INST. No. INE-312A

CHINO

LT400 SERIES
DIGITAL INDICATING CONTROLLER
COMMUNICATIONS INTERFACES

INSTRUCTIONS

Retain this manual apart from the instrument and in an easily

Please make sure that this manual is handed to the final user of the instrument.

CHINO

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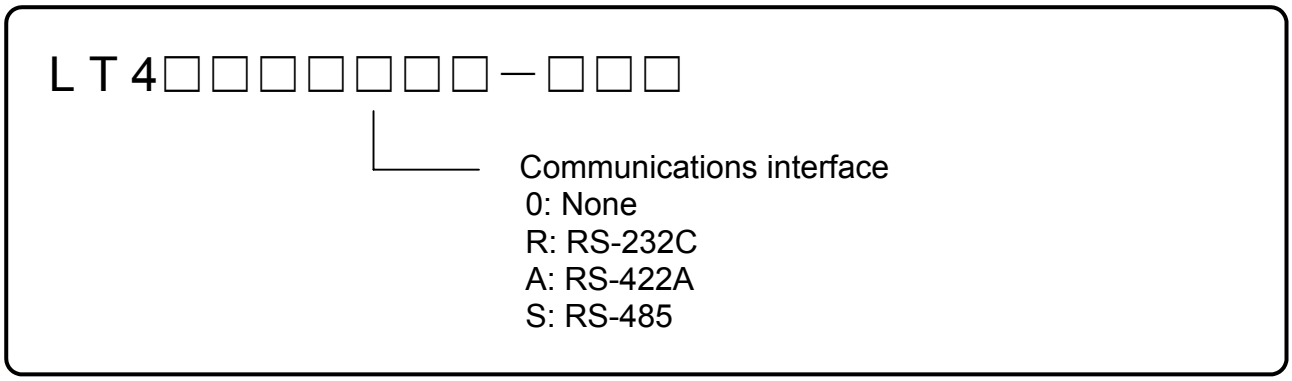
INTRODUCTION

This instruction manual describes the specifications and operation of three built-in communications interfaces (RS-232C, RS-422A, and RS-485) of the LT400 series Digital Indicating Controllers.
The explanation for these interfaces are partly the same. However, their differences are explained separately in [In case of RS-232C] and [In case of RS-422A and RS-485]. Please read the required part carefully. Be sure to confirm the model code of the LT400 controllers you purchased as this determines the required communications interface type.



1. Other Instruction Manual to be consulted.

To understand the contents of this instruction, it is necessary to fully understand the operations and specifications of the LT400 series Digital Indicating Controllers.
This instruction manual is for the communications interface only. For the running and operation, please refer to the following instruction manuals:

1. LT400 series Digital Indicating Controllers (Manual No. INE-303)
2. LT400 series Reference Manual (Manual No.INE-311)
3. SC8-10 Line Converter (Manual No. INE-39)

* Also refer to the instruction manual of the computer being used.

2. Caution Display ⚠

This manual contains explanation of precautions. Observe these precautions when operating and handling the communications interfaces, otherwise the instrument may be damaged, resulting in a deterioration in its performance, or operation failures may also occur.

⚠ Caution

(1) The right is reserved to change the contents of this manual at any time without notice.

(2) The contents of this manual have been prepared professionally. However, if you have any questions, or notice of error or an omission of descriptions found on this manual, please contact your nearest CHINO sales agent.

(3) CHINO Corporation is not responsible for any results influenced by the operation of this communications interface, irrespective of item (2) above.

1 GENERAL

There are three types of communication interfaces (RS-232C, RS-422A and RS-485) available between the LT400 controllers and personal computers (PCs).
PCs can be used to receive measured data from the LT400 controllers, program different parameters and issue control commands. The number of LT400 controllers that are connectable to a PC is one for the RS-232C and up to 31 for the RS-422A/485.

1.1 RS-232C Communications Interface

The RS-232C is the data communications standard being set and issued by EIA (Electronic Industries Association) in the USA and JIS C 6361 in Japan.
This standard is a basic interface between MODEM and connected data terminal units, and specifies electrical and mechanical specifications only. Most of the RS-232C communications interface is being used for personal computers and industrial instruments such as LT400 controllers do not completely conform to this standard at present, and have different signal wire numbers, connectors to those specified in the standard. Also, since this standard does not specify any software parts, or so-called [data transmission procedures], units having the RS-232C communications interface can not be interconnected with each other unconditionally. With these reasons, users must survey and check the specifications and transmission procedures in advance of units being connected. However, if the counter unit is for a personal computers or similar device which can optionally program the specifications, then all the units can be combined by having proper programs prepared by a program designer.

1.2 RS-422A/485 Communications Interface

The RS-422A and RS-485 communications interface can communicate with multiple LT400 controllers (up to 31 sets) in parallel by signals conforming to RS-422A and RS-485.
There are few personal computers which provide RS-422A or RS-485 communications interface. However, since these communications interfaces are characterized with serial communications, these are easily connectable to the personal computer having the RS-232C communications interface by using an RS-422A or RS-485 ⇔ RS-232C signal converting unit. A line converter (Model SC8-10: sold separately) is available for RS-422A and RS-485 ⇔ RS-232C signal conversion at CHINO.
Regarding the difference between RS-422A and RS-485 communications interfaces, the RS-422A needs four signal cables, while RS-485 needs only two signal cables.

2 COMMUNICATIONS PROTOCOL

LT400 controller has the following two communications protocols which can be selected by key programming.

(1) MODBUS Protocol (MODBUS is the registered trademark of Schneider Automation Inc.)

MODBUS Protocol has RTU mode and ASCII mode that can be selected by key programming. MODBUS protocol provides the function of transmitting measured data as well as the programming and operating function.

(2) Private Protocol

This protocol has the function of communications transmission and communications remote.
When you do master and slave operation, you will use above protocols with our controller (such as DP,KP, DB and DZ)

（Details: See 7 communications transmission and communications remote）

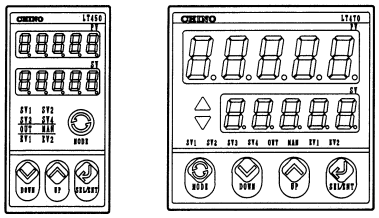
3 COMMUNICATIONS SPECIFICATIONS

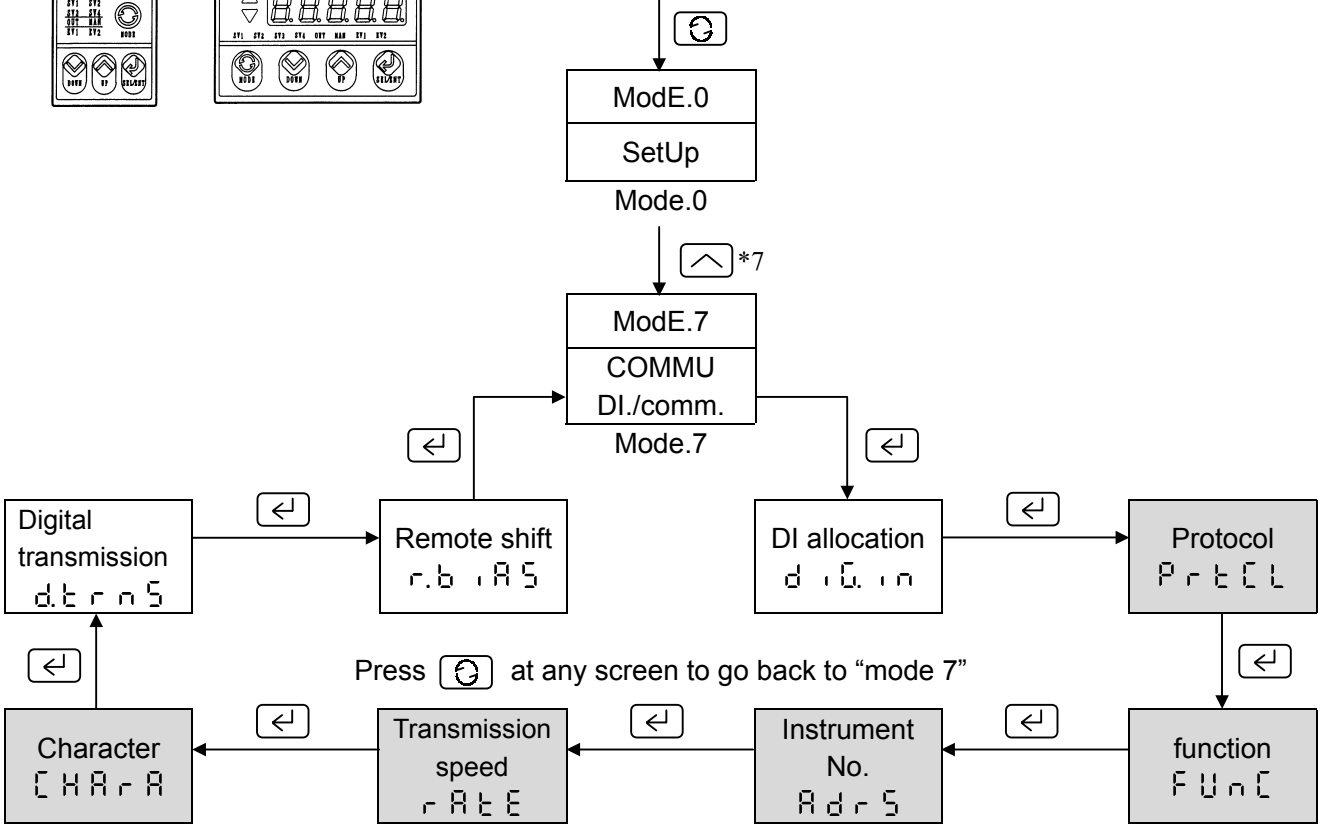
* Half-duplex (polling selecting system)
* Protocol: MODBUS protocol
* Transmission speed: 19200, 9600,bps selectable
* Start bit: 1 bit
* Data length: 7 bits(ASCII)/8 bits(RUT/ASCII) selectable
* Parity bit: Even / Odd / Disabled selectable
* Stop bit: 1 bit / 2 bits selectable
* Transmission code : Binary(RTU) / ASCII(ASCII) (depending on protocol)
* Error check: LRC(ASCII)/CRC-16(RTU) Depending on protocol
* Data transmission procedure: None
* Signals in use: Transmitted and received data only (no control signal in use)

4 SETTING OF COMMUNICATIONS PARAMETERS

Follow the flow chart and set up 5 items such as ”Protocol”, ”Communications function”, “Instrument No.”,” Transmission speed” and “Character”.

(Operation screen)





4.1 Setting of Protocol (PrtCL)

(1) Press [↵] to see [PrtCL]
(2) Choose the protocol by pressing [∧] and [∨], then press [↵] to register.

Kind	Protocol	Default
rtU	Modbus rtu	rtU
ASCii	Modbus ascii	
PrivAE	Private protcol	

*When you change the protocol, the communications function and character will become initial value.

4.2 Setting of Communications Function (FUnC)

(1) Press [↵] , then you will see [FUnC]
(2) Choose the communications function by pressing [∧] and [∨] , then press [↵] to register.

<table>
<tr><th>Kind</th><th>Function</th><th>Protocol</th><th>Details</th><th>Default</th></tr>
<tr><td>CoM</td><td>Upper Communication</td><td rowspan="4">MODBUS

Private</td><td>Set up the upper communication when you communicate with the personal computer.</td><td rowspan="2">CoM</td></tr>
<tr><td>trS.2</td><td>Communications Transmission</td><td>By setting up “trs.2” at communications transmission, the transmitting date at LT400 will be sent to LT400 that was set up with [CoM]. It also transmits SV No. and Run/Ready information.
(See 7 Communications Transmission and Communications Remote)
<table><tr><td>PV</td><td>Transmit the measured data (default).</td></tr><tr><td>SV</td><td>Transmit the set up value.</td></tr><tr><td>rSV</td><td>Transmit the SV value received with Remote</td></tr></table>Type of transmission data can be set at “mode 7”, which is digital transmission.</td></tr>
<tr><td>rEM</td><td>Communications Remote</td><td>By setting communications remote, the data that is set at transmission type will be received through digital transmission.
(See 7 Communications Transmission and Communications Remote)</td><td rowspan="2">rEM</td></tr>
<tr><td>trS</td><td>Communications Transmission</td><td>By setting communications transmission, the transmitting data at LT400 will be sent to LT400 that is set with [rEM].
(See 7 Communications Transmission and Communications Remote)
<table><tr><td>PV</td><td>Transmit the measured data (default).</td></tr><tr><td>SV</td><td>Transmit the set up value.</td></tr><tr><td>rSV</td><td>Transmit the SV value received with Remote</td></tr></table>Types of transmitting data will be set with the same way as [trs.2].</td></tr>
</table>

4.3 Setting of Instrument No. (AdrS)

From one to a few LT400, which communicate with personal computer, will be set the instrument Number that dose not fell on another LT400

(1) Press [↵] to display [AdrS]

(2) Choose the instrument number (from 01 to 99) by pressing [∧] or [∨] , then press [↵] to register.

⚠ CAUTION

1.The instrument number should be from 01 to 99, and should not fell on another LT400.（default 01）
2.In case of RS-232C, set the instrument number though it is one-set connection. (default 01 is fine.)

4.4 Setting of Transmission speed (rAtE)

Operate LT400 and personal computer by the same Transmission speed.
(Usually, the default 9600 bps is fine.)

(1) Press [↵] to display see [rAtE]

(2) Choose the Transmission speed by pressing [∧] or [∨], then press [↵] to register
Transmission speed : 9600, 19200 bps（default is 9600 bps.）

4.5 Setting of Character (CHArA)

(1) Press [↵] to display [CHArA]

(2) Choose the character by pressing [∧] or [∨] , then press [↵] to register.

Kind	Bit length	Parity	Stop bit	Default value
7E1	7bit	Even	1	[at MODBUS RTU] 8N1 [else above] 7E1
7E2			2	
7O1		Odd	1	
7O2			2	
8N1	8bit	None	1	
8N2			2	
8E1		Even	1	
8E2			2	
8O1		Odd	1	
8O2			2	

5 CONNECTIONS

5.1 Connection Precautions

5.1.1 Communication Terminals

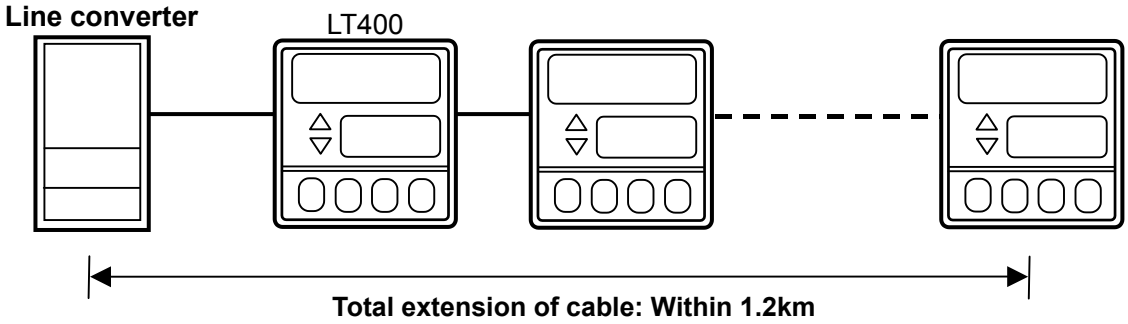
Disposition of terminals are different from each communications interface.

No.	RS-232C	RS-422A	RS-485
⑪	SD	SDA	SA
⑫		SDB	SB
⑬	RD	RDA	
⑭		RDB	
⑮	SG	SG	SG
⑯	DI1+		
⑰	DI2+		
⑱	DI3+		
⑲	DI4+		
⑳	DI-COM		

5.1.2 Total extension of RS-422A/485 communications cable is up to 1.2km.

The wiring interval between each instrument is option, but the total extension distance of cable is within 1.2km.

(Line converter ⟺ the final end of LT400 controllers)

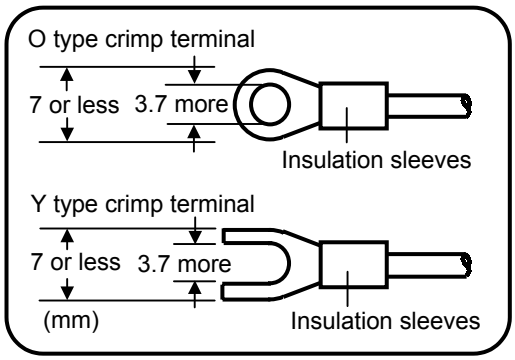


5.1.3 Noise preventive terminals

Separate the communications cable from drive power cables and other communications cable more than 50cm so as not to be affected by noises.

5.1.4 Crimp style terminals

Falling off of connections is one of communications failures. Terminate the communications cable with an [O] or [Y] type crimp style terminal having an insulation sleeve. (The terminal screws of LT400 controllers and line converters are M3.5mm.)



5.1.5 Mount an insulation resistor

For using the RS-422A or RS-485 communications interface, mount a 100 Ω resistor to the LT400 controller connected at the final end. (For details, see Section 5.4)
[A general metal film resistor can be used. The resistor (sold separately) is available at CHINO.]

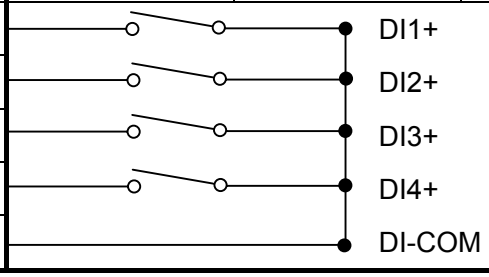
5.1.6 Number of LT400 controllers connectable

For RS-232C: 1 set
For RS-422A or RS-485: Up to 31 sets

5.1.7 Remote/Local Change

Those terminals are for contact signal with no voltage at「Communications Remote」.
Do not connect when you communicate with the personal computer.

(1)Terminals

No.	RS-232C	RS-422A	RS-485
⑪	SD	SDA	SA
⑫		SDB	SB
⑬	RD	RDA	
⑭		RDB	
⑮	SG	SG	SG
⑯		DI1+	
⑰		DI2+	
⑱		DI3+	
⑲		DI4+	
⑳		DI-COM	

(2)DI layout

Kind	DI1	DI2	DI3	DI4
UNUSE	Unused	Unused	Unused	Unused
1	SV1	SV2	SV3	SV4
⋮				
12	Not defiined	REM/LOC	Run/Ready	A/M

(3) The way to switch to communications remote

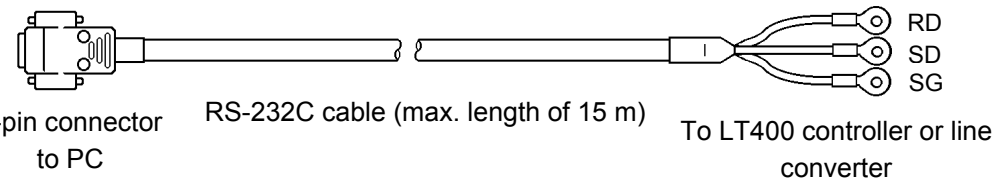
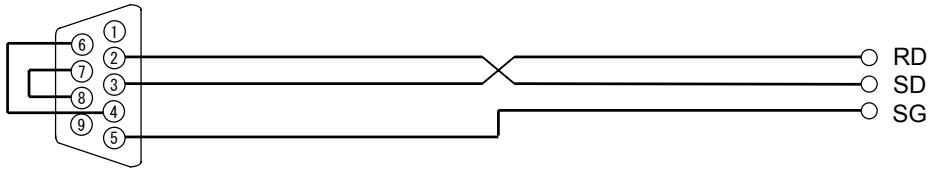
- Follow the above chart (2), and set DI layout at 12. DI layout is at mode7.
- Input the contact signal to DI 2 terminal.
  DI 2 short ＝ remote
  DI 2 open ＝ local

5.2 Communications Cables

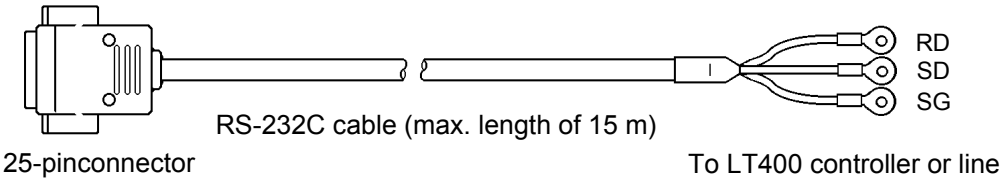
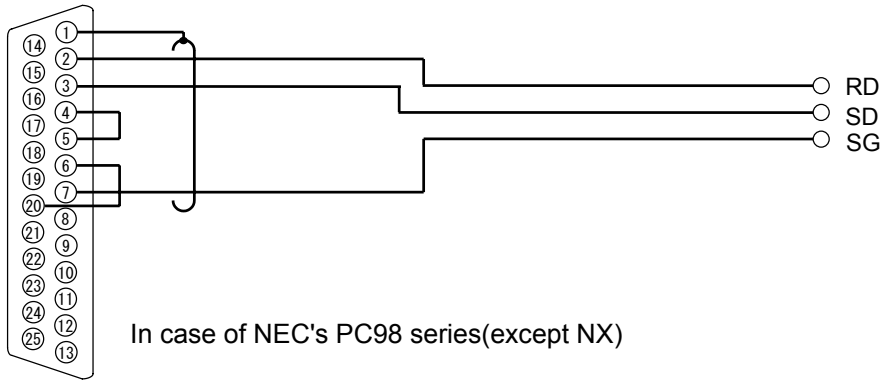
Make ready cables dedicated to communications before performing connection. Dedicated communications cables (sold separately) are available at CHINO.

5.2.1 Communications cables for RS-232SC

(1) Connection between PC (with 9 pin-terminal) and LT400 controller and between PC (with 9 pin-terminal) and line converter.

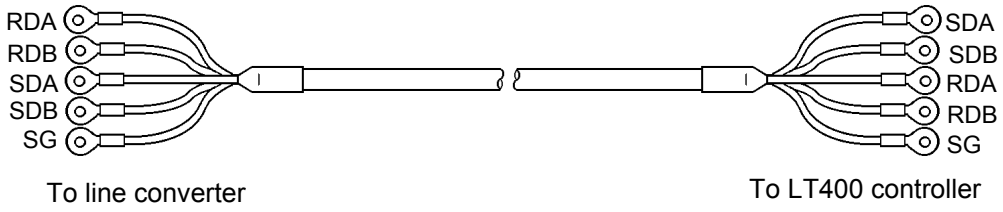
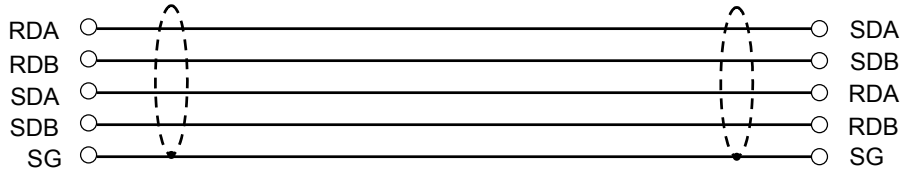
Cable	9-pin connector ⟷ RS-232C cable with O-shaped crimp terminal
Style	
Internal wiring	
Type code	**RZ-CRS6** □□ Cable length of 1 to 15 m (To be specified)

(2) Connection between PC (with 25 pin-terminal) and LT400 controller and between PC(with 25 pin-terminal) and line converter.

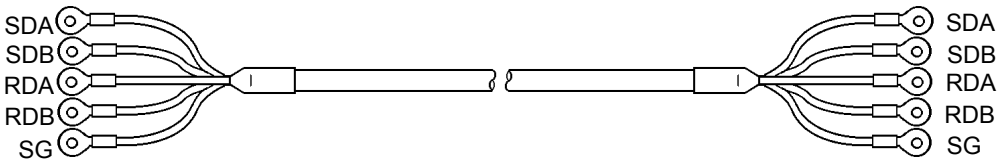
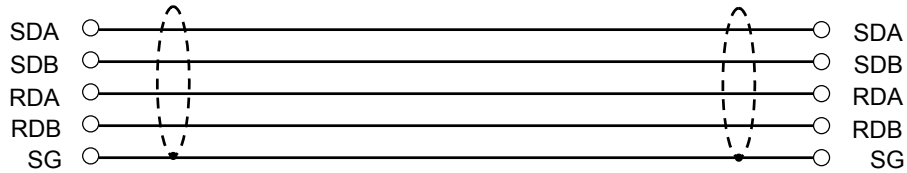
Cable	25-pin connector ⟷ RS-232C cable with O-shaped crimp terminal
Style	
Internal wiring	
Type code	**RZ-CRS2** □□ Cable length of 1 to 15 m (To be specified)

5.2.2 Communications cables for RS-422A

(1) Connection between line converter and LT400 controller

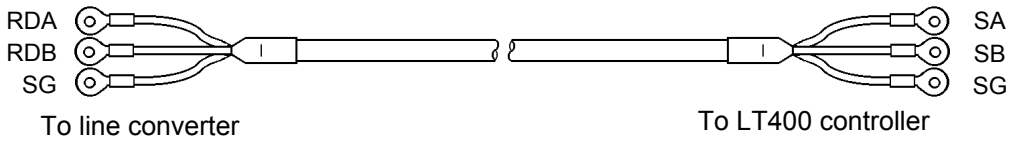
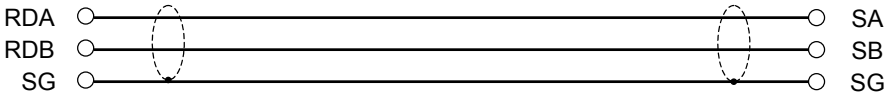
Cable	O-shaped crimp terminal ⟷ RS-422A cable with O-shaped crimp terminal (for line converter)
Style	 To line converter To LT400 controller The cable consists of a pair of twisted dual-core CVVS wires with SG (signal grounding) wire at both ends. Cut off the SG wire on the line converter side because this has no SG terminal.
Internal wiring	
Type code	**RZ-CRA2**□□ Cable length of 1 to 99 m (To be specified)

(2) Connection between LT400 controller and LT400 controller

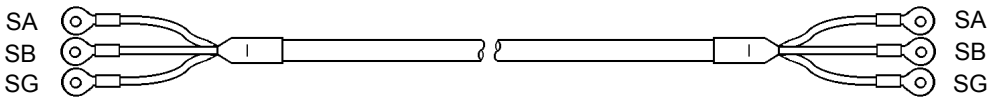
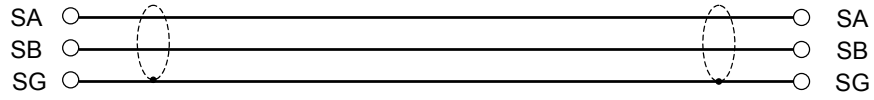
Cable	O-shaped crimp terminal ⟷ RS-422A cable with O-shaped crimp terminal (for parallel connection)
Style	 To LT400 controller To LT400 controller The cable consists of a pair of twisted dual-core CVVS wires with SG (signal grounding) wire at both ends.
Internal wiring	
Type code	**RZ-CRA1**□□ Cable length of 1 to 99 m (To be specified)

5.2.3 Communications cables for RS-485

(1) Connection between line converter and LT400 controller

Cable	O-shaped crimp terminal ⟷ RS-485 cable with O-shaped crimp terminal (for line converter)
Style	 To line converter To LT400 controller The cable consists of a twisted dual-core CVVS wires with SG (signal grounding) wire at both ends. Cut off the SG wire on the line converter side because this has no SG terminal.
Internal wiring	
Type code	**RZ-LEC** □□□ (for line converter) Cable length of 1 to 200 m (To be specified)

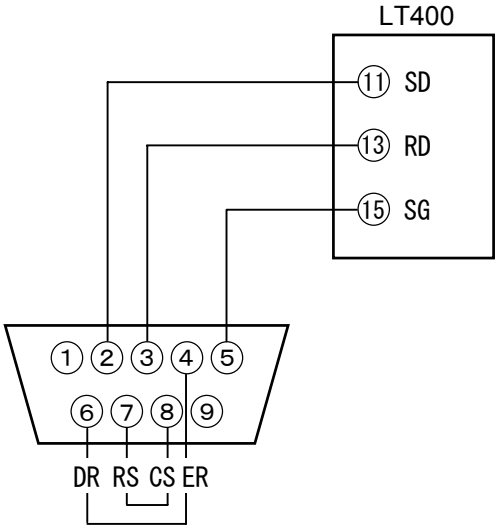
(2) Connection between LT400 controller and LT400 controller

Cable	O-shaped crimp terminal ⟷ RS-485 cable with O-shaped crimp terminal (for parallel connection)
Style	 To LT400 controller To LT400 controller The cable consists of a twisted dual-core CVVS wires with SG (signal grounding) wire at both ends.
Internal wiring	
Type code	**RZ-CSS1Z2(0.2m) or RZ-LEC** □□□ (For parallel connection) Cable length of 1 to 200 m (To be specified)

5.3 RS-232C Connections

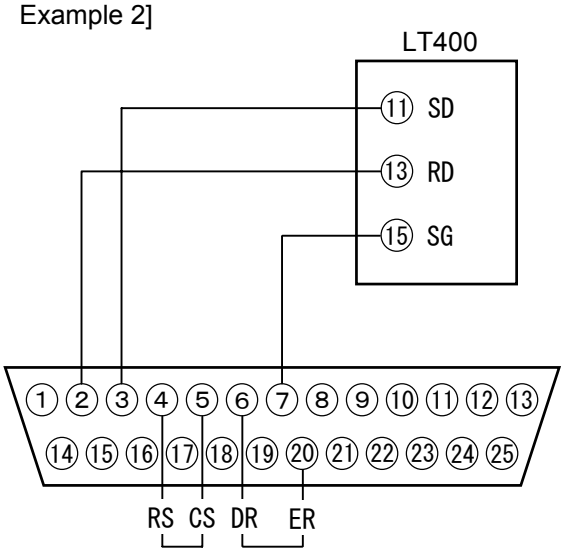
The LT400 controllers use three control signals of Send(SD), Receive(RD), Signal ground (SG) only. Since general personal computers are controlled by control signals, the computer does not function by only connecting three signal cables without wiring processing inside the connectors. Wiring processing depends upon the control signals being controlled by the personal computer. For details, read the instruction manual for the personal computer used.

[Connection Example 1]



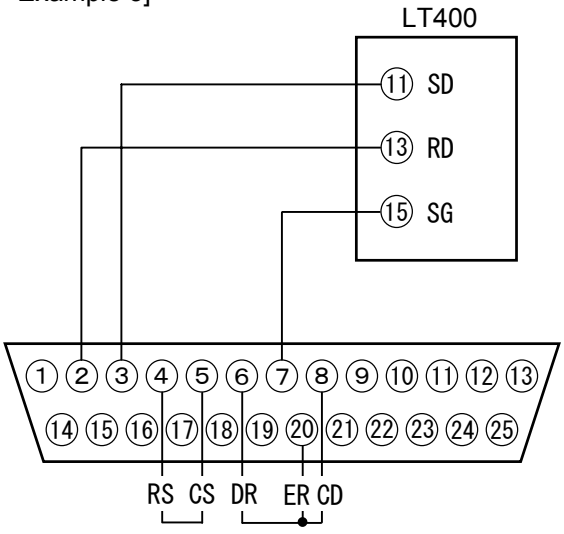
9-pin connector
(PC-98 series/IBM-PC/AT)

[Connection Example 2]



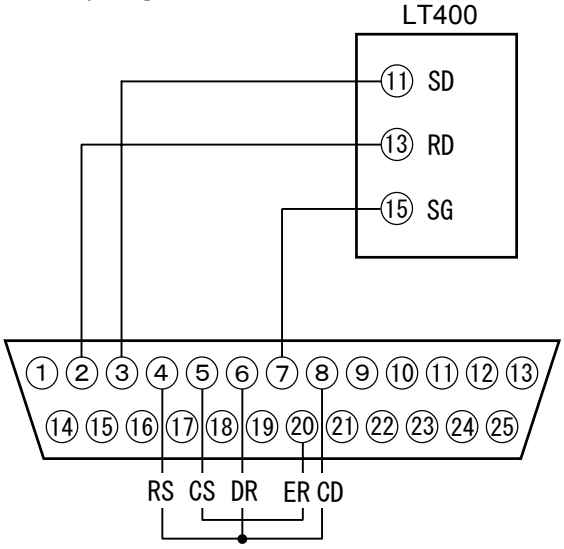
25-pin connector
(PC-98 series)

[Connection Example 3]



25-pin connector

[Connection Example 4]



25-pin connector

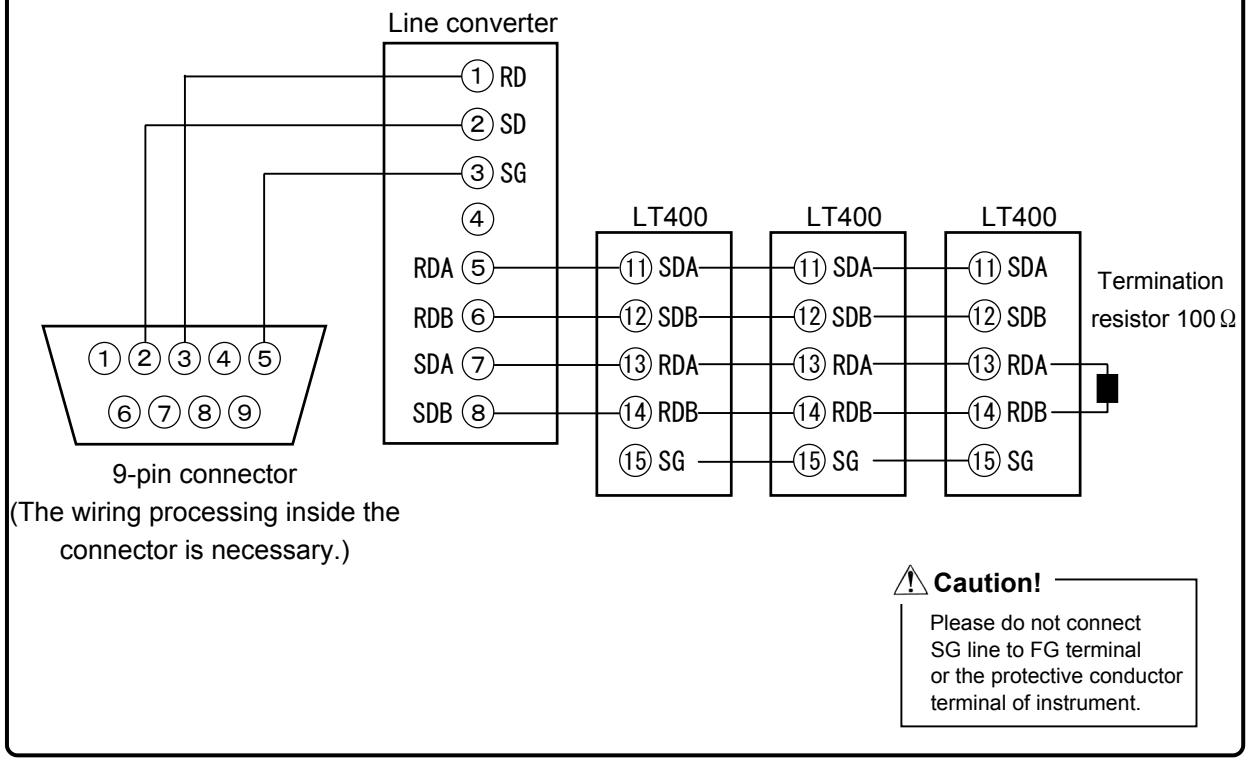
⚠ ATTENTION!

The RS-232C cable length is restricted to be within 15m. The connection for NEC PC98 series 9-pin connector is on [Connection sample 1] and for the 25-pin connector is on [Connection sample 2].

5.4 RS-422A / RS-485 Connections

This paragraph describes the method of connecting the RS-422/485 communications interface to the personal computer by using the line converter (Model SC8-10: sold separately). Since the line converter and the personal computer use three control signal of Send, Receive and Signal ground only, the wiring processing inside the connectors is necessary in the same way as in RS-232C connections.
[For details, read the instruction manual for line converter (Model SC8-10: sold separately).]

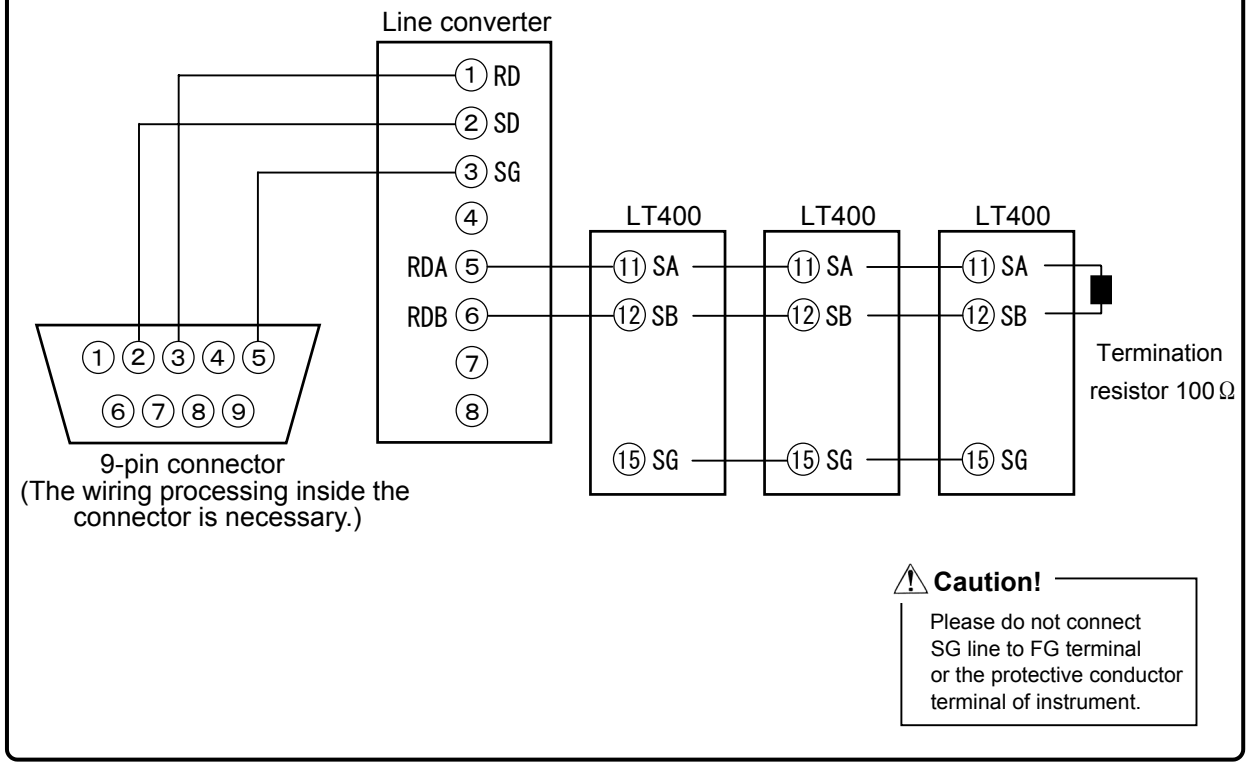
In case of RS-422A



⚠ Caution!

Please do not connect SG line to FG terminal or the protective conductor terminal of instrument.

In case of RS-485



⚠ Caution!

Please do not connect SG line to FG terminal or the protective conductor terminal of instrument.

6 MODBUS PROTOCOL

Basic Procedures of Communications and Precautions

⚠ Attention!

1. When you set the parameter (writing), set the key lock at first.

LT400 controller is always ready for communication. It responds at anytime to data requests from the personal computer. However, when you set the parameter or control the instrument from the personal computer, you need to set key lock (lock 4) on LT400 at first. Key lock will be set at the front key on LT400 or through personal computer communication. If you try to set the parameter or operate instrument from the personal computer at Non-lock, Lock1, Lock 2 and Lock 3, LT400 will show error code 12H.（See paragraph 6.6）

2. In case of RS-232C, LT400 needs the instrument number.

In case of RS-232C, though personal computer and LT400 are one-by-one connection, set the instrument number on LT400 and communicate by using this instrument number.

3. Take care of command re-transmission as there is no control signal line in use.

Since the LT400 controllers' serial interfaces communicate freely without using any control line, a reception failure may occur under some conditions. Exercise care when resending a command.

4. Don't disconnect or short any cables or instruments constituting the serial interface, or turn the power on or off during communications.

Don't disconnect or short any cables or instruments constituting the serial interface, or turn the power on or off during communications, or the operation may stop or lead to a malfunction. When this happens, all the components of the serial interface must be reset to repeat the operation from the beginning.

5. Send the next command after making sure that the communications drive has been turned off.

For RS-485 communications interface, multiple instruments are connected to the same communications line, only one instrument, of which instrument No. is specified by the PC, drives the communications line. The communications drive is turned off at a certain time (approx. 5 msec) after sending the last character so that all the characters are safely received by the personal computer. If the PC sends a command to the next unit before the communications drive is turned off, signals interfere with each other resulting in some communication failure. Exercise caution when you use a high-speed PC.

6.1 Message Transmission Modes

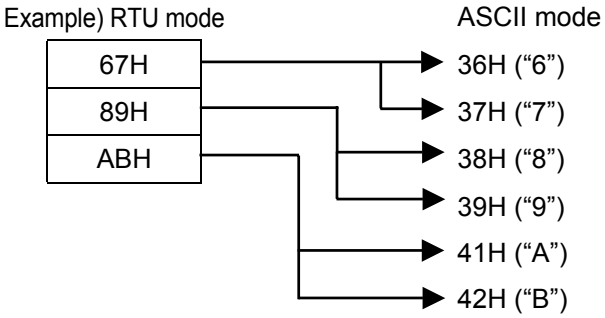
There are two modes of message transmission, RTU (Remote Terminal Unit) and ASCII, which can be selected by key programming.

(Table 1　Comparison between RTU and ASCII modes)

Item		RTU mode	ASCII mode
Interface		RS-232C, RS-422A、RS-485	
Communications system		Half-duplex start-stop synchronization	
Transmission speed		9600，19200bps	
Character code		Binary	ASCII
Error check	Vertical	Parity	
	Horizontal	CRC-16	LRC
Character Configuration	Start bit	1 bit	
	Data bit	8 bits	7 bits, 8 bits
	Parity bit	Disabled, even, odd	Disabled , odd, even
	Stop bit	1,2 bit	
Message start code		None	: (Colon)
Message stop code		None	CR, LF
Data time interval		28 bit-time or less	1 second or less

6.1.1 Transmitted data

The RTU-mode data is transmitted in binary numbers. In ASCII mode, the 8-bit binary data of RTU is separated into higher-order 4 bits and lower-order 4 bits and both are turned into characters (0 - 9, A - F).

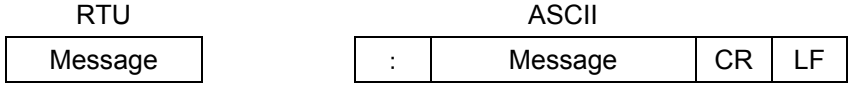


Length of the RTU-mode message is half that of an ASCII-mode message, ensuring a more efficient transmission.

6.1.2 Message frame configuration

The RTU-mode data consists only of a message section.

The ASCII mode data consists of a start character [": (colon, 3AH)], a message and a stop character [("CR (carriage return, 0DH) + LF (line feed, 0AH)].



The ASCII mode has the advantage of easier troubleshooting because its message has a start character [:].

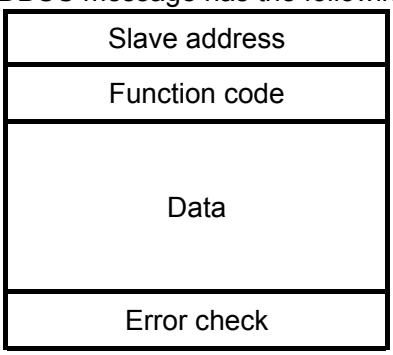
6.2 Data Time Interval

In RTU mode: Below 28 bit-time (2.9 msec. at 9600 bps, 1.4 msec. at 19200 bps)
In ASCII mode: Below 1 second

When sending a message, keep the time interval of data constituting one message not longer than the time specified above. When the time interval of data is longer than the above, the receiver unit (i.e., this controller) recognizes that the data transmission from the sending unit is complete, so that the subsequent data is processed as an abnormally received message.
While the message characters must be consecutively sent in RTU mode, the ASCII modes allows for a maximum interval of 1 second between characters, making it possible to use a master unit (PC) with a relatively slow processing speed.

6.3 Message Configuration

The MODBUS message has the following configuration in both RTU and ASCII modes.



6.3.1 Slave address

The slave address can be programmed in advance by key operation within a range between 1 and 99. The master unit usually communicates with one slave unit. While messages from the master unit are received commonly by all the units in connection, only the slave unit corresponding to the slave address included in the command message responds to the message sent.
The slave address "0" is used for a message from the master unit addressed to all the slave units (broadcast message). The slave units do not send a response back to the master unit.

6.3.2 Function code

Function codes refer to the functions to be executed by the slave units. The data is generally classified as follows. Refer to the reference table for details.

(1) Digital parameters: AT Start ,etc
(2) Digital input data: Parameters are such as remote contacts input status, and event status.
(3) Analog parameters: Information on various parameters. Numerical values should be kept within the 16-bit range between -32768 and 32767 (see the reference table for details).
(4) Analog input data: Information on measured data. Numerical values within the range of 16-bits are delivered as an output.

(Table 2. Function code table)

Code	Functions	Unit	MODBUS original functions (ref.)
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 hold register contents
04	Read analog input data	16 bit	Read input register contents
05	Write digital parameter	1 bit	Change single coil status
06	Write analog parameter	16 bit	Write into single hold register
08	Send received data (for diagnosis)		Loop-back test
15	Write two or more digital parameters		Change multiple coils status
16	Write two or more analog parameters		Write into multiple hold registers

6.3.3 Data section

Data configurations depend on the function codes. A master request consists of the code number of the data to be read or written (Relative No. to be calculated from the Reference No. described below) and the number of data pieces. Response from slave units consists of data responsive to the request.
Every MODBUS basic data consists of 16-bit integers, with or without codes depending on individual data. It is thus configured as integers with their decimal places assigned to separate addresses, or normalized with the upper and lower limits specified by the scale with fixed decimal places. The LT400 controlles employ the system of assigning the decimal places to separate addresses.

6.3.4 Reference Nos.

Data in the LT400 controllers have "Reference No." assigned to each of them which is required for reading and writing the data. The data in the LT400 controllers are classified into "Digital parameter", "Digital input data", "Analog input data", "Analog parameter" depending on their type. The Nos. In the message are designated by the "Relative Nos." corresponding to the Reference Nos.

(Table 3. Reference Nos. and Relative Nos.)

Data type	Reference No.	Relative No.	MODBUS original (for reference)
Digital parameter	1 to 10000	Reference No. – 1	Coil
Digital input data	10001 to 20000	Reference No. – 10001	Input relay
Analog input data	30001 to 40000	Reference No. – 30001	Input register
Analog parameter	40001 to 50000	Reference No. – 40001	Hold register

Example) “The Relative No” of the measured value(PV) at "Reference No. 30101" is "100”.

(Table 4　Quick search table for LT400-Reference Nos.)

Data type	Parameters	Reference No	Corresponding function code	Reference table
Digital parameter	AT start NAVI on/off Cascade on/off	101 to 109	01(READ) 05(WRITE) 15(WRITE)	Section 6.7.3 (P.38)
Digital input data	Error status Remote contacts status (contact input) Event status	10002 to 10124	02(READ)	Section 6.7.4 (P.39)
Analog input data	Measured data(PV/SV/MV) Run parameter Event status	30101 to 30142	04(READ)	Section 6.7.2 (P.37)
Analog parameter	Set up parameter Input type Engineering unit Range L/H Linear scale L/H Linear decimal point SV limiter PV decimal point Digital filter Burnout Deviation deadband Control action Pulse cycle F.B. zero/span/deadband Cool pulse cycle Heat/Cool type EVmode/deadband/outputphase/delay Analog transmission/scale Remote range/scale Remote shift Digital transmission DI allocation Power recovery action Event output atReady	40001 to 40093	03(READ) 06(WRITE) 16(WRITE)	Section 6.7.1 (P.27)
	One kind parameter PV error output Preset –out SV rise ramp SV fall ramp PV start Split direct/reverse H/C deadband / Cooling P factor Cascade para Initial screen Sensor correction ARW Output preset	40112 to 40166		(P.30)
	No.1/No.2/No.3/No.4parameter SV P/I/D Output limiter L Output limiter H Variation limiter L/H PID deadband EV1/EV2/EV3/EV4 setting	40201 to 40388		(P.32)

Data type	Parameters	Reference No	Corresponding function code	Reference table
Analog parameter	Instrument Operation Key lock A/M switch Run/ready SV No. Selection Remote SV setting	49501 to 49512	03(READ) 06(WRITE) 16(WRITE)	(P.36)

6.3.5 Error check

Error check for transmission frames is different between the transmission modes.
RTU mode: CRC-16
ASCII mode: LRC

6.3.5.1 Calculation of CRC-16

In the CRC system, the information to be transmitted is divided by a generating polynomial, the resulting remainder being added to the end of the data. The generation polynomial is as follows.

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

The data from its slave address to its end is calculated in the following procedure.

1) Initialize the CRC-16 data (assumed as X) (= FFFFH)
2) Exclusive logical sum (EX - OR) between data 1 and X → X
3) Shift X one bit to the right → X
4) When a carry is generated, take A001H and EX-OR. If not, go to 5). → X
5) Repeat 3) and 4) until shifting 8 times.
6) EX-OR between the next data and X → X
7) Same as 3) to 5)
8) Repeat up to the last data
9) Create a message in the sequence from lower to upper orders of the calculated 16-bit data (X).

Example) Since CRC-16 is 1241H for the data | 02H | 07H | , the error check data will be | 41H | 12H |.

Reference: CRC-16 Calculation Program

```
 10  D(1) = &H2 : D(2) = &H7 : N = 2
 20  GOSUB *CRCMAKE
 30  END
 40
100  *CRCMAKE
110  CRC = &HFFFF
120  FOR  I = 1 TO N
130   CRC = CRC XOR D(I)
140   FOR  J = 1 TO 8
150    CY = CRC AND &H1
160    IF CRC  <  0 THEN P = &H4000 ELSE
          P = 0 : GOTO 180
170    CRC = CRC AND &H7FFF
180    CRC = CRC ¥ 2
190    CRC = CRC OR P
200    IF CY = 1 THEN CRC = CRC XOR
          &HA001
210    NEXT  J
220  NEXT  I
230  IF CRC  <  0 THEN P = &H80 ELSE
        P = 0 : GOTO 250
240  CRC = CRC AND &H7FFF
250  C1 = CRC AND &HFF
260  C2 = ( CRC AND &H7F00 ) ¥ 256
270  C2 = C2 OR P
280  D (N+1) = C1 : D(N+2) = C2
290  RETURN
```

6.3.5.2 Calculation of LRC

The data from its slave address to its end is calculated in the following procedure.

1) Create a message in RTU mode.
2) Add the start (slave address) to end of the data. → X
3) Complement X (bit reverse) → X
4) Add 1 (X = X + 1)
5) Add X as an LRC to the end of the message.
6) Convert the whole data to ASCII characters.

Example) For the data | 02H | 07H | , LRC is F7H which will be | 02H | 07H | F7H | as a binary message, so that the ASCII message will be | 30H | 32H | 30H | 37H | 46H | 37H | .

6.3.6 Precautions on data processing

(1) Since the measured data and decimal places are assigned to separate numbers, it is necessary to use both parts of the information when playing back the data. The decimal place of each data is showed on the reference table. There are some types of data, which are fixed decimal place, followed by each measuring range, (See paragraph 6.8), followed by linear decimal place setting. Pay attention to the decimal place, when you replay the data.
(2) Since data is accessible (changeable) one by one, care must be taken when programming related data, for instance when initializing related data by changing the range number. Processing details are given in the Reference No. list.
(3) Read or write the data within the range of Reference Nos. specified. If data is written on any non-specified Reference No., it is likely to affect the proper operation of the instruments.
(4) While it is possible to write data on two or more discreet Reference Nos., a start number with Reference No. not specified will result in an error (error No. 02H).
(5) When reading two or more Reference Nos., the data with non-specified Reference No. becomes "0".
(6) When an error is detected during writing on two or more Reference Nos., all the programming becomes invalid.

6.4 Creating a Message

A message consists of (1) Slave address, (2) Function code, (3) Data section and (4) Error check code. (See Section 6.3)

The message readable or writable at one time is within the following range.

function code	Number of data pieces	
	ASCII	RTU
01	64	64
02	64	64
03	32	32
04	32	32
15	64	64
16	32	32

How to create a message will be described by an example given below.

Example) Reading a measured data for LT400 controller with "slave address 02".

6.4.1 RTU mode message

(1) Slave address : 02 (02H)

(2) Function code : 04 (04H)

The data type is "Read analog input data (read input register contents)". When the function code is "04", specify the “data's Relative No. by 2 bytes" and the "number of data pieces by 2 bytes" to be read from the data section. (See Section 6.5. See Section 6.5.4 for "Function code: 04".)

* It is necessary to make sure of the number of bytes of data.

(3) Data section:

Starting Relative No. 100 (00H | 64H) and Number of data pieces 2 (00H | 02H)

Measured data (analog input data) are stored in Reference Nos. "30001 to 40000" (See Table 3 in Section 6.3.4). The reference table shows that the Measured data (PV) is stored in "30101" and the PV states in "30102". (See Section 6.7. See Section 6.7.2 for reading the measured data.)

The relative No. of the starting "Reference No. 30101” is 30101 - 30001 = 100 that can be expressed by 2 bytes “ 00H | 64H “.(See Table 3 of Section 6.3.4)

The number of data pieces to be read is "2" of the Measured data (PV) and the PV status which can be expressed by “ 00H | 02H “ in 2 bytes

(4) Error check: 2730H calculated with CRC-16 (30H | 27H)

Error check in RTU mode is calculated with CRC-16. (See Section 6.3.5.1)

The data in the core message is:

02H	04H	00H	64H	00H	02H

according to (1) to (3), whose CRC-16 is 2730H.

Error check data is therefore 30H | 27H .

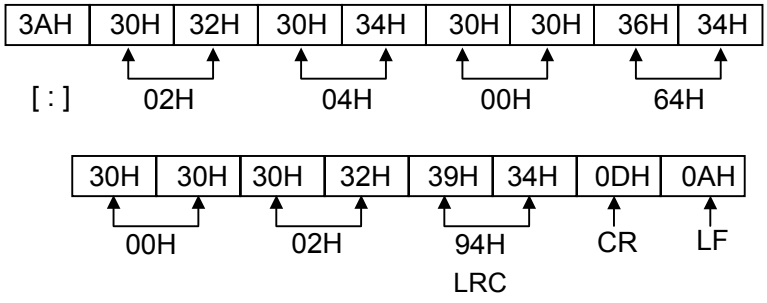
(5) Message:

02H	04H	00H	64H	00H	02H	30H	27H

Create a message according to the message configuration. (See Section 6.3)

6.4.2 Message in ASCII mode

Calculate the error check LRC from the core message. (See Section 6.4.1 (4)). LRC is 94H (See Section 6.3.5.2). Each data in the core message is converted to ASCII code. LRC is also converted to ASCII code to be added to the core message. Add a message starting character " : " and "CR" and "LF" to the end of the message.



6.5 Function Code

Responses by function code are given below. (See Table 2. Function code table in Section 6.3.2)
Note) See Section 6.6 for responses in abnormal status.

6.5.1 Read digital parameter (read coil status)

[Function code: 01 (01H)]

The specified number of "digital (ON/OFF) parameters" are read out consecutively commencing with the designated Reference No. For ON/OFF data, 8 Reference Nos. are placed in each data (1 byte) sequentially in number to constitute the response message data. The LSB (D0 side) of each data becomes the digital data with the smallest number. If the number of Reference No. is anything other than a multiple of 8, an unnecessary bit becomes 0.

Example) Reading 1 Reference Nos. 101of digital parameters for the slave unit 2.

Reference No	101
Data	OFF

AT
stop

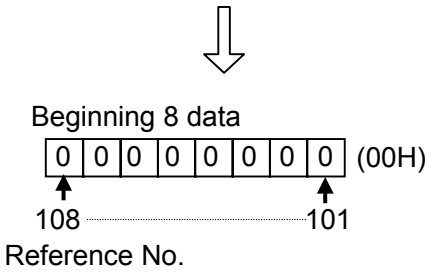
(RTU mode)

Master→Instruments

Slave address	02H
Function code	01H
Start No. (H)	00H
Start No. (L)	64H
Number of Reference No. (H)	00H
Number of Reference No. (L)	01H
CRC (L)	BCH
CRC (H)	26H

Instruments→Master (normal)

Slave address	02H
Function code	01H
No. of data	01H
1st 8 data	00H
CRC (L)	51H
CRC (H)	CCH



(Error check in ASCII mode)

The error check: CRC (L) and CRC (H) will be as follows.

LRC	98H

LRC	FCH

Note) Start No. (Relative No.) is given by "Reference No. - 1".
(Decimal number 100 (=101 - 1) ⟶ Hexadecimal 64H)

Note) No. of data is the number of data bytes.
(which is different from the requested number of Reference No. In the example given above, the requested number of Reference No. is1 and the number of data is 1).

6.5.2 Read digital input data (read input relay status)

[Function code. 02 (02H)]

The specified number of "digital (ON/OFF) input data" are read out consecutively commencing with the designated Reference No. For ON/OFF data, 8 Reference Nos. data are placed in one data (1 byte) sequentially in number to constitute the response message data. The LSB (on DO side) of each data is a digital data with the smallest number. If the number of Reference No. read is anything 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".

6.5.3 Read analog set value (read hold register contents)

[Function code. 03 (03H)]

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

Example) Reading P1/I1/D1 of the slave unit 2.

(Reading 3 Reference Nos. from 40206 to 40208 of analog parameters for the slave unit 2)

Reference No.	40206	40207	40208
Data	50 (0032H)	60 (003CH)	15 (000FH)

← Example: P=5.0%,I=60Sec,D=15Sec.

(RTU mode)

Master→Instruments

Slave address	02H
Function code	03H
Start No. (H)	00H
Start No. (L)	CDH
Number of Reference No. (H)	00H
Number of Reference No. (L)	03H
CRC (L)	94H
CRC (H)	07H

Instruments→Master (normal)

Slave address	02H
Function code	03H
No. of data	06H
P data (H)	00H
P data (L)	32H
I data (H)	00H
I data (L)	3CH
D data (H)	00H
D data (L)	0FH
CRC (L)	8CH
CRC (H)	49H

(Error check in ASCII mode)

LRC	2BH

LRC	78H

Note) Start No. (Relative No.) is given by "Reference No. - 40001".
(Decimal number 205 (=40206-40001) ⟶ Hexadecimal CDH)

Note) No. of data is the number of data bytes. (which is different from the requested number of data. In the example given above, the requested number of reference No. is 3 and the number of data is 6).

Note) The number of data of a message receivable at one time (that can be transmitted from the controller) is limited. (See Section 6.4).

6.5.4 Read analog input data (read input register contents)

[Function code. 04 (04H)]

The specified number of " analog input (2 bytes: 16 bits)" are read out consecutively commencing with the designated Reference No. The data is split into higher-order 8 bits and lower-order 8 bits arranged sequentially in number to constitute a data of response message. The response example is the same as in "Function code 03", though its start number (Relative No.) is "Reference No. - 30001".

6.5.5 Write digital parameter (Change single coil status)

[Function code: 05 (05H)]
A digital parameter with specified numbers is brought into specified status (ON/OFF).

Example) Executing the AT on the slave unit 2 (Turn on Reference No. 101 of digital parameter for the slave unit 2)

(RTU mode)

Master→Instruments

Slave address	02H
Function code	05H
Parameter No. (H)	00H
Parameter No. (L)	64H
Programming status (H)	FFH
Programming status (L)	00H
CRC (L)	CDH
CRC (H)	D6H

Instruments→ Master (normal)

Slave address	02H
Function code	05H
Parameter No. (H)	00H
Parameter No. (L)	64H
Programming status (H)	FFH
Programming status (L)	00H
CRC (L)	CDH
CRC (H)	D6H

(Error check in ASCII mode)

LRC	96H

LRC	96H

Note) The response is the same as command message in the case of a normal response.
Note) Parameter No. (Relative No.) is given by "Reference No. - 1".
(Decimal number 100 (=101-1) ⟶ Hexadecimal 64H)
Note) Upon execution, program "FF00H". The program "0000H" is for terminating the AT command.
Note) When the slave address is programmed to "0", all the slave units execute this command, although no response is received from any of them.

6.5.6 Write analog parameter (write into a single hold register)

[Function code: 06 (06H)]
An analog parameter with specified numbers is brought into a specified value.

Example) Programming the variation limiter 1H of the slave unit 2 to 50.0 %.
(Program Reference No. 40212 of analog parameter to "500" for the slave unit 2.)

(RTU mode)

Master→Instruments

Slave address	02H
Function code	06H
Parameter No. (H)	00H
Parameter No. (L)	D3H
Programming status (H)	01H
Programming status (L)	F4H
CRC (L)	78H
CRC (H)	17H

Instruments→Master (normal)

Slave address	02H
Function code	06H
Parameter No. (H)	00H
Parameter No. (L)	D3H
Programming status (H)	01H
Programming status (L)	F4H
CRC (L)	78H
CRC (H)	17H

(Error check in ASCII mode)

LRC	30H

LRC	30H

Note) The response is the same as command message in case of normal response.
Note) Parameter No. (Relative No.) is given by "Reference No. - 40001". (Decimal number 211 (=40212 - 40001) ⟶ Hexadecimal D3H)
Note) When the slave address is programmed to "0", all the slave units execute this command, though with no response received from any of them.

6.5.7 Loop back test

[Function code: 08 (08H)]

Check transmission between master and slave units. Response is made according to a specified diagnosis code. With the diagnosis code fixed at “0000H”, the LT400 controller performs a "return check” of unaltered received data transmissions.

Example) Executing "Loop back test" on the slave unit 2.

(RTU mode)

Master→Instruments

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

Instruments→ Master (normal)

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

6.5.8 Write multiple analog parameters (Change multiple coils status)

[Function code: 15 (0FH)]

According to the specified number, programs the specified number of digital parameters into the specified status (OFF or ON). Every 8 specified numbers which are OFF or ON form a single data unit (byte). The LSB of each data unit (D0) is the digital data of the smallest numbered data. When the number of specified numbers is not a multiple of 8, the unnecessary bits are ignored.

Example) Executing the AT on the slave unit 2.

(Program the data of the digital parameters with reference numbers 101 of the slave unit 2 as shown below.)

Reference No.	101
Data	ON

AT start

(RTU mode)

Master→Instruments

Slave address	02H
Function code	0FH
Start No. (H)	00H
Start No. (L)	64H
Number of Reference No. (H)	00H
Number of Reference No. (L)	01H
Number of data	01H
1st 8 data	01H
CRC (L)	DEH
CRC (H)	8AH

Instruments→Master (normal)

Slave address	02H
Function code	0FH
Start No. (H)	00H
Start No. (L)	64H
Number of Reference No. (H)	00H
Number of Reference No. (L)	01H
CRC (L)	D5H
CRC (H)	E7H

(Error check in ASCII mode)

LRC	88H

LRC	8AH

Note) Start No. (Relative value) is given by "Reference No. - 1". (Decimal number 100 (=101 - 1) → Hexadecimal 64H)

Note) When the slave address is programmed to "0", all the slave units execute this command, although no response is received from any of them.

Note) The number of message data transmittable (receivable by this controller) at one time is limited. (See Section 6.4)

6.5.9 Write multiple analog parameters (write into multiple hold registers)

[Function code: 16 (10H)]

A specified number of analog parameters from designated numbers are programmed to specified values. The data is split into higher-order 8 bits and lower-order 8 bits to be sent sequentially in number.

Example) Programming the P1/I1/D1 of the slave unit 2 to P=12.0%,I=90Sec,D=25Sec.
(Program 3 Reference Nos. from 40206 to 40208 of analog parameters for the slave unit 2)

Reference No.	40206	40207	40208
Data	120 (0078H)	90 (005AH)	25 (0019H)

(RTU mode)

Master→Instruments

Slave address	02H
Function code	10H
Start No. (H)	00H
Start No. (L)	CDH
Number of Reference No. (H)	00H
Number of Reference No. (L)	03H
Number of data	06H
1st data (H)	00H
1st data (L)	78H
2nd data (H)	00H
2nd data (L)	5AH
3rd data (H)	00H
3rd data (L)	19H
CRC (L)	36H
CRC (H)	56H

Instruments→Master (normal)

Slave address	02H
Function code	10H
Start No. (H)	00H
Start No. (L)	CDH
Number of Reference No. (H)	00H
Number of Reference No. (L)	03H
CRC (L)	11H
CRC (H)	C4H

(Error check in ASCII mode)

LRC	2DH

LRC	1EH

Note) Start No. (Relative value) is given by "Reference No. - 40001". (Decimal number 205 (=40206 - 40001) → Hexadecimal CDH)

Note) When the slave address is programmed to "0", all the slave units execute this command, although no response is received from any of them.

Note) The number of message data transmittable (receivable by this controller) at one time is limited. (See Section 6.4)

6.6 Processing in Abnormal Status

The following response is given when any problem is found in the content of a message from the master unit.

6.6.1 Case of no response

The message is ignored with no response given when

(1) A transmission error (overrun, framing, parity, CRC or LRC) is detected in the message;

(2) The slave address in the message is not the receiver's own address;

(3) Data interval in messages is too long;

28 bits or more in RTU mode

1 second or more in ASCII mode

(4) Transmission parameters are not consistent with those of the receiver;

(5) The bytes of the received message exceeds 96.

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 given to it. Since no response is given also when the above error is detected in the message, whether it is normal or abnormal can not be judged by the response from this controller when the slave address is "0".

6.6.2 Response error message

If the following failure is detected in a message from the master unit with no error specified in Section 6.6.1, the code indicating the error is responded as an "error message".
The error message format is as follows.

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

Error codes are as follows.

Error code	Description
01H	Function code failure When receiving an unspecified function code
02H	Relative No. (Reference No.) failure When the start No. or parameter No. received is not the specified number.
03H	Data pieces failure The number of data pieces to be transmitted in response to the message received exceeds a specified number. (See Section 6.4)
11H	Not in the programming range ● When the number is set beyond the range of the reference table.
12H	Programming disabled ● When you try to set or operate at non-lock, lock 1, lock 2 and lock 3. ● When AT is set to start at ”FB - AT”. ● When AT is set to start at ”Ready”. ● When AT is positioned at 2 controls. ● When input type unit, EVENT mode, key lock, Auto/Manual selection are continuously written by function code 16. ● When you write at the linear decimal point on Tc/Pt inputs. ● When you write at the linear scale on Tc/Pt inputs.

6.7 Table of LT400-Reference

6.7.1 Analog parameters

(1) Setup Parameter

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40001	03 06	R W	Input type	1/2/3/4/5/6/7/8/9/10/11/12/13/14/15/16/17/18/19 (B/R/S/N/K/E/J/T/U/L/ WRe5-WR26/ WRe-WRe26/ PtRh40-PtRh20/ Platinel Ⅱ/Pt100/ JPt100/20mV/5V/10V)	5 (K)	Refer to the Table 5. List of input types (P.40)
40002	03 06	R W	Engineering unit	0/1 (ºC/ºF)	0 (ºC)	Refer to the Table 5. List of input types (P.40) Only TC/Pt input allows writing.
40004	03 06 16	R W W	Range L	0.00 to 20.00 (0 to 2000) 0.000 to 5.000 (0 to 5000) 0.000 to 10.000 (0 to 10000) Scale L to Scale H	0.00 1.000 0.000 Scale L	Input type =20mV Input type =5V Input type =10V Input type =TC/Pt Set the exact working ranges on measuring range. In case of linear input, set the exact working input range.
40005	03 06 16	R W W	Range H	0.00 to 20.00 (0 to 2000) 0.000 to 5.000 (0 to 5000) 0.000 to 10.000 (0 to 10000) Scale L to Scale H	20.00 5.000 10.000 Scale H	Input type =20mV Input type =5V Input type =10V Input type =TC/Pt Decimal place : Set by the each range. It should be set L<H.
40006 40007	03 06 16	R W W	Linear scale L Linear scale H (Linear input)	-19999 to 20000 -19999 to 20000	0.00 100.00	Scaling the input range to exact indication. Decimal place : Set linear decimal point L ≠ H Only reading is allowed on TC/Pt inputs, but writing is not allowed.
40008	03 06 16	R W W	Linear decimal point (SV DOT) (Linear input)	0 to 4	1	Set decimal place on linear scale. It reads fixed number according to the each range at temperature input , but not writing.

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40009 40010	03 06 16	R W W	SV limiter L SV limiter H	-19999 to 20000 -19999 to 20000 Written setting range on TC/Pt inputs. Within linear scale on liner input.	Scale L Scale H	Decimal place : Temperature input =Set by the each range Linear input =Set linear decimal point It should be set L<H.
40011	03 06 16	R W W	PV decimal point (PV DOT)	0 to 4	1	
40012	03 06 16	R W W	Digital filter	0.0 to 99.9 (0 to 999)	0.1sec.	0.0=OFF
40013	03 06 16	R W W	Burnout	0/1 (UP/DOWN)	0 (UP)	0= Up-scale Burnout 1= Down-scale Burnout Only TC/Pt/20mV allows writing.
40015	03 06 16	R W W	Deviation deadband	0.0 to 2000.0 (0 to 20000)	1.0□	Decimal place depends on set value.
40021	03 06 16	R W W	Control action Control output Direct / Reverse	0/1 (REVSE/DIRCT)	0 (REVSE)	0=REVSE: Reverse action 1=DIRCT: Direct action
40022	03 06 16	R W W	Pulse cylcle	1 to 180	30sec	In case the output 1 is ON-OFF pulse,SSR,Multi, writing is allowed.
40023 40024 40025	03 06 16	R W W	FB(62)zero FB(62)span FB(62)deadband	0.0 to 50.0 (0 to 500) 50.0 to 100.0 (500 to 1000) 1.0 to 20.0 (10 to 200)	0.0 100.0 4.0	In case the output 1 is ON-OFF servo, writing is allowed.
40027	03 06 16	R W W	Cool Pulse cycle	1 to 180	30sec	In case output 2 is ON-OFF pulse/SSR, writing is allowed.
40028	03 06 16	R W W	Heat/Cool Type	0/1 (COOL.P/SPLIT)	0 (COOL.P)	0=Cooling P (COOL.P) 1=Split(SPLIT) The instrument with output 2 can allow to write.
40031	03 06	R W	Event1 mode	0/1/2/3/4/5/6/7/8/9/10/11/12/13/14 (UNUSE/PV H/PV L/DV H/DV L/ADV H/ADV L/SV H/SV L/MV H/MV L/LOOP/FAIL/CT/TIMER)	3 (Deviation high limit)	0= Unused(UNUSE) 1= Absolute high limit(PV H) 2= Absolute low limit(PV L) 3= Deviation high limit(DV H) 4= Deviation low limit(DV L) 5= Absolute Deviation H(ADV H) 6= Absolute Deviation L(ADV L) 7= Setting value high(SV H) 8= Setting value low(SV L) 9= Output value high(MV H) 10= Output value low(MV L) 11= Control loop abnormal(LOOP) 12= FAIL(FAIL) 13= Heater disconnection(CT) 14= Timer(TIMER)

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40032	03 06 16	R W W	Event1 deadband	0.00 to 200.00 (0 to 20000)	2.00	When the event mode is an absolute value ,deviation value, absolute value deviation, or setting value: Decimal place: SV DOT=0 → 1 SV DOT=1 → 2 SV DOT=2 → 3 SV DOT=3 → 4 SV DOT=4 → 4
				0.00 to 105.00 (0 to 10500)	0.20	When the event mode is output value.
				0.00 to 50.00 (0 to 5000)	0.20	When the event mode is in a heater disconnection.
40033	03 06 16	R W W	Event 1 output phase	0/1 (NOMAL/REVSE)	0 (NOMAL)	0=Normal (NOMAL) 1=Reverse (REVSE)
40034	03 06 16	R W W	Event 1 delay	0 to 9999	0 sec	
40036	03 06	R W	Event 2 mode	Same as Event 1	4 (Deviation low)	Same as Event 1 mode.
40037 40038 40039	03 06 16	R W W	Event 2deadband Event 2 output phase Event 2 delay	Same as Event 1		Same as Event 1deadband Same as Event 1output phase Same as Event 1delay
40041	03 06	R W	Event 3 mode	0/1/2/3/4/5/6/7/8 (UNUSE/PV H/PV L/ DV H/DV L/ADV H/ ADV L/SV H/SV L)	3 (Deviation high)	0=Unused(UNUSE) 1=Absolute high limit(PV H) 2=Absolute low limit(PV L) 3=Deviation high limit(DV H) 4=Deviation low limit(DV L) 5=Absolute Deviation H(ADV H) 6=Absolute Deviation L(ADV L) 7=Setting value high limit (SV H) 8=Setting value low limit (SV L)
40042	03 06 16	R W W	Event 3 deadband	0.00 to 200.00 (0 to 20000)	2.00	Decimal place: SV DOT=0 → 1 SV DOT=1 → 2 SV DOT=2 → 3 SV DOT=3 → 4 SV DOT=4 → 4
40043 40044	03 06 16	R W W	Event 3 output phase Event3delay	Same as Event 1		Same as Event1output phase Same as Event1delay
40046	03 06	R W	Event 4 mode	Same as Event 3	4 (Deviation low limit)	Same as Event3 mode
40047	03 06 16	R W W	Event 4 deadband	Same as Event 3		Same as Event 3 deadband
40048 40049	03 06 16	R W W	Event 4 output phase Event 4 delay	Same as Event 1		Same as Event 1 output phase Same as Event 1 delay

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40051	03 06 16	R W W	Analog transmission	0/1/2/3/4 (PV/SV/MV/ RSV/MFB)	0 (PV)	In case of no-retransmission, writing is not allowed. In case of no-remote- input, RSV is not allowed to write. In case output 1 is other than on-off servo, MFB is not allowed to write
40052 40053	03 06 16	R W W	Transmission scale L Transmission scale H	-19999 to 20000 [PV/SV/RSV] -199.99 to 200.00 [MV/MFB]	scale L scale H 0.00 100.00	L ≠ H In case of no-retransmission, writing is not allowed.
40061 40062	03 06 16	R W W	Remote range L Remote range H	0.00 to 20.00 (0 to 2000) 0.000 to 1.000 (0 to 1000) 0.000 to 10.000 (0 to 10000)	4.00 to 20.00 0.000 to 1.000 0.000 to 10.000	It should be set L<H. In case of no-remote-input, writing is not allowed.
40063 40064	03 06 16	R W W	Remote scale L Remote scale H	-19999 to 20000	scale L scale H	L=H forbids. In case of no-remote-input, writing is not allowed.
40065	03 06 16	R W W	Remote shift	-19999 to 20000	0.0	In case of no-remote-input, writing is not allowed Decimal place:: SV DOT=0 → 1 SV DOT=1 → 1 SV DOT=2 → 2 SV DOT=3 → 3 SV DOT=4 → 4
40079	03 06 16	R W W	Digital transmission	0/1/2 (PV/SV/RSV)	0 (PV)	In case of no-remote- input, RSV is not allowed to write.
40081	03 06 16	R W W	DI Allocation	0/1/2/3/4/5/6/7/8/9/10/ 11/12/ (UNUSE/1/2/3/4/5/6/7/8/9/ 10/11/12)	5	In case of no-DI, writing is not allowed. Refer to Remote/Local terminals. (Chapter 5.1.7, P.7)
40092	03 06 16	R W W	Power recovery action	0/1 (CONTI/READY)	0 (CONTI)	0=Continue (CONTI) 1=Ready (READY)
40093	03 06 16	R W W	Event output at Ready	0/1 (CALCU/OFF)	0 (CALCU)	0=calculate output(CALCU) 1= Compulsive OFF (OFF)

(2) One kind parameter

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40112	03 06 16	R W W	PV error output (PV ERR OUT)	-5.0 to 105.0 (-50 to 1050)	0.0%	
40114	03 06 16	R W W	Preset -out	-5.0 to 105.0 (-50 to 1050)	0.0%	Set the output value at ready condition.

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40116 40117	03 06 16	R W W	SV rise ramp SV fall ramp	0 to 20000	0	0= no inclining Decimal place: Temperature input = Set by the each range Linear input = Set linear decimal point
40118	03 06 16	R W W	SV ramp unit	0/1/2	1 (°C / min)	0=°C / sec 1=°C / min 2=°C / hour
40119	03 06 16	R W W	PV start ON/OFF	0/1 (OFF/ON)	0 (OFF)	0=OFF 1=ON
40121	03 06 16	R W W	Split direct	0.0 to 60.0 (0 to 600)	0.0%	In case output 2 is SPLIT.
40122	03 06 16	R W W	Split Reverse	40.0 to 100.0 (400 to 1000)	100.0%	In case output 2 is SPLIT
40123	03 06 16	R W W	Heat/Cool deadband	-50.0 to 50.0 (-500 to 500)	0.0%	In case output 2 is cool P.
40124	03 06 16	R W W	Cooling proportional factor	0.00 to 10.00 (0 to 1000)	1.00	In case output 2 is cool P.
40133	03 06 16	R W W	cascade fixed constant value for primary ratio a	0.01 to 1.00 (1 to 100)	0.20	In case cascade loop is ON with remote input.
40134	03 06 16	R W W	cascade fixed constant value for primary bias b	-100.0 to 100.0 (-1000 to 1000)	-10.0%	In case cascade loop is ON with remote input.
40135	03 06 16	R W W	cascade variable constant value for primary bias c	0.00 to 1.00 (0 to 100)	1.00	In case cascade loop is ON with remote input.
40136	03 06 16	R W W	cascade variable constant value for primary ratio d	0.00 to 1.00 (0 to 100)	0.00	In case cascade loop is ON with remote input.
40141	03 06 16	R W W	Initial screen	0/1/2 (SV/OUT/BLANK)	0 (SV)	0=PV/SV screen 1=PV/OUT screen 2=PV screen
40163	03 06 16	R W W	Sensor correction	-1999.9 to 2000.0 (-19999 to 20000)	0.0	Decimal place:: SV DOT=0 → 1 SV DOT=1 → 1 SV DOT=2 → 2 SV DOT=3 → 3 SV DOT=4 → 4
40164 40165	03 06 16	R W W	Anti-reset windup L Anti-reset windup H	-100.0 to 0.0 (-1000 to 0) 0.0 to 100.0 (0 to 1000)	-100.0% 100.0%	Note) Unit is % for scale. In case P for execution No. is 0.0%, writing is allowed.

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40166	03 06 16	R W W	Output preset	-100.0 to 100.0 (-1000 to 1000)	50.0%	

(3)No.1/No.2/No.3/No.4 Parameter

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40201	03 06 16	R W W	SV1	-19999 to 20000 (SV limit Min to SV limit Max)	0	Decimal place: Temperature input = Set by the each range Linear input = Set linear decimal point
40206	03 06 16	R W W	P1	0.0 to 999.9 (0 to 9999)	5.0%	0.0 = 2 position (On/off)
40207	03 06 16	R W W	I1	0 to 9999	60 Sec	0 = off
40208	03 06 16	R W W	D1	0 to 9999	15 Sec	0 = off
40209 40210	03 06 16	R W W	SV1 side Output limiter L SV1 side Output limiter H	-5.0 to 100.0 (-50 to 1000) 0.0 to 105.0 (0 to 1050)	0.0% 100.0%	It should be set L< H.
40211	03 06 16	R W W	SV1 side Variation limiter L	-100.0 to -0.1 (-1000 to -1)	-100.0%	
40212	03 06 16	R W W	SV1 side Variation limiter H	0.1 to 100.0 (1 to 1000)	100.0%	
40217	03 06 16	R W W	SV1 side PID deadband	0.0 to 9.9 (0 to 99)	0.0%	

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40231	03 06 16	R W W	SV1 side Event1 Setting	-19999 to 20000		When the event mode is an absolute value, deviation value, or setting value: Decimal place : Temperature input =Set by the each range Linear input =Set linear decimal point
				0 to 20000		When the event mode is an absolute value deviation: Decimal place : Temperature input =Set by the each range Linear input =Set linear decimal point
				-5.0 to 105.0 (-50 to 1050)		When the event mode is output value.
				0.0 to 120.0 (0 to 1200)		When event mode is loop abnormal, loop abnormal judgment time is set.
				0.0 to 50.0 (0 to 500)		When the event mode is in a heater disconnection.
				1 to 9999		When the event mode is set with timer.
						When the event mode is changed,it will become default.
					20000	Eventmode=Absolute high limit
					-19999	Eventmode=Absolute low limit
					20000	Eventmode=Deviation high limit
					-19999	Eventmode=Deviation low limit
					20000	Event mode=Absolute Deviation H
					0	Event mode=Absolute Deviation L
					20000	Eventmode=Setting value high
					-19999	Eventmode=Setting value low
					105.0	Eventmode=Output value H
					-5.0	Eventmode=Output value L
					0.0	Eventmode=Control Loop abnormal
					20000	Eventmode=FAIL
					0.0	Eventmode=Heater disconnection
					1	Eventmode=timer
40232	03 06 16	R W W	SV1 side Event1 standby	0/1 (OFF/ON)		When the event mode is an absolute value , deviation value , absolute value deviation , setting value , output value , or fail: “ON/OFF”of standby.
				0.0 to 100.0 (0 to 1000)		When event mode is control loop abnormal, loop abnormal width is set.
						When the event mode is changed,it will become default.
					OFF(0)	Event mode=Absolute high limit
					OFF(0)	Event mode=Absolute low limit
					OFF(0)	Event mode=Deviation high limit
					OFF(0)	Event mode=Deviation low limit
					OFF(0)	Event mode=Absolute Deviation H
					OFF(0)	Event mode=Absolute Deviation L
					OFF(0)	Event mode=Setting value high
					OFF(0)	Event mode=Setting value low
					OFF(0)	Event mode=Output value H
					OFF(0)	Event mode=Output value L
					5.0%	Event mode=Control Loop abnormal

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40233 40234	03 06 16	R W W	SV1 side Event2 setting SV1 side Event2 stand by	Same as event1 setting Same as event1 standby		Same as event1 setting Same as event1 stand by
40235	03 06 16	R W W	SV1 side Event3 setting	-19999 to 20000		When the event mode is an absolute value,deviation value,or setting value: Decimal place : Temperature input =Set by the each range Linear input =Set linear decimal point
				0 to 20000		When the event mode is an absolute value deviation: Decimal place : Temperature input =Set by the each range Linear input =Set linear decimal point
						When the event mode is changed,it will become default.。
					20000	Event mode=Absolute high limit
					-19999	Event mode=Absolute low limit
					20000	Event mode=Deviation high limit
					-19999	Event mode=Deviation low limit
					20000	Event mode=Absolute Deviation H
					0	Event mode=Absolute Deviation L
					20000	Event mode=Setting value high
					-19999	Event mode=Setting value low
40236	03 06 16	R W W	SV1 side Event3 stand by	0/1 (OFF/ON)		When the event mode is an absolute value , deviation value , absolute value deviation, setting value,setting “ON/OFF”of standby
						When the event mode is changed,it will become default.。
					OFF(0)	Event mode=Absolute high limit
					OFF(0)	Event mode=Absolute low limit
					OFF(0)	Event mode=Deviation high limit
					OFF(0)	Event mode=Deviation low limit
					OFF(0)	Event mode=Absolute Deviation H
					OFF(0)	Event mode=Absolute Deviation L
					OFF(0)	Event mode=Setting value high
					OFF(0)	Event mode=Setting value low
40237 40238	03 06 16	R W W	SV1 side Event4 setting SV1 side Event4 standby	Same as event3 setting Same as event3 standby		Same as event3 setting Same as event3 standby

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40251			SV2			Same as SV1
40256			P2			Same as P1
40257			I2			Same as I1
40258			D2			Same as D1
40259			Output limiter 2L			Same as Output limiter 1L
40260			Output limiter 2H			Same as Output limiter 1H
40261			Variation limiter 2L			Same as Variation limiter 1L
40262			Variation limiter 2H			Same as Variation limiter 1H
40267			PIDdeadband2			Same as SV1 side PID deadband
40281			SV2 sideEvent1 setting			Same as SV1 side Event1 setting
40282	03 06 16	R W W	SV2 sideEvent1 standby	Same as SV1 side		Same as SV1 side Event1 standby
40283			SV2 sideEvent2 setting			Same as SV1 side Event2 setting
40284			SV2 sideEvent2 standby			Same as SV1 side Event2 standby
40285			SV2 sideEvent3 setting			Same as SV1 side Event3 setting
40286			SV2 sideEvent3 standby			Same as SV1 side Event3 standby
40287			SV2 sideEvent4 setting			Same as SV1 side Event4 setting
40288			SV2 sideEvent4 standby			Same as SV1 side Event4 standby
40301			SV3			Same as SV1
40306			P3			Same as P1
40307			I3			Same as I1
40308			D3			Same as D1
40309			Output limiter 3L			Same as Output limiter 1L
40310			Output limiter 3H			Same as Output limiter 1H
40311			Variation limiter 3L			Same as Variation limiter 1L
40312			Variation limiter 3H			Same as Variation limiter 1H
40317			PIDdeadband3			Same as SV1 side PIDdeadband
40331			SV3 side Event1 setting			Same as SV1 side Event1 setting
40332	03 06 16	R W W	SV3 side Event1 standby	Same as SV1 side		Same as SV1 side Event1 standby
40333			SV3 side Event2 setting			Same as SV1 side Event2 setting
40334			SV3 sideEvent2 stand y			Same as SV1 side Event2 standby
40335			SV3 side Event3 setting			Same as SV1 side event3 setting
40336			SV3 side Event3 standby			Same as SV1 side event3 stand by
40337			SV3 side Event4 setting			Same as SV1 side Event4 setting
40338			SV3 side Event4 standby			Same as SV1 side Event4 standby

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
40351			SV4			Same as SV1
40356			P4			Same as P1
40357			I4			Same as I1
40358			D4			Same as D1
40359			Output limiter 4L			Same as Output limiter 1L
40360			Output limiter 4H			Same as Output limiter 1H
40361			Variation limiter 4L			Same as Variation limiter 1L
40362			Variation limiter 4H			Same as Variation limiter 1H
40367			PIDdeadband 4			Same as SV1 side PID deadband
40381			SV4 sideEvent1 setting			Same as SV1 side Event1 setting
40382	03 06 16	R W W	SV4 sideEvent1 stand by	Same as SV1 side		Same as SV1 side Event1 standby
40383			SV4 sideEvent2 setting			Same as SV1 side Event2 setting
40384			SV4 sideEvent2 stand by			Same as SV1 sideEvent2 standby
40385			SV4 sideEvent3 setting			Same as SV1 side Event3 setting
40386			SV4 sideEvent3 stand by			Same as SV1 side Event3 standby
40387			SV4 sideEvent4 setting			Same as SV1 side Event4 setting
40388			SV4 sideEvent4 stand by			Same as SV1 sideEvent4 standby

(4) Instrument Operation

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communic range)	Default	Details
49501	03 06	R W	Key lock	0/1/2/3/4 (UNLOK/LOCK1/LOCK2 /LOCK3/LOCK4)	0 (UNLOK)	0=Unlock 1=Key lock1 2=Keyl ock2 3=Keyl ock3 4=Keyl ock4
49503	03 06	R W	auto/ manual select 1 (Heating output)	0/1 (AUTO/MAN)	0 (AUTO)	0=automatic 1=manual (Note) It can be switched by front keys or common IF or external signals. The practical control follows to the final operation.
49504	03 06	R W	manualOutput value (Heating output)	-5.0 to 105.0 (-50 to 1050)		0.1% unit setting。 Writing is not made when automatic.。
49510	03 06 16	R W W	Run/ready	0/1 (RUN/READY)	0 (RUN)	(Note) It can be switched by front keys or common IF or external signals. The practical control follows to the final operation.

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communic range)	Default	Details
49511	03 06 16	R W W	SV No. select	1/2/3/4 (SV1/SV2/SV3/SV4)	1 (SV1)	1=SV1 2=SV2 3=SV3 4=SV4 (Note) It can be switched by front keys or common IF or external signals. The practical control follows to the final operation.
49512	03 06 16	R W W	Remote SV Setting	-19999 to 20000 (SV limit MIN to SV limit MAX)		When the communication function is COM, remote SV can be set by communication. R/L is switched by the external signals. In a Local condition, Writing is not accepted. Decimal place: Temperature input = Set by the each range Linear input = Set linear decimal point

6.7.2 Analog input data

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Details
30101	04	R	Measured value (PV)	Decimal place:Set PV decimal point When PV is + over range 32767 When PV is – under -32768
30102	04	R	PV status	0 = normal 1 = + Over range 2 = -Under range
30103	04	R	Setting value(SV)	Current adopted SV (fixed SV,inclining SV and remote SV etc.) Decimal place: Temperature input = Set by the each range Linear input = Set linear decimal point
30104	04	R	SV status	0= fixed value 1= remote SV 2= inclining working
30105	04	R	Control output value 1 (heating output)	-50 to 1050=-5.0 to 105.0%
30106	04	R	MV1 status	0= auto 1= manul output 2= during AT execution output 3= pre-set output(at Ready condition)
30107	04	R	Control output value 2 (cooling output)	-50 to 1050=-5.0 to 105.0%
30108	04	R	MV2 status (cooling output)	0= auto 1= manul output 3= pre-set output(at Ready condition)
30109 30110 30111 30112 30113	04	R	Execution SV Execution EV 1 Execution EV 2 Execution EV 3 Execution EV 4	Execution No.SVset ting value (Decimal place is same as 30103) EV1 set ting value (Decimal place is same as 40231) EV2 set ting value (Decimal place is same as 40233) EV3 set ting value (Decimal place is same as 40235) EV4 set ting value (Decimal place is same as 40237)

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Details
30114 30115 30116	04	R	Execution P Execution I Execution D	P setting value(0 to 9999=0.0 to 999.9%) I setting value D setting value
30124	04	R	ExecutionNo.	Execution parameter NO.(1/2/3/4)
30142	04	R	Event status	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 EV4 EV3 EV2 EV1 EventOFF→ 0 0 0 0 EventON→ 0 1 0 1 during standby,event OFF→ 1 0 1 0

6.7.3 Digital parameters

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Setting range (communication range)	Default	Details
101	01 05 15	R W W	Auto tuning	0/1 [0000h/FF00h] (End/Start) in[ ],FNC code is at 05.	0 (END)	0=AT End(END) 1=AT start or AT Execution During “Ready”,cannot be execute.。 During 2-position control,cannot be execute.。 During FB automatic tuning, execution is not allowed.
103	01 05 15	R W W	NAVI1 ON/OFF	0/1 [0000h/FF00h] (OFF/ON) in[ ],FNC code is at 05.	0 (OFF)	0=OFF 1=ON
104	01 05 15	R W W	NAVI2 ON/OFF	Same as NAVI1	0 (OFF)	Same as NAVI1
105	01 05 15	R W W	NAVI3 ON/OFF	Same as NAVI1	0 (OFF)	Same as NAVI1
106	01 05 15	R W W	NAVI4 ON/OFF	Same as NAVI1	0 (OFF)	Same as NAVI1
109	01 05 15	R W W	Cascade ON/OFF	0/1 [0000h/FF00h] (OFF/ON) in[ ],FNC code is at 05.	0 (OFF)	0=OFF 1=ON

6.7.4. Digital input data

FNC code ……Applicable function code,R/W……R:READ, W:WRITE

Reference No.	FNC code	R/W	DATA	Details
10002	02	R	A/D error	0=normal 1=A/D error occurrence
10004	02	R	RJ error	0=normal 1=RJ error occurrence
10005	02	R	Calibration data error	0=normal 1=Calibration data error occurrence
10009 10010 10011 10012	02	R	DI1 status DI2 status DI3 status DI4 status	0=external setting input OFF 1=external setting input ON
10117 10118 10119 10120 10121 10122 10123 10124	02	R	Event1status Event1status Event2status Event2status Event3status Event3status Event4status Event4status	0=EventOFF 1=EventON 0=during stand by,event OFF 0 0 1 0=EventOFF 1=EventON 0=during stand by,event OFF 0 0 1 0=EventOFF 1=EventON 0=during stand by,event OFF 0 0 1 0=EventOFF 1=EventON 0=during stand by,event OFF 0 0 1

6.8 Table of Input types & SV_Dot

(Table 5. List of input types.)

input type		input type (°C)	SV DOT	input type (°F)	SV DOT	Communication setting range No.
T/C	B	0.0 to 1820.0	1	32 to 3300	0	1
	R	0.0 to 1760.0	1	32 to 3200	0	2
	S	0.0 to 1760.0	1	32 to 3200	0	3
	N	0.0 to 1300.0	1	32 to 2350	0	4
	K	-200.0 to 1370.0	1	-300 to 2450	0	5
	E	-200.0 to 700.0	1	-300.0 to 1250.0	1	6
	J	-200.0 to 900.0	1	-300.0 to 1650.0	1	7
	T	-200.0 to 400.0	1	-300.0 to 700.0	1	8
	U	-200.0 to 400.0	1	-300.0 to 700.0	1	9
	L	-200.0 to 900.0	1	-300.0 to 1650.0	1	10
	WRe5-WRe26	0 to 2310	0	32 to 4190	0	11
	WRe-WRe26	0 to 2310	0	32 to 4190	0	12
	PtRh40 -PtRh20	0.0 to 1880.0	1	32 to 3400	0	13
	Platinel Ⅱ	0.0 to 1390.0	1	32 to 2500	0	14
RTD	PT100	-200.0 to 850.0	1	-300.0 to 1500.0		15
	JPT100	-200.0 to 649.0	1	-300.0 to 1200.0		16
	input type	Range		scale		Communication setting range No.
DC voltage	20mV	0.00 to 20.00		-19999 to 20000		17
	5V	0.000 to 5.000		-19999 to 20000		18
	10V	0.000 to 10.000		-19999 to 20000		19

6.9 Remote SV Setting Through Communication

6.9.1 Digital communications between LT and LT controllers

(Between CHINO's controller and LT)

Set the communication function at communications transmission [t r S] and communications remote [r e M], then digital communication can be done between LT and LT.（Details: See 7 Communications Transmission and Communications Remote）

In this case, LT that is set at communications remote will receive all types of remitted data (PV, SV,RSV) as remote SV.

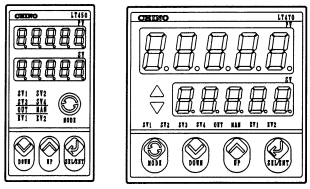
6.9.2 Personal Computer Communication + Communications Remote Functions

There will be the case that it needs to receive the remote SV in a connecting condition of personal computer and LT (communication function is CoM.). In this case, keep the communication function [CoM] and write SV data on reference no.49512 (remote SV), and it will become to receive remote SV with receiving measuring data between personal computer and LT and sending & receiving of parameter. This case of receiving data of remote SV works as remote SV data that is same as communications remote (6.9.1).

7 Communications Transmission and Communications Remote (PRIVATE PROTOCOL)

7.1 General

Digital communications is available not only between LT controllers and personal computers but also between a LT controller and other LT controllers (LT controller and other CHINO's controllers). These functions are called "Communications Transmission" and "Communications Remote".
By programming a LT controller to Communication Transmission as a master unit and other LT controllers to Communications Remote as slave units, the SV of the slave unit (up to 31 sets) can be programmed through communications. This function can be utilized for using multiple LT controllers in the same condition. The master or slave designation of the LT controllers can be programmed by key operation.



When the communications function of the Mode 7 is programmed to "trS (Private protocol)" or "trS.2 (MODBUS)", LT controller is programmed as a master unit (Communications Transmission).

When the communications function of the Mode 7 is programmed to "rEM (in case a master LT controller is programmed to "trS") " or "CoM (in case a master LT controller is programmed to "trS.2")", LT controller is programmed as a slave unit (Communications Remote).

[Communications Functions Programs and Details of Transmission Data]

Mode 7, Communications Functions Programming (Master) → (Slave)	Details of Transmission Data
(trS) →(rEM) [LT,CHINO's controllers]	• Sending (Master) and receiving (Slave) Remote SV data • Private protocol
(trS. 2) → (CoM) [LT] (N.B.) Slave unit has to be programmed to Key Lock 4 to receive data.	• Sending (Master) and receiving (Slave) Remote SV data and Execution SVNo. (1/2) and Run/Ready. • MODBUS protocol

*To receive data by slave unit, it need to be switched to remote mode. (Refer to section 5.7.1)

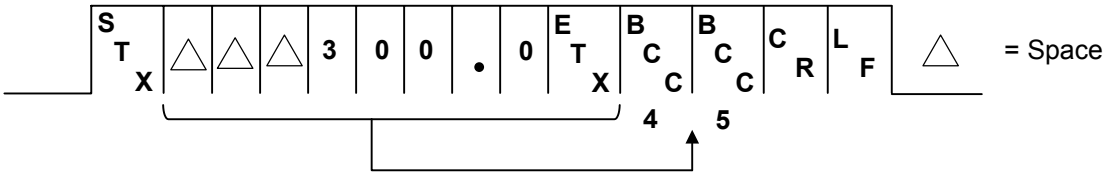
7.2 Communications Specifications

*Start-stop synchronization system

* Transmission speed:	19200, 9600 bps (selectable)
* Start bit:	1 bit
* Data length:	7bits (ASCII mode) or 8 bits (RTU mode / ASCII mode)
* Parity bit:	Even or Odd or None
* Stop bit:	1 bit or 2 bit
* Character code:	ASCII (ASCII mode) or Binary (RTU mode)
* Error check:	Checksums*1 - - - When communications function is programmed to "trS" and "rEM". CRC-16 or LRC (depending on transmission mode) - - - When communications function is programmed to "CoM" and "trS. 2".
* Signals in use:	Sending and receiving data only (no control signal in use)

*1 Checksums (BCC)
A checksum is a protocol which calculates the sum of characters after STX up to ETX and divides the lower-order 8 bits into higher and lower-order 4 bits, then converts them to 0 to F characters. They are sent and received sequentially from lower order to higher order bits.

(Example)



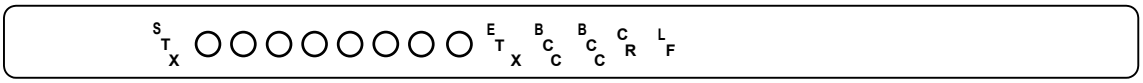
Character	△	△	△	3	0	0	•	0	ETX	Sum ＝BCC
ASCII code	20h	20h	20h	33h	30h	30h	2Eh	30h	03h	154h=45

7.3 Programming Communications Transmission

Following parameters should be programmed for the LT controller programmed to the Communication Transmission.

1) Program the communications function “Func”. (Refer to Section 7.5.1).
2) Program the transmission speed “rAtE”. (Refer to Section 7.5.2).
3) Program the character “CHArA”. (Refer to Section 7.5.3).
4) Program the digital transmission type “d. trnS” (Refer to Section 7.5.4).

Reference When “trS (communications transmission)” is programmed, LT controller transmits data as following format.



Data output: PV (Measured value), SV (Setpoint), RSV (Remote receiving SV)

* When “trS. 2 (communications transmission)” is programmed, the data is output as the slave address “0” with the MODBUS format mentioned before.

7.4 Programming Communications Remote

When Communications Remote is programmed, SV data is received with digital communications instead of analog communications. In this case, SV data receiving is only executed digitally. Functions are the same as for Remote/Local (optional) functions. However, remote scale function is not provided to the Communications Remote function. By combining a master LT controller (Communications Transmission) and slave LT controllers (Communications Remote), digital remote control and zone control will be available.

(1) Following parameters should be programmed for slave LT controllers (Communications Remote).
   1) Program the communications function “Func”. (Refer to section 7.5.1)
   2) Program the transmission speed “rAtE”. (Refer to section 7.5.2)
   3) Program the character “CHArA”. (Refer to Section 7.5.3).
   4) Program the remote shift “r.biAS” if necessary. (Refer to section 7.5.5).

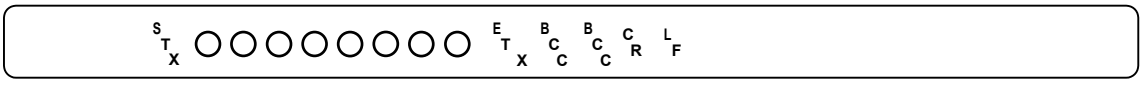
(2) When the communications function of the Mode 7 is programmed to “rEM (in case a master LT controller is programmed to “trS”) “ or “CoM (in case a master LT controller is programmed to “trS.2”)”, LT controller is programmed to Communications Remote (slave).

(3) Refer to section 7.5 for the programming of communications parameters.

(4) Switching between Remote and Local can be done from the R/L terminals. (Refer to section 5.1.7.)

(5) Control is executed by SV on local condition until the first remote SV data is received since remote condition has been ready. The same function is executed when the power is turned on.

Reference When “rEM (communications remote)” is programmed, LT controller receives data as following format.



7.5 Programming Communications Transmission/Remote Parameters

Parameters related to Communications Transmission/Remote are provided to the Mode 7. Program the "Communications Function" , "Transmission Speed" , "Character" , "Digital Transmission Type" and "Remote Shift" by following the flowchart on page 3.
"Remote Shift" is only programmed for the Communications Remote.

7.5.1 Programming Communications Functions (CoM)

(1) Press [↵] , then you will see [FUnC]

(2) Choose the communications fanction by pressing [^] and [v] , then press [↵] to register.

C o M: Programmed for communications with a personal computer (Default CoM)

T r S.2: Programmed for Communication Transmission with MODBUS (on a master unit)

r E M: Programmed for Communication Remote with private protocol (on slave units)

t r S: Programmed for Communication Transmission with private protocol (on a master unit)

7.5.2 Programming Transmission Speed (rAtE)

LT controllers to be used as a master unit (Communications Transmission) and slave units (Communications Remote) have to be programmed at same transmission speed.

(1) Press [↵] , then you will see [rAtE]

(2) Choose the transmission speed by pressing [^] and [v] , then press [↵] to register

Transmission speed : 9600, 19200 bps

7.5.3 Setting of Character (CHArA)

(1) Press [↵] , then you will see [CHArA]

(2) Choose the character by pressing [^] and [v] , then press [↵] to register.

Kind	Bit length	Parity	Stop bit	Default value
7E1	7bit	Even	1	[For MODBUS RTU selected] 8N1 [Other than above] 7E1
7E2			2	
7O1		Odd	1	
7O2			2	
8N1	8bit	None	1	
8N2			2	
8E1		Even	1	
8E2			2	
8O1		Odd	1	
8O2			2	

7.5.4 Programming Digital Transmission Type (d. trnS)

Transmission Type Programming	Meanings
PV	Transmits a measured value. (Default)
SV	Transmits a setpoint value.
RSV	Receives LT setting value by analog remote, then transmits.

(1) Press [↵] , then you will see [d.trnS]

(2) Choose the Transmission Type by pressing [^] and [v] , then press [↵] to register.

7.5.5 Programming Remote Shift (r. biAS)

The shift width of the SV data received by Communications Remote can be adjusted.
Arbitrary shift width can be programmed for each slave unit programmed to the Communications Remote. Program it as necessary.

(1) Press [↵] , then you will see [r.biAS]

(2) To program the desired shift width with [^] / [v] , then press [↵] to register.
Shift variable width: -1999.9 to 2000.0 (Default: 0.0)

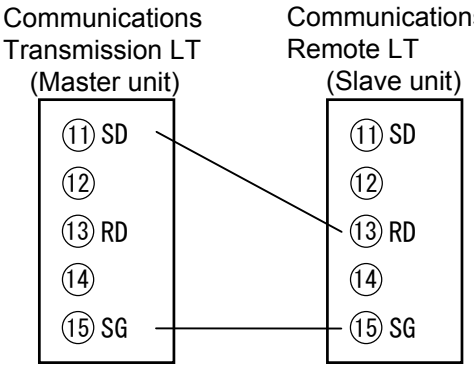
⚠ Caution

1) LT controllers to be used as a master unit (Communications Transmission) and slave units (Communications Remote) have to be programmed at the same transmission speed.
2) When Analog Remote and Communications Remote are used at the same time, the Analog Remote has a priority.
3) Analog transmission type and communications transmission type can be programmed independently.

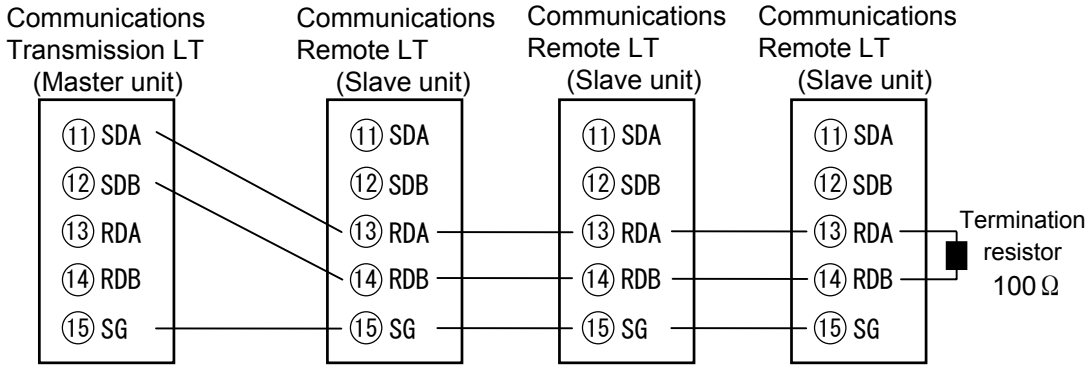
“Re-Transmission scale L”, “Re-Transmission scale H”, “Remote scale L” and “Remote scale H” of parameters are set when analog re-transmission / remote are executed. So when communication re-transmission and communication remote are used, setting is not necessary.

7.6 Connections

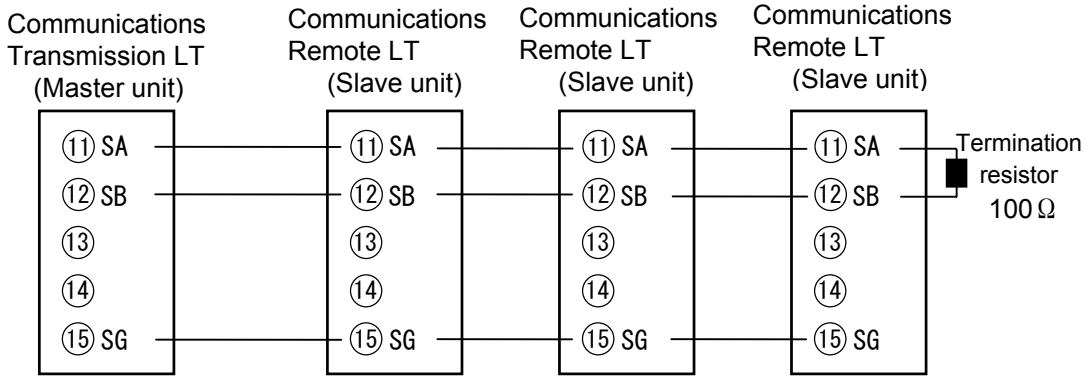
(1) [RS-232C]



(2) [RS-422A]



(3) [RS-485]



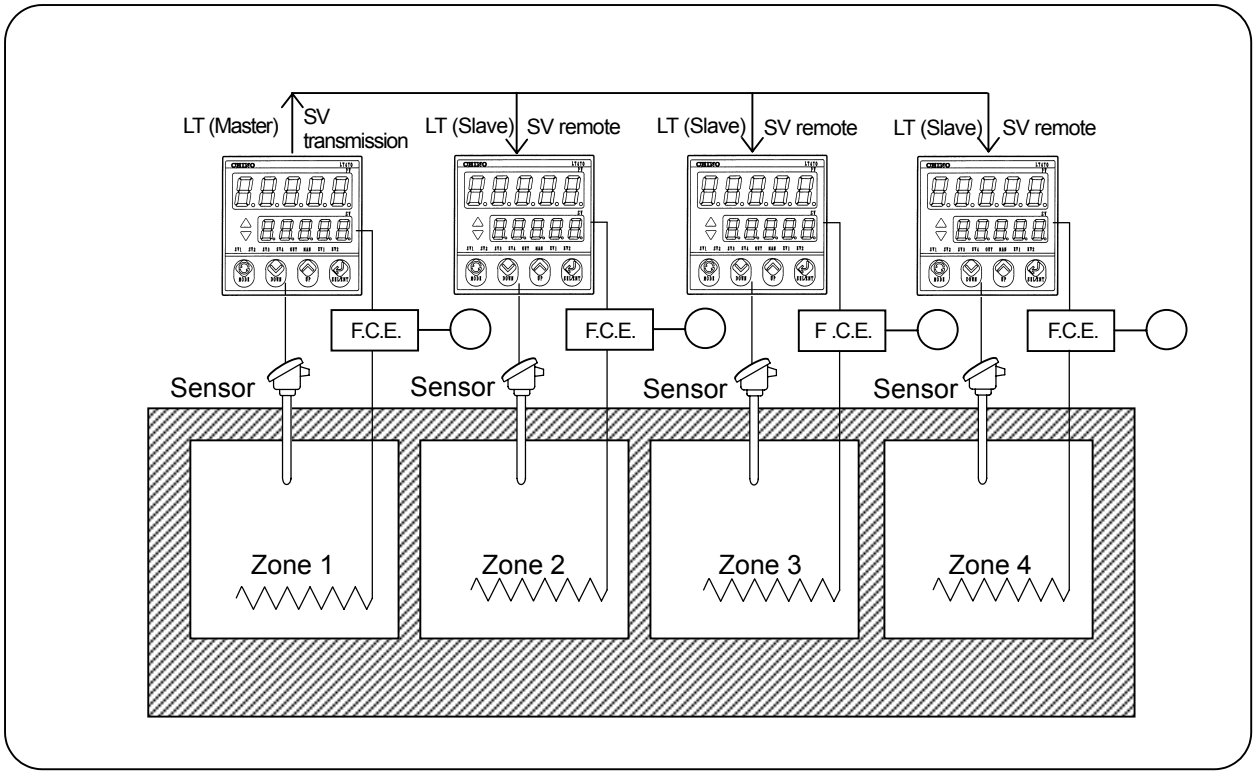
*Refer to Section 5.1.7 for the remote change to a slave unit.

7. 7 Temperature Control Examples

7.7.1 Temperature Control for Multi Zone

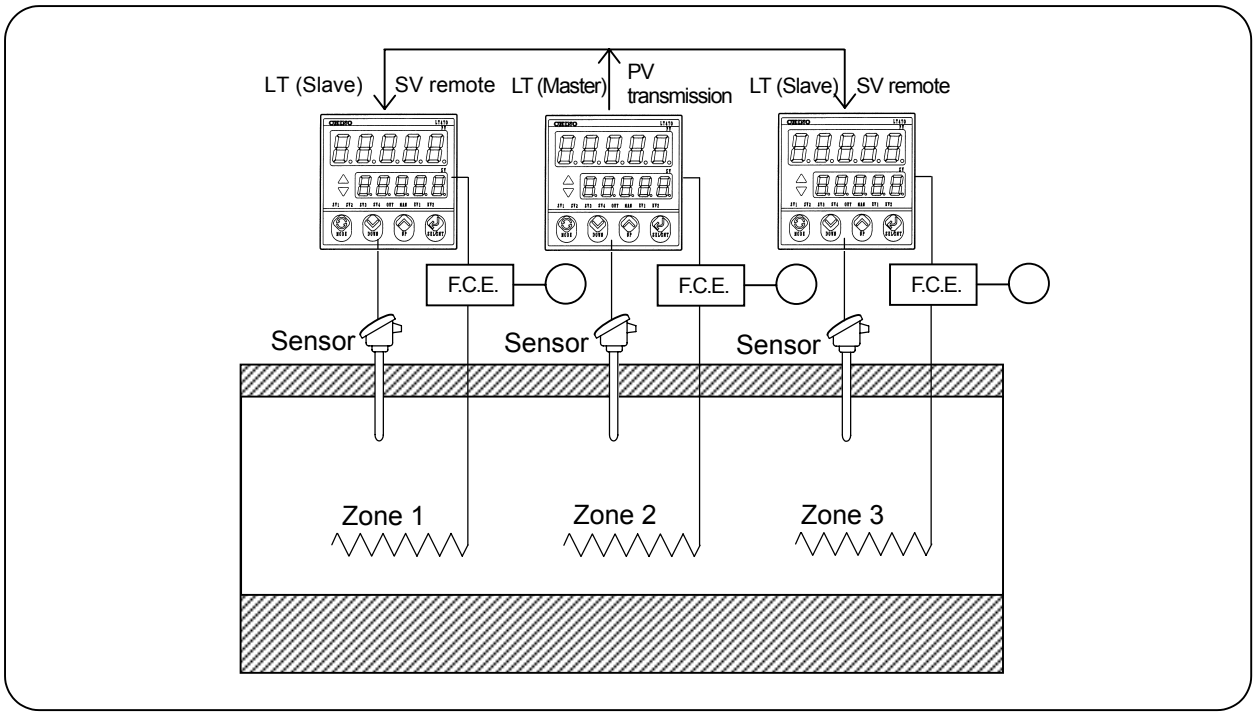
A master LT controller sends SV with the communications transmission and slave LT controllers receive it with the communications remote.

With the remote shift function, temperature slope can be programmed at multiple zones.



7.7.2 Zone Control In A Soaking Pit

A master LT controller located in the middle sends PV by the communications transmission, and slave LT controllers located at both sides receive the PV as SV by the communications remote. This results in a control with superior characteristics in soaking.



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