INST.No.INE-363

CHINO

Three-Phase Thyristor Regulator

JW Series

Communication Interfaces

Instruction Manual

INSTRUCTIONS

Thank you for purchasing the JW Series of thyristor regulator.

♦ To use the instrument correctly and safely and to prevent troubles, read the manual carefully.

Note for Dealers and Instrument Suppliers	Note for Users
Be sure to deliver this manual to the final user.	Retain this manual carefully until the instrument is disposed of.

CHINO

— CONTENTS —

INTRODUCTION

This instruction manual describes exclusively the handling precautions and specifications of the communication interfaces (RS-422A/RS-485) of the setting communication unit for the JW Series.

Reference manuals

This instruction manual describes the “Communication Interfaces ” instructions only on the JW Series. For the descriptions on the thyristor regulators and the setting communication unit, refer to the separate manuals.

1) JW General (Instruction manual: INST. No. INE-361□)
1) JW Setting Communication Unit (Instruction manual: INST. No. INE-362□)

* In addition, refer to the instruction manual of the computer being used.

⚠ CAUTION

(1) The information given in this manual may be subject to change without notice.
(2) Every possible care was taken in compiling this manual. However, if you find a question, error or mistake in it, please contact your dealer or local CHINO agent.
(3) In spite of (2) above, CHINO does not assume any liabilities concerning the results of the instrument’s operation.

1 OUTLINE

When these communication interfaces are added to the JW series communication setting unit, the setting of parameters including the manual output, slope and elevation and information including the load voltage value, current value, power value, resistance value and alarm can be collected from a master unit (PC, PLC, etc.). Two communications interfaces, RS-422A and RS-485 are provided and can be selected by terminal connections. The communication protocol employs MODBUS for easy configuration of a system with other instruments using the same protocol.

1.1 RS-422A/485 Communication Interfaces

The RS-422A/485 communication interfaces allow multiple (up to 31) setting communication units and other units to be connected to a same communication line.
When a PC is used as the master unit, it may sometimes be required to use an RS-232C ⇔ RS-422A/485 signal converter. For this purpose, CHINO has a line converter (Model SC8-10) for RS-232C ⇔ RS-422A/485 signal conversion.
In the communication interfaces, the difference between RS-422A and RS-485 is that the RS-422A uses a total of 4 lines composed of 2 lines for sending and 2 lines for receiving, and the RS-485 uses 2 signal lines and switches sending and receiving.

1.2 Communication Protocol

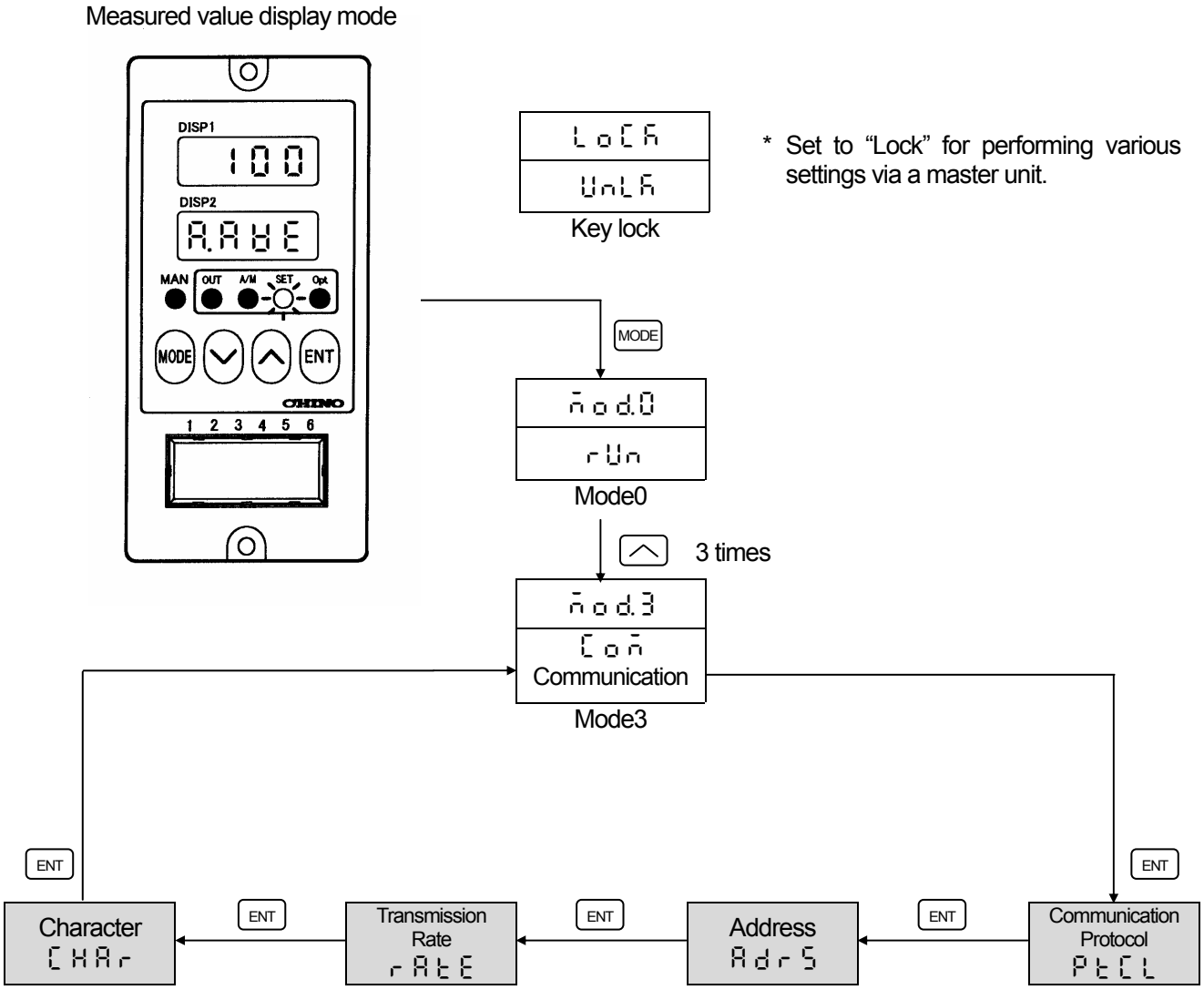
The communication protocol is the MODBUS protocol. (MODBUS is a registered trademark of Schneider Electric SA.)
The MODBUS protocol has the RTU and ASCII modes, which can be selected with the front function keys.

1.3 Communication Specifications

Communication type	: Half-duplex asynchronous type
Communication protocol	: MODBUS (RTU/ASCII)
Transmission rate	: 9200 bps, 9600 bps
Start bit	: 1-bit
Data length	: 7-bit (ASCII mode)
	: 8-bit (RTU mode/ASCII mode)
Parity bit	: None/Even/Odd
Stop bit	: 1-bit/2-bit
Communication code	: ASCII (ASCII mode)
	: Binary (RTU mode)
Error check	: LRC (ASCII mode)
	: CRC-16 (RTU mode)
	: Parity

2 COMMUNICATION PARAMETER SETTING

Set the four communication parameters of the communication protocol, address, transmission rate and character following the flowchart shown below.



Press MODE in any screen to return to Mode 3.

2.1 Communication Protocol (PtCL) Setting

(1) Press the [ENT] key to show [PtCL] in DISP2.

(2) Press the [∧] or [∨] key to select the protocol, and then press the [ENT] key to enter it.

Option	Protocol	Default
rtU	MODBUS RTU	rtU
ASC	MODBUS ASCII	

* Changing the communication protocol initializes the character to the default setting.

2.2 Address (AdrS) Setting

For 1 set or multiple sets of the setting communication unit to be communicated with a master unit (PC, PLC, etc.), an address not overlapping with the addresses of other setting communication unit should be set.

(1) Press the [ENT] key to show [AdrS] in DISP2.

(2) Press the [∧] or [∨] key to select the address (01 ~ 99), and then press the [ENT] key to enter it.

⚠ CAUTION

Each address should be between 01 and 99 and be set so that it does not overlap with addresses of other setting communication unit or other units on the same communication line. (Default: 01)

2.3 Transmission Rate (rAtE) Setting

The setting communication unit and a master unit (PC, PLC, etc.) should be run with the same transmission rate.

(1) Press the [ENT] key to show [rAtE] in DISP2 .

(2) Press the [∧] or [∨] key to select the transmission rate, and then press the [ENT] key to enter it.
Transmission rate: 9600 (9.6 k) or 19200 (19.2 k) bps (Default: 9600 bps)

2.4 Character (CHAr) Setting

(1) Press the [ENT] key to show [CHAr] in DISP2.

(2) Press the [∧] or [∨] key to select the character, and then press the [ENT] key to enter it.

Option	Bit length	Parity	Stop bit	Default
7E1	7-bit	Even	1	8n1
7E2			2	
7o1		Odd	1	
7o2			2	
8n1	8-bit	None	1	
8n2			2	
8E1		Even	1	
8E2			2	
8o1		Odd	1	
8o2			2	

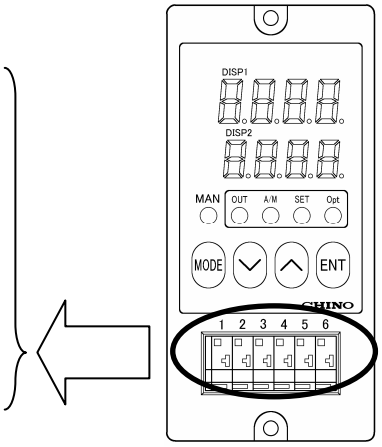
3 CONNECTIONS

3.1 Connection Precautions

3.1.1 Communication terminals

The terminal connection varies depending on the communication interface to be used.

No.	RS-422A	RS-485
(1)	SDA	SA
(2)	SDB	SB
(3)	RDA	Short with (1)
(4)	RDB	Short with (2)
(5)	SG	SG
(6)	(No Connection)	

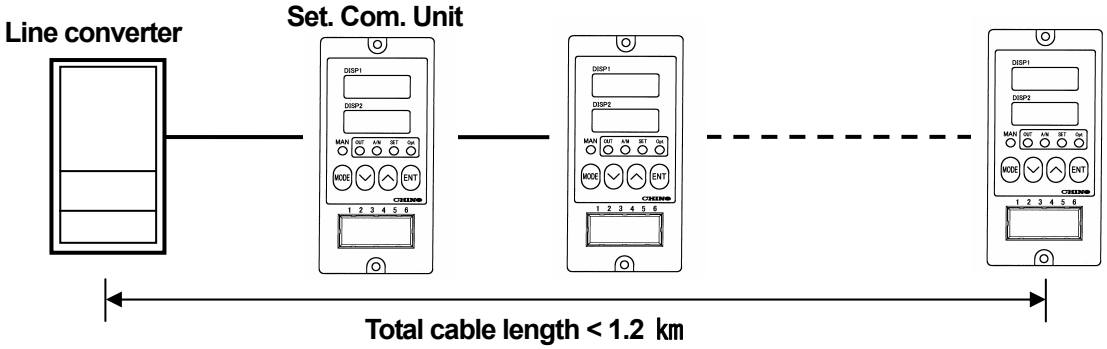


* The illustration shows an example of the setting communication unit's model number is 3. The connection of the model number 4 is performed on the rear of the setting communication unit.

3.1.2 The total length of the RS-422A/485 communication cable should be 1.2 km or less.

The intervals between units are not determined, but the total cable length should be 1.2 km or less.

Example (Distance between the line converter ⟺ setting communication unit at the termination end)



3.1.3 Noise countermeasures

To avoid noise interference, separate the communication cable from drive power lines or other lines more than 50cm.

3.1.4 Termination resistor

When using the RS-422A/485 communication, attach a 100-Ω resistor to the setting communication unit or another unit placed at the termination end. (See Section 3.3 for details.)

(An ordinary metal film resistor can be used. It is also available from CHINO.)

3.1.5 Number of Setting Communication Units

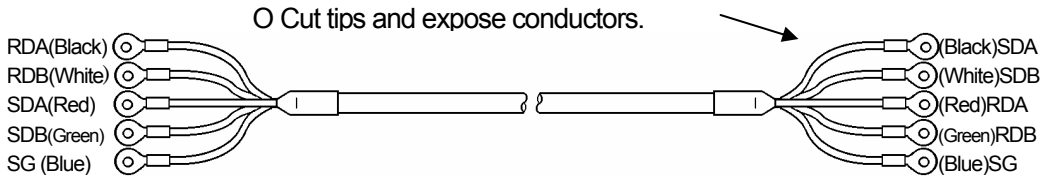
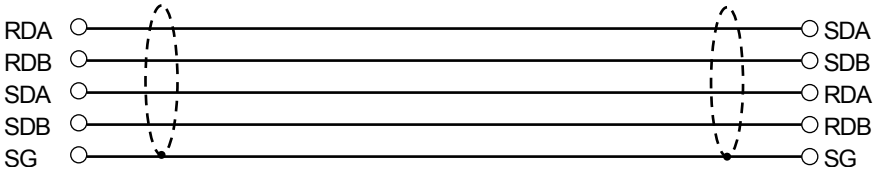
Max. 31 units

3.2 Communication Cables

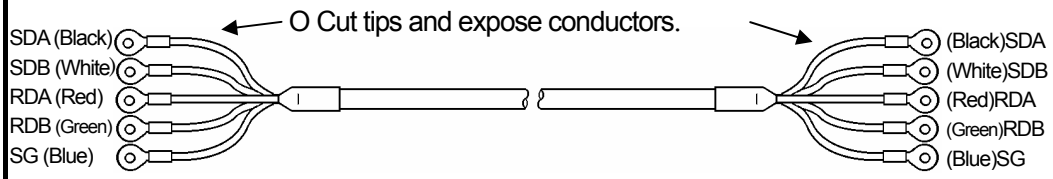
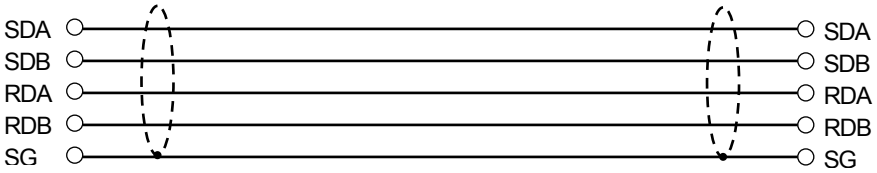
The exclusive communication cables should be prepared before proceeding to make a connection. These cables are also available from CHINO.

3.2.1 RS-422A communication cable

(1) Connection between line converter and setting communication unit

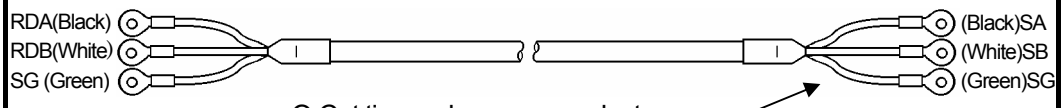
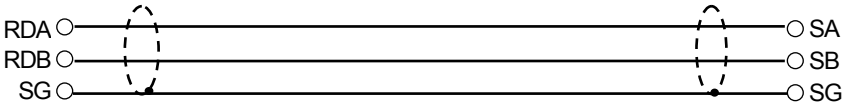
Cable	O-shaped crimp terminal ↔ Twisted wire RS-422A cable (for line converter)
Design	 Line converter side Set. Com. Unit side The cable is the 4-core cable twisted with the dual-core cables that are twisted with the VCTF wires and has the SG (Signal Ground) wires at both ends. The SG wire on the line converter side should be cut off because the line converter does not have an SG terminal. The O-shaped terminals on the setting communication unit side should be cut and stripped to expose the conductors.
Internal wiring	
Model code	**RZ-CRA2□□** Cable length: 01-99 m (To be specified)

(2) Connection between setting communication units

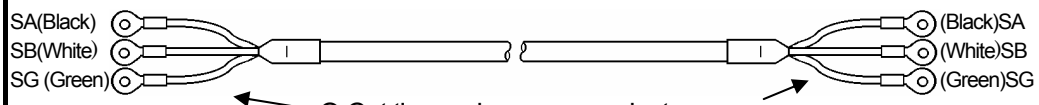
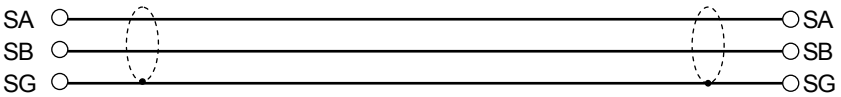
Cable	Twisted wire ⟷ Twisted wire RS-422A cable (For parallel connection)
Design	 Set. Com. Unit side Set. Com. Unit side The cable is the 4-core cable twisted with the dual-core cables that are twisted with the VCTF wires and has the SG (Signal Ground) wires at both ends,
Internal wiring	
Model code	**RZ-CRA1□□** Cable length: 01-99 m (To be specified)

3.2.2 RS-485 communication cable

(1) Connection between line converter and setting communication unit

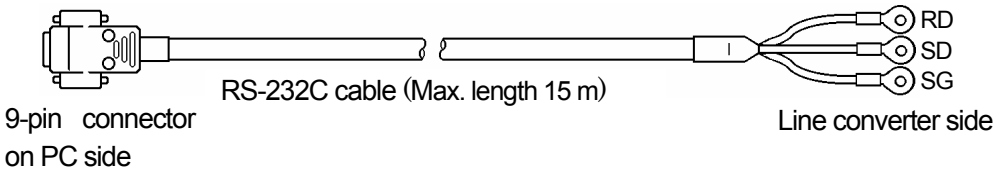
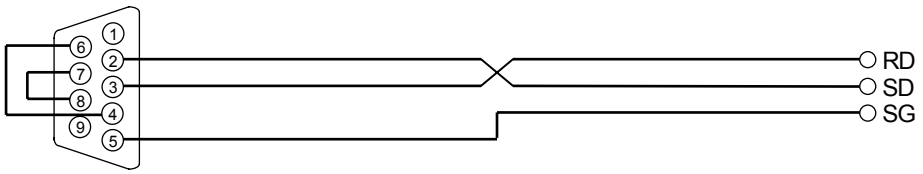
Cable	O-shaped crimp terminal ⟷ Twisted wire RS-485 cable (for line converter)
Design	 Line converter side O Cut tips and expose conductors. Set. Com. Unit side The cable is the dual-core cable twisted with the CVVS wires and has the SG (Signal Ground) wires at both ends. The SG wire on the line converter side should be cut off because the line converter does not have an SG terminal.
Internal wiring	
Model code	**RZ-LEC□□□** Cable length: 001-200 m (to be specified)

(2) Connection between setting communication units

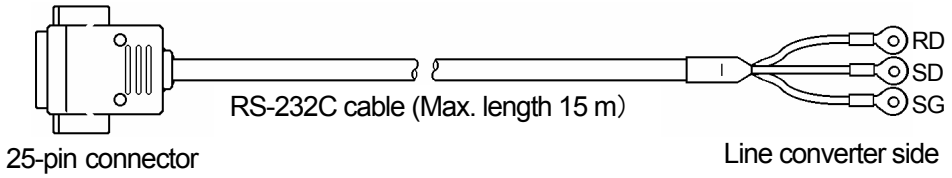
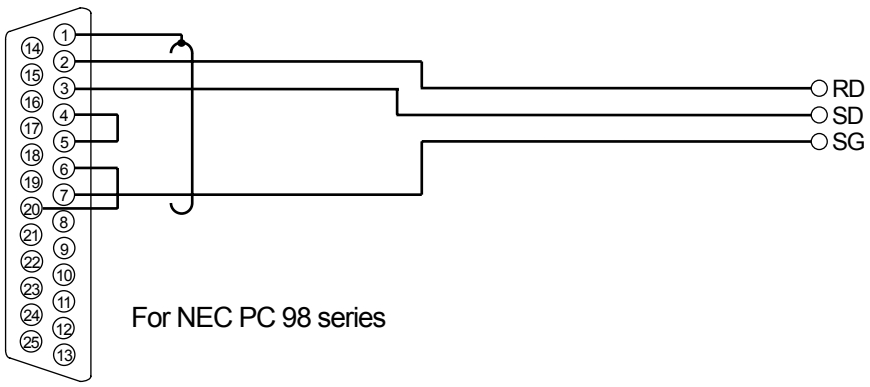
Cable	Twisted wire ⟷ Twisted wire RS-485 cable (For parallel connection)
Design	 Set. Com. Unit side O Cut tips and expose conductors Set. Com. Unit side The cable is the dual-core cable twisted with the CVVS wires and has the SG (Signal Ground) wires at both ends.
Internal wiring	
Model code	**RZ-CSS1Z2 (0.2 m) or RZ-LEC□□□** Cable length: 001-200 m (to be specified)

3.2.3 RS-232C communication cable (Reference)

(1) Connection between PC (9-pin) and line converter

Cable	9-pin connector ⟷ O-shaped crimp terminal RS-232C cable
Design	
Internal wiring	
Model code	**RZ-CRS6□□** Cable length: 1-15 m (Specification)

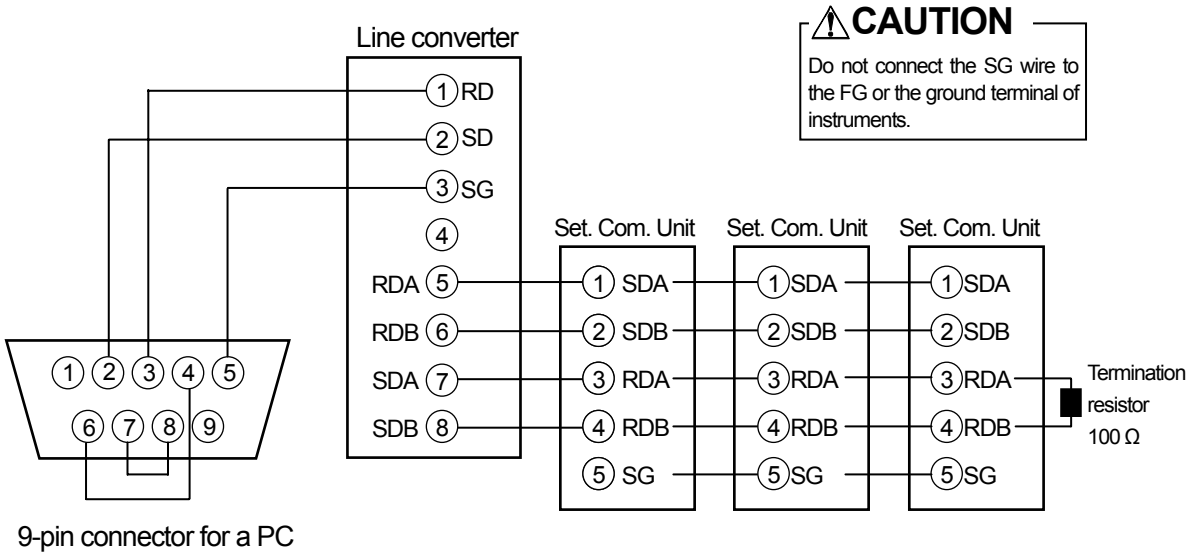
(2) Connection between PC (25-pin) and line converter

Cable	25-pin connector ⟷ O-shaped crimp terminal RS−232C cable
Design	
Internal wiring	
Model code	**RZ-CRS2□□** Cable length: 1-15 m (to be specified)

3.3 Connection of RS-422A/485

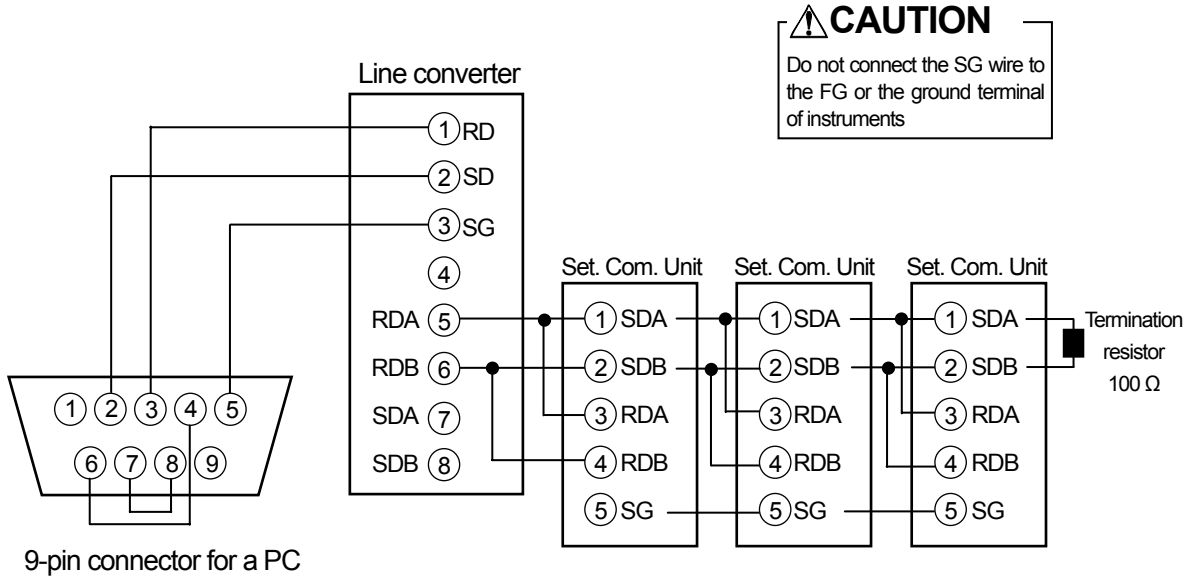
The following example is the connection of the RS-422A/485 communication interface and a PC using the line converter (model SC8-10). Since the connection between the line converter and the PC uses only 3 signal lines for the sending, the receiving and the signal ground and does not use other control signals, a wiring arrangement inside the connectors is required like the connection of the RS-232C (For its details, refer to the instruction manual for the line converter).

RS-422A connection



* If a line converter is at the termination end, a 100-Ω termination resistor is also required across (5) – (6). For Model SC8-10, shorting (4) –(5) provides the termination resistor.

RS-485 connection



* If a line converter is at the terminal end, a 100-Ω termination resistor is also required across (5) – (6). For Model SC8-10, shorting (4) – (5) provides the termination resistor.

4 MODBUS PROTOCOL

Basic Communication Procedure and Precautions

⚠ CAUTION

1. Set the Key Lock before setting (writing) a parameter.

The setting communication unit is ready for communication and can output the response to a data request from a master unit (PC, PLC, etc.). However, for the setting of parameters from the master unit, the setting communication unit should be set to the key lock status in advance. The key lock setting is possible using the front keys of the setting communication unit or with communication from the master unit. If the parameters are set to the setting communication unit under unlock status from the master unit, the setting communication unit returns the error code 12H.

2. Care is required in command re-transmission due to no control signal lines used.

The serial interface of the setting communication unit performs communication without using the control lines. As a result, care is required in retransmitting a command because receiving failure may happen depending on the status of the setting communication unit. In addition, when sending commands continuously, leave sufficient wait intervals between commands (1 second or more is recommended).

3. Do not disconnect cables/units or switch power ON/OFF during communication.

If cables or units in the serial interface are disconnected or power is switched OFF/ON during communication, the operation may stop or an error may occur. If this happens, it is required to reset all of the units in the serial interface and restart communication from the beginning.

4. Do not send a command before the communication drive is switched OFF.

With RS-485, multiple units are connected to a single communication line and only one having the address specified by a master (PC, PLC, etc.) drives the communication line. To ensure arrival of all of the characters at the master unit, the communication line drive is turned OFF in a certain period after the last character is sent. If the PC sends a command to the next unit before the drive is turned OFF, collision of signals makes normal communication impossible. This caution applies particularly when using a high-speed PC. The period until the communication drive is turned OFF is about 5 ms.

5. The thyristor regulator may sometimes be reset when a control switching command is issued.

When the setting communication unit is given the priority and the control being run is changed by setting (writing) a control system (Ref. No. 1013) or feedback control (Ref. No. 41013), the thyristor regulator performs the reset operation. Before sending a command to follow a control command, reserve a sufficient wait time (3 sec. or more).

6. The settings are restricted according to the models.

Some settings are not available depending on the models of thyristor regulators. This caution applies when using a model with the following control systems.

(1) Control system N: The feedback control setting is fixed at OFF.

(2) Control system Z: The feedback control setting is fixed at OFF (0).
The control system setting is fixed at zero-cross control (1).

4.1 Message Transmission Modes

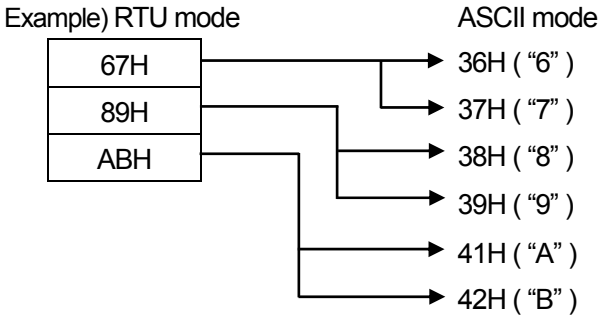
The RTU (Remote Terminal Unit) or ASCII mode can be selected according to the front key setting.

(Table 1. Comparison between RTU and ASCII modes)

Items		RTU mode	ASCII mode
Interfaces		RS-422A, RS-485	
Communication type		Half duplex asynchronous type	
Transmission rate		9600, 19200 bps	
Transmission code		Binary	ASCII
Error check	Vertical direction	Parity	
	Horizontal direction	CRC-16	LRC
Character configuration	Start bit	1-bit	
	Data length	8-bit	7-bit/8-bit
	Parity bit	None/Even/Odd	None/Even/Odd
	Stop bit	1-bit/2-bit	
Start code of message		None	: (Colon)
End code of message		None	CR, LF
Data time interval		28-bit time or less	1 sec. or less

4.1.1 Data transmission

The RTU mode is based on binary data transfer. The ASCII mode decomposes 8-bit binary data of the RTU mode into the higher 4-bit data and lower 4-bit data and converts each data item into a character (0 to 9, A to F).

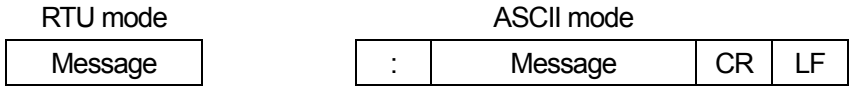


The RTU mode can transfer data more efficiently because its message length is half the ASCII mode.

4.1.2 Message frame configuration

The RTU mode message frame is composed only of the message part.

The ASCII mode message frame is composed of the start character “: (colon, or 3AH)”, a message and the end character “CR (Carriage Return, or 0DH) + LF (Line Feed, or 0AH).”



The ASCII mode facilitates troubleshooting because it uses the start character “:” of message.

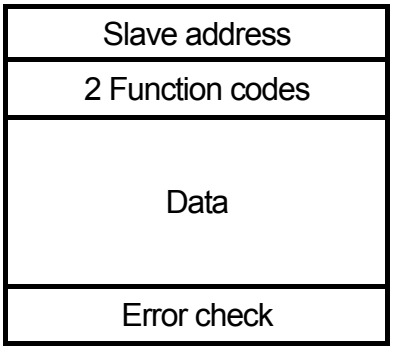
4.2 Data Time Interval

RTU mode: 28-bit time or less (9600 bps: 2.9 ms. 19200 bps: 1.4 ms.)
ASCII mode: 1 second or less

When sending a message, the time interval between data in a single message should not exceed the above time limits. If a longer time interval has elapsed, the receiving unit (setting communication unit) recognizes that the data transmission from the sending unit is complete, and processes the subsequent message as an abnormal message. This means that the RTU mode requires continuous sending of message characters but that the ASCII mode can send characters at intervals of maximum 1 second and a master unit (PC, PLC, etc.) with a 5elatively slow processing speed can be used in this mode.

4.3 Message Configuration

The MODBUS message has a configuration as shown below in both the RTU and ASCII modes.



4.3.1 Slave address

This corresponds to the address of the setting communication unit (Ref. Section 2.2). The address should be set in advance in the range between 1 and 99 with the front keys. The master unit usually communicates with a single slave unit. The message from the master unit is received by all units being connected. However, only the slave unit having the address matching the slave address specification included with the command message responds to its message.

The address “0” is used in a message from the master unit to all slave units (broadcast message). The slave units do not send any response to the master unit.

4.3.2 Function codes

The function codes indicate the functions to be executed by the slave units. The data is generally classified as shown below. For the details, refer to the reference tables.

(Function code list)

Code	Function	Unit	MODBUS original function (Reference)
01	Read digital (ON/OFF) parameter	1-bit	Read coil status
02	Read digital input data	1-bit	Read input relay status
03	Read analog parameter	16-bit	Read buffer register
04	Read analog input data	16-bit	Read input register
05	Write digital parameter	1-bit	Change single coil status
06	Write analog parameter	16-bit	Write single buffer register
08	Send received data (for diagnostics)		Loop-back test
15	Write multiple digital parameters		Change multiple coil statuses
16	Write multiple analog parameters		Write multiple buffer registers

4.3.3 Data part

The configuration of data varies depending on the function code. A request from the master unit is composed of the code number of the data to be read or written (the relative number calculated from the reference number described below) and the quantity of data, etc. A response from the slave unit is composed of the data corresponding the request, etc.

Every MODBUS basic data consists of 16-bit integers, and whether there is a sign or not is defined per each data. Therefore, the data is configured as integers with their decimal places assigned in other addresses, or normalized with the high and low limits specified by the scale with fixed decimal places. The setting communication unit adopts the method of assigning the decimal places in other addresses.

4.3.4 Reference number

Each data in the setting communication unit is given a “Reference Number,” which is required for sending and receiving the data. Each data is classified into “Digital parameter,” “Digital input data,” “Analog input data” and “Analog parameter.” The designation of data in a message is executed by a “Relative number” corresponding to each reference number as shown below.

(Reference number list)

Data types	Reference number	Relative number
Digital parameter	1 to 10000	Reference number -1
Digital input data	10001 to 20000	Reference number -10001
Analog input data	30001 to 40000	Reference number - 30001
Analog parameter	40001 to 50000	Reference number - 40001

4.3.5 Error check

The method of checking errors in the transferred frames varies depending on the mode.

RTU mode: CRC-16

ASCII mode: LRC

4.3.5.1 CRC-16 calculation

With the CRC method, the sent information is divided by a generator polynomial and the remainder is appended after the data. The generator polynomial used is as follows:

$$1 + X^2 + X^{15} + X^{16}$$

The calculation is performed from the slave address till the end of data in the following procedure.

1) Initialization (= FFFFH) of CRC-16 data (assuming it is X).
2) Exclusive logical sum (EX-OR) between data 1 and X. → X
3) Shifting of X by 1 bit toward the right → X
4) When a carry is produced, EX-OR and A001H are taken. (If not produced, go to the step 5). → X
5) Steps 3) and 4) are repeated until 8 times of shifting.
6) EX-OR between the next data and X. → X
7) Same as steps 3) to 5)
8) Repetition of the above steps until the last data
9) Creation of a message in the sequence from low to high orders of the calculated 16-bit data (X)

Example) When data is | 02H | 07H | , the CRC-16 calculation result is 1241H,

so the error check data becomes | 41H | 12H | .

Reference 1: CRC-16 calculation program (C-language)

```
/***** CRC-16 Calculation Program *****/
#include    <stdio.h>
#include    <conio.h>

void main(void)
{
        /*** Internal variable declaration ***/
        unsigned int        iLoopCnt;           /* Loop counter          */
        unsigned short      usData;             /* Input data            */
        unsigned short      usCrcData;          /* CRC-16 data           */
        unsigned short      usErrChkData;       /* Error check data      */
        int                 iDummy;             /* Dummy variable        */

        /* (1) Initialization of CRC-16 data output result */
        usCrcData = 0xffff;

        printf("Input hex data. ([q] to quit) >¥n");
        while( scanf("%x",&usData) != 0 ){
                /* (2)(6) EX-OR of CRC output result and input data */
                usCrcData =   usData ^ usCrcData;

                /*** CRC calculation ***/
                /* (5) Repeating until 8 times of bit shifting */
                for( iLoopCnt = 0 ; iLoopCnt < 8 ; iLoopCnt++ ){
                        /* (4) Checking whether carry is produced or not */
                        if( usCrcData & 0x0001 ){
                                /* (4) If a carry is produced */
                                /* (3) Shifting of CRC output result by 1 bit to the right */
                                usCrcData = usCrcData >> 1;

                                /* (4) EX-OR with A001H */
                                usCrcData = usCrcData ^ 0xa001;
                        }else
                                /* (4) If a carry is not produced */
                                /* (3) Shifting of CRC output result by 1 bit to the right */
                                usCrcData = usCrcData >> 1;
                        }
                } /* for */
        } /* while */

        printf( "CRC-16 data is %xH. ¥n", usCrcData );

        /* Creation of error check data */
        usErrChkData = ( usCrcData >> 8) | ( usCrcData << 8 );
        printf( "The error check data is %xH", usErrChkData );

        iDummy = getch();
}
```

Reference 2: CRC-16 calculation program (Microsoft Visual Basic.NET)

```
'***** CRC-16 Calculation Function *****/
Function fncCalcCrc(ByVal sCharData As String) As String

'*** Variable declaration ***
Dim intLoopCnt1 As Integer                          ' Loop counter 1
Dim intLoopCnt2 As Integer                          ' Loop counter 2
Dim intLoopCnt3 As Integer                          ' Loop counter 3
Dim intSdChrCnt As Integer                          ' Byte count in sending character
Dim intCrc16Data As Integer                         ' Mask data
Dim intCarryFlg As Integer                          ' Carry flag buffer
Dim strWorkBuf As String                            ' Work buffer
Dim int2ByteImage(16) As Integer                    ' Shifting buffer
Dim strCRC As String                                ' CRC result

'*** Initial value setting ***
'* Calculation of bytes in the sending character *
intSdChrCnt = Len(sCharData) / 2                    ' Sent string 2
'* Initialization of CRC-16 data (FFFFH)
intCrc16Data = &HFFFF

'*** CRC-16 calculation (CRC generator polynomial ---> 1+X^2+X^15+X^16) ***
'* Repeating with the same number as the byte count of sending character *
For intLoopCnt1 = 1 To intSdChrCnt
    '* EX-OR between sending character and X : Every 2 bytes *
    intCrc16Data = intCrc16Data Xor Val("&H" + Mid(sCharData, 2 * intLoopCnt1 - 1, 2))
    '* Performing of 8 times of shifting *
    For intLoopCnt2 = 0 To 7
        '* Shifting of X by 1 bit to the right *
        For intLoopCnt3 = 0 To 15                   ' Checking each bit in 2-byte size data
            If (intCrc16Data And (2 ^ intLoopCnt3)) = 0 Then    ' Is the bit 0?
                int2ByteImage(intLoopCnt3) = 0      '     Set YES:0
            Else
                int2ByteImage(intLoopCnt3) = 1      '     Set NO :1
            End If
        Next intLoopCnt3
        ' Checking per every bit
        intCarryFlg = int2ByteImage(0)              ' Buffering of carry flag
        For intLoopCnt3 = 1 To 15                   ' Shifting of bits 1 to 15 by 1 bit to the right
            int2ByteImage(intLoopCnt3 - 1) = int2ByteImage(intLoopCnt3)
        Next intLoopCnt3
        int2ByteImage(15) = 0                       ' Setting 0 at the 15th bit

        intCrc16Data = 0                            ' Clearing CRC-16 data to 0
        For intLoopCnt3 = 0 To 15                   ' Converting of 16-data array of the bit image
                                                    '                                  into Int type
            intCrc16Data = intCrc16Data + ((2 ^ intLoopCnt3) * int2ByteImage(intLoopCnt3))
        Next intLoopCnt3                            ' (For Loop)

        '* Carry produced? *
        If intCarryFlg = 1 Then
            intCrc16Data = intCrc16Data Xor &HA001  ' EX-OR with A001H
```

```
            End If
        Next intLoopCnt2                                    ' (For Loop)
    Next intLoopCnt1                                        ' (For Loop)

    '*** Creation of a message in the sequence from low to high orders of the calculated 16-bit data (X)
    '* Setting by adding 0 at the head of the 4-byte data *
    strWorkBuf = "0000"                                     ' Conversion of processing results into 4
                                                            ' characters (set '0' in lacking positions)
    Mid(strWorkBuf, 5 - Len(Hex(intCrc16Data))) = Hex(intCrc16Data)
    strCRC = Mid(strWorkBuf, 3, 2) & Mid(strWorkBuf, 1, 2)  ' Exchanging of low and high data
    '     (Example) 1241H-->'41H"12H'

    '*** Returned value ***
    Return strCRC                                           ' CRC character
End Function
```

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4.3.5.2 LRC calculation method

The calculation is performed from the slave address until the end of the data in accordance with the following procedure.

1) Creation of message in the RTU mode
2) Addition from the start (slave address) to end of the data → X
3) Calculation of the complement (bit inversion) of X → X
4) Addition of 1 (X = X+1)
5) Appending of X as the LRC at the end of the message
6) Conversion of the entire data into ASCII characters

Example) When data is | 02H | 07H | , LRC is F7H so

the binary message becomes | 02H | 07H | F7H | and

the ASCII message becomes | 30H | 32H | 30H | 37H | 46H | 37H | .

Reference 1: LRC calculation program (C-language)

```
/***** LRC Calculation Program *****/
#include    <stdio.h>
#include    <conio.h>

void main(void)
{
        /*** Internal variable declaration ***/
        unsigned short      usData;             /* Input data              */
        unsigned short      usLrcData;          /* LRC data                */
        int                 iDummy;             /* Dummy variable          */

        /* Initialization of LRC data output result */
        usLrcData = 0;

        printf("Input hex data. ([q] to quit) >¥n");
        while( scanf("%x",&usData) != 0 ){
                /* (2) Addition from the start to end of data */
                usLrcData += usData;
                /* Disposal of the highest 1 byte */
                usLrcData = usLrcData & 0xff;
        } /* while */

        /* (3) EX-OR with FFH */
        usLrcData = usLrcData ^ 0xff;

        /* (4) Addition of 1 */
        usLrcData = usLrcData++;
        /* Disposal of the highest 1 byte */
        usLrcData = usLrcData & 0xff;

        /* LR error check */
        printf( "The LRC-16 data is %xH. ¥n", usLrcData );

        iDummy = getch();
}
```

Reference 2: LRC calculation program (Microsoft Visual Basic.NET)

```
'***** LRC Calculation Function *****/

Function fncCalcLrc(ByVal sCharData As String) As String
   '*** Variable declaration ***
   Dim intLoop As Integer                                    ' Loop counter
   Dim intStrSize As Integer                                 ' String size
   Dim intLRC As Integer                                     ' LRC value
   Dim sRtnLrc As String                                     ' LRC for return value

   '*** String size calculation ***
   intStrSize = Len(sCharData) / 2

   '*** LRC value initialization ***
   intLRC = 0

   '*** LRC value calculation ***
   For intLoop = 1 To intStrSize
         intLRC = intLRC + Val("&H" + Mid(sCharData, 2 * intLoop - 1, 2))
   Next intLoop
   '* Calculation of complement of 1 *
   sRtnLrc = Hex(&HFF - intLRC + 1)
   sRtnLrc = Microsoft.Visual Basic.Right("0" & sRtnLrc, 2)

   '*** Return value (LRC) ***
   Return sRtnLrc                                            ' LRC string
End Function
```

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4.3.6 Notes on data processing

(1) The decimal place of each data is specified in the reference tables. The decimal place is fixed for some data, determined according to the measuring range or determined according to the linear decimal point setting. Use special care for the decimal point place when reproducing data.

(2) As every data can be accessed (modified) independently, care is required when setting related data. An example in which this care is required is for the initialization processing of related data following a change in the measuring range. The details of processing are described in the reference number list.

(3) Data should be read or written in the range of the defined reference numbers. If write is performed for an undefined reference number, the operation of setting communication unit may be affected.

(4) Read and write are also possible in multiple, non-consecutive reference numbers. However, an error (error 02H) occurs if a number that is not defined as a reference number is used as the start number.

(5) When read of multiple reference numbers is performed, the data of the undefined reference numbers become “0”.

(6) When an error is detected when write of multiple reference numbers is being performed, the settings after the error become invalid.

4.4 Message Creation Method

The message is composed of (1) slave address, (2) function code, (3) data and (4) error check code.
The following table shows the ranges of messages that can be read or written at one time.

Function code	Quantity of Data	
	ASCII mode	RTU mode
01	10	10
02	10	10
03	10	10
04	10	10
15	10	10
16	10	10

The following examples show how to create a message.

Example) Reading of the voltage value and voltage value decimal place from the setting communication unit with “slave address 02”

4.4.1 RTU mode message

(1) Slave address: 02 (02H)

(2) Function code: 04 (04H)

According to the reference table, the function code for reading the voltage value and voltage decimal place is 04H, and the function is to “read analog input data” (Ref. Section 4.7). For details on the function codes, see Section 4.5, “Function Codes.”

(3) Data: Relative number of start 1100 (04H | 4CH), Quantity: 2 (00H | 02H)

The measured values (analog input data) are assigned with reference numbers “30001 – 40000”. According to the reference tables (Ref. Section 4.7), “31101” is assigned for the voltage value and “31102” is assigned for the voltage decimal place. The relative number of “reference number 31101” at the start is 31101 – 30001 = 1100, which is 04H | 4CH in 2-byte expression (Ref. Section 4.3.4). The quantity of data to be read is 2, the voltage and the voltage decimal place, which is

00H | 02H in 2-byte expression.

(4) Error check: CRC-16 calculation result 1FB1H (B1H | 1FH)

The error check in the RTU mode uses the CRC-16 calculation (Ref. Section 4.3.5.1).

According to (1) to (3) above, the data in the basic part of message is

02H	04H	04H	4CH	00H	02H

, and the CRC-16 result is 1FB1H.

Therefore, the error check data is | B1H | 1FH | .

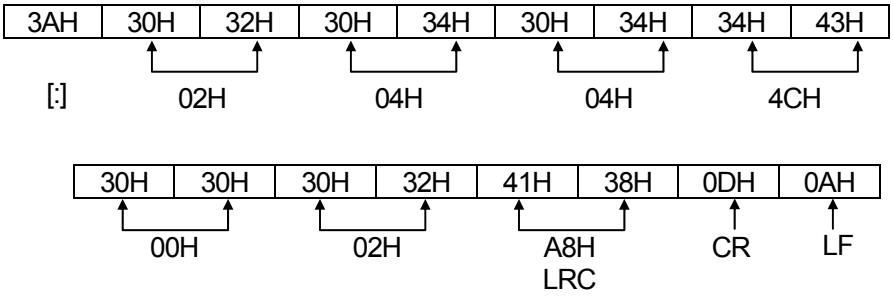
(5) Message:

02H	04H	04H	4CH	00H	02H	B1H	1FH

The message is created according to the message configuration (Ref. Section 4.3).

4.4.2 ASCII mode message

The error check LRC is calculated from the basic part of the message (Ref. Section 4.3.5.2). The LRC becomes A8H. Each data in the basic part is converted into ASCII codes and then the LRC converted into ASCII codes is appended to the basic part. In addition, the start-of-message character ":" is added and "CR" and "LF" are appended at the end.



4.5 Function Codes

The response to each function code is described below (Ref. “Function code list” in Section 4.3.2).
Note) For the response in case of errors, see Section 4.6.

4.5.1 Read digital parameter (read coil status)

[Function code: 01(01H)]

The specified quantity of "digital (ON/OFF) parameters” are read out consecutively commencing with the designated Reference No. 8 pieces of ON/OFF data are placed in each data (1 byte) sequentially in number to constitute the response message data. The LSB of each data becomes the digital data with the smallest number. If the read quantity is other than a multiple of 8, an unnecessary bit becomes 0.

Example) Reading digital parameters of reference No. 1001 (Auto/Manual) and 1002 (Run/Stop) of the slave unit 2

Ref. No.	1001	1002
Data item	ON	ON
	Manual selection	Stop selection

(RTU mode)

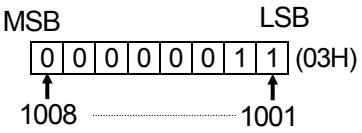
Master → Unit

Slave address	02H
Function code	01H
Start number (H)	03H
Start number (L)	E8H
Quantity read out (H)	00H
Quantity read out (L)	02H
CRC (L)	3DH
CRC (H)	88H

Unit → Master (Normal)

Slave address	02H
Function code	01H
Quantity of data (byte)	01H
First 8 data	03H
CRC (L)	11H
CRC (H)	CDH

First 8 data items



(Error check in ASCII mode)

Error check CRC (L) and CRC (H) become as shown below.

LRC	10H

LRC	F9H

Note) The start number (relative number) is “Ref. No. – 1”. (Decimal 1000 (= 1001-1) → Hex 3E8H)
Note) The quantity of data refers to the number of bytes in the data (which is not different from the requested quantity. In this example, the requested quantity is 2 but the data quantity is 1.

4.5.2 Read digital input data (read input relay status)

[Function code: 02(02H)]

The specified quantity of "digital (ON/OFF) input data” are read out consecutively commencing with the designated Reference No. 8 pieces of ON/OFF data are placed in one data (1 byte) sequentially in number to constitute the response message data. The LSB of each data is a digital data with the smallest number. If the read quantity is other than a multiple of 8, an unnecessary bit becomes 0. An example of response message is the same as in "Function code 01", though its start number (Relative No.) is "Reference No. - 10001".

4.5.3 Read analog parameter (read buffer register)

[Function code: 03(03H)]

The specified quantity of "analog parameters (2 bytes: 16 bits)" are read out consecutively commencing with the designated Reference No. The data is split into high-order 8 bits and low-order 8 bits arranged sequentially in number to constitute a data of response message.

Example) Reading the slope setting and elevation of the slave unit 2.

(Reading two analog parameters from Ref. Nos. 41002 to 41003 of the slave unit 2)

Reference No.	41002	41003
Data	50 (0032H)	10 (000AH)

← Example with 50% slope and 10% elevation

(RTU mode)

Master → Unit

Slave address	02H
Function code	03H
Start number (H)	03H
Start number (L)	E9H
Quantity read out (H)	00H
Quantity read out (L)	02H
CRC (L)	15H
CRC (H)	88H

Unit → Master (Normal)

Slave address	02H
Function code	03H
Quantity of data (byte)	04H
Slope data (H)	00H
Slope data (L)	32H
Elevation data (H)	00H
Elevation data (L)	0AH
CRC (L)	E8H
CRC (H)	FBH

(Error check in ASCII mode)

LRC	04H

LRC	22H

Note) The start number (relative number) is “Ref. No. – 40001”. (Decimal 1001 (=41002-40001) → Hex 3E9H)

Note) The quantity of data refers to the number of bytes in the data.

Note) The maximum data quantity of message that can be sent at one time is restricted (Ref. Section 4.4).

Note) It may sometimes take more than 3 seconds before the unit responds (Unit → Master).

4.5.4 Read analog input data (read input register)

[Function code: 04(04H)]

The specified quantity of "analog parameters (2 bytes: 16 bits)" are read out consecutively commencing with the designated Reference No. The data is split into high-order 8 bits and low-order 8 bits arranged sequentially in number to constitute a data of response message. The response example is identical to that for [Function code 03], except that the start number (relative number) is “Ref. No. – 30001”.

4.5.5 Write digital parameter (change single coil status)

[Function code: 05(05H)]

The digital parameter of the specified number is set to the specified status (ON/OFF).

Example) Setting the slave unit 2 to the manual output type (using the manual output parameter of the setting communication unit) (Setting the digital parameter Ref. No. 1001 of the slave unit 2 to ON)

(RTU mode)

Master → Unit

Slave address	02H
Function code	05H
Parameter No. (H)	03H
Parameter No. (L)	E8H
Setting status (H)	FFH
Setting status (L)	00H
CRC (L)	0CH
CRC (H)	79H

Unit → Master (Normal)

Slave address	02H
Function code	05H
Parameter No. (H)	03H
Parameter No. (L)	E8H
Setting status (H)	FFH
Setting status (L)	00H
CRC (L)	0CH
CRC (H)	79H

(Error check in ASCII mode)

LRC	0FH

LRC	0FH

Note) The normal response is identical to the response to the command message.

Note) The parameter number (relative number) is “Ref. No. – 1”. (Decimal 1000 (= 1001-1) → Hex 3E8H)

Note) Set “FF00H” for execution. Set “0000H” for the automatic output type (using the input at the thyristor regulator).

Note) When the slave address is set to 0, this command is executed by all slave units. However, no slave unit returns the response in this case.

4.5.6 Write analog parameter (write single buffer register)

[Function code: 06(06H)]

The analog parameter of the specified number is set to the specified value.

Example) Setting the manual output value of the slave unit 2 to 90.0%
(Setting the analog parameter Ref. No. 41001 of the slave unit 2 to “900”)

(RTU mode)

Master → Unit

Slave address	02H
Function code	06H
Parameter No. (H)	03H
Parameter No. (L)	E8H
Setting data (H)	03H
Setting data (L)	84H
CRC (L)	09H
CRC (H)	1AH

Unit→Master (Normal)

Slave address	02H
Function code	06H
Parameter No. (H)	03H
Parameter No. (L)	E8H
Setting data (H)	03H
Setting data (L)	84H
CRC (L)	09H
CRC (H)	1AH

(Error check in ASCII mode)

LRC	86H

LRC	86H

Note) The normal response is identical to the response to the command message.

Note) The parameter number (relative number) is “Ref. No. – 40001”. (Decimal 1000 (= 41211-40001) → Hex 3E8H)

Note) When the slave address is set to 0, this command is executed by all slave units. However, no slave unit returns the response in this case.

4.5.7 Loop-back test

[Function code: 08(08H)]

The transfer between the master and slave is checked. A response is returned according to the specified diagnostic code. With the setting communication unit, a "return check by transmitting the same data as the received data" is performed, and the diagnostic code is fixed at "0000H".

Example) Performing the loop-back test on the slave unit 2

(RTU mode)

Master → Unit

Slave address		02H
Function code		08H
Diagnostic code (H)	Fixed	00H
Diagnostic code (L)		00H
Arbitrary data		*
Arbitrary data		*
CRC (L)		*
CRC (H)		*

Unit→Master (Normal)

Slave address		02H
Function code		08H
Diagnostic code (H)	Fixed	00H
Diagnostic code (L)		00H
Received data		*
Received data		*
CRC (L)		*
CRC (H)		*

4.5.8 Write multiple digital parameters (change multiple coil status)

[Function code: 15(0FH)]

The specified quantity of digital parameters becomes the specified status (ON/OFF) commencing with the designated Reference No. The designation of ON/OFF is one data with 8-piece unit sequentially. The LSB of each data is a digital data with the smallest number. If the read quantity is other than a multiple of 8, unnecessary bits are ignored.

Example) Setting the slave unit 2 to the manual output type (using the manual output setting value of the setting communication unit) and the stop status
(Setting two digital parameters from Ref. Nos. 1001 to 1002 of the slave unit 2 to the following status)

Reference No.	1001	1002
Data item	ON	ON
	Manual selection	Stop selection

(RTU mode)

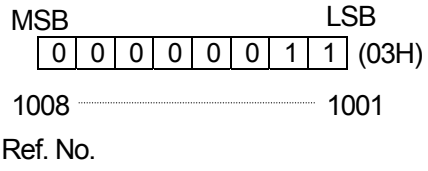
Master → Unit

Slave address	02H
Function code	0FH
Start No. (H)	03H
Start No. (L)	E8H
Quantity written (H)	00H
Quantity written (L)	02H
Quantity of data (byte)	01H
First 8 data	03H
CRC (L)	BEH
CRC (H)	A7H

Unit→Master (Normal)

Slave address	02H
Function code	0FH
Start No. (H)	03H
Start No. (L)	E8H
Quantity (H)	00H
Quantity (L)	02H
CRC (L)	54H
CRC (H)	49H

First 8 data items



(Error check in ASCII mode)

Error check CRC (L) and CRC (H) become as shown below.

LRC	FEH

LRC	02H

Note) The start number (relative number) is "Ref. No. – 1". (Decimal 1000 (=1001-1) → Hex 3E8H)

Note) When the slave address is set to 0, this command is executed by all slave units. However, no slave unit returns the response in this case.

Note) The maximum data quantity of message that can be sent at one time is restricted (Ref. Section 4.4).

Note) It may sometimes take more than 3 seconds before the unit responds (Unit → Master).

4.5.9 Write multiple analog parameters (write multiple buffer registers)

[Function code: 16(10H)]

The specified quantity of analog parameters commencing are set to the specified values consecutively commencing with the designated Reference No. The data is split into high-order 8 bits and low-order 8 bits to be sent sequentially in number.

Example) Setting the slave unit 2 to 50% slope and 10% elevation
(Setting two analog parameters from Ref. Nos. 41002 to 41003 of the slave unit 2)

Reference No.	41002	41003
Data	50 (0032H)	10 (000AH)

(RTU mode)

Master → Unit

Slave address	02H
Function code	10H
Start No. (H)	03H
Start No. (L)	E9H
Quantity written (H)	00H
Quantity written (L)	02H
Quantity of data	04H
First data (H)	00H
First data (L)	32H
Second data (H)	00H
Second data (L)	0AH
CRC (L)	07H
CRC (H)	F1H

Unit→Master (Normal)

Slave address	02H
Function code	10H
Start No. (H)	03H
Start No. (L)	E9H
Quantity written (H)	00H
Quantity written (L)	02H
CRC (L)	90H
CRC (H)	4BH

(Error check in ASCII mode)

LRC	C0H

LRC	00H

Note) The start number (relative number) is “Ref. No. – 40001”. (Decimal 1001(=41002-40001) → Hex 3E9H)

Note) When the slave address is set to 0, this command is executed by all slave units. However, no slave unit returns the response in this case.

Note) The maximum data quantity of message that can be sent at one time is restricted (Ref. Section 4.4).

Note) It may sometimes take more than 3 seconds before the unit responds (Unit → Master).

4.6 Error Processing

When a message from the master unit is erroneous, the response becomes as described below.

4.6.1 Cases of No Response

A message is ignored and no response is returned when

(1) A transmission error (overruns, framing, parity, CRC or LRC) is detected in the message;
(2) The slave address in the message is not the address of the receiver’s own address;
(3) The data interval in the message is too long;
RTU mode: 28 bits or longer, ASCII mode : 1 second or more
(4) The transmission parameters are not coincident;
(5) The received message is longer than 90 bytes.
(6) The control is switched (resetting of the thyristor regulator).

Note) When the slave address is "0" in the write function, the message is executed unless any error is detected in it, but with no response returned to it. Since no response is returned also when the above error is detected in the message, whether it is normal or abnormal cannot be judged by the response from the setting communication unit when the slave address is "0".

Note) It may sometimes take some time (3 seconds or more) to read or write multiple reference numbers.

4.6.2 Error message response

When the message from the master unit does not contain an error as described in section 4.6.1 but contains one of the troubles listed below, the code indicating the error content is returned as the “error message.”

The error message has a format as shown below.

Slave address
Function code +80H
Error code
CRC (L)
CRC (H)

Function code	Function code +80H
01	81H
02	82H
03	83H
04	84H
05	85H
06	86H
08	88H
15	8FH
16	90H

The following table shows the list of error codes.

Error code	Details
01H	**Function code error** An undefined function code is received.
02H	**Relative number (reference number) error** The received start number or parameter number is other than specified.
03H	**Data quantity error** The quantity of data to be sent in response to a received message exceeds the specified quantity. Refer to Section 4.4 for details.
09H	**Setting Unit – JW thyristor regulator communication error** • When this error occurs during a continuous data write, the data should be rewritten after recovery from the error.
11H	**Out of setting range** • A value outside the setting range shown in the reference tables is set.
12H	**Setting unavailable** • The key lock is not set. • An item that cannot be selected with models is set.

4.7 Reference Tables

Digital parameters

Reference No.	Function code	Write / Read	Data name	Setting range	Default	Note
1001	01 05 15	Read Write Write	Output type Auto / Manual	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 0) is on the set. com. unit 0: Auto 1: Manual (The manual output value of the Set. com. unit is used.)
1002	01 05 15	Read Write Write	Operating status Run / Stop	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 0) is on the set. com. unit 0: Run 1: Stop
1003	01 05 15	Read Write Write	Priority (MODE1) Thyristor regulator / Setting communication unit	0 / 1 [0000h / ff00h] when the function code is 05	0	Whether the priority of parameters (Slope, Elevation, SV high/low limits, Soft Start) are given to: 0: Thyristor regulator/ 1: Set. com. unit
1004	01 05 15	Read Write Write	Priority (MODE2) Thyristor regulator / Setting communication unit	0 / 1 [0000h / ff00h] when the function code is 05	0	Whether the priority of parameters (Heater disconnection alarm, Current limit, Imbalance alarm) are given to: 0: Thyristor regulator / 1: Set. com. unit
1005	01 05 15	Read Write Write	Priority (MODE0) Thyristor regulator / Setting communication unit	0 / 1 [0000h / ff00h] when the function code is 05	0	Whether the priority of parameters (Operation status, Control method phase, Output method, Manual output value, Alarm output, Feed back control method) are given to : 0: Thyristor regulator / 1: Set. com. unit *When the control (control type and feedback) differs between the thyristor regulator and set. com. unit, changing this setting causes the thyristor regulator to be reset.
1006	01 05 15	Read Write Write	Alarm output OFF / ON	0 / 1 [0000h / ff00h] when the function code is 05	1	Valid when the priority (MODE 0) is on the set. com. unit. 0: Alarm output OFF 1: Alarm output ON
1010	01 05 15	Read Write Write	Disconnection alarm OFF / ON	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 2) is on the set. com. unit. 0: OFF / 1: ON
1011	01 05 15	Read Write Write	Disconnection alarm Initial resistance storage	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 2) is on the set. com. unit. 1: Set 0: When the setting is completed * When the priority (MODE 2) is on the thyristor regulator, the setting of "1" leads to "JW internal communication error 3" (write error).
1012	01 05 15	Read Write Write	Current limit OFF / ON	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 2) is on the set. com. unit. 0:OFF / 1:ON
1013	01 05 15	Read Write Write	Control type Phase/Zero-cross	0 / 1 [0000h / ff00h] when the function code is 05	Per type	Valid when the priority (MODE 0) is on the set. com. unit. 0: Phase angle / 1: Zero-cross * Changing the setting causes the thyristor regulator to be reset. * The type with zero-cross control is fixed at the zero-cross control (writing "0" is inhibited).
1014	01 05 15	Read Write Write	Imbalance alarm OFF / ON	0 / 1 [0000h / ff00h] when the function code is 05	0	Valid when the priority (MODE 2) is on the set. com. unit. 0: OFF / 1: ON

Digital input data

Reference No.	Function code	Write / Read	Data name	Details
11001	02	Read	JW internal communication error 1	0: Normal 1: No response from JW thyristor regulator
11002	02	Read	JW internal communication error 2	0: Normal 1: JW thyristor regulator – set. com. unit communication error
11003	02	Read	JW internal communication error 3	0: Normal 1: JW thyristor regulator – set. com. unit parameter ablomality error
11010	02	Read	JW operation error	0: Normal 1: JW thyristor regulator memory error
11011	02	Read	Heater disconnection detection	0: Normal 1: Heater disconnection detected
11012	02	Read	Abnormalities in a thyristor element	0: Normal 1: Abnormalities in a thyristor element detected
11013	02	Read	Over-current detection	0: Normal 1: Over-current detected
11014	02	Read	Rapid-break fuse meltdown	0: Normal 1: Rapid-break fuse meltdown detected
11015	02	Read	Radiation fin temperature abnormality	0: Normal 1: Radiation fin temperature abnormality detected
11016	02	Read	Phase-sequence abnormality	0: Normal 1: Phase-sequence abnormality detected
11017	02	Read	Open phase	0: Normal 1: Open phase detected.
11018	02	Read	Imbalance alarm	0: Normal 1: Imbalance alarm detected.
11019	02	Read	Frequency abnormality	0: Normal 1: Frequency abnormality detected.

Analog parameters

Reference No.	Function code	Write / Read	Data name	Setting range	Default	Note
41001	03 06 16	Read Write Write	Manual output value	0.0 to 100.0 (0 to 1000)	0.0 (0)	Valid when the priority (MODE 0) is on the set. com. unit and the output type is Manual.
41002	03 06 16	Read Write Write	Slope	0 to 100	100	Valid when the priority (MODE 1) is on the set. com. unit.
41003	03 06 16	Read Write Write	Elevation	0 to 100	0	Valid when the priority (MODE 1) is on the set. com. unit.
41004	03 06 16	Read Write Write	SV high limit	0 to 100	100	Valid when the priority (MODE 1) is on the set. com. unit.
41005	03 06 16	Read Write Write	SV low limit	0 to 100	0	Valid when the priority (MODE 1) is on the set. com. unit.
41006	03 06 16	Read Write Write	Soft start	1.0 to 20.0 (10 to 200)	1.0 (10)	Valid when the priority (MODE 1) is on the set. com. unit.
41010	03 06 16	Read Write Write	Disconnection ratio for disconnection alarm	10 to 100	100	Valid when the priority (MODE 2) is on the set. com. unit.
41011	03 06 16	Read Write Write	Alarm detection time	1 to 255	1	Valid when the priority (MODE 2) is on the set. com. unit.
41012	03 06 16	Read Write Write	Current limit value	0 to 100	100	Valid when the priority (MODE 2) is on the set. com. unit.

41013	03 06 16	Read Write Write	Feedback control OFF / Voltage / Current / Power	0 to 3	Per type	Valid when the priority (MODE 0) is on the set. com. unit and the phase angle control is used. The setting is possible even during zero-cross control. 0: OFF / 1: Voltage / 2: Current / 3: Power * Changing the setting causes the thyristor regulator to be reset. * Types with a control type of N and Z are fixed at OFF (Write of a value other than 0 inhibited).
41014	03 06 16	Read Write Write	Imbalance rate for imbalance alarm	1 to 40	20	Valid when the priority (MODE 2) is on the set. com. unit.
41015	03 06 16	Read Write Write	Pulse interval	0.5 to 6.0 (5 to 60)	1.5	
41016	03 06 16	Read Write Write	Voltage scaling	10 to 9999	Per type	Conformance to the rated voltage (Decimal place: 200 to 440V = 1 digit)
41017	03 06 16	Read Write Write	Current scaling	10 to 9999	Per type	Conformance to the rated current (Decimal place: 10 to 75A = 2 digits, 100 to 750A = 1 digit, 1000A = 0 digit)
41018	03 06 16	Read Write Write	Power scaling	10 to 9999	Per type	Conformance to Rated current × Rated voltage × $\sqrt{3}$. (Decimal place: 10 to 100A = 2 digits, 150 to 1000A = 1 digit)
49501	03 06 16	Read Write Write	Front keys Unlock / Lock	0 to 1	0	0: Unlock / 1: Lock

Analog input data

Reference No.	Function code	Write / Read	Data name	Details
31101	04	Read	Voltage (Average value)	Measured voltage, The decimal point is added according to the decimal place below.
31102	04	Read	Voltage decimal place (Average value)	Determined by the rated voltage (200 to 440 V= 1 digit)
31103	04	Read	Voltage status (Average value)	0: Normal 1: + over-range (when the voltage exceeds 9999)
31104	04	Read	Current (Average value)	Measured current, The decimal point is added according to the decimal place below.
31105	04	Read	Current decimal place (Average value)	Determined by the rated current (10 to 75A = 2 digits, 100 to 750A = 1 digit, 1000A = 0 digit)
31106	04	Read	Current status (Average value)	0: Normal 1: + over-range (When the current exceeds 9999)
31107	04	Read	Power	Measured voltage, The decimal point is added according to the decimal place below.
31108	04	Read	Power decimal place	Determined by the rated current (10 to 100A = 2 digits, 150 to 1000A = 1 digit)
31109	04	Read	Power status	0: Normal 1: + over-range (when the power exceeds 9999)
31113	04	Read	Voltage (between U & V)	Measured voltage, The decimal point is added according to the decimal place below.
31114	04	Read	Voltage decimal place (between U & V)	Determined by the rated voltage (200 to 440V = 1 digit)
31115	04	Read	Voltage status (between U & V)	0: Normal 1: + over-range (When the voltage exceeds 9999)
31116	04	Read	Current (U)	Measured current, The decimal point is added according to the decimal place below.
31117	04	Read	Current decimal place (U)	Determined by the rated current (10 to 75A = 2 digits, 100 to 750A =1 digit, 1000A = 0 digit)
31118	04	Read	Current status (U)	0: Normal 1: + over-range (When the current exceeds 9999)
31119	04	Read	Load resistance (U)	Load resistance value, The decimal point is added according to the decimal place below.
31120	04	Read	Load resistance decimal place (U)	1 digit
31121	04	Read	Load resistance status (U)	0: Normal 1: + over-range (when the load resistance exceeds 9999)
31122	04	Read	Voltage (between V & W)	Measured voltage, The decimal point is added according to the decimal place below.
31123	04	Read	Voltage decimal place (between V & W)	Determined by the rated voltage (200 to 440V = 1 digit)
31124	04	Read	Voltage status (between V & W)	0: Normal 1: + over-range (When the voltage exceeds 9999).
31125	04	Read	Current (V)	Measured current, The decimal point is added according to the decimal place below.
31126	04	Read	Current decimal place (V)	Determined by the rated current (10 to 75A = 2 digits, 100 to 750A = 1 digit, 1000A = 0 digit)
31127	04	Read	Current status (V)	0: Normal 1: + over-range (When the current exceeds 9999)
31128	04	Read	Load resistance (V)	Load resistance value, The decimal point is added according to the decimal place below.
31129	04	Read	Load resistance decimal place (V)	1 digit
31130	04	Read	Load resistance status (V)	0: Normal 1: + over-range (When the load resistance exceeds 9999)
31131	04	Read	Voltage (between W & U)	Measured voltage, The decimal point is added according to the decimal place below.
31132	04	Read	Voltage decimal place (between W & U)	Determined by the rated voltage (200 to 440V = 1 digit)
31133	04	Read	Voltage status (between W & U)	0: Normal 1: + over-range (When the voltage exceeds 9999)
31134	04	Read	Current (W)	Measured current, The decimal point is added according to the decimal place below.
31135	04	Read	Current decimal place (W)	Determined by the rated current (10 to 75A = 2 digits, 100 to 750A = 1 digit, 1000A = 0 digit)

Reference No.	Function code	Write / Read	Data name	Details
31136	04	Read	Current status (W)	0: Normal 1: + over-range (When the current exceeds 9999)
31137	04	Read	Load resistance (W)	Load resistance value, The decimal point is added according to the decimal place below.
31138	04	Read	Load resistance decimal place (W)	1 digit
31139	04	Read	Load resistance status (W)	0: Normal 1: + over-range (When the Load resistance exceeds 9999)
31180	04	Read	Initial resistance (U)	Initial resistance value (Decimal 1 digit)
31181	04	Read	Initial resistance (V)	Initial resistance value (Decimal 1 digit)
31182	04	Read	Initial resistance (W)	Initial resistance value (Decimal 1 digit)

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