SAM

Speedy Accurate Maintainable

Instruction Manual
for
Digital Commands

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1. Preface

Thank you for purchasing our SAM mass flow controllers from the SFC1480F/SFC2480F (Fantas®) series. In order to make the most of this mass flow controller, check the name plate of MFC as to whether the specifications of this MFC match with your requirements, and then read this manual thoroughly before using it.

The SFC1480F/SFC2480F series MFC has both analog and digital interfaces. This manual only describes the use of the digital interface. For details about using the analog interface, see the separate instruction manual for it.

2. How to use the Digital commands

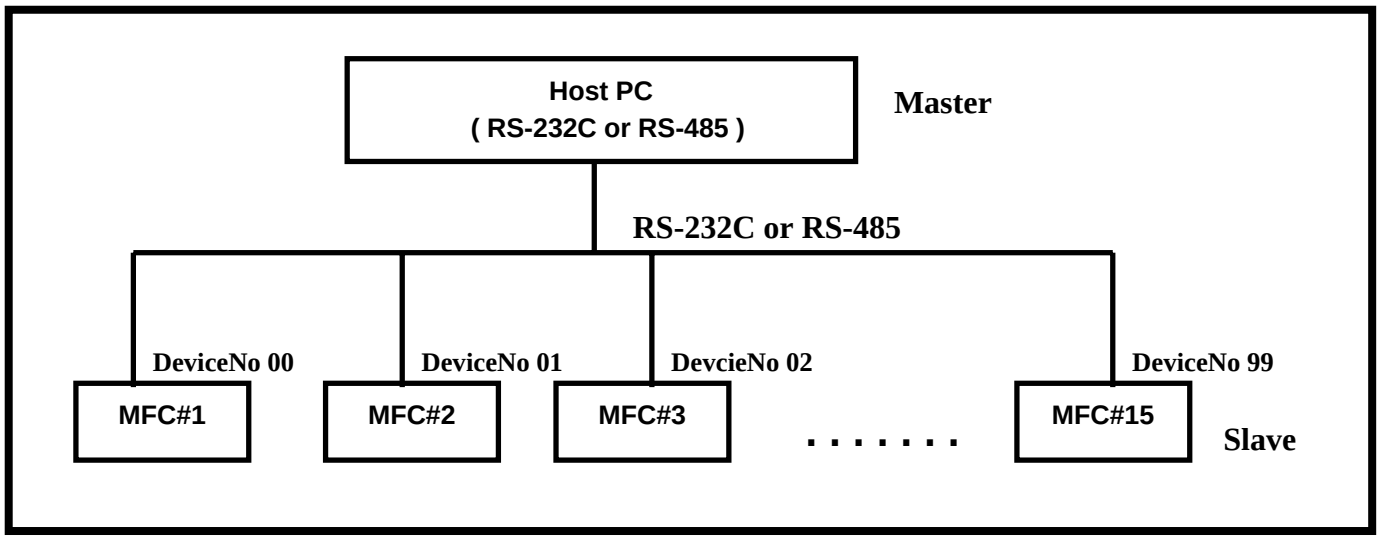


Fig.1 diagram of connections (Host PC – MFCs)

2-1. RS-232C

This is one of most common communication standards used in personal computers. Normally this communication system can only be used for 1 to 1 communications. Using one of our interface adapters (RS-1, RS-8), you can communicate with more than one mass flow controller (MFC) through a single RS-232 interface.

Although full-duplex communication is available in the hardware, the MFC software uses half-duplex communication.

2-2. RS-485

This is a modified RS-232C system. This system can communicate with bus connections. This system can communicate with multiple MFCs without any additional adapters. Also, the maximum transfer distance can be greatly extended. Only half-duplex communication is available when using RS-485.

2-3. Communication conditions

The default settings when delivered are as follows:

Baud rate: 1200 bps
Start bit: 1 bit (fixed)
Character length: 7 bit ASCII code
Parity: None
Stop bit: 2 bit
Device No.: 00

The communication conditions can be changed using the communication speed change command (command: TS), communication format change command (command: TP), and device number change command (command: DW).

After sending one of the change commands above, send a software reset command, or reapply power to restart the MFC.

If the communication conditions in a particular MFC are not known and you cannot communicate with this MFC, hold down the zero point input switch on the top of the housing for about 30 seconds to clear all of the settings. Then the MFC will be reset to the default communication conditions.

* With this all clear operation, other settings will also return to their initial values. There is a setting that prohibits changing the communication conditions with the all reset command. It is available as a special, optional factory setting.

2-4. Read/write to a device number (command: DR/DW)

In the SFC2480F MFC series, device numbers (ID numbers) are assigned to each MFC and commands are used to control them.

Normally, commands are sent to an MFC by specifying its device number. Device numbers are specified as two digits, from 00 to 99.

2-5. Read/write group numbers (command: GR/GW)

When you want to send a command to a group of MFCs, specify the group number for these MFCs. Specify group numbers as two digits, from 00 to 99. Use numbers that are different from the device numbers already assigned.

There is a special case of group numbers. If the group number "AL" is used, a command is sent to all of the MFCs that are connected. However, commands sent to a group of MFCs using a group number, or by specifying "AL", are limited to commands that do not require or allow a response from the MFCs.

2-6. Command level

Commands used by the 2480F series can generally be classified into tree types (command levels 0 to 2). The command transmission procedure is different for each command level.

(1) Command level 0: Operation setting commands

Use these commands to change the settings in MFCs. The setting for a group of MFCs can be changed at the same time by specifying a group number or by using "AL" for the group number.

Normally, MFCs do not send responses back to the host PC. When the checksum is enabled and a device number is specified, the will MFC send back a response.

Ex.: a) Open the valves on all the MFCs.

Host => MFC AL, VO [CR] [LF]
MFC => Host (No response is sent)

b) Hold the valve open on MFC device number 03.

Host => MFC 03, VH [CR] [LF]
MFC => Host (No response is sent)

c) Close the valve on MFC device number 05 (When the checksum is ON)

Host => MFC 05, VCC [CR] [LF] (the "C" just in front of the [CR] is the checksum code)
MFC => Host 05, AKE [CR] [LF] (the "E" just in front of the [CR] is the checksum code)

d) Open the valves on all the MFCs (When the checksum is ON)

Host => MFC AL, VO3 [CR] [LF] (the "3" just in front of the [CR] is the checksum code)
MFC => Host (No response is sent)

(2) Command level 1: Read commands

Used to read data from an MFC. Group numbers or "AL" cannot be used instead of a device number. (However, the device number read command can use the group number or "AL." In this case, connect only one MFC to the interface.)

Each complete process is as follows: A host sends a command to an MFC and the MFC sends back a response to the host.

Ex.: Read the flow rate output of an MFC (device number 02)

Host => MFC 02, OR [CR] [LF]
MFC => Host 02, +05000 [CR] [LF]

(3) Command level 2: Write commands

Used to write data to an MFC. Group numbers or "AL" cannot be used instead of a device number.

Each complete process is as follows:

a. A host sends a command 1 to a specific MFC.
b. The MFC sends back a response 1 to the host.
c. The host sends a command 2 (sends data) to the MFC.
d. The MFC sends a response 2 (returns the data sent) to the host.

For internal processing reasons, the data that are sent back from the MFC as response 2 will be identical to the data sent by response 2.

Complete the sending of Command 2 within 30 seconds after Response 1 is received.

Ex.: Write a digital setting to MFC device number 02.

Host => MFC 02, SW [CR] [LF]
MFC => Host 02, AK [CR] [LF]
Host => MFC 02, 05000 [CR] [LF]
MFC => Host 02, 04999 [CR] [LF]

2-7. Data format

The data format for commands and responses is as follows: the device number comes first, followed by the command (or data), and then a [CR] [LF]. When the checksum function is enabled, the checksum code (BCD) will be inserted before the [CR]. A comma (ASCII code 2Ch) must be added after the device number.

, $$ ([BCC]) [CR] [LF]

##: Device number, group number, or "AL."

$$: Command or data (2 to 6 characters)

[BCC]: Checksum hex digit ("0" to "9", "A" to "F")

[CR]: Carriage return (ASCII 0Dh)

[LF]: Line feed code (ASCII 0Ah)

The characters used for commands in computers using a Japanese language operating system are half-size uppercase letters and numbers. Half-size katakana and full-size (2-byte) characters cannot be used.

* There are some commands that do not allow a checksum to be added, even if the checksum function is enabled.

2-8. Return timing

For commands that generate a response from the MFC, normally the MFC returns a response within 30 ms after receiving the command.

2-9. Waiting between commands

When the host receives a series of level 0 commands at high speed, its internal processing may not catch up with the command string. In order to receive level 0 commands at 9600 bps or faster, a waiting time of 10 ms or longer must be left between commands.

When the MFC receives the all reset command or a software reset command, it will take 200 ms to reset or restart. During this interval, the MFC cannot receive any other commands.

2-10. Switching between send and receive (RS-485 only)

When using RS-485 to communicate with the MFCs, change the host to command receive status right after it sends command, or leave it always in command receive status, and check whether the data received is a command from a host or a response from an MFC using software.

3. Lists of commands

Table 1: Basic commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2	Response 2	
OR	Read output	1	dv,OR ([BCC])[CR][LF]	dv,+/-***** ([BCC])[CR][LF]			0%=>00000 100%=>10000 *1
SR	Read setting	1	dv,SR ([BCC])[CR][LF]	dv,+/-***** ([BCC])[CR][LF]			0%=>00000 100%=>10000 *1
SA	Read analog setting	1	dv,SA ([BCC])[CR][LF]	dv,+/-***** ([BCC])[CR][LF]			0%=>00000 100%=>10000 *1
SD	Read digital setting	1	dv,SD ([BCC])[CR][LF]	dv,+***** ([BCC])[CR][LF]			00000 (0%) to 10000 (100%) *1
SW	Write digital setting	2	dv,SW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 (0%) to 10000 (100%) *1
CA	Change setting mode to analog	0	dv (AL/gr),CA	(dv,AK[BCC][CR][LF])			
CD	Change setting mode to digital	0	dv (AL/gr),CD	(dv,AK[BCC][CR][LF])			
CF	Fast control speed	0	dv (AL/gr),CF	(dv,AK[BCC][CR][LF])			
CS	Slow control speed	0	dv (AL/gr),CS	(dv,AK[BCC][CR][LF])			
VS	Valve servo	0	dv (AL/gr),VS	(dv,AK[BCC][CR][LF])			
VO	Open valve	0	dv (AL/gr),VO	(dv,AK[BCC][CR][LF])			
VC	Close valve	0	dv (AL/gr),VC	(dv,AK[BCC][CR][LF])			
VH	Hold valve	0	dv (AL/gr),VH	(dv,AK[BCC][CR][LF])			

Table 2: Alarm control commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
EA	Enable alarm A	0	dv (AL/gr),EA ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
DA	Disable alarm A	0	dv (AL/gr),DA ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
EB	Enable alarm B	0	dv (AL/gr),EB ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
DB	Disable alarm B	0	dv (AL/gr),DB ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
AA	Enable alarm mode	1	dv,AA ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-1
AB	Write alarm mode	2	dv,AB ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 8-1
CL	Clear alarm	0	dv (AL/gr),CL ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
RA	Read alarm code	1	dv,RA ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-5
TR	Read alarm timer	1	dv,TR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [s]
TW	Write alarm timer	2	dv,TW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [s]
AX	Read alarm extension mode	1	dv,AX ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-4
AV	Write alarm extension mode	2	dv,AV ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 8-4
AC	Read alarm A code	1	dv,AC ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-6
AM	Read alarm A mode	1	dv,AM ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-2
MA	Write alarm A mode	2	dv,MA ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 8-2
AR	Read alarm A window	1	dv,AR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [%]
AW	Write alarm A window	2	dv,AW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [%]
AI	Read alarm A window 2	1	dv,AI ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [%]
AH	Write alarm A window 2	2	dv,AH ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [%]
BC	Read alarm B code	1	dv,BC ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-7
BM	Read alarm B mode	1	dv,BM ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 8-3
MB	Write alarm B mode	2	dv,MB ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 8-3
BR	Read alarm B window	1	dv,BR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [%]
BW	Write alarm B window	2	dv,BW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [%]
BI	Read alarm B window 2	1	dv,BI ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [%]
BH	Write alarm B window 2	2	dv,BH ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [%]
BS	Preset alarm B at the rated point	0	dv (AL/gr),BS ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
Bn	Preset alarm B (n: 1 to 3)	0	dv (AL/gr),Bn ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
RV	Read alarm B valve preset open level.	1	dv,RV ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 (0%) to 10000 (100%)
WV	Write alarm B valve preset open level	2	dv,WV ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 (0%) to 10000 (100%)

Table 3: Setting command details

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
MR	Read mode	1	dv,MR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 9-1
ST	Read memory switch	1	dv,ST ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]			See table 9-2
SM	Read switch	1	dv,SM ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 9-3
RP	Change ramp coefficient unit (as a percent of one second)	0	dv (AL/gr),RP ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
RT	Change ramp coefficient unit to sec.	0	dv (AL/gr),RT ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
LR	Read ramp coefficient	1	dv,LR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			40 to 65535 [0.1 s,%/s]
LW	Write ramp coefficient	2	dv,LW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	40 to 65535 [0.1 s,%/s]
C3	Control to close at lower setting	0	dv (AL/gr),C3 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
C4	Control to hold at lower setting	0	dv (AL/gr),C4 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
CN	Control to operate normally below a lower setting	0	dv (AL/gr),CN ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
CR	Read lower setting control mode	1	dv,CR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00=Normal, 03=Close, 04=Hold
RC	Read lower setting	1	dv,RC ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [0.1 %]
WC	Write lower setting	2	dv,WC ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [0.1 %]
WR	Read close delay timer	1	dv,WR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 99 [0.1 s]
WW	Write close relay timer	2	dv,WW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 99 [0.1 s]
VR	Read valve open level	1	dv,VR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 (Fully close) to 10000 (Fully open)
VW	Write valve open level	2	dv,VW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 (Fully close) to 10000 (Fully open)
NR	Read gas number	1	dv,NR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			Gas type, max. 6 types: 00 to 05
NW	Write gas number	2	dv,NW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	Gas type, max. 6 types: 00 to 05
FI	Reset CF	0	dv (AL/gr),FI ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
FR	Read CF	1	dv,FR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			1.0000=>10000 07500 to 15000
FW	Write CF	2	dv,FW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	1.0000=>10000 07500 to 15000
JR	Read CF2	1	dv,JR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			1.0000=>10000
JW	Write CF2	2	dv,JW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	1.0000=>10000
JK	Read CF2B	1	dv,JK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			1.0000=>10000
ZR	Read extension mode	1	dv,ZR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 9-4
ZW	Write extension mode	2	dv,ZW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 9-4
AZ	Set analog input to zero	0	dv (AL/gr),AZ ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
AS	Set analog input to 100%	0	dv (AL/gr),AS ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
ZS	Zero switch	0	dv (AL/gr),ZS ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
AL	Reset all	0	dv (AL/gr),AL[CR][LF]				
RE	Reset software	0	dv (AL/gr),RE ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			

Table 4: Start up operation setting commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
KR	Read start up mode	1	dv,KR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 10-1
KW	Write start up mode	2	dv,KW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 10-1
PR	Read start up mode2	1	dv,PR ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			See table 10-2
RW	Write start up mode2	2	dv,PW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 10-2
YR	Read valve open level at start up	1	dv,YR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 (fully close) to 10000 (fully open)
YW	Write valve open level at start up	2	dv,YW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 (fully close) to 10000 (fully opne)
RD	Read digital setting at start up	1	dv,RD ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 (0%) to 10000 (100%) *1
WD	Write digital setting at start up	2	dv,WD ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 (0%) to 10000 (100%) *1
XR	Read ramp coefficient at start up	1	dv,XR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			40 to 65536 [0.1s,%/s]
XW	Write ramp coefficient at start up	2	dv,XW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	40 to 65536 [0.1s,%/s]
PA	Power ON analog setting mode	0	dv (AL/gr),PA ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
PS	Power ON preset setting mode	0	dv (AL/gr),PS ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			

Table 5: Integration function commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
II	Clear integration	0	dv (AL/gr),II ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
IG	Start integration	0	dv (AL/gr),IG ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
IS	Stop integration	0	dv (AL/gr),IS ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
IM	Save integration value	0	dv (AL/gr),IM ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
E1	Enable integration alarm 1	0	dv (AL/gr),E1 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
E2	Enable integration alarm 2	0	dv (AL/gr),E2 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
D1	Disable integration alarm 1	0	dv (AL/gr),D1 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
D2	Disable integration alarm 2	0	dv (AL/gr),D2 ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
IR	Read integration value	1	dv,IR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 to 99999 [Integration unit
IY	Read integration flow rate units	1	dv,IY ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]			00 to 06, See table 11-1
IU	Write integration flow rate units	2	dv,IU ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	00 to 06, See table 11-1
1R	Read integration alarm value 1	1	dv,1R ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00000 to 99999 [Integration unit]
1W	Write integration alarm value 1	2	dv,1W ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 to 99999 [Integration unit]
2R	Read integration alarm value 2	1	dv,2R ([BCC])[CR][LF]	dv,*****			00000 to 99999 [Integration unit]
2W	Write integration alarm value 2	2	dv,2W ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00000 to 99999 [Integration unit]
IQ	Read integration condition	1	dv,IQ ([BCC])[CR][LF]	dv,**			See table 1-1-2
IJ	Write integration condition	2	dv,IJ ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	See table 1-1-2
RI	Read integration status	1	dv,RI ([BCC])[CR][LF]	dv,*** ([BCC])[CR][LF]			See table 1-1-3

Table 6: Communication condition setting commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
DR	Read device number	1	dv (AL/gr),DR ([BCC])[CR][LF]	dv,dv ([BCC])[CR][LF]			
DW	Write device number	2	dv,DW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,dv' ([BCC])[CR][LF]	dv',dv' ([BCC])[CR][LF]	
GR	Read group number	1	dv (AL/gr),GR ([BCC])[CR][LF]	dv,gr ([BCC])[CR][LF]			
GW	Write group number	2	dv,GW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,gr' ([BCC])[CR][LF]	dv,gr' ([BCC])[CR][LF]	
TP	Change communication format	2	dv,TP ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	01 to 09, 0A, 0B, 0C See table 1-2-1
TS	Change communication speed	2	dv,TS ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	dv,** ([BCC])[CR][LF]	01 to 05 See table 1-2-2
SC	Turn OFF checksum	0	dv (AL/gr),SC[CR][LF]				
SS	Turn ON checksum	0	dv (AL/gr),SS[CR][LF]				
QI	Reset F･S	0	dv (AL/gr),QI ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
QR	Read F･S	1	dv,QR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00001 to 99999
QW	Write F･S	2	dv,QW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00001 to 99999
HI	Reset F･S2	0	dv (AL/gr),HI ([BCC])[CR][LF]	(dv,AK[BCC][CR][LF])			
HR	Read F･S2	1	dv,HR ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]			00001 to 99999
HW	Write F･S2	2	dv,HW ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	dv,***** ([BCC])[CR][LF]	00001 to 99999

Table 7: Other commands

Command	Description	Command level	Format				Data format
			Command 1 (HOST=>MFC)	Response 1 (MFC=>HOST)	Command 2 (HOST=>MFC)	Response 2 (MFC=>HOST)	
VE	Read version number	1	dv,VE ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]			
VN	Read serial number	1	dv,VN ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]			
OP	Read option	1	dv,OP ([BCC])[CR][LF]	dv,O* ([BCC])[CR][LF]			
Gn	Read gas name (n: 0 to 2)	1	dv,Gn ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]			n=0: Gas name, 1: Flow rate, 2: Unit
Mn	Read user memory (n: 0 to 9)	1	dv,Mn ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]			
Un	Write user memory (n: 0 to 9)	2	dv,Mn ([BCC])[CR][LF]	dv,AK ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]	dv,****** ([BCC])[CR][LF]	

*1: When reading and setting the flow rate, the F-S value will be 100%. (F-S initial value = 10,000)
*2: When using preset operation: 0.1 sec. units
When operating from a program: If the option code is "03", unit = 1s. If the option code is "02," unit = 0.1 s.

dv: Device number. 2 ASCII characters (Normally, use 00 to 99.)
gr: Group number. 2 ASCII characters (Normally, use G0 to G9.)
AL: Code used to specify all MFCs.
[BCC]: Checksum code. Add the ASCII values of all bytes from the 1st character of a command or response to last byte just before the [BCC]. Divide the result by 256. The remainder is expressed as two hexadecimal digits. Add the 1st and 2nd digit and divide the sum by 16. Then convert this to a hexadecimal value (0 to F). Add the ASCII code for this character to the transmission.

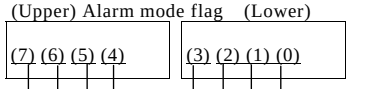
Command level 0: Operation setting commands
Commands used to change MFC operation. Specifying "AL" in place of a device number will address all the MFCs that are connected. Specifying a group number will specify all the MFCs in that group.
A complete communication is as follows:
Host => MFC: Command 1
(MFC => Host: Response 1 ["AK"]: When the checksum function is enabled and the device number is specified, a response will be returned. However, there are exceptions for some commands.)

Command level 1: Read command
Commands used to read data from an MFC. The device number must be specified. (There are exceptions for some commands.)
A complete communication is as follows:
Host => MFC: Command 1
MFC => Host: Response 1 (Data section)

Command level 2: Write command
Commands used to write to MFCs. The device number must be specified.
A complete communication is as follows:
Host => MFC: Command 1
MFC => Host: Response 1["AK"]
(Do not send another command during this interval. Send Command 2 within 30 seconds.)
Host => MFC: Command 2 (Data section)
MFC => MFC: Response 2 (Sends back data)

Table 8-1: Alarm mode

- The Alarm mode read/write commands read and set 8-bit alarm mode flags that show the settings for all of the alarms. Two ASCII hexadecimal digits are used.



Contents	Bit 0	Description
Hold alarm A	0	Is not held.
	1	Is held.

Contents	Bit 1	Description
Hold alarm A	0	Is not held.
	1	Is held.

(Reserved): Bit 2 data is always 0.
(Reserved): Bit 3 data is always 0.

Contents	Bit 4	Description
Alarm A terminal output detail	0	Outputs an alarm
	1	Outputs data

Contents	Bit 5	Description
Alarm B terminal output detail	0	Outputs alarm
	1	Outputs data

Contents	Bit 6	Description
Alarm A terminal output polarity	0	NO: On when alarm is output
	1	NC: OFF when alarm is output

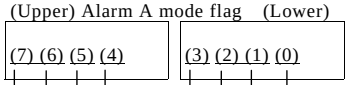
Contents	Bit 7	Description
Alarm B terminal output polarity	0	NO:ON when alarm is output
	1	NC: OFF when alarm is output

Ex.: When the alarm mode flag is 00[HEX] (=00000000[BIN]

Hold alarm A: Is not held	(Bit 0:0)
Hold alarm B: Is not held	(Bit 1:0)
	(Bit 2:0)
	(Bit 3:0)
Alarm A terminal output detail: Alarm is output	(Bit 4:0)
Alarm B terminal output detail: Alarm is output	(Bit 5:0)
Alarm A terminal output polarity: Number: ON when an alarm is output	(Bit 6:0)
Alarm B terminal output polarity: Number: ON when an alarm is output	(Bit 7:0)

Table 8-2: Alarm A mode

- The Alarm A mode read/write commands read and set 8-bit alarm mode flags that show the mask setting for alarm A. Two ASCII hexadecimal digits are used.



Content	Bit 0	Description
Power voltage error	0	Enabled
	1	Masked

Content	Bit 1	Description
Communication error	0	Enabled
	1	Masked

Content	Bit 2	Description
EEPROM error	0	Enabled
	1	Masked

Content	Bit 3	Description
Setting and output mismatch error	0	Enabled
	1	Masked

(Reserved): Bit 4 data is always 0.
(Reserved): Bit 5 data is always 0.

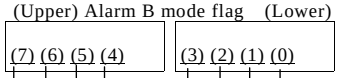
Content	Bit 6	Description
Integration level 2 over	0	Enabled
	1	Masked

(Reserved): Bit 7 data is always 0.

Table 8-3: Alarm B mode

- The Alarm B mode read/write commands read and set 8-bit alarm mode flags that show the mask setting for alarm B. Two ASCII hexadecimal digits are used.

(Upper) Alarm B mode flag (Lower)



Content	Bit 0	Description
Zero offset error	0	Enabled
	1	Masked

Content	Bit 1	Description
Sensor output change	0	Enabled
	1	Masked

Content	Bit 2	Description
Sensor output change	0	Enabled
	1	Masked

Content	Bit 3	Description
Sensor voltage change	0	Enabled
	1	Masked

Content	Bit 4	Description
Valve voltage change	0	Enabled
	1	Masked

Content	Bit 5	Description
Analog setting valve change	0	Enabled
	1	Masked

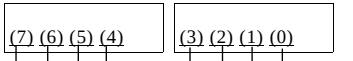
Content	Bit 6	Description
Integration level 1 exceeded	0	Enabled
	1	Masked

(Reserved): Bit 7 data is always 0.

Table 8-4: Alarm Extension mode

- The Alarm Extension mode read/write commands read and set 8-bit alarm extension mode flags that show the settings of the extension alarm function. Two ASCII hexadecimal digits are used.

(Upper) Alarm extension mode flag (Lower)



Content	Bit 0	Description
Increase of alarm B analog setting	0	Is monitored
	1	Is not monitored

Content	Bit 1	Description
Decrease of alarm B analog setting	0	Is monitored
	1	Is not monitored

Content	Bit 2	Description
Alarm B mode	0	Monitor rated point change
	1	Slide setting

Content	Bit 3	Description
Alarm A window	0	Against full scale
	1	Against the setting

Content	Bit 4	Description
Alarm A window 2	0	Disabled
	1	Enabled

Content	Bit 5	Description
Alarm B window 2	0	Disabled
	1	Enabled

Content	Bit 6	Description
Alarm B window	0	Against full scale
	1	Against the pre-set

(Reserved): Bit 7 data is always 0.

Table 8-5: Alarm code

- The Alarm code read command reads the status for alarms that occur. Two ASCII hexadecimal digits are used.

Alarm code
(Upper) (Lower)
# #

Content	2nd digit	Description
Alarm B status	0	Normal
	1	Integration alarm B
	I	Sensor current changed
	V	Valve voltage changed
	T	Sensor bridge voltage changed
	S	Analog setting changed
	O	Sensor output changed
	Z	Too large a zero offset

Content	1st digit	Description
Alarm A status	0	Normal
	2	Integration alarm A
	C	Mismatch between setting and output
	T	Communication error
	P	Power supply voltage dropped
	E	EEPROM data error

Table 8-6: Alarm A code

- The Alarm A code read command reads the 8-bit alarm A code flags which show the status of alarm A when an alarm occurs. Two ASCII hexadecimal digits are used.

(Upper) Alarm mode flag (Lower)
(7) (6) (5) (4) (3) (2) (1) (0)

Content	Bit 0	Description
Power voltage error	0	Normal
	1	Alarm occurred

Content	Bit 1	Description
Communication error	0	Normal
	1	Alarm occurred

Content	Bit 2	Description
EEPROM error	0	Normal
	1	Alarm occurred

Content	Bit 3	Description
Setting and output mismatch error	0	Normal
	1	Alarm occurred

(Reserved): Bit 4 data is always 0.
(Reserved): Bit 5 data is always 0.

Content	Bit 6	Description
Integration level 2 exceeded	0	Normal
	1	Alarm occurred

Content	Bit 7	Description
Alarm A disabled/enabled	0	Disabled
	1	Enabled

Table 8-7: Alarm B code

- The Alarm B code read command reads the 8-bit alarm B code flags which show the status of alarm B when an alarm occurs. Two ASCII hexadecimal digits are used.

(Upper) Alarm mode flag (Lower)
(7) (6) (5) (4) (3) (2) (1) (0)

Content	Bit 0	Description
Zero offset error	0	Normal
	1	Alarm occurred

Content	Bit 1	Description
Sensor output changed	0	Normal
	1	Alarm occurred

Content	Bit 2	Description
Sensor current changed	0	Normal
	1	Alarm occurred

Content	Bit 3	Description
Sensor voltage changed	0	Normal
	1	Alarm occurred

Content	Bit 4	Description
Valve voltage changed	0	Normal
	1	Alarm occurred

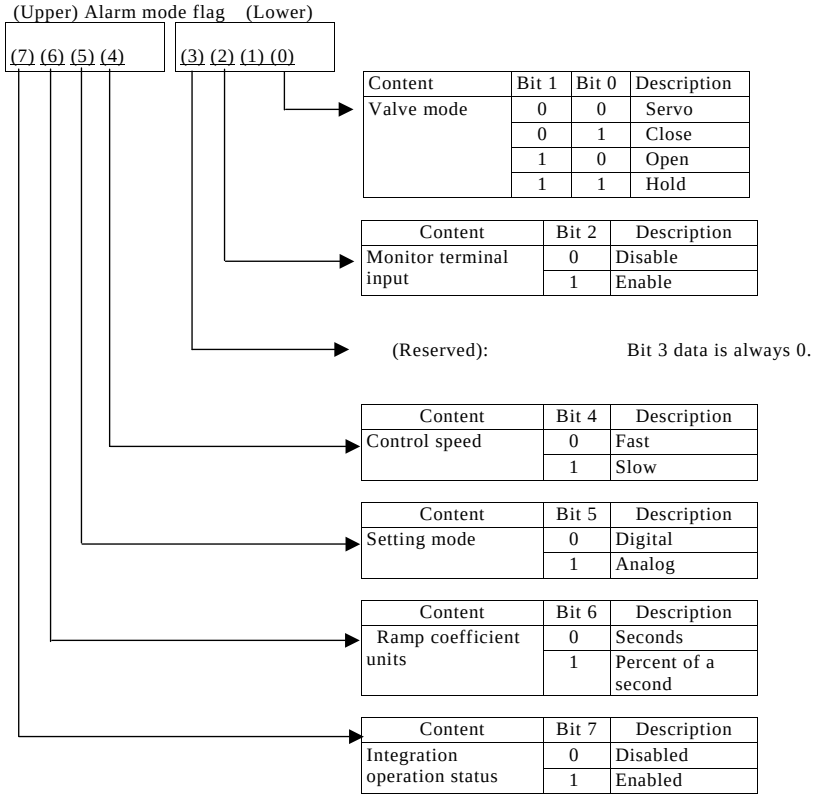
Content	Bit 5	Description
Analog setting changed	0	Normal
	1	Alarm occurred

Content	Bit 6	Description
Integration level 1 exceeded	0	Normal
	1	Alarm occurred

Content	Bit 7	Description
Disable/enable Alarm B	0	Disable
	1	Enable

Table 9-1: Mode flag

- The Mode read command reads the 8-bit alarm mode flags that show the control status of an MFC. Two ASCII hexadecimal digits are used.



Content	Bit 1	Bit 0	Description
Valve mode	0	0	Servo
	0	1	Close
	1	0	Open
	1	1	Hold

Content	Bit 2	Description
Monitor terminal input	0	Disable
	1	Enable

(Reserved): Bit 3 data is always 0.

Content	Bit 4	Description
Control speed	0	Fast
	1	Slow

Content	Bit 5	Description
Setting mode	0	Digital
	1	Analog

Content	Bit 6	Description
Ramp coefficient units	0	Seconds
	1	Percent of a second

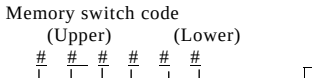
Content	Bit 7	Description
Integration operation status	0	Disabled
	1	Enabled

Ex.: When the mode flag is 20[HEX] (=00100000[BIN]

Valve mode: Servo	(Bit 1: 0, Bit 0: 0)
Terminal input: Disabled	(Bit 2: 0)
	(Bit 3: 0)
Control speed: Fast	(Bit 4: 0)
Setting mode: Analog	(Bit 5: 1)
Ramp coefficient units: Seconds	(Bit 6: 0)
Integration operation: Disabled	(Bit 7: 0)

Table 9-2: Memory switch

- The Memory switch read command reads the MFC control status and reports it using six ASCII characters.



Content	6th digit	Description
Valve mode when below the lower setting	C	Close
	H	Hold
	N	Normal

Content	5th digit	Description
Control speed	F	Fast
	S	Slow

Content	4th digit	Description
Valve mode	H	Hold
	S	Servo
	1	Max. valve voltage
	0	Min. valve voltage

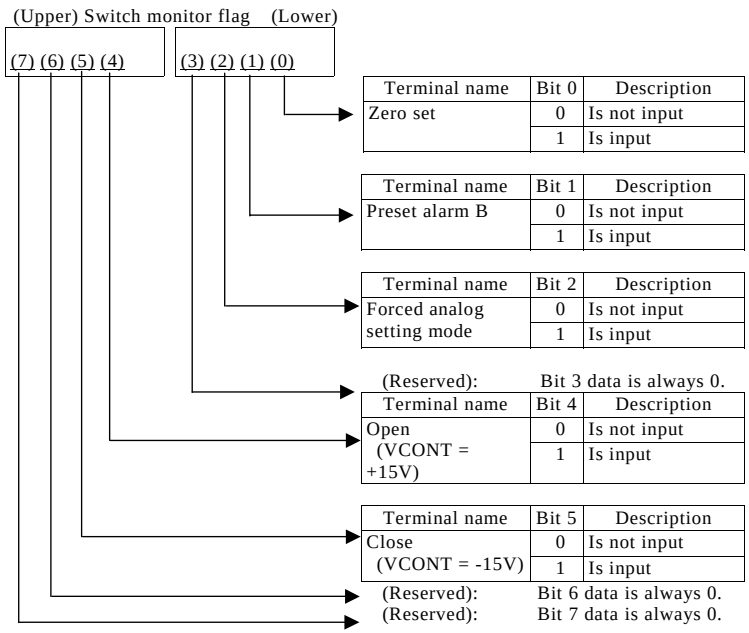
Content	3rd digit	Description
Setting mode	A	Analog
	D	Digital

Content	2nd digit	Description
Alarm B	D	Disabled
	E	Enabled

Content	1st digit	Description
Alarm A	D	Disabled
	E	Enabled

Table 9-3: Switch monitor

- The Switch read command reads the 8-bit switch monitor flags that show the terminal input status. Two ASCII hexadecimal digits are used.



Terminal name	Bit 0	Description
Zero set	0	Is not input
	1	Is input

Terminal name	Bit 1	Description
Preset alarm B	0	Is not input
	1	Is input

Terminal name	Bit 2	Description
Forced analog setting mode	0	Is not input
	1	Is input

(Reserved): Bit 3 data is always 0.

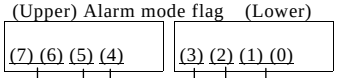
Terminal name	Bit 4	Description
Open (VCONT = +15V)	0	Is not input
	1	Is input

Terminal name	Bit 5	Description
Close (VCONT = -15V)	0	Is not input
	1	Is input

(Reserved): Bit 6 data is always 0.
(Reserved): Bit 7 data is always 0.

Table 9-4: Extension mode

- The extension mode read/write commands read and set the 8-bit extension mode flags that show the extension function settings. Two ASCII hexadecimal digits are used.



Content	Bit 1	Bit 0	Description
Extension operation mode	0	0	MFC
	0	1	SMV
	1	0	ECV (Forward operation)
	1	1	ECV (Reverse operation)

Content	Bit 2	Description
Analog setting input-voltage range	0	0 to 5V
	1	1 to 5V

Content	Bit 3	Description
Analog setting input voltage control	0	Default value at factory
	1	Set by user

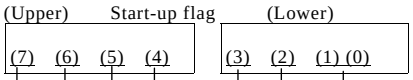
Content	Bit 4	Description
Output voltage range	0	0 to 5V
	1	1 to 5V

(Reserved): Bit 5 data is always 0.

Content	Bit 7	Bit 6	Description
Analog output	0	0	Flow rate output
	0	1	Setting
	1	0	Digital setting
	1	1	Analog setting

.Table 10-1: Start-up mode

- The Start-up mode read/write commands are used to read and set the 8-bit start mode flags which contain the settings used when the MFCs are started. Two ASCII hexadecimal digits are used.



Content	Bit 1	Bit 0	Description
Valve mode when starting	0	0	Servo
	0	1	Close
	1	0	Open
	1	1	Hold

Content	Bit 2	Description
Setting mode when starting	0	Digital
	1	Analog

Content	Bit 3	Description
Latch valve mode when starting	0	According to bit 0 and 1
	1	Latch the last valve mode

Content	Bit 4	Description
Latch digital setting when starting	0	Use a new digital setting
	1	Latch the last digital setting

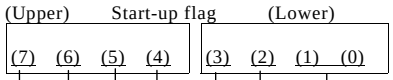
Content	Bit 5	Description
Valve-open level when starting	0	Set a new valve-open level
	1	Latch the last valve-open level

Content	Bit 6	Description
Latch setting when starting	0	According to bit 2
	1	Latch the last setting mode

(Reserved): Bit 7 data is always 0

Table 10-2: Start mode 2

- The Start-up mode 2 read/write commands are used to read and set the 8-bit start mode 2 flags which contain the settings used when the MFCs are started. Two ASCII hexadecimal digits are used.



Content	Bit 2	Description
Latch the control speed when starting	0	According to bit 4
	1	Latch the last control speed

(Reserved): Bit 1 data is always 0.

Content	Bit 2	Description
Latch the mode ramp coefficient when starting	0	According to bit 6
	1	Latch the last mode

Content	Bit 3	Description
Latch the integration operation when starting	0	According to bit 7
	1	Latch the last integration operation

Content	Bit 4	Description
Control speed when starting	0	Fast
	1	Slow

(Reserved): Bit 5 data is always 0.

Content	Bit 6	Description
Lamp mode coefficient when starting	0	Seconds
	1	Percent of a second

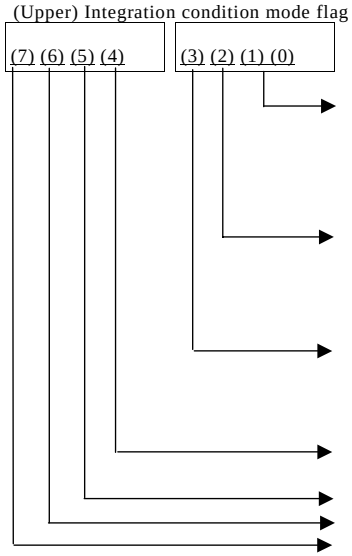
Content	Bit 7	Description
Integration operation when starting	0	Stop integration
	1	Integrate

Table 11-1: Integration units

Integration unit number	Unit volume (time to increment by 1 at a continuous flow of 100% of the flow rate)	Ex.: Mass volume according to integration value 1 when using 500SCM MFC.	Time needed for overflow when continuously flowing at 100%
00	10 min.	5.0l	Approx. 694 days
01	5 min.	2.5l	Approx. 347 days
02	1 min.	500cc	Approx. 69 days
03	30 sec.	250cc	Approx. 35 days
04	6 sec.	50cc	Approx. 167 hours
05	3 sec.	25cc	Approx. 83 hours
06	0.6 sec.	5cc	Approx. 17 hours

Table 11-2: Integration conditions

- The Integration read/write commands are used to read and set the 8-bit integration condition flags that control the integration operation settings. Two ASCII hexadecimal digits are used.



Content	Bit 1	Bit 0	Description
Integration halt flow rate	0	0	0% or less
	0	1	2% or less
	1	0	5% or less
	1	1	10% or less

Content	Bit 2	Description
Operation when opening a valve	0	Continue integration
	1	Stop integration

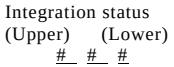
Content	Bit 3	Description
Operation when closing a valve	0	Continue integration
	1	Stop integration

Content	Bit 4	Description
Object to integrate	0	Flow rate output
	1	Analog input

(Reserved): Bit 5 data is always 0.
(Reserved): Bit 6 data is always 0.
(Reserved): Bit 7 data is always 0.

Table 11-3: Integration status

- The integration status read commands are used to read the integration operating status. Thee ASCII characters are used.



Content	3rd digit	Description
Integration alarm level 1	D	Disabled
	E	Enabled

Content	2nd digit	Description
Integration alarm level 2	D	Disabled
	E	Enabled

Content	1st digit	Description
Integration operation	G	Integrating
	S	Integration stopped

Table 12-1: Communication format

Data to set	Character length (in bits)	Parity	Number of stop bits
01	7	None	2
02	7	None	1
03	8	None	2
04	8	None	1
05	7	Odd	2
06	7	Odd	1
07	8	Odd	2
08	8	Odd	1
09	7	Even	2
0A	7	Even	1
0B	8	Even	2
0C	8	Even	1

Table 12-2: Communication speed

Data to set	Speed (bps)
01	1200
02	2400
03	4800
* 04	9600
* 05	19200

* When using a communication speed of 9600 bps or faster, consider the processing capacity limitations of the host controller and the requirements for laying data cable.
* When using a speed of 9600 bps or faster, insert a wait time of 10 ms or more between commands.

4. Command setting

4-1. Basic commands (See table 1)

1) Valve mode

Serve (Command: VS): Controls the valve-open level so that the flow rate output matches the flow rate setting.

Close (Command: VC): Close the valve completely, regardless of the flow rate output or flow rate setting.

Open (Command: VO): Open the valve completely, regardless of the flow rate output or flow rate setting.

Hold (Command: VH): Maintain the same valve-open level, regardless of the flow rate output or flow rate setting.

* The valve mode can be changed by either a terminal input or by a command. The terminal input has priority.
* Even if the setting mode is analog, the valve mode can be changed by a command.

2) Select the flow rate setting mode

Analog (Command: CA): Uses the input voltage setting as the flow rate setting.

Digital (Command: CD): Uses the number entered with a command as the flow rate setting.

3) Set the control speed

Change the time constant between a change in the flow rate setting and the time when the flow rate output changes after the servo is set to valve mode.

Fast (Command: CF): Let the flow rate output follow the flow rate setting as quickly as possible.

Slow (Command: CS): When the setting mode is analog, the controls are set to match the flow rate output to the flow rate setting after 4 seconds.
When the setting mode is digital, the controls match the flow rate output with the flow rate setting according to the ramp coefficient.

4-2 Alarm Control command (See table 2)

1) Disable/Enable Alarm (Alarm A: Command: DA/EA, Alarm B: Command: DB/EB)

Disable/Enable Alarm A and Alarm B output to each output terminal. Use the Disable/Enable command to make each setting. To check the enabled/disabled status, use Memory Switch read command and the Alarm A/B code read command.

2) Alarm Mask

The monitoring of unneeded alarms can be disabled. To set the alarm mask, use the Alarm A mode flag read/write (Command: AM/MA) and Alarm B mode flag read/write (Command: BM/MB).

3) Read/Write Alarm Timer (Command: TR/TW)

The interval after an alarm occurs until the host controller outputs an alarm can be specified. If the cause of an alarm is restored to normal during this interval, the alarm output will not be turned ON. However, some causes of alarms turn the alarm output on immediately after the alarm occurs, regardless of this alarm timer setting. The alarm timer setting is used by both alarm A and alarm B.

4) Alarm Hold

When an alarm cause occurs, and the cause is not restored to normal during the delay interval for the alarm timer, the MFC turns ON the alarm output. The MFC can be set to continue or turn OFF this alarm output when the cause of the alarm is removed. If alarm hold is selected, you must send an Alarm Clear command to turn the alarm off. In addition, with this selection, the MFC will store a maximum of 10 alarm causes since the last time an alarm clear command was given. If another alarm occurs while the last alarm is occurring, the MFC

may not clear the alarm output by issuing a single Alarm Clear command.

The MFC does not automatically return to the normal, depending on the alarm cause. When any of these special alarm causes exists, the MFC will maintain the alarm and it cannot be turned off. Use this function to select whether or not to store these error causes.

To select alarm hold, use the Alarm Mode read/write command (Command: AA/AB).

7) Read/Write the Alarm Window (Command: AR/AW)

Reads and sets the alarm detection width.

8) Read/Write Alarm Window 2 (Command: AM/MA)

Alarm window 2 is used to specify both the upper allowable amount (object > standard) and lower allowable amount (object < standard), independently. Alarm window 2 is used to set the upper allowable amount. Alarm window 2 can be used when only the alarm extension mode is enabled.

9) Constant point monitor change mode

When the constant point alarm B preset command (Command: BS) is input, the MFC stores each of the settings as fixed values. Select this mode when you want to use the MFC with the fixed settings.

If this mode is selected, the MFC latches the analog settings when the constant point analog B preset command is entered and uses them as the reference values, regardless of whether analog or digital is selected for the setting mode. With this setting, you can control the MFC in the digital setting mode, use the analog input as an external input, and set the MFC to output an alarm signal when the external input value changes.

10) Setting the slide mode

Operate the MFC with different three settings, and enter an Alarm B preset command (Command: B1, B2, B3) at each point. The order of these B1, B2, and B3, and the upper and lower settings is not restricted.

If the setting changes when the Alarm B preset command is entered, the MFC calculates the standard value for the setting and detects an alarm. However, the MFC will calculate the standard value with a linear correction, and if the setting is too much different from the setting entered using the Alarm B preset command, an alarm may occur even though the MFC condition is normal.

4-3 Detailed setting commands (See table 3)

1) Read/write the Valve-open level (Command: VR/VW)

The MFC can read and set the voltage sent to the valve actuator.

The valve-open level write command can only be issued when the valve is in hold mode. When the pressure difference is constant and the flow rate setting is the same, the valve-open level will show almost the same value. However, when the pressure difference changes, or an object gets stuck inside the valve, the valve-open level will change.

2) Read/write the ramp coefficient (Command: LR/LW)

When the valve is in servo mode, the setting mode is digital and the control speed setting is slow, the time lag after the flow rate setting changes until the flow rate output changes can be specified.

3) Switch Over ramp coefficient unit

Percent of a second (Command: RP): Changes the flow rate output in units of (ramp coefficient x 0.1) per second.

Seconds (Command: RT): Control to make the flow rate output equal to the flow rate setting after (ramp coefficient x 0.1) seconds.

4) 2% Control mode

Regulates the control status when the flow rate setting is less than 2%.

Close at 2% (Command: C3): The valve closes.

Hold at 2% (Command: C4): Always maintains a 2% flow

Normal at 2% (Command: CN): Executes normal control.

5) Read/write the gas number (Command: NR/NW)

Calibration gas data can be read and set.

After changing the gas number, issue a software reset command (command: RE) or reapply the power to reset the unit.

When the current gas number and calibration gas data are not known, you can read the gas number and adjustment description using the gas number read command and the gas name read command, respectively.

* The MFC can store a maximum of 6 types of calibration data inside. (Factory option)

6) Read/write CF (Command: FR/FW)

Regardless of gas type used, "10000" is specified when delivered.

Rewrite this value when the specified flow rate deviates from the actual flow rate in any of the following cases:

- The gas being used has not changed but the gas temperature may have changed greatly.
- A small ratio of other gas might be mixed in.

However, the value should always be set within 7500 to 15000.

7) Read/write CF2 (Command: JR/JW)

When delivered, the conversion factor between the gas being used and nitrogen was entered here.

If you want to use a different gas, and conversion factor for this gas compared with nitrogen is already known, rewrite this value. When CF2 is changed, CF is also changed according to the following equation.

CF = (CF2) /(CF)(2B)

However, the value should always be set within 7500 to 15000.

Rewriting either CF or CF2 will lead to the same results. Rewriting the conversion factor for either CF or CF2 will change the other conversion factor automatically.

8) Read CF2B (Command: JK)

The CF2B conversion factor is entered in the MFC. This is a base value for CF2 and is the same as the CF2 setting when delivered. This value cannot be rewritten. It can only be read.

* When the conversion factor is changed, the flow rate precision is not guaranteed. Especially, when the conversion factor is decreased and the actual flow rate increases, the flow rate will be outside the linear correction function.

9) Reset CF (Command: FI)

Reset the CF and CF2 values to their default values when delivered.

10) Extension functions

Read and set the extension functions using Extension Mode read/write (Command: ZR/ZW).

(1) MFC: Executes MFC operation.

(2) SMV: Control the valve-open level directly according to the setting.

Although the MFC does not control the valve according to the flow rate, the flow rate output is available.

When the setting is 0%, the valve is fully closed. When the setting is 100%, the valve is fully open.

(3) ECV: The MFC uses the analog input value as an object for controlling the valve-open level, so as to make it equal to the digital setting.
Ex.: When a pressure sensor is connected to the analog input, the MFC can function as regulator.
Reverse operation: Increase the open level when the analog input value < digital setting
Forward operation: Increase the open level when the analog input value > digital setting

(4) Analog input voltage level setting
Specify the standard analog input value (normal flow rate setting)
0 to 5V: 0% when 0V, 100% when 5 V.
1 to 5V: 0% when 1V, 100% when 5 V.

(5) Specify the analog input voltage source
Specify the standard source for the analog input value (normal flow rate setting)
Factory setting: Follow the analog input voltage setting.
User setting: Follow the user specified voltage level.
When the analog zero set command is entered, the current analog value will be treated as 0% and when the analog value 100% set command is entered, the current analog value will be treated as 100%.
* These are for fine adjustment of 0 to 5 V and 1 to 5 V ranges. Although, this function can be used for the 0 to 1V range, the resolution will be deteriorated.

(6) Output voltage level
Specify the standard value for analog output (normal flow rate output).
0 to 5V: 0% when 0V, 100% when 5 V.
1 to 5V: 0% when 1V, 100% when 5 V.

(7) Analog output
Specify details of the analog output.
Flow rate output: Output the flow rate sensor reading after correcting it.
Setting: Output the value specified by the setting mode.
Digital setting: Output the digital setting that was entered using a command.
Analog setting: Output the input on the analog input terminal.

11) All reset (Command: AL)
Return all the user settings to the default factory values, and restart the system.
In addition to this command, pressing the zero point input switch for 30 seconds or more will cause the same reset operation to take place.
The checksum code cannot be added to this command, regardless of the status of the check sum function.

(1) Initial values after an all reset.

FS	:	10000
FS2	:	10000
CF	:	10000
CF2	:	Factory value
Digital setting	:	00000 * The setting in the start up mode has priority.
Valve-open level	:	00000 * The setting in the start up mode has priority.
Valve mode	:	Servo * The setting in the start up mode has priority.
Setting mode	:	Analog * The setting in the start up mode has priority.
Integration operation	:	Stop * The setting in the start up mode has priority.
Ramp coefficient unit	:	sec * The setting in the start up mode has priority.
Setting control speed	:	Fast* The setting in the start up mode has priority.
Communication speed	:	1200bps
Start bit	:	One bit (fixed)

Character length	:	7-bits (ASCII code)
Parity	:	None
Stop bits	:	2 bits
Checksum	:	Disabled
Integration value	:	Clear
Extension mode	:	00h
Extension operation mode	:	MFC mode
Analog input voltage setting	:	0 to 5V
Analog input voltage regulation	:	Factory setting
Output voltage level	:	0 to 5V
Analog output	:	Flow rate output

* The use of an all reset to reset the communication speed and format to the factory settings can be disabled.

(2) Zero Switch command (Command: ZS)

Correct the zero point of the internal flow rate sensor. When the flow rate is 0, enter this command. The MFC will perform the same operations as when you press the zero point input switch on top of the unit.

If the sensor output reading is larger than +/-10%/FS of the default value, a zero offset error will occur. If the value read is more than the +/-20%/FS the initial value, the MFC will not correct the zero point.

(3) Analog input zero/100% set (Command: AZ, AS)

Correct the analog input value.

(4) Software reset (Command: RE)

Reapplying the power causes the identical operation.

When the all reset command or a software reset command is received, the MFC takes 200 ms to perform an internal reset and then restart. During this period, the MFC cannot receive any other commands.

(5) Read Version number (Command: VE)

Return the version number of the software inside the MFC.

(6) Read Serial number (Command: VN)

Returns the serial number specific to each MFC.

(7) Read Option (Command: OP)

The current model returns "O2" as data.

(8) Read Gas name (Command: Gn, n=0 to 2)

Return the gas type calibration data specified by the gas number, and the full scale flow rate.

a) G0 command: Gas name
b) G1command: Full-scale flow rate
c) G2 command: Full-scale flow rate units

(9) Read/Write User Memory (Command: Mn/Un, n=0 to 2)

The MFC can store data. It can store 6 character ASCII codes as one string and it can store a maximum of 10 strings. These data are written into non-volatile memory.

The allowed ASCII codes are 20h to 60h. Lowercase letters cannot be used.

4-4. Start up operation setting commands (See table 4)

1) Read/Write Startup mode (Command: KR/KW)

Specify the unit's operation when the power is turned on. This setting will be effective if the CPU stops for any reason while the power is on or when a software reset command is received or if the unit is reset by hardware (the watchdog timer), and then restarts.

(1) Start up valve mode

Use when you want to force the MFC to use a certain valve mode when starting.

* Start up in valve hold mode (described later) has priority in this mode.

(2) Start up setting mode

Use when you want to force the MFC to use a certain setting mode when starting.

* Start up value set mode hold (describe later) has priority on this mode.

(3) Start up digital setting

Determines whether the last digital setting will be used or whether some other specified digital setting is used when starting. The setting mode will not change no matter which selection is made.

(4) Start up valve-open level

Determine whether the last valve-open level is used or some other specified valve-open level voltage setting will be used at start up. This is only useful when the start up valve hold mode is selected.

(5) Start up hold valve mode

Determines whether to keep the last valve mode or to follow the start up valve mode.

(6) Start up setting hold

Determines whether to hold the last setting mode or to follow the start up setting mode.

2) Power ON analog setting mode (Command: PA)

A command can be used to override the start up mode so that the MFC is forced into the analog setting mode. The same setting can be made using the start up write mode.

3) Power ON preset setting mode (Command: PS)

A command can be used to override the start up mode and keep the previous setting mode. The same setting can be made using the start up write mode.

4-5 Integration function command (See table 5)

Integrates flow rate output values. The MFC stores an integration value every 30 minutes. The integration setting (enabled/disabled) is stored in non-volatile memory so that it is saved when the power is off. In some power conditions, the settings may not be stored normally. If the MFC is used in environment with frequent power failures, we recommend forcibly storing the integration values using the integration value save commands at certain intervals (much less than 30 minutes). However, please note that number of times the non-volatile memory can be overwritten is limited to 100 thousand times.

While the integration conditions are met, the MFC will integrate on a 10 ms cycle. In its internal processing, the MFC calculates out to 0.01% units of the full scale. It will integrate up to 99999 times.

1) Read/write integration unit (Command: IY/IU)

Seven integration units can be set, from 00 to 06, ranging between 10 minutes and 0.6 seconds of the full-scale flow rate. (See table 11-1)

2) Read/write integration conditions (Command: IQ/IJ)

Reads and sets the integration conditions.

(1) Low flow rate integration halt

Halts integration when flow rate is too small. The rate at which integration is halted can be selected from 0, 2, 5, or 10%.

When the flow rate output value is negative, the integration function is not available.

(2) When opening a valve

Integration can be set to halt when the valve is opened. There is no need to stop the integration function when purging.

(3) Valve close mode

Integration can be halted when the valve is closed.

(4) Integration object

The analog input is an object that can be integrated. Select the digital setting mode on the MFC, and connect the flow meter output voltage to the analog input. Then this value can be integrated.

3) Integration alarm

Two types of values can be stored for use as integration alarm values. Using both the Alarm A and Alarm B output terminals, you can output alarm signals when the integration value is full. To enable/disable the alarms, set the Alarm modes for A and B.

The integration alarm is one of the possible triggers for Alarm A and B. The disable/enable alarm A and B settings have priority over the setting of this integration alarm.

4) Integration status monitor

The integration status can be monitored using the monitor read command (Command: MR) or the integration status read command (Command: RI).

4-6. Communication condition setting command (see table 6)

1) Enable/disable checksums (Command's/SC)

In order to improve communication reliability, checksum codes can be added to commands and responses. A description of the checksum code is as follows.

(1) All of the ASCII character codes in commands and response character strings (except [CR] and [LF]) are treated as numbers which are summed.

(2) The total is divided by 256 (100h) and this result is expressed in two hexadecimal digits.

(3) The upper and lower hexadecimal digits are added together.

(4) The result is divided by 16 and the first digit of this number is the checksum code. Place the checksum code just before the [CR] in command character strings and response character strings.

The MFC will execute a command if its calculated check sum matches the check sum code that accompanied the command.

Ex.: Command character strings 05,OR [CR][LF]

"0" "5" "," "O" "R"

30h + 35h + 2Ch + 4Fh + 52h = 132h

132h / 100h = 1h SURPLUS 32h

3h + 2h = 5h

5h / 10h = 0h SURPLUS 5h

The checksum code will be 5 (35h).

The string sent will be 05,OR5 [CR][LF].

When the checksum function is enabled, the MFCs return a response to all commands including commands that normally do not give a response, as long as a device number is specified.

The checksum enable/disable command itself is not attached to the checksum code.

The checksum status (enabled/disabled) is stored in non-volatile memory.

2) Full scale setting

(1) Read/Write Full Scale (FS) (Command: QR/QW)

The MFC has a full-scale value. Overwriting this value will not change the gas flow rate itself. This value only represents 100% when reading and setting the flow rate using commands. When delivered this value is set to 1000.

When you want to read and set the actual flow rate from a host program, over write this value with the full-scale flow rate of the MFC. However, any flow rate to the right of the decimal point cannot be entered.

The full-scale value can be set up to 99999. But this does not mean that the resolution becomes 9.99999x.

(2) Full Scale 2 (FS2) (Command: HR/HW)

This value is the full-scale value used when in SMV mode or ECV mode (described later). The 100% value is also shown.

(3) Reset Full Scale (FS: Command: QI, FS2: Command: HI)

Reset the FS and FS2 values to their factory settings.