INSTRUCTION MANUAL FOR FCL-100 COMMUNICATION
(OPTION CODE: C5,SVTC)

To prevent the accidents by mishandling of this controller, please arrange to give this manual into the hands of the operator who actually uses our products.
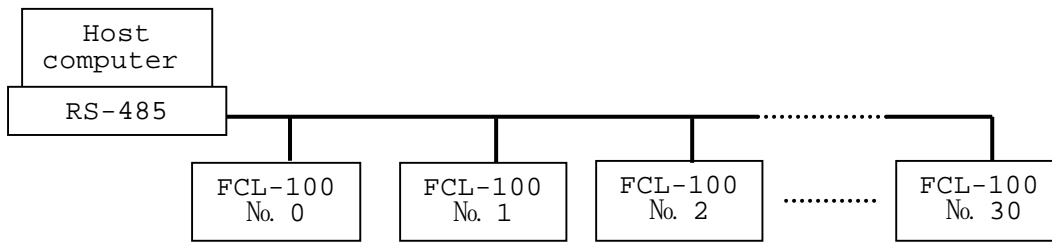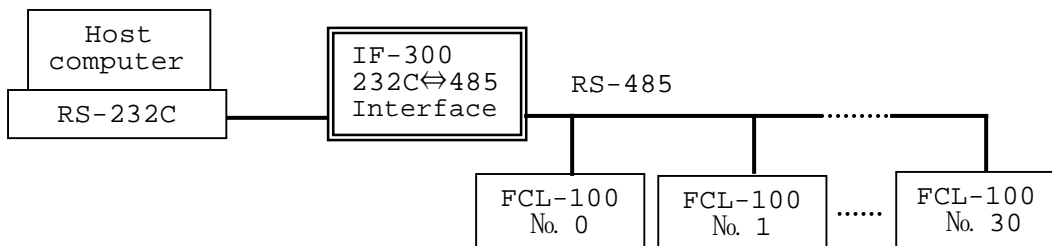
⚠ Warning

Turn the power supplied to the instrument OFF before wiring or checking. If working or touching the terminal on the power ON status, there is a possibility of Electric Shock which can cause severe injury or death.
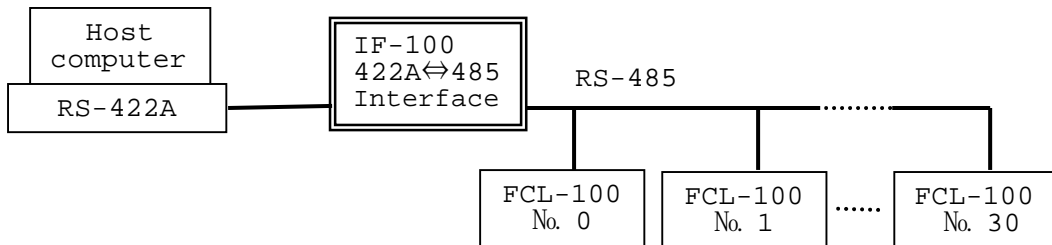
1. System configuration

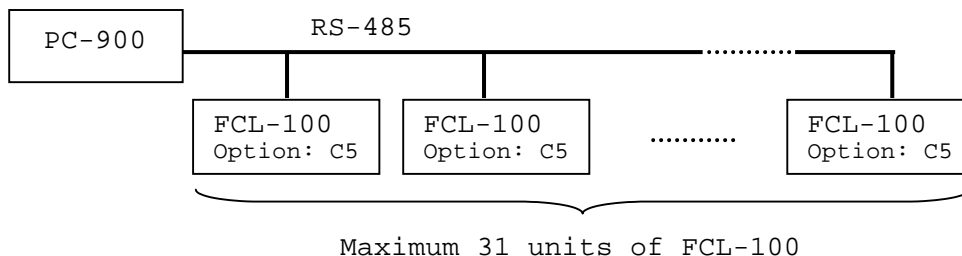### 1.1 RS-485 Multipoint connection (Option code: C5)

[Fig. 1.1-1]

[Fig. 1.1-2]

[Fig. 1.1-3]

1.2 When executing setting value digital transmission by option C5.

Maximum 31 units of FCL-100

[Fig. 1.2-1]

· The main setting value of PC-900(option code: SVTC) can be transmitted to the FCL-100 (option code: C5).
· Fit the transfer rate of PC-900 and FCL-100.
· Designate Lock 3 in Setting value lock designation of the FCL-100.
· Maximum 31 units of FCL-100 are connectable to one PC-900.

● **Notices when using the setting value digital transmission**
　· Memory life of the FCL-100 is approximately 10 000 000 (ten million) times

in writing. Therefore when frequently writing the command, designate Lock 3 in Setting value lock of the FCL-100, since it has no relation to memory life. If the Lock 3 is not designated, it writes the memory every time the setting command is sent, and the memory life becomes shorter.

· Fit the transfer rate of FCL-100 and PC-900.

· It is not necessary to set instrument number to the FCL-100.

2. Connection

2.1 RS-485 (Option code: C5)

● In case the converter is IF-100-C5, and between the converter and Host computer is connected by RS-232C.
Connection: RS-232C ◄─► RS-485 (Data transfer rate: 1200, 2400, 4800 or 9600bps)
When communicating by the transfer rate **19200bps**, **IF-300-C5** is required instead of IF-100-C5 for the converter.
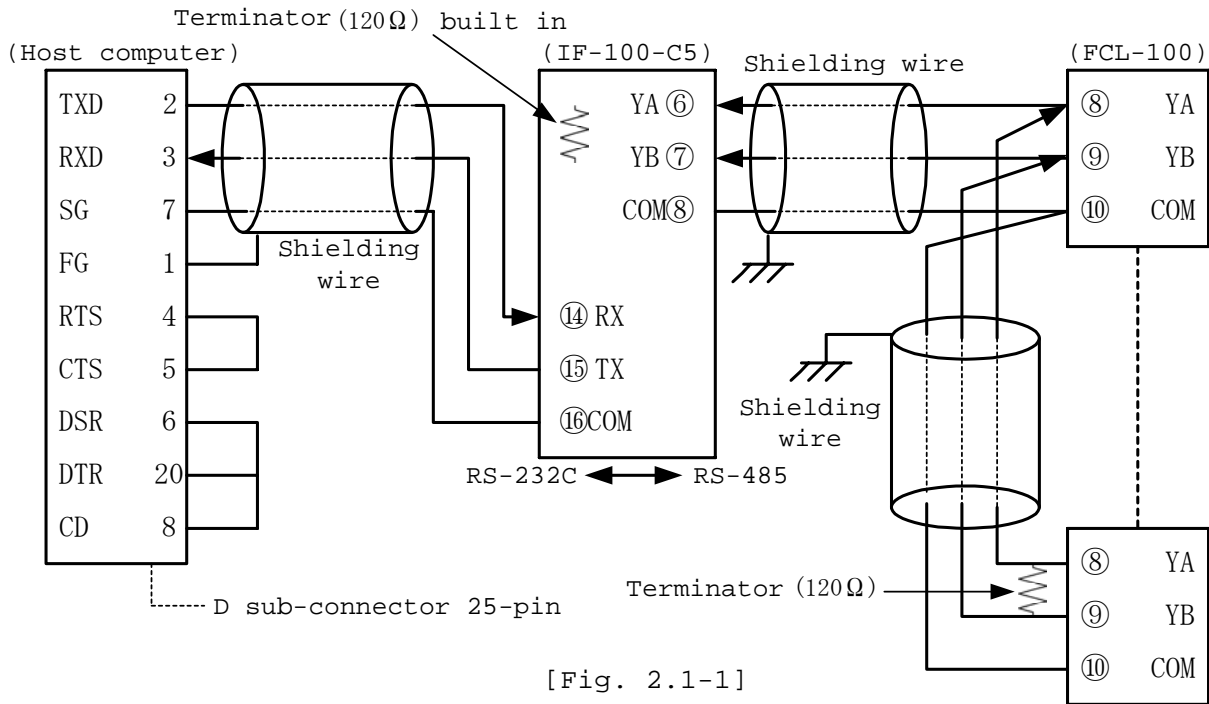
[Fig. 2.1-1]

● In case the converter is IF-100-C5, and between the converter and Host computer is connected by RS-422A.
Connection: RS-422A ◄─► RS-485 (Data transfer rate: 1200, 2400, 4800 or 9600bps)

[Fig. 2.1-2]

2

2.2 Setting value digital transmission

In case the option C5 (RS-485) is applied, connect the wire between the PC-900 and the FCL-100 as shown below figure.
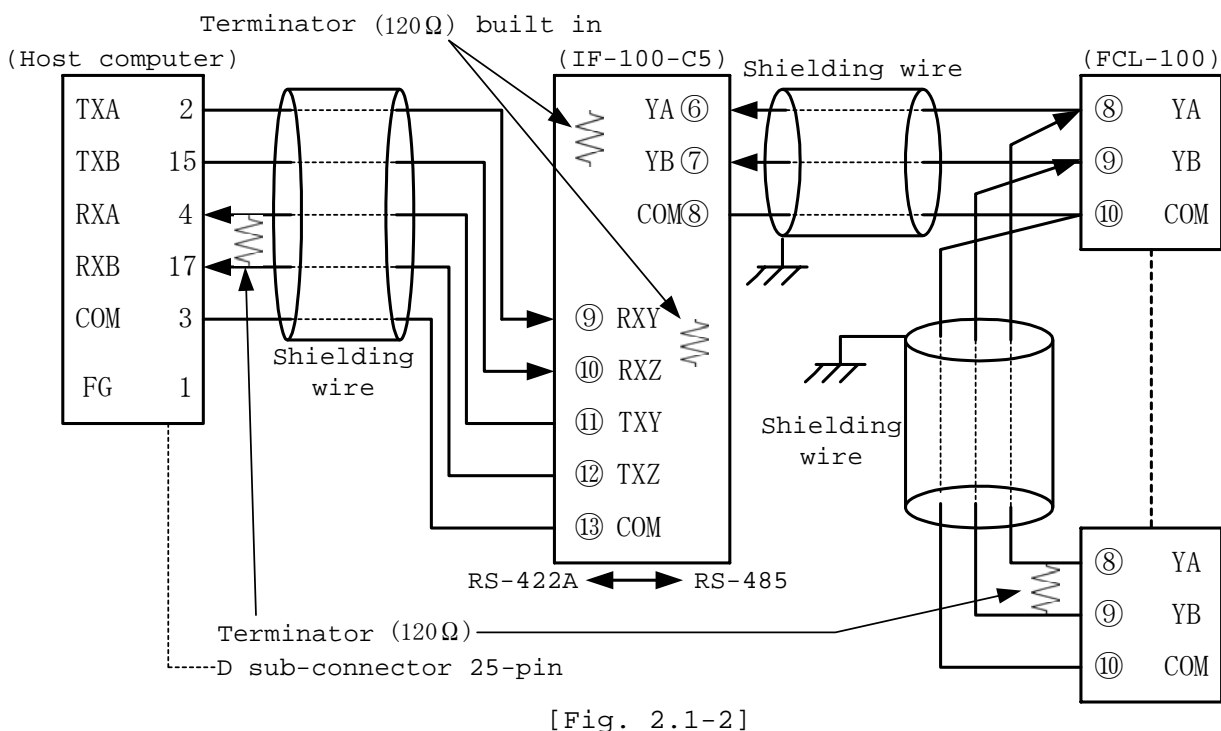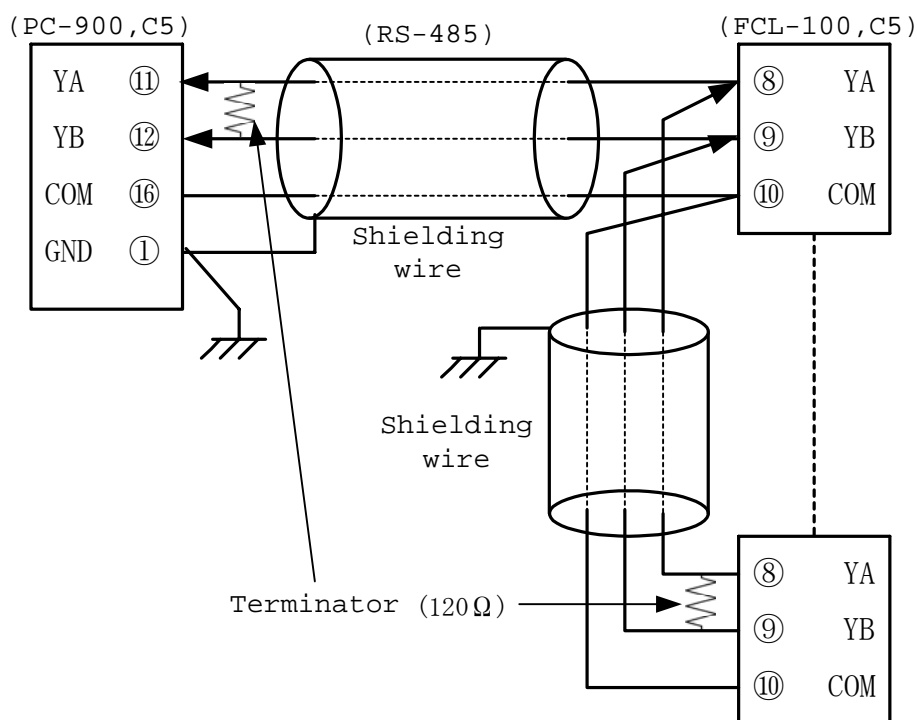

[Fig. 2.3-1]

- **As for the shielding wire**
  - Connect the shielding wire **only one side to** FG or ground terminal so as not to flow the current into the shielding wire.

    If both sides of the wire are connected to the FG or ground terminal, the circuit is made between the wire and ground, and **the noise may easily occur by the current**.
  - The FG or ground terminal must be grounded.

- **As for the terminator (Terminal resistor)**
  - The more the communication line becomes long, the less the communication performs because **the transfer waveform becomes wrong owing to the echo**. To prevent this, connect the terminator.
  - The place to connect should be the physical terminal of the communication cable.

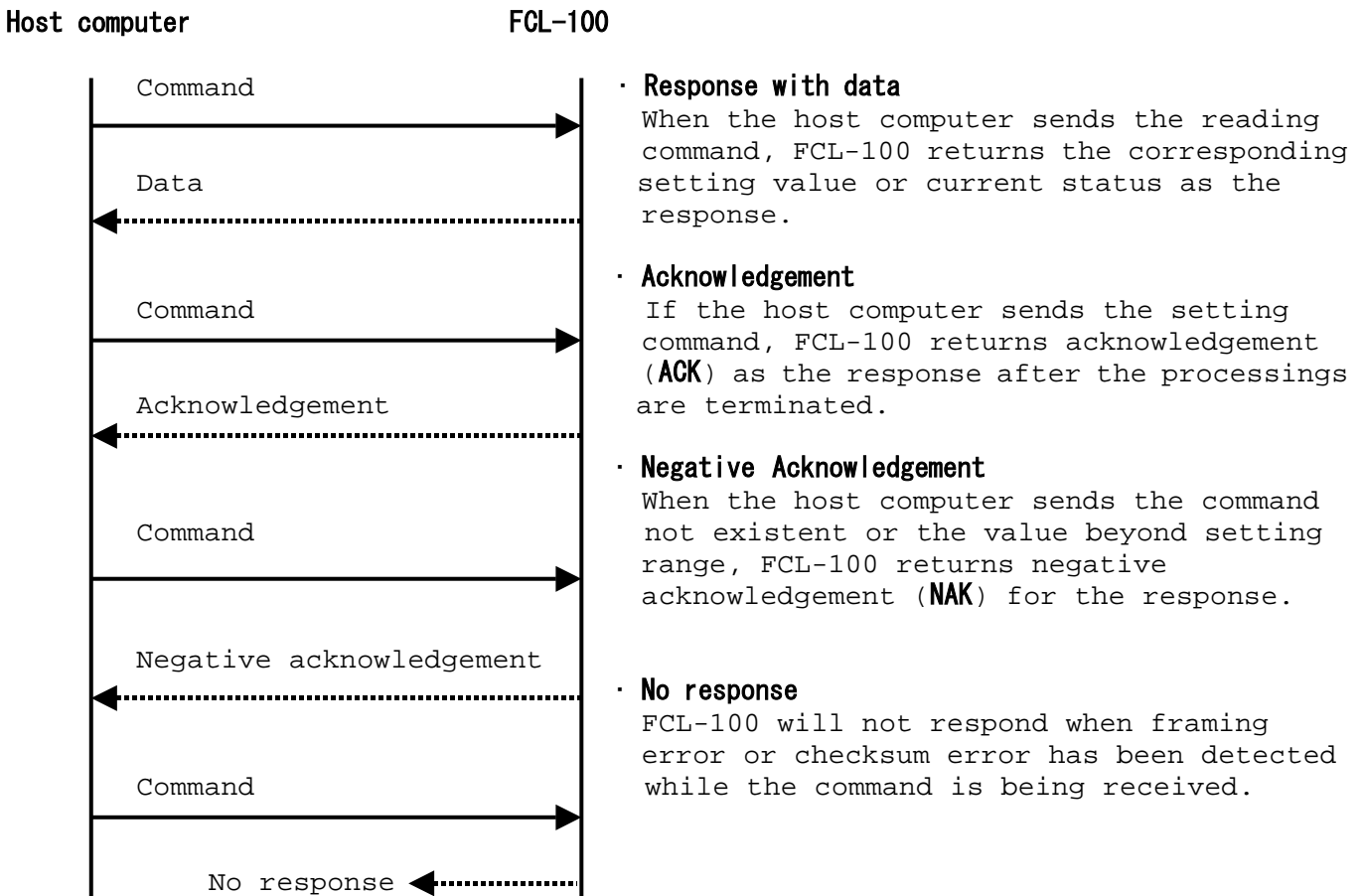- Communication converter of [IF-100-C5] or [IF-300-C5] is provided **on separate sale**.

3. As for the instrument setting
- When communicating by connecting plural FCL-100s in serial communication, the instrument number should be set individually.
- Select the Data transfer rate for the FCL-100 to fit the host computer.
- Refer to the instruction manual of FCL-100 for the instrument number setting and Data transfer rate selection.

4. Communication procedure

RS-485 (Option code: C5)
Communications between a host computer and the FCL-100 are started by sending the command from the host computer, and terminated by receiving the response from the FCL-100.

Host computer   FCL-100

Host computer	FCL-100 side notes
Command →	**· Response with data** When the host computer sends the reading command, FCL-100 returns the corresponding setting value or current status as the response.
Data ←	
Command →	**· Acknowledgement** If the host computer sends the setting command, FCL-100 returns acknowledgement (**ACK**) as the response after the processings are terminated.
Acknowledgement ←	
Command →	**· Negative Acknowledgement** When the host computer sends the command not existent or the value beyond setting range, FCL-100 returns negative acknowledgement (**NAK**) for the response.
Negative acknowledgement ←	
Command →	**· No response** FCL-100 will not respond when framing error or checksum error has been detected while the command is being received.
No response ←	

[Fig. 4-1]

● **Communication timing of RS-485 (Option code: C5)**

· **As to the FCL-100 side**

When the FCL-100 starts transmission to RS-485 communication line, the FCL-100 is arranged so as to provide 1 character transmission period or more of idle status (mark status) to make the synchronous sure on the receiving side.

The FCL-100 is arranged so as to cut the transmitter off from the communication line within the period of 1 character transmission after sending the response.

· **As to the host computer side**

Make the program so that the host computer can provide 1 character transmission period or more of idle status (mark status) before sending the command to make the synchronous sure on the receiving side when the host computer starts the transmission to RS-485 communication line.

Make the program so that the host computer can cut the transmitter off from the communication line within the period of 1 character transmission after sending the command in preparation for reception of the response from the FCL-100.

To avoid the collision of transmission between the host computer and the FCL-100, send the next command after checking that the host computer surely received the response.

> In case the host computer communicates with FCL-100 through the line converter (IF-100-C5, IF-300-C5, sold separately), it is not required to manage the transmission timing described above because the converter takes the timing interpreting the protocol automatically.
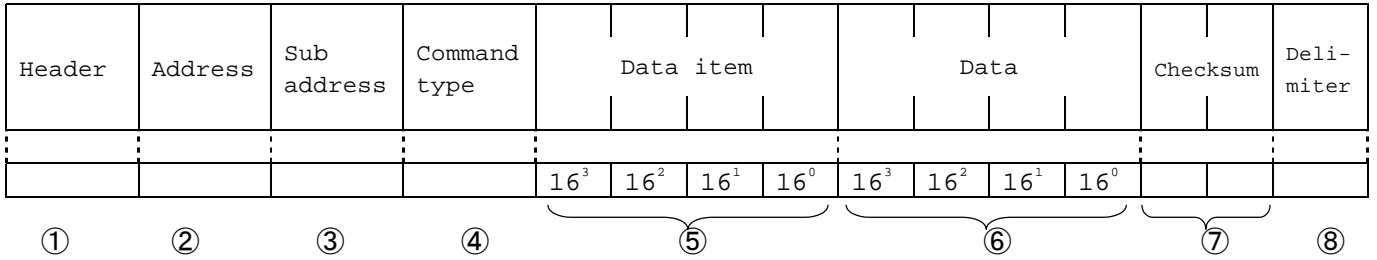
5. Command configuration
5.1 Command configuration

All commands are composed with ASCII codes.
The data (setting value) are converted to Hexadecimal number
and ASCII codes are used for the command.
Negative number is represented by 2's complement.

(1) Command

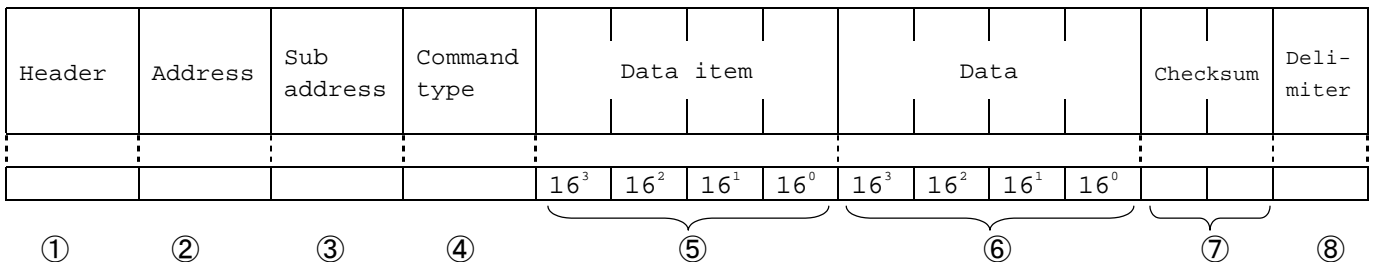| Header	Address	Sub address	Command type	Data item				Data				Checksum	Deli- miter
				16^3	16^2	16^1	16^0	16^3	16^2	16^1	16^0		
①	②	③	④			⑤				⑥		⑦	⑧

[Fig. 5.1-1]

① **Header** : STX(02H fixed), Start of text.
Control code to represent the beginning of the command (text).

② **Address** : Instrument number 0 to 95 (20H to 7FH)
Number by which the host computer discriminates the FCL-100.
The numbers are used by giving 20H of bias (20H to 3FH),
because 0 to 31 (00H to 1FH) are used for control code.
95 (7FH) is called as **Global address,** and is used when sending
the same command to all the FCL-100s connected.
However, the response is not returned.

③ **Sub address** : It is fixed as 20H.

④ **Command type** : Code to discriminate the Reading command or Setting command.
20H, Reading command
50H, Setting command

⑤ **Data item** : It represents the data sort for the command.
It is made up by 4 digits of hexadecimal number.
(Refer to the command table.)

⑥ **Data** : The contents of the data differ by the setting command.
It is made up by 4 digits of hexadecimal number.
(Refer to the command table.)
Reading command has no data.

⑦ **Checksum** : 2-character of data to detect the communication error.

⑧ **Delimiter** : ETX (03H, fixed), End of text.
Control code to represent the ending of the command (text).

(2) Response to the command
· Response with data (Response to the reading command)

Header	Address	Sub address	Command type	Data item				Data				Checksum	Deli- miter
				16^3	16^2	16^1	16^0	16^3	16^2	16^1	16^0		
①	②	③	④			⑤				⑥		⑦	⑧

[Fig. 5.1-2]

① **Header** : ACK(06H, fixed), [Acknowledgement].
Control code to represent the beginning of the response.

② **Address** : It represents the instrument number 0 to 95 (20H to 7FH).
The same code as the received command is used for the response.

③ **Sub address** : It is fixed as 20H

④ **Command type** : Code to discriminate the reading or setting command.
20H, Reading command
50H, Setting command
The same code as the received command is used for the response.

⑤ **Data item** : It represents the data sort for the command.
It is made up by 4 digits of hexadecimal number.
(Refer to the command table.)
The same code as the received command is used for the response.

⑥ **Data** : The contents of the data differ by the reading command.
It is made up by 4 digits of hexadecimal number.
(Refer to the command table.)

⑦ **Checksum** : 2-character of data to detect the communication error.

⑧ **Delimiter** : ETX (03H, fixed), End of text.
Control code to represent the ending of the response.

● **Acknowledgement**

Header	Address	Checksum	Delimiter

①   ②   ③   ④
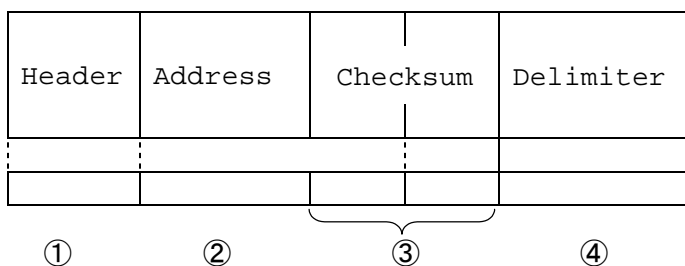[Fig. 5.1-3]

① **Header** : ACK(06H fixed), Acknowledgement.
Control code to represent the beginning of the response.

② **Address** : It represents the instrument number 0 to 95 (20H to 7FH).
The same code as the received command is used for the response.

③ **Checksum** : 2-character of data to detect the communication error.

④ **Delimiter** : ETX (03H, fixed), End of text.
Control code to represent the ending of the response.

● **Negative acknowledgement**

Header	Address	Error code	Checksum	Delimiter

①   ②   ③   ④   ⑤
[Fig. 5.1-4]

① **Header** : NAK(15H fixed), [Negative acknowledgement].
Control code to represent the beginning of the response.

② **Address** : It represents the instrument number 0 to 95 (20H to 7FH).
The same code as the received command is used for the response.

③ **Error code**: It represents the type of error.
It is made up by 1 digit of hexadecimal number.
1 (31H) When it is the command not existent
2 (32H) Not used
3 (33H) When setting beyond the settable range
4 (34H) When the status is not settable [Auto-tuning].
5 (35H) During the setting mode by key operation.

④ **Checksum** : 2-character of data to detect the communication error.

⑤ **Delimiter** : ETX (03H, fixed), End of text.
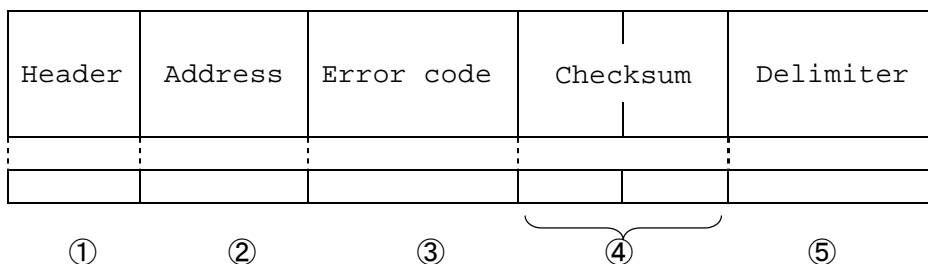Control code to represent the ending of the response.
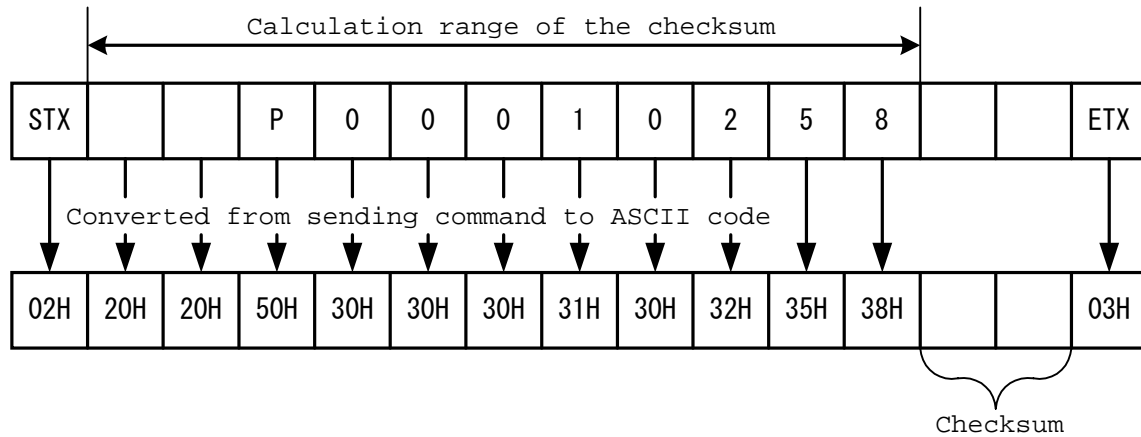
5.2 Checksum calculation

Checksum is used to detect the receiving error of the command or data.
Make the program for the host computer side as well to calculate the checksum
of the response data from the FCL-100 to check the communication error.

ASCII code (hexadecimal) corresponding to the character from the address
(instrument number) to the character front of the checksum is converted to
binary notation, and the total value is made.
The lower 2-digit of the total value are converted to 2's complements and
further to hexadecimal, that is, ASCII code. This is the checksum.

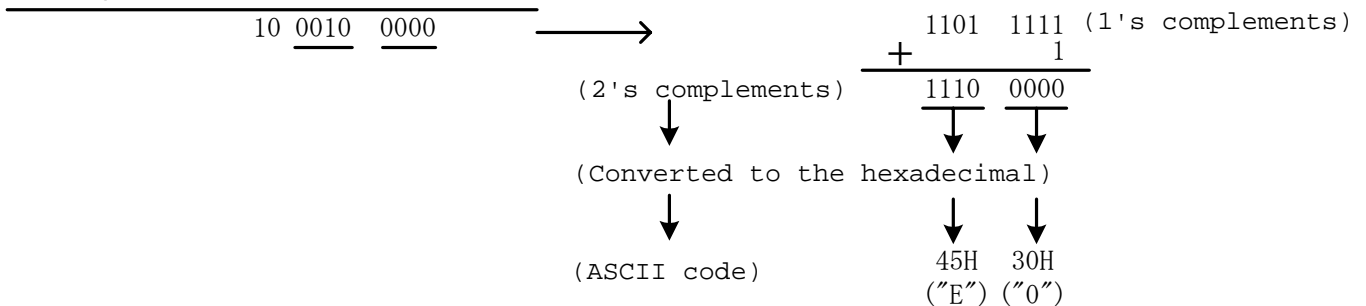Refer to the following example procedure.

● Checksum calculation example is shown as follows.
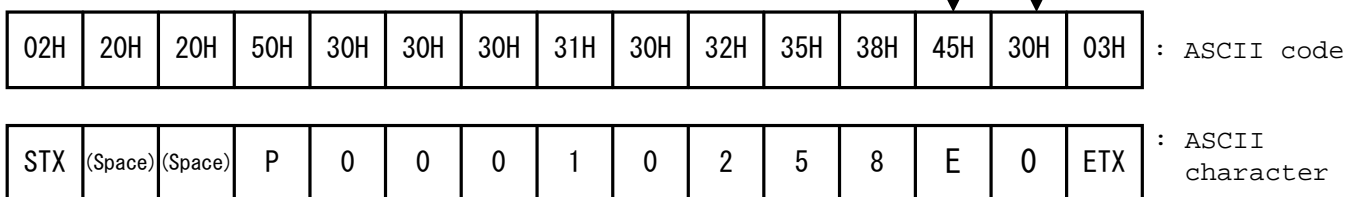   Main setting value: 600℃ (Fixed value control)
   Instrument number : 0 (20H)

```
                Calculation range of the checksum
    <--------------------------------------------------------->
   | STX |     |     |  P  |  0  |  0  |  0  |  1  |  0  |  2  |  5  |  8  |     |     | ETX |
     |     |     |     |     |     |     |     |     |     |     |     |                 |
     Converted from sending command to ASCII code
     v     v     v     v     v     v     v     v     v     v     v     v                 v
   | 02H | 20H | 20H | 50H | 30H | 30H | 30H | 31H | 30H | 32H | 35H | 38H |     |     | 03H |
                                                                      _____/
                                                                       Checksum
```

[Hexadecimal]	[Binary notation]
20H	0010 0000
20H	0010 0000
50H	0101 0000
30H	0011 0000
30H	0011 0000
30H	0011 0000
31H	0011 0001
30H	0011 0000
32H	0011 0010
35H	0011 0101
+ 38H	0011 1000

```
        10 0010 0000    ----->
```

1's complements:
   Make each bit of binary 0 and 1 reverse.
2's complements:
   Add 1 to the 1's complements.

```
                                        1101  1111  (1's complements)
                                     +          1
                                       ----------------
          (2's complements)            1110  0000
                                          v     v
          (Converted to the hexadecimal)
                                          v     v
          (ASCII code)                   45H   30H
                                         ("E") ("0")
```

[Code to be transmitted]

02H	20H	20H	50H	30H	30H	30H	31H	30H	32H	35H	38H	45H	30H	03H	: ASCII code

STX	(Space)	(Space)	P	0	0	0	1	0	2	5	8	E	0	ETX	: ASCII character

6. Contents of the command
6.1 Notices for setting and reading command

- Though lock mode is designated by Setting value lock, the setting by setting command is effective.

- Even if the option is not applied, it is possible to set by setting command, however, the setting is ineffective.

- The life of memory is approximately 10 000 000 (ten million) in number of times of writing. If the number of times exceeds the limit, it cannot memorize the data.

- When connecting plural FCL-100s, the same instrument numbers should not be applied to the plural FCL-100s.

- When sending the command by Global address [95 (7FH)], the same command is sent to all FCL-100s connected. However, the response is not returned.

- The instrument number and Data transfer rate of FCL-100 cannot be set by communication. Set them by front key operations of the FCL-100.

● **As to setting command**
- The settable range is the same as key operation. Refer to the Command table for the communication command.

- All commands are composed with ASCII codes.

- The data (setting value) is converted to hexadecimal number, and ASCII code is used. Negative number is represented by 2's complement.

- When the data (setting value) has a decimal point, make the value 10 times as much value as the setting.

● **As to reading command**
- All commands are composed with ASCII codes.

- The data (setting value) is converted to hexadecimal number, and ASCII code is used. Negative number is represented by 2's complement.

- When the setting value has a decimal point, it returns the value by making 10 times as much value as the setting.

6.2 Command table
- Table below describes ⑤ Data item, ⑥ Data and ④ Command type.
  When the setting value for the data has a decimal point, make the value 10 times as much value as the setting and convert to hexadecimal.

Data item		Data	Command type
0001H	Main setting 1	Setting value	20H/50H
0002H	Main setting 2	Setting value	20H/50H
0003H	PID auto-tuning Performance/Cancellation, or PD Auto-reset Performance **(Auto-reset can be performed only when temperature is within the proportional band, however, cancelled automatically in 4 minutes after start.)**	0000H: Cancellation 0001H: Performance	20H/50H
0004H	Proportional band setting	Setting value	20H/50H
0006H	Integral time setting	Setting value	20H/50H
0007H	Derivative time setting	Setting value	20H/50H
0008H	Proportional cycle setting	Setting value	20H/50H
000BH	Temperature alarm setting	Setting value	20H/50H
000FH	Heater burnout alarm setting	Setting value	20H/50H

	Data item	Data	Command type
0010H	Loop break alarm action time setting	Setting value	20H/50H
0011H	Loop break alarm action span setting	Setting value	20H/50H
0012H	Setting value lock selection. **When lock mode 3 is selected, set data is not saved in the memory. By power supply OFF, the setting value returns to the former one.**	0000H: Unlock 0001H: Lock 1 0002H: Lock 2 0003H: Lock 3	20H/50H
0013H	Main setting value high limit setting	Setting value	20H/50H
0014H	Main setting value low limit setting	Setting value	20H/50H
0015H	Sensor correction setting	Setting value	20H/50H
001BH	PV filter time constant setting	Setting value	20H/50H
001CH	Output high limit setting	Setting value	20H/50H
001DH	Output low limit setting	Setting value	20H/50H
001EH	Output ON/OFF hysteresis setting	Setting value	20H/50H
0023H	Temperature alarm action type selection. **If temperature alarm action type is changed, the alarm setting value becomes 0, and alarm output status is initialized.**	0000H: No action 0001H: High limit 0002H: High limit with standby 0003H: Low limit 0004H: Low limit with standby 0005H: High and low limits 0006H: High and low limits with standby 0007H: Within high and low limit range 0008H: Within high and low limit range with standby 0009H: Process high alarm 000AH: Process high alarm with standby 000BH: Process low alarm 000CH: Process low alarm with standby	20H/50H
0025H	Temperature alarm hysteresis setting	Setting value	20H/50H
0029H	Temperature alarm action delayed timer setting	Setting value	20H/50H
0033H	Main setting value rising rate setting	Setting value	20H/50H
0034H	Main setting value falling rate setting	Setting value	20H/50H
0037H	Control output OFF function setting	0000H: PV or SV display 0001H: OFF display	20H/50H
0040H	Temperature alarm Energized/De-energized setting	0000H: Alarm energized 0001H: Alarm de-energized	20H/50H

Data item		Data	Command type
0044H	Sensor type selection	0000H: K　　　　　　　　　℃ 0001H: J　　　　　　　　　℃ 0002H: PL-Ⅱ　　　　　　　℃ 0003H: N　　　　　　　　　℃ 0004H: E　　　　　　　　　℃ 0005H: Pt100　　　　　　　℃ 　　　　(with decimal point) 0006H: JPt100　　　　　　℃ 　　　　(with decimal point) 0007H: Pt100　　　　　　　℃ 0008H: JPt100　　　　　　℃ 0009H: K　　　　　　　　　℉ 000AH: J　　　　　　　　　℉ 000BH: PL-Ⅱ　　　　　　　℉ 000CH: N　　　　　　　　　℉ 000DH: E　　　　　　　　　℉ 000EH: Pt100　　　　　　　℉ 　　　　(with decimal point) 000FH: JPt100　　　　　　℉ 　　　　(with decimal point) 0010H: Pt100　　　　　　　℉ 0011H: JPt100　　　　　　℉	20H/50H
0045H	Output Direct/Reverse action change	0000H: Reverse action 0001H: Direct action	20H/50H
0046H	Event output function setting. **Heater burnout alarm function (0002H) is effective only when the option is applied.**	0000H: Alarm function 0001H: Loop break alarm function 0002H: Heater burnout alarm function	20H/50H
0047H	Auto-tuning bias setting	Setting value	20H/50H
0070H	Clearing the key operation change flag	0000H: Not processed 0001H: All clearing	50H
0080H	Current PV reading	Current PV (Process variable)	20H
0081H	Current MV reading	Current MV (Manipulating value)	20H
0083H	Current SV reading	Current SV (Setting value)	20H
0085H	Current output status reading. **Items below are not applicable to 2^{15} digit.** **・Instrument number setting** **・Data transfer rate setting** **・PV/SV display changing** **・MV display mode**	$\underline{0000}$ $\underline{0000}$　$\underline{0000}$ $\underline{0000}$ 2^{15}　　　　to　　　　2^{0} 2^{0} digit: Main control output 　　　　0: OFF, 1: ON 　　**(Current output unfixed)** 2^{1} digit: Always 0 2^{2} digit: Alarm output 　　　　0: OFF, 1: ON 2^{3} digit: Always 0 2^{4} digit: Always 0 2^{5} digit: Always 0 2^{6} digit: Heater burnout alarm 　　　　output 　　　　0: OFF, 1: ON 2^{7} digit: Loop break alarm output 　　　　0: OFF, 1: ON 2^{8} digit: Upscale 　　　　0: OFF, 1: ON 2^{9} digit: Downscale 　　　　0: OFF, 1: ON 2^{10} to 2^{14} digit: Always 0 2^{15} digit: Changed or Not changed 　　by key operation. 　　0: Not changed 　　1: Changed	20H

● Data items below (00A0H to 00A3H) are to know the specification of the instrument on the monitoring software.

Data item		Data	Command type
00A0H	Reading the software version of instrument	Numerical value	20H

00A1H	Reading the specification 1 of instrument	0000 0000 0000 0000
		2^{15} to 2^{0}
		2^{0} digit: Always 0
		2^{1} digit: Always 0
		2^{2} digit: Alarm applied or not
		    0: Not applied
		    1: Applied
		2^{3} to 2^{5} digit: Not used,
		    always 0
		2^{6} digit: Heater burnout alarm
		    applied or not
		    0: Not applied
		    1: applied
		2^{7} digit: Loop break alarm
		    applied or not
		    0: Not applied
		    1: applied
		2^{8} digit: Always 0
		2^{9} to 2^{15} digit: Always 0
			20H

00A2H	Reading the specification 2 of instrument	0000 0000 0000 0000
		2^{15} to 2^{0}
		2^{0} to 2^{2} digit: Model name
		    0(000): XXD
		    1(001): XXR
		    2(010): XXM
		    3(011): XXS
		    4(100): XXL
		2^{3} to 2^{4} digit: Output type
		    0(00) : R/
		    1(01) : S/
		    2(10) : A/
		2^{5} to 2^{15} digit: always 0
			20H

00A3H	Reading the data item changed by key operation. **The data item code changed by key operation is read.** **If plural items are changed, the lowest value of data item code is read.** **the data item code is cleared after being read.**	Data item code When none of items is changed: 0(0000H)	20H

7. Specifications

```
Communication system: Half-duplex
Data transfer rate  : 9600bps (2400, 4800, 9600, 19200bps)
                       Selectable by key operation.
Synchronous system  : Start-stop
Code form           : ASCII
Error detection     : Parity check, Checksum
Error correction    : Command request repeat system
Data format         : Start bit  1
                       Data bit   7
                       Parity     Even parity
                       Stop bit   1
```

Start bit	Data bit	Parity	Stop bit

8. When troubled

When troubled, make sure the following items after checking the power supply of the host computer and the FCL-100.

● Phenomenon: It is unable to communicate.

Check the follows
The connection.
The burnout or imperfect contact on the communication cable and the connector.
Data transfer rate of the FCL-100 and the Host computer.
The data bit, parity, stop bit, etc. of the Host computer whether they accord with the FCL-100.
The instrument number of the FCL-100 and the command.
The instrument number whether used in plural FCL-100s.
When communicating by RS-485 (option:C5) without IF-100-C5 or IF-300-C5 (communication converter), make sure that the program is proper for the transmission timing.

● Phenomenon: Though it is able to communicate, 'NAK' is responded.

Check the follows
The command code is surely existent or not.
The setting range if it exceeds or not on the setting command.
In case of the situation being unable to set (such as AT is being carried out).
The operation mode whether being under the setting mode by the key operation.

If happened unclear phenomenon other than the above mentioned, make inquiries about the matters at our agency or your shop where purchased.