zero.
30139～30179	Spare	—	Spare Note: when read this address, return data is zero.
30180～30419	240	4	Read fault record value (1st – 10th phenomena)
30420～33107	—	—	— Note: when read this address, return data is zero.
40001～40062	62	6 3	Read/set setting
40063～40064	Spare	—	Spare Note: when read this address, return data is zero.
40065～40110	—	—	— Note: when read this address, return data is zero.

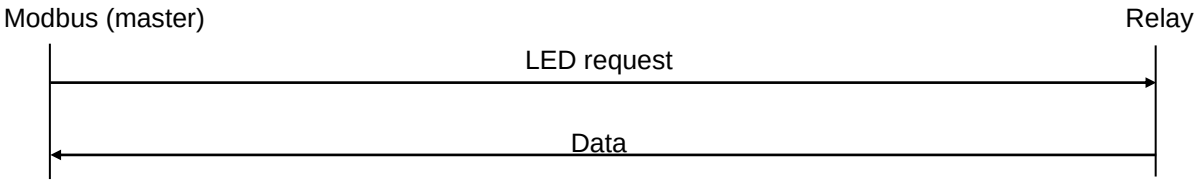
4. Communication Interface

This chapter shows the communication processing and the operating suggestion which is indicated as <ATTENTION>.
Please also comply with chapter 5. Precautions on Programming.

4.1. Read / Reset Front LED

4.1.1. Read Front LED (FC: 2)

(1) Interface Procedures



(2) Data Format

Modbus Address	Item	Contents of data (1 bit)
10002	Reserved	• Light ON LED: 1 Light OFF LED: 0 • For the detailed contents of assignment, see each protection relay type's address map. • The “Reserved” means not assigned elements.
10003	LED condition on front panel	
～		
10008	LED condition on front panel	
10009	Reserved	
～		
10015	Reserved	

If the master requests some items, the data contains 8 bits.

<Example>

- Request message
  Starting position of reading Modbus address: 100003
  Number of reading register: 4
  (These settings comply Function Code 2)

- Condition of lighted LED
  The phase-A trip LED (Modbus address= 10003) and zero-sequence trip LED (Modbus address= 10006) is ON in relay model COC4.

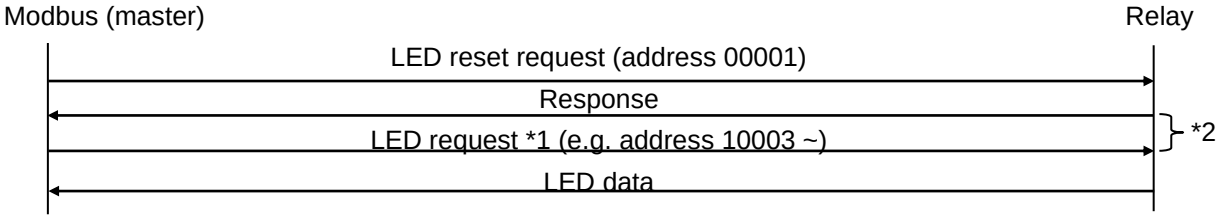
- Received data
  0x 09 (hex) = 1001 (Bin)
  The binary data means following.
  1 0 0 1 (Bin)
  | |
  | Phase-A trip LED (Modbus address= 10003)
  Zero-sequence trip LED (Modbus address= 10006)

For the detail of the message flame of Modbus protocol, refer to section 3.2.

<ATTENTION>
When an auto-reset (self-reset) LED changing from ON to OFF while it is shorter than the polling cycle by the master device, this LED condition can NOT be read.

4.1.2. Reset Front LED (FC:5)

(1) Interface Procedures



*1: The “LED request” query is an example process to confirm the success of “LED reset request”.
This step would be not necessary. However, it can make sure confirm the success the reset query by the “LED request” query after the “LED reset request”.
The master device can send other query without the “LED request” when the protection relay successful complete the “LED reset request”.
The details of “LED request”, refer to sub-clause 4.1.1.

*2: Sends the “LED request” query after the update cycle. Refer to sub-clause 3.7.3 for confirming the update cycle.

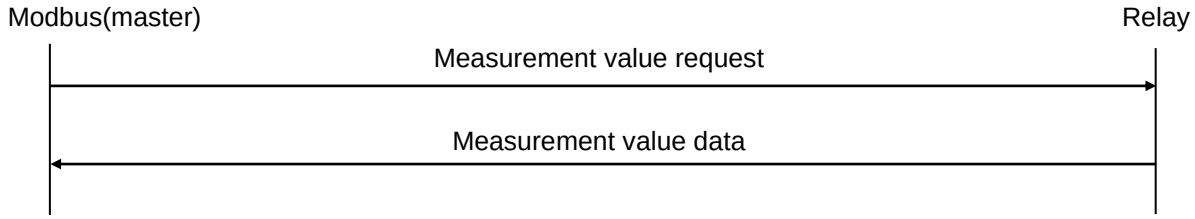
(2) Relationship of LED Condition

These query can be read the actual LED conditions on the front panel of the protection relay.
If LEDs are reset by the reset switch on the front panel, the LED conditions which read data by a master device are also turn off.
Of course, the actual LEDs on the front panel can be turned off by “LED reset request” query.

4.2. Read Measurement

4.2.1. Read Real-Time Measurement (FC: 4)

(1) Interface Procedures



(2) Data Format

Modbus Address	Item	Contents of data (16 bit)
30001	Measurement 1	• For the detailed contents of assignment, see each protection relay type's address map. • The “Reserved” means not assigned elements. • For data format, see following example.
~	⋮	
30048	Measurement 48	

(3) Raw Data and Decode

The raw data of sent value is encoded data.
Please decode the read raw data to indicate the measurement values.

One measurement value is contained 16 bits.
From LSB (0 bit) to 9th-bit are analogue data without a decimal point. By dividing this received data by 100, the actual measurement value can be obtained.
From 10th-bit to 13th-bit means the exponent of 10.
The 14th-bit is a sign of the exponent of 10. Plus sign (+) is indicated 0, and minus sign (−) is indicated 1.
The MSB (15 bit) is a sign of the analogue value. The plus sign (+) is indicated as 0, and the minus sign (−) is indicated as 1.

<Example>
Actual measured value : 5.25(A)
Received data: 0b 0 0 0 0 0 0 1 0 0 0 0 0 1 1 0 1
p q r s
The actual measured value is obtained by following equation.

$$\text{Actual measured value} = (-1)^{p} \times \frac{s}{100} \times 10^{(-1)^{q} \times r}$$

- s: LSB ~ 9th-bit
  1 0 0 0 0 0 1 1 0 1 (Bin) = 20D (Hex) = 525 (Dec)
  The actual measured value is obtained by dividing the received data by 100.
  525 / 100 = 5.25 [A]

- r: 10th-bit ~ 13th-bit
  In this case, these data are zero.
  Therefore, the data which exponent of 10 is zero.

- q: 14th-bit
  In this case, this data is zero.
  Therefore, the sign of exponent of 10 is plus (+).

  From r and q, it indicates $10^{qr} = 10^{+0}$

- p: 15th-bit
  In this case, this data is zero.
  Therefore, the sign of analogue measured vale is plus (+).

As a result, the actual measured value is obtained as follows.

$$(-1)^{p} \times \frac{s}{100} \times 10^{(-1)^{q} \times r} = (-1)^{0} \times \frac{525}{100} \times 10^{(-1)^{0} \times 0} = 1 \times \frac{525}{100} \times 10^{0} = 5.25[A]$$

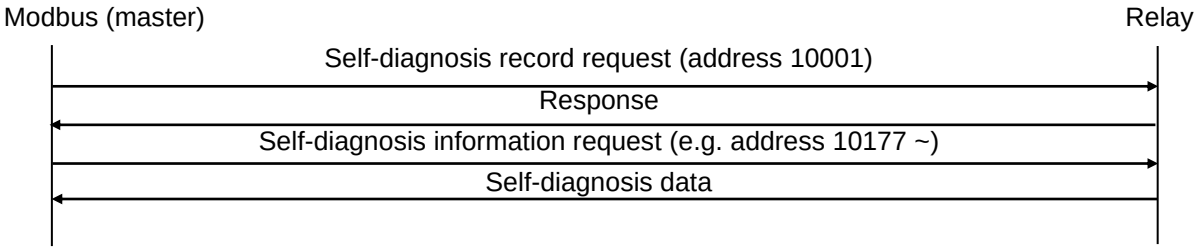
<ATTENTION>

- Please also comply with chapter 5. Precautions on Programming.
- The measured timing of the measurement value would NOT match of the request timing from a master device.
  Therefore this measured value should NOT use for other control.
- In this measured value, the harmonic elements are eliminated by the protection relay's filters. The different value would be appeared between this measured value from protection relay and an electrical indicators (e.g. voltage meter or current meter).
  Therefore this measured value should NOT use for other control.

4.3. Read / Reset Self-Diagnosis

4.3.1. Read Self-diagnosis (FC: 2)

(1) Interface Procedures

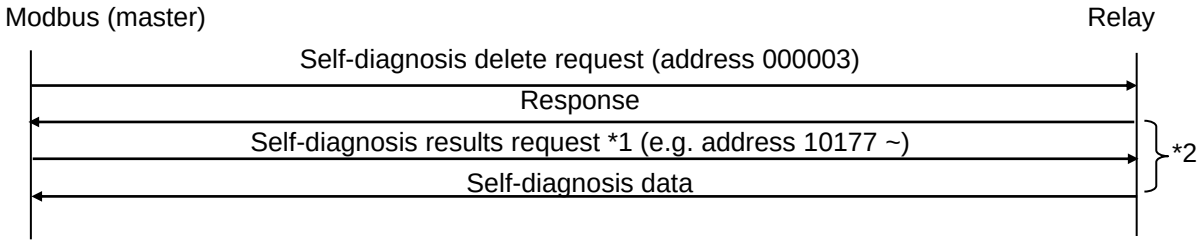


(2) Data Format

Modbus Address	Item	Contents of data (1 bit)
10001	Self-diagnosis results	• Abnormal condition: 1 • Normal condition: 0
10177	ROM check	
10178	RAM check	
10179	Reserved	
10180	A/I check	
10181	A/D check	
10182	Reserved	
10183	Reserved	
10184	D/O status check	
10185	D/O operation check	
10186	Analog filter check	
10187	A/I duplex check	
10188	Reserved	
10189	EEPROM Check	
10190	Computation function check Arithmetic Function Check	
10191	WDT check	
10192	A/D accuracy check	
10193	Reserved	
10194	Reserved	
~		
10203		
10204	Reserved	
~		
10208		

4.3.2. Reset Self-diagnosis (FC: 5)

(1) Interface Procedures



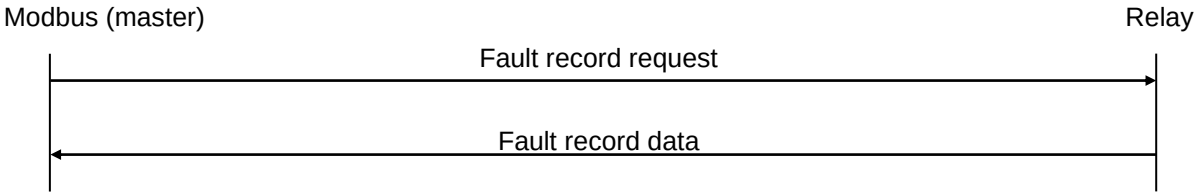
*1: The “Self-diagnosis information request” query is an example process to confirm the success of “Self-diagnosis delete”.
This step would be not necessary. However, it can make sure confirm the success the reset query by the “Self-diagnosis results request” query after the Self-diagnosis delete”.
The master device can send other query without the “Self-diagnosis results request” when the protection relay successful complete the “Self-diagnosis delete”.
The details of “Self-diagnosis”, refer to sub-clause 4.1.1.

*2: Sends the “Self-diagnosis” query after the update cycle. Refer to sub-clause 3.7.3 for confirming the update cycle.

4.4. Read /Reset Fault Record Data

4.4.1. Read Fault Measured Value (FC: 4)

(1) Interface Procedures



Sends the request after the update cycle. Refer to sub-clause 3.7.3 for confirming the update cycle.

(2) Data Format

Modbus Address	Item	Contents of data (16 bit)
30180	First (latest) fault record data Measured value 1	• Record values 1 – 24 according to the model. See each address map. • The “Reserved” means not assigned elements. • For data format, see following example.
30181	First (latest) fault record data Measured value 2	
~	⋮	
30202	First (latest) fault record data Measured value 23	
30203	First (latest) fault record data Measured value 24	
30204	Second fault record data Measured value 1 – 24	
~		
30227		
30228	Third fault record data Measured value 1 – 24	
~		
30251		
30352	Fourth fault record data Measured value 1 – 24	
~		
30275		
30276	Fifth fault record data Measured value 1 – 24	
~		
30299		
30300	Sixth fault record data Measured value 1 – 24	
~		
30323		
30324	Seventh fault record data Measured value 1 – 24	
~		
30347		
30348	Eighth fault record data Measured value 1 – 24	
~		
30371		
30372	Ninth fault record data Measured value 1 – 24	
~		
30395		
30396	Tenth fault record data Measured value 1 – 24	
~		
30419		

(3) Raw Data and Decode

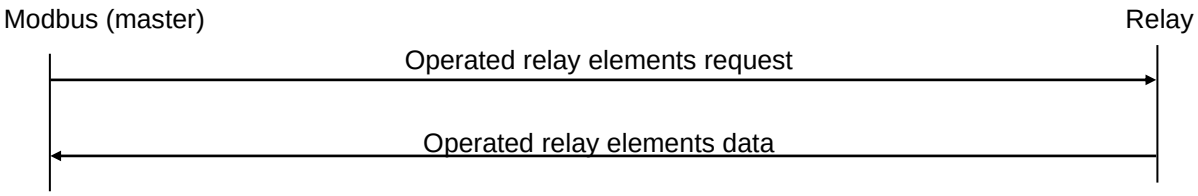
For the format of this fault record data, refer to sub-clause 4.2.1(3).

<ATTENTION>

- Please also comply with chapter 5. Precautions on Programming.
- The measured timing of the measurement value would NOT match of the request timing from a master device.
  Therefore this measured value should NOT use for other control.
- In this measured value, the harmonic elements are eliminated by the protection relay's filters. The different value would be appeared between this measured value from protection relay and an electrical indicators (e.g. voltage meter or current meter).
  Therefore this measured value should NOT use for other control.

4.4.2. Read Operated Relay Elements (FC:2)

(1) Interface Procedures



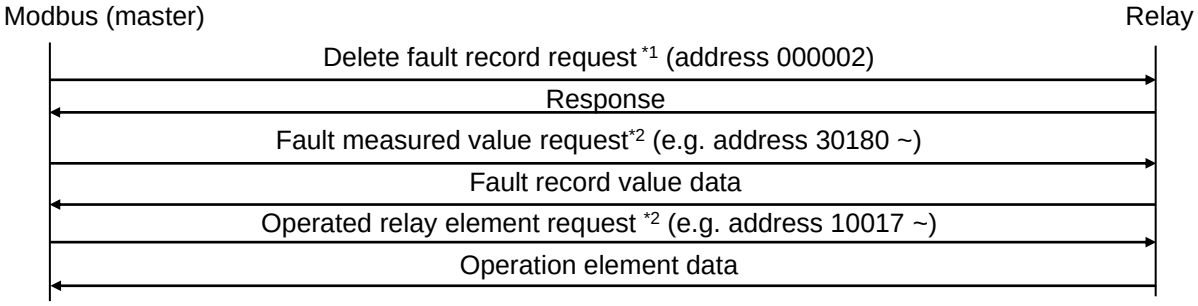
Sends the request after the update cycle. Refer to sub-clause 3.7.3 for confirming the update cycle.

(2) Data Format

Modbus Address	Item	Contents of data (1 bit)
10017	First (latest) fault record data Operated relay elements 1	• Operated: 1 No-operation: 0 • Record values 1 – 16 according to the model. See each address map. • The “Reserved” means not assigned elements.
10018	First (latest) fault record data Operated relay elements 2	
~	⋮	
10031	First (latest) fault record data Operated relay elements 15	
10032	First (latest) fault record data Operated relay elements 16	
10033 ~ 10048	Second fault record data Operated relay elements 1 − 16	
10049 ~ 10064	Third fault record data Operated relay elements 1 − 16	
10065 ~ 10080	Fourth fault record data Operated relay elements 1 − 16	
10081 ~ 10096	Fifth fault record data Operated relay elements 1 – 16	
10097 ~ 10112	Sixth fault record data Operated relay elements 1 – 16	
10113 ~ 10128	Seventh fault record data Operated relay elements 1 – 16	
10129 ~ 10144	Eighth fault record data Operated relay elements 1 – 16	
10145 ~ 10160	Ninth fault record data Operated relay elements 1 – 16	
10161 ~ 10176	Tenth fault record data Operated relay elements 1 − 16	

4.4.3. Reset (Delete) Fault Record (FC: 5)

(1) Interface Procedures



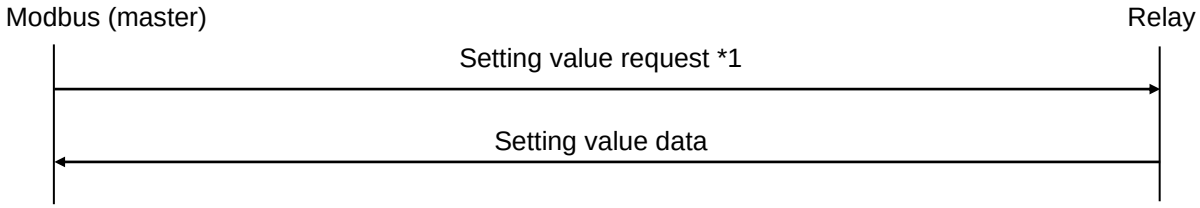
*1: By the “Delete fault record request”, all record data (such as operated elements, fault measured values) are deleted.

*2: The “Fault measured value request” and “Operated relay element request” query are example process to confirm the success of “Delete fault record request”.
This step would be not necessary. However, it can make sure confirm the success the reset query by the “Fault measured value request” or “Operated relay element request” query after the “Delete fault record request”.
The master device can send other query without these confirmation requests when the protection relay successful complete the “Delete fault record request”.
The details of “Fault measured value request” and “Operated relay element request”, refer to sub-clause 4.4.1 and 4.4.2.

4.5. Read and Set Setting Values

4.5.1. Read Setting Values (FC: 3)

(1) Interface Procedures



*1: For data bundle-read, pay due attention to the maximum number of address read points.

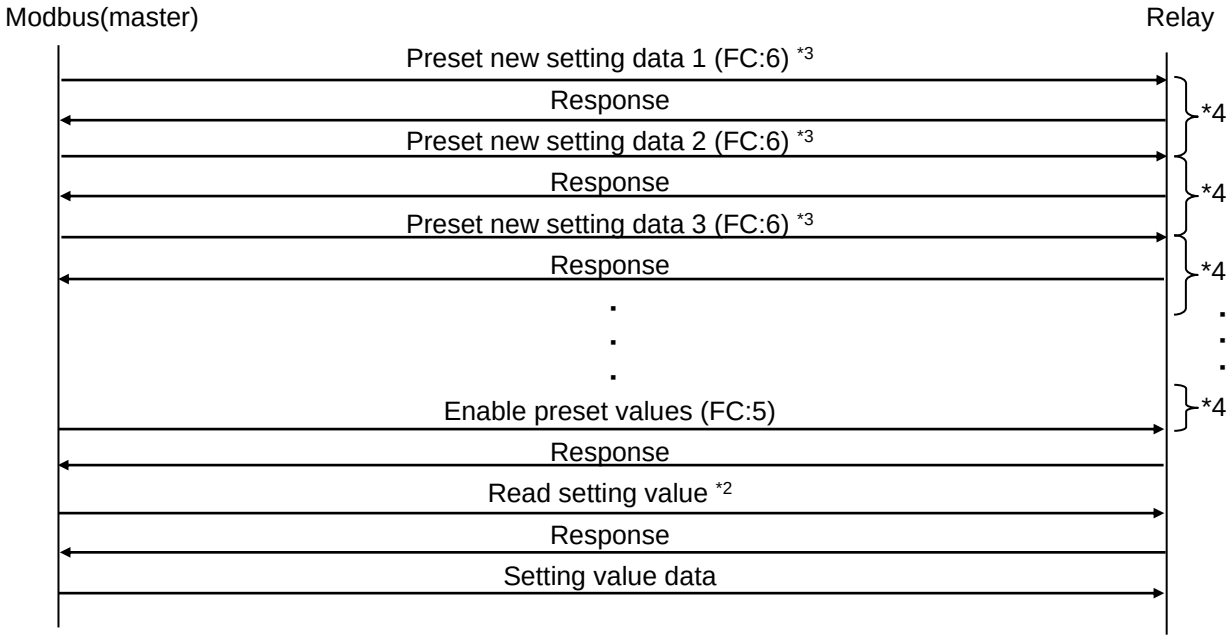
(2) Data Format

The received raw data is multiplied by 100 of the actual setting data.
The actual setting value is obtained by dividing the received raw data by 100.

<Example>
Actual setting value of overvoltage element in the relay: 150V
Received raw data: 11 1010 1001 1000 (Bin) = 3A98 (Hex) = 15 000 (Dec)

4.5.2. Set Setting Values (FC: 6 → 5)

(1) Interface Procedures



*2: The “Read setting value” is an example process to confirm the success of “Enable preset values” query.
This step would be not necessary. However, it can make sure confirm the success the reset query by the “Read setting value” query after the “Enable preset values”.
The master device can send other query without these confirmation requests when the protection relay successful complete the “Enable preset values” query.
The details of “Read setting value”, refer to sub-clause 4.5.1.

*3: This protection relay supports only Function Code 6 which is Preset Single Register.
This protection relay do NOT support Function Code 16 which is Preset Multiple Registers.

*4: The request period is less than 60 seconds between each message.
However the master must NOT send next other query before the receiving response message from the protection relay.
When a no-message period over 60 seconds even once is occurred, all sent data before enabling setting

are discarded.
When the period between sending new setting data and enabling setting data is less than 60 seconds data, a master device can send other request to this protection relay.

<ATTENTION>

- The relay does NOT send response message when the relay setting is sent via communication during the relay setting changing at front panel operation.
  In this case, send again the request after finishing the front panel operation.

- In case of sending out of range value, the relay does NOT send response message.

(2) Data Format

Modbus Address	Item	Contents of data (16 bit)
40001	Setting value 1	• Each setting value according to the model. See each address map. • The "Reserved" means not assigned elements. • For data format, see following example.
～	⋮	
40062	Setting value 62	
40063～40064	Not usable	

The setting data should be send multiplied by 100 of the actual setting data.

<Example>
Actual setting value of overvoltage element: 150V
Sending data: 15 000 (Dec) = 3A98 (Hex) = 0011 1010 1001 1000 (Bin)

(3) Exception Data Format

(A) Common Format for All Protection Relay Model

Data (HEX)	Detail
0x 270F	This value means "LOCK" setting of the relay element.

The prefix as "0x" means 16 bit (hex) data.

(B) For Relay Model = CBV2

Data (HEX)	Detail
0x 0457	This value means "INST" setting of the relay element.
0x 0000	This value means "OFF" setting of the Test Mode in the over/under voltage element.
0x 0001	This value means "AB-phase" setting of the Test Mode in the over/under voltage element.
0x 0002	This value means "BC-phase" setting of the Test Mode in the over/under voltage element.
0x 0003	This value means "CA-phase" setting of the Test Mode in the over/under voltage element.

The prefix as "0x" means 16 bit (hex) data.

(C) For Relay Model = COC4

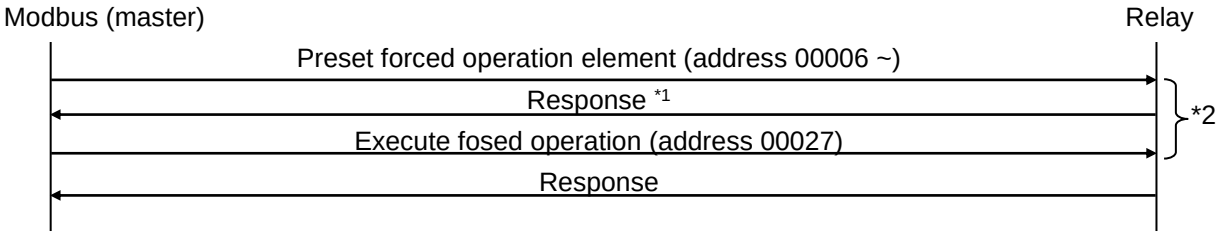
Data (HEX)	Detail
0x 0000	This value means “NI01” setting of the IDMT curve.
0x 0001	This value means “VI01” setting of the IDMT curve.
0x 0002	This value means “EI01” setting of the IDMT curve.
0x 0003	This value means “LI01” setting of the IDMT curve.
0x 0004	This value means “DT01” setting of the IDMT curve.
0x 0005	This value means “DT (Inst.)” setting of the IDMT curve.
0x 0006	This value means “NI11” setting of the IDMT curve.
0x 0007	This value means “EI11” setting of the IDMT curve.
0x 0008	This value means “EI12” setting of the IDMT curve.
0x 0009	This value means “NI21” setting of the IDMT curve.
0x 000A	This value means “VI21” setting of the IDMT curve.
0x 000B	This value means “LI21” setting of the IDMT curve.
0x 000C	This value means “MI31” setting of the IDMT curve.
0x 000D	This value means “NI31” setting of the IDMT curve.
0x 000E	This value means “VI31” setting of the IDMT curve.
0x 000F	This value means “EI31” setting of the IDMT curve.

The prefix as “0x” means 16 bit (hex) data.

4.6. Set Forced Operation

4.6.1. Set Forced Operation (FC: 5)

(1) Interface Procedures



*1: This response message send just preset address for confirmation.
The preset element is operated by “Execute fosed operation” query.

*2: The request period is less than 60 seconds between each message.
However the master must NOT send next other query before the receiving response message from the protection relay.
When a no-message period over 60 seconds even once is occurred, all sent data before enabling setting are discarded.
When the period between sending new setting data and enabling setting data is less than 60 seconds data, a master device can send other request to this protection relay.

<ATTENTION>

- The relay does NOT send response message when the relay setting is sent via communication during the relay setting changing at front panel operation.
  In this case, send again the request after finishing the front panel operation.

- By the specification of Function Code 5 which is Forced Single Coil, this query can operate the element one by one.

(2) Data Format

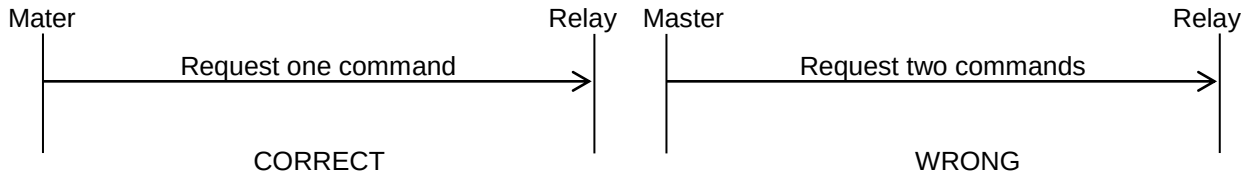
Modbus Address	Item	Contents of data (a bit)
00006	Contact 0	• Operation (ON): 1 No-operation (OFF): 0 • Each setting value according to the model. See each address map. • The “Reserved” means not assigned elements.
00007	Contact 1	
00008	Contact 2	
～	⋮	
00025	Contact 20	
00026	Contact 21	
00027	Forced operation execute	• Execute: 0x FF00 Normal condition (before execute): 0x 0000

5. Precautions on Programming

5.1. Number of Sending Message

Send one request in a one message. DON'T send any requests in one message.

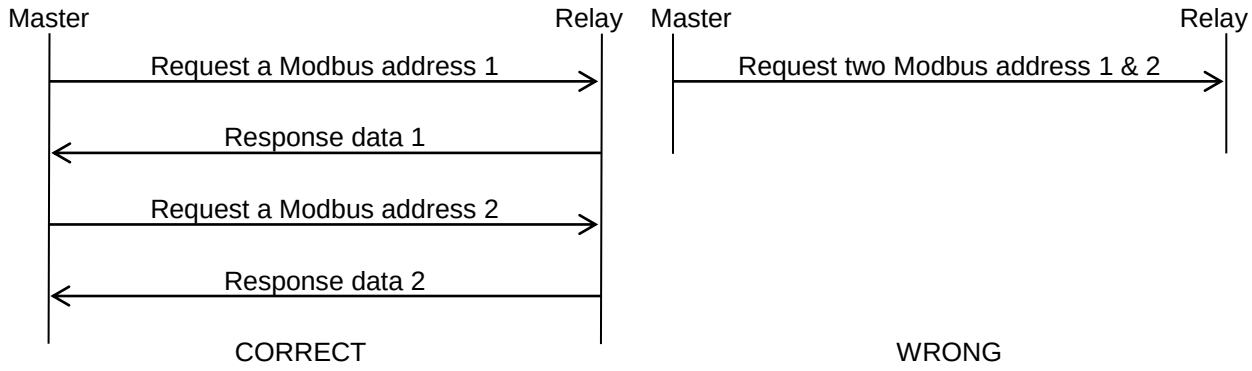
Related query:
- All request items



5.2. Number of Sending Modbus Address

Contain one Modbus address in a one message. DON'T send any Modbus address in one message.

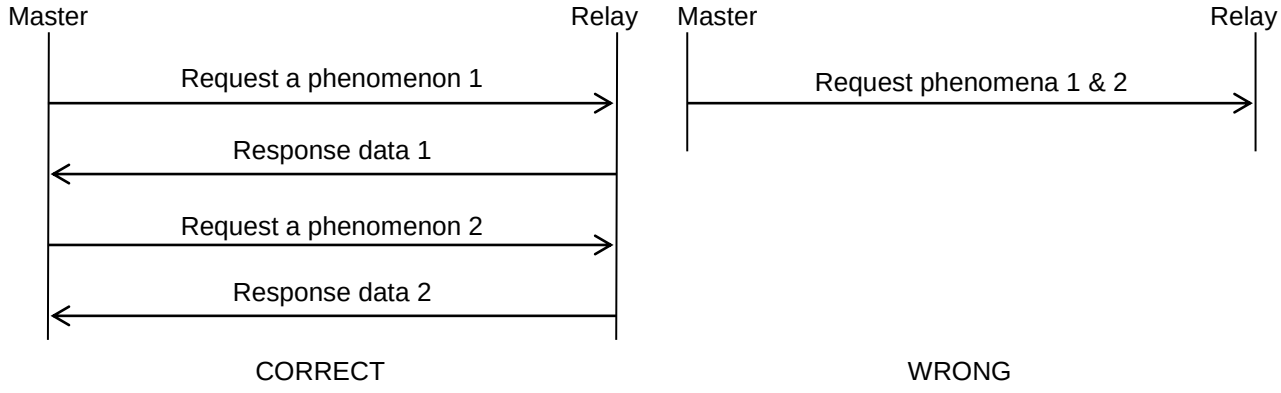
Related query:
- Read (get) setting data
- Read (get) real-time measuring value
- Read (get) fault measuring value
- Preset forced operation



5.3. Number of Requesting Fault Record Data

Request one fault record data in a one message. DON'T request any fault records in one message.

Related query:
- Read (get) fault record data of the operated element

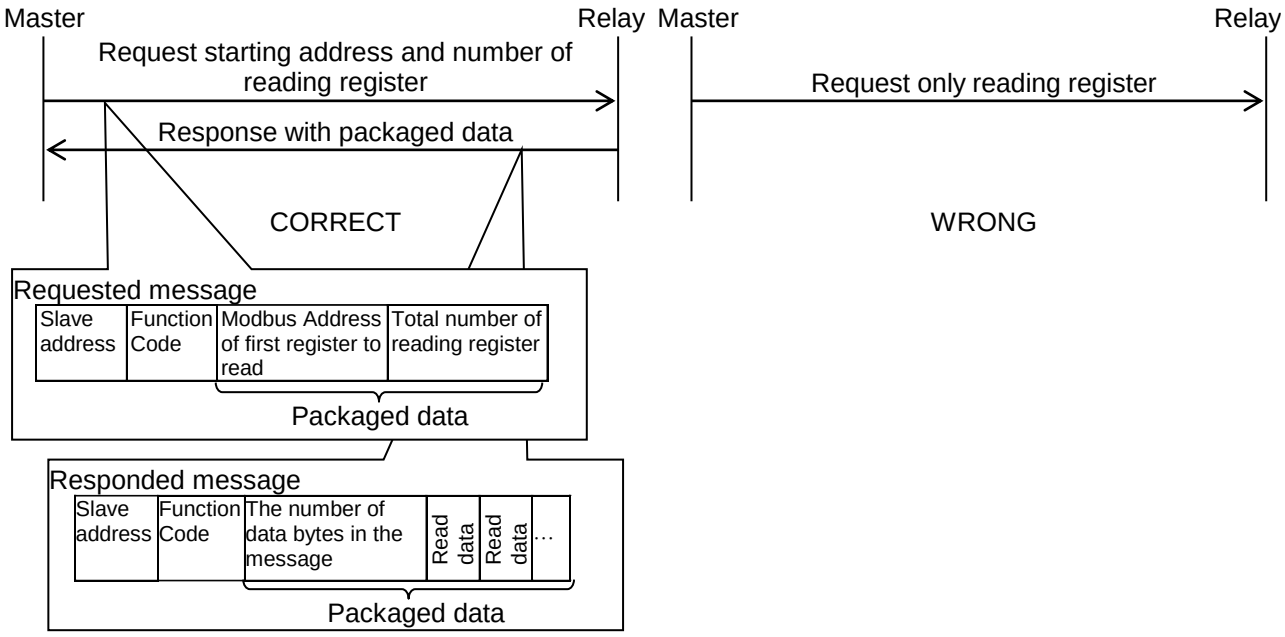


5.4. Number of Requesting Address (FC: 2)

Using Function Code 2, set the Modbus Address of the first register to read and the total number of reading register.
The responded data from the protection relay contains 8 bit as a one unit message.

Related query:

- Read (get) front LED condition
- Read (get) self-diagnosis condition



5.5. Interval Time of Sending Request

It is highly recommended that the master device sends the next request after the receiving the response data from the protection relay.
If the constructed system is not able to comply above sequence, the master device should be set 100 ms as the request interval.
Refer to section 3.6.

5.6. Real-Time Measurement Data against Noise in Communication Path

Before using the real-time measurement data, it is recommended that an average calculation is applicable as a pre-preceded for the measured data.
This is an example to be tolerance of a noise for the Modbus communication path.

5.7. Retry a Request Considering Slave Device Power Off

The master device should be implemented retrying a request.
This retry sequence is countermeasure against a situation that the protection relay cannot send a response (e.g. by auxiliary power off).

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: 7-3 MARUNOUCHI 2-CHOME, CHIYODA-KU TOKYO, 100-8310, JAPAN

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