
Instruction Manual

**Flow Control System
FCS Thermal Series**

FCST1000

**Command Reference
(RS 485 Communication)**



Please read this manual carefully before using the product for proper operation.

Fujikin Incorporated



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For Your Safety

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For Your Safety

■ Introduction

Thank you for purchasing the thermal based flow controller, “FCST1000”. To fully familiarize you with the equipment, gain the most from it and above all, ensure absolute safety in use and handling, read this manual before using the product.

■ Graphical Warnings Used in This Text

This manual uses the below graphical conventions to alert you to warnings, cautions and other notes important towards the safe use of this equipment.



WARNING

Items so marked alert you to potential dangers. Failure to abide by these warnings can result in serious accident or even death.



CAUTION

Items so marked alert you as to potential dangers. Failure to abide by these precautions can result in minor injury or damage to property including this product.



Items so marked offer valuable information on how to use this product safely and comfortably.

The contents of this manual are subject to change without prior notice.

Every effort has been made to prepare and produce this manual, however should you notice anything incorrect, missing or otherwise strange, contact Fujikin Inc.

For your safety, follow the instructions shown below



Safety Precautions

[WARNING]

(1) Do not disassemble or reconfigure the product.



Unauthorized disassembly and reconfiguration can hinder performance of the FCS-T1000 and cause device failure and damage. Before disassembling or reconfiguring the FCS-T1000, contact the Fujikin representative.

(2) Operate the product within the specified power supply voltage range.



Operate outside of specified voltage range can cause the device failure and/or damage.

(3) Wire the product as specified in this manual.



Improper wiring can cause the device failure and/or fire.

[CAUTION]

- (1) **The FCST1000 is built with precision electronic and mechanical parts. Do not drop it or subject it to strong impacts.**



Drops and strong impacts can cause device failure and/or damage.

- (2) **Shut OFF the primary power supply before connecting or disconnecting external connectors.**



Connecting and disconnecting the external connector with Power-ON can cause device failure.

- (3) **“Warranty Label” is attached on the product. The warranty shall be void if there is any indication of peeling off the label.**

Follow these warnings and cautions for safe and proper use of the product. Also, each item is explained at the following chapters of this manual. Read carefully to understand each item for proper use.

1. Overview

FCST1000 is controlled by RS485 communication standard.

Controller (Master) send the command to FCST1000 (Slave) to execute a MFC basic operation, such as changing the flow rate setting or reading out the flow rate output, and additional functions, such as alarm functions, and accumulation flow rate functions. Electric wiring can be simplified by using a digital communication. Using RS485 will increase noise resistance properties.

2. Communication Specifications

Communication specifications of FCST1000 are in the table below.

Item	Contents
Communications standard	EIA Standard, RS485
Connection method	Two-wire, half duplex multi drop system
Communication distance	1.2Km maximum, depending on the environment
Synchronization method	Start-stop synchronization
Baud rate (bps)	9600, 38400, 57600, 115200 Default setting is 38400.
Data format	Start Bit: 1bit Data Bit: 8bit Parity Bit: None Stop Bit: 1bit
Transmission control procedure	Polling/Selecting
Maximum number of units that can be connected	127 units
Control character	STX: 0x02 ACK: 0x06 NAK: 0x16 Text data (gas name, etc) is output by ASCII code.

3. Connection

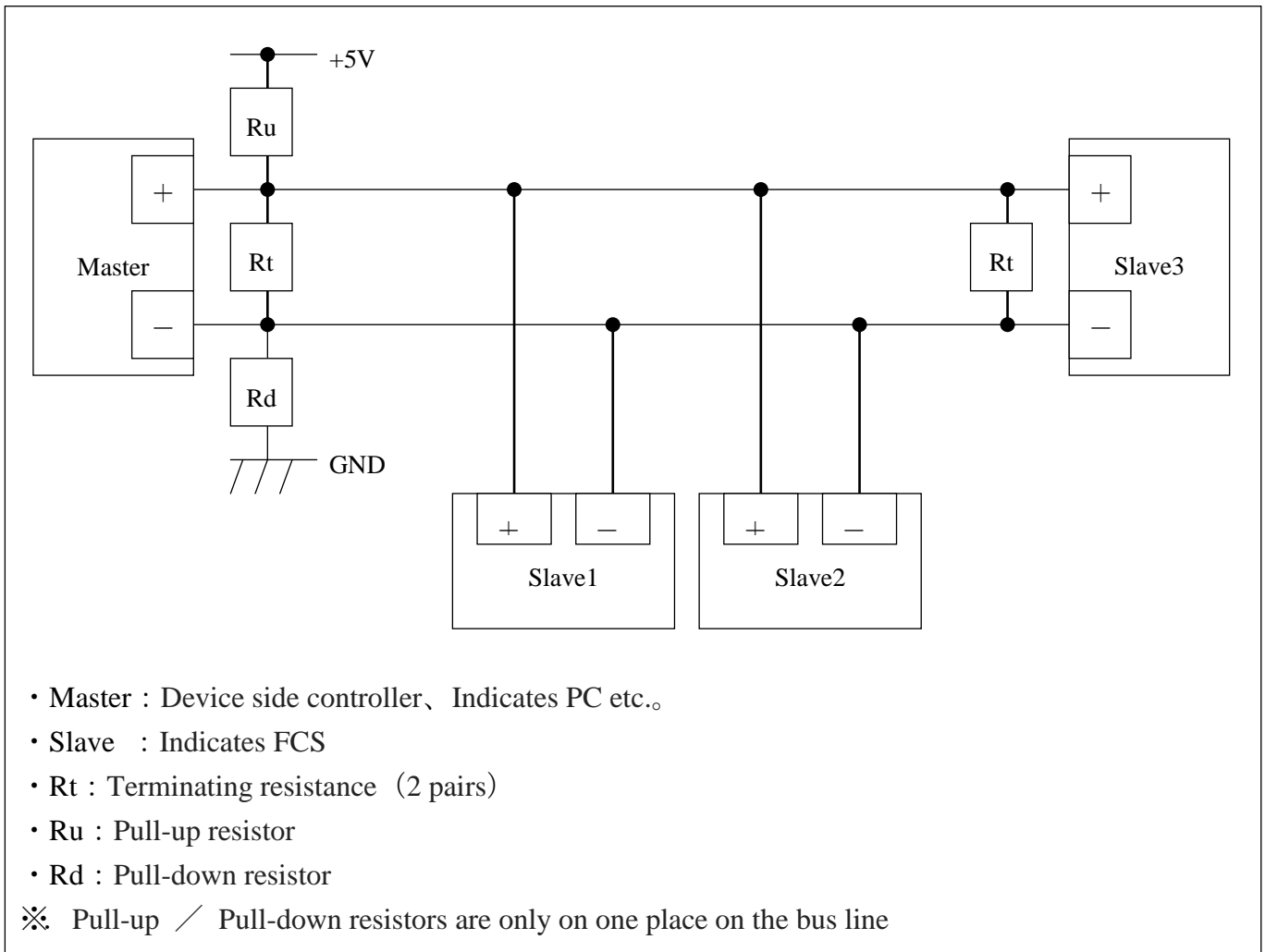
Pull up / About pull-down resistor

RS485 requires a voltage difference of at least 200 mV between signal + and signal -.

By attaching a pull-up / pull-down resistor so that the voltage across the terminating resistor is at least 200 mV or more, Signal is either High level or Low Level.

(Stabilize the signal)

- When signal + is 200 mV higher than signal - \Rightarrow signal High
- When signal + is 200 mV lower than signal - \Rightarrow signal Low



Reference value of pull-up / pull-down resistor。

When the terminating resistor is set to 120 Ω , $R_u=680\Omega$, $R_d=680\Omega$

Command Format

4.1. Basic Format

Master send command messages to Slave in the following order.

Order	Contents
1	Slave MAC ID (0x21 ~ 0x9F)
2	STX (0x02)
3	Command Code
4	Packet Length
5	Class ID
6	Instance ID
7	Attribute ID
8	Data x n Byte (0~20 Byte)
9 + n	Pad (0x00)
10 + n	Checksum

Slave response to Master in the following order.

Order	Contents
1	Master MAC ID (0x00)
2	STX (0x02)
3	Command Code
4	Packet Length
5	Class ID
6	Instance ID
7	Attribute ID
8	Data x n Byte (0 ~ 20Byte)
9 + n	Pad (0x00)
10 + n	Checksum

Data content of each item is 1ByteData.

Slave returns the above responses if data exists.

If data does not exist, slave returns “ACK (=0x06)” as the response.

If commands from Master have errors, slave returns “NAK (=0x16)” as the response.

4.1.1. MAC ID

MAC ID is an individually controlled number that connects all Slave (FCS) on the communication cable.

Slave (FCS) is assigned any of the 127 MAC ID from 0x21 to 0x9F.

Same MAC ID cannot be assigned on the single communication line.

MAC ID for Master is fixed 0x00.

MAC ID	Contents
0x00	MAC ID assigned for Master
0x21 ~ 0x9F	MAC ID for Slave (FCS), default setting is 0x21
0xFF	Master enable to send the command to Slave (FCS) regardless of the MAC ID. This MAC ID is use when Master connects to Slave (FCS) one on one.

4.1.2. STX

STX shows the beginning of command contents and is fixed 0x02

4.1.3. Command Code

Command codes assign the operating contents of command.

Command	Contents
0x80	Read command, which is use when getting the data from Slave (FCS).
0x81	Write command, which is use when setting the data to Slave (FCS). It is also use the Zero Point Adjustment command and Reset command.

4.1.4. Packet Length

Packet length shows the total amount of data of Class ID, Instance ID, and Attribute ID.

4.1.5. Class ID, Instance ID, and Attribute ID

Those ID assign the command contents. Refer to item 8.

4.1.6. Data

Number of data is changed by the command. Refer to item 8.

4.1.7. Pad

Pad shows the end of command contents and is fixed 0x00.

4.1.8. Checksum

Input the sum of STX, Command Code, Packet Length, Class ID, Instance ID, Attribute ID, and Data to Increase the reliability of command message.

Example) Flow rate setting command

When we set the flow rate setting value 0x8CCD to MAC ID: 0x21 Slave,

Sum STX=0x02, Command Code=0x81, Packet Length =0x05, Class ID=0x69, Instance ID=0x01, Attribute

ID=0xA4, Data1=0xCD, and Data1=0x8C.

Checksum = 0x02 + 0x81 + 0x05 + 0x69 + 0x01 + 0xA4 + 0xCD + 0x8C

= 0x2EF

=> 0xEF

※ Checksum is 1 ByteData, so more than 255 (0xFF) of data is deleted.

4.2. Data Transfer Sequence

4.2.1. 1Byte Data

Sequence	Data Contents
1	MAC ID
2	STX (=0x02)
3	Command Code
4	Packet Length (=0x04)
5	Class ID
6	Instance ID
7	Attribute ID
8	Data
9	Pad (=0x00)
10	Checksum

4.2.2. 2 Byte Data

Sequence	Data Contents
1	MAC ID
2	STX (=0x02)
3	Command Code
4	Packet Length (=0x05)
5	Class ID
6	Instance ID
7	Attribute ID
8	Data (LSB)
9	Data (MSB)
10	Pad (=0x00)
11	Checksum

Example) Transfer sequence of data 0x1234

Low data (LSB) of 0x34 is transferred eighth and high data (MSB) of 0x12 is transferred ninth.

4.2.3. 4Byte Data

Sequence	Data Contents
1	MAC ID
2	STX (=0x02)
3	Command Code
4	Packet Length (=0x07)
5	Class ID
6	Instance ID
7	Attribute ID
8	Data (LSB)
9	Data
10	Data
11	Data (MSB)
12	Pad (=0x00)
13	Checksum

Example) Transfer sequence of data 0x12345678

Data is transferred the following sequence: Low data (LSB) of 0x78 is eighth, 0x56 is ninth, 0x34 is tenth, and high data (MSB) of 0x12 is eleventh.

4.2.4. Character Data (ex. “ABCDE”)

Sequence	Data Contents
1	MAC ID
2	STX (0x02)
3	Command Code
4	Packet Length
5	Class ID
6	Instance ID
7	Attribute ID
8	“A” (0x41)
9	“B” (0x42)
10	“C” (0x43)
11	“D” (0x44)
12	“E” (0x45)
13	Pad (0x00)
14	Checksum

4.2.5. Floating Point Data REAL (4Byte)

Sequence	Data Contents
1	MAC ID
2	STX (=0x02)
3	Command Code
4	Packet Length (=0x07)
5	Class ID
6	Instance ID
7	Attribute ID
8	Data (LSB)
9	Data
10	Data
11	Data (MSB)
12	Pad (=0x00)
13	Checksum

Example) Transfer sequence of data “3F800000” (=1.0)

Data is transferred the following sequence: Low data (LSB) of 0x00 is eighth, 0x00 is ninth, 0x80 is tenth, and high data (MSB) of 0x3F is eleventh.

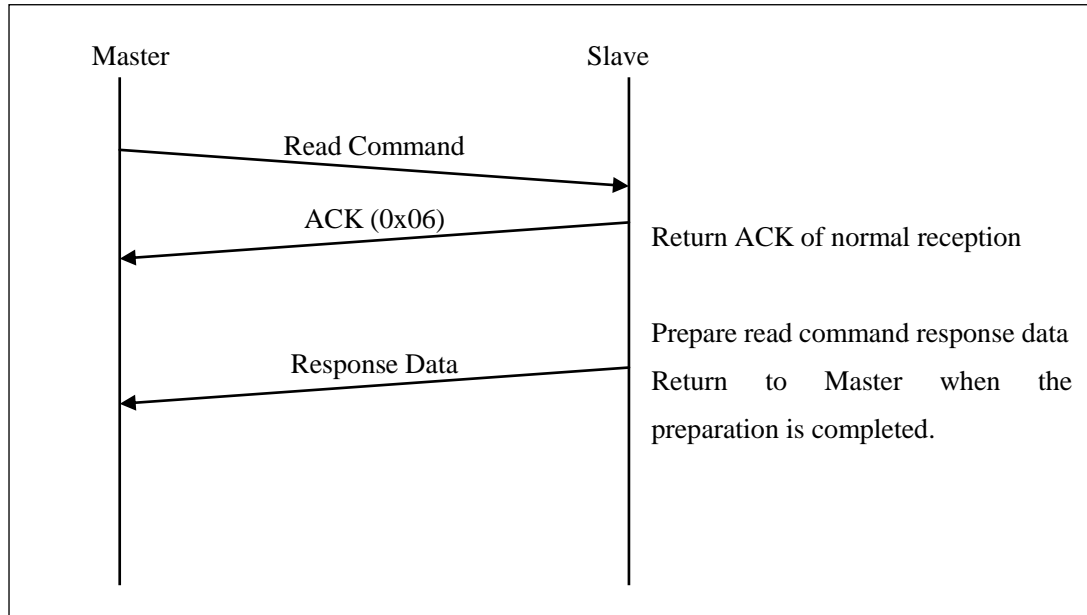
5. Communication Protocol

Communication protocol of Master and Slave is the following.

5.1. Read Command Message

When Slave (FCS) receives Read Command Messages from Master, Slave (FCS) checks the message format and Checksum, and returns ACK (=0x06) to Master if no error.

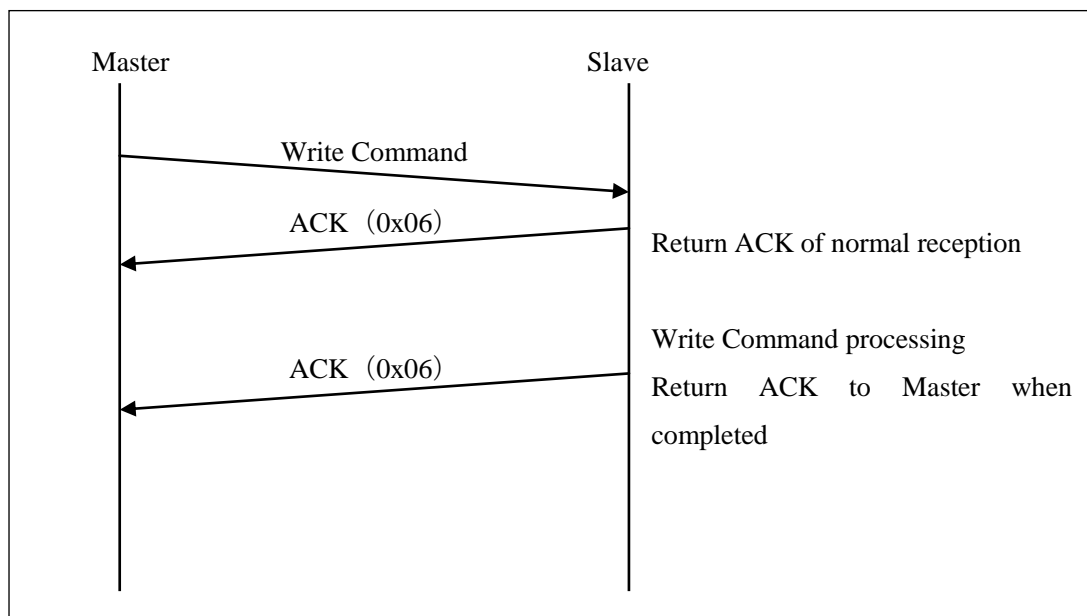
Then Slave (FCS) checks the message contents and sends Response Data to Master if no error.



5.2. Write Command Message

When Slave (FCS) receives Read Command Messages from Master, Slave (FCS) checks the message format and Checksum, and returns ACK (=0x06) to Master if no error.

Then Slave (FCS) checks the message contents and sends ACK (=0x06) to Master if no error.

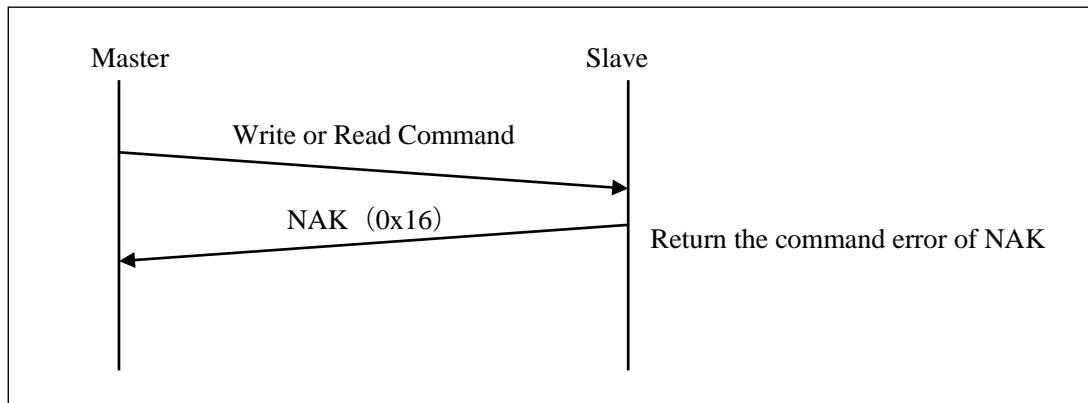


5.3. Processing of Read Command or Write Command with error

5.3.1. Errors in Command Message Format or Checksum

When Slave (FCS) receives Read Command Messages or Write Command Messages from Master, Slave (FCS) checks the message format and Checksum.

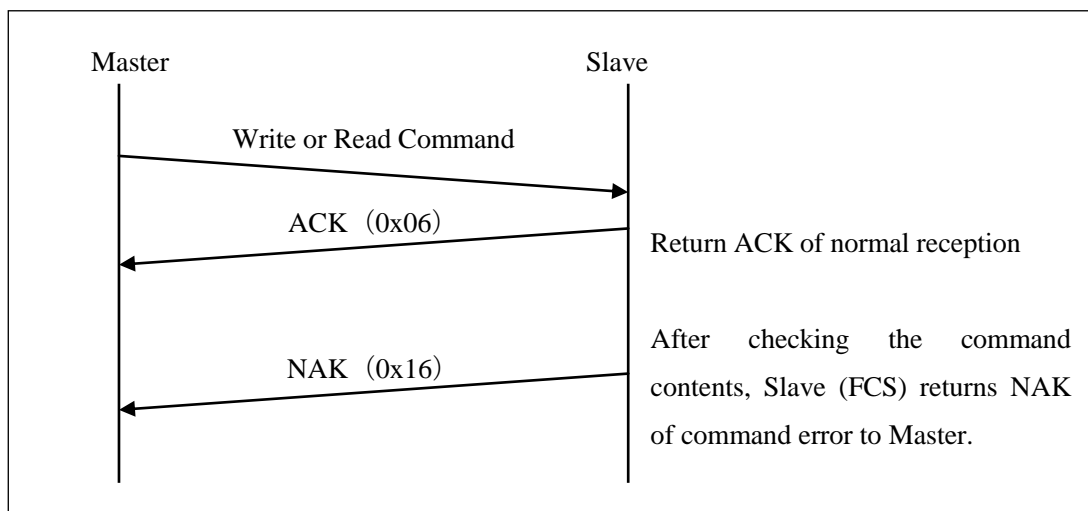
If they contain errors, Slave (FCS) returns NAK (=0x16) to Master.



5.3.2. Errors in Command Contents

When Slave (FCS) receives Read Command Messages or Write Command Messages from Master, Slave (FCS) checks the message format and Checksum and returns ACK (=0x06) to Master if no error.

If they contain errors in command contents and/or data, Slave (FCS) returns NAK (=0x16) to Master.



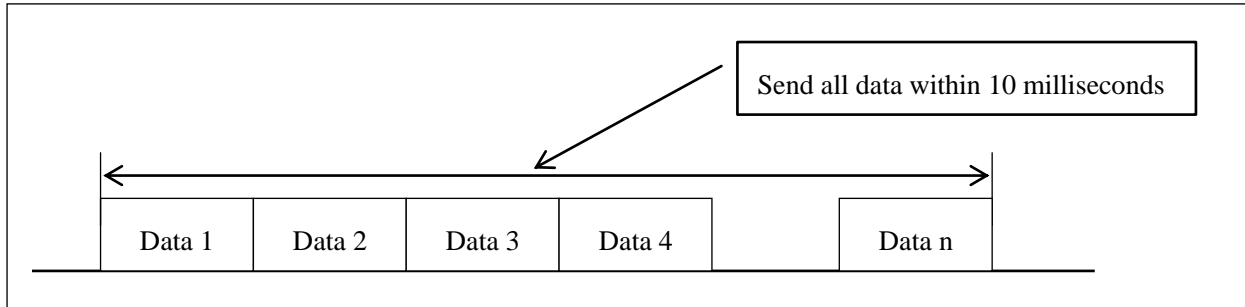
6. Communication Timing

Please create software of Master to meet all the following requirements when communicating in between Master and Slave.

6.1. Character Spacing

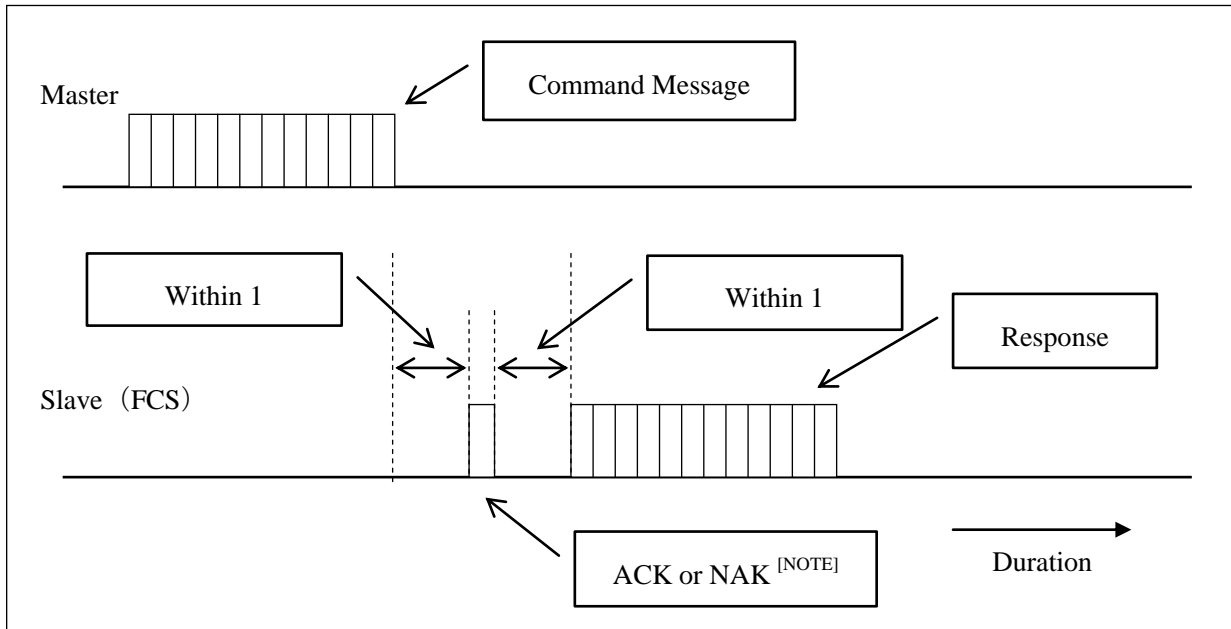
Please send the data continuously. Slave (FCS) waits for 10 milliseconds after receiving the initial data, MAC ID. Please complete sending all data within the duration.

Slave (FCS) will delete all data if it fails to receive the data within 10 milliseconds.



6.2. Duration to return to Master

Slave (FCS) returns ACK (=0x06) or NAK (=0x16) to Master within 1 millisecond of receiving the command. Only when Slave (FCS) returns ACK (=0x06) to Master, it starts sending the response data within 1 millisecond.



[NOTE] When Slave (FCS) returns NAK, no further response will be sent.

7. Command Message

Following tables show the command messages used in FCST1000 series.

Abbreviations and meanings

Access Rule	r: Read only, w: Write only, r/w Read and Write
NV(Non-Volatile)	NV: Write on nonvolatile memory. Data is saved when power is off. V: Volatile data. Data is deleted when power is off. --: Write operations are not allowed in memory.
Data Type	UINT8: Unsigned 8bit (1Byte) data, UINT16: Unsigned 16bit (2Byte) data UINT32: Unsigned 32bit (4Byte) data TEXT: Text data (ASCII code), REAL: Floating point data, Date: Date

Command Message	Access Rule	NV	Address			Data Type	Class Name
			Class	Instance	Attribute		
Vender ID	r	--	0x01	0x01	0x01	UINT16	Identity Class (0x01)
Product Type	r	--	0x01	0x01	0x02	UINT16	
Product Code	r	--	0x01	0x01	0x03	UINT16	
Revision	r	--	0x01	0x01	0x04	UINT16	
Product Name	r	--	0x01	0x01	0x07	TEXT	
Reset	w	--	0x01	0x01	0xC7	UINT8	
MAC ID	r/w	NV	0x03	0x01	0x01	UINT8	Network Class (0x03)
Baud Rate	r/w	NV	0x03	0x01	0x02	UINT8	
Device Type	r	--	0x64	0x01	0x01	TEXT	Device Manager Class (0x64)
Device Manufacturer Identity	r	--	0x64	0x01	0x03	TEXT	
Manufacturer Model Number	r	--	0x64	0x01	0x04	TEXT	
Firmware Revision	r	--	0x64	0x01	0x05	TEXT	
Hardware Revision	r	--	0x64	0x01	0x06	TEXT	
Serial Number	r	--	0x64	0x01	0x07	TEXT	
Exception Status	r	--	0x65	0x01	0xA0	UINT8	Exception Class (0x65)
Occurred Alarm Details	r	--	0x65	0x01	0xA1	UINT16	
Occurred Warning Details	r	--	0x65	0x01	0xA2	UINT16	
Flow Totalizer Alarm Enable/Disable	r/w	NV	0x65	0x01	0xB5	UINT8	
Flow Totalizer Alarm Level	r/w	NV	0x65	0x01	0xB6	UINT32	
Flow Totalizer Warning Enable/Disable	r/w	NV	0x65	0x01	0xB7	UINT8	
Flow Totalizer Warning Level	r/w	NV	0x65	0x01	0xB8	UINT32	

Command Message	Access Rule	NV	Address			Data Type	Class Name
			Class	Instance	Attribute		
Calibration Instance	r	--	0x66	0x00	0x65	UINT8	Gas Calibration Class (0x66)
nProcess Gases	r	--	0x66	0x00	0xA0	UINT8	
Gas Identifier	r	--	0x66	0x01	0x01	TEXT	
Full Scale Range	r	--	0x66	0x01	0x02	UINT16	
Flow Units	r	--	0x66	0x01	0x03	TEXT	
Reference Temperature	r	--	0x66	0x01	0x04	UINT16	
Reference Pressure	r	--	0x66	0x01	0x05	UINT16	
Calibration Date	r	--	0x66	0x01	0x09	DATE	
Gas STD No	r	--	0x66	0x01	0x10	UINT16	
Gas CF	r	--	0x66	0x01	0x17	REAL	
Status	r	--	0x68	0x01	0x07	UINT8	Flow Meter Class (0x68)
Alarm Enable/Disable	r/w	NV	0x68	0x01	0x08	UINT8	
Warning Enable/Disable	r/w	NV	0x68	0x01	0x09	UINT8	
Alarm Trip Point High	r/w	NV	0x68	0x01	0x11	UINT16	
Alarm Trip Point Low	r/w	NV	0x68	0x01	0x12	UINT16	
Alarm Trip Hysteresis	r/w	NV	0x68	0x01	0x13	UINT16	
Alarm Settling Time	r/w	NV	0x68	0x01	0x14	UINT16	
Warning Trip Point High	r/w	NV	0x68	0x01	0x15	UINT16	
Warning Trip Point Low	r/w	NV	0x68	0x01	0x16	UINT16	
Warning Trip Hysteresis	r/w	NV	0x68	0x01	0x17	UINT16	
Warning Settling Time	r/w	NV	0x68	0x01	0x18	UINT16	
Zero Enable/Disable	r/w	NV	0x68	0x01	0xA5	UINT8	
Flow Totalizer Enable/Disable	r/w	NV	0x68	0x01	0xB0	UINT8	
Flow Totalizer Data	r	--	0x68	0x01	0xB2	UINT32	
Flow Totalizer Time1	r	--	0x68	0x01	0xB3	UINT32	
Flow Totalizer Time2	r	--	0x68	0x01	0xB4	UINT32	
Requested Zero	r/w	--	0x68	0x01	0xBA	UINT8	

Command Message	Access Rule	NV	Address			Data Type	Class Name
			Class	Instance	Attribute		
Control Mode Selection	r/w	V	0x69	0x01	0x03	UINT8	Flow Controller Class (0x69)
Default Control Mode	r/w	NV	0x69	0x01	0x04	UINT8	
Freeze Follow	r/w	V	0x69	0x01	0x05	UINT8	
Status	r	--	0x69	0x01	0x0A	UINT8	
Alarm Enable/Disable	r/w	NV	0x69	0x01	0x0B	UINT8	
Warning Enable/Disable	r/w	NV	0x69	0x01	0x0C	UINT8	
Alarm Settling Time	r/w	NV	0x69	0x01	0x0D	UINT16	
Alarm Error Band	r/w	NV	0x69	0x01	0x0E	UINT16	
Warning Settling Time	r/w	NV	0x69	0x01	0x0F	UINT16	
Warning Error Band	r/w	NV	0x69	0x01	0x10	UINT16	
Setpoint	r/w	V	0x69	0x01	0xA4	UINT16	
Valve Override	r/w	V	0x6A	0x01	0x01	UINT8	Valve Driver Class (0x6A)
Status	r	--	0x6A	0x01	0x07	UINT8	
Alarm Enable/Disable	r/w	NV	0x6A	0x01	0x08	UINT8	
Warning Enable/Disable	r/w	NV	0x6A	0x01	0x09	UINT8	
Alarm Trip Point High	r/w	NV	0x6A	0x01	0x0F	UINT16	
Alarm Trip Point Low	r/w	NV	0x6A	0x01	0x10	UINT16	
Alarm Trip Hysteresis	r/w	NV	0x6A	0x01	0x11	UINT16	
Warning Trip Point High	r/w	NV	0x6A	0x01	0x12	UINT16	
Warning Trip Point Low	r/w	NV	0x6A	0x01	0x13	UINT16	
Warning Trip Hysteresis	r/w	NV	0x6A	0x01	0x14	UINT16	
Valve Type	r	--	0x6A	0x01	0xA0	UINT8	
Ramp Time	r/w	--	0x6A	0x01	0xA4	UINT32	
Filtered Setpoint	r	--	0x6A	0x01	0xA6	UINT16	
Indicated Flow	r	--	0x6A	0x01	0xA9	UINT16	
Valve Voltage	r	--	0x6A	0x01	0xB6	UINT16	

8. Command Message Details

8.1. Identity Class (0x01), Instance1

Hold the device specific data

Attribute	Command Message	Access Rule	NV	Data Type	Note
0x01	Vender ID	r	--	UINT16	Vender ID: 0x0209 ODVA registered vender identification number
0x02	Product Type	r	--	UINT16	Product ID: 0x001A ODVA provided MFC number
0x03	Product Code	r	--	UINT16	Product code: 0x03E8 Product code of FCS-T
0x04	Revision	r	--	UINT16	Product revision number
0x07	Product Name	r	--	TEXT	Product name: "FCS"
0xC7	Reset	w	--	UINT8	Reset the device (FCS)

8.1.1. Command example of checking Vender ID

Send commands to Slave (FCS), MAC ID=0x21

Send command

Sequence	Data contents
1	0x21 (Slave MAC ID)
2	0x02 (STX)
3	0x80 (Command Code)
4	0x03 (Packet Length)
5	0x01 (Class ID)
6	0x01 (Instance ID)
7	0x01 (Attribute ID)
8	0x00 (Pad)
9	0x88 (Checksum)

Response data

Sequence	Data contents
1	0x00 (Master MAC ID)
2	0x02 (STX)
3	0x80 (Command Code)
4	0x05 (Packet Length)
5	0x01 (Class ID)
6	0x01 (Instance ID)
7	0x01 (Attribute ID)
8	0x09 (data LSB)
9	0x02 (data MSB)
10	0x00 (Pad)
11	0x95 (Checksum)

※ Slave send ACK (=0x06) to Master before sending the response data.

8.1.2 Reset

When reset FCS, assign either one of the following data.

Data	Contents
0	Reset FCS. (Condition is power off to on.) ※ Data of nonvolatile memory is not changed.
1	Before reset FCS, alarm setting, accumulation function setting, and ramp time that saved in nonvolatile memory become the default setting.

8.2. Network Class (0x03), Instance1

Execute read and modify the communication related data

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x01	MAC ID	r/w	NV	UINT8	Communication address (default: 0x21) Data range: 0x21 ~ 0x9F
0x02	Baud Rate	r/w	NV	UINT8	Baud Rate (Default: 0x01, 38400bps) Data range: 0x00 ~ 0x03 0x00: 9600bps, 0x01: 38400bps, 0x02: 57600bps, 0x03: 115200bps

8.2.1. MAC ID

New MAC ID is updated as soon as command is executed.

Example) Change the Slave (FCS) MAC ID from MAC ID =0x21 to MAC ID=0x4C.

Sequence	Data Contents
1	0x21 or 0xFF (MAC ID)
2	0x02 (STX)
3	0x81 (Command Code)
4	0x04 (Packet Length)
5	0x03 (Class ID)
6	0x01 (Instance ID)
7	0x01 (Attribute ID)
8	0x4C (Data)
9	0x00 (Pad)
10	Checksum

※. If MAC ID uses 0xFF, connect Master to Slave one-on-one.

※. If MAC ID is changed successfully, ACK (=0x06) returns twice.

8.2.2. Baud Rate

Baud rate is not changed after command is executed.

When you want to change baud rate, turn off reset command or power and turn on again.

8.3. Device Manager Class (0x64), Instance1

Hold the device information

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x01	Device Type	r	--	TEXT	Product type of device (“MFC”)
0x03	Device Manufacturer Identity	r	--	TEXT	Manufacturer name (“Fujikin. Inc.”)
0x04	Manufacturer Model Number	r	--	TEXT	Product model number (“FCS-T”)
0x05	Firmware Revision	r	--	TEXT	Firmware version
0x06	Hardware Revision	r	--	TEXT	Hardware version
0x07	Serial Number	r	--	TEXT	Fujikin serial number (Same serial number printed on top decals of the product)

8.4. Exception Class (0x65), Instance1

Enable to check Alarm/Warning

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0xA0	Exception Status	r/w	NV	UINT8	Alarm/Warning status
0xA1	Alarm Details	r	--	UINT16	Occurred Alarm details
0xA2	Warning Details	r	--	UINT16	Occurred Warning details
0xB5	Flow Totalizer Alarm Enable/Disable	r/w	NV	UINT8	Flow Totalizer Alarm function Enable (=0x01)/Disable (=0x00), Default: Disable
0xB6	Flow Totalizer Alarm Level	r/w	NV	UINT32	Flow Totalizer Alarm Level
0xB7	Flow Totalizer Warning Enable/Disable	r/w	NV	UINT8	Flow Totalizer Warning function Enable (=0x01)/Disable (=0x00), Default: Disable
0xB8	Flow Totalizer Warning Level	r/w	NV	UINT32	Flow Totalizer Warning Level

8.4.1. Exception Status

Enable to check Alarm/Warning status

bit	Contents
0	Always 0
1	0: No alarm, 1: In alarm
2-4	Always 0
5	0: No warning, 1: In warning
6,7	Always 0

※ Alarm/Warning information is automatically clear when the device recover from abnormal conditions.

8.4.2 Occurred Alarm Details

Enable to check the detail of occurred alarm

bit	Contents
0	Always 0
1	0: No alarm flow rate output lower trip point, 1: In alarm flow rate output lower trip point
2	0: No alarm flow rate output upper trip point, 1: In alarm flow rate output upper trip point
3	0: No alarm flow rate setting, 1: In alarm flow rate setting
4	0: No alarm valve lower trip point, 1: In alarm valve lower trip point
5	0: No alarm valve upper trip point, 1: In alarm valve upper trip point
6-13	Always 0
14	0: No alarm flow totalizer, 1: In alarm flow totalizer
15	Always 0

※ Alarm information is automatically clear when the device recover from abnormal condition, except Flow Totalizer Alarm.

Refer to 8.6.4 to clear Flow Totalizer Alarm.

8.4.2 . Occurred Warning Details

Enable to check the detail of occurred warning

bit	Contents
0	Always 0
1	0: No warning flow rate output lower trip point, 1: In warning flow rate output lower trip point
2	0: No warning flow rate output upper trip point, 1: In warning flow rate output upper trip point
3	0: No warning flow rate setting, 1: In warning flow rate setting
4	0: No warning valve lower trip point, 1: In warning valve lower trip point
5	0: No warning valve upper trip point, 1: In warning valve upper trip point
6-13	Always 0
14	0: No warning flow totalizer, 1: In warning flow totalizer
15	Always 0

※ Warning information is automatically clear when the device recover from abnormal condition, except Flow

Totalizer Warning.

Refer to 8.6.4 to clear Flow Totalizer Warning.

8.5. Gas Calibration Class (0x66)

Enable to read Gas Calibration Data

8.5.1. Instance0

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x65	Calibration Instance	r	--	UINT8	Calibration gas table number (=1)
0xA0	nProcess Gases	r	--	UINT8	Number of calibration gas (=1)

8.5.2. Instance1

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x01	Gas Identifier	r	--	TEXT	Gas name
0x02	Full Scale Range	r	--	UINT16	Full scale value
0x03	Flow Units	r	--	TEXT	Flow rate unit (SCCM or SLM)
0x04	Reference Temperature	r	--	UINT16	Temperature at flow rate calibration
0x05	Reference Pressure	r	--	UINT16	Pressure at flow rate calibration
0x09	Calibration Date	r	--	DATE	Date of flow rate calibration
0x10	Gas STD No	r	--	UINT16	Gas STD number
0x17	Gas CF	r	--	REAL	Gas CF

8.5.2.1. Gas Identifier

Enable to read the name of calibrated gas

8.5.2.2. Full Scale Range and Flow Units

Enable to read full scale of calibrated gas. Refer to the following example to see the output value.

Example 1) If output value is 1000 and flow unit is “SCCM”, it means 100.0 SCCM.

Example 2) If output value is 10 and flow unit is “SLM”, it means 1.0 SLM.

8.5.2.3. Gas STD No

SEMI provided gas STD number is input.

8.5.2.4. Calibration Date

Output the date of calibration executed.

Example) If calibration date is January 29, 2008, output is “01292008”. Order is month, day, year.

8.6. Flow Meter Class (0x68), Instance1

Read and change the sensor related data.

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x07	Status	r	--	UINT8	Flow rate output alarm/warning occurred status
0x08	Alarm Enable/Disable	r/w	NV	UINT8	Flow rate output alarm function Enable (=0x01)/Disable (=0x00), Default: Disable
0x09	Warning Enable/Disable	r/w	NV	UINT8	Flow rate output warning function Enable (=0x01)/Disable (=0x00), Default: Disable
0x11	Alarm Trip Point High	r/w	NV	UINT16	Alarm flow rate output upper trip point (Default: 0xC000) Data range: 0x4000 ~ 0xC000
0x12	Alarm Trip Point Low	r/w	NV	UINT16	Alarm flow rate output lower trip point (Default: 0x4000) Data range: 0x4000 ~ 0xC000
0x13	Alarm Trip Hysteresis	r/w	NV	UINT16	Alarm flow rate output hysteresis (Default: 0) Data range: 0x0000 ~ 0xCCC
0x14	Alarm Settling Time	r/w	NV	UINT16	Flow rate output alarm timer (Default: 5000 milliseconds)
0x15	Warning Trip Point High	r/w	NV	UINT16	Warning flow rate output upper trip point (Default: 0xC000) Data range: 0x4000 ~ 0xC000
0x16	Warning Trip Point Low	r/w	NV	UINT16	Warning flow rate output lower trip point (Default: 0x4000) Data range: 0x4000 ~ 0xC000
0x17	Warning Trip Hysteresis	r/w	NV	UINT16	Warning flow rate output hysteresis (Default: 0) Data range: 0x0000 ~ 0xCCC
0x18	Warning Settling Time	r/w	NV	UINT16	Flow rate output warning timer (Default: 5000 milliseconds)
0xA5	Zero Enable/Disable	r/w	NV	UINT8	Zero adjustment Enable (=0x01)/Disable (=0x00), Default: Enable
0xB0	Flow Totalizer Enable/Disable	r	V	UINT8	Flow totalizer function Enable (=0x01)/Disable (=0x00), Default: Disable
0xB2	Flow Totalizer Data	r	V	UINT32	read: Read flow totalizer data write: Clear flow totalizer data (Clear of integration value and integration time) ※ Data is not required for write command. ※ Occurred information is clear if alarm or warning is occurred.
0xB3	Flow Totalizer Time1	r	V	UINT32	Flow rate totalized time after the function is enabled. Duration of uncontrolled flow rate is not included.
0xB4	Flow Totalizer Time2	r	V	UINT32	Flow rate totalized time from enable to disable the function.
0xBA	Requested Zero	r/w	--	UINT8	Start zero adjustment/ check zero adjustment condition Data: 0x01 (fixed)

8.6.1 Status

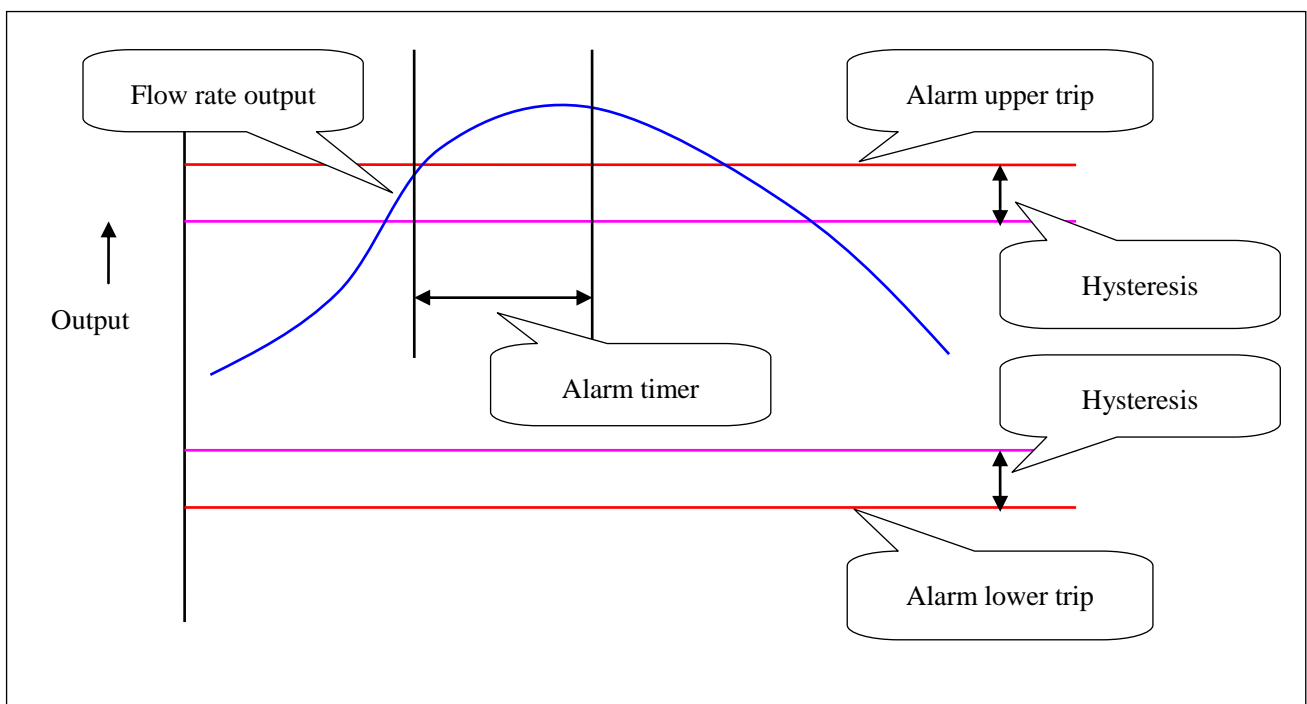
Status shows the occurred condition of flow rate output alarm/warning. Response is 8bit and each bit has the following meanings.

bit	Contents
0	0: No alarm flow rate output upper trip point, 1: In alarm flow rate output upper trip point
1	0: No alarm flow rate output lower trip point, 1: In alarm flow rate output lower trip point
2	0: No warning flow rate output upper trip point, 1: In warning flow rate output upper trip point
3	0: No warning flow rate output lower trip point, 1: In warning flow rate output lower trip point
4-7	Always 0

※ Alarm/Warning information is automatically clear when the device recover from abnormal conditions.

8.6.2. Flow Rate Output Alarm/Warning Functions

Alarm/Warning operation is the following



Alarm trips when the flow rate output exceeds either upper or lower trip point and duration passes the alarm timer.

Alarm releases when the flow rate output is within the inside of hysteresis.

(Upper trip point – hysteresis) or (Lower trip point + hysteresis)

Warning function operates the same manner as Alarm.

Setting range of Alarm/Warning is 0x4000 ~ 0xC000, which represents 0% ~ 100% of flow rate output.

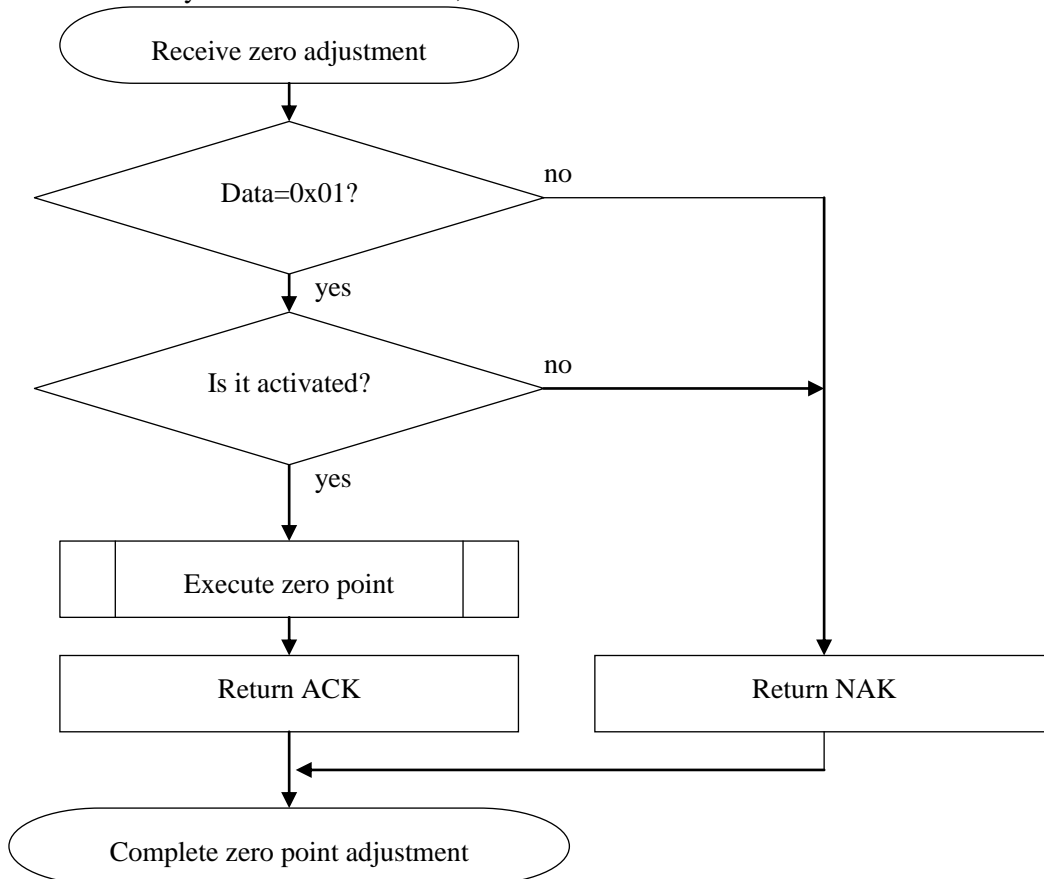
Hysteresis is 0x0000 ~ 0x0CCC, which represents 0% ~ 10%.

8.6.3. Zero Point Adjustment Function

Zero point adjustment by command is the following.

Sequence	Data Contents
1	Slave (FCS) MAC ID
2	0x02 (STX)
3	0x81 (Command Code)
4	0x04 (Packet Length)
5	0x68 (Class ID)
6	0x01 (Instance ID)
7	0xBA (Attribute ID)
8	0x01 (Data)
9	0x00 (Pad)
10	Checksum

※ When you send the command, set Data to 0x01.



※ “Zero Enable/Disable (Attribute=0xA5) enable to activate the zero adjustment.

Current zero adjustment condition is enabled to check if you execute to “Read” on “Requested Zero”.

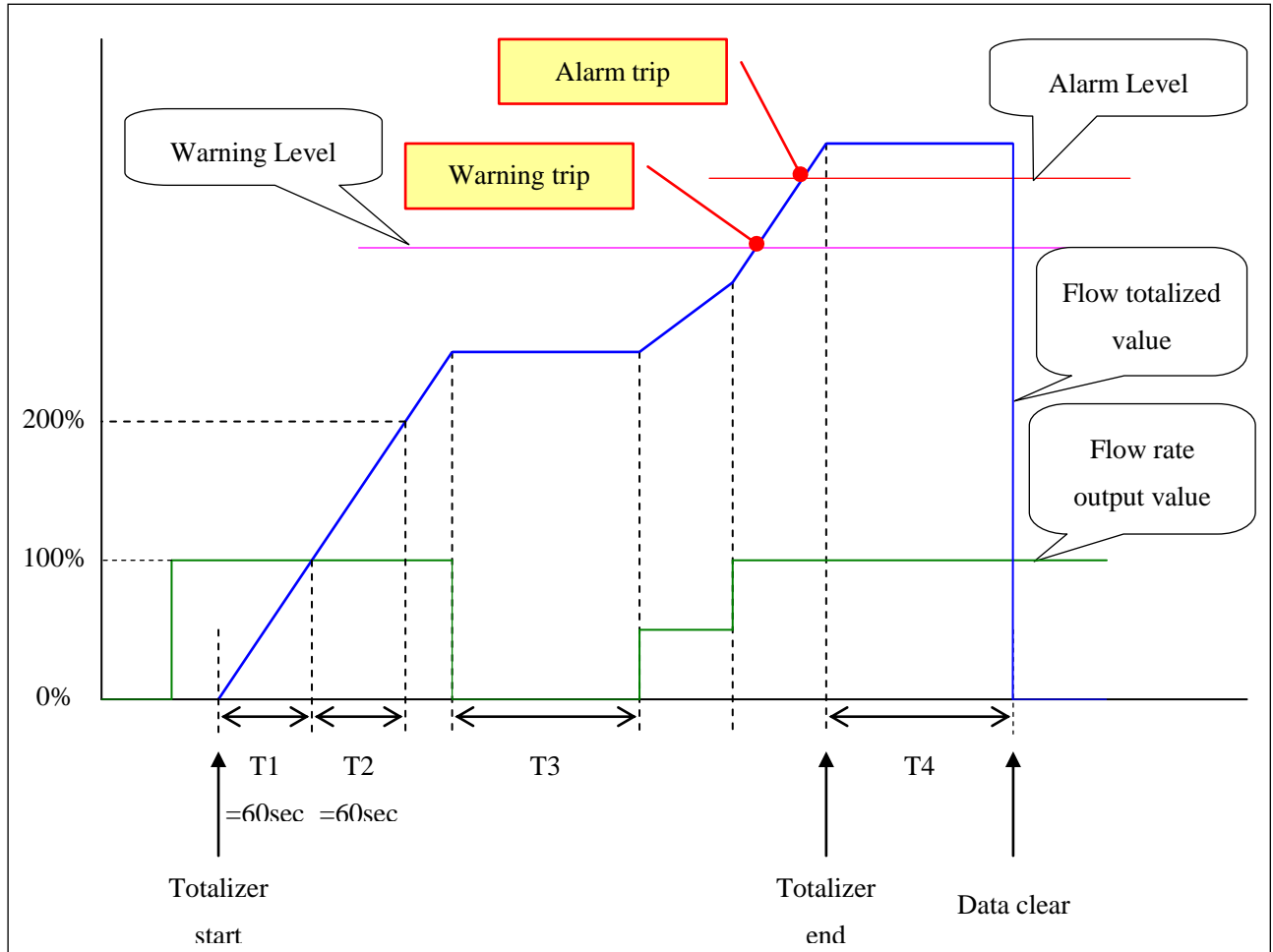
Set the flow rate control mode after the power is on.

Data	Contents
0x00	Enable to adjust zero point, enable to start zero point adjustment
0x01	Execute zero adjustment, disable to start zero adjustment

8.6.4. Flow Totalizer Function

This is a function to integrate the flow rate output value. When starting the flow totalizer function, 1/60 of sensor output value (%) is added in every second. If the flow rate output value is 100%, the output of flow totalizer function becomes 100% after 60 seconds has passed.

Flow totalizer output value is output % of a full-scale flow rate.



If FCS keeps 100% of flow rate output for 60 seconds (T1) after receiving the totalizer start (Enable) command, the integrated flow rate value becomes 100% because FCS flows the gas equivalent of full-scale flow rate.

If FCS keeps 100% of flow rate output for 120 seconds (T1+T2) after receiving the totalizer start command, the integrated flow rate value becomes 200% because FCS flows the gas twice of equivalent of full-scale flow rate.

If FCS does not control the flow (T3), the flow totalized value is not added. [NOTE]

After receiving the totalizer end (Disable) command (T4), the flow totalized value is not added but those integrated value is held.

After receiving the data clear command (after T4), integrated data and time become zero. If flow totalizer alarm or warning has been occurred, those alarm or warning becomes clear.

Flow totalized value becomes 4Byte (hexadecimal) of response data. If it is the response of 0x00000033, the value is integrated 51% (decimal). Response data of integrated time is also 4Byte (hexadecimal). If it is the response of 0x0000001F, the time is integrated for 31 seconds.

[NOTE] FCS is in control state when a value has been input to the flow rate setting value of 2 ~ 100% (control range).

8.7. Flow Controller Class (0x69), Instance1

Read and change the flow rate setting related data

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x03	Control Mode Selection	r/w	V	UINT8	Select flow rate control mode
0x04	Default Control Mode	r/w	NV	UINT8	Select flow rate control mode at power on
0x05	Freeze Follow	r/w	V	UINT8	Flow rate control
0x0A	Status	r	--	UINT8	Status of flow rate setting alarm/warning
0x0B	Alarm Enable/Disable	r/w	NV	UINT8	Flow rate setting alarm function Enable (=0x01)/Disable (=0x00), Default: Disable
0x0C	Warning Enable/Disable	r/w	NV	UINT8	Flow rate setting warning function Enable (=0x01)/Disable (=0x00), Default: Disable
0x0D	Alarm Settling Time	r/w	NV	UINT16	Flow rate setting alarm timer (Default: 0)
0x0E	Alarm Error Band	r/w	NV	UINT16	Flow rate setting alarm band (Default: 0x0000) Data range: 0x0000 ~ 0x8000
0x0F	Warning Settling Time	r/w	NV	UINT16	Flow rate setting warning timer (Default: 0)
0x10	Warning Error Band	r/w	NV	UINT16	Flow rate setting warning band (Default: 0x0000) Data range: 0x0000 ~ 0x8000
0xA4	Set point	r/w	V	UINT16	Flow rate set point Data range: 0x4000 ~ 0xC000

8.7.1. Control Mode Selection

Read and change the flow rate control mode

Data	Contents
0x01	Digital mode: Control the flow rate by the input of flow rate setting value from the digital communication. ※ Analog mode input is disabled.
0x02	Analog mode: Control the flow rate by the input of flow rate setting value from the analog voltage (Voltage Input) ※ Digital mode input is disabled.

※ Flow rate control mode after power on is decided by the “Default Control Mode”.

8.7.2. Default Control Mode

Set the flow control mode after power on

Data	Contents
0x01	Digital mode
0x02	Analog mode (Default)

8.7.3. Freeze Follow

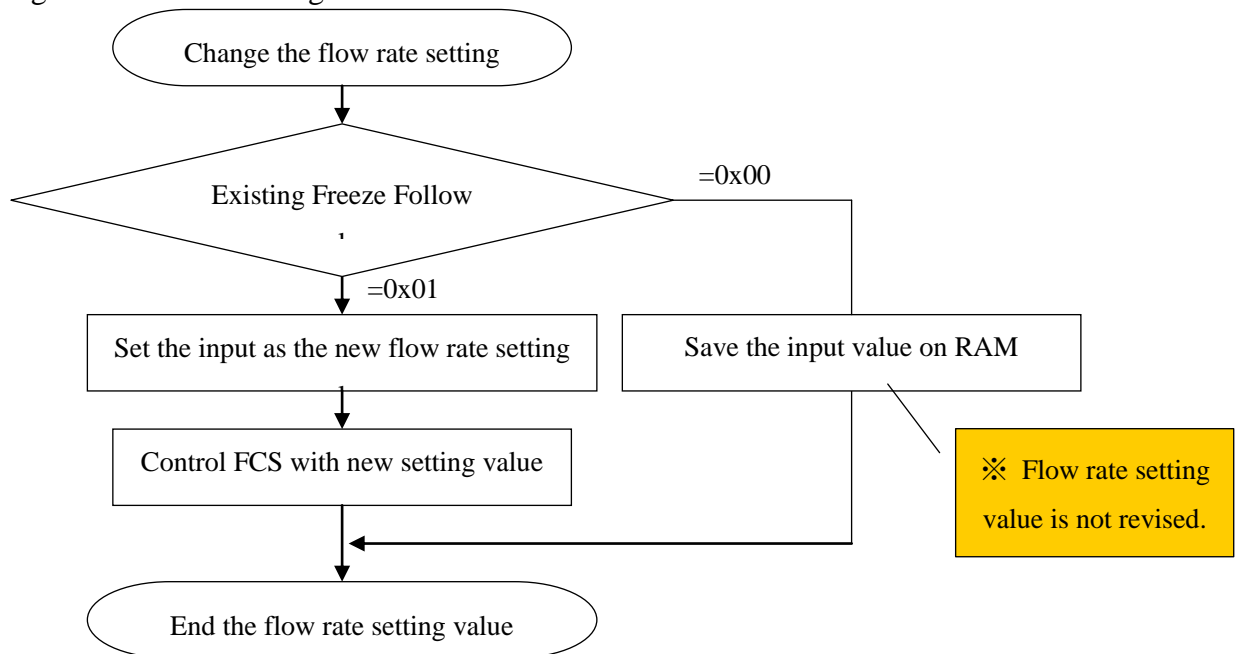
Restrict the operation of flow rate setting value by digital communication.

Data	Contents
0x00	Hold the existing set point even if the flow rate setting value is input. Input value is saved on RAM, and if Freeze Follow is 0x01, the value becomes the flow rate setting value. (Default)
0x01	Revise the flow rate setting value if Set point is input.

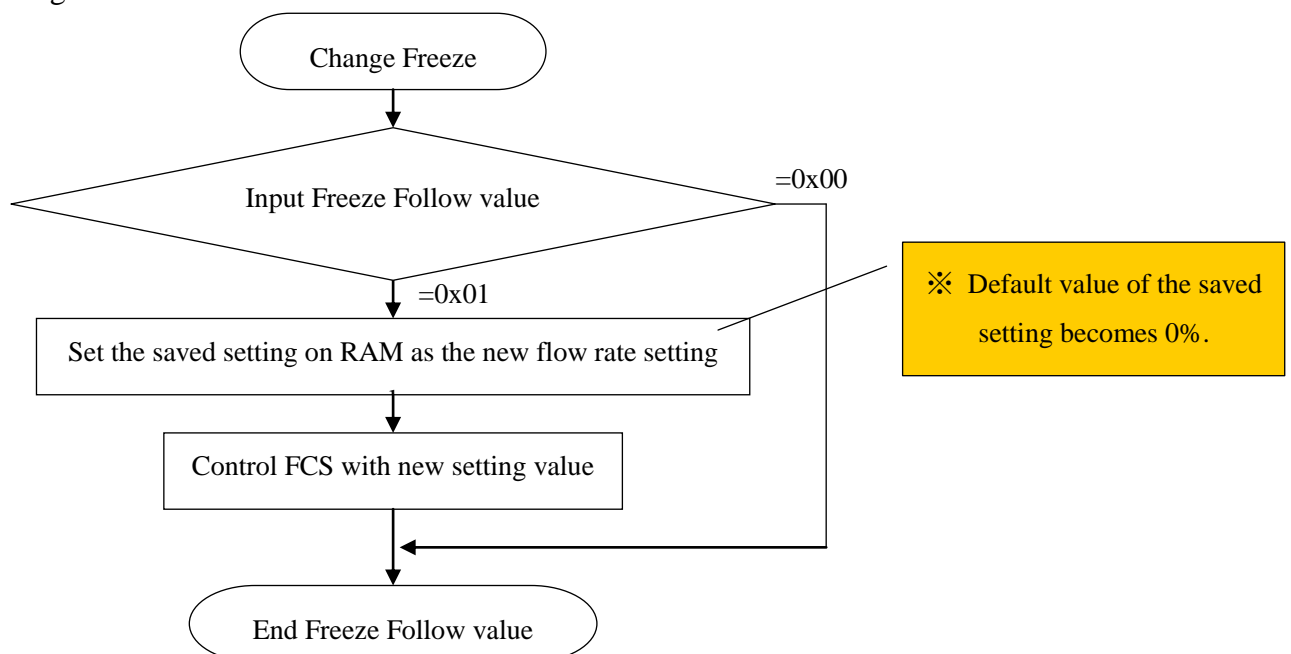
- ※ Freeze Follow value does not use in Analog mode. (Disabled)
- ※ Freeze Follow holds the input value until the device is reset or power off.

Operation of Freeze Follow in digital mode

(1) Change the flow rate setting



(2) Change Freeze Follow



8.7.4. Status

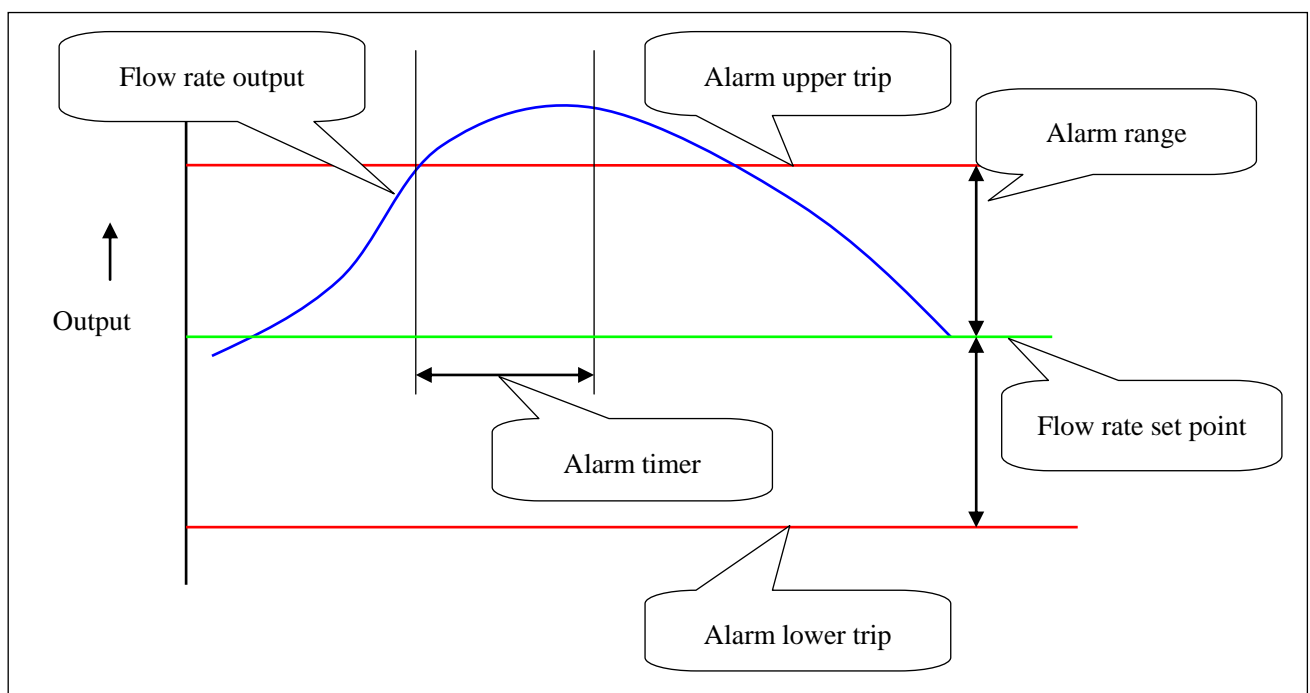
Status shows the occurred condition of the flow rate setting alarm and warning. Response is 8bit and each bit has the following meanings.

bit	Contents
0	0: No alarm flow rate setting, 1: In alarm flow rate setting
1	0: No warning flow rate setting, 1: In warning flow rate setting
2-7	Always 0

※ Alarm/Warning information is automatically clear when the device recover from abnormal conditions.

8.7.5. Alarm/Warning Function

Alarm/Warning operation is the following



Alarm trips when the flow rate output exceeds either upper or lower trip point and duration passes the alarm timer.

Alarm releases when the flow rate output is inside of the alarm range.

Warning function operates the same manner as Alarm.

Setting range of Alarm/Warning is 0x0000 ~ 0x8000, which represents a span of flow rate set point (100%).

8.7.6. Set point

When Master sends the flow rate set point to Slave (FCS), it is required to send by unsigned number 16bit (2Byte).

Flow rate set point is calculated by the following formula.

Formula of flow rate set point

$$\text{Setpoint} = \frac{\text{Required flow rate (SCCM or SLM)}}{\text{FCS full scale flow rate (SCCM or SLM)}} \times 32768 + 16384$$

Calculation example

Flow rate set point %	Set point data
0.0%	0x4000
1.0%	0x4147
5.0%	0x4666
10.0%	0x4CCC
25.0%	0x6000
50.0%	0x8000
75.0%	0xA000
100.0% (full scale flow rate)	0xC000

8.8. Valve Driver Class (0x6A), Instance1

Read and change the valve related data

Attribute	Command Message	Access Rule	NV	Data Type	Contents
0x01	Valve Override	r/w	V	UINT8	Valve override OPEN/CLOSE
0x07	Status	r	--	UINT8	Valve alarm/warning status
0x08	Alarm Enable/Disable	r/w	NV	UINT8	Valve alarm function Enable (=0x01)/Disable (=0x00), Default: Disable
0x09	Warning Enable/Disable	r/w	NV	UINT8	Valve warning function Enable (=0x01)/Disable (=0x00), Default: Disable
0x0F	Alarm Trip Point High	r/w	NV	UINT16	Valve alarm upper trip point (Default: 0)
0x10	Alarm Trip Point Low	r/w	NV	UINT16	Valve alarm lower trip point (Default: 0)
0x11	Alarm Trip Hysteresis	r/w	NV	UINT16	Valve alarm hysteresis (Default: 0)
0x12	Warning Trip Point High	r/w	NV	UINT16	Valve warning upper trip point (Default: 0)
0x13	Warning Trip Point Low	r/w	NV	UINT16	Valve warning lower trip point (Default: 0)
0x14	Warning Trip Hysteresis	r/w	NV	UINT16	Valve warning hysteresis (Default: 0)
0xA0	Valve Type	r	--	UINT8	Valve type (N/C, N/O)
0xA4	Ramp Time	r/w	--	UINT32	Ramping time (Default: 0 millisecond) Data range: 0x0000 0000 ~ 0x000F4240
0xA6	Filtered Set point	r	--	UINT16	Current flow rate set point
0xA9	Indicated Flow	r	--	UINT16	Current flow rate output
0xB6	Valve Voltage	r	--	UINT16	Current valve output

8.8.1. Valve Override

Enable to control the valve directly

Valve override becomes 0x00 after power is on or after the reset.

Data	Contents
0x00	Valve control condition (FCS controls flow rate by the set point)
0x01	Valve override CLOSE
0x02	Valve override OPEN

8.8.2. Status

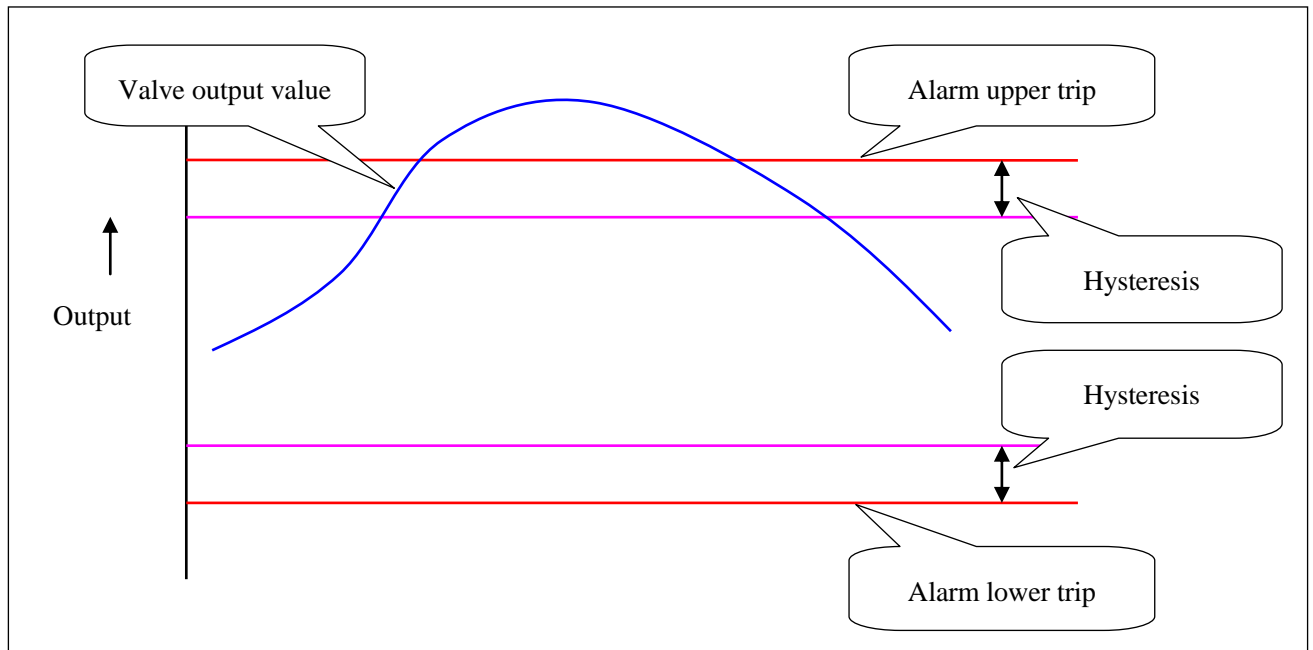
Status shows the occurred condition of valve alarm and warning. Response is 8bit and each bit has the following meanings.

bit	Contents
0	0: No alarm valve upper trip point, 1: In alarm valve upper trip point
1	0: No alarm valve lower trip point, 1: In alarm valve lower trip point
2	0: No warning valve upper trip point, 1: In warning valve upper trip point
3	0: No warning valve lower trip point, 1: In warning valve lower trip point
4-7	Always 0

※ Alarm/Warning information is automatically clear when the device recover from abnormal conditions.

8.8.3. Valve alarm function

Alarm/Warning operation is the following



Alarm trips when valve output exceeds either upper or lower trip point.

Alarm releases when valve output is within the inside of hysteresis.

(Upper trip point – hysteresis) or (Lower trip point + hysteresis)

Warning function operates the same manner as Alarm.

Setting range of Alarm/Warning is 0x4000 ~ 0xC000, which represents 0% ~ 100% of flow rate output.

Hysteresis is 0x0000 ~ 0x0CCC, which represents 0% ~ 10%.

8.8.4. Valve type

Read valve type

Data	Contents
0x00	No valve (flow mater)
0x01	Normally Closed type valve
0x02	Normally Open type valve

8.8.5. Ramp Time

Set ramp time

Data range is 0x0000 0000 ~ 0x000F4240, which indicates 0 ~ 1000000 milliseconds (1000 seconds).

If the ramp time is set 0 millisecond, ramping function turns off.

If the ramp time is set 0 millisecond to 500 milliseconds, it takes 500 milliseconds.

Ramping function only enable to use in digital mode.

8.8.6. Filtered Set point

Current set point is output the following.

Set point %	Filtered Set point data
0.0% (Maximum value)	0x4000
1.0%	0x4147
5.0%	0x4666
10.0%	0x4CCC
25.0%	0x6000
50.0%	0x8000
75.0%	0xA000
100.0% (Maximum value)	0xC000

8.8.7. Indicated Flow

Current flow rate output value is output the following.

Flow rate output %	Indicated Flow data
-10.0% (Maximum value)	0x3333
-5.0%	0x3999
-1.0%	0x3EB8
0.0%	0x4000
1.0%	0x4147
5.0%	0x4666
10.0%	0x4CCC
25.0%	0x6000
50.0%	0x8000
75.0%	0xA000
100.0%	0xC000
149.9% (Maximum value)	0xFFFF

8.8.8 . Valve Voltage

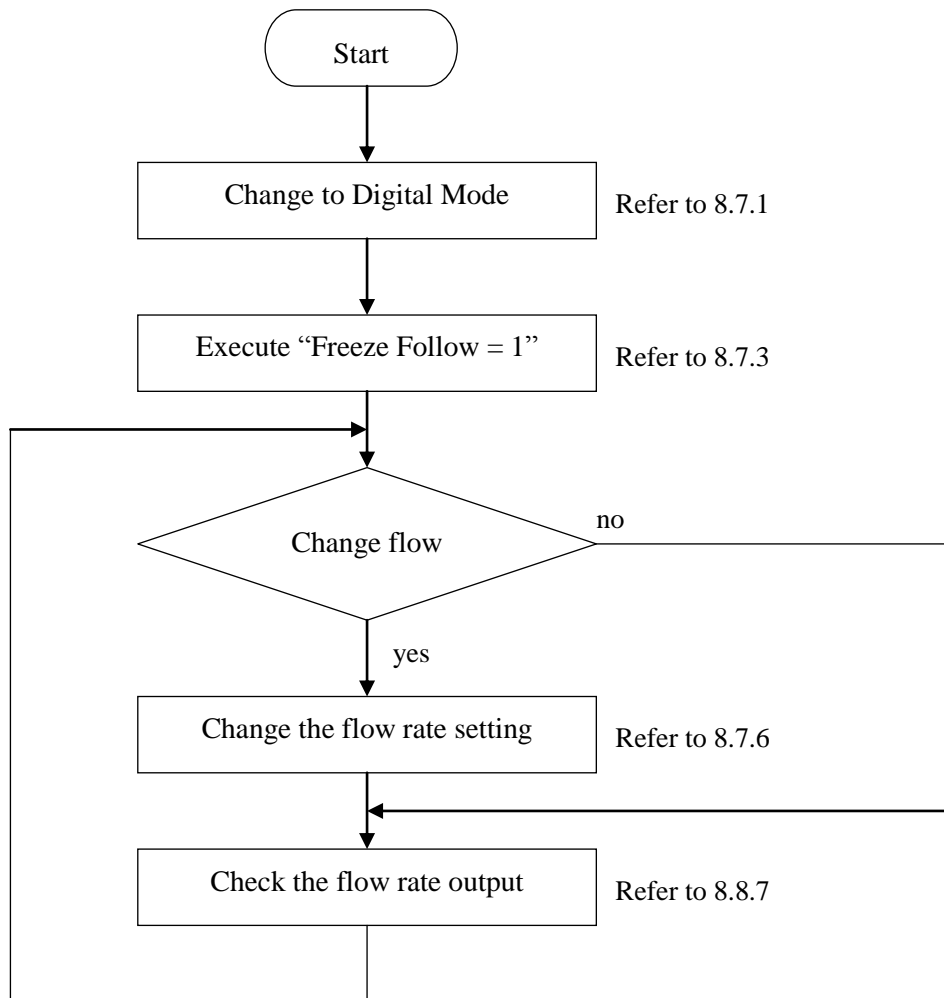
Current valve output value is output the following.

Valve output %	Valve Voltage data
0.0% (Maximum value)	0x4000
10.0%	0x4CCC
25.0%	0x6000
50.0%	0x8000
75.0%	0xA000
100.0% (Maximum value)	0xC000

※ Valve output is different from the valve opening.

9. Example of Use

Following schematic shows an example of use.



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