INE-282

CHINO

DZ1000/DZ2000 SERIES

DIGITAL CONTROLLER

COMMUNICATIONS INTERFACES

(MODBUS PROTOCOL)

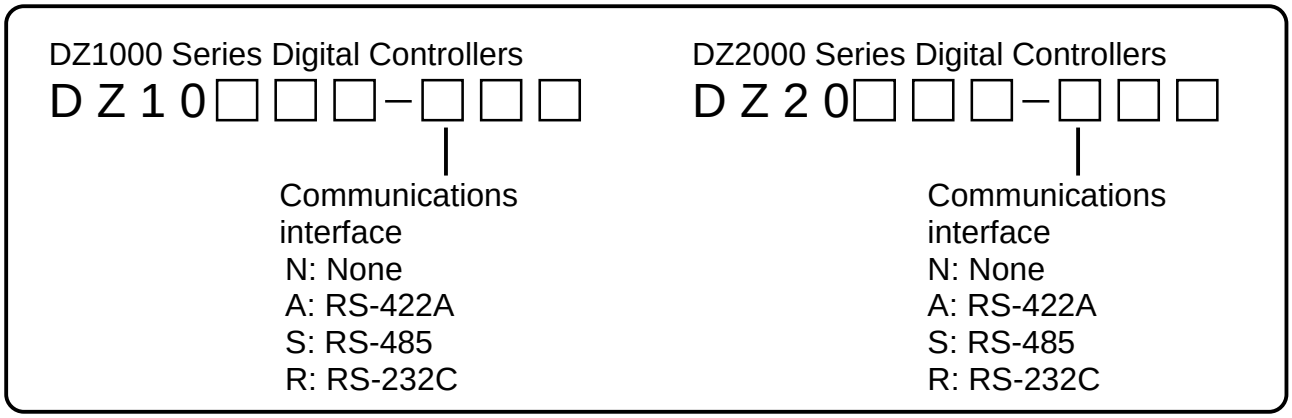
INSTRUCTIONS

CHINO

Contents

INTRODUCTION

The DZ1000/DZ2000 series digital controller communications interfaces manual describes the specifications and operation of three optional communications interfaces (RS-232C, RS-422A, and RS-485) of the DZ1000/DZ2000 series Digital Controllers.
The explanations for these interfaces are in part similar. However, their differences are explained separately in [In the 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 DZ1000/DZ2000 series digital controllers you have purchased as this determines the required communications interface type.



1. Other Instruction Manual to be consulted.

The DZ1000/DZ2000 series digital controller communications interfaces manual is for the communications interface only. For the running and operation, please refer to the following instruction manuals:

1. DZ1000 series Digital Controllers (Manual No. INE-164)
2. DZ2000 series Step-type Digital Controllers (Manual No. INE-167)
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 explanations of precautions. Observe these precautions when operating or handling the communications interfaces, otherwise the instrument may be damaged, resulting in a deterioration of 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 any errors or omissions in the descriptions in 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 communications interfaces (RS-232C, RS-422A and RS-485) available between the DZ1000/DZ2000 series digital controllers and personal computers (PCs).
PCs can be used to receive measured data from the DZ1000/DZ2000 series digital controllers, program different parameters and issue control commands. The number of DZ1000/DZ2000 series digital 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 covers basic interfaces between the MODEM and the connected data terminal units, and specifies electrical and mechanical specifications only. Most of the RS-232C communications interfaces are being used for personal computers and industrial instruments such as the DZ1000/DZ2000 series digital controllers do not completely conform to this standard at present. They have different signal wire numbers and 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. For these reasons, users must survey and check the specifications and transmission procedures in advance of units being connected. However, if the counter unit is a personal computer or similar device that can optionally program the specifications, then all the units can be combined by having proper programs prepared by a systems designer.

1.2 RS-422A/485 Communications Interface

The RS-422A and RS-485 communications interfaces can communicate with multiple DZ1000/DZ2000 series digital 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 a personal computer having an 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 from CHINO.
Regarding the difference between RS-422A and RS-485 communications interfaces, the RS-422A needs four signal cables, while the RS-485 needs only two signal cables.

2 COMMUNICATIONS PARAMETERS

DZ1000/DZ2000 series digital controllers employ MODBUS protocol. (MODBUS is the registered trademark of Schneider Automation Inc.)

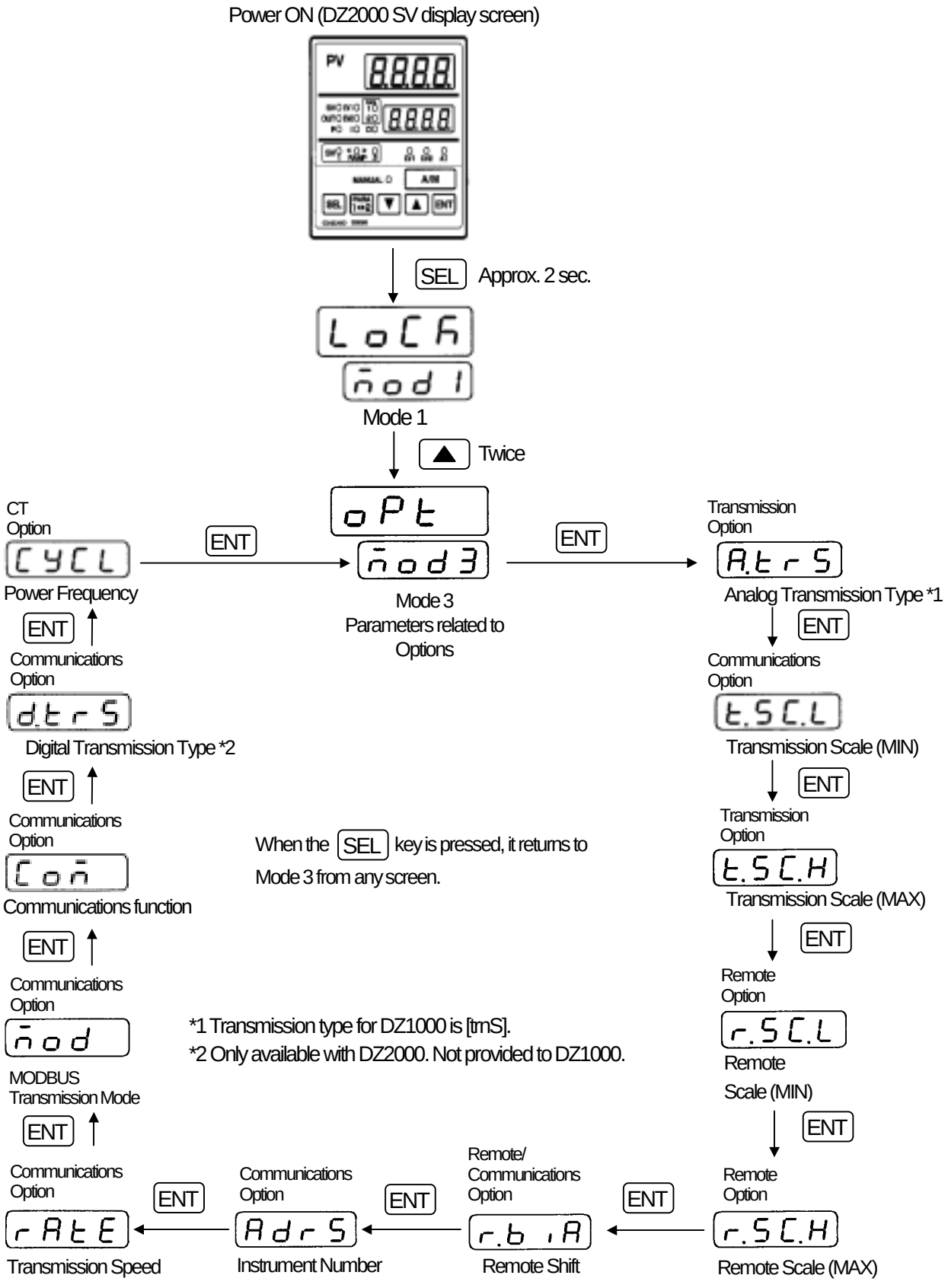
MODBUS have the following two communications protocols, RTU mode and ASCII mode that can be selected by front key programming. MODBUS protocol provides the function of transmitting measured data as well as the programming and operating function.

3 COMMUNICATIONS SPECIFICATIONS

* Start-stop synchronization system
* Half-duplex (polling selecting system)
* Protocol: MODBUS protocol
* Transmission speed: 19200, 9600 bps selectable
* Start bit: 1 bit
* Data length: 7 bits (ASCII mode)
  8 bits (RTU mode)
* Parity bit: Even (Even number parity) (ASCII mode)
  Non (No parity) (RTU mod)
* Stop bit: 1 bit
* Character code: ASCII (ASCII mode)
  Binary (RTU mode)
* Error check: LRC (ASCII mode)
  CRC-16 (RTU mode)
* External units given priority for communications
* Data transmission procedure: None
* Signals in use: Sent and received data only (no control signal in use)

4 PROGRAMMING PARAMETERS FOR COMMUNICATIONS WITH PERSONAL COMPUTERS

Program the "Unit number", "Transmission speed", "MODBUS transmission mode" and "Communications function" by following the flow chart below.



4.1 Programming Instrument Numbers (AdrS)

Program instrument numbers to DZ controller(s) which communicate(s) with personal computers. Make sure the number given is not used for other DZ controllers.

① Display [AdrS] with the [ENT] key.

② Press [▲] (Dot starts blinking.) and program the instrument numbers (01 to 31) with [▲] and [▼]. Store them with the [ENT] key. (Dot stops blinking.)

⚠ Caution

1. An instrument number has to be given with two digits between 01 to 31. Make sure the number given is not used for other DZ series digital controller. (Default is 01)
2. Only one DZ series digital controller can be connected with RS-232C, however, an instrument number still needs to be programmed. (The default of 01 can be used.)

4.2 Programming Transmission Speed (rAtE)

The transmission speeds for DZ controllers and personal computers have to be the same. (The default of 9600 bps can be used for ordinary use.)

① Display [rAtE] with the [ENT] key.

② Press [▲] (Dot starts blinking.) and specify the transmission speed with [▲] and [▼]. Store it with the [ENT] key. (Dot stops blinking.)
Transmission speed: 9600 and 19200 bps (displayed as 19.2 K). (Default is 9600 bps.)

4.3 Programming MODBUS Transmission Mode (Mod)

① Display [Mod] with the [ENT] key.

② Press [▲] (Dot starts blinking.) and specify the transmission mode with [▲] and [▼]. Store it with the [ENT] key. (Dot stops blinking.)

MODBUS Transmission Modes

[ASC] : ASCII mode

[rtU] : RTU mode

4.4 Programming Communications Functions (CoM)

① Display [CoM] with the [ENT] key.

② Press [▲] (Dot starts blinking.) and display [CoM] with [▲] and [▼].
Store it with the [ENT] key. (Dot stops blinking.)

Communications Functions

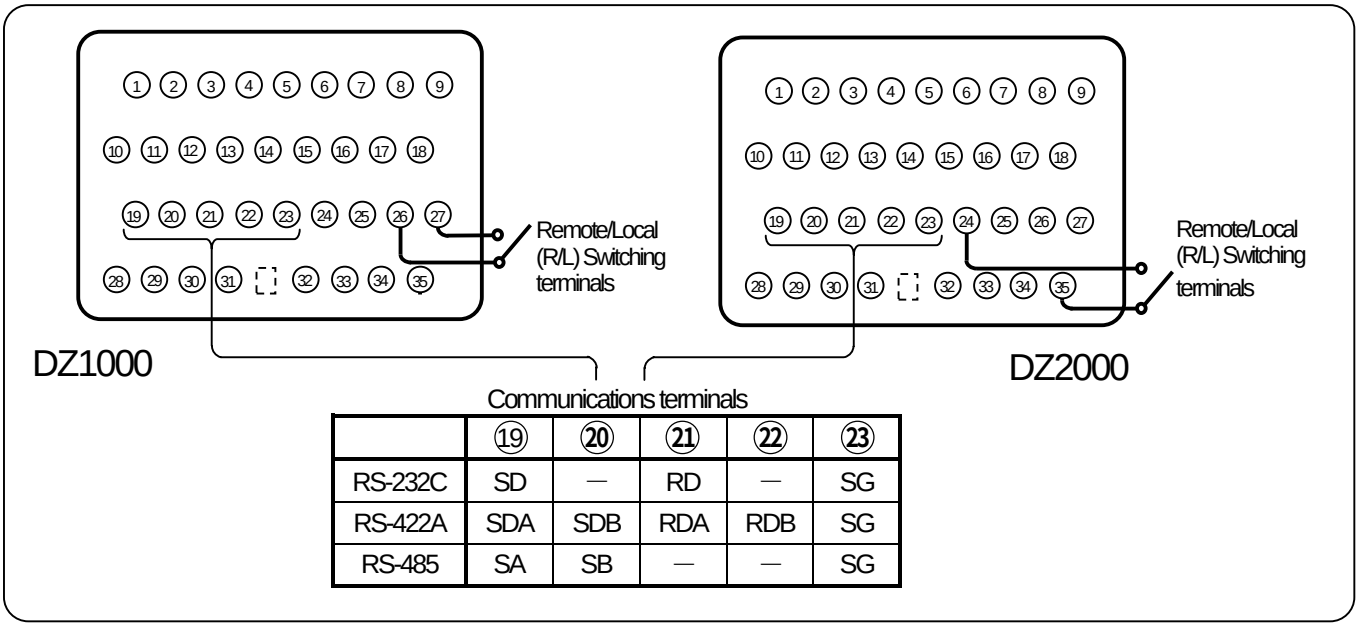
[CoM] PC Communications	To be programmed when communicating with a PC. (This parameter should be selected and stored.)
[rEM] Communications Remote	When the Communications Remote is programmed, the transmission data specified at the Transmission Type can be received with digital communications. (Refer to the [7] COMMUNICATIONS TRANSMISSION AND COMMUNICATIONS REMOTE.)
[trS] Communications Transmission (Private protocol)	When the Communications Transmission is programmed, the transmission data of a DZ controller can be digitally transmitted to other DZ controllers of which the communications function is programmed to the Communications Remote "rEM". (Refer to the [7] COMMUNICATIONS TRANSMISSION AND COMMUNICATIONS REMOTE.) PV — Transmits a measured value. (Default) SV — Transmits a setpoint value. MV — Transmits a control output value. RSV — Transmits a SV value received with Remote. MFB — Transmits valve open degree of an ON/OFF servo output. Type of transmission data is programmed at the Transmission Type on the Mode 3. ■ DZ1000 --------- Transmission Type "trnS" ■ DZ2000 --------- Digital Transmission Type "d.trS"
[trS.2] Communications Transmission (MODBUS)	When "trs. 2" communications transmission is programmed, the transmission data of a DZ controller can be digitally transmitted to other DZ controllers of which the communications function is programmed to "CoM". Execution SV No. can be also transmitted with DZ2000. (Refer to the [7] COMMUNICATIONS TRANSMISSION AND COMMUNICATIONS REMOTE.) PV — Transmits a measured value. (Default) SV — Transmits a setpoint value. rSV — Transmits a setpoint value received with Remote. Type of transmission data can be programmed as same procedure as that of "trs".

5 CONNECTIONS

5.1 Connection Precautions

5.1.1 Communications Terminals

Disposition of terminals are different with each communications interface.

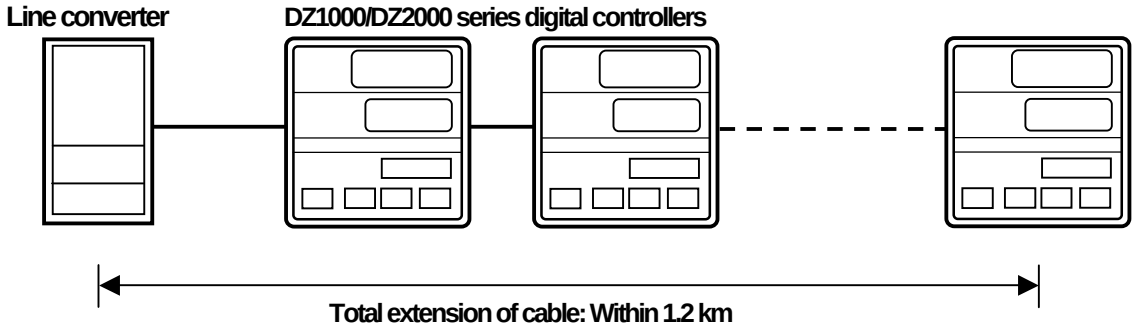


Communications terminals

	⑲	⑳	㉑	㉒	㉓
RS-232C	SD	—	RD	—	SG
RS-422A	SDA	SDB	RDA	RDB	SG
RS-485	SA	SB	—	—	SG

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 should be less than 1.2 km. (Line converter ⟺ the last of the DZ1000/DZ2000 series digital controllers)

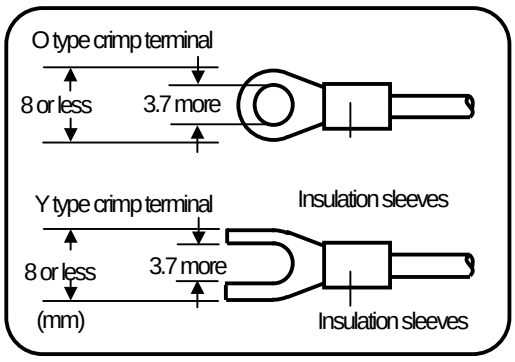


5.1.3 Noise preventive terminals

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

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 DZ1000/DZ2000 series digital 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 DZ1000/DZ2000 series digital controllers 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 DZ1000/DZ2000 series digital controllers connectable

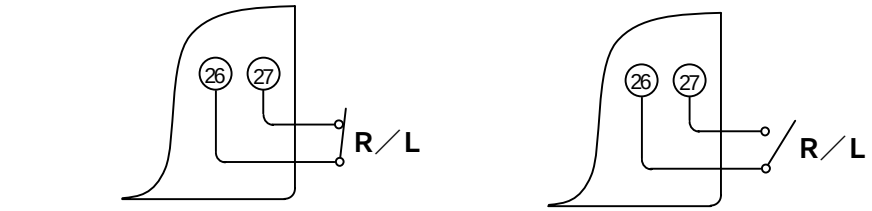
For RS-232C: 1 set
For RS-422A or RS-485: Up to 31 sets

5.1.7 Switching terminals between Remote and Local (R/L)

These are non-voltage contact signal terminals only when the controller is used with "Communications Remote" or "Analog Remote". Do not connect these terminals for the communications with personal computers.

[DZ1000 digital controller]

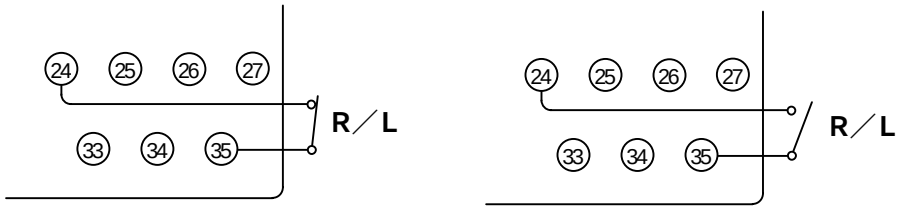
Remote (R): When the terminals ㉖ and ㉗ are short circuited, the Remote Operation is executed.
Local (L): When the terminals ㉖ and ㉗ are open, the Local Operation is executed and external signals cannot be received.



Short circuited: Remote Operation　　Open: Local Operation

[DZ2000 digital controller]

Remote (R): When the terminals ㉔ and ㉟ are short circuited, the Remote Operation is executed.
Local (L): When the terminals ㉔ and ㉟ are open, the Local Operation is executed and external signals cannot be received.



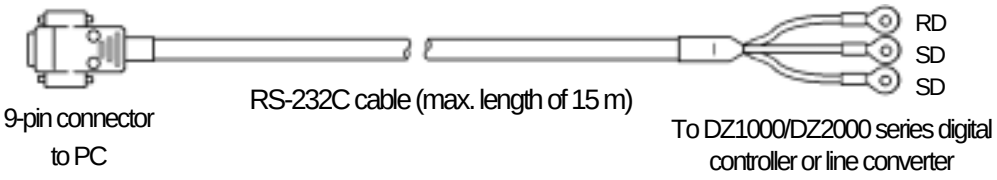
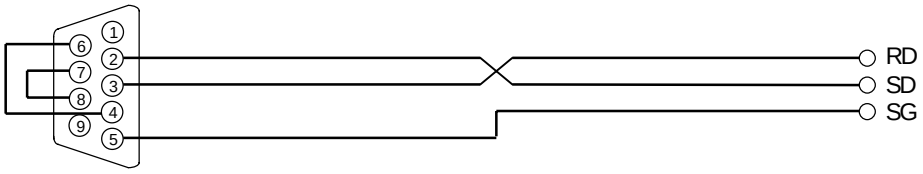
Short circuited: Remote Operation　　Open: Local Operation

5.2 Communications Cables

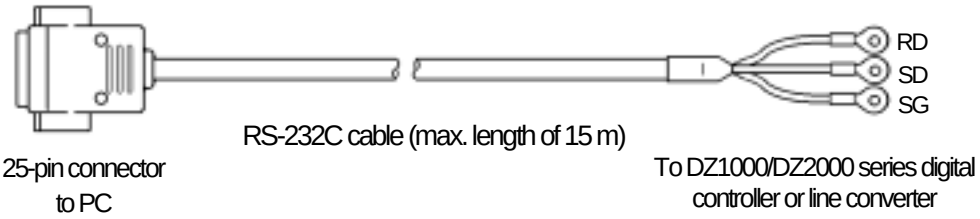
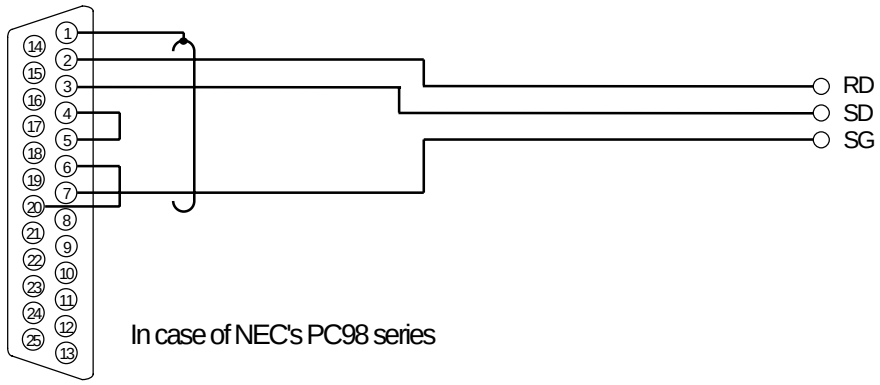
Make ready cables dedicated to communications before performing connection. Dedicated communications cables (sold separately) are available at CHINO.

5.2.1 Communications cables for RS-232SC

(1) Connection between PC (with 9 pin-terminal) and DZ1000/DZ2000 series digital controller and between PC (with 9 pin-terminal) and line converter.

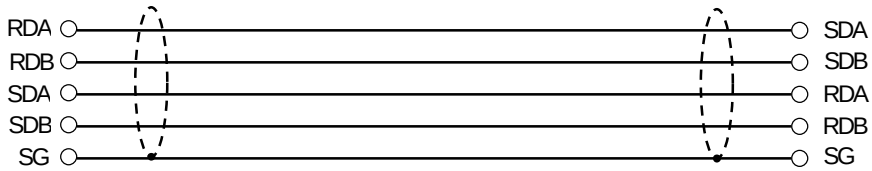
Cable	9-pin connector ⟷ RS-232C cable with O-shaped crimp terminal
Style	
Internal wiring	
Type code	**RZ-CRS6** □□ Cable length of 1 to 15 m (To be specified)

(2) Connections between PC (with 25 pin-terminals) and DZ1000/DZ2000 series digital controller and between PC (with 25 pin-terminals) and line converter.

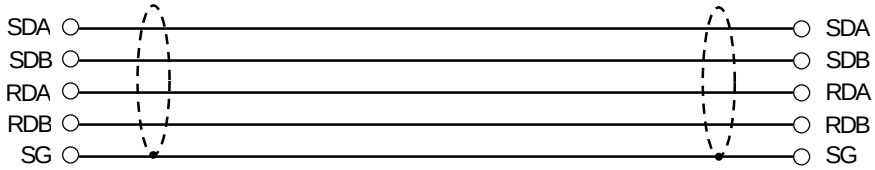
Cable	25-pin connector ⟷ RS-232C cable with O-shaped crimp terminal
Style	
Internal wiring	
Type code	**RZ-CRS2** □□ Cable length of 1 to 15 m (To be specified)

5.2.2 Communications cables for RS-422A

(1) Connection between line converter and DZ1000/DZ2000 series digital controller

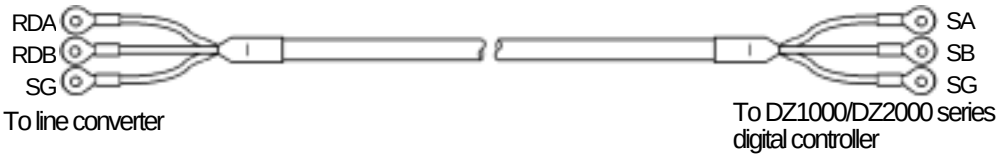
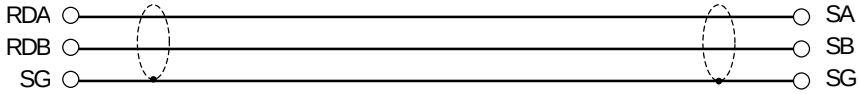
Cable	O-shaped crimp terminal ⟷ RS-422A cable with O-shaped crimp terminal (for line converter)
Style	 To line converter To DZ1000/DZ2000 series digital controller The cable consists of a pair of twisted dual-core CVVS wires with SG (signal grounding) wire at both ends. Cut off the SG wire on the line 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 DZ1000/DZ2000 and DZ1000/DZ2000 series digital controllers

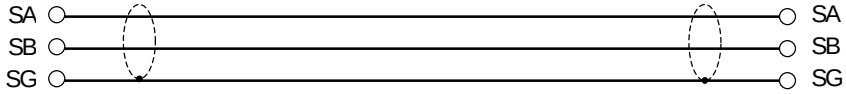
Cable	O-shaped crimp terminal ⟷ RS-422A cable with O-shaped crimp terminal (for parallel connection)
Style	 To DZ1000/DZ2000 series digital controller To DZ1000/DZ2000 series digital controller The cable consists of a pair of twisted dual-core CVVS wires with SG (signal grounding) wire at both ends.
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 DZ1000/DZ2000 series digital controller

Cable	O-shaped crimp terminal ⟷ RS-485A cable with O-shaped crimp terminal (for line converter)
Style	 To line converter To DZ1000/DZ2000 series digital 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-LED**□□□ (for line converter) Cable length of 1 to 200 m (To be specified)

(2) Connection between DZ1000/DZ2000 and DZ1000/DZ2000 series digital controllers

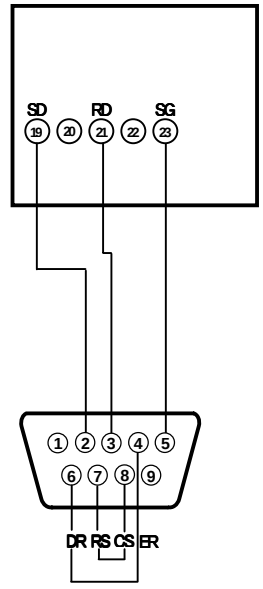
Cable	O-shaped crimp terminal ⟷ RS-485 cable with O-shaped crimp terminal (for parallel connection)
Style	 To DZ1000/DZ2000 series digital recorder To DZ1000/DZ2000 series digital controller The cable consists of a twisted dual-core CVVS wires with SG (signal grounding) wire at both ends.
Internal wiring	
Type code	**RZ-CSS1Z2 (0.2 m) or RZ-LEC** □□□ (for parallel connection) Cable length of 1 to 200 m (To be specified)

5.3 RS-232C Connections

The DZ1000/DZ2000 series digital controllers use three control signals of Send (SD), Receive (RD), Signal Ground (SG) only. Since personal computers are generally controlled by signals, the computer does not function by connecting three signal cables only and without performing the requisite wiring processing inside the connectors. This will depend upon the control applicable to a particular personal computer. For details, read the instruction manual for the personal computer being used.

DZ1000/DZ2000 series digital controller

[Connection Example 1]

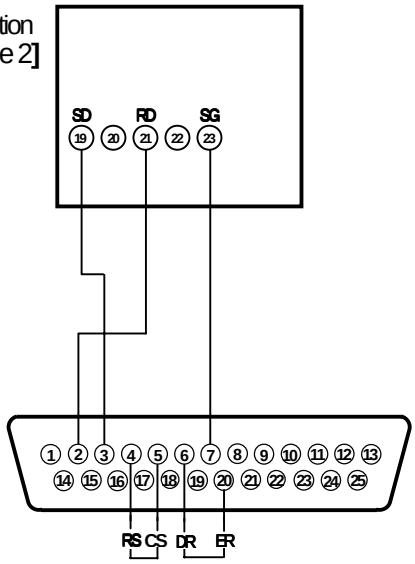


9-pin connector

(PC-98 series/IBM-PC/AT)

DZ1000/DZ20000 series digital controller

[Connection Example 2]

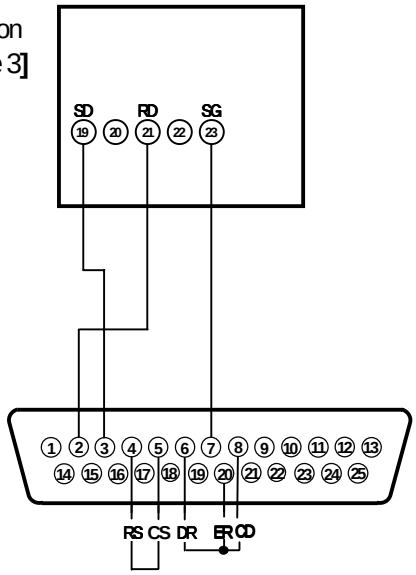


25-pin connector

(PC-98 series)

DZ1000/DZ2000 series digital controller

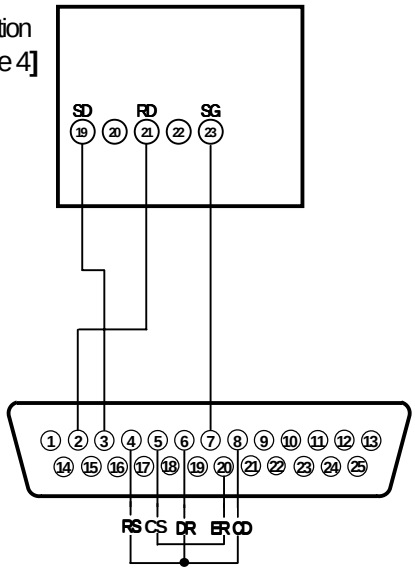
[Connection Example 3]



25-pin connector

DZ1000/DZ2000 series digital controller

[Connection Example 4]



25-pin connector

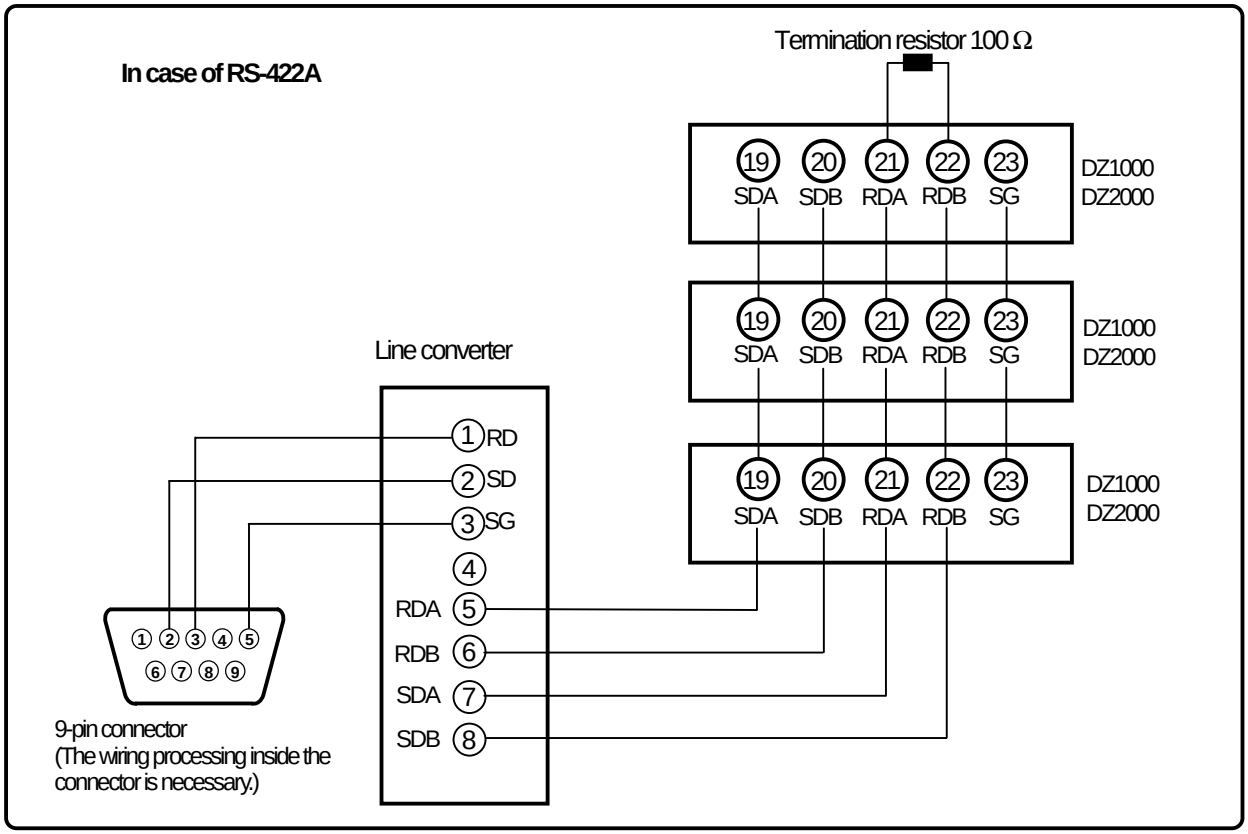
ATTENTION

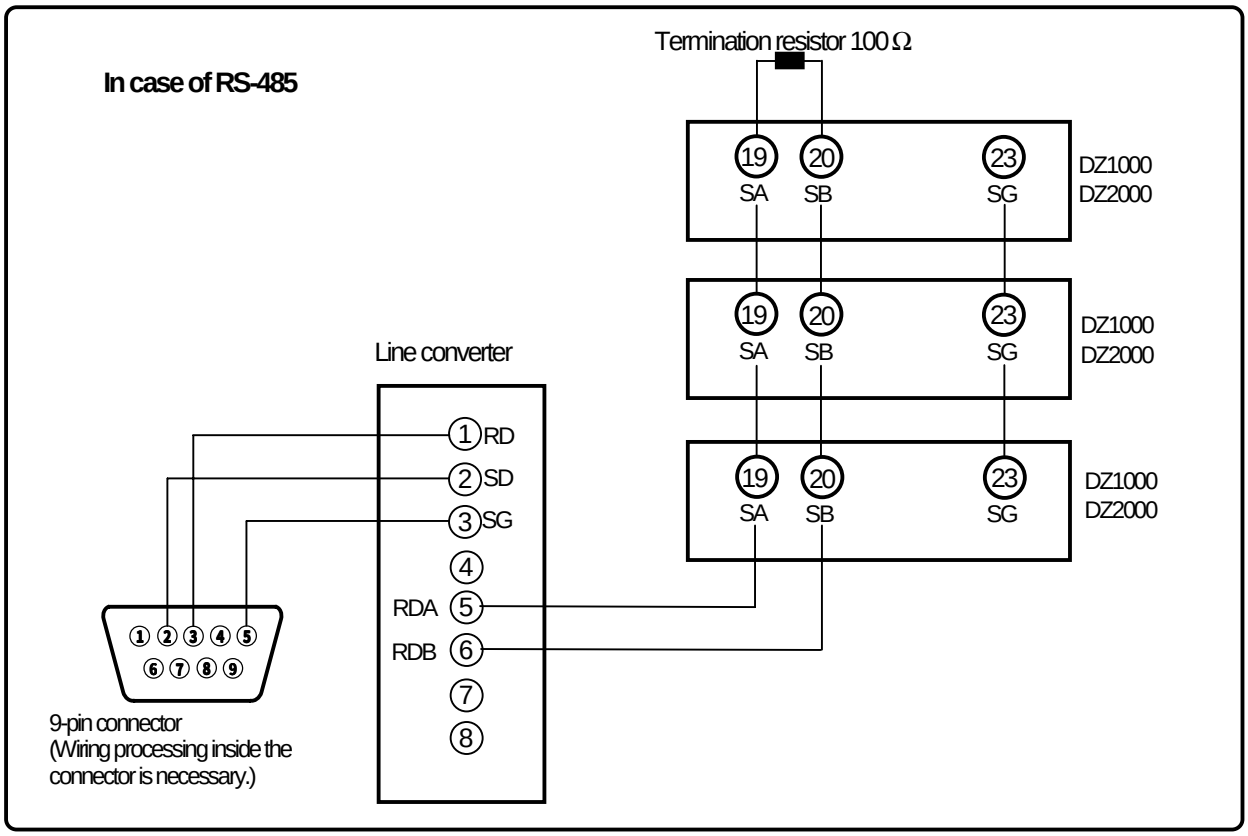
The RS-232C cable length is restricted to a maximum 15 m. The connection for NEC PC98 series 9-pin connector is on [Connection sample 1] and for the 25-pin connector is on [Connection sample 2].

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 the three control signals 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 the line converter (Model SC8-10: sold separately).]





6 MODBUS PROTOCOL

Basic Procedures of Communications and Precautions

Attention!

1. Program the “Key Lock” first when programming (write) parameters

The DZ1000/DZ2000 series digital controllers are always ready for communications. They are at anytime responsive to data requests from personal computers. However make sure to program the DZ1000/DZ2000 series digital controllers to the Key Lock (Lock 2) first, before programming parameters or operation of the controllers from personal computers. A Key Lock program can be carried out at the front panel keys on the DZ1000/DZ2000 series digital controllers or from personal computers through communications. If the parameter programming or operation of the controllers is carried out from personal computers while Non Lock or Lock 1 is programmed, the controllers return the error message No.12. (See Section 6.6)

2. An instrument No. is required even when it is used via RS-232C

When RS-232C is used, only one DZ1000/DZ2000 series digital controller can be connected to each personal computer. However, an instrument No. has to be programmed for the communications.

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

Since the DZ1000/DZ2000 series digital controllers' serial interfaces communicate freely without using any control line, a reception failure may occur under some conditions. Exercise care when re-sending 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 an RS-485 communications interface, multiple instruments are connected to the same communications line, only one instrument, of which the instrument No. is specified by the personal computer, 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 personal computer sends a command to the next unit before the communications drive is turned off, signals interfere with each other resulting in communications failures. Exercise caution when you use a high-speed personal computer.

6.1 Message Transmission Modes

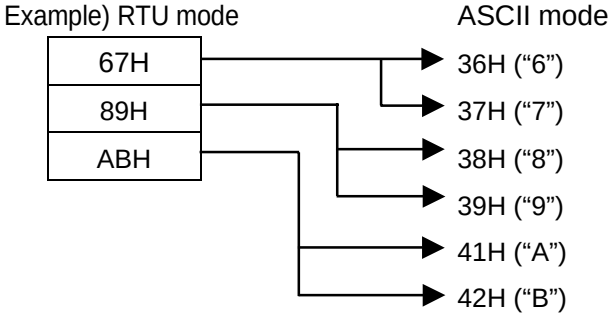
There are two modes of message transmission, RTU (Remote Terminal Unit) and ASCII, which can be selected by front key programming.

(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, 19200 bps	
Character code		Binary	ASCII
Error check	Vertical	Parity	
	Horizontal	CRC-16	LRC
Character Configuration	Start bit	1 bit	
	Data bit	8 bits	7 bits
	Parity bit	None	Even
	Stop bit	1 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).

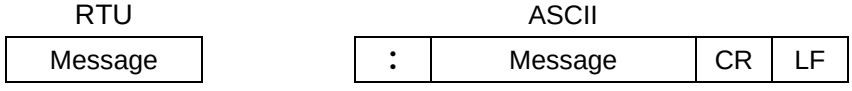


Length of an RTU-mode message is half that of an ASCII-mode message, ensuring a more efficient transmission.

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 (2.8 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 (personal computer) with a relatively slow processing speed.

6.3 Message Configuration

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

Slave address
Function code
Data
Error check

6.3.1 Slave address

The slave address can be programmed in advance by front key operation within a range between 1 and 31. 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
(2) Digital input data:	Parameters including Event /Alarm activation 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 and status. Numerical values within the range of 16-bits are 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 answering 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 DZ1000/DZ2000 series digital controllers employ the system of assigning the decimal places to separate addresses.

6.3.4 Reference No.

Data in the DZ1000/DZ2000 series digital controllers have a "Reference No." assigned to each of them which is required for reading and writing the data. The data in the DZ1000/DZ2000 series digital controllers are classified into "Digital parameter", "Digital input data", "Analog input data" and "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 DZ1000 series digital controller Reference Nos.)

Data type	Parameters	Reference No	Corresponding function code	Reference table
Digital parameter	AT start	101	01 (READ) 05 (WRITE)	Section 6.7.3 (P.32)
Digital input data	Alarm status	10117 to 10120	02 (READ)	Section 6.7.4 (P.32)
Analog input data	Real data (PV, SV, MV) Execution parameter Alarm status	30101 to 30142	04 (READ)	Section 6.7.2 (P.31 to 32)
Analog parameter	Set up parameter SV (linear) decimal point	40008	03 (READ) 06 (WRITE) 16 (WRITE)	Section 6.7.1 (P.30)
	Running parameter Output variation limitter	40161		(P.30)
	No. 1 parameter Parameter SV Alarm 1/2 PID Max./Min. output limitter	40201 to 40210		(P.30 to 31)
	Instrument operation Key lock Auto/Manual Remote SV programming	49501 to 49512		(P.31)

(Table 5 Quick search table for DZ2000 series digital controller Reference Nos.)

Data type	Parameters	Reference No	Corresponding function code	Reference table
Digital parameter	AT start	101	01(READ) 05 (WRITE)	Section 6.8.3 (P.38)
Digital input data	Event status Program status	10117 to 10187	02 (READ)	Section 6.8.4 (P.38)
Analog input data	Real data (PV, SV, MV) Execution parameter Event status Program status	30101 to 30144	04 (READ)	Section 6.8.2 (P.36 to 37)
Analog parameter	Set up parameter SV (linear) decimal point	40008		Section 6.8.1 (P.32)
	Running parameter Preset manual Setpoint slope Program pattern Output variation limitter	40114 to 40161		(P.33 to 34)
	No. 1 /No.2 parameter Parameter SV Event 1/2 PID Max./Min. output limitter	40201 to 40210	03 (READ) 06 (WRITE) 16 (WRITE)	(P.34 to 35)
	Instrument operation Key lock Auto/Manual SV1/2 switching Remote SV program Program operation	49501 to 49512		(P.35 to 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 $\rightarrow$ X
3) Shift X one bit to the right $\rightarrow$ X
4) When a carry is generated, take A001H and EX-OR. If not, go to 5). $\rightarrow$ X
5) Repeat 3) and 4) until shifting 8 times.
6) EX-OR between the next data and X $\rightarrow$ 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 | E7H | 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) The decimal point positions for each data are described in the Reference No. list. Some decimal point positions are fixed, some are fixed due to measurement range and a linear decimal point program decides some. When playing back the data, pay attention to the position of the decimal point.
(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 measuring range. 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 for any unspecified Reference No., it is likely to affect the proper operation of the instruments.
(4) While it is possible to write data for two or more discreet Reference Nos., a starting number with an unspecified Reference No. will result in an error (error No. 02H).
(5) When reading two or more Reference Nos., data with an unspecified “Reference No.” becomes "0".
(6) When an error is detected during writing for 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 mode	RTU mode
01	1	1
02	186	186
03	13	26
04	13	26
15	1	1
16	11	26

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

Example) Reading a measured data for DZ1000/DZ2000 series digital 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 "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 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 integer part of Measured Value (PV) is stored in "30101" and the PV status 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)

The data pieces to be read is "2" of the integer part of CH No.1 and the decimal place, 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.

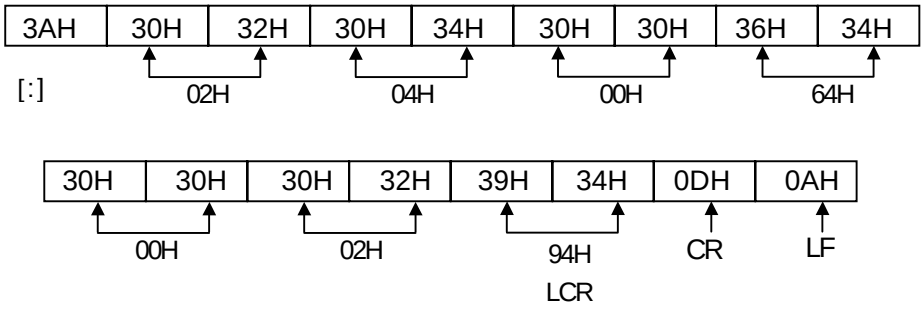
Error check data is therefore 30H | 27H .

(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 6.5.3.2). 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 Reference No. 101 of the digital parameters for the slave unit 2.

Reference No	101
Data	OFF

AT Stop

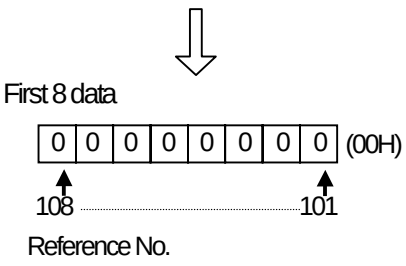
(RTU mode)

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
First 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. is 2 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 Reading analog set value (reading hold register contents)

[Function code. 03 (03H)]

The specified number of "analog parameters (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

Example) Reading clock information "PID at SV1" 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=60 sec., D=15 sec.

(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
Data P (H)	00H
Data P (L)	32H
Data I (H)	00H
Data I (L)	3CH
Data D (H)	00H
Data D (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 the 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 sent from the DZ1000/DZ2000 series digital 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		Instruments→ Master (normal)	
Slave address	02H	Slave address	02H
Function code	05H	Function code	05H
Parameter No. (H)	00H	Parameter No. (H)	00H
Parameter No. (L)	13H	Parameter No. (L)	13H
Programming status (H)	FFH	Programming status (H)	FFH
Programming status (L)	00H	Programming status (L)	00H
CRC (L)	7DH	CRC (L)	7DH
CRC (H)	CCH	CRC (H)	CCH

(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 executing, 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) Program the output variation limitter of the slave unit 2 to 50 %.
(Program Reference No. 40161 of analog parameter to "500" for the slave unit 2.)

(RTU mode)

Master→Instruments		Instruments→Master (normal)	
Slave address	02H	Slave address	02H
Function code	06H	Function code	06H
Parameter No. (H)	00H	Parameter No. (H)	00H
Parameter No. (L)	A0H	Parameter No. (L)	A0H
Programming status (H)	01H	Programming status (H)	01H
Programming status (L)	F4H	Programming status (L)	F4H
CRC (L)	89H	CRC (L)	89H
CRC (H)	CCH	CRC (H)	CCH

(Error check in ASCII mode)

LRC	63H	LRC	63H

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 160 (=40161 – 40001) ⟶ Hexadecimal A0H)

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)]

Checks transmission between master and slave units. Response is made according to a specified diagnosis code. With the diagnosis code fixed at “0000H”, the DZ1000/DZ2000 series digital controllers performs a "return check” of unaltered received data transmissions.

(Example 2) to execute a "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 digital 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 (ON/OFF). Every 8 specified numbers which are 0 or 1 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) Programming AT of the slave unit 2 to START.

(Program Reference No. 101 of digital parameters for the slave unit 2 as 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 bit 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)

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

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 data of a message that can be sent at any one time (that can be received by this controller) 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 PID at SV1 of the slave unit 2 to P=12.0%, I=90 sec. And D=25 sec.
(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 data of a message that can be sent at any one time (that can be received by this controller) 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 exceed 64.

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 a start No. or a parameter No. received is not the specified number.
03H	Data pieces failure The 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 Programmed value (binary) exceeds the range specified in the Reference list.
12H	Programming disabled ● When programming and operating during Non Lock and Lock 1 mode. ● When programming AT Start during FB tuning. ● When programming Program Pattern Setting during RUN/END. (DZ2000) ● When switching SV1/2 via communications during SV switching with external signal communications. (DZ2000) ● When switching SV1/2 during program operation. (DZ2000) ● When programming program operation via communications during program operation with external signal communications. ● When programming Start during END. (DZ2000) ● When programming Program Operation (Reset/Start) during controlling fixed value.

6.7 DZ1000 Series Digital Controller Reference List

6.7.1 Analog parameter

(1) Setup parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40008	03	R	SV decimal point (SV DOT)	0 to 3	(1)	Read only. WRITE is disabled. With temperature input, fixed values for every range can be read. With linear input, programming of linear decimal points can be read.

(2) Running parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40161	03 06 16	R W W	Output variation limitter	0.1 to 100.0 (1 to 1000)	100.0%	Prevent drastic output variation by programming the variation of every control output (0.2 sec.) to a desired value.

(3) No. 1 parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40201	03 06 16	R W W	Set Value (SV)	-1999 to 9999 (SV limitter Min. to SV limitter Max.)	0	Decimal point place: Temperature input = Fixed at every range Linear input = Depending on programming of linear decimal point
40202 40203	03 06 16	R W W	Alarm 1 Alarm 2	-1999 to 9999		When Alarm mode is programmed to deviation/ absolute value; Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point
				0.0 to 5.0 (0 to 50)		When Alarm mode is programmed to CT;
					4000 -1999 4000 -1999 0.0	It returns to the default value when the Alarm mode is changed. Alarm mode = Max. absolute value Alarm mode = Min. absolute value Alarm mode = Max. deviation Alarm mode = Min. deviation Alarm mode = CT
40206	03 06 16	R W W	Proportional band (P)	0.1 to 999.9 (1 to 9999)	5.0%	
40207	03 06 16	R W W	Integral time (I)	0 to 9999	60 sec.	∞ at I = 0

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40208	03 06 16	R W W	Derivative time (D)	0 to 9999	15 sec.	OFF at D = 0
40209 40210	03 06 16	R W W	Min. output limitter Max. output limitter	-0.5 to 100.0 (-50 to 1000) 0.0 to 105.0 (0 to 1050)	0.0% 100.0%	Limit the Max. and Min. of outputs so that the control output will not be higher or lower than the programmed value. Make sure the programmed values for H and L is L<H.

(4) Unit operation

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
49501	03 06	R W	Key Lock	0/1/2	0	Lock 1 = Lock 1 2 = Lock 2
49503	03 06 16	R W W	Auto/Manual (A/M) switching	0/1	0	0 = Switching to Auto 1 = Switching to Manual
49504	03 06 16	R W W	Manual output value	-5.0 to 105.0 (-50 to 1050)		Available to program output value at every 0.1% Manual operation is not possible for 2-position control.
49512	03 06 16	R W W	Remote SV program	-1999 to 9999 (SV limitter Min. to SV limitter Max.)	0	Remote SV program via communications. Switching between R and L with external signal. Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point

6.7.2 Analog input data (Read only)

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

Reference No.	FNC code	R/W	Data Name	Detailed explanation
30101	04	R	Measured value (PV)	Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point When PV is (+) Over Range: 32767 When PV is (-) Over Range: -32768
30102	04	R	PV status	0 = Normal 1 = (+) Over Range 2 = (-) Over Range 4 = Input circuit hardware error

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

Reference No.	FNC code	R/W	Data Name	Detailed explanation
30103	04	R	Setpoint (SV)	SV (Fixed value SV, Remote SV) being used currently Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point
30104	04	R	SV status	0 = Fixed value 1 = Remote SV
30105	04	R	Control output value (MV)	-50 to 1050 = -5.0 to 105.0%
30106	04	R	MV status	0 = Auto 1 = Manual output 2 = Output during AT execution
30109 30110 30111	04	R	Setpoint SV AL 1 AL 2	SV setpoint (Decimal point place is same as 30103.) AL 1 setpoint (Decimal point palce is same as 40202.) AL 2 setpoint (Decimal point place is same as 40203.)
30114 30115 30116	04	R	Execution P Execution I Execution D	P programmed value (1 to 9999 = 0.1 to 999.9%) I programmed value D programmed value
30142	04	R	Alarm status	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 AL2 AL1 Alarm OFF → 0 0 0 0 Alarm ON → 0 1 0 1 Alarm OFF during stanby mode → 1 0 1 0

6.7.3 Digital parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
101	01 05	R W	AT start	Stop/Start (0/1 = [FF00h]) Figures in [ ] shows the range when FNC code is 05.	0	DZ1000/2000 series digital controllers automatically caluculates the most appropriate PID constants. 0 = AT stop or End 1 = AT start or AT is being executed. Not available to be carried out during FB tuning.

6.7.4 Digital input data (Read only)

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

Reference No.	FNC code	R/W	Data Name	Detailed explanation
10117 10118 10119 10120	02	R	Alarm 1 status Alarm 1 status Alarm 2 status Alarm 2 status	0=Alarm OFF, 1=Alarm ON, 0=Alarm OFF during standby mode 0, 0, 1 0=Alarm OFF, 1=Alarm ON, 0=Alarm OFF during standby mode 0 , 0, 1

6.8 DZ2000 Series Digital Controller Reference List

6.8.1 Analog parameter

(1) Set up parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40008	03	R	SV decimal point (SV DOT)	0 to 3	(1)	Read only. WRITE is disabled. With temperature input, fixed values for every range can be read. With linear input, programming of linear decimal points can be read.

(2) Running parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40114	03 06 16	R W W	Preset manual	-0.5 to 105.0 (-50 to 1050)	0.0%	By programming output value in advance, the programmed value is output when the preset is executed.
40116 40117	03 06 16	R W W	SV slope increase SV slope decrease	0 to 9999	0	0 = No slope operation Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point
40118	03 06 16	R W W	Slope time unit	°C/min., °C/hour (1, 2)	°C/min., (1)	0 = °C/min. 2 = °C/hour
40119	03 06 16	R W W	PV Slope start ON/OFF	OFF/ON (0/1)	OFF (0)	Selection between ON (The slope start is executed by PV.) and OFF (The slope start is not executed by PV.). 0 = OFF 1 = ON
40121	03 06 16	R W W	Program Pattern select	0/1/2/3/4	OFF (0)	Selection between fixed value control and program control Program control by selecting PG1 to PG4 0 = OFF (Fixed value control) 1 = PG1 (One step trapezoid program control) 2 = PG2 (Two steps trapezoid program control) 3 = PG3 (Three steps trapezoid program control) 4 = PG4 (Repetition of two steps trapezoid program control) Above programs can be changed only during the fixed value control mode or RESET. Writing is disable during RUN/END.
40126 - - 40128 - - 40130	03 06 16	R W W	SV1 retain time SV2 retain time SV3 retain time	1 to 999 1 to 999 1 to 999	60 min. 60 min. 60 min.	

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40138	03 06 16	R W W	Control when program is end	CONST/P-MAN (0/1)	P-MAN (1)	Selection of control type when program control is end. 0 = Fixed value control 1 = Switching to Preset Manual
40161	03 06 16	R W W	Output variation limitter	0.1 to 100.0 (1 to 1000)	100.0%	Prevent drastic output variation by programming the variation of every control output (0.2 sec.) to a desired value.

(3) No. 1 parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40201	03 06 16	R W W	Setpoint (SV)	-1999 to 9999 (SV limitter Min. to SV limitter Max.)	0	Decimal point place: Temperature input = Fixed at every range Linear input = Depending on programming of linear decimal point
40202 40203	03 06 16	R W W	SV side Event 1 SV side Event 2	-1999 to 9999		When Event mode is programmed to deviation/ absolute value/status Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point
				-199.9 to 999.9 (-1999 to 9999)		When Event mode is programmed to control output.
				0.0 to 5.0 (0 to 50)		When Alarm mode is programmed to CT;
						It returns to the default value when the Event mode is changed.
					4000	Event mode = Max. absolute value
					-1999	Event mode = Min. absolute value
					4000	Event mode = Max. deviation
					-1999	Event mode = Min. deviation
					400.0	Event mode = Max. control output
					-199.9	Event mode = Min. control output
					0.0	Event mode = CT
					4000	Event status = Status
40206	03 06 16	R W W	SV1 side Proportional band (P)	0.1 to 999.9 (1 to 9999)	5.0%	
40207	03 06 16	R W W	SV1 side Integral time (I)	0 to 9999	60 sec.	∞ at I = 0
40208	03 06 16	R W W	SV1 side Derivative time (D)	0 to 9999	15 sec.	OFF at D = 0

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
40209 40210	03 06 16	R W W	SV1 side Min. output limitter SV1 side Max. output limitter	-0.5 to 100.0 (-50 to 1000) 1.0 to 105.0 (0 to 1050)	0.0% 100.0%	Limit the Max. and Min. of outputs so that the control output will not be higher or lower than the programmed value. Make sure the programmed values for H and L is L< H.
40251	03 06 16	R W W	Setpoint SV 2			Same as for Setpoint SV 1
40252 40253	03 06 16		SV 2 side Event 1 SV 2 side Event 2			Same as for SV1 side/Event 1 Same as for SV1 side/Event 2
40256	03 06 16	R W W	SV 2 side Proportional band (P)			Same as for SV1 side /Proportioanl band (P)
40257	03 06 16	R W W	SV 2 side Integral time (I)			Same as for SV1 side/Integral time (I)
40258	03 06 16	R W W	SV 2 side Derivative time (D)			Same as for SV1 side/Derivative time (D)
40259 40260	03 06 16	R W W	SV 2 side Min. output limitter SV 2 side Max. output limitter			Same as for SV1 side/Min. output limitter Same as for SV1 side/Max. output limitter

(4) Instrument Operation

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
49501	03 06	R W	Key Lock	0/1/2	0	0= Not Locked 1= Lock 1 2= Lock 2
49503	03 06 16	R W W	Auto/Manual (A/M) switching	0/1	0	0= Switching to Auto 1= Switching to Manual
49504	03 06 16	R W W	Manual Output value	-5.0 ～ 105.0 (-50 ～ 1050)		Available to program output value at every 0.1% Manual operation is not possible for 2-position control.

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
49511	03 06 16	R W W	Switching Execution SV1/2	SV1/SV2 (1 / 2)	1	1 = Select SV1 (side 1 parameter) 2 = Select SV2 (side 2 parameter Selection between SV 1 and SV2 is not available during programming operation. (Note) Invalid when being switched by external signals.
49512	03 06 16	R W W	Remote SV programming	-1999～9999 (SV limitter Min. to SV limitter Max.)	0	Remote SV programming is available when the communications function is programmed to COM. R/L switching is available with external signals. Decimal point place: Temperature input: = Fixed at every range. Linear input = Depanding on programming of linear decimal point
49516	03 06	R W	Program operation	Reset/Start (0 / 1))	0	0 = Reset 1 = Start (Note) Invalid when being operated by external signals.

6.8.2 Analog Input Data (Read Only)

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

Reference No.	FNC code	R/W	Data Name	Detailed explanation
30101	04	R	Measured value (PV)	Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of inear decimal point When PV is (+) Over Range: 32767 When PV is (-) Over Range: -32768
30102	04	R	PV status	0 = Normal 1 = (+) Over Range 2 = (-) Over Range 4 = Input circuit hardware error
30103	04	R	Setpoint (SV)	SV (Fixed value SV, SV during slope, Remote SV, SV during program) being used currently Decimal point place: Temperature input: = Fixed at every range Linear input = Depending on programming of linear decimal point
30104	04	R	SV status	0 = Fixed value 1 = Remote SV 2 = Slope operation
30105	04	R	Control output value (MV)	-50 to 1050 = -5.0 to 105.0%
30106	04	R	MV status	0 = Auto 1 = Manual output 2 = Output during AT execution 3 = Preset manual output

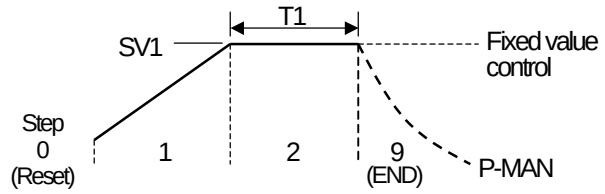
FNC code ----- Applicable function code, R/W ------- R: READ, W: WRITE

Reference No.	FNC code	R/W	Data Name	Detailed explanation
30109 30110 30111	04	R	Execution SV Execution EV 1 Execution EV 2	SV setpoint at Execution No. side (Decimal point place is the same as for 30103.) EV 1 setpoint at Execution No. side (Decimal point palce is the same as for 40202.) EV 2 setpoint at Execution No. sdie (Decimal point place is the same as for 40203.)
30114 30115 30116	04	R	Execution P Execution I Execution D	P programmed value at Execution No. side (1 to 9999 = 0.1 to 999.9%) I programmed at Execution No. side D programmed at Execution No. side
30124	04	R	Execution No.	Parameter No. during execution(1 or 2)
30142	04	R	Event status	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 EV 2 / AEV 1 Event OFF → 0 0 0 0 Event ON → 0 1 0 1 Event OFF during standby mode → 1 0 1 0
34143	04	R	Program Pattern status	0 = Fixed value control mode 1 = PG1 (One step trapezoid program control) 2 = PG2 (Two steps trapezoid program control) 3 = PG3 (Three steps trapezoid program control) 4 = PG4 (Repetition of two steps trapezoid program control)
30144	04	R	Program progress status*	0 = Reset and Fixed value control mode 1 to 6 = Step Nos. 9 = END

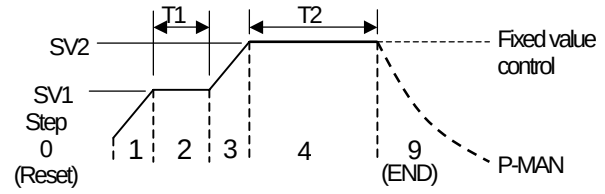
*Program Porgress Status

- The condition of the Program END will be continued until reset is executed.

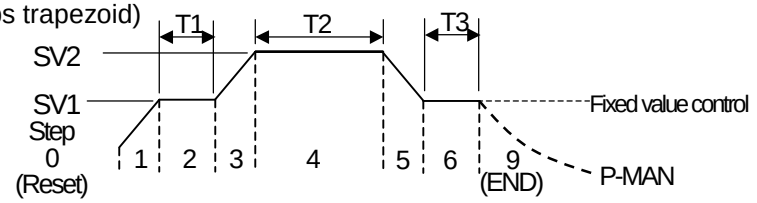
(1) PG-1 (One step trapezoid)



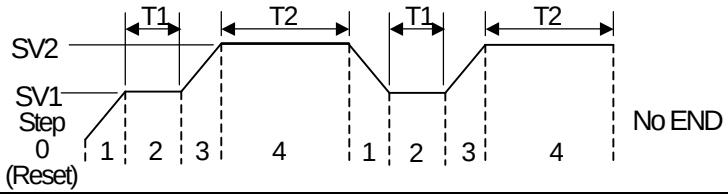
(2) PG-2 (Two steps trapezoid)



(3) PG-3 (Three steps trapezoid)



(4) PG-4 (repeat)



T1,T2,T3 = Retain time

6.8.3 Digital Parameter

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

Reference No.	FNC code	R/W	Data Name	Programming Range (Range for communications)	Initial value	Remarks
101	01 05	R W	AT Start	Stop/Start (0 / 1 = [FF00h]) Code inside [ ] is when FNC code is "05".	0	DZ1000/2000 series digital controllers automatically calculates the most appropriate PID constants. 0 = AT Stop or End 1 = AT Start or AT Execution AT Execution is not available during FB tuning.

6.8.4. Digital Input Data (Read Only)

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

Reference No.	FNC code	R/W	Data Name	Detailed explanation
10117 10118 10119 10120	02	R	Event 1 Status Event 1 Status Event 2 Status Event 2 Status	0 = Event OFF, 1 = Event ON, 0 = Event OFF during standby mode 0 , 0 , 1 0 = Event OFF, 1 = Event ON, 0 = Event OFF during standby mode 0 , 0 , 1
10181 -- --	02	R	Program Status RUN	0 1 1 0 0 0 0 0 0
10184 -- --			Program Status RESET	1 0 0 0 0 0 0 0 0
10187			Program Status END	0 0 1 END Status RUN Status RESET Status

6.9 Measuring Range and Decimal Point Place

<Table 6 Measuring Range List>

Input type		SV (°C) Programming and display range	SV DOT	SV (°F) Programming and display range	SV DOT
Thermocouple	B	0 to 1820	0	32 to 3300	0
	R	0 to 1760	0	32 to 3200	0
	S	0 to 1760	0	32 to 3200	0
	K	200 to 1370	0	-300 to 2450	0
	K	-199.9 to 500.0	1	-300 to 900	0
	E	-199.9 to 700.0	1	-300 to 1250	0
	J	-199.9 to 900.0	1	-300 to 1650	0
	T	-199.9 to 400.0	1	-300 to 700	0
	N	0 to 1300	0	32 to 2350	0
	U	-199.9 to 400.0	1	-300 to 700	0
	L	-199.9 to 900.0	1	-300 to 1650	0
Resistance thermometer	JPT100	-199.9 to 649.0	1	-300 to 1200	0
	JPT100	-199.9 to 200.0	1	-300 to 300	0
	PT100	-199.9 to 660.0	1	-300 to 1200	0
	PT100	-199.9 to 200.0	1	-300 to 300	0
	PT50	-199.9 to 649.0	1	-300 to 1200	0
	Input type	Programming range (Range)		Programming range (Scale)	
Voltage	20mV	-20.0 to 20.0		-1999 to 9999	
	5V	-5.00 to 5.00		-1999 to 9999	
Current	20mA	0.00 to 20.00		-1999 to 9999	

6.10 Remote SV Programming via Communications

6.10.1 Digital Communications between DZ and DZ controllers

When the DZ controller is programmed to “trS (Communications Transmission)” and the other DZ controllers are programmed to “rEM (Communications Remote), digital communications between these DZ controllers is available. (Refer to the section Communications 7 Transmission/ Communications Remote.)

In this case, DZ controllers programmed to the Communication Remote receives all the transmitted data (PV, SV, MV, RSV, MFB) as Remote SV data from the DZ controller programmed to the Communications Transmission.

6.10.2 Personal Computer Communications + Communications Remote Functions

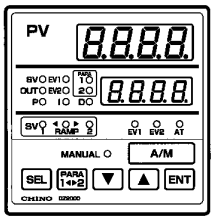
Under the condition that a personal computer and DZ controllers (communications function is CoM) are connected, the DZ controllers can receive Remote SV data by writing the SV data to the Reference No. 49512 (Remote SV), while transmitting and receiving measured data and parameters between a personal computer and the DZ controllers. In this case, the received Remote SV data is treated the same as the Remote SV data like the Communication Remote in section 6.10.1. If the communications function of the DZ controller is changed from “CoM” to “trS (Communications Transmission) ” or “rEM” (Communications Remote), communications with a personal computer (transmitting and receiving measured data and parameters) cannot be executed.

7 COMMUNICATIONS TRANSMISSION AND COMMUNICATIONS REMOTE

7.1 General

Digital communications is available not only between DZ controllers and personal computers but also between a DZ controller and other DZ controllers. These functions are called "Communications Transmission" and "Communications Remote".

By programming a DZ controller to Communication Transmission as a master unit and other DZ controllers to Communications Remote as slave units, the SV of the slave unit (up to 32 sets) can be programmed through communications. This function can be utilized for using multiple DZ controllers in the same condition. The master or slave designation of the DZ controllers can be programmed by key operation.



When the communications function of the Mode 3 is programmed to "trS (Private protocol)" or "trS.2 (MODBUS)", DZ controller is programmed as a master unit (Communications Transmission).

When the communications function of the Mode 3 is programmed to "rEM (in case a master DZ controller is programmed to "trS") " or "CoM (in case a master DZ controller is programmed to "trS.2")", DZ controller is programmed as a slave unit (Communications Remote).

[Communications Functions Programs and Details of Transmission Data]

Mode 3, Communications Functions Programming (Master) → (Slave)	Details of Transmission Data	
	DZ1000	DZ2000
(trS) →(rEM)	• Sending and receiving Remote SV data • Private protocol	• Sending and receiving Remote SV data • Private protocol
(trS. 2) → (CoM) (N.B.) Slave unit has to be programmed to Key Lock 2 to receive data.	• Sending and receiving Remote SV data • MODBUS protocol	• Sending and receiving Remote SV data and Execution SV No. (1/2) • MODBUS protocol

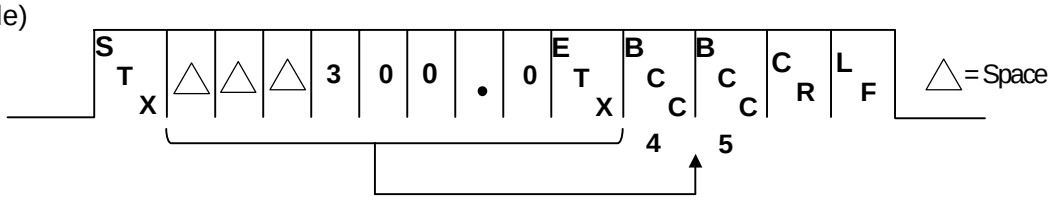
7.2 Communications Specifications

* Start-stop synchronization system	
* Transmission speed:	19200, 9600 bps (selectable)
* Start bit:	1 bit
* Data length:	7bits (ASCII mode) or 8 bits (RTU mode)
* Parity bit::	Even (ASCII mode) or None (RTU mode)
* Stop bit:	1 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 = BBC
ASCII code	20h	20h	20h	33h	30h	30h	2Eh	30h	03h	154h=45

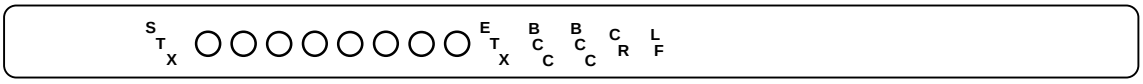
7.3 Programming Communications Transmission

When Communications Transmission is programmed, data is output with digital communications transmission instead of analog transmission. In this case, output transmission is only executed digitally. The functions are the same as for analog transmission.

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

1) Program the transmission type “trnS” for DZ1000 series digital controller and digital transmission type “d. trS” for DZ2000 series digital controller (Refer to Section 7.5.1).
2) Program the transmission speed “rAtE”. (Refer to Section 7.5.3)
3) Program the communications function “CoM”. (Refer to Section 7.5.4)

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



Data output: PV (Measured value), SV (Setpoint), MV (Control output value), RSV (Remote Received SV), MFB (Feedback input value)

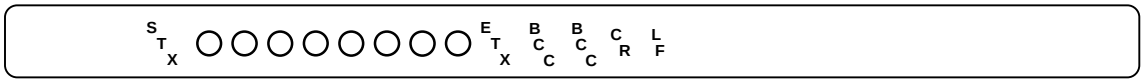
* When “trS. 2 (communications transmission)” is programmed, the data is output as the slave address “0” with the MODBUS format mentioned before.

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 DZ controller (Communications Transmission) and slave DZ controllers (Communications Remote), digital remote control and zone control will be available.

(1) Following parameters should be programmed for slave DZ controllers (Communications Remote).
   1) Program the remote shift “r.biA” if necessary. (Refer to section 7.5.1).
   2) Program the transmission speed “rAtE”. (Refer to section 7.5.3)
   3) Program the communications function “CoM”. (Refer to section 7.5.4)
(2) When the communications function of the Mode 3 is programmed to “rEM (in case a master DZ controller is programmed to “trS”) “ or “CoM (in case a master DZ controller is programmed to “trS.2”)”, DZ 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. DZ1000: ㉖ ㉗, DZ2000: ㉔ ㉟)
(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, DZ controller receives data as following format.



7.5 Programming Communications Transmission/Remote Parameters

Parameters related to Communications Transmission/Remote are provided to the Mode 3. Program the “Digital Transmission Type”, “Remote Shift”, “Transmission Speed” and “Communications Function” by following the flowchart on page 4.
“Remote Shift” is only programmed for the Communications Remote.

7.5.1 Programming Digital Transmission Type (d. trS)

(Programming of transmission type (trnS) for the DZ1000 series digital controller)

Transmission Type Programming	Meanings
PV	Transmits a measured value. (Default)
SV	Transmits a setpoint value.
MV	Transmits a control output value.
RSV	Transmits a setpoint value received with Analog Remote
MFB	Transmits valve open degree of an ON/OFF servo output.

(1) Display d.trS with the ENT key.
(2) Press ▲ (Dot starts blinking.) to display desired “Transmission Type” with ▲ / ▼.
Store it with ENT. (Dot stops blinking.)

7.5.2 Programming Remote Shift (r. biA)

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) Display r.b iA with the ENT key.
(2) Press ▲ (Dot starts blinking.) to program the desired shift width with ▲ / ▼.
Store it with ENT. (Dot stops blinking.)
Shift variable width: -1999.9 to 999.9 (Default: 0.0)

7.5.3 Programming Transmission Speed (rAtE)

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

(1) Display rAtE with the ENT key.
(2) Press ▲ (Dot starts blinking.) to display the desired transmission speed with ▲ / ▼.
Store it with ENT . (Dot stops blinking.)

Transmission speed: 9600, 19200 (displayed as 19.2 K) bps

7.5.4 Programming Communications Functions (CoM)

(1) Display [CoM] with the [ENT] key.

(2) Press [▲] (Dot starts blinking.) to display “rEM”, “trS” or “trS. 2” with [▲] / [▼].
Store it with [ENT]. (Dot stops blinking.)

C o M:	Programmed for communications with a personal computer (Default CoM)
r E M:	Programmed for Communication Remote (on slave units)
t r S:	Programmed for Communication Transmission with private protocol (on a master unit)
T r S. 2:	Programmed for Communication Transmission with MODBUS (on a master unit)

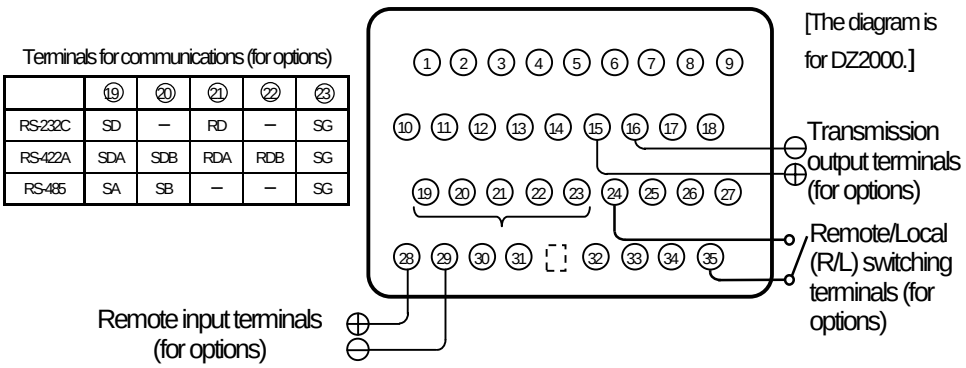
Caution

1) DZ 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. (DZ2000)

“Transmission Scale MIN”, “Transmission Scale MAX”, “Remote Scale MIN” and “Remote Scale MAX” in the flow chart should be programmed when Analog Transmission/Remote is used. This means that the programming of these parameters is not necessary for Communications Transmission and Communications Remote.

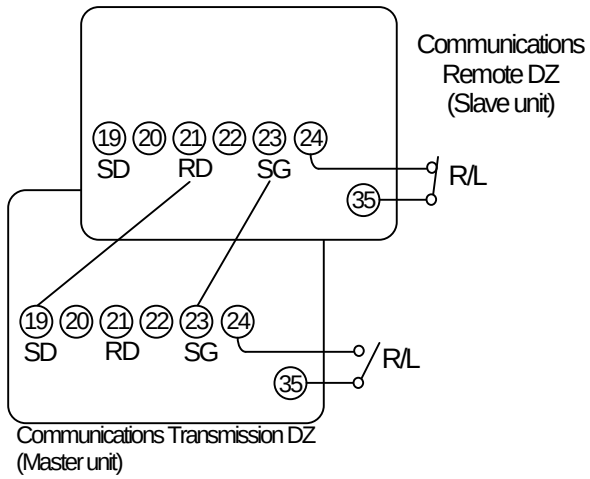
Transmission Scale	MIN: Programming of minimum value of Transmission Scale (-1999 to 9999) MAX: Programming of maximum value of Transmission Scale (-1999 to 9999)）
Remote Scale	MIN: Programming of minimum value of Remote Scale (-1999 to 9999) MAX: Programming of maximum value of Remote Scale (-1999 to 9999)

Reference Comparison of "Transmission" and "Remote" of "Communications/Analog signal"

Item	Communications Transmission/Remote	Analog Communications/Remote
1. Terminals for Transmission/ Remote.		
2. Transmission/ Remote type	Communications Transmission/Remote ・ RS-232C ・ RS-422A ・ RS-485	Analog Transmission/Remote (Transmission output terminal, Remote input terminal)
3. Transmission output (Master unit)	Communications Transmission ・ PV: Measured Value ・ SV: Setpoint ・ MV: Control Output Value ・ RSV: Remote SV ・ MFB: Feed Back Input Value	Analog Transmission ・ 4 to 20 mA (DC) ・ 0 to 1 V (DC) ・ 0 to 10 V (DC) } From transmission output terminals
4. Remote input (Slave unit)	Transmission output is received as SV.	Transmission output is received as SV. (Received at remote input terminals)
5. Remote/Local switching	R/L switching terminals	R/L switching terminals
6. <Number of connected units> Number of slave units available to be connected to a master unit	・ RS-232C 1unit ・ RS-422A Max. 32 units ・ RS-485 Max. 32 units	Depending on load resistance of transmission output and input resistance of remote input.

7.6 Connections

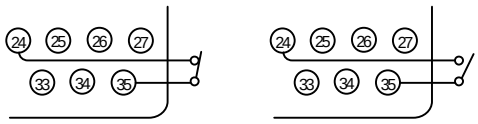
(1) [RS-232C]



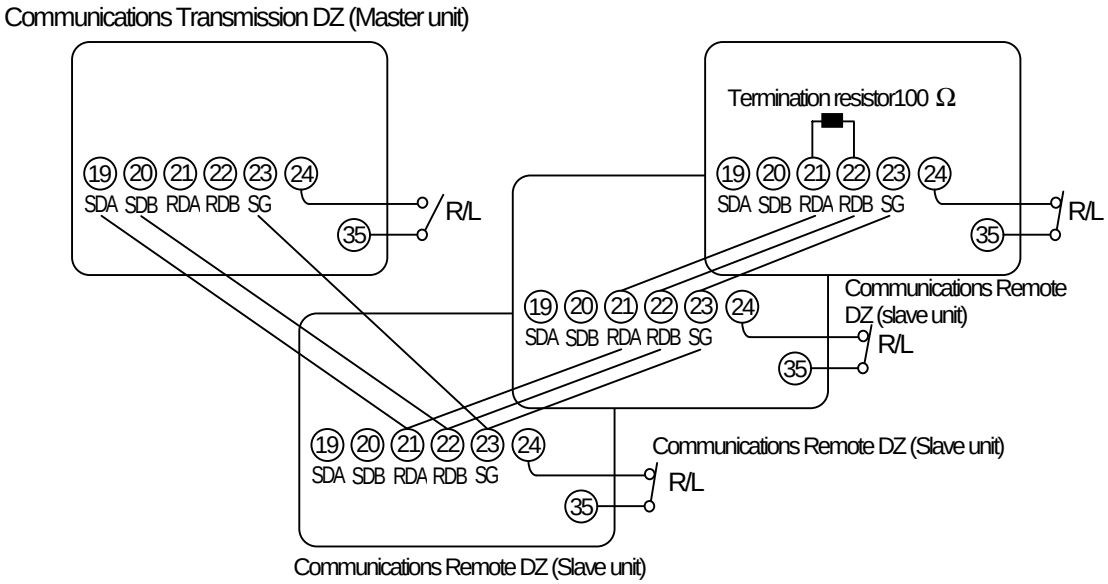
Caution

1. These examples are for DZ2000 controllers. Different R/L switching terminals are provided for DZ1000 controllers.
2. Remote/Local (R/L) switching terminals
   These terminals are non-voltage contact terminals. Be sure to short these terminals for Communications Remote. With open circuits, local operation is executed and SV can be programmed on slave DZ controllers.

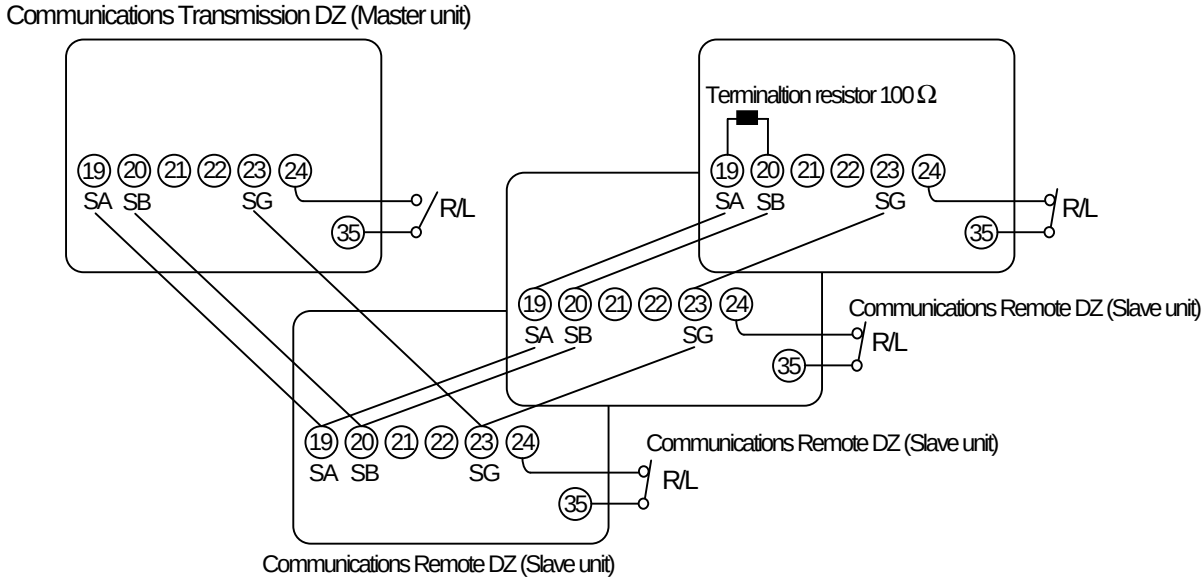
When the R/L terminals are open circuited, the data from a master unit (Communications Transmission) cannot be received.



(2) [RS-422A]



(3) [RS-485]

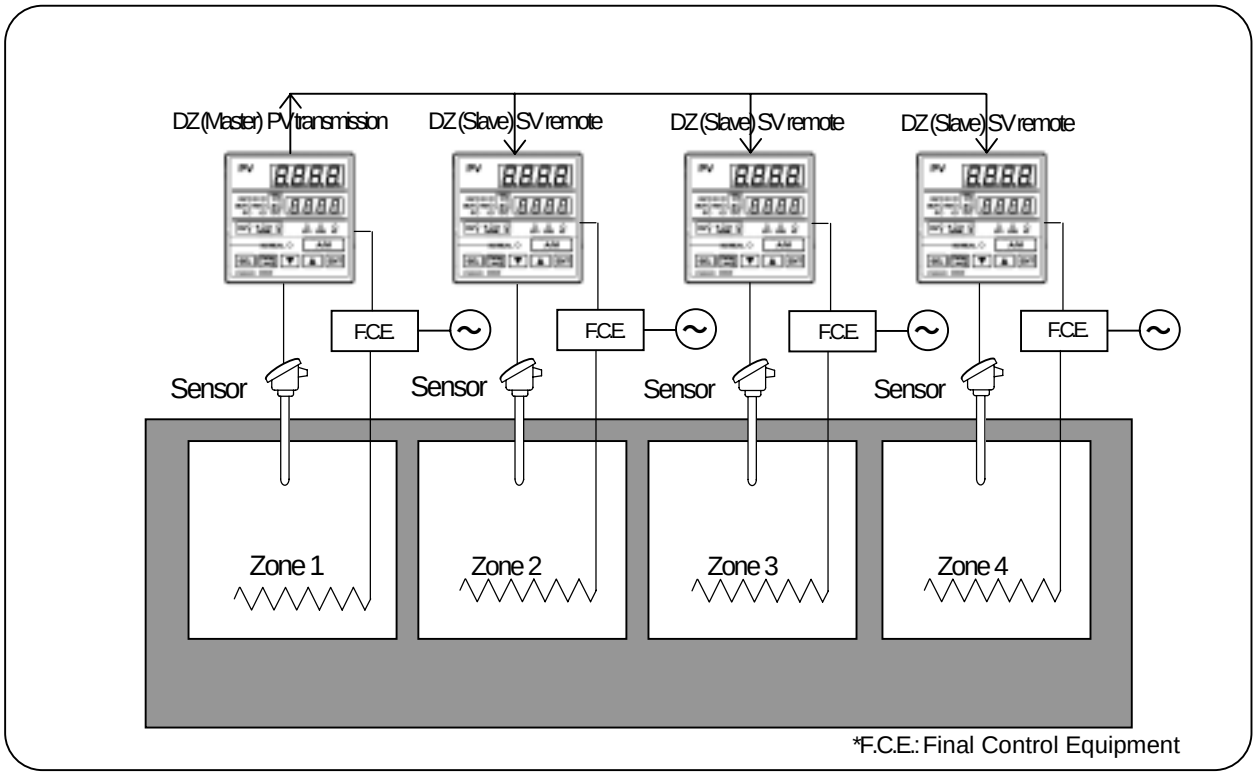


7. 7 Temperature Control Examples

7.7.1 Temperature Control for Multi Zone

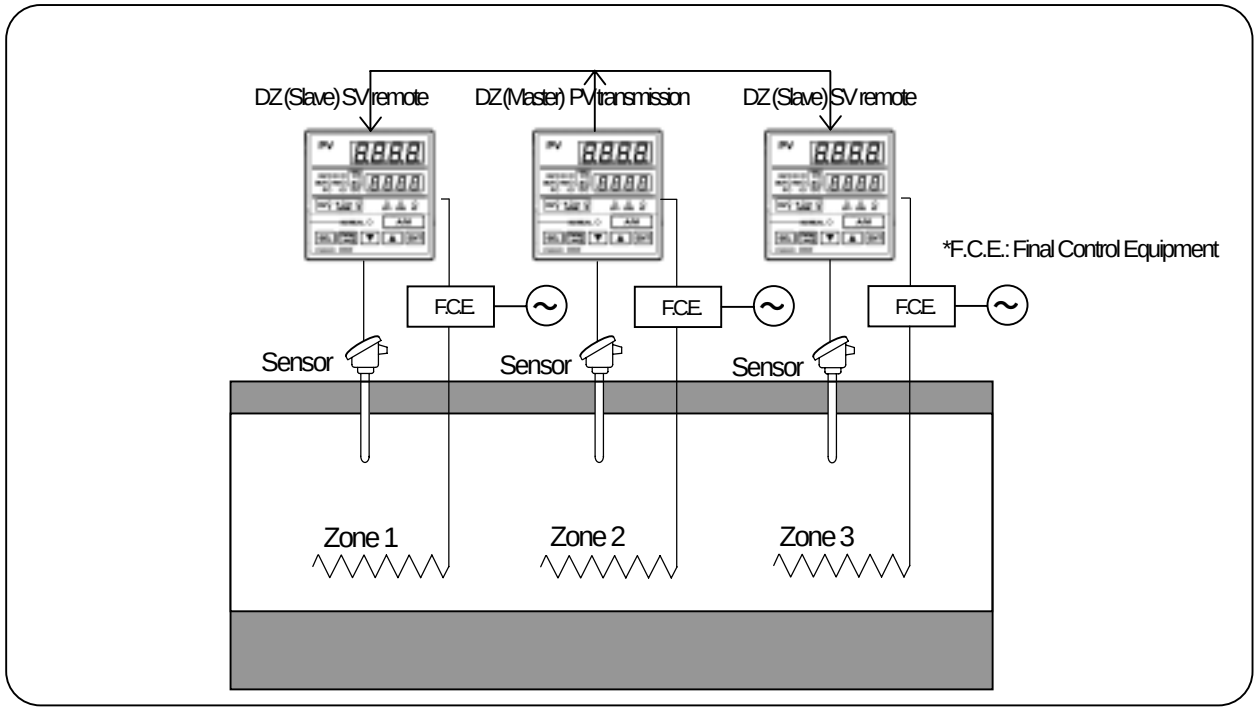
A master DZ controller sends SV with the communications transmission and slave DZ controllers receive it with the communications remote.

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



7.7.2 Zone Control In A Soaking Pit

A master DZ controller located in the middle sends PV by the communications transmission, and slave DZ 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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