MELSEC System Q

Programmable Logic Controllers

Programming Manual
(Process Control Instructions)

QnPH CPUs

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SH (NA)-080316
Version A

• SAFETY CAUTIONS •

(You must read these cautions before using the product)

In connection with the use of this product, in addition to carefully reading both this manual and the related manuals indicated in this manual, it is also essential to pay due attention to safety and handle the product correctly.

The safety cautions given here apply to this product in isolation. For information on the safety of the PLC system as a whole, refer to the CPU module User's Manual.

Store this manual carefully in a place where it is accessible for reference whenever necessary, and forward a copy of the manual to the end user.

A - 1

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	* Manual Number	Revision
Apr., 2002	SH (NA)-080316E-A	First edition

Japanese Manual Version SH-080265-A

INTRODUCTION

Thank you for purchasing the Mitsubishi MELSEC-Q Series (Q mode) PLC.
Before using the product, please read this manual carefully to develop full familiarity with the functions and performance of the Q Series (Q mode) PLC you have purchased, so as to ensure correct use.

CONTENTS

About Manuals

The manuals related to the Q/QnACPU are listed in the table below.
Please order those you require.

Related Manuals

Manual Name	Manual Number (Model Code)
Process CPU User's Manual (Hardware Design, Maintenance and Inspections) Describes the specifications of the CPU module, power supply module, base unit, expansion cables, and memory card. (Sold separately)	SH-080314E (13JR55)
Process CPU User's Manual (Function Explanation, Program Fundamentals) This manual explains the functions, programming methods, devices and so on necessary to create programs with the Process CPU. (Sold separately)	SH-080315E (13JR56)
QCPU (Q Mode)/QnACPU Programming Manual (Common Instructions) This manual describes how to use the sequence instructions, basic instruction and application instructions. (Sold separately)	SH-080039 (13JF58)
QCPU (Q mode)/QnACPU Programming Manual (SFC) Describes the system configuration, performance specifications, functions, programming, debugging, and error codes, for MELSAP3. (Sold separately)	SH-080041 (13JF60)
QCPU (Q mode) Programming Manual (MELSAP-L) Describes the system configuration, performance specifications, functions, programming, debugging, error codes and others of MELSAP-L. (Sold separately)	SH-080076 (13JF61)

A - 7

MEMO

A - 8

1 OVERVIEW

This manual describes the process control instructions equipped for the QnPHCPU.

1.1 Features

The process control instructions have the following features.

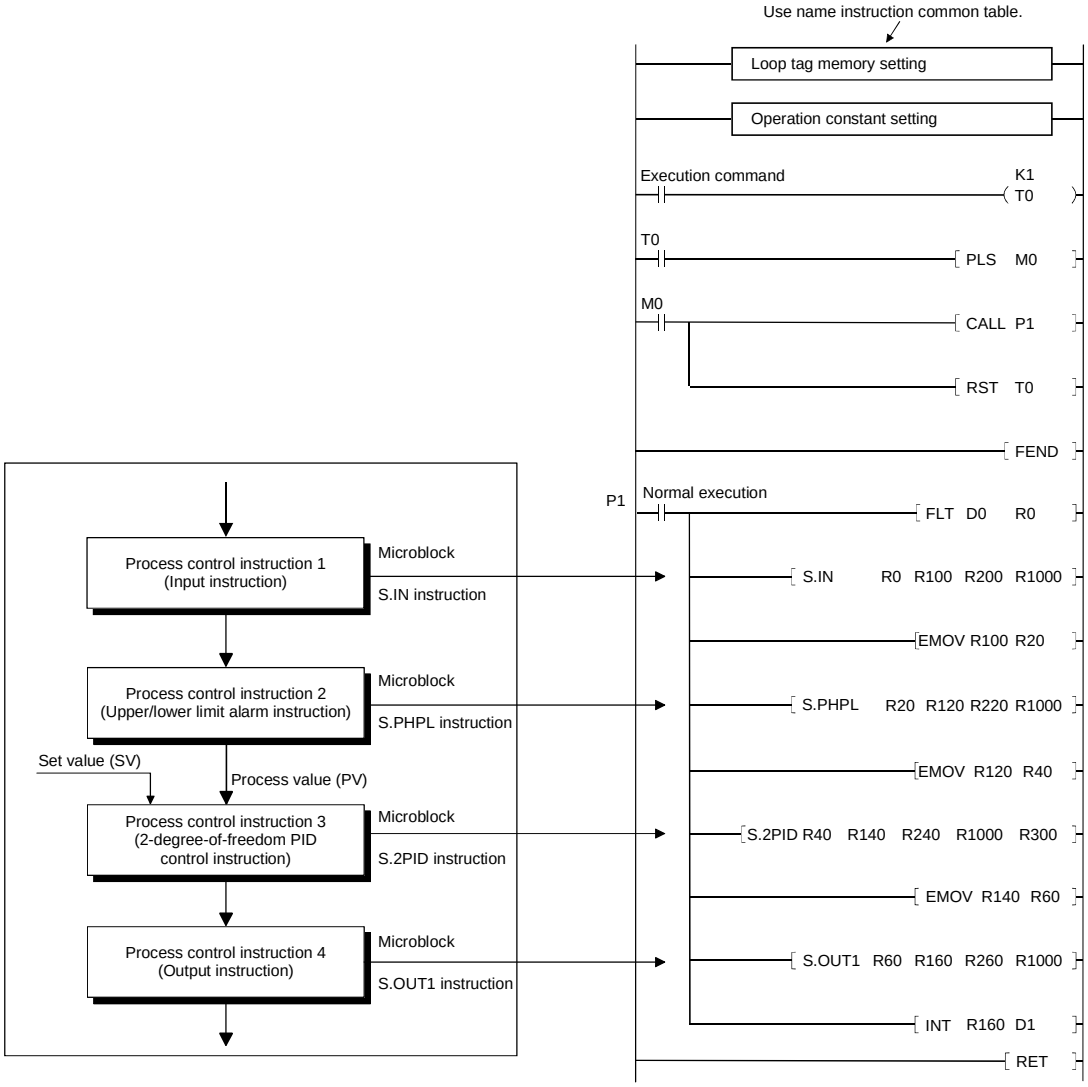
(1) Use of floating-point data

Capable of handling floating-point type real number data, the instructions can perform wide-range and accurate operations.

(2) Increased efficiency of system adjustment

Micro-blocked process control instructions are combined to perform PID control.
This enables actions to be confirmed on a process control instruction basis, ensuring efficient system adjustment.

Example) Process control instructions used to carry out 2-degree-of-freedom PID control



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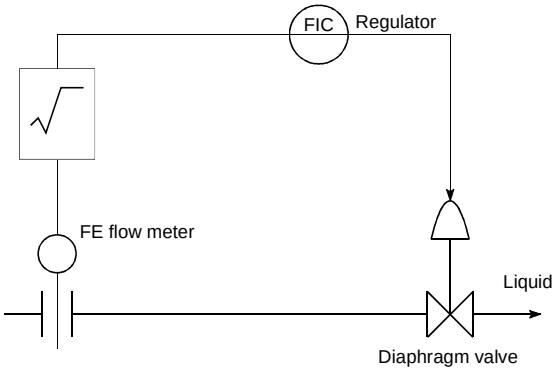
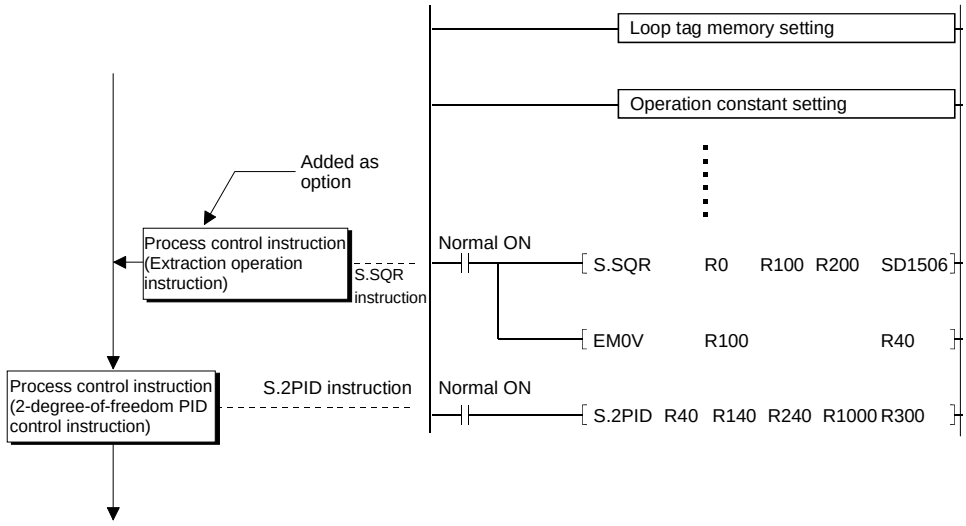
(3) Free combination of process control instructions for application to a wide range of control

As an option, a process control instruction can be inserted in a loop that links process control instructions.

Add the extraction operation instruction (S.SQR) to perform the extraction operation of an input signal to provide an output signal as shown below.



[Example of adding extraction operation instruction (S.SQR) to process control instructions]



(4) Automatic detection of various alarms

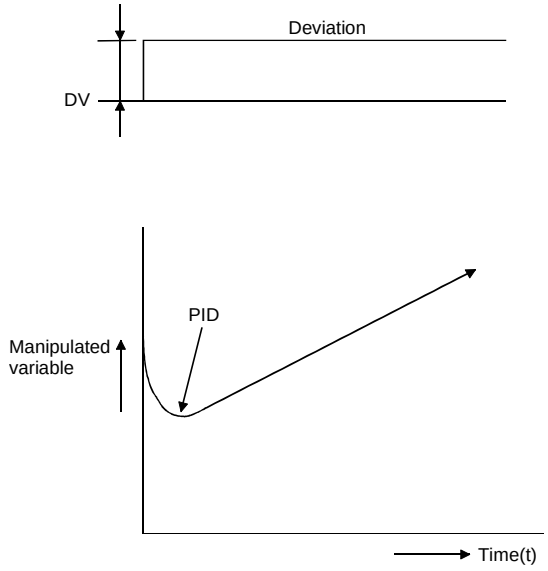
A system can be configured safely since various alarms are detected automatically in the system.

(5) PID algorithm using a velocity type incomplete differential format

Partial differential has the following advantages over the complete differential format.

(a) The differential gain is $1/\eta$ and the limit value can be set.

(b) The output contains time amplitude, so the system actually responds to the operation edge so the derivative operation makes the movement valid.



1.2 PID Control Overview

PID control is applied to the process control of flow rate, speed, air volume, temperature, tension, compounding or like.
In a configuration shown in Fig. 1.1, PID control maintains the object to be controlled at a preset value.

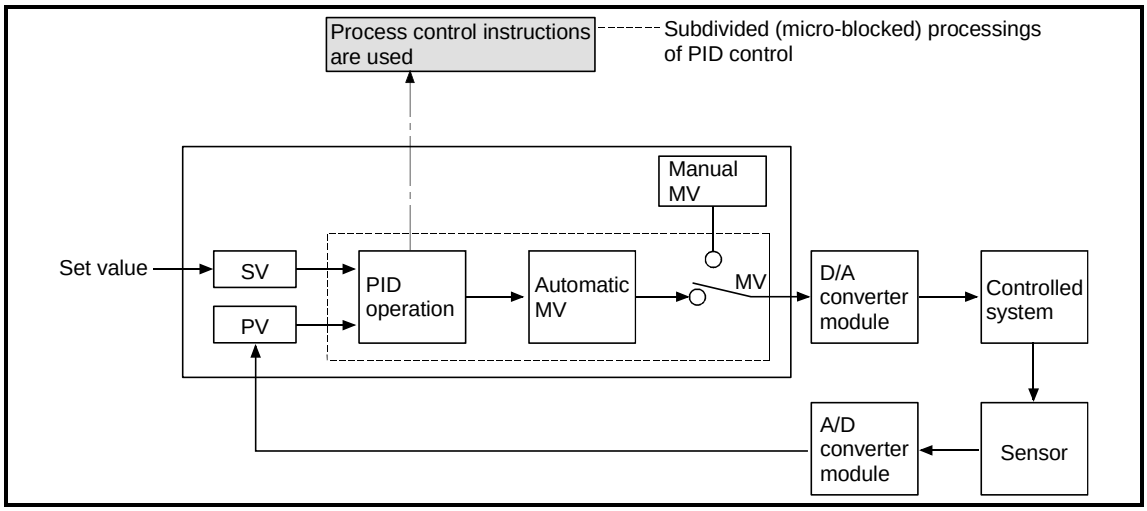


Fig. 1.1 Example of application to process control

PID control compares the value measured in the detection section (process value: PV) with the preset value (set value: SV) and adjust the output value (manipulated value: MV) to eliminate the difference between the process value and set value.

In PID control, proportional operation (P), integral operation (I) and derivative operation (D) are combined to calculate the manipulated value that will make the process value equal to the set value fast and precisely.

- If the difference between the process value and set value is large, the manipulated value is increased to make it close to the set value fast.
- When the difference between the process value and set value has reduced, the manipulated value is decreased to make it equal to the set value slowly and precisely.

1.3 Forward Operation and Reverse Operation

(1) Forward operation is the action that increases the manipulated value when the process value increases more than the set value.

(2) Reverse operation is the action that increases the manipulated value when the process value is decreasing more than the set value.

(3) Forward operation and reverse action make the manipulated value larger as the difference between the set value and the process value becomes larger.

(4) An example of process control performed by forward and reverse operations is shown in Fig. 1.2.

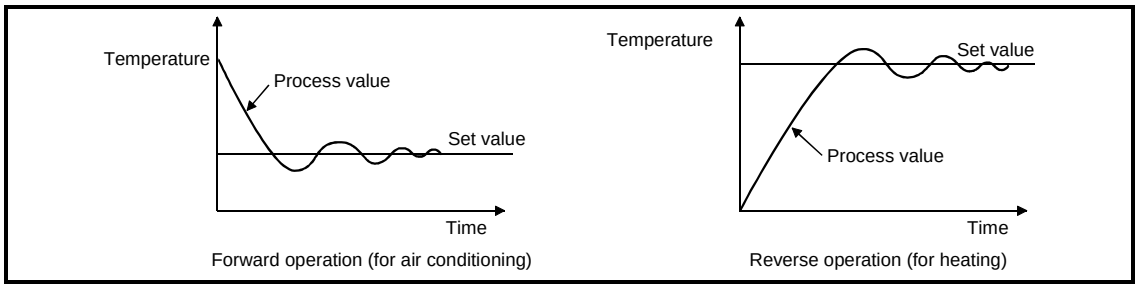


Fig. 1.2 Example of process control performed by forward and reverse operations

1.4 PID Control

This section explains "proportional operation", "integral operation" and "derivative operation" performed for PID control using the process control instructions.

1.4.1 Proportional operation (P operation)

This section explains the control method using proportional operation.

(1) Proportional operation is the action that compares the deviation (difference between the set value and the process value) to find the manipulated value.

(2) The change in relationship between deviation (DV) and manipulated value (MV) using proportional operation is shown using the following numeric expression.

$$MV = Kp \cdot DV$$

Kp is called the proportional gain or proportional constant.

(3) The proportional operation when the deviation is a constant stepped response is shown in Fig. 1.3.

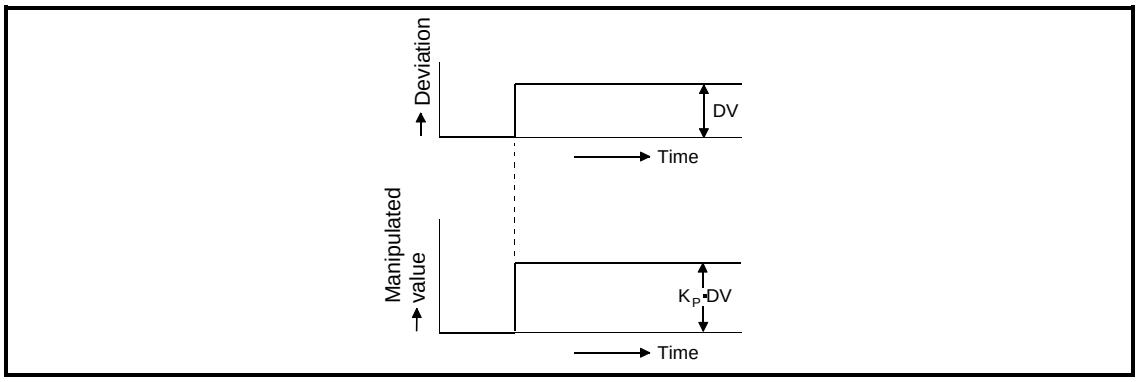


Fig. 1.3 Proportional operation when deviation is constant

(4) The manipulated value fluctuates between −10 and 110%.
As Kp becomes larger the manipulated value corresponding to the deviation also becomes larger making the compensation operation stronger.

(5) Offset occurs in proportional operation.

1.4.2 Integral operation (I operation)

This section explains the control method using integral operation.

(1) Integral operation is the operation that continuously changes the manipulated value to eliminate deviation when there is deviation.
This operation can eliminate the offset that occurs during control performed by a proportional operation.

(2) The time from when a deviation occurs until the manipulated value of the integral operation reaches the manipulated value of the proportional operation in the integral operation is called integral time (T_I).
(a) Increasing the integral time decreases the effect of integration.
(It will take time to stabilize.)

(b) Decreasing the integral time increases the effect of integration.
However, since the integral operation will be stronger, hunting may become greater.

(3) The integral operation when the deviation is a constant value stepped response is shown in Fig. 1.4.

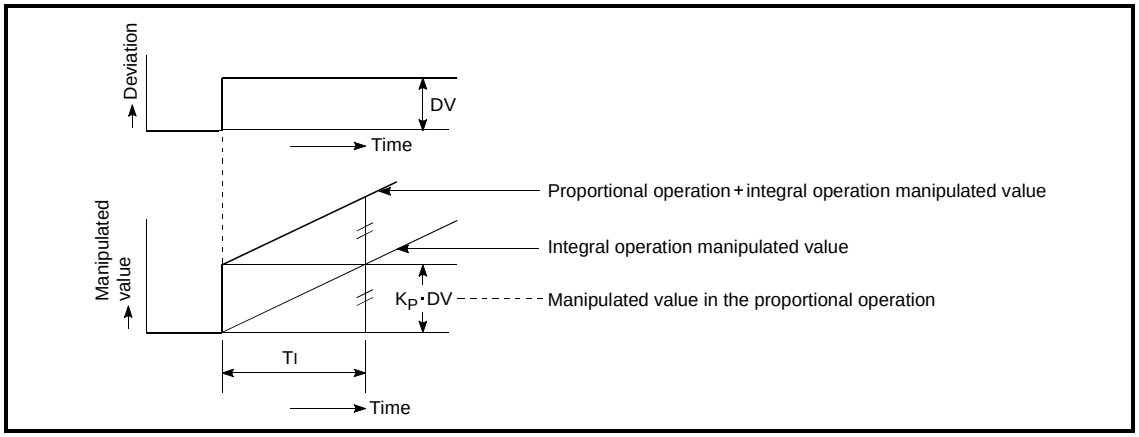


Fig. 1.4 Integral operation when the deviation is a constant

(4) The integral operation is used as the PI operation that is combined with the proportional operation or as the PID operation that is combined with the proportional operation and the derivative operation.
Control cannot be carried out by merely performing the integral operation.

1.4.3 Derivative operation (D operation)

This section explains the control method using the derivative operation.

(1) The derivative operation is an operation that adds the proportional manipulated value to the change speed to eliminate deviation when a deviation has occurred.
The derivative operation can prevent large changes in the object control from disturbances.

(2) Derivative time (T_D) indicates the length of time from when a deviation occurred until the manipulated value of a derivative operation reaches that of a proportional operation.
Increasing the derivative time makes the derivative operation stronger.

(3) The derivative operation when the deviation is a constant value stepped response is shown in Fig. 1.5.

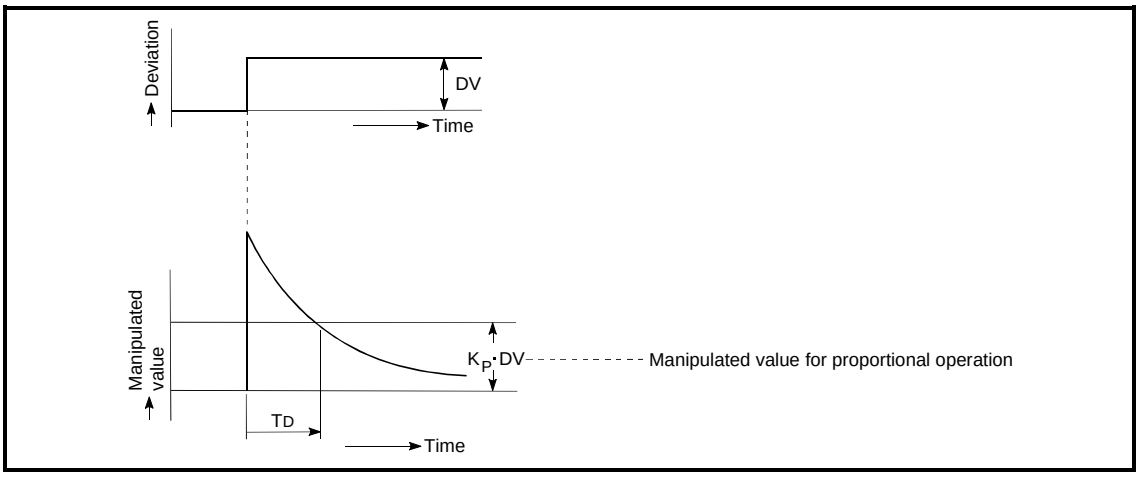


Fig. 1.5 Derivative operation when the deviation is a constant

(4) The derivative operation can be used as PD operation in combination with a proportional operation or as a PID operation in combination with the proportional operation and integral operation.
Control cannot be carried out by merely performing the derivative operation.

1.4.4 PID operation

This section explains the control operation using combinations of proportional operation (P operation), integral operation (I operation), and derivative operation (D operation).

(1) The PID operation controls the calculated manipulated value using (P + I + D) operation.

(2) The PID operation when the deviation is a constant value stepped response is shown in Fig. 1.6.

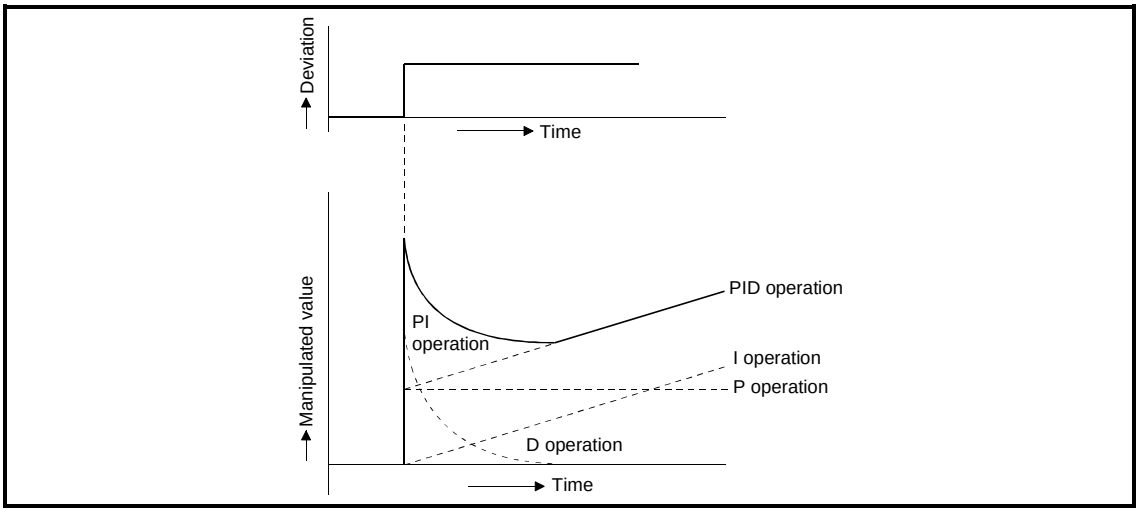


Fig. 1.6 PID operation when deviation is constant

2 STRUCTURE AND COMBINATIONS OF PROCESS CONTROL INSTRUCTIONS

2.1 Instruction Configuration

The instructions that can be used by the process control instructions can be divided into the "instruction part" and "device part".
The instruction part and device part are as follows.

- Instruction part..... This shows the functions for these instructions.
- Device part ..... This shows the data required for operations and the storage destination of the stored operation results.

The device part is classified as the source device and destination device.

(1) Source (S)

The source stores the data used for operation.

(a) In the process control instruction, specify the head device that stores the source data.

(b) Data must have been stored in the specified device until the process control instruction is executed.

(c) Changing the source data allows you to change the data used in that instruction.

(2) Destination (D)

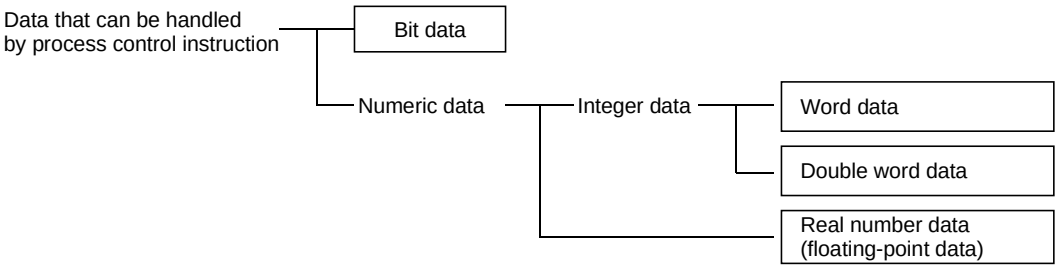
Destination is where the data is stored after operation.

(a) Sets the device for which the data will be stored in the destination.

(b) Depending on the instruction used, data used for operation must also be stored in the destination before start of the operation.

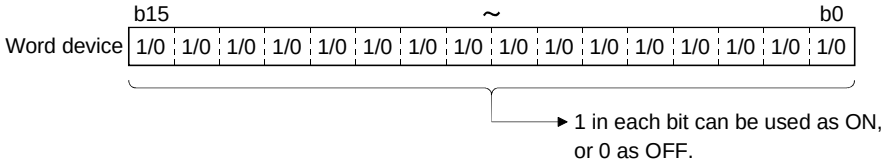
2.2 Method for Specifying the Data in a Device

The following 4 types of data can be used by the process control instructions.



2.2.1 For bit data

Bit data is handled on a single bit basis.
The QnPHCPU uses a word device for alarm condition or selection on a single bit basis.
By specifying the bit number of the word device, you can use the 1/0 of the specified bit number as bit data.



Specify the bit of the word device in the form of "Word device.Bit No.".

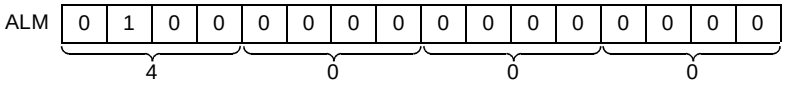
(Specify the bit number in hexadecimal.)
For example, specify the bit 5 (b5) of D0 as D0.5, and the bit 10 (b10) of D0 as D0.A.
However, you cannot specify the bits of the timer (T), retentive timer (ST), counter (C) and index register (Z). (Example: You cannot specify Z0.0.)

2.2.2 For word (16-bit) data

Word data is the 16-bit numeric data that is used for the loop tag memory bit pack contents and operation constants, etc.

- Decimal constant.....K-32768 to K32767
- Hexadecimal constant.....H0000 to HFFFF

Example) For the loop tag memory ALM (standard value setting 4000_H)



2.2.3 Double word (32-bit) data

Double word data is 32-bit numeric data.
• Decimal constant.....K-2147483648 to K2147483647
• Hexadecimal constant.....H00000000 to HFFFFFFFF

When using double word data, specify the word device to be used in the lower-order 16 bits. The 32-bit data is stored into the (specified word device number) and ((specified word device number) + 1).
Example) When D10 is specified for double word data, D10 and D11 are used.

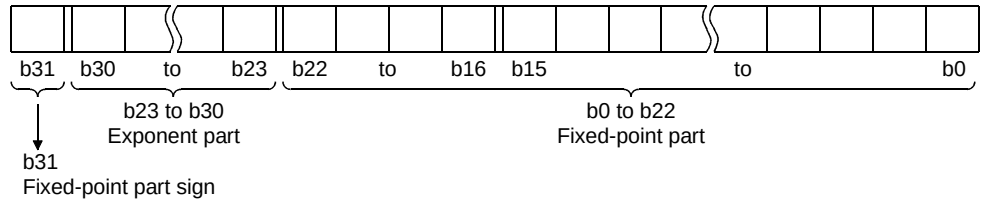
D11	D10
(BW1) H	(BW1) L

2.2.4 For real number data (floating-point data)

The data required for operations and the operation results are 32-bit floating-point data. Floating-point data is displayed as follows using 2 word devices.

1. [Fixed-point part] × 2 [Exponent part]

The bit configuration when the floating-point data is expressed internally and its meaning are as follows.



• Fixed-point part sign This shows the fixed-point part sign in b31.
0: Positive
1: Negative

• Exponent part This shows the 2^n's n and b23 to b30.
The n from b23 to b30's BIN value is as follows.

b23 to b30	FFH	FEH	FDH		81H	80H	7FH	7EH		02H	01H	00H
n	Non-numeric data	127	126		2	1	0	-1		-125	-126	Non-numeric data

• Fixed-point part This shows the value of XXXXXX... in the 23 bits, b0 to b22, when 1.XXX XXX... is represented in binary.

POINT

• The monitor function of GX Developer allows you to monitor the real number data of the QnPHCPU.
• The real number setting range is 0, $\pm 2^{-126} \leqq |value| < \pm 2^{128}$.
• To represent 0, set 0 in all of b0 to b31.

2.2.5 Process control instruction operation error

Operation errors from these process control instruction are stored in the following special registers. For information regarding other than operation errors, refer to the error codes listed in the QCPU(Q Mode)/QnACPU Programming Manual (Common Instructions). (The error codes are stored in special register SD0.)

REMARK

The following contents for errors other than operation errors are stored in the special register.

Error code 4100..... When there is data that cannot be handled.
4300..... When the specified instruction is incorrect.
4301..... When the process control instruction number of devices is incorrect.
4302..... When a device that cannot be specified is specified.

(1) For error code 4100, the detailed information is stored in special registers SD1502 to SD1503. At times other than when a process control instruction operation error occurs, SD1502 and SD1503 are set to 0.

SD1502..... This shows the error code when an error occurs in the process control instruction.
SD1503..... This shows the instruction process No. when an error occurs.

For an explanation of the error contents refer to the Chapter 14.

2.2.6 Instruction execution conditions

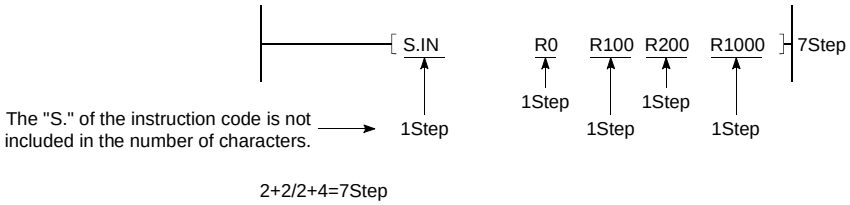
The process control instructions are instructions that are executed while the input condition is ON.

2.2.7 Number of steps

The number of process control instruction steps differs depending upon the number of instruction characters, the device used, and whether or not an indirect setting is valid.
The basic number of steps for the extension instruction are as follows.

$$\text{Number of steps in process control instruction} = 2 + \frac{\text{number of instruction characters (Note 1)}}{2} + \text{number of devices}$$

Note 1: The number of characters is calculated by adding 1 when the number is odd. (For example when rounding up the results of a division.)

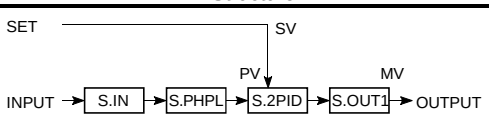
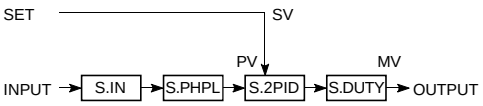
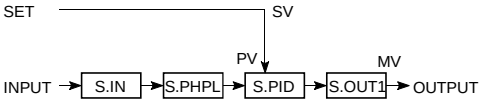
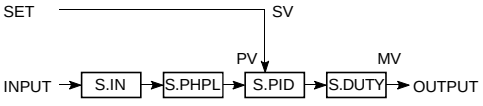
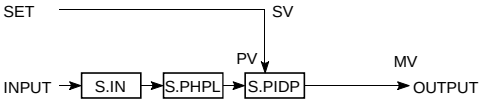
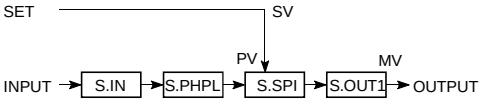
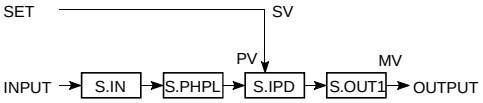
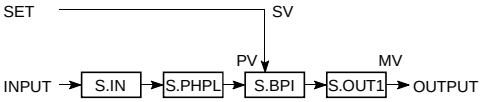
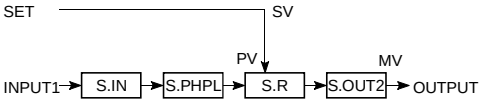
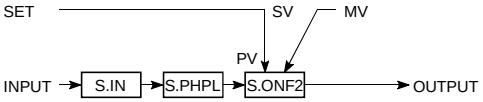
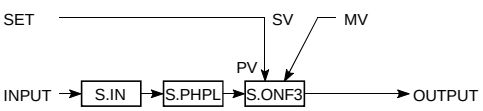


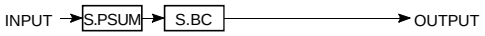
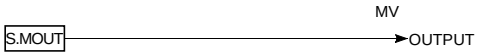
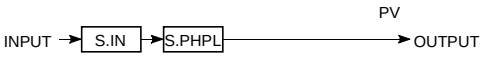
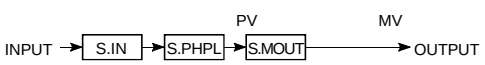
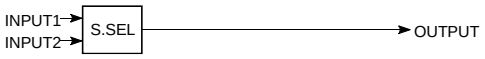
For details refer to QCPU (Q Mode)/QnACPU Programming Manual (Common Instructions).

2.2.8 Index qualification

Index qualification usable with the process control instructions is the same as the one usable with the basic instructions of the QnPHCPU.

2.3 Basic Loop Types Available by Combinations of Process Control Instructions

Loop type	Structure	Application
2-degree-of-freedom PID control (S2PID)	 	Used for general PID control (2-degree-of-freedom). (velocity type) Conducts PID operations for each control cycle.
PID control (SPID)	 	Used for general PID control. (velocity type) Conducts PID operations for each control cycle.
PIDP control (SPIDP)		Used for general PID control. (Position type) Conducts PID operation for each control cycle.
Sample PI control (SSPI)		Used for a process that has long dead time. PI control is executed for only the period of control execution time in each control cycle and the output is kept constant after that.
I-PD control (SIPD)		Used to make slow response so that the operation end and process are not given impact when the set value is varied.
Blend PI control (SBPI)		Used for a process where the manipulated value may vary in a short period of time and may be constant in a long period of time.
Rate control (SR)		Control is performed to keep constant the rate of the given manipulated value to the other varying value.
2-position ON/OFF control (SONF2)		Depending on the sign (positive/negative) of a deviation, operation to turn the manipulated value ON or OFF is performed.
3-position ON/OFF control (SONF3)		3-position ON/OFF control outputs signals of three areas in response to the process value to carry out control. This control can suppress the sudden variation of the manipulated value.

Loop type	Structure	Application
Batch counter (SBC)		A valve or like is controlled ON/OFF in a process of batch preparation for a tank or like.
Program setting device (SPGS)		This is output in accordance with the previously set value time change.
Manual output (SMOUT)		This manually operates the operation terminal end.
Monitor (SMON)		This inputs the process value and detects process errors such as upper/lower limit alarms.
Manual output with monitor (SMWM)		This inputs the process value and conducts manual operation while checking that no errors occur.
Selector (SSEL)		This is used to select signals.

3 DATA USED FOR PROCESS CONTROL INSTRUCTIONS AND HOW TO SPECIFY DATA

3.1 Process Control Instructions and Data Configuration

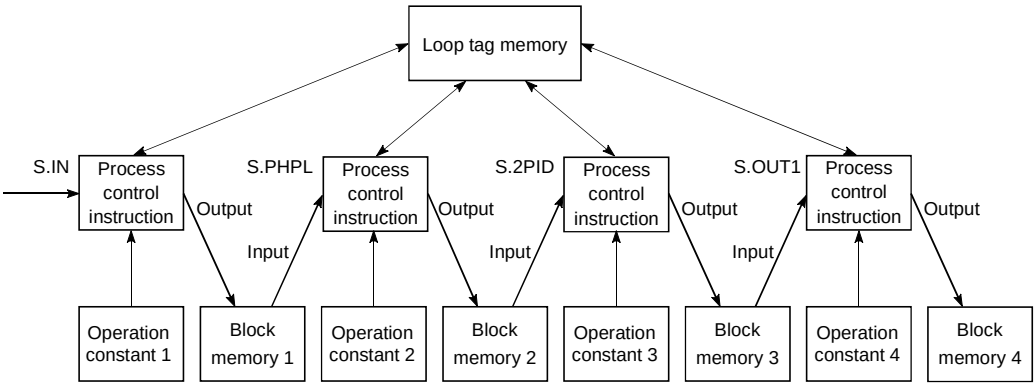
This section explains the data structure (data flow) used for process control instructions.

(a) Configuration when using loop tag

1) The loop units have common storage areas that show the control information. This collection of common information is called a loop tag and the storage memory is called the loop tag memory.

2) By monitoring the loop tag, you can monitor and tune the loop (control unit).

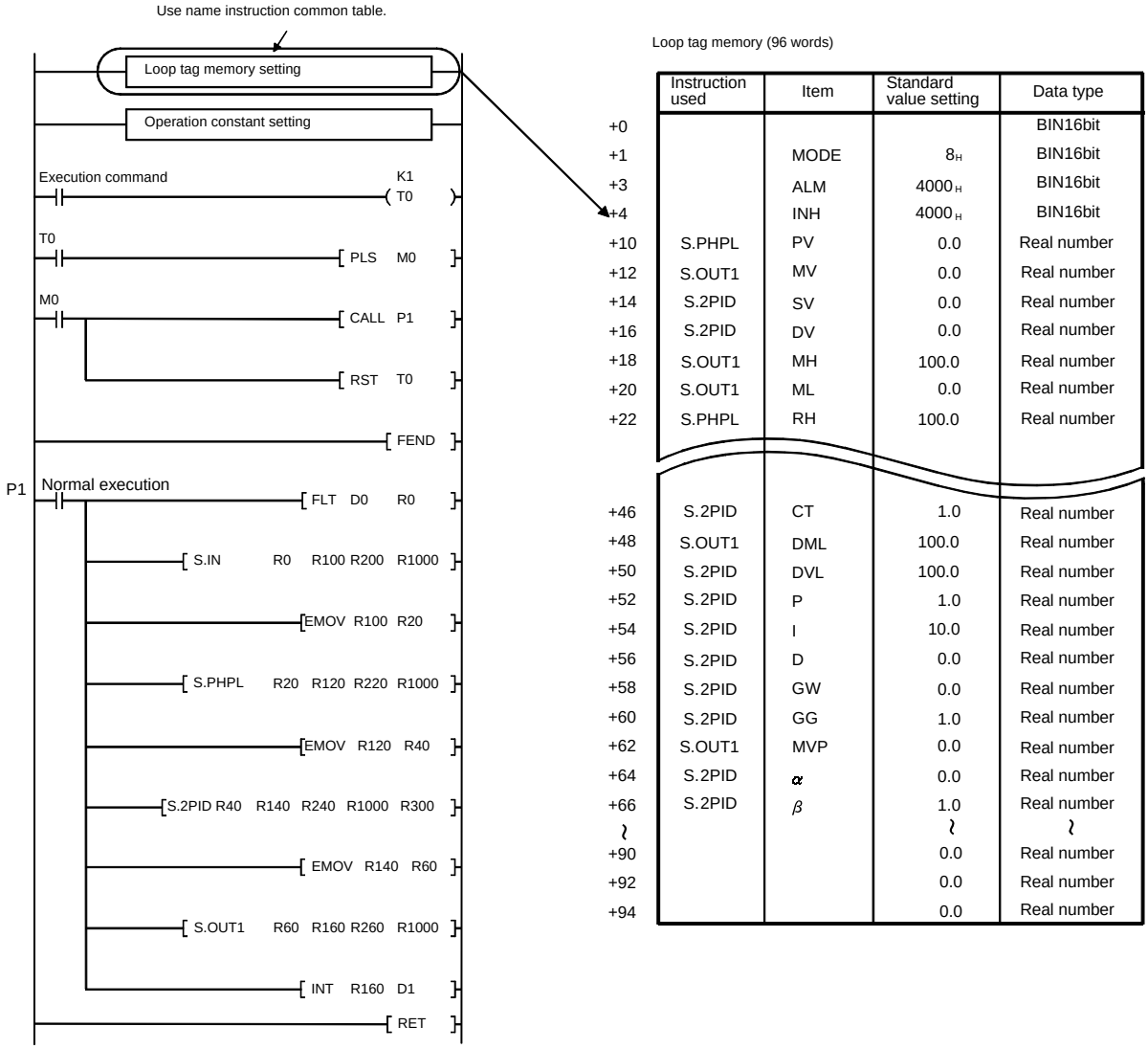
Block diagram



3 - 1

(b) Loop tag memory and operation constant locations in ladder diagram

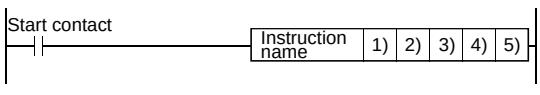
Ladder diagram



Loop tag memory (96 words)

	Instruction used	Item	Standard value setting	Data type
+0				BIN16bit
+1		MODE	8_H	BIN16bit
+3		ALM	4000_H	BIN16bit
+4		INH	4000_H	BIN16bit
+10	S.PHPL	PV	0.0	Real number
+12	S.OUT1	MV	0.0	Real number
+14	S.2PID	SV	0.0	Real number
+16	S.2PID	DV	0.0	Real number
+18	S.OUT1	MH	100.0	Real number
+20	S.OUT1	ML	0.0	Real number
+22	S.PHPL	RH	100.0	Real number
+46	S.2PID	CT	1.0	Real number
+48	S.OUT1	DML	100.0	Real number
+50	S.2PID	DVL	100.0	Real number
+52	S.2PID	P	1.0	Real number
+54	S.2PID	I	10.0	Real number
+56	S.2PID	D	0.0	Real number
+58	S.2PID	GW	0.0	Real number
+60	S.2PID	GG	1.0	Real number
+62	S.OUT1	MVP	0.0	Real number
+64	S.2PID	α	0.0	Real number
+66	S.2PID	β	1.0	Real number
≀			≀	≀
+90			0.0	Real number
+92			0.0	Real number
+94			0.0	Real number

The symbols in the ladder diagram mean the following.



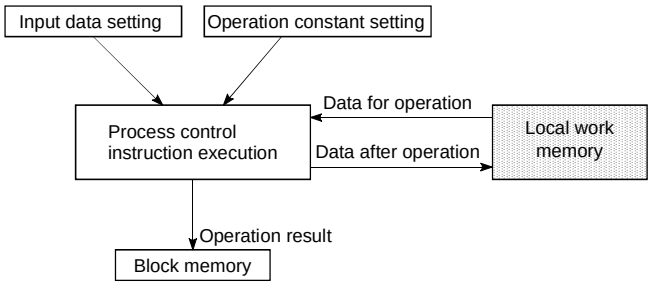
Instruction name	S.IN	S.PHPL	S.2PID	S.OUT1
1) Input data head device	R0	R20	R40	R60
2) Block memory head device	R100	R120	R140	R160
3) Operation constant head device	R200	R220	R240	R260
4) Loop tag memory head device	R1000			
5) Set value head device	—	—	R300	—

3.2 Local Work Memory

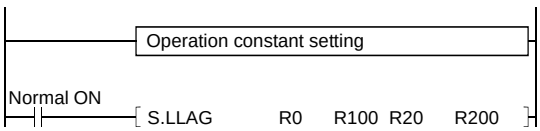
The local work memory is used as a temporary storage area in process control instruction operation. (Memory used for micro blocks only)
The following instructions use the local work memory.

Instruction name	Remarks
S.LLAG (Lead/Lag) S.D (Differentiation) S.DED (Dead time) S.FLT (Standard filter) S.BUMP (Bump-less transfer) S.AT1 (Auto tuning)	This stores the midway operation results for the OS itself. (Cannot be used by the user.)
S.FG (Polygon) S.IFG (Inverted polygon)	This stores the polygon coordinate value (Xn, Yn) used by the user. Operations are conducted based on this.

Block diagram



Ladder diagram



Instruction name	S.LLAG (Lead/Lag)
Input data head device	R0
Block memory head device	R100
Operation constant head device	R20
Local work memory head device	R200

The application of the local work memory changes depending on the used instruction. Refer to the explanation section of the corresponding instruction.

3.3 Data Used for Process Control Instructions

The following data are used for the process control instructions.

- Loop tag memory Section 3.3.1
- Input data Section 3.3.2
- Block memory Section 3.3.3
- Operation constant Section 3.3.4
- Local work memory Section 3.2

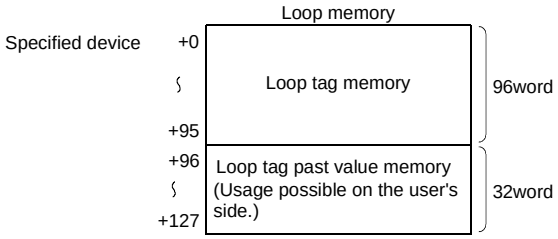
3.3.1 Loop memory

(1) Loop memory

(a) The loop memory is an area that stores the data used commonly by the process control instructions specified as the loop type.
The loop memory also has an area that stores the data used by the QnPHCPU system during process control instruction execution.

(b) The loop memory has the "loop tag memory" and "loop tag past value memory" areas.

(c) The loop memory consists of 128 words (word device: 128 points).
When setting the loop memory areas, specify the device that can occupy 128 words consecutively.



(2) Loop tag memory

(a) The loop tag memory is an area that stores the data used commonly by the process control instructions specified as the loop type indicated in Section 2.3.

(b) The loop tag memory consists of 96 words.

(c) Refer to Appendix 2 (Loop tag memory list) for the applications of the area used by the process control instructions in the loop tag memory.

(3) Loop tag past value memory

(a) The loop tag past value memory is an area used by the QnPHCPU system at the time of process control instruction execution.
The user cannot write data to this memory during run.
If the user writes data to the loop tag past value memory during run, normal operation cannot be performed.

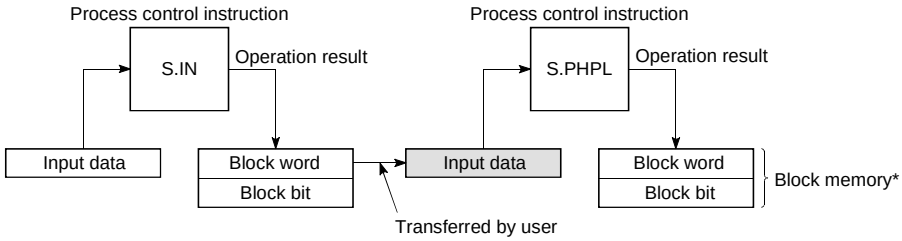
(b) The loop tag past value memory is a 32-word area after the loop tag memory.

(c) At the start of the process control instruction, write "0" to the loop tag past value memory.

3.3.2 Input data

(1) Input data is variable data given to each process control instruction.

(2) The input data uses the block word of the block memory that stores the operation result of the process control instruction executed previously.



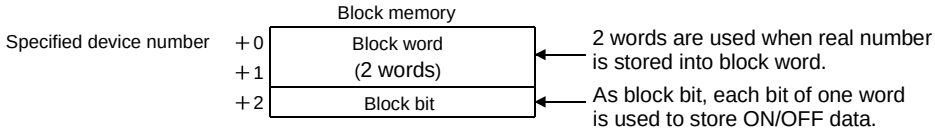
(3) The application of the input data changes depending on the used instruction. Refer to the explanation section of the corresponding instruction.

REMARKS

*: Refer to Section 3.3.3 for the block memory.

3.3.3 Block memory

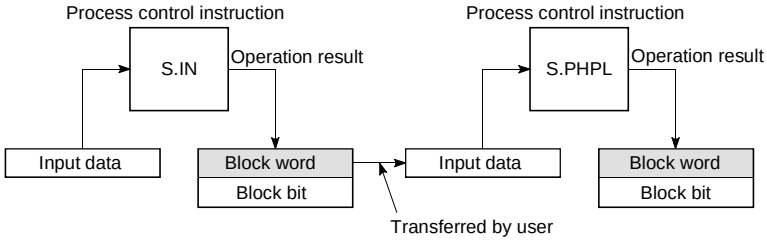
The block memory is an area that stores the output information of the corresponding process control instruction.
The block memory has "block words" and "block bits".
The application of the block memory changes depending on the used instruction.
Refer to the explanation section of the corresponding instruction.



(1) Block word (BW)

(a)The block word is an area that stores the operation result of the process control instruction.

(b) As the input data of the next process control instruction linked by the loop, the data stored in the block word is used.



(2) Block bit (BB)

The block bit is an area that stores the corresponding alarm data at process control instruction execution.
As the block bits, 16 bits of b0 to b15 are represented as BB1 to BB16.

3.3.4 Operation constant

(1) The operation constant is an area that stores the data used by only one process control instruction.

(2) The application of the operation constant changes depending on the used instruction. Refer to the explanation section of the corresponding instruction.

3.3.5 Loop tag memory allocation contents

The loop tag memory allocation contents are shown below.

Instructions used in loop tag

Show the number of words from the loop tag header

Abbreviated name of each item

After setting some values are changed by the numbers from the operation results. (Highlighted areas)

For PID control (S2PID loop) All commonly set in the same loop tag

Sets the offset position for each instruction

Instruction used	Offset	Item	Setting range	Standard value setting	Data type
	+0				
	+1	MODE	0 to FFFFH	8H	BIN16bit
	+3	ALM	0 to FFFFH	4000H	BIN16bit
	+4	INH	0 to FFFFH	4000H	BIN16bit
S.PHPL	+10	PV	RL to RH	0.0	Real number
S.OUT1	+12	MV	-10 to 110	0.0	Real number
S.2PID	+14	SV	RL to RH	0.0	Real number
S.2PID	+16	DV	-110 to 110	0.0	Real number
S.OUT1	+18	MH	-10 to 110	100.0	Real number
S.OUT1	+20	ML	-10 to 110	0.0	Real number
S.PHPL	+22	RH	-999999 to 999999	100.0	Real number
S.PHPL	+24	RL	-999999 to 999999	0.0	Real number
S.PHPL	+26	PH	RL to RH	100.0	Real number
S.PHPL	+28	PL	RL to RH	0.0	Real number
S.PHPL	+30	HH	RL to RH	100.0	Real number
S.PHPL	+32	LL	RL to RH	0.0	Real number
S.IN	+38	α	0 to 1	0.2	Real number
S.PHPL	+40	HS	0 to 999999	0.0	Real number
S.PHPL	+42	CTIM	0 to 999999	0.0	Real number
S.PHPL	+44	DPL	0 to 100	100.0	Real number
S.2PID	+46	CT	0 to 999999	1.0	Real number
S.OUT1	+48	DML	0 to 100	100.0	Real number
S.2PID	+50	DVL	0 to 100	100.0	Real number
S.2PID	+52	P	0 to 999999	1.0	Real number
S.2PID	+54	I	0 to 999999	10.0	Real number
S.2PID	+56	D	0 to 999999	0.0	Real number
S.2PID	+58	GW	0 to 100	0.0	Real number
S.2PID	+60	GG	0 to 999999	1.0	Real number
S.OUT1	+62	MVP	-999999 to 999999	0.0	Real number
S.2PID	+64	α	0 to 1	0.0	Real number
S.2PID	+66	β	0 to 1	1.0	Real number

(1) Shows the contents of the bit pack using the loop tag data.

(a) ALM

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	SPA			DMLA	OOPA	SEA	HHA	LLA	PHA	PLA	DPPA	DPNA	DVLA	MHA	MLA

The standard value setting 4000H is shown when manual operation is conducted using the loop step status. Use 0000H

S: Stored by the system

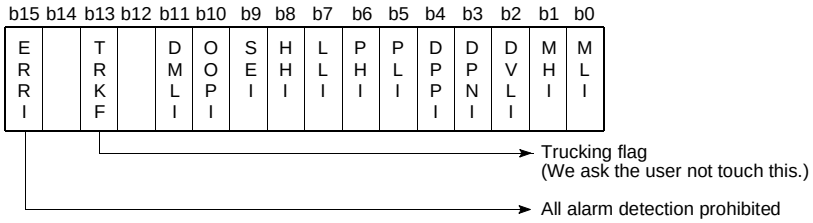
U: Set by the user

Table 3.1 ALM details list

Name	Abbreviation	Description	Flag establishment conditions
Stop alarm	SPA	Shows the loop stop status. Changes the loop mode to manual. Conducts stop alarm processing for the output value (BW) and alarm signal.	U
Output change rate limit alarm	DMLA	Conducts the change rate limiter for the input data and outputs the change rate alarm. (For the output change upper limit value/control value).	S
Output open alarm	OOPA	Shows that it has changed to open status when the operation output signal has become disconnected, etc.	S
Sensor alarm	SEA	Sensor error alarm	S
Upper upper limit alarm	HHA	Checks the upper limit value of the process equipment upper limit, and outputs an alarm if the process value is higher than the upper limit value.	S
Lower lower limit alarm	LLA	Checks the lower limit value of the process equipment lower limit, and outputs an alarm if the process value is lower than the lower limit value.	S
Upper limit alarm	PHA	Checks the upper limit value of the process value, and outputs an alarm if the process value is higher than the upper limit value.	S
Lower limit alarm	PLA	Checks the lower limit value of the process value, and outputs an alarm if the process value is lower than the lower limit value.	S
Positive direction change rate alarm	DPPA	Outputs an alarm if the change rate is higher than the upward trend change rate range.	S
Negative direction change rate alarm	DPNA	Outputs an alarm if the change rate is lower than the downward trend change rate range.	S
Deviation large alarm	DVLA	Conducts an error check and then outputs an alarm if over. In addition, if the error check determines that the deviation is completely less than the warning value and the error is reduced by a set value from the warning value then the deviation large alarm will be released.	S
Output upper limit alarm	MHA	Conducts a check using the upper/lower limiter and if the limiter results are larger than the input upper limit value an alarm is output.	S
Output lower limit alarm	MLA	A check is conducted by an upper/lower limiter and if the limiter results are smaller than the input lower limit value an alarm is output.	S

(b) INH

This prohibits alarm detection for each item. In addition, the alarms prohibited by INH are not detected. (The INH bits 0 to 11 correspond to the bits 0 to 11 of ALM.)



(c) MODE

The process control instructions have the following operation modes that satisfy the following operations in a system connected to an operator station, PLC, host computer, machine side operation panel and like.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
					CSV	CMV	CCB	CAB	CMB	CAS	AUT	MAN	LCC	LCA	LCM

For MODE make one of them a 1 bit only flag 1.

Operation mode	Description	Application
MAN (MANUAL)	• Manual operation from OPS • SV and MV can be set.	Monitoring and control from operator station are performed.
AUT (AUTOMATIC)	• Automatic operation • SV can be set. • MV cannot be set.	
CAS (CASCADE)	• Cascade operation • SV and MV cannot be set.	
CMV (COMPUTER MV)	• Automatic MV setting from host computer	Loop operation from host computer can be performed and operation mode is controlled and monitored at operator station.
CSV (COMPUTER SV)	• Automatic SV setting from host computer	
CMB (COMPUTER MANUAL BACK UP)	• Manual operation backup when host computer is abnormal	During loop control by host computer, backup is provided by predetermined operator station when computer fails.
CAB (COMPUTER AUTOMATIC BACK UP)	• Automatic operation backup when host computer is abnormal	
CCB (COMPUTER CASCADE BACK UP)	• Cascade operation backup when host computer is abnormal	
LCM (LOCAL MANIPULATED)	• Local manual operation	At startup of plant, operation and startup are performed by loop display or like from other than operator station and operation mode is monitored by operator station.
LCA (LOCAL AUTOMATIC)	• Local automatic operation	
LCC (LOCAL CASCADE)	• Local cascade operation	

4 HOW TO EXECUTE PROCESS CONTROL INSTRUCTIONS

4.1 Execution Cycle and Control Cycle

(1) Execution cycle

(a) An execution cycle is an interval at which the process control instruction is executed.

(b) There are the following methods to execute the process control instruction in each execution cycle.

1) Method using timer
A timer is used to measure the execution cycle and the process control instruction is executed when the timer times out.

2) Method using interrupt programs
Any of interrupt programs of I28 to I31 is run in each execution cycle.

3) Method using fixed scan execution type program
A fixed scan execution type program is run in each execution cycle.

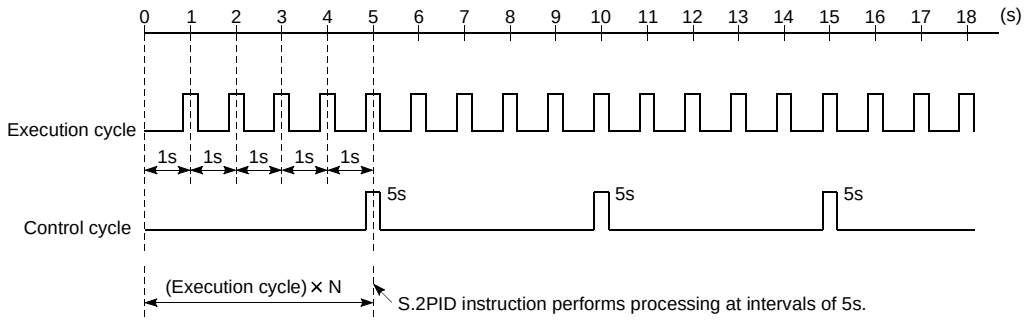
(c) Specify in the special registers (SD1500, SD1501) the value of the execution cycle used for the process control instruction as a real number.

(2) Control cycle

(a) A control cycle is an interval in which PID control is performed for an instruction such as S.2PID (2-degree-of-freedom PID).
As the control cycle, specify an integral multiple of the execution cycle.
The S.2PID or similar instruction counts the execution cycle in each execution cycle and starts PID operation when the specified control cycle is reached.

(b) Specify in the loop tag memory (See Section 3.3.1) the control cycle used for the S.2PID or similar instruction.
The S.2PID or similar instruction uses the value of the control cycle specified in the loop tag memory to perform PID control.

Example) When monitoring is performed at intervals of 1s in 2-degree-of-freedom PID control and PID control is carried out at intervals of 5s.

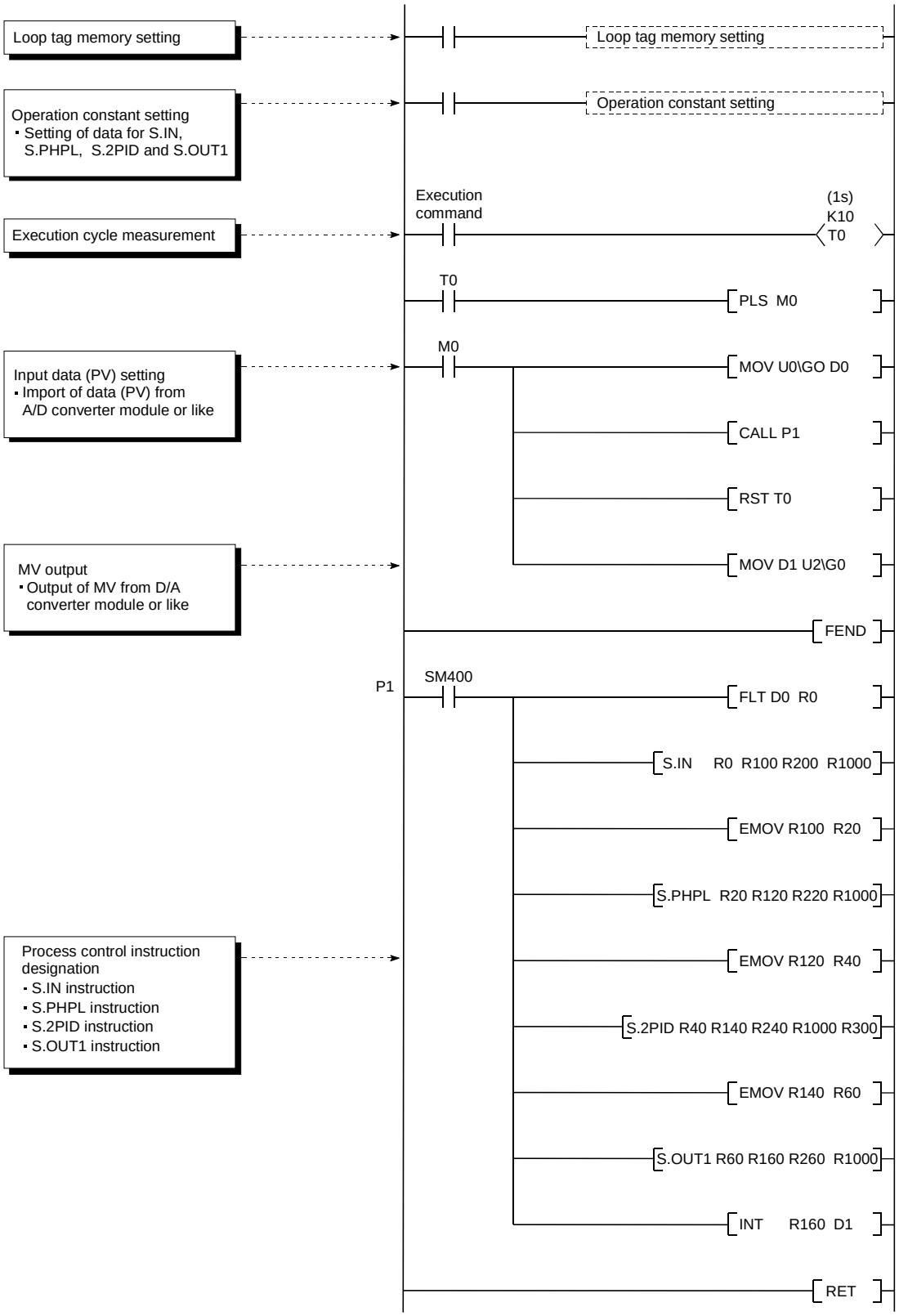


POINT

When the control cycle is set to an integral multiple of the execution cycle, monitoring such as a PV check can be performed in each execution cycle.

4.2 Concept of Program

[Program example using S.2PID instruction at execution cycle of 1s]



5 EXECUTION CONDITION SWITCHING AND FUNCTIONS

5.1 Execution Condition Switching

5.1.1 Loop RUN/STOP

If any loop component such as a detector or operation end other than the PLC fails, each loop can be run/stopped to perform the maintenance of the corresponding loop.
The "SPA" bit of the alarm detection (ALM) is used to run/stop the corresponding loop.

(1) Basic operation during loop STOP

(a) Output status hold (The S.2PID instruction is output = 0)

(b) Alarm No detection (Process alarm)

(c) Make the control mode MAN.

5 - 1

5.2 Functions

5.2.1 Tracking function

The tracking function includes the "bump-less function" and "output limiter processing".

(1) Bump-less function

The bump-less function prevents manipulated value (MV) output stepping changes when switching from the automatic mode to manual mode and continuously controls MV output.

(2) Output limiter processing function

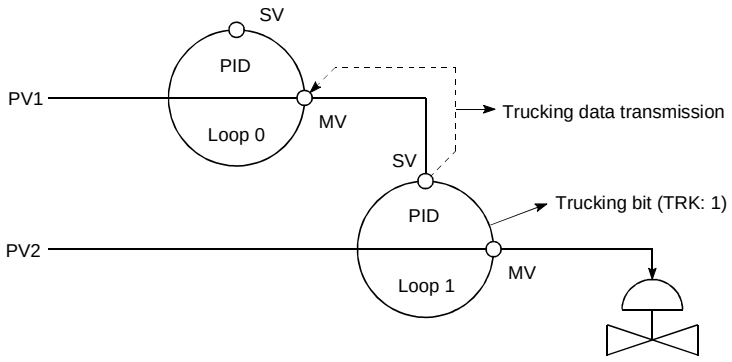
The output limiter processing function limits the upper limit and lower limit of the manipulated value (MV) output by the PID operation during the automatic mode. This output limiter processing function is only valid in the automatic mode and is not executed for manual data. In addition, when the parameter tracking function execution validity is set to not valid when in the automatic mode the output limiter processing function will not execute.

5.2.2 Cascade loop tracking

The process control loops that comprise a cascade loop use the manipulated value (MV) of a primary loop (Loop 0) as the set value (SV) of a secondary loop (Loop 1).
Tracking is performed to prevent the sudden variation of the set value (SV) when the operation mode of the secondary loop (Loop 1) is changed.

(1) The cascade PID loop Tracking processing is shown in the diagram below.

[Processing concept diagram]



(a) In cascade operation, the manipulated value (MV) of Loop 0 is transferred to the set value (SV) of Loop 1.

(b) When cascade operation is not performed, the set value (SV) of Loop 1 is transferred to the manipulated value (MV) of Loop 0.
(Tracking to the source specified as the input terminal of the set value (SV) of Loop 1)

(2) Make the following settings to perform tracking.

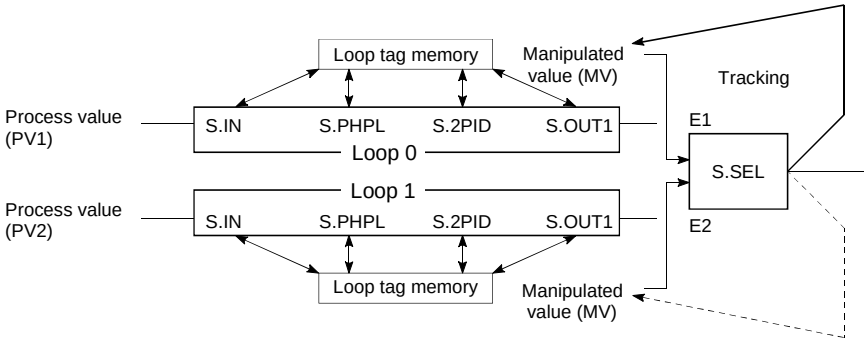
(Tracking is performed when the operation mode is switched to other than CAS, CSV or CCB.)
For 2-degree-of-freedom PID (S.2PID), set the following operation constant items to specify tracking.

Setting item		Setting
Tracking bit (TRK)		1 (Tracking performed)
Set value pattern (SVPTN)	Set value pattern	0 (Set value is upper loop MV.)
	Set value Used	0 (E2 is used)

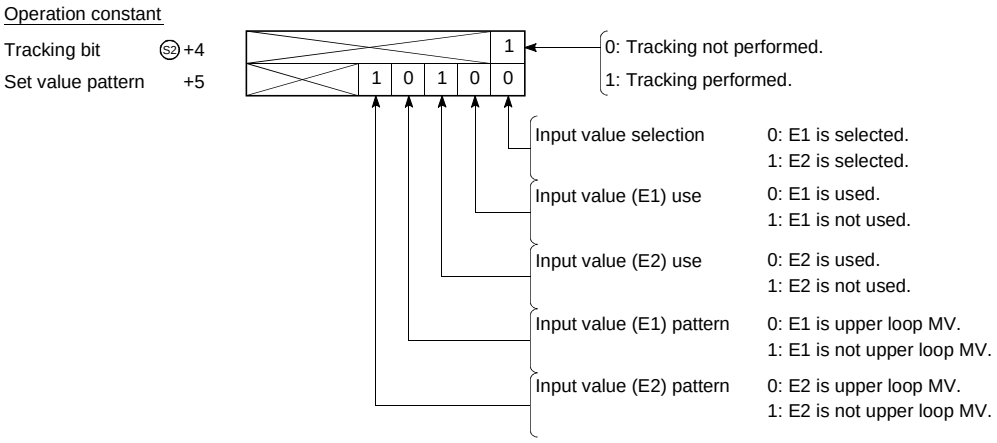
5.2.3 Loop selector tracking

Tracking is performed under the following conditions.

- The operation mode is any of MAN, CMB, CMV and LCM and the tracking bit (TRK) is 1
- When the operation mode is any of AUT, CAS, CAB, CCB, CSV, LCA and LCC
  The tracking bit (TRK) is 1 and BB1 of BB is 1



Example) When the S.SEL instruction uses the input value E1 and E1 uses the upper loop (loop 0) MV, the S.SEL instruction's MV is trucked to loop 0's MV. The setting that conducts Tracking is shown below.



6 INSTRUCTION LIST

6.1 How to Read the Instruction List Table

The process control instruction is largely divided into the I/O control instructions, control operation instructions, compensation operation instructions, arithmetic operation instructions, comparison operation instructions, and auto tuning instructions.

Table 6.1 How to read the instruction list

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
I/O control instruction	S.IN	S.IN S1 D1 S2 D2	Conducts the input data (PV) Upper/lower limit check, input limiter processing, engineering value conversion, and digital filter processing.	7	8- 1
	S.OUT1	S.OUT1 S1 D1 S2 D2	Calculates the MV (0 to 100%) from the input data (MV), processes the upper and lower limit and Change rate limiter processing, and conducts output	8	8- 6

1) 2) 3) 4) 5) 6)

Explanation

1) Classifies the instructions by application.
2) Shows the instruction symbols used by the program.
3) Shows the symbol diagram used in the circuit.

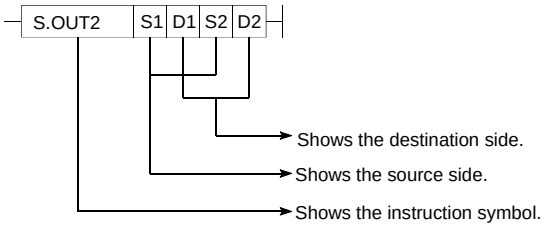


Figure 6.1 Symbols in the circut

Destination: Shows the destination of the data after operation.
Source: Stores the data before the operation.

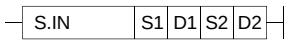
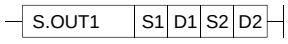
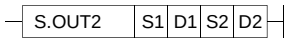
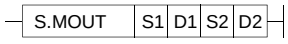
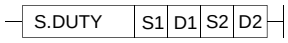
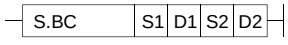
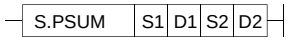
4) Shows the processing content of each instruction.
5) Shows the number of steps for each instruction. For information regarding the number of steps refer to Item 2.2.7.
6) Shows the explanation page for each instruction.

6 - 1

6.2 Functions

6.2.1 I/O control instruction

Table 6.2 I/O Control instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
I/O control instruction	S.IN		Conducts the input data (PV) Upper/lower limit check, input limiter processing, engineering value conversion, and digital filter processing.	7	8- 1
	S.OUT1		Calculates the MV (0 to 100%) from the input data (MV), processes the upper and lower limit and Change rate limiter processing, and conducts output on time conversion.	8	8- 6
	S.OUT2		Performs change rate, upper/lower limiter processing and output on time conversion from the input data (MV).	8	8-12
	S.MOUT		Reads the MV of the loop tag memory and performs output conversion and alarm clear processing.	8	8-17
	S.DUTY		Changes the ON/OFF rate within a given cycle in proportion to the input data (0 to 100%) and outputs the result.	8	8-21
	S.BC		Compares the input data with the set value and outputs bit data as soon as the input data reaches the set value.	7	8-28
	S.PSUM		Integrates the number of input pulses and outputs the result.	8	8-32

6.2.2 Control operation instruction

Table 6.3 Control Operation Instruction

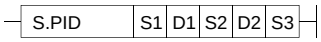
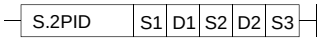
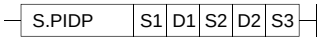
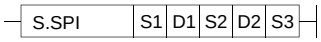
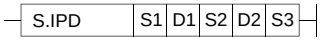
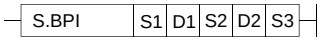
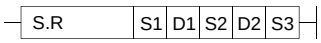
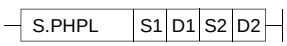
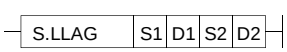
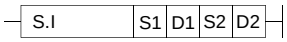
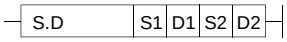
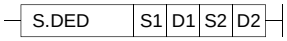
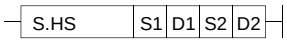
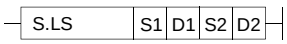
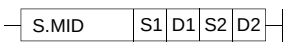
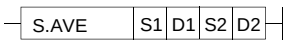
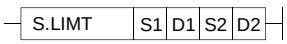
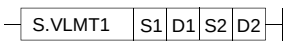
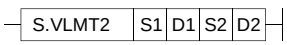
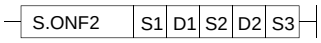
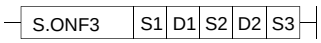
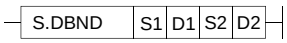
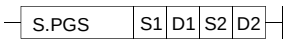
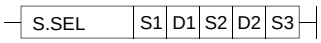
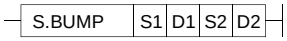
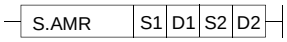
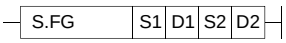
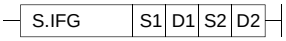
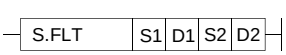
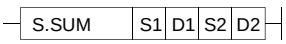
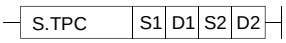
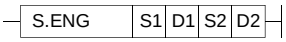
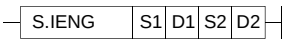
Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Control operation instruction	S.PID		Conducts process value derivative type PID operations. (Incomplete differentiation) Performs SV setting processing, tracking processing, gain Kp operation processing, PID operation and deviation check.	9	9-1
	S.2PID		Performs 2-degree-of-freedom PID operation (incomplete differentiation). Performs SV setting processing, tracking processing, gain Kp operation processing, 2-degree-of-freedom PID operation and deviation check.	9	9-9
	S.PIDP		Performs position type PID operation. Performs SV setting processing, tracking processing, gain Kp operation processing, PID operation, deviation check and operation mode judgment. According to the result, performs change rate, upper/lower limiter and output on time conversion or performs alarm clear processing and output on time conversion.	9	9-17
	S.SPI		Judges between the operating time and hold time, and if it is the operating time, performs SV setting processing, tracking processing, gain Kp operation processing, SPI operation and deviation check.	9	9-26
	S.IPD		Performs I-PD operation. Performs SV setting processing, tracking processing, gain Kp operation processing, IPD operation and deviation check.	9	9-33
	S.BPI		Performs blend PI operation. Performs SV setting processing, tracking processing, gain Kp operation processing, BPI operation and deviation check.	9	9-41
	S.R		Performs engineering value conversion, tracking processing, change rate limiter and rate operation on the input data.	8	9-48
	S.PHPL		Conducts an Upper limit value/lower limit value check of the PV output by the S.IN instruction.	8	9-53
	S.LLAG		Conducts Lead/lag compensation for input data and outputs the operation results.	8	9-59

Table 6.3 Control Operation Instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Control operation instruction	S.I		Conducts integral operations on the input data and outputs the operation results.	7	9-61
	S.D		Conducts Derivative operations on the input data and outputs the operation results.	7	9-63
	S.DED		Delays the input data by the specified dead time and then outputs it.	8	9-65
	S.HS		Outputs the maximum value among the input data.	7	9-68
	S.LS		Outputs the minimum value among the input data.	7	9-70
	S.MID		Outputs the intermediate value between the maximum value and minimum value among the input data.	8	9-72
	S.AVE		Calculates and outputs the average value of the input data.	8	9-75
	S.LIMT		Limits the output value with hysteresis.	8	9-77
	S.VLMT1		Limits the varying speed of the output value.	9	9-79
	S.VLMT2		Limits the varying speed of the output value.	9	9-81
	S.ONF2		Performs two-position ON/OFF control. Performs SV setting processing, tracking processing, MV compensation, MV output and two-position ON/OFF control.	9	9-83
	S.ONF3		Performs three-position ON/OFF control. Performs SV setting processing, tracking processing, MV compensation, MV output and three-position ON/OFF control.	9	9-89
	S.DBND		Provides a dead band and performs output processing.	8	9-95
	S.PGS		Provides a control output according to the SV and MV pattern.	8	9-97
	S.SEL		Outputs the value selected by the selection signal out of the input data in the automatic mode, or outputs the MV of the loop tag memory in the manual mode.	9	9-102
	S.BUMP		Brings the output value closer to the output set value from the output control value gradually when the mode select signal is switched from manual to automatic.	8	9-108
	S.AMR		Increases or decreases the output value at the fixed rate.	8	9-110

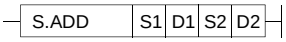
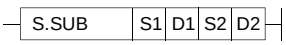
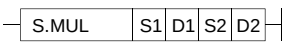
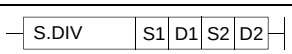
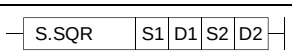
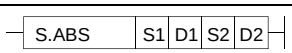
6.2.3 Compensation operation instruction

Table 6.4 Compensation Operation Instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Compensation operation instruction	S.FG		Outputs the value that follows the polygon pattern whose input data is specified.	7	10- 1
	S.IFG		Outputs the value that follows the inverted polygon pattern whose input data is specified.	8	10- 3
	S.FLT		Outputs the average value of n pieces of data sampled at the specified data collection intervals.	8	10- 5
	S.SUM		Integrates the input data and outputs the result.	8	10- 8
	S.TPC		Makes temperature/pressure compensation to the input data and outputs the result.	8	10-10
	S.ENG		Converts the input data into an engineering value.	8	10-12
	S.IENG		Reversely converts the input data from the engineering value and outputs the result.	8	10-14

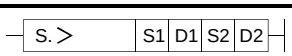
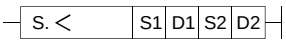
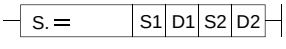
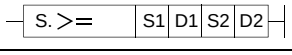
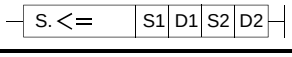
6.2.4 Arithmetic operation instruction

Table 6.5 Arithmetic Operation Instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Arithmetic operation instruction	S.ADD		Adds the input data with coefficients.	8	11- 1
	S.SUB		Subtracts the input data with coefficients.	8	11- 3
	S.MUL		Multiplies the input data with coefficients.	8	11- 5
	S.DIV		Divides the input data with coefficients.	8	11- 7
	S.SQR		Outputs the extraction ($\sqrt{}$) of the input data.	8	11- 9
	S.ABS		Outputs the absolute value of the input data.	8	11-11

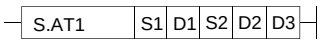
6.2.5 Comparison operation instruction

Table 6.6 Comparison Operation Instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Comparison operation instruction	S.>		Compares the input data and outputs the result of comparison.	7	12- 1
	S.<		Compares the input data and outputs the result of comparison.	7	12- 3
	S.=		Compares the input data and outputs the result of comparison.	7	12- 5
	S.>=		Compares the input data and outputs the result of comparison.	7	12- 7
	S.<=		Compares the input data and outputs the result of comparison.	7	12- 9

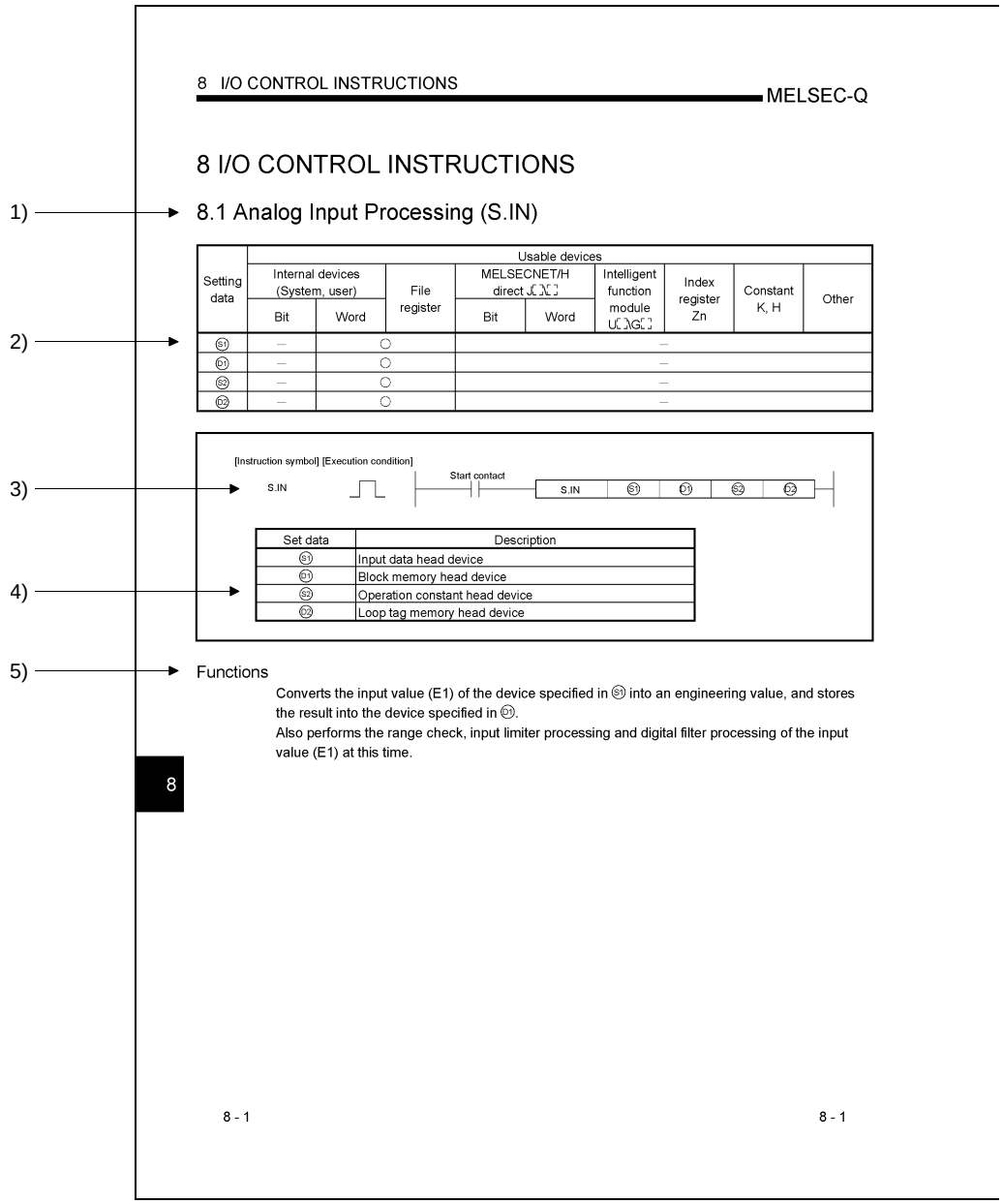
6.2.6 Auto tuning instruction

Table 6.7 Auto Tuning Instruction

Category	Instruction Symbols	Symbol	Processing Details	Number of Basic Steps	See for Description
Auto Tuning Instruction	S.AT1		Performs auto tuning and makes the initial setting of the PID constants.	9	13-4

7 HOW TO READ INSTRUCTIONS

The following format will be used to explain to read instructions presented hereafter.



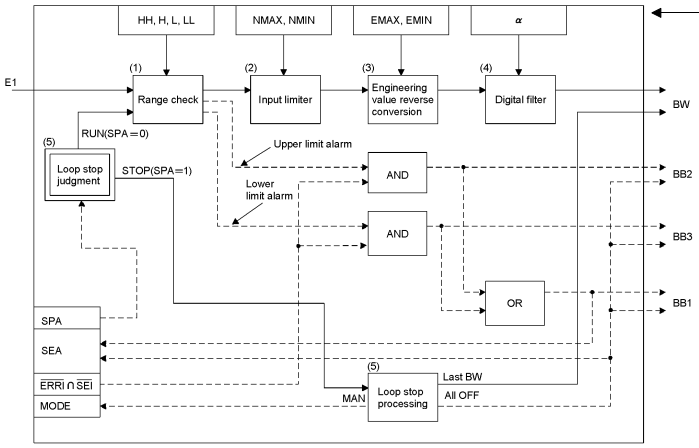
1) Shows the item No. in the instruction summary.
2) ○ is added to devices that can be used the instruction.
The usage classifications for devices that can be used is shown below.

Device classifications	Internal devices (System, user)		File register	MELSECNET/H direct J \		Intelligent function module U \G	Index register Z	Constant *1	Other *1
	Bit	Word		Bit	Word				
Usable devices *3	X, Y, M, L, SM, F, B, SB, FX, FY *2	T, ST, C, D, W, SD, SW, FD, @	R, ZR	J \X J \Y J \B J \SB	J \W J \SW	U \G	Z	Decimal constant Hexadecimal constant Real number constant Character string constant	P, I, J, U, DX, DY, N, BL, TR, BL\S, V

*1: The devices that can be set are given in the Constant and others field.
*2: FX and FY can be used with only bit data and FD with only word data.
*3: For the explanation of each device, refer to the user's manual (function explanation, program fundamentals) of the used CPU module.

Block diagram

The processing block diagram of the S.IN instruction is shown below.
(The numerals (1) to (5) in the diagram indicate the order of the processing.)



6)

Control data

Data specified in S.IN instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Alarm	b15 b12 b8 b4 b0 (BB3 BB2 BB1)	—	BIN 16bit	—	S
		BB2	Input upper limit alarm					
		BB3	Input lower limit alarm	(0: Without alarm) (1: With alarm)				

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

7)

8

7

3) This shows the expression and instruction execution conditions in the circuit mode.

Execution conditions	Normal execution	Executed during on	Executed once during on	Executed once during off
Displays the No. of the explanation page	Nothing recorded		Nothing recorded	Nothing recorded

4) Explains the set data of the instruction.

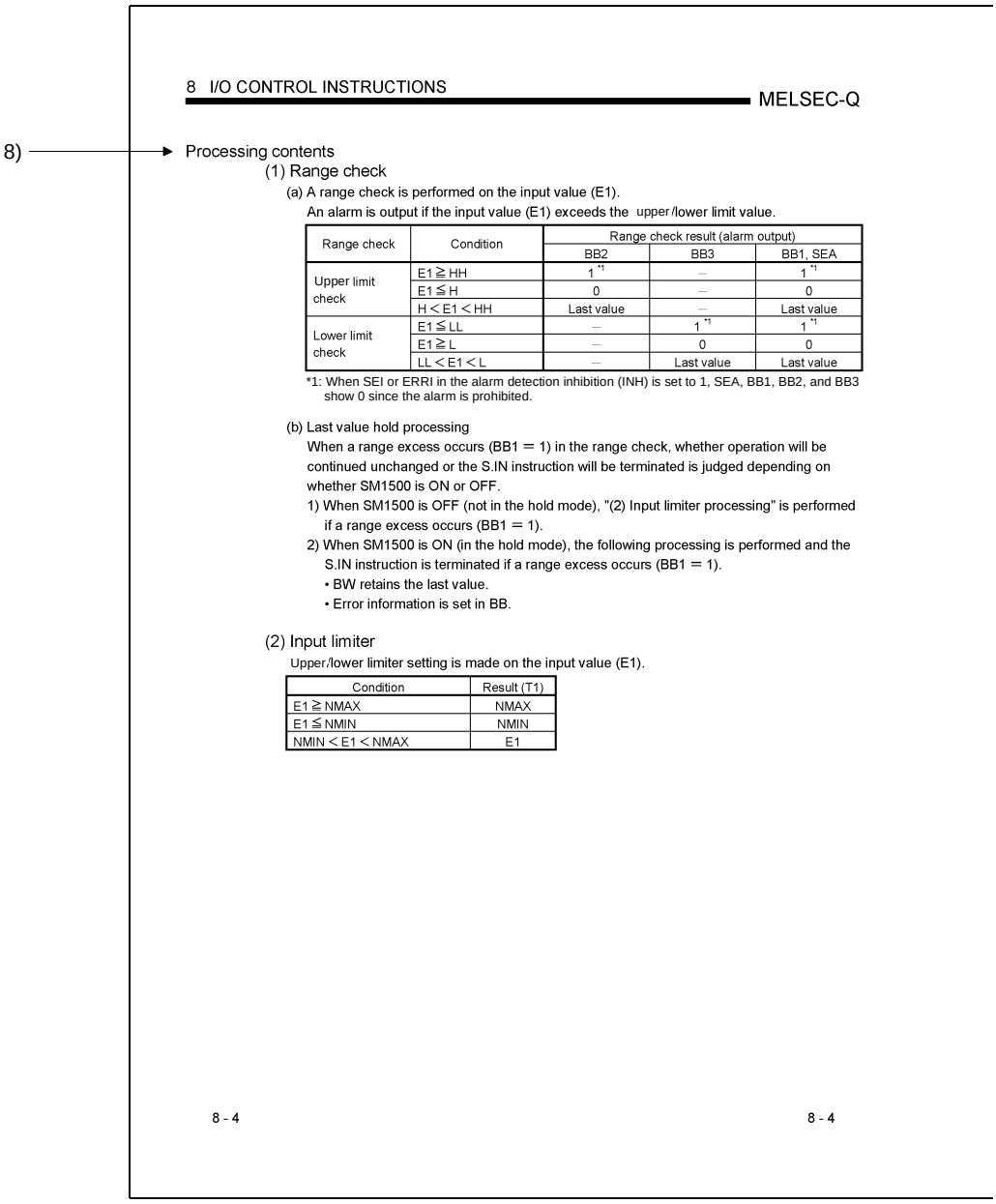
5) Indicates the functions performed by the instruction.

6) Indicates the processing sequence of the instruction.

7) Lists the data specified for the instruction.

S and U in the Storage field indicate the following.

- S: Stored by the system
- U: Set by the user



8 I/O CONTROL INSTRUCTIONS
MELSEC-Q

8) → Processing contents

(1) Range check

(a) A range check is performed on the input value (E1).
An alarm is output if the input value (E1) exceeds the upper/lower limit value.

Range check	Condition	Range check result (alarm output)		
		BB2	BB3	BB1, SEA
Upper limit check	E1 ≧ HH	1 *1	—	1 *1
	E1 ≦ H	0	—	0
	H < E1 < HH	Last value	—	Last value
Lower limit check	E1 ≦ LL	—	1 *1	1 *1
	E1 ≧ L	—	0	0
	LL < E1 < L	—	Last value	Last value

*1: When SEI or ERRI in the alarm detection inhibition (INH) is set to 1, SEA, BB1, BB2, and BB3 show 0 since the alarm is prohibited.

(b) Last value hold processing
When a range excess occurs (BB1 = 1) in the range check, whether operation will be continued unchanged or the S.IN instruction will be terminated is judged depending on whether SM1500 is ON or OFF.
1) When SM1500 is OFF (not in the hold mode), "(2) Input limiter processing" is performed if a range excess occurs (BB1 = 1).
2) When SM1500 is ON (in the hold mode), the following processing is performed and the S.IN instruction is terminated if a range excess occurs (BB1 = 1).
• BW retains the last value.
• Error information is set in BB.

(2) Input limiter
Upper/lower limiter setting is made on the input value (E1).

Condition	Result (T1)
E1 ≧ NMAX	NMAX
E1 ≦ NMIN	NMIN
NMIN < E1 < NMAX	E1

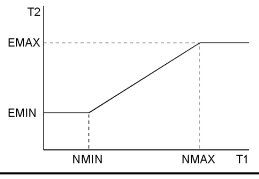
8 - 4 8 - 4

8) Explains each processing of the instruction.

(3) Engineering value reverse conversion

The result (T1) of the input limiter is converted reversely from the engineering value according to the following expression.

$$T2=(EMAX-EMIN)\times\frac{T1-NMIN}{NMAX-NMIN}+EMIN$$



(4) Digital filter

The input value (E1) is digitally filtered according to the following expression.
The digital filter is used to reduce noise.

$$BW=T2+\alpha\times(\text{Previous BW value}-T2)$$

(5) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.IN instruction.
1) BW retains the last value.
2) SEA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB3 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(1) Range check ".

ERROR ◄ 9)

• When an operation error occurred — Error code: 4100

8 - 5

9) Indicates the condition for error occurrence and the error number.
For errors other than the one described, refer to the QCPU (Q Mode)/QnACPU Programming Manual (Common Instructions).

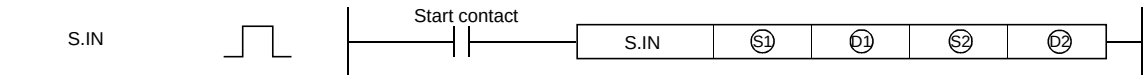
7 - 4

8 I/O CONTROL INSTRUCTIONS

8.1 Analog Input Processing (S.IN)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device

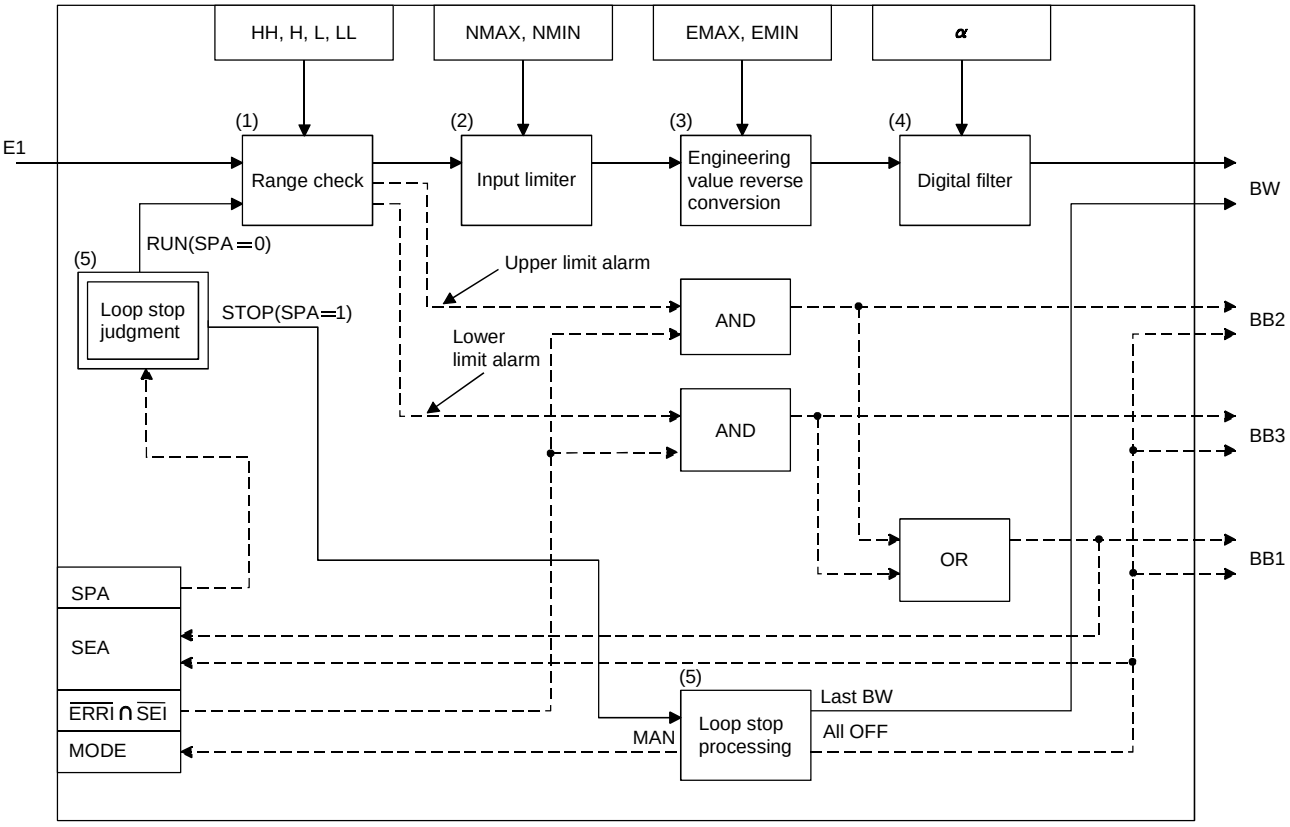
Functions

Converts the input value (E1) of the device specified in ⓢ1 into an engineering value, and stores the result into the device specified in ⓓ1.
Also performs the range check, input limiter processing and digital filter processing of the input value (E1) at this time.

8 - 1

Block diagram

The processing block diagram of the S.IN instruction is shown below.
(The numerals (1) to (5) in the diagram indicate the order of the processing.)



Control data

Data specified in S.IN instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Alarm	b15 b12 b8 b4 b0 (BB3, BB2, BB1) (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Input upper limit alarm					
		BB3	Input lower limit alarm					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

8

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Operation constant	(S2)+0 +1	EMAX	Engineering conversion upper limit	-999999 to 999999	%	Real number	100.0	U
	+2 +3	EMIN	Engineering conversion lower limit	-999999 to 999999	%	Real number	0.0	U
	+4 +5	NMAX	Input upper limit	-999999 to 999999	—	Real number	100.0	U
	+6 +7	NMIN	Input lower limit	-999999 to 999999	—	Real number	0.0	U
	+8 +9	HH	Upper limit range error occurrence	-999999 to 999999	—	Real number	110.0	U
	+10 +11	H	Upper limit range error return	-999999 to 999999	—	Real number	100.0	U
	+12 +13	L	Lower limit range error return	-999999 to 999999	—	Real number	0.0	U
	+14 +15	LL	Lower limit range error occurrence	-999999 to 999999	—	Real number	-10.0	U
Loop tag memory *2	(D1)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA SEA SPA: 0: Loop RUN, 1: Loop STOP SEA: (0: Without alarm), (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI SEI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+38 +39	α	Filter coefficient	0 to 1	—	Real number	0.2	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Range check

(a) A range check is performed on the input value (E1).

An alarm is output if the input value (E1) exceeds the upper/lower limit value.

Range check	Condition	Range check result (alarm output)		
		BB2	BB3	BB1, SEA
Upper limit check	E1 ≧ HH	1 *1	—	1 *1
	E1 ≦ H	0	—	0
	H < E1 < HH	Last value	—	Last value
Lower limit check	E1 ≦ LL	—	1 *1	1 *1
	E1 ≧ L	—	0	0
	LL < E1 < L	—	Last value	Last value

*1: When SEI or ERRI in the alarm detection inhibition (INH) is set to 1, SEA, BB1, BB2 and BB3 show 0 since the alarm is prohibited.

(b) Last value hold processing

When a range excess occurs (BB1 = 1) in the range check, whether operation will be continued unchanged or the S.IN instruction will be terminated is judged depending on whether SM1500 is ON or OFF.

1) When SM1500 is OFF (not in the hold mode), "(2) Input limiter processing" is performed if a range excess occurs (BB1 = 1).
2) When SM1500 is ON (in the hold mode), the following processing is performed and the S.IN instruction is terminated if a range excess occurs (BB1 = 1).
   • BW retains the last value.
   • Error information is set in BB.

(2) Input limiter processing

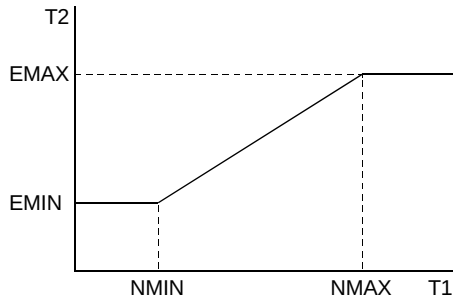
Upper/lower limiter setting is made on the input value (E1).

Condition	Result (T1)
E1 ≧ NMAX	NMAX
E1 ≦ NMIN	NMIN
NMIN < E1 < NMAX	E1

(3) Engineering value reverse conversion

The result (T1) of the input limiter is converted reversely from the engineering value according to the following expression.

$$T2 = (EMAX - EMIN) \times \frac{T1 - NMIN}{NMAX - NMIN} + EMIN$$



(4) Digital filter

The input value (E1) is digitally filtered according to the following expression.
The digital filter is used to reduce noise.

$$BW = T2 + \alpha \times (\text{Previous BW value} - T2)$$

(5) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.IN instruction.
1) BW retains the last value.
2) SEA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB3 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(1) Range check".

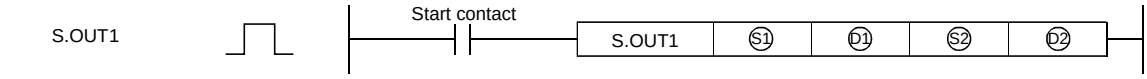
ERROR

• When an operation error occurs — Error code: 4100

8.2 Output Processing with Mode Switching1 (S.OUT1)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device

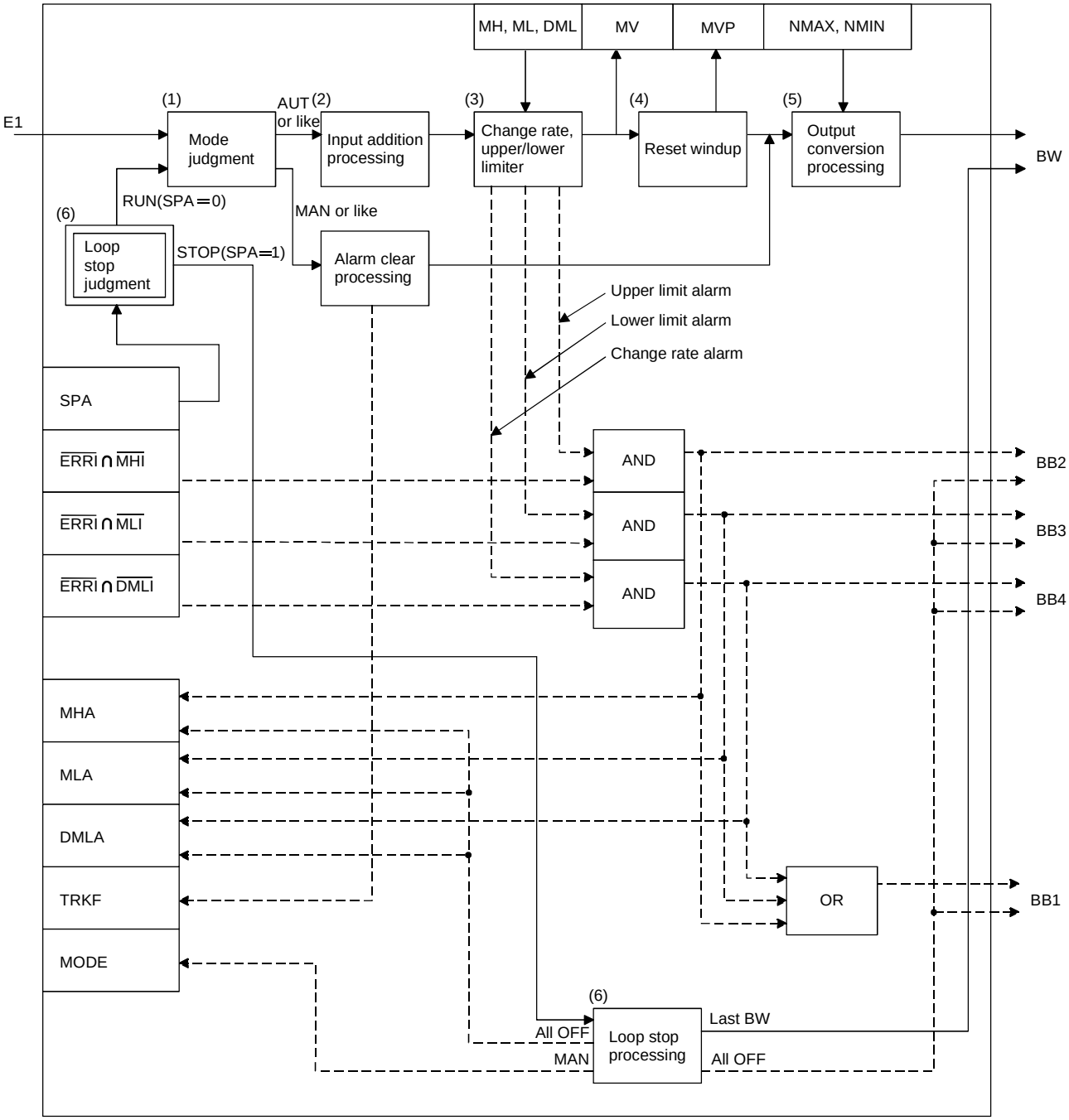
Functions

Calculates the manipulated value (MV) by performing input addition processing from the input value (E1 = ΔMV) of the device specified in ⓢ1, and stores the result into the device specified in ⓓ1.

Also performs the change rate, upper/lower limiter, reset windup and output conversion processings of the calculated manipulated value (MV) at this time.

Block diagram

The processing block diagram of the S.OUT1 instruction is shown below.
(The numerals (1) to (6) in the diagram indicate the order of the processing.)



Control data

(1) Data specified in S.OUT1 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value (ΔMV)	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
	+2	BB	—					
		BB1	Alarm	b15 b12 b8 b4 b0 BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Output upper limit alarm					
		BB3	Output lower limit alarm					
		BB4	Output change rate alarm					
Operation constant	(S2)+0 +1	NMAX	Output conversion upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	NMIN	Output conversion lower limit	-999999 to 999999	—	Real number	0.0	U
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DMLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DMLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DMLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DMLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+48 +49	DML	Output change rate limit value	0 to 100	%	Real number	100.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+62 +63	MVP	MV inside operation value	(-999999 to 999999)	%	Real number	0.0	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE).

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM (alarm clear processing)

1) MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.
2) BB1 to BB4 of BB are turned to 0.
3) The tracking flag (TRKF) of the alarm detection inhibition (INH) is turned to 1.
4) "(5) Output conversion processing" is performed and the instruction is terminated.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, "(2) Input addition processing" is performed.
However, when SEA of the alarm detection (ALM) is 1 and SM1501 is ON (with hold), BB1 to BB4 are turned to 0 and the S.OUT1 instruction is terminated.

(2) Input addition processing

The temporary MV (T) is calculated on the basis of the input value (E1 = ΔMV).

(a) When the tracking flag (TRKF) of the alarm detection inhibition (INH) is 1, the following processing is performed.

1) The manipulated value (MV) is stored into the MV internal operation value (MVP).
2) The input value (E1) is changed to 0. (ΔMV = 0)
3) The tracking flag (TRKF) of the alarm detection inhibition (INH) is turned to 0.
4) The temporary MV (T) is calculated with the following expression.

$$T = E1 + MVP$$
$$MVP = T$$

(b) When the tracking flag (TRKF) of the alarm detection inhibition (INH) is 0, the temporary MV (T) is calculated with the following expression.

$T = E1 + MVP$
$MVP = T$

(3) Change rate, upper/lower limiter

Change rate and upper/lower limit checks are performed on a difference between the temporary MV (T) and manipulated value (MV), and the data and alarm are output after the limiter processings.

(a) The change rate limiter performs the following operation and outputs the result of the operation to BB4 and DMLA.

Condition	BB4, DMLA	Result (T1)
$\|T - MV\| \leqq DML$	0	T
$(T - MV) > DML$	1 *1	MV + DML
$(T - MV) < -DML$	1 *1	MV − DML

*1: When DMLI or ERRI in the alarm detection inhibition (INH) is set to 1, DMLA and BB4 show 0 since the alarm is prohibited.

(b) The upper/lower limiter performs the following operation and outputs the result of the operation to BB2, BB3, MHA and MLA.

Condition	BB3, MLA	BB2, MHA	MV
$T1 > MH$	0	1 *2	MH
$T1 < ML$	1 *3	0	ML
$ML \leqq T1 \leqq MH$	0	0	T1

*2: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB2 show 0 since the alarm is prohibited.

*3: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB3 show 0 since the alarm is prohibited.

(4) Reset windup

If the manipulated value (MV) exceeds the upper/lower limit value, the following operation is performed to return it to the upper/lower limit value and enable immediate response when the deviation is inverted.

However, when the integral constant (T1) is 0, the reset windup processing is not performed.

Condition	Operation expression
When MHA = 1, $\frac{\Delta T}{T_I} \leqq 1$	$MVP = \frac{\Delta T}{T_I}(MH - T) + T$
When MLA = 1, $\frac{\Delta T}{T_I} \leqq 1$	$MVP = \frac{\Delta T}{T_I}(ML - T) + T$

(5) Output conversion

In the output conversion, the output value is calculated from the following formula.

$$BW = \frac{NMAX - NMIN}{100} \times MV + NMIN$$

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.OUT1 instruction.

1) BW retains the last value.
2) DMLA, MHA and MLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB4 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(1) Mode judgment".

(7) Hold processing

Used to specify whether the output value will be held or not by the S.OUT1 instruction is specified at sensor error occurrence (detected by the S.IN instruction) in the loop stop processing.

Use SM1501 to select whether the manipulated value (MV) will be held or not at sensor alarm occurrence.

- SM1501 = OFF: Manipulated value (MV) will not be held.
- SM1501 = ON: Manipulated value (MV) will be held.

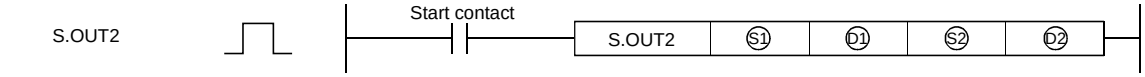
ERROR

- When an operation error occurs — Error code: 4100

8.3 Output Processing with Mode Switching2 (S.OUT2)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



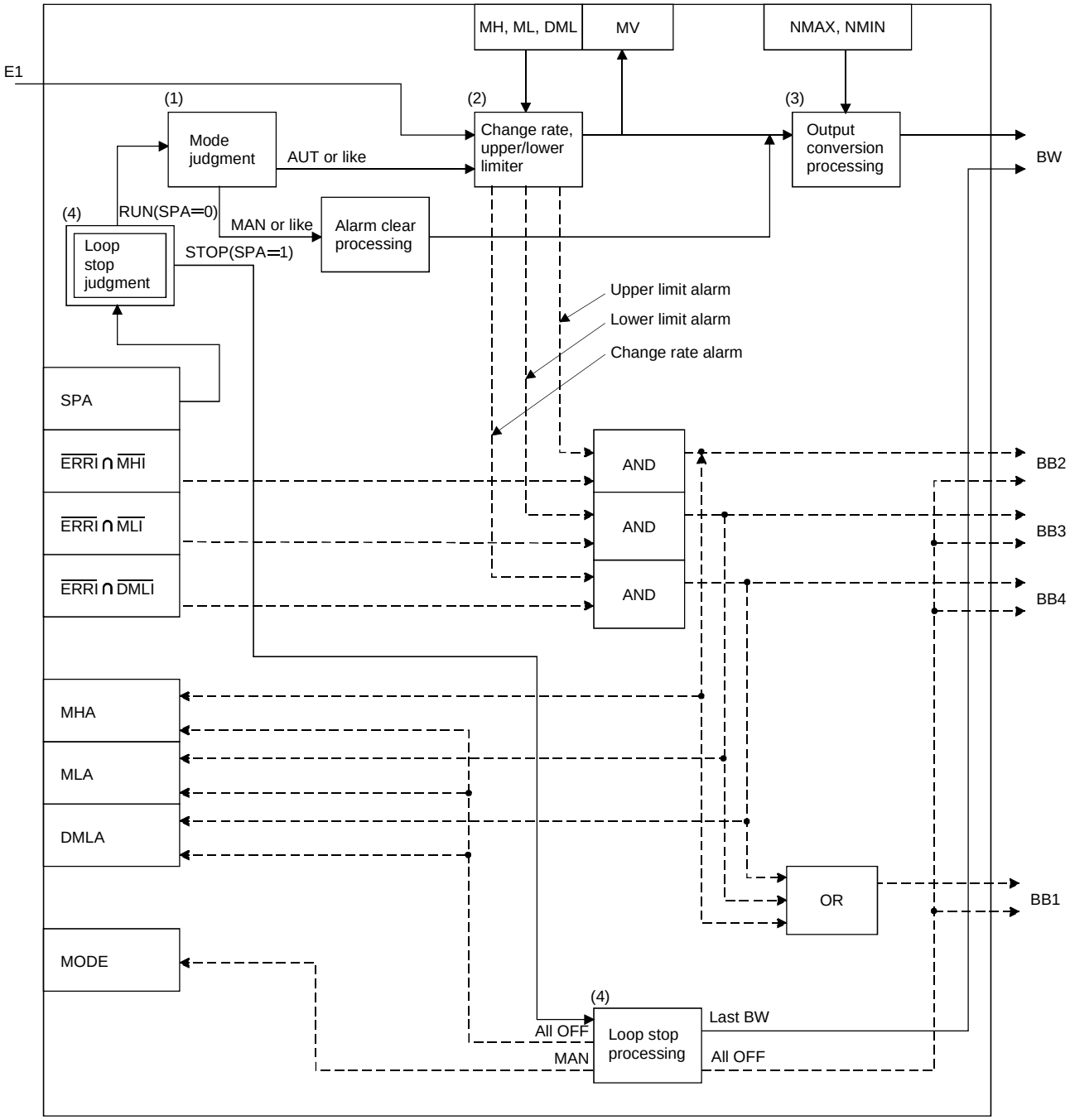
Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device

Functions

Converts the input value (E1 = MV) of the device specified in ⓢ1 into an output, and stores the result into the device specified in ⓓ1.
Also performs the change rate, upper/lower limiter processing and output conversion processing of the input value at this time.

Block diagram

The processing block diagram of the S.OUT2 instruction is shown below.
(The numerals (1) to (4) in the diagram indicate the order of the processing.)



8 - 13

Control data

(1) Data specified in S.OUT2 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value(MV)	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
	+2	BB		b15 b12 b8 b4 b0: BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB1	Alarm					
		BB2	Output upper limit alarm					
		BB3	Output lower limit alarm					
		BB4	Output change rate alarm					
Operation constant	(S2)+0 +1	NMAX	Output conversion upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	NMIN	Output conversion lower limit	-999999 to 999999	—	Real number	0.0	U
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0: CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0: SPA DMLA MHA MLA SPA: 0: Loop RUN, 1: Loop STOP DMLA, MHA, MLA: (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0: ERRI DMLI MHI MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+48 +49	DML	Output change rate limit value	0 to 100	%	Real number	100.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE).

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM (alarm clear processing)

1) MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.

2) BB1 to BB4 of BB are turned to 0.

3) "(3) Output conversion processing" is performed and the S.OUT2 instruction is terminated.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, "(2) Change rate, upper/lower limiter" is performed.

However, when SEA of the alarm detection (ALM) is 1 and SM1501 is ON (with hold), BB1 to BB4 are turned to 0 and the S.OUT2 instruction is terminated.

(2) Change rate, upper/lower limiter

Change rate and upper/lower limit checks are performed on a difference between the temporary MV (T) and manipulated value (MV), and the data and alarm are output after the limiter processings.

(a) The change rate limiter performs the following operation and outputs the result of the operation to BB4 and DMLA.

Condition	BB4, DMLA	Result (T1)
$\|E1 - MV\| \leqq DML$	0	E1
$(E1 - MV) > DML$	1 *1	MV + DML
$(E1 - MV) < -DML$	1 *1	MV − DML

*1: When DMLI or ERRI in the alarm detection inhibition (INH) is set to 1, DMLA and BB4 show 0 since the alarm is prohibited.

(b) The upper/lower limiter performs the following operation and outputs the result of the operation to BB2, BB3, MHA and MLA.

Condition	BB3, MLA	BB2, MHA	MV
$T1 > MH$	0	1 *2	MH
$T1 < ML$	1 *3	0	ML
$ML \leqq T1 \leqq MH$	0	0	T1

*2: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB2 show 0 since the alarm is prohibited.

*3: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB3 show 0 since the alarm is prohibited.

(3) Output conversion

In the output conversion, the output value is calculated from the following formula.

$$BW = \frac{NMAX - NMIN}{100} \times MV + NMIN$$

(4) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.OUT2 instruction.
1) BW retains the last value.
2) DMLA, MHA and MLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB4 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(1) Mode judgment".

(5) Hold processing

Used to specify whether the output value will be held or not by the S.OUT2 instruction is specified at sensor error occurrence (detected by the S.IN instruction) in the loop stop processing.
Use SM1501 to select whether the manipulated value (MV) will be held or not at sensor alarm occurrence.
• SM1501 = OFF: Manipulated value (MV) will not be held.
• SM1501 = ON: Manipulated value (MV) will be held.

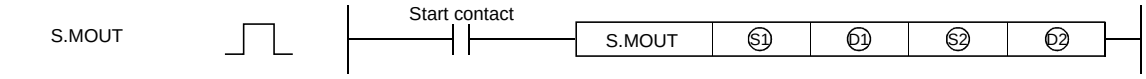
ERROR

• When an operation error occurs — Error code: 4100

8.4 Manual Output (S.MOUT)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Dummy device *1
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device

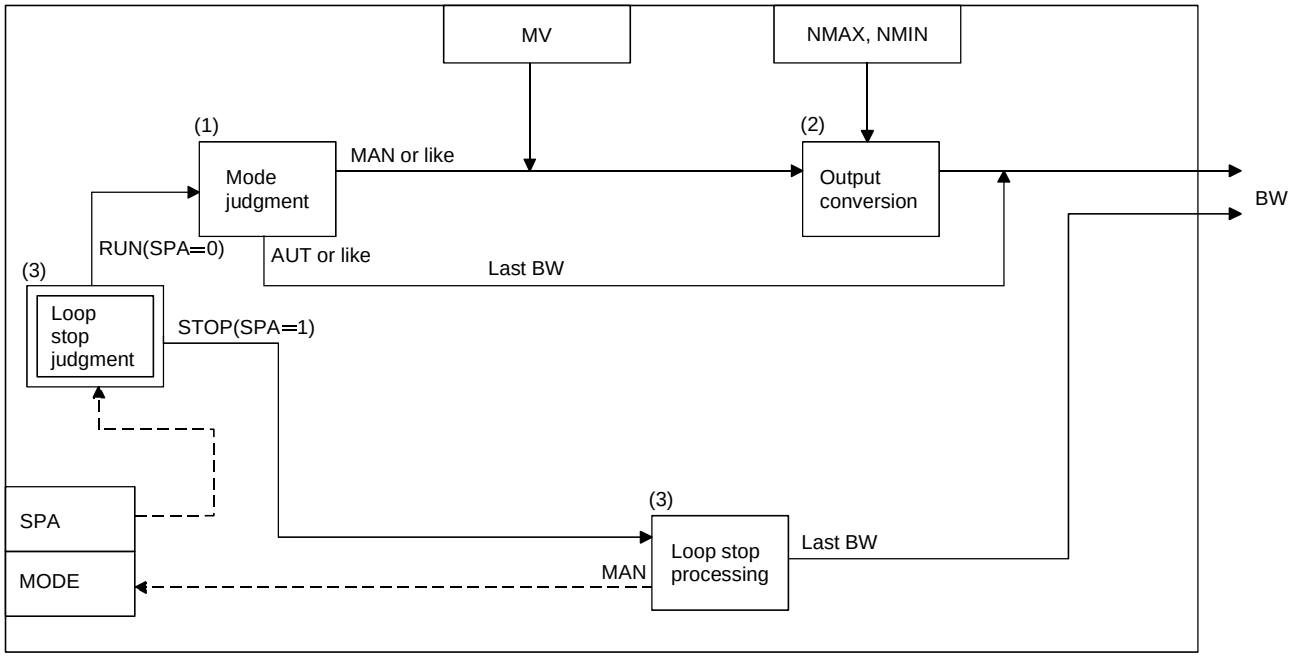
*1: Special register SD1506 can be specified as a dummy device.

Functions

Converts the manipulated value (MV) specified in ⓓ2 into an output, and stores the result into the device specified in ⓓ1.

Block diagram

The processing block diagram of the S.MOUT instruction is shown below.
(The numerals (1) to (3) in the diagram indicate the order of the processing.)



8 - 18

Control data

(1) Data specified in S.MOUT instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	NMAX	Output conversion upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	NMIN	Output conversion lower limit	-999999 to 999999	—	Real number	0.0	U
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA SPA 0: Loop RUN 1: Loop STOP	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE).

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM

1) The manipulated value (MV) is used as the output value (BW).

2) "(2) Output conversion processing" is performed.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, BW retains the last value.

(2) Output conversion

In the output conversion, the output value is calculated from the following formula.

$$BW = \frac{NMAX - NMIN}{100} \times MV + NMIN$$

(3) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.MOUT instruction.
1) BW retains the last value.
2) The operation mode (MODE) is changed to MAN.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(1) Mode judgment".

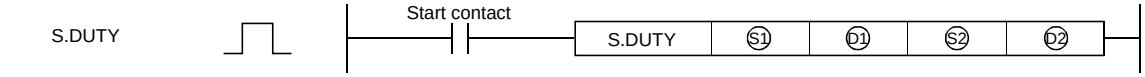
ERROR

• When an operation error occurs — Error code: 4100

8.5 Time Rate Example (S.DUTY)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Loop tag memory head device

*1: Special register SD1506 can be specified as a dummy device.

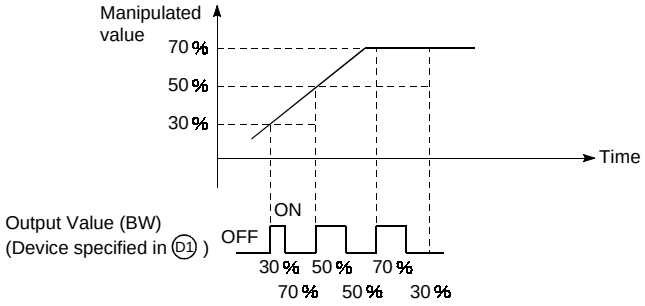
Functions

Calculates the manipulated value (MV) by performing input addition processing from the input value (E1 = ΔMV) of the device specified in ⓢ1. Turns ON/OFF the device specified in ⓓ1 in proportion to the manipulated value (MV).

The ON/OFF time is a value on the assumption that the time specified as the control output cycle (CTDUTY) is 100%.

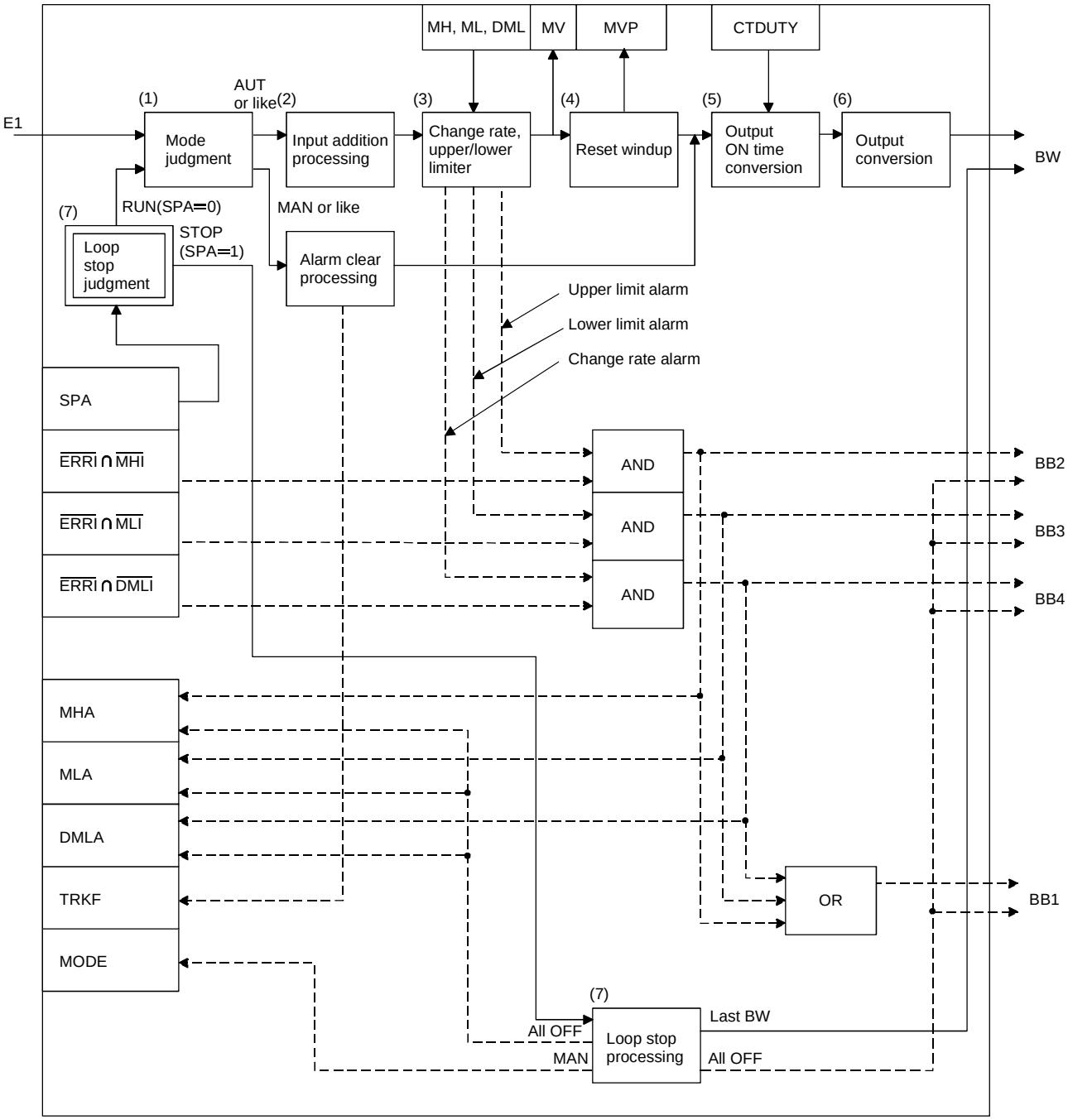
The ON/OFF time is changed in each execution cycle.

Also performs the change rate, upper/lower limiter and reset windup of the calculated manipulated value (MV) at this time.



Block diagram

The processing block diagram of the S.DUTY instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



8 - 22

Control data

(1) Data specified in S.DUTY instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value (ΔMV)	-999999 to 999999	%	Real number	—	U
Block memory		BW		—				
	(D1)+0	BW1	Output bit	b15 b12 b8 b4 b0 — BW1 (0: OFF) (1: ON)	—	BIN 16Bit	—	S
		BB						
	+1	BB1	Alarm	b15 b12 b8 b4 b0 — BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16Bit	—	S
		BB2	Output upper limit alarm					
		BB3	Output lower limit alarm					
		BB4	Output change rate alarm					
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 — CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16Bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 — SPA — — DMLA — — — — — — — MHA MLA SPA: 0: Loop RUN, 1: Loop STOP DMLA, MHA, MLA: (0: Without alarm) (1: With alarm)	—	BIN 16Bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI — TRKF — DMLI — — — — — — — MHI MLI TRKF: (0: Without tracking) (1: With tracking) ERRI, DMLI, MHI, MLI: 0: Alarm enable, 1: Alarm inhibit	—	BIN 16Bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+48 +49	DML	Output change rate limit value	0 to 100	%	Real number	100.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+62 +63	MVP	MV inside operation value	(-999999 to 999999)	%	Real number	0.0	S
	+68 +69	CTDUTY	Control output cycle	0 to 999999 Note that $\frac{CTDUTY}{\Delta T} \leqq 32767$	s	Real number	1.0	U
Loop tag past value memory *2 *3	(D2)+118 ⋮ +121	—	—	Used by the system as a work area.	—	—	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+118	Control output cycle counter initial preset flag
+119	Control output cycle counter
+120	Output counter
+121	Output ON counter

When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE).

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM (alarm clear processing)

1) MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.
2) BB1 to BB4 of BB are turned to 0.
3) The tracking flag (TRKF) of the alarm detection inhibition (INH) is turned to 1.
4) "(5) Output ON time conversion processing" is performed.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, "(2) Input addition processing" is performed.
However, when SEA of the alarm detection (ALM) is 1 and SM1501 is ON (with hold), BB1 to BB4 are turned to 0 and the S.DUTY instruction is terminated.

(2) Input addition processing

The temporary MV (T) is calculated on the basis of the input value (E1 = ΔMV).

(a) When the tracking flag (TRKF) of the alarm detection inhibition (INH) is 1, the following processing is performed.

1) The manipulated value (MV) is stored into the MV internal operation value (MVP).
2) The input value (E1) is changed to 0. (ΔMV = 0)
3) The tracking flag (TRKF) of the alarm detection inhibition (INH) is turned to 0.
4) The temporary MV (T) is calculated with the following expression.

$$T = E1 + MVP$$
$$MVP = T$$

(b) When the tracking flag (TRKF) of the alarm detection inhibition (INH) is 0, the temporary MV (T) is calculated with the following expression.

$$T = E1 + MVP$$
$$MVP = T$$

(3) Change rate, upper/lower limiter

Change rate and upper/lower limit checks are performed on a difference between the temporary MV (T) and manipulated value (MV), and the data and alarm are output after the limiter processings.

(a) The change rate limiter performs the following operation and outputs the result of the operation to BB4 and DMLA.

Condition	BB4, DMLA	Result (T1)
$\|T - MV\| \leqq DML$	0	T
$(T - MV) > DML$	1 *1	MV + DML
$(T - MV) < -DML$	1 *1	MV − DML

*1: When DMLI or ERRI in the alarm detection inhibition (INH) is set to 1, DMLA and BB4 show 0 since the alarm is prohibited.

(b) The upper/lower limiter performs the following operation and outputs the result of the operation to BB2, BB3, MHA and MLA.

Condition	BB3, MLA	BB2, MHA	MV
$T1 > MH$	0	1 *2	MH
$T1 < ML$	1 *3	0	ML
$ML \leqq T1 \leqq MH$	0	0	T1

*2: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB2 show 0 since the alarm is prohibited.

*3: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB3 show 0 since the alarm is prohibited.

(4) Reset windup

If the manipulated value (MV) exceeds the upper/lower limit value, the following operation is performed to return it to the upper/lower limit value and enable immediate response when the deviation is inverted.

However, when the integral constant (T1) is 0, the reset windup processing is not performed.

Condition	Operation expression
When MHA = 1, $\frac{\Delta T}{T_I} \leqq 1$	$MVP = \frac{\Delta T}{T_I}(MH - T) + T$
When MLA = 1, $\frac{\Delta T}{T_I} \leqq 1$	$MVP = \frac{\Delta T}{T_I}(ML - T) + T$

(5) Output ON time conversion processing

(a) When the control output cycle (CTDUTY) is reached, the output ON counter is calculated with the following expression. At this time, the output counter is cleared (to 0).

$$\text{OutputON Counter} = \frac{\text{CTDUTY}}{\Delta T} \times MV \times \frac{1}{100}$$

The output ON counter rounds off a fraction to no decimal places.

(b) When the control output cycle (CTDUTY) is not reached, the output counter is incremented by 1 and "(6) Output conversion processing" is performed.

(6) Output conversion processing

In the output conversion processing, the following processing is performed.

Condition	BW
Output counter < output ON counter	1 (ON)
Output counter ≧output ON counter	0 (OFF)

(7) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.DUTY instruction.
1) BW is output at the last ON/OFF rate.
2) DMLA, MHA and MLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB4 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(1) Mode judgment".

(8) Hold processing

Used to specify whether the output value will be held or not by the S. DUTY instruction is specified at sensor error occurrence (detected by the S.IN instruction) in the loop stop processing.
Use SM1501 to select whether the manipulated value (MV) will be held or not at sensor alarm occurrence.
• SM1501 = OFF: Manipulated value (MV) will not be held.
• SM1501 = ON: Manipulated value (MV) will be held.

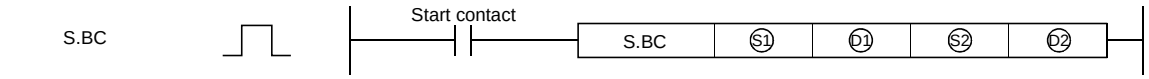
ERROR

• When an operation error occurs — Error code: 4100

8.6 Batch Counter (S.BC)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Loop tag memory head device

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value (E1) with the set value 1 (SV1)/set value 2 (SV2), and outputs bit data as soon as the input value (E1) reaches the set value 1 (SV1)/set value 2 (SV2).
Also performs the upper limit check processing, change rate check processing and output conversion processing of the input value (E1) at this time.

Control data

(1) Data specified in S.BC instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	0 to 2147483647	—	BIN 32Bit	—	U
Block memory	(D1)+0	BW		—				
		BW1	Output1	b15 b12 b8 b4 b0 (BW2, BW1) (0: OFF) (1: ON)	—	BIN 16Bit	—	S
		BW2	Output2					
	+1	BB		—				
		BB1	Alarm	b15 b12 b8 b4 b0 (BB3, BB2, BB1) (0: Without alarm) (1: With alarm)	—	BIN 16Bit	—	S
		BB2	Upper limit alarm					
		BB3	Change rate alarm					
Loop tag memory *2	(D2)+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 (PHA, DPPA) PHA, DPPA (0: Without alarm) (1: With alarm)	—	BIN 16Bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 (ERRI, PHI, DPPI) 0: Alarm enable 1: Alarm inhibit	—	BIN 16Bit	4000H	S/U
	+14 +15	SV1	Set value1	0 to 2147483647	—	BIN 32Bit	0	U
	+16 +17	SV2	Set value2	0 to 2147483647	—	BIN 32Bit	0	U
	+26 +27	PH	Upper limit alarm set value	0 to 2147483647	—	BIN 32Bit	0	U
	+42 +43	CTIM	Change rate alarm check time	0 to 999999 Note that $\frac{CTIM}{\Delta T} \leqq 32767$	s	Real number	0.0	U
	+44 +45	DPL	Change rate alarm value	0 to 2147483647	—	BIN 32Bit	0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag past value memory *2 *3	(D2)+124 ⋮ +127	—	—	Used by the system as a work area.	—	—	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)
*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+124	Change rate monitor counter initial preset flag
+125	Change rate monitor counter
+126 +127	X_{n-m}

When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Upper limit check processing

In the upper limit check processing, the following operation is performed and the result of the operation is output to BB2 and PHA.

Condition	BB2, PHA
E1 > PH	1 *1
Others	0

*1: When PHI or ERRI in the alarm detection inhibition (INH) is set to 1, PHA and BB2 show 0 since the alarm is prohibited.

(2) Change rate check processing

Performs a change rate alarm check during the change rate alarm check time (CTIM) specified in the loop tag memory. The change rate alarm check compares the change of the input value (E1) with the change rate alarm value (DPL) in each execution cycle (ΔT).

Condition	BB3, DPPA
$(Xn - X_{n-m}) \geqq DPL$	1 *2
Others	0

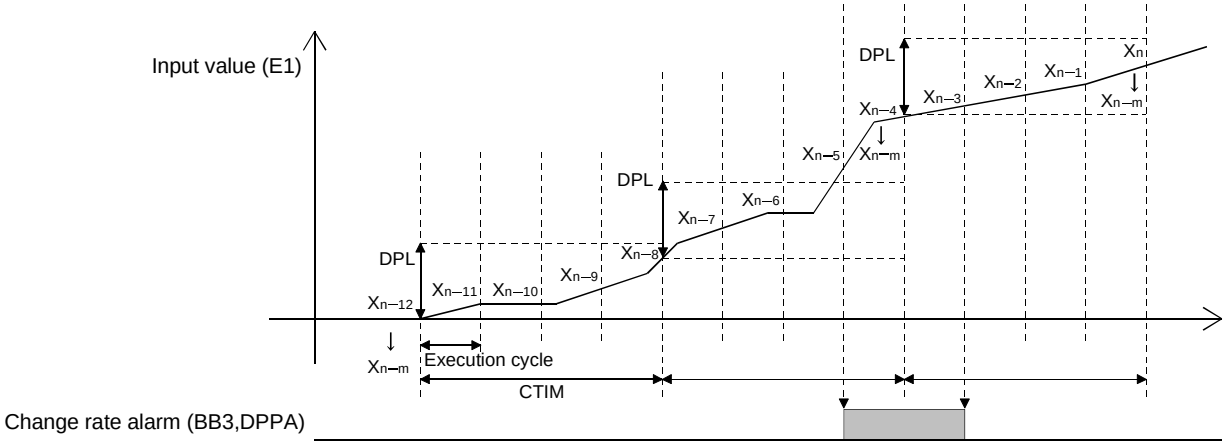
*2: When DPPI or ERRI of the alarm detection inhibition (INH) is 1, DPPA and BB3 turn to 0 since the alarm is prohibited.

The change rate alarm counter (m) is calculated with the following expression.

$$\text{Change rate alarm counter (m)} = \frac{CTIM}{\Delta T}$$

The change rate alarm counter (m) varies from 1 to m.
However, when the change rate alarm counter (m) = 0, no processing is performed.

Example) When the change rate alarm counter (m) = 4, processing is perform as shown below.



(3) Output conversion processing

In the output conversion processing, the following operation is performed and the result of the operation is stored into BW1 and BW2.

Condition	BW1	BW2
E1 < 0	0	0
0 ≦ E1 < SV1	0	—
E1 ≧ SV1	1	—
0 ≦ E1 < SV2	—	0
E1 ≧ SV2	—	1

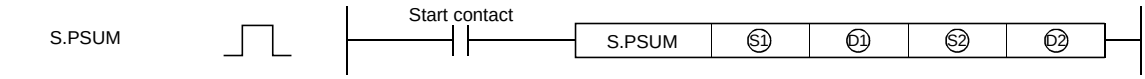
ERROR

• When an operation error occurs — Error code: 4100

8.7 Pulse Retentive (S.PSUM)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

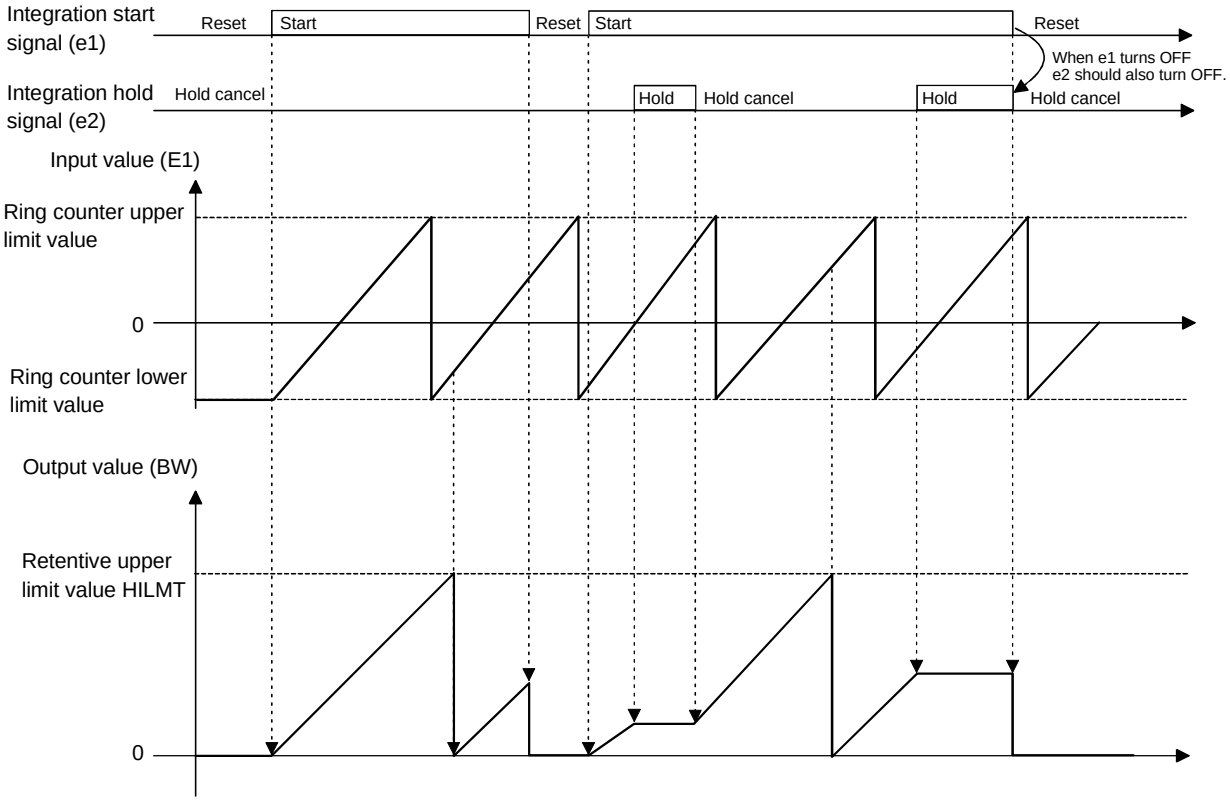


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device

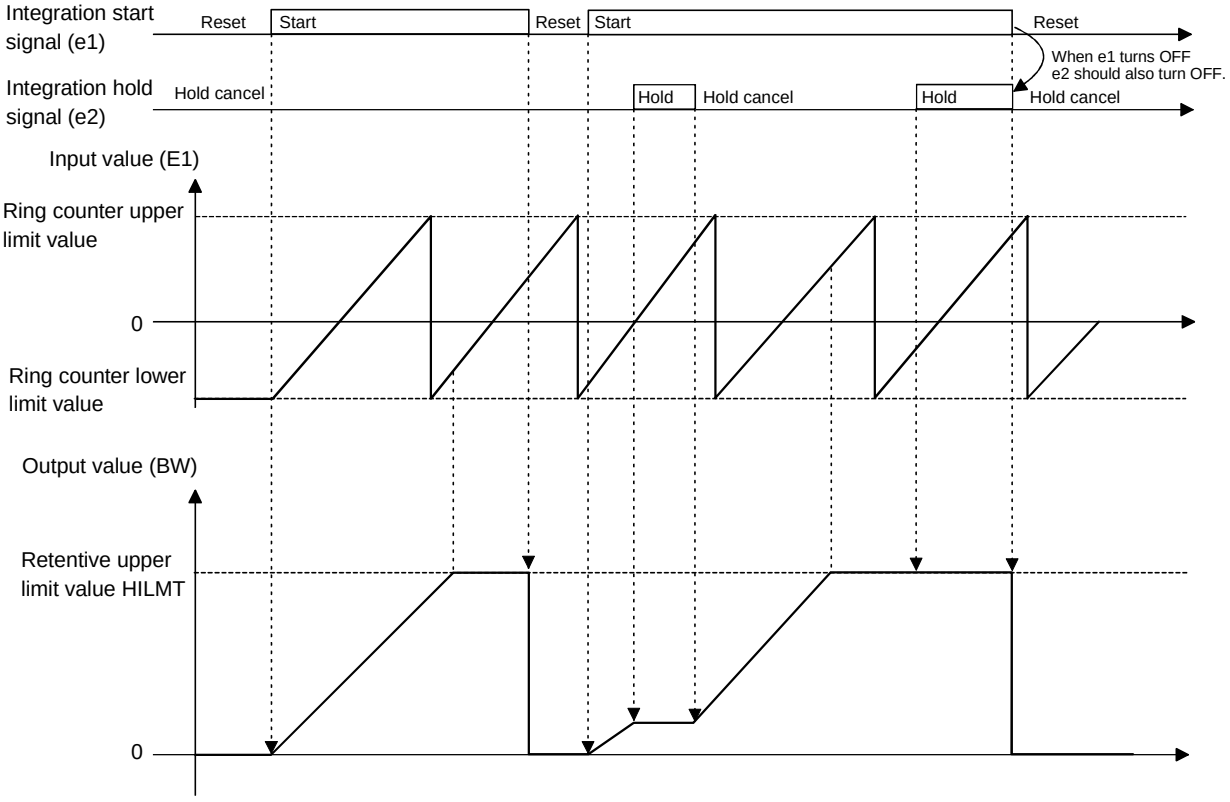
Functions

Integrates the input value (E1) of the device specified in ⓢ1, and stores the result into the device specified in ⓓ1.
The integration upper limit value and integration pattern can be used to select whether the integrated value will be returned to 0 or retained at the upper limit value if the output value exceeds the integration upper limit value.
The integration start signal and integration hold signal can be used to start and suspend the integration of the input value.

(1) Operation performed when the integration pattern is set to "integrated value returns to 0 when the integration upper limit value is exceeded"



(2) Operation performed when the integration pattern is set to " integrated value is retained at the integration upper limit value when the upper limit value is exceeded"



Control data

(1) Data specified in S.PSUM instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	Use the ring counter of 16 bits or more. • 16-bit ring counter 00000000H→0000FFFFH→00000000H • 24-bit ring counter 00000000H→00FFFFFFH→00000000H • 32-bit ring counter 00000000H→FFFFFFFFH→00000000H Set 32767 (7FFFH) or less as a pulse increment at each instruction execution.	pulse	BIN 32Bit	—	U
	+2	e		—				
		e1	Integration start signal	b15 b12 b8 b4 b0; e2 e1 Integration start signal 0: Integration stop/reset 1: Integration start	—	BIN 16Bit	—	U
		e2	Integration hold signal	Integration hold signal 0: Integration hold cancel 1: Integration hold				
Block memory	(D1)+0 +1	BW1	Output value (Integer part)	(0 to 2147483647)	—	BIN 32Bit	—	S
	+2 +3	BW2	Output value (Fraction part)	(0 to 2147483647)	—	BIN 32Bit	—	S
Operation constant	(S2)+0	W	Weight per pulse	1 to 999	—	BIN 16Bit	1	U
	+1	U	Unit conversion constant	1, 10, 100, 1000	—	BIN 16Bit	1	U
	+2 +3	HILMT	Retentive upper limit value	1 to 2147483647	—	BIN 32Bit	2147483647	U
	+4	SUMPTN	Integration pattern	0: Returns to 0 when the integration upper limit value (HILMT) is exceeded. 1: Retains the integration upper limit value when the integration upper limit value (HILMT) is exceeded.	—	BIN 16Bit	0	U
Loop tag memory *2	+10 +11	SUM1	Retentive value (Integer part)	(0 to 2147483647)	—	BIN 32Bit	0	S
	+12 +13	SUM2	Retentive value (Fraction part)	(0 to 2147483647)	—	BIN 32Bit	0	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

8 - 34

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag past value memory *2 *3	(D2)+116 +117	—	—	Used by the system as a work area.	—	—	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)
*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+116 +117	$E1_{n-1}$ (Last input value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

Processing contents

(1) Upper limit check processing

In the upper limit check processing, the following operation is performed and the result of the operation is output to BB2 and PHA.

e1	e2	Input value increment (T1)
0	0	—
0	1	—
1	0	$E1 - E1_{n-1}$
1	1	—

(2) Integrated value operation processing

In the integrated value operation processing, the following processing is performed for the input value increment (T1).

e1	e2	Retentive value (Integer part) (T2), Retentive value (Fraction part) (T3)
0	0	T2 = 0 T3 = 0
0	1	T2 = 0 T3 = 0 *1
1	0	T4 = quotient of {(T1 × W) / U} <integer part> T5 = remainder of {(T1 × W) / U} <fraction part> T2 = SUM1 + T4 + [quotient of {(SUM2 + T5) / U}] <integer part> T3 = remainder of {(SUM2 + T5) / U} <fraction part>
1	1	T2 = SUM1 T3 = SUM2

*1: At an integration stop/reset (e1 = 0), processing is performed on the assumption that integration hold is canceled (e2 = 0).

(3) Output conversion

In the output conversion, the following processing is performed for the integrated value (T2, T3).

SUMPTN	Condition	BW1, SUM1	BW2, SUM2
0	T2 ≧ HILMT	BW1 = remainder of T2 / HILMT SUM1 = remainder of T2 / HILMT	BW2 = T3 SUM2 = T3
	Others	BW1 = T2 SUM1 = T2	BW2 = T3 SUM2 = T3
1	T2 ≧ HILMT	BW1 = HILMT SUM1 = HILMT	BW2 = 0 SUM2 = 0
	Others	BW1 = T2 SUM1 = T2	BW2 = T3 SUM2 = T3

ERROR

• When an operation error occurs — Error code: 4100

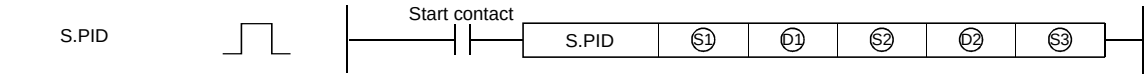
8 - 36

9 CONTROL OPERATION INSTRUCTIONS

9.1 Basics PID (S.PID)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					
(S3)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Loop tag memory head device
(S3)	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

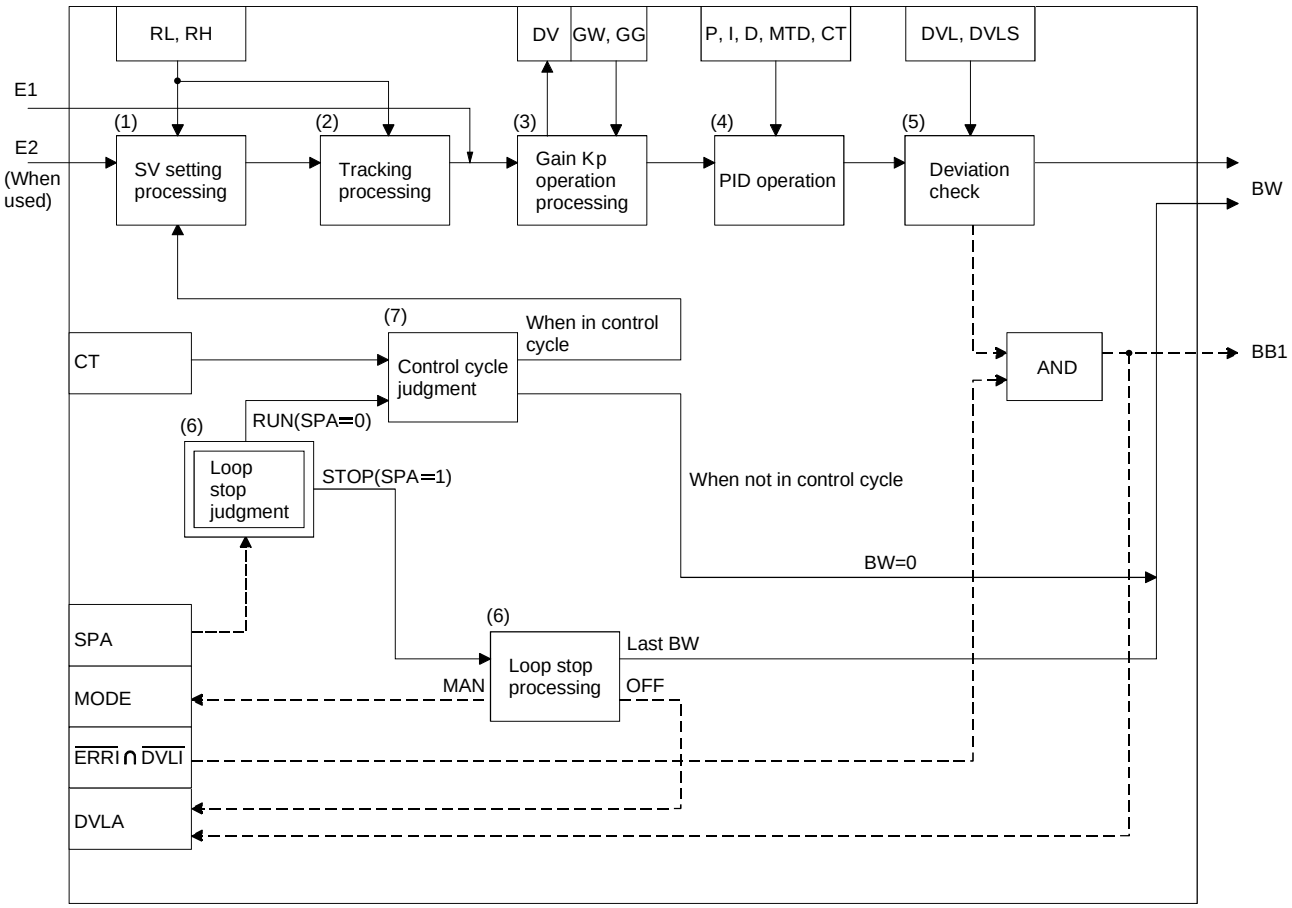
Functions

Performs PID operation when the specified control cycle is reached. (PID operation is of velocity type/process value derivative type (incomplete differentiation type).)
Also performs SV setting processing, tracking processing, gain (Kp) operation processing and deviation check processing at this time.

9 - 1

Block diagram

The processing block diagram of the S.PID instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



Control data

(1) Data specified in S.PID instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value (ΔMV)	(-999999 to 999999)	—	Real number	—	S
		BB	—					
	+2	BB1	Deviation large alarm	b15 b12 b8 b4 b0 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	MTD	Derivative gain	0 to 999999	—	Real number	8.0	U
	+2 +3	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+4	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+5	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+6	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DVLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DVLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U
	+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	D	Derivative constant	0 to 999999	s	Real number	0.0	U
	+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
	+62 +63	MVP	MV Inside operation value	(-999999 to 999999)	%	Real number	0.0	S
Loop tag past value memory *2 *3	(D2)+96 ⋮ +111	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+102 +103	B_{n-1} (Last value)
+104 +105	PV_n (Process value)
+106 +107	PV_{n-1} (Last process value)
+108 +109	PV_{n-2} (Process value before last)
+110 +111	DV_{n-1} (Last deviation value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH-RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH-RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation(PN=1)	$DV = E1 - SV_n'$
Reverse operation(PN=0)	$DV = SV_n' - E1$

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When $\|DV\| \leqq GW$	$K = GG$
When $\|DV\| > GW$	$K = 1 - \frac{(1-GG) \times GW}{\|DV\|}$

(4) PID operation

PID operation is performed with the following operation expression.

Item		Operation expression
Bn	When forward operation (PN=1)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times B_{n-1}}{T_D}\}$
	When reverse operation (PN=0)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{-(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times B_{n-1}}{T_D}\}$
BW (ΔMV)		$K_P\times\{(DV_n-DV_{n-1})+\frac{CT}{T_I}\times DV_n+B_n\}$

K_P: K × Gain (P), M_D: Derivative gain (MTD)

T_I: Integral constant (I), T_D: Derivative constant (D)

In the following case, however, note that special processing will be performed.

Condition	Processing
In either of the following cases 1, 2 1. Derivative constant (D) = 0 (T_D = 0) 2. Operation mode (MODE) is any of MAN, LCM and CMV	Bn = 0 (However, the loop tag past value memory is set.)
In any of the following cases 1, 2, 3 1. Integral constant (I) = 0 (T_I = 0) 2. When MH or ML error occurred (MVP > MH) and ($\frac{CT}{T_I}\times DV_n>0$) 3. When MH or ML error occurred (MVP < ML) and ($\frac{CT}{T_I}\times DV_n<0$)	$\frac{CT}{T_I}\times DV_n=0$

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB1) of the block memory.

Condition	Result
DVL < |DV|	DVLA = BB1 = 1 *1
(DVL − DVLS) < |DV| ≦ DVL	DVLA = BB1 = Last value status hold *1
|DV| ≦ (DVL − DVLS)	DVLA = BB1 = 0

*1: When DVLI or ERRI in the alarm detection inhibition (INH) is set to 1, DVLA and BB1 show 0 since the alarm is prohibited.

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.PID instruction.

1) BW is turned to 0.
2) DVLA of the alarm detection (ALM) is turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached, BW (ΔMV) is turned to 0 and the S.PID instruction is terminated.

(b) When the specified control cycle is reached, "(1) SV setting processing" is performed.

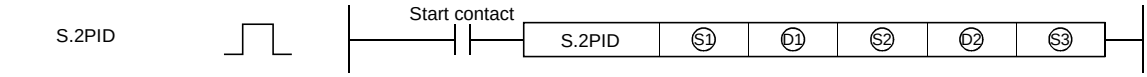
Error

• When an operation error occurs — Error code: 4100

9.2 2-degree-of-freedom PID (S.2PID)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

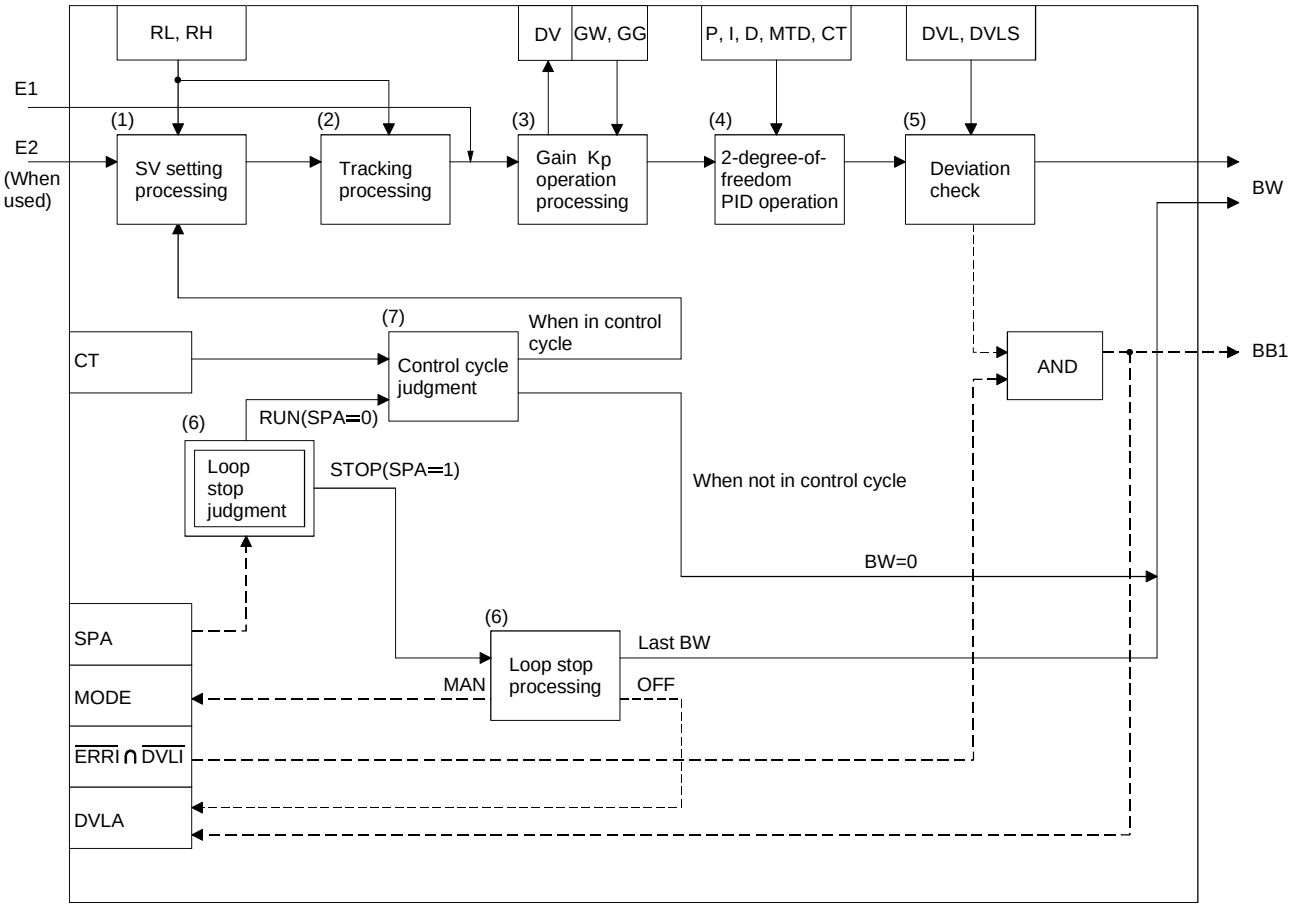
*1: Special register SD1506 can be specified as a dummy device.

Functions

Performs 2-degree-of-freedom PID operation when the specified control cycle is reached.
Also performs SV setting processing, tracking processing, gain (Kp) operation processing and deviation check processing at this time.

Block diagram

The processing block diagram of the S.2PID instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



Control data

(1) Data specified in S.2PID instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value (ΔMV)	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Deviation large alarm	b15 b12 b8 b4 b0 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	MTD	Derivative gain	0 to 999999	—	Real number	8.0	U
	+2 +3	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+4	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+5	TRK	Tracking bit	0: Not tracked 1: Tracked	—	BIN 16bit	0	U
	+6	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: Specify whether the set value (E2) is to be used or not.

*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DVLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DVLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U
	+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	D	Derivative constant	0 to 999999	s	Real number	0.0	U
	+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
	+62 +63	MVP	MV inside operation value	(-999999 to 999999)	%	Real number	0.0	S
	+64 +65	α	2 degree-of-freedom parameter α *5	0 to 1	—	Real number	0.0	U
	+66 +67	β	2 degree-of-freedom parameter β *6	0 to 1	—	Real number	1.0	U
Loop tag past value memory *2 *3	+96 ⋮ +115	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system.
Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+102 +103	B_{n-1} (Last value)
+104 +105	PV_n (Process value)
+106 +107	PV_{n-1} (Last process value)
+108 +109	PV_{n-2} (Process value before last)
+110 +111	DV_{n-1} (Last deviation value)
+112 +113	DV_{n-2} (Deviation value before last)
+114 +115	D_{n-1} (Last value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

*5: Increasing α decreases the manipulated value variation relative to the set value change.
(It will take time to stabilize.)
Decreasing α increases the manipulated value variation relative to the set value change.
However, since a compensation operation will be stronger, hunting may become greater.

*6: Increasing β decreases the effect of differentiation on the set value change.
Decreasing β increases the effect of differentiation on the set value change.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH-RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH-RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation (PN=1)	$DV = E1 - SV_n'$
Reverse operation (PN=0)	$DV = SV_n' - E1$

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When $\|DV\| \leqq GW$	$K = GG$
When $\|DV\| > GW$	$K = 1 - \frac{(1-GG) \times GW}{\|DV\|}$

(4) 2-degree-of-freedom PID operation

2-degree-of-freedom PID operation is performed with the following operation expression.

Item		Operation expression
B_n		$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{(DV_n-2DV_{n-1}+DV_{n-2})-\frac{CT\times B_{n-1}}{T_D}\}$
C_n	When forward operation (PN=1)	PV_n-PV_{n-1}
	When reverse operation (PN=0)	$-(PV_n-PV_{n-1})$
D_n	When forward operation (PN=1)	$D_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times D_{n-1}}{T_D}\}$
	When reverse operation (PN=0)	$D_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{-(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times D_{n-1}}{T_D}\}$
BW (ΔMV)		$K_P\times\{(1-\alpha)\times(DV_n-DV_{n-1})+\frac{CT}{T_I}\times DV_n+(1-\beta)\times B_n+\alpha\times C_n+\beta\times D_n\}$

K_P: K × Gain (P), M_D: Derivative gain (MTD)

T_I: Integral constant (I), T_D: Derivative constant (D)

In the following case, however, note that special processing will be performed.

Condition	Processing
In either of the following cases 1, 2 1. Derivative constant (D) = 0 (T_D = 0) 2. Operation mode (MODE) is any of MAN, LCM and CMV	B_n = 0, D_n = 0 (However, the loop tag past value memory is set.)
In any of the following cases 1, 2, 3 1. Integral constant (I) = 0 (T_I = 0) 2. When MH or ML error occurred (MVP > MH) and ($\frac{CT}{T_I}\times DV_n>0$) 3. When MH or ML error occurred (MVP < ML) and ($\frac{CT}{T_I}\times DV_n<0$)	$\frac{CT}{T_I}\times DV_n=0$

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB1) of the block memory.

Condition	Result
DVL < |DV|	DVLA = BB1 = 1 *1
(DVL − DVLS) < |DV| ≦ DVL	DVLA = BB1 = Last value status hold *1
|DV| ≦ (DVL−DVLS)	DVLA = BB1 = 0

*1: When DVLI or ERRI in the alarm detection inhibition (INH) is set to 1, DVLA and BB1 show 0 since the alarm is prohibited.

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.2PID instruction.
1) BW is turned to 0.
2) DVLA of the alarm detection (ALM) is turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached, BW (ΔMV) is turned to 0 and the S.2PID instruction is terminated.
(b) When the specified control cycle is reached, "(1) SV setting processing" is performed.

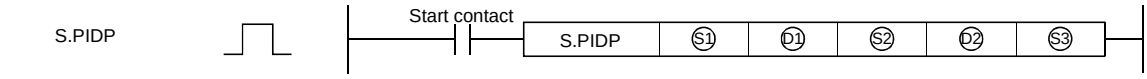
ERROR

• When an operation error occurs — Error code: 4100

9.3 Position type PID (S.PIDP)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

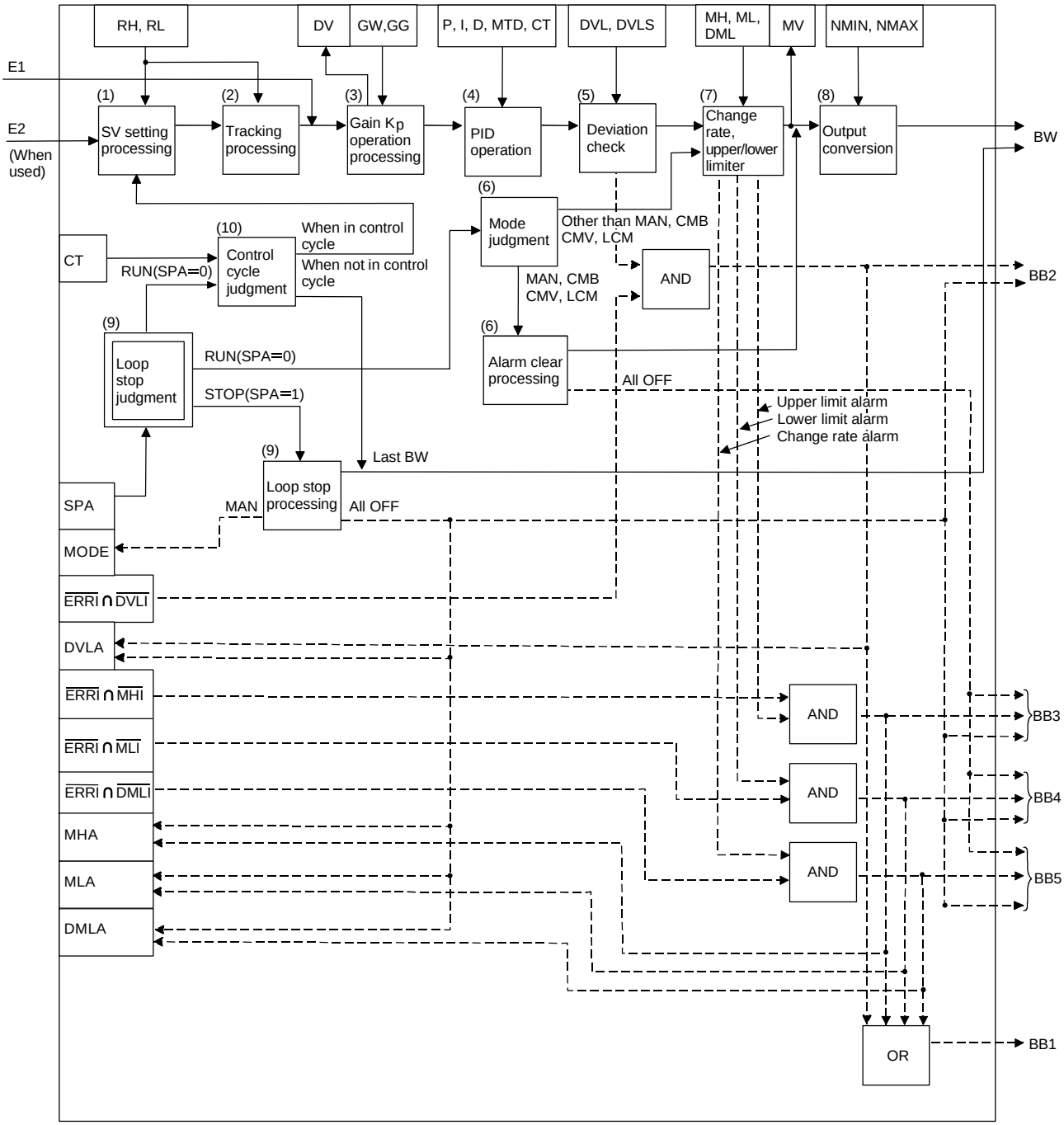
*1: Special register SD1506 can be specified as a dummy device.

Functions

Performs position type PID operation when the specified control cycle is reached.
Also performs SV setting processing, tracking processing, gain (Kp) operation processing, deviation check processing and operation mode (MODE) judgment at this time.
Performs change rate, upper/lower limiter and output processings or alarm clear processing and output conversion according to the result of the judgment.

Block diagram

The processing block diagram of the S.PIDP instruction is shown below.
(The numerals (1) to (10) in the diagram indicate the order of the processing.)



9 - 18

Control data

(1) Data specified in S.PIDP instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
	+2	BB	—					
		BB1	Alarm	b15 b12 b8 b4 b0 — BB5 BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Deviation large alarm					
		BB3	Output upper limit alarm					
		BB4	Output lower limit alarm					
		BB5	Output change rate alarm					
Operation constant	(S2)+0 +1	MTD	Derivative gain	0 to 999999	—	Real number	8.0	U
	+2 +3	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+4	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+5	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+6	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U
	+7 +8	NMAX	Output conversion upper limit	-999999 to 999999	—	Real number	100.0	U
	+9 +10	NMIN	Output conversion lower limit	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DMLA DVLA MHA MLA SPA: 0: Loop RUN, 1: Loop STOP DVLA, DMLA, MHA, MLA: (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DMLI DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DMLI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+48 +49	DML	Output change rate limit value	0 to 100	%	Real number	100.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	D	Derivative constant	0 to 999999	s	Real number	0.0	U
	+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U
	+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
Loop tag past value memory *2 *3	(D2)+96 ⋮ +107	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+100 +101	I_{n-1} (Last value)
+102 +103	B_{n-1} (Last value)
+104 +105	PV_n (Process value)
+106 +107	PV_{n-1} (Last process value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH-RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH-RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation (PN=1)	$DV = E1 - SV_n'$
Reverse operation (PN=0)	$DV = SV_n' - E1$

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When $\|DV\| \leqq GW$	$K = GG$
When $\|DV\| > GW$	$K = 1 - \frac{(1-GG) \times GW}{\|DV\|}$

(4) PID operation

PID operation is performed with the following operation expression.

Item		Operation expression
Bn	When forward operation (PN = 1)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{(PV_n-PV_{n-1})-\frac{CT\times B_{n-1}}{T_D}\}$
	When reverse operation (PN = 0)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{-(PV_n-PV_{n-1})-\frac{CT\times B_{n-1}}{T_D}\}$
In		$I_{n-1}+\frac{CT}{T_I}\times DV_n$
T		$Kp\times(DVn+In+Bn)$

K_P: K × Gain (P), M_D: Derivative gain (MTD)

T_I: Integral constant (I), T_D: Derivative constant (D)

In the following case, however, note that special processing will be performed.

Condition	Processing
In either of the following cases 1, 2 1. Derivative constant (D) = 0 (T_D = 0) 2. Operation mode (MODE) is any of MAN, LCM and CMV	B_n = 0 (However, the loop tag past value memory is set.)
In any of the following cases 1, 2, 3 1. Integral constant (I) = 0 (T_I = 0) 2. When MH error occurred $\frac{CT}{T_I}\times DV_n>0$ 3. When ML error occurred $\frac{CT}{T_I}\times DV_n<0$	$\frac{CT}{T_I}\times DV_n=0$

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB2) of the block memory.

Condition	Result
DVL < |DV|	DVLA=BB2=1 *1
(DVL−DVLS) < |DV| ≦ DVL	DVLA=BB2=Last value status hold *1
|DV| ≦ (DVL−DVLS)	DVLA=BB2=0

*1: When DVLI or ERRI in the alarm detection inhibition (INH) is set to 1, DVLA and BB2 show 0 since the alarm is prohibited

(6) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM (alarm clear processing)

1) MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.
2) BB3 to BB5 of BB are turned to 0.
3) Data of BB2 is transferred to BB1 of BB. (BB1 = BB2)
4) "(8) Output conversion processing" is performed and the S.PIDP instruction is terminated.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, "(7) Change rate, upper/lower limiter" is executed.

(7) Change rate, upper/lower limiter

Change rate and upper/lower limit checks are performed on a difference between the temporary MV (T) and manipulated value (MV), and the data and alarm are output after the limiter processings.

(a) The change rate limiter performs the following operation and outputs the result of the operation to BB5 and DMLA.

Condition	BB5, DMLA	T1
$\|T - MV\| \leqq DML$	0	T
$(T - MV) > DML$	1 *1	MV + DML
$(T - MV) < -DML$	1 *1	MV − DML

*1: When DMLI or ERRI in the alarm detection inhibition (INH) is set to 1, DMLA and BB5 show 0 since the alarm is prohibited.

(b) The upper/lower limiter performs the following operation and outputs the result of the operation to BB3, BB4, MHA and MLA.

Condition	BB4, MLA	BB3, MHA	MV
$T1 > MH$	0	1 *2	MH
$T1 < ML$	1 *3	0	ML
$ML \leqq T1 \leqq MH$	0	0	T1

*2: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB3 show 0 since the alarm is prohibited.

*3: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB4 show 0 since the alarm is prohibited.

(8) Output conversion

In the output conversion, the output value is calculated from the following formula.

$$BW = \frac{NMAX - NMIN}{100} \times MV + NMIN$$

(9) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.PIDP instruction.
1) BW retains the last value.
2) DVLA, MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB5 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(10) Control cycle judgment".

(10) Control cycle judgment

(a) When the specified control cycle is not reached, BW is retained and the S.PIDP instruction is terminated.

(b) When the specified control cycle is reached, "(1) SV setting processing" is performed.

ERROR

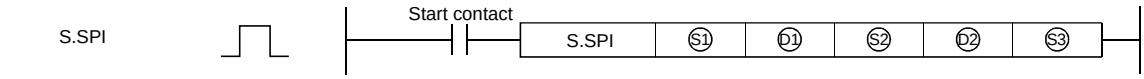
• When an operation error occurs — Error code: 4100

9 - 25

9.4 Sample PI (S.SPI)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]

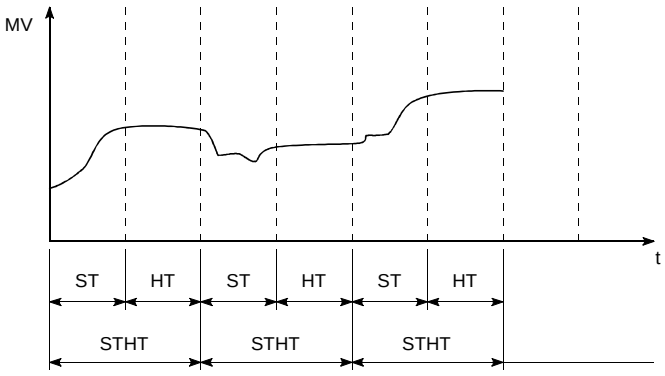


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

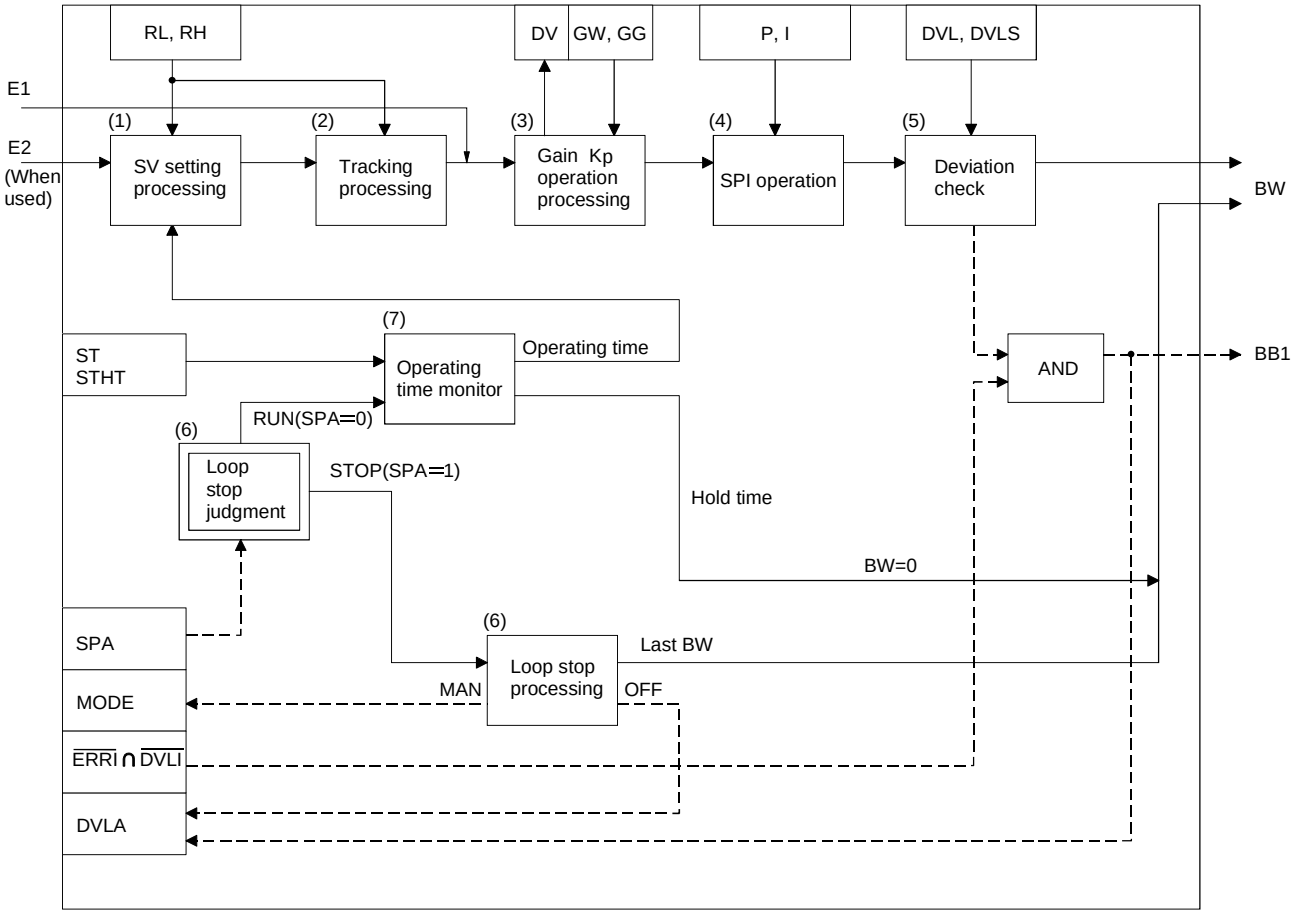
Functions

Performs normal PI operation during operating time (ST).
Judges between operating time (ST) or hold time (HT), and if it is the operating time, performs SV setting processing, tracking processing, gain (Kp) operation processing, SPI operation and deviation check.



Block diagram

The processing block diagram of the S.SPI instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 27

Control data

(1) Data specified in S.SPI instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value (ΔMV)	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Deviation large alarm	b15 b12 b8 b4 b0 (BB1) (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+2	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+3	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+4	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: Specify whether the set value (E2) is to be used or not.

*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

9 - 28

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16Bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DVLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DVLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16Bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16Bit	4000H	S/U
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	ST	Operating time	0 to 999999 Note that $\frac{ST}{\Delta T} \leqq 32767$	s	Real number	0.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U
	+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	STHT	Sample cycle	0 to 999999 Note that $\frac{STHT}{\Delta T} \leqq 32767$	s	Real number	0.0	U
	+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

9 - 29

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
	+62 +63	MVP	MV inside operation value	(-999999 to 999999)	%	Real number	0.0	S
Loop tag past value memory *2 *3	(D2)+96 ⋮ +101	—	—	Used by the system as a work area.	—	—	—	—
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Sample counter
+98	Operation definition
+99	Hold counter
+100 +101	DV_{n-1} (Last deviation value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH-RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH - RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation(PN = 1)	DV = E1 − SVn'
Reverse operation(PN = 0)	DV = SVn' − E1

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When |DV| ≦ GW	K = GG
When |DV| > GW	$K = 1 - \frac{(1 - GG) \times GW}{\|DV\|}$

(4) SPI operation

SPI operation is performed with the following operation expression.

Condition	Operation expression
During operating time (ST)	$BW = K_P \times \{(DV_n - DV_{n-1}) + \frac{BT}{T_I} \times DV_n\}$
During hold time (STHT−ST)	BW = 0 (loop tag past value memory is not set.)

K_P: K × Gain (P), T_I: Integral constant (I), BT: Execution cycle (ΔT)

In the following case, however, note that special processing will be performed.

Condition	Operation expression
In any of the following cases 1, 2, 3 1. Integral constant (I) = 0 (T_I = 0) 2. When MH or ML error occurred (MVP > MH) and $(\frac{BT}{T_I} \times DV_n > 0)$ 3. When MH or ML error occurred (MVP < ML) and $(\frac{BT}{T_I} \times DV_n < 0)$	$\frac{BT}{T_I} \times DV_n = 0$

9 - 31

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB1) of the block memory.

Condition	Result
DVL < |DV|	DVLA = BB1 = 1 *1
(DVL − DVLS) < |DV| ≦ DVL	DVLA = BB1 = Last value status hold *1
|DV| ≦ (DVL−DVLS)	DVLA = BB1 = 0

*1: When DVLI or ERRI of the alarm detection inhibition (INH) is 1, DVLA and BB1 turn to 0 since the alarm is inhibited.

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.SPI instruction.

1) BW is turned to 0.
2) DVLA of the alarm detection (ALM) is turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(7) Operating time/hold time check judgment ".

(7) Operating time/hold time check judgment

Whether it is the operating time (ST) or hold time (HT = STHT − ST) is judged and the following processing is performed.

(a) Operating time (ST)

SV setting processing, tracking processing, gain (Kp) operation processing, PI operation (operating time) and deviation check are performed.

(b) Hold time (HT = STHT − ST)

Tracking processing, SPI operation (hold time) and deviation check are performed.
Under the following condition, however, the hold time is set to 0 and continuous PI control is carried out.

$\frac{STHT}{\Delta T} \leqq \frac{ST}{\Delta T}$

When the integer part of $\frac{STHT}{\Delta T}$ is 0, no processing is performed. (ΔMV also remains unchanged.)

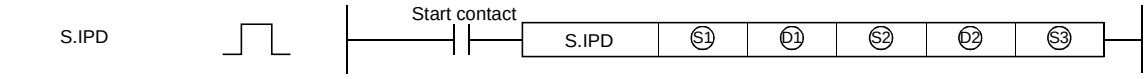
Error

• When an operation error occurs — Error code: 4100

9.5 I-PD Control (S.IPD)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

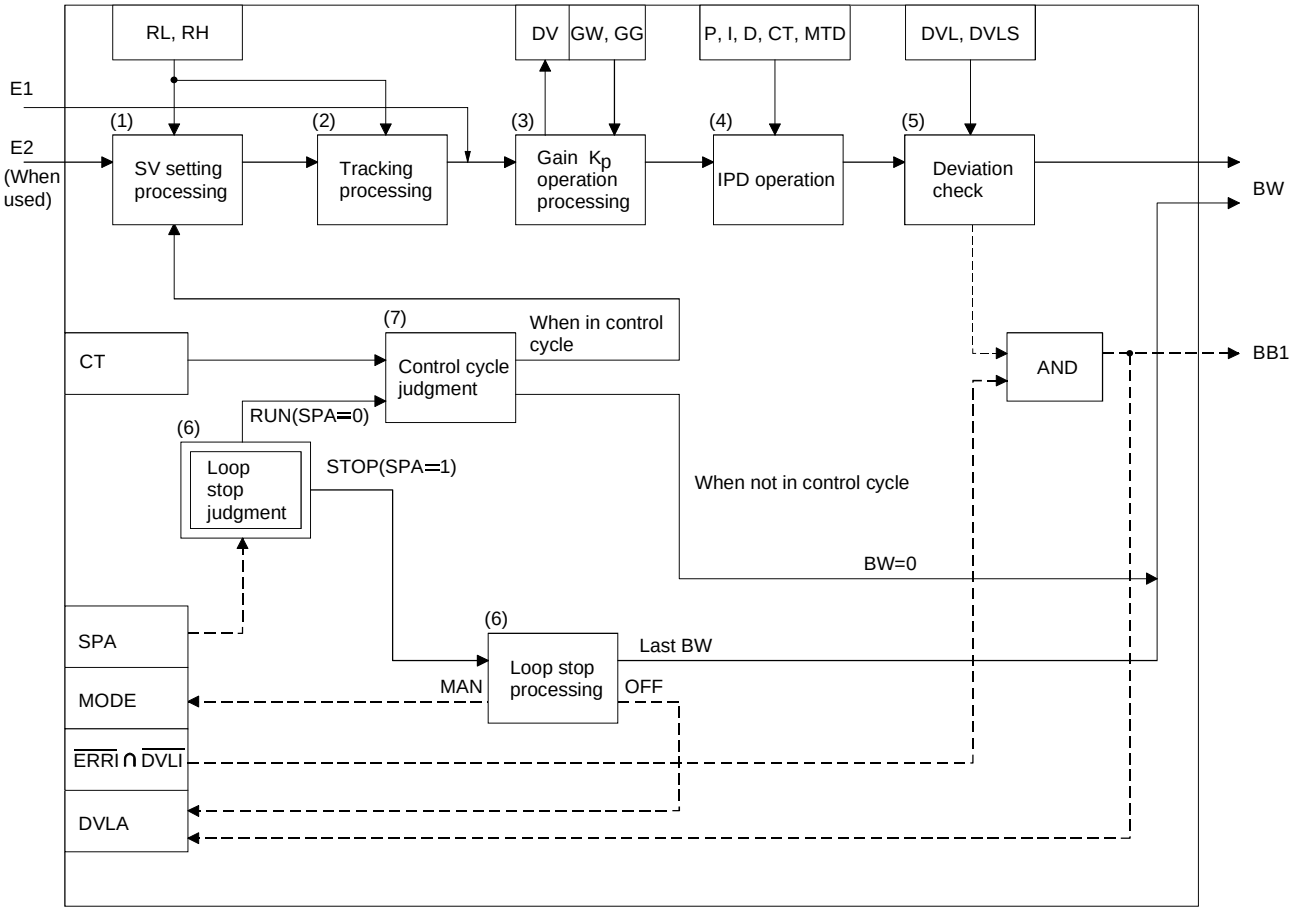
*1: Special register SD1506 can be specified as a dummy device.

Functions

Performs I-PD control when the specified control cycle is reached.
Also performs SV setting processing, tracking processing, gain (Kp) operation processing and deviation check at this time.

Block diagram

The processing block diagram of the S.IPD instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 34

Control data

(1) Data specified in S.IPD instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value (Δ MV)	(-999999 to 999999)	%	Real number	—	S
		BB	—					
	+2	BB1	Deviation large alarm	b15 b12 b8 b4 b0 (BB1) (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	MTD	Derivative gain	0 to 999999	—	Real number	8.0	U
	+2 +3	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+4	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+5	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+6	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

9 - 35

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DVLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DVLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U
	+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	D	Derivative constant	0 to 999999	s	Real number	0.0	U
	+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
	+62 +63	MVP	MV inside operation value	(-999999 to 999999)	%	Real number	0.0	S
Loop tag past value memory *2 *3	(D2)+96 ⋮ +109	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+102 +103	B_{n-1} (Last value)
+104 +105	PV_n (Process value)
+106 +107	PV_{n-1} (Last process value)
+108 +109	PV_{n-2} (Process value before last)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH-RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH-RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation (PN = 1)	DV = E1 − SVn'
Reverse operation (PN = 0)	DV = SVn' − E1

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When $\|DV\| \leqq GW$	K = GG
When $\|DV\| > GW$	$K = 1 - \frac{(1-GG) \times GW}{\|DV\|}$

9 - 38

(4) I-PD operation

I-PD operation is performed with the following operation expression.

Item		Operation expression
Bn	When forward operation (PN = 1)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times B_{n-1}}{T_D}\}$
	When reverse operation (PN = 0)	$B_{n-1}+\frac{M_D\times T_D}{M_D\times CT+T_D}\times\{-(PV_n-2PV_{n-1}+PV_{n-2})-\frac{CT\times B_{n-1}}{T_D}\}$
BW (ΔMV)	When forward operation (PN = 1)	$K_P\times\{\frac{CT}{T_I}\times DV_n+(PV_n-PV_{n-1})+B_n\}$
	When reverse operation (PN = 0)	$K_P\times\{\frac{CT}{T_I}\times DV_n-(PV_n-PV_{n-1})+B_n\}$

K_P: K × Gain (P), M_D: Derivative gain (MTD)

T_I: Integral constant (I), T_D: Derivative constant (D)

In the following case, however, note that special processing will be performed.

Condition	Processing
In either of the following cases 1, 2 1. Derivative constant (D) = 0 (T_D = 0) 2. Operation mode (MODE) is any of MAN, LCM and CMV	B_n = 0 (However, the loop tag past value memory is set.)
In any of the following cases 1, 2, 3 1. Integral constant (I) = 0 (T_I = 0) 2. When MH or ML error occurred (MVP > MH) and ($\frac{CT}{T_I}\times DV_n>0$) 3. When MH or ML error occurred (MVP < ML) and ($\frac{CT}{T_I}\times DV_n<0$)	$\frac{CT}{T_I}\times DV_n=0$

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB1) of the block memory.

Condition	Result
DVL < |DV|	DVLA = BB1 = 1 *1
(DVL − DVLS) < |DV| ≦ DVL	DVLA = BB1 = Last value status hold *1
|DV| ≦ (DVL − DVLS)	DVLA = BB1 = 0

*1: When DVLI or ERRI in the alarm detection inhibition (INH) is set to 1, DVLA and BB1 show 0 since the alarm is prohibited.

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.IPD instruction.

1) BW is turned to 0.
2) DVLA of the alarm detection (ALM) is turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached, BW (ΔMV) is turned to 0 and the S.IPD instruction is terminated.

(b) When the specified control cycle is reached, "(1) SV setting processing" is performed.

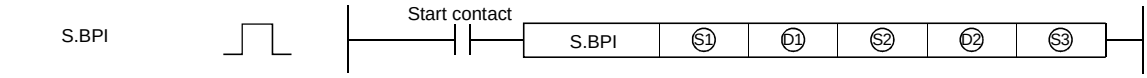
Error

• When an operation error occurs — Error code: 4100

9.6 Blend PI control (S.BPI)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

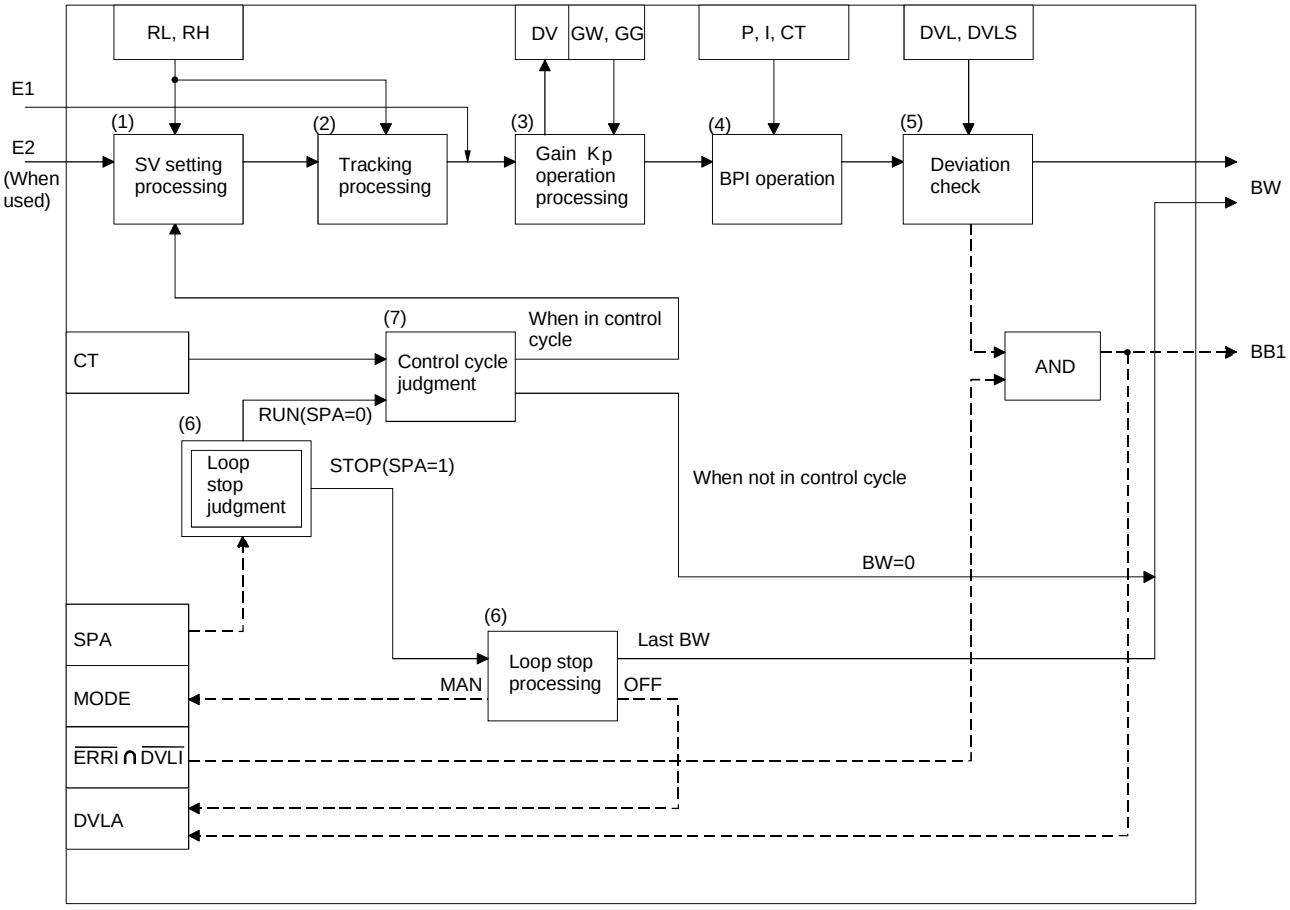
*1: Special register SD1506 can be specified as a dummy device.

Functions

Performs BPI operation when the specified control cycle is reached.
Also performs SV setting processing, tracking processing, gain (Kp) operation processing and deviation check at this time.

Block diagram

The processing block diagram of the S.BPI instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 42

Control data

(1) Data specified in S.BPI instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value (ΔMV)	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Deviation large alarm	b15 b12 b8 b4 b0 (BB1) (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	DVLS	Deviation large alarm hysteresis	0 to 100	%	Real number	2.0	U
	+2	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+3	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+4	SNPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DVLA MHA MLA SPA 0: Loop RUN 1: Loop STOP DVLA, MHA, MLA (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI TRKF DVLI MHI MLI TRKF (0: Without tracking) (1: With tracking) ERRI, DVLI, MHI, MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+50 +51	DVL	Change rate limit value	0 to 100	%	Real number	100.0	U
	+52 +53	P	Gain	0 to 999999	—	Real number	1.0	U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	U
	+56 +57	SDV	DV cumulative value (Σ DV)	-999999 to 999999	%	Real number	0.0	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

9 - 44

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag Memory *2	(D2)+58 +59	GW	Gap width	0 to 100	%	Real number	0.0	U
	+60 +61	GG	Gap gain	0 to 999999	—	Real number	1.0	U
Loop tag past value Memory *2 *3	(D2)+96 ⋮ +99	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+98 +99	$\frac{CT}{T_I} \times \Sigma DV_I$

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH - RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH - RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) Gain (Kp) operation processing

(a) The deviation (DV) is calculated under the following condition.

Condition	Operation expression
Forward operation (PN = 1)	DV = E1 − SVn'
Reverse operation (PN = 0)	DV = SVn' − E1

(b) The output gain (K) is calculated under the following condition.

Condition	Operation expression
When $\|DV\| \leqq GW$	K = GG
When $\|DV\| > GW$	$K = 1 - \frac{(1 - GG) \times GW}{\|DV\|}$

(4) BPI operation

BPI operation is performed with the following operation expression.

Condition	Operation expression
BW (ΔMV)	$K_P \times BT \times (DV_n + \frac{CT}{T_I} \times \Sigma DV_I)$

Kp: K × Gain (P), BT: Execution cycle, T_I: Integral constant (I),
Σ DV_I: Cumulative value of DVn, DVn: Deviation

In the following case, however, note that special processing will be performed.

Condition	
In either of the following cases 1, 2 1. Integral constant (I) = 0 (T_I = 0) 2. Either MLA or MHA of alarm detection (ALM) is 1	$\frac{CT}{T_I} \times \Sigma DV_I$ = last value unchanged
1. Integral constant (I) ≠ 0 (T_I ≠ 0)	$\frac{CT}{T_I} \times \Sigma DV_I = \frac{CT}{T_I} \times (\Sigma DV_I + DV_n)$

9 - 46

(5) Deviation check

A deviation check is made under the following condition and the result of the check is output to DVLA of the alarm detection (ALM) and the deviation large alarm (BB1) of the block memory.

Condition	Result
DVL < |DV|	DVLA = BB1 = 1 *1
(DVL − DVLS) < |DV| ≦ DVL	DVLA = BB1 = Last value status hold *1
|DV| ≦ (DVL − DVLS)	DVLA = BB1 = 0

*1: When DVLI or ERRI in the alarm detection inhibition (INH) is set to 1, DVLA and BB1 show 0 since the alarm is prohibited.

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.BPI instruction.
1) BW is turned to 0.
2) DVLA of the alarm detection (ALM) is turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached, BW is turned to 0 and the S.BPI instruction is terminated.
(b) When the specified control cycle is reached, "(1) SV setting processing" is performed.

Error

• When an operation error occurs — Error code: 4100

9.7 Rate (S.R)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					
(S3)	—	○		—					

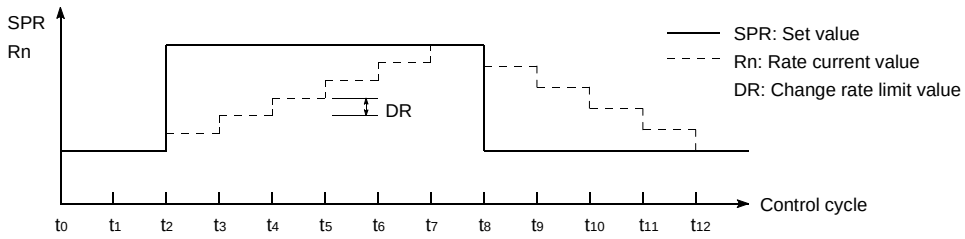
[Instruction symbol] [Execution condition]

Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Loop tag memory head device
(S3)	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

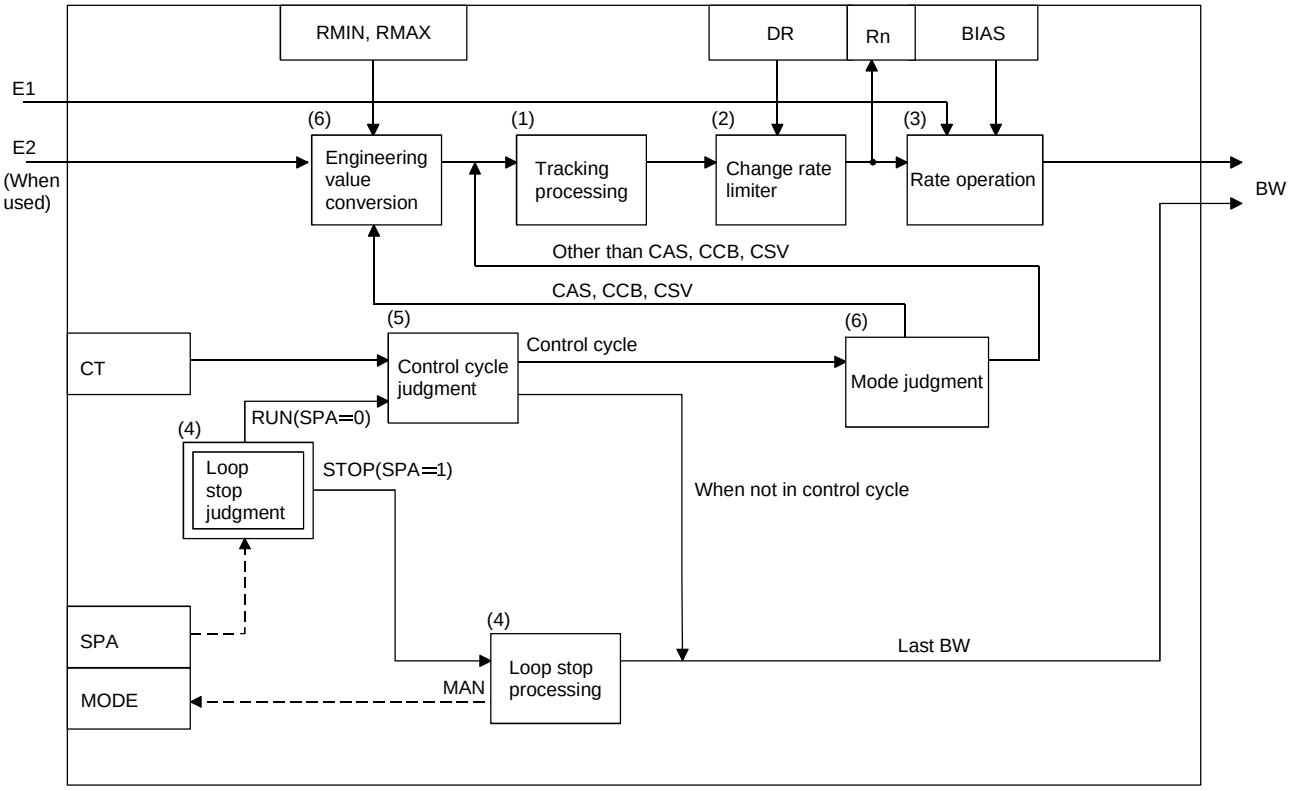
Performs rate operation when the specified control cycle is reached.
Also performs operation mode (MODE) judgment, engineering value conversion, tracking processing and change rate limiter processing at this time.



9 - 48

Block diagram

The processing block diagram of the S.R instruction is shown below.
(The numerals (1) to (6) in the diagram indicate the order of the processing.)



9 - 49

Control data

(1) Data specified in S.R instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
Operation constant	(S2)+0	TRK	Tracking bit	0: Not trucked 1: Trucked	—	BIN 16bit	0	U
	+1	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U
Loop tag memory *4	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA SPA 0: Loop RUN 1: Loop STOP	—	BIN 16bit	4000H	S/U
	+14 +15	SPR	Set value	-999999 to 999999	—	Real number	0.0	U
	+16 +17	BIAS	Bias	-999999 to 999999	%	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+50 +51	DR	Change rate limit value	0 to 999999	—	Real number	100.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).
*4: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+52 +53	RMAX	Rate upper limit value	-999999 to 999999	—	Real number	100.0	U
	+54 +55	RMIN	Rate lower limit value	-999999 to 999999	—	Real number	0.0	U
	+56 +57	R_n	Rate current value	(-999999 to 999999)	—	Real number	0.0	S
Loop tag past value memory *2 *3	(D2)+96 ⋮ +99	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter
+98 +99	R_{n-1} (Last value)

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Tracking processing

(a) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = \frac{100}{RMAX - RMIN} \times (SPR - RMIN)$$

(b) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(2) Change rate limiter

In the change rate limiter, the following operation is performed and the result of the operation is stored into the current rate value (Rn).

Condition	Operation expression
$(SPR - Rn) \geqq DR$	$Rn = Rn\text{-}1 + DR$
$(SPR - Rn) \leqq -DR$	$Rn = Rn\text{-}1 - DR$
$\lvert SPR - Rn \rvert < DR$	$Rn = SPR$

(3) Rate operation

Rate operation is performed with the following operation expression.

$$BW = \frac{Rn - RMIN}{RMAX - RMIN} \times E1 + BIAS$$

(4) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.R instruction.
1) BW retains the last value.
2) The operation mode (MODE) is changed to MAN.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(5) Control cycle judgment".

(5) Control cycle judgment

(a) When the specified control cycle is not reached, BW is retained and the S.R instruction is terminated.
(b) When the specified control cycle is reached, "(6) Mode judgment" is performed.

(6) Mode judgment

Either of the following processings is performed depending on the operation mode (MODE) setting.
(a) When the operation mode (MODE) is any of CAS, CCB and CSV
1) When the set value (E2) is specified, engineering value conversion is made with the following expression and then "(2) Change rate limiter" is performed.

$$SPR = \frac{RMAX - RMIN}{100} \times E2 + RMIN$$

2) When the set value (E2) is not specified, "(2) Change rate limiter" is performed without engineering value conversion being made.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(1) Tracking processing" is executed.

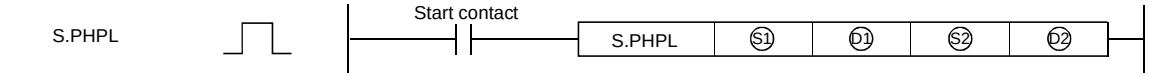
ERROR

• When an operation error occurs — Error code: 4100

9.8 Upper/lower limit alarm (S.PHPL)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Loop tag memory head device

*1: Special register SD1506 can be specified as a dummy device.

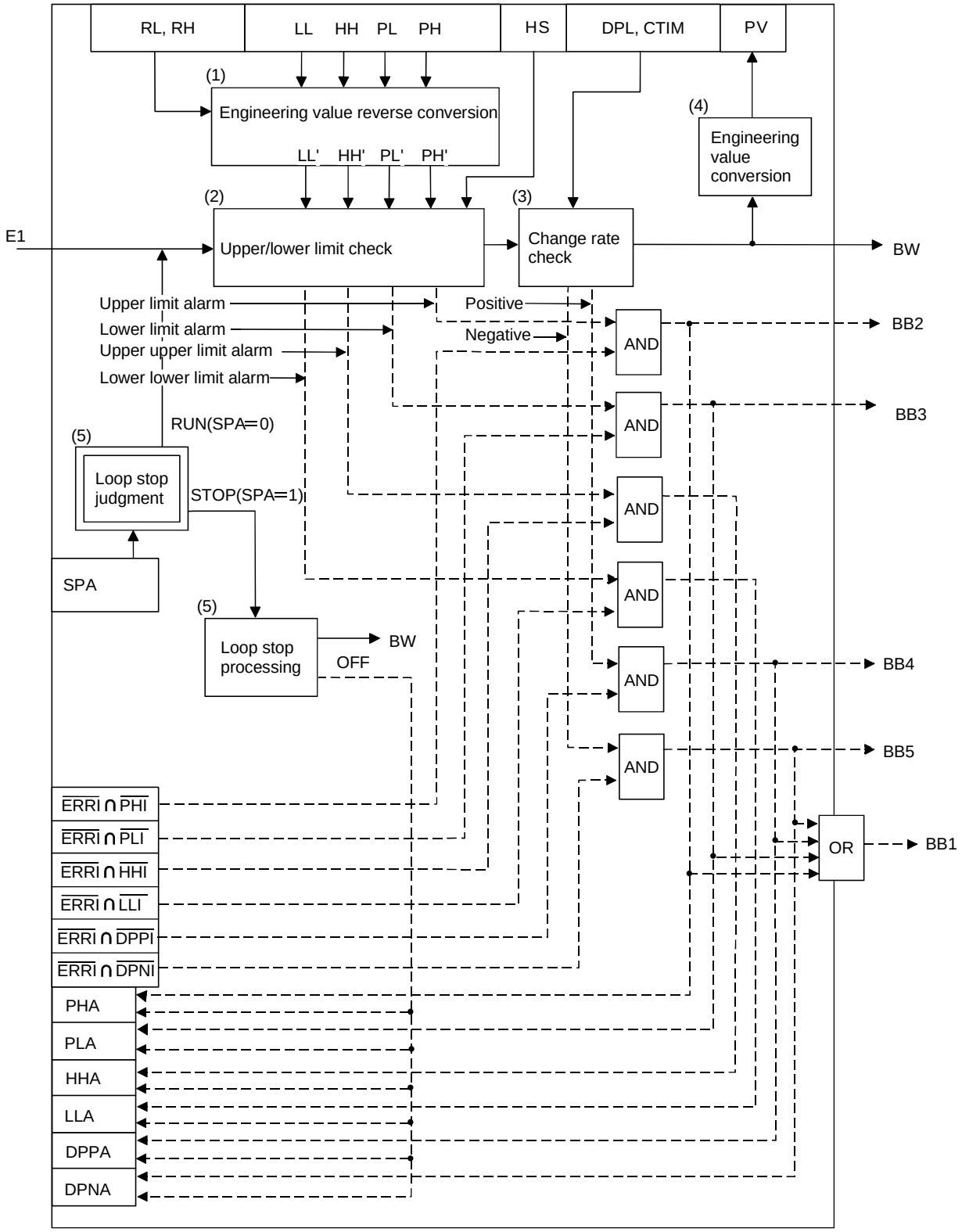
Functions

Performs a upper/lower limit check on the input value (E1) and provides an alarm output.

9 - 53

Block diagram

The processing block diagram of the S.PHPL instruction is shown below.
(The numerals (1) to (5) in the diagram indicate the order of the processing.)



9 - 54

Control data

(1) Data specified in S.PHPL instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Alarm	b15 b12 b8 b4 b0 BB5 BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Upper limit alarm					
		BB3	Lower limit alarm					
		BB4	Positive direction change rate alarm					
		BB5	Negative direction change rate alarm					
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA HHA LLA PHA PLA DPPA DPNA SPA: 0: Loop RUN, 1: Loop STOP Other: (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI HHI LLI PHI PLI DPPI DPNI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+10 +11	PV	Process value	(RL to RH)	—	Real number	0.0	S
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+26 +27	PH	Upper limit alarm set value	RL to RH	—	Real number	100.0	U
	+28 +29	PL	Lower limit alarm value	RL to RH	—	Real number	0.0	U
	+30 +31	HH	Upper upper limit alarm value	RL to RH	—	Real number	100.0	U
	+32 +33	LL	Lower lower limit alarm value	RL to RH	—	Real number	0.0	U
	+40 +41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	Real number	0.0	U
	+42 +43	CTIM	Change rate alarm Check time	0 to 999999 Note that $\frac{CTIM}{\Delta T} \leqq 32767$	s	Real number	0.0	U
	+44 +45	DPL	Change rate alarm value	0 to 100	%	Real number	100.0	U
Loop tag past value memory *2 *3	(D2)+96 ⋮ +127	—	—	Used by the system as a work area.	—	—	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Change rate monitor counter initial preset flag
+97	Change rate monitor counter
+126 +127	$E1_{n-m}$

When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Engineering value reverse conversion

The following operations are performed to match the upper limit alarm value (PH), lower limit alarm value (PL), upper upper limit alarm value (HH) and lower lower limit alarm value (LL) ranges with the input value (E1).

$$PH' = \frac{100}{RH-RL} \times (PH-RL), \qquad PL' = \frac{100}{RH-RL} \times (PL-RL)$$

$$HH' = \frac{100}{RH-RL} \times (HH-RL), \qquad LL' = \frac{100}{RH-RL} \times (LL-RL)$$

(2) Upper/lower limit check

The upper/lower limit checks of the input value (E1) are made under the following conditions.

Check item	Condition	ALM	BB2	BB3
Upper limit check	E1 > PH'	PHA = 1 *1	1 *1	—
	E1 ≦ PH' −HS	PHA = 0	0	—
	Others	PHA: Last value is status hold *1	Hold *1	—
Lower limit check	E1 < PL'	PLA = 1 *2	—	1 *2
	E1 ≧ PL' + HS	PLA = 0	—	0
	Others	PLA: Last value is status hold *2	—	Hold *2
Upper Upper limit check	E1 > HH'	HHA = 1 *3	—	—
	E1 ≦ HH' −HS	HHA = 0	—	—
	Others	HHA: Last value is status hold *3	—	—
Lower lower limit check	E1 < LL'	LLA = 1 *4	—	—
	E1 ≧ LL' + HS	LLA = 0	—	—
	Others	LLA: Last value is status hold *4	—	—

*1: When PHI or ERRI in the alarm detection inhibition (INH) is set to 1, PHA and BB2 show 0 since the alarm is prohibited.

*2: When PLI or ERRI in the alarm detection inhibition (INH) is set to 1, PLA and BB3 show 0 since the alarm is prohibited.

*3: When HHI or ERRI in the alarm detection inhibition (INH) is set to 1, HHA show 0 since the alarm is prohibited.

*4: When LLI or ERRI in the alarm detection inhibition (INH) is set to 1, LLA show 0 since the alarm is prohibited.

(3) Change rate check

(a) A change rate check is performed for the time specified in CTIM.

The number of change rate checks to be made is found by the following expression.

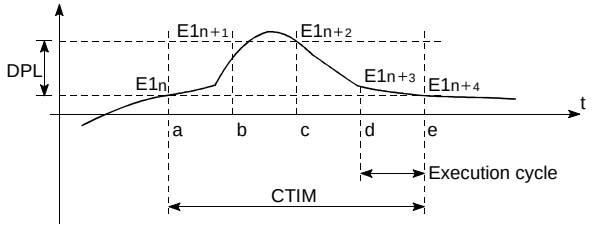
$$m = \frac{CTIM}{\Delta T}$$

m varies from 1 to m.

However, when m = 0 (integer part), no processing is performed.

For example, when m = 4, the processing is performed as shown below.

(a) Zero time $E1_n - E1_{n-4}$
(b) One time $E1_{n+1} - E1_n$
(c) Two time $E1_{n+2} - E1_n$
(d) Three time $E1_{n+3} - E1_n$
(e) Four time $E1_{n+4} - E1_n$
⋮



9 - 57

(b) The change of the input data is compared with the change rate alarm value (DPL) in each execution cycle (ΔT).

Check item	Condition	ALM	BB4	BB5
Change rate check	$E1_{n+m} - E1_n \geqq DPL$	DPPA = 1 *1	1 *1	—
	Others	DPPA = 0	0	—
	$E1_{n+m} - E1_n \leqq -DPL$	DPNA = 1 *2	—	1 *2
	Others	DPNA = 0	—	0

*1: When DPPI or ERRI in the alarm detection inhibition (INH) is set to 1, DPPA and BB4 show 0 since the alarm is prohibited.

*2: When DPNI or ERRI in the alarm detection inhibition (INH) is set to 1, DPNA and BB5 show 0 since the alarm is prohibited.

(4) Engineering value conversion

Engineering value conversion is made with the following expression.

$$PV = \frac{RH-RL}{100} \times E1 + RL$$

(5) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.PHPL instruction.

1) Engineering value reverse conversion is performed with the following expression.

$$BW = \frac{100}{RH-RL} \times (PV - RL)$$

2) BB1 to BB5 of BB are turned to 0.

3) DPNA, DPPA, LLA, HHA, PLA and PHA of the alarm detection (ALM) are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(1) Engineering value reverse conversion".

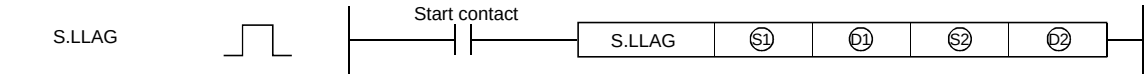
Error

• When an operation error occurs — Error code: 4100

9.9 Lead/lag (S.LLAG)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

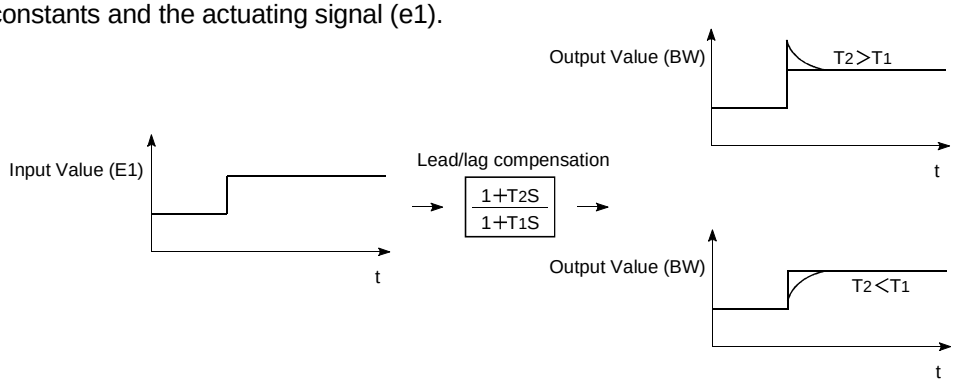
[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

Functions

Performs lead/lag operation according to the lag time and lead time settings of the operation constants and the actuating signal (e1).



Control data

(1) Data specified in S.LLAG instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
	+2	e1	Actuating signal	b15 b12 b8 b4 b0 (e1) 0: With lead/lag compensation 1: Without lead/lag compensation	—	BIN 16bit	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
Operation constant	(S2)+0 +1	T_1	Delay time	0 to 999999	s	Real number	1.0	U
	+2 +3	T_2	Lead time	0 to 999999	s	Real number	1.0	U
Local work memory *2	(D2)+0 +1	$E1_{n-1}$	Last Input value	Used by the system as a work area.	—	Real number	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

The S.LLAG instruction instructs the following operation.

Condition	BW (Output value)
e1 = 0	$BW = \frac{1}{T_1+\Delta T} \times \{T_2 \times (E1 - E1_{n-1}) + T_1 \times (\text{BW Last value}) + \Delta T \times E1\}$ However, when $T_1 + \Delta T = 0$, $BW = 0$
e1 = 1	BW = E1 (Input value is output unchanged)

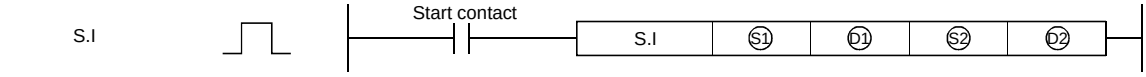
Error

• When an operation error occurs — Error code: 4100

9.10 Integration (S.I)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

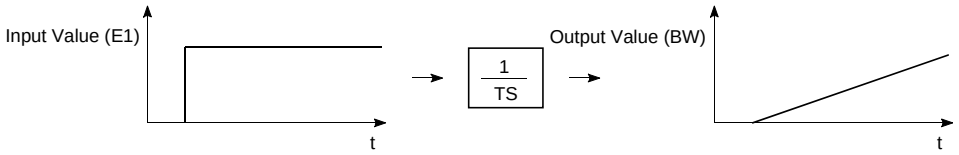


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Performs integral operation according to the operation control signal (e1).



Control data

(1) Data specified in S.I instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
	+2	e1	Operation control signal	b15 b12 b8 b4 b0 (e1) 0: With integral operation 1: Without derivative operation	—	BIN 16bit	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	T	Integral time	0 to 999999	s	Real number	1.0	U
	+2 +3	Ys	Output initial value	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

The S.I instruction performs the following operation.

e1	T	BW
0	≠0	$BW = Y_n = \frac{\Delta T}{T} \times E1 + Y_{n-1}$
0	0	$BW = Y_{n-1}$
1	—	$BW = Y_s$

E1: Current input value, ΔT: Execution cycle, Yn: Current output value, Y_{n-1}: Last output value

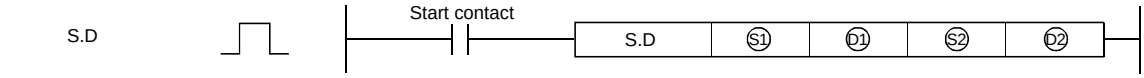
Error

• When an operation error occurs — Error code: 4100

9.11 Differentiation (S.D)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

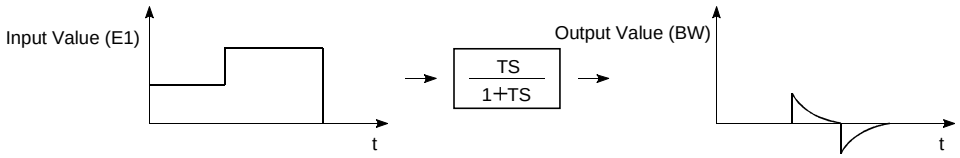
[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

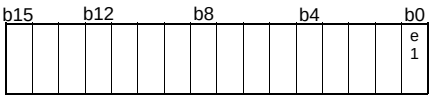
Functions

Executes derivative operation according to the operation control signal (e1).



Control data

(1) Data specified in S.D instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
	+2	e1	Operation control signal	 0: With derivative operation 1: Without derivative operation	—	BIN 16bit	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	T	Derivative time	0 to 999999	s	Real number	1.0	U
	+2 +3	Ys	Output initial value	-999999 to 999999	—	Real number	0.0	U
Local work memory *2	(D2)+0 +1	$E1_{n-1}$	Last input value	Used by the system as a work area.	—	Real number	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

The S.D instruction performs the following operation.

e1	BW
0	$BW = \frac{T}{T+\Delta T} \times (Y_{n-1} - E1_{n-1} + E1)$ Note that $T + \Delta T = 0$, $BW = 0$.
1	$BW = Y_s$

E1: Current input value, ΔT: Execution cycle, Y_n: Last output value, Y_{n-1}: Last output value

Error

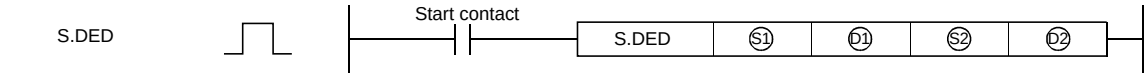
• When an operation error occurs — Error code: 4100

9 - 64

9.12 Dead Time (S.DED)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

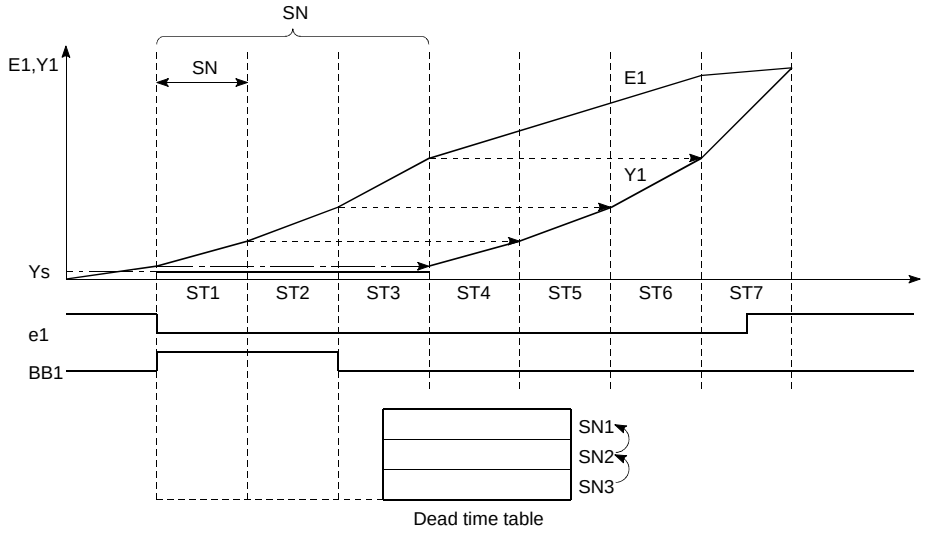
[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

Functions

Outputs the input value (E1) with a delay of dead time according to the setting of the operation control signal (e1).



SN: Sampling count E1: Input value
ST: Data collection interval Ys: Output initial valuel

Control data

(1) Data specified in S.DED instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
	+2	e1	Operation control signal	b15 b12 b8 b4 b0 e1 0: With dead time 1: Without dead time	—	BIN 16bit	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
	+2	BB	—					
		BB1	Data sufficiency bit	b15 b12 b8 b4 b0 BB1 (0: Data sufficiency) (1: Data insufficiency)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	ST	Data collection Interval	0 to 999999 Note that $\frac{ST}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+2	SN	Sampling count	0 to 48	—	BIN 16bit	0	U
	+3 +4	Ys	Output initial value	-999999 to 999999	—	Real number	0.0	U
	+5	OCHG	output switching	b15 b12 b8 b4 b0 OCHG 0: E1 when e1 turned from 1 to 0 is output up to SN times. 1: Ys is output up to SN times.	—	BIN 16bit	0	U
Local work memory *2	(D2)+0	—	Last value input (e1')	Used by the system as a work area.	—	—	—	S
	+1		Cycle counter					
	+2		Dead time table number of stored data					
	+3 +4		Dead time table 1					
	+5 +6		Dead time table 2					
	:		:					
	+2SN +1 +2SN +2		Dead time table SN					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) The S.DED instruction performs the following operation.

e1	OCHG	Dead time	BW	
1	0/1	None	E1	
1→0	0	ST × SN	Up to SN times	E1 when e1 turns from 1 to 0
			Later than SN times	Oldest data *1
	1		Up to SN times	Y_S
			Later than SN times	Oldest data *1
0→0	0/1	ST × SN	Oldest data *1	

*1: The oldest date is the E1 after the SNth time.

• When the dead time table date is not filled, BB1 is turned 1.

• When SN = 0, BB1 = 0 and BW = E1.

Error

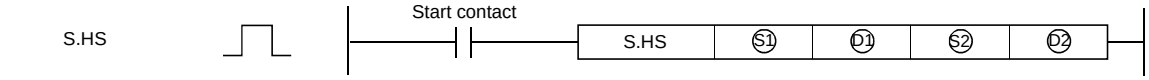
• When an operation error occurs — Error code: 4100

• When the sampling count is other than 0 to 48 — Error code: 4100

9.13 High Selector (S.HS)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Outputs the maximum value of the input values 1 (E1) to n (En).

9 - 68

Control data

(1) Data specified in S.HS instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	1 to 16	—	BIN 16bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	+2n-1 +2n	E_n	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(Maximum value of E1 to En)	—	Real number	—	S
	+2	BB	—					
		BB1 to BB16	Output selection	b15 b12 b8 b4 b0 BB16 BB15 BB14 BB13 BB12 BB11 BB10 BB9 BB8 BB7 BB6 BB5 BB4 BB3 BB2 BB1 (0: The corresponding input value is not the maximum value) (1: The corresponding input value is the maximum value)	—	BIN 16bit	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) High selector processing

The maximum value of the input values 1 (E1) to n (En) is stored into BW.

Also, any of BB1 to BB16 of BB corresponding to the maximum value is turned to 1.

Input value	E16	E15	E14	to	E2	E1
Bit turned to 1 at maximum value	BB16	BB15	BB14	to	BB2	BB1

(a) If there are two or more maximum values, the bits corresponding to the maximum values are all turned to 1.

(b) If there is only one input

1) When only E1 is used as the input value
- E1 is stored into BW.
- BB1 of BB is turned to 1.
- BB2 to BB16 of BB are turned to 0.

2) Only one of E2 to E16 is used as the input value
- The input values of E2 to E16 and the data of E1 are used to perform processing.

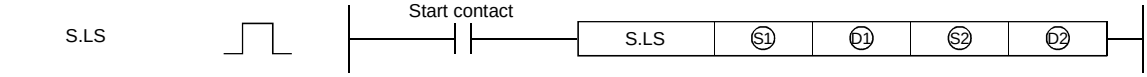
Error

- When an operation error occurs — Error code: 4100
- When not 1 ≦ number of inputs (n) ≦ 16 — Error code: 4100

9.14 Low Selector (S.LS)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Outputs the minimum value of the input values 1 (E1) to n (En).

Control data

(1) Data specified in S.LS instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	1 to 16	—	BIN 16bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	+2n-1 +2n	E_n	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(Minimum value of E1 to En)	—	Real number	—	S
	+2	BB	—					
		BB1 to BB16	Output selection	b15 b12 b8 b4 b0 BB16 BB15 BB14 BB13 BB12 BB11 BB10 BB9 BB8 BB7 BB6 BB5 BB4 BB3 BB2 BB1 (0: The corresponding input value is not the minimum value) (1: The corresponding input value is the minimum value)	—	BIN 16bit	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) Low selector processing

The minimum value of the input values 1 (E1) to n (En) is stored into BW.
Also, any of BB1 to BB16 of BB corresponding to the minimum value is turned to 1.

Input value	E16	E15	E14	to	E2	E1
Bit turned to 1 at minimum value	BB16	BB15	BB14	to	BB2	BB1

(a) If there are two or more minimum values, the bits corresponding to the minimum values are all turned to 1.

(b) If there is only one input

1) When only E1 is used as the input value
- E1 is stored into BW.
- BB1 of BB is turned to 1.
- BB2 to BB16 of BB are turned to 0.

2) Only one of E2 to E16 is used as the input value
- The input values of E2 to E16 and the data of E1 are used to perform processing.

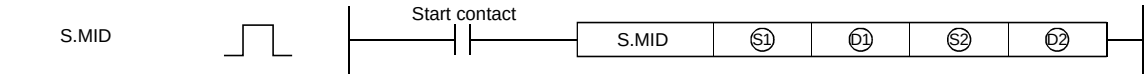
Error

- When an operation error occurs — Error code: 4100
- When not 1 ≦ number of inputs (n) ≦ 16 — Error code: 4100

9.15. Intermediate Value Selection (S.MID)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Outputs the intermediate value between the maximum value and minimum value among the input value 1 (E1) to input value n (En).

Control data

(1) Data specified in S.MID instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	1 to 16	—	BIN 16bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	$+2_{n-1}$ $+2_n$	E_n	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(Intermediate value between maximum value and minimum value)	—	Real number	—	S
	+2	BB	—					
		BB1 to BB16	Output selection	b15 b12 b8 b4 b0 BB16 BB15 BB14 BB13 BB12 BB11 BB10 BB9 BB8 BB7 BB6 BB5 BB4 BB3 BB2 BB1 (0: The corresponding input value is not the intermediate value) (1: The corresponding input value is the intermediate value)	—	BIN 16bit	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) Intermediate value selector processing

The intermediate value of the input values 1 (E1) to n (En) is stored into BW.
Also, any of BB1 to BB16 of BB corresponding to the intermediate value is turned to 1.

Input value	E16	E15	E14	to	E2	E1
Bit turned to 1 at intermediate value	BB16	BB15	BB14	to	BB2	BB1

(a) If there are an even number of inputs, the smaller value of the intermediate values is stored.

(b) If there are two or more intermediate values, the bits corresponding to the intermediate values are all turned to 1.

9 - 73

Remark

The intermediate value is selected as described below.

1) The input value 1 (E1) to input value n (En) are rearranged in order of increasing value.
   (If there are the same input values, they are arranged in order of increasing input number.)
2) The intermediate value among the rearranged values is selected.

Example) When the input data are 2, 5, 1, 4 and 3, the intermediate value is selected as described below.

Input data

E1	E2	E3	E4	E5
2	5	1	4	3

Rearrangement →

Rearranged data

E3	E1	E5	E4	E2
1	2	3	4	5

In the above case, the intermediate value is "3" and BB5 turns to 1.

Error

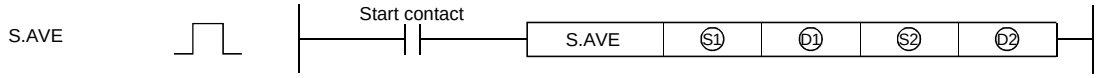
- When an operation error occurs — Error code: 4100
- When not 1 ≦ number of inputs (n) ≦ 16 — Error code: 4100

9 - 74

9.16 Average Value (S.AVE)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Calculates and outputs the average value of the input value 1 (E1) to n (En).

Control data

(1) Data specified in S.AVE instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	1 to 16	—	BIN 16bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	$+2_{n-1}$ $+2_n$	E_n	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(Average value of E1 to En)	—	Real number	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) Calculation of average value

The average value of the input value 1 (E1) to n (En) is calculated.

As the denominator (N), the value specified as the number of inputs (n) is used.

$$BW = \frac{E1 + E2 + E3 + \cdots E_n}{N}$$

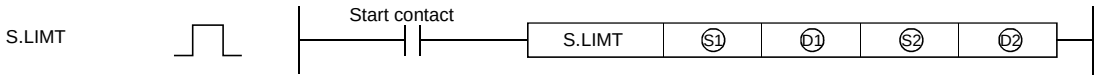
Error

- When an operation error occurs — Error code: 4100
- When not 1 ≦ (number of inputs (n)) ≦ 16 — Error code: 4100

9.17 Upper/lower Limiter (S.LIMT)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

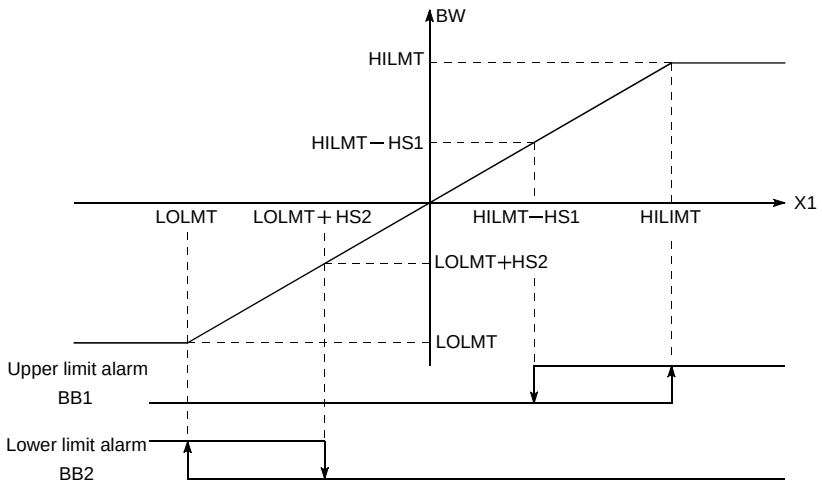


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The upper and lower limit limiter is applied to the output value by adding a hysteresis.



9 - 77

Control data

(1) Data specified in S.LIMT instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Upper limit alarm	b15 b12 b8 b4 b0 (BB2, BB1)	—	BIN 16bit	—	S
		BB2	Lower limit alarm	(0: Without alarm) (1: With alarm)				
Operation constant	(S2)+0 +1	HILMT	Upper limit value*2	-999999 to 999999	%	Real number	100.0	U
	+2 +3	LOLMT	Lower limit value*2	-999999 to 999999	%	Real number	0.0	U
	+4 +5	HS1	Upper limit hysteresis	0 to 999999	%	Real number	0.0	U
	+6 +7	HS2	Lower limit hysteresis	0 to 999999	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: Make setting to satisfy HILMT ≧ LOLMT.

Processing contents

(1) The S.LIMT instruction performs the following operation.

Condition	BW	BB1	BB2
E1 ≧ HILMT	HILMT	1	0
(LOLMT + HS2) < E1 < (HILMT − HS1)	E1	0	0
E1 ≦ LOLMT	LOLMT	0	1
Other than above (hysteresis section)	E1	Last value	Last value

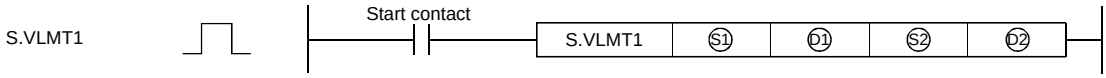
Error

- When an operation error occurs — Error code: 4100
- When HS1 < 0 or HS2 < 0 — Error code: 4100

9.18 Change rate limiter 1 (S.VLMT1)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

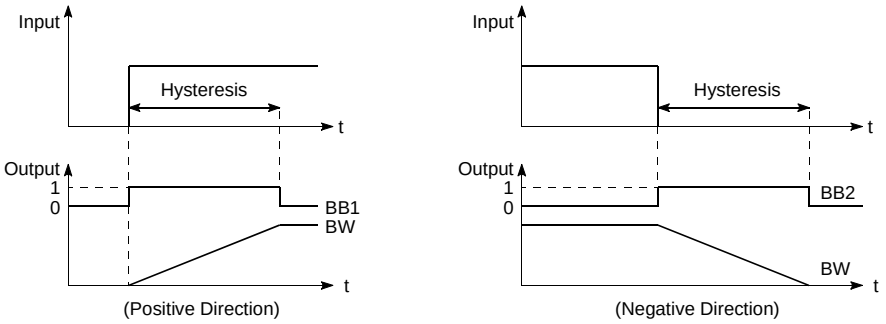


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Limits the varying speed of the output value.



Control data

(1) Data specified in S.VLMT1 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Positive direction restriction alarm	b15 b12 b8 b4 b0 (BB2, BB1) (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Negative direction restriction alarm					
Operation constant	(S2)+0 +1	V1	Positive direction limit value	0 to 999999	%/s	Real number	100.0	U
	+2 +3	V2	Negative direction limit value	0 to 999999	%/s	Real number	100.0	U
	+4 +5	HS1	Positive direction hysteresis	0 to 999999	%	Real number	0.0	U
	+6 +7	HS2	Negative direction hysteresis	0 to 999999	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) The S.VLMT1 instruction performs the following operation.

	Input (E1 − BW)	BW	BB1	BB2
Positive direction When E1 ≧ BW	(E1 − BW) ≧ (V1 × ΔT)	BW = BW + V1 × ΔT	1	0
	(E1 − BW) < (V1 × ΔT − HS1)	BW = E1	0	0
	Others	BW = E1	Last value	Last value
Negative direction When E1 < BW	(BW − E1) ≧ (V2 × ΔT)	BW = BW − V2 × ΔT	0	1
	(BW − E1) < (V2 × ΔT − HS2)	BW = E1	0	0
	Others	BW = E1	Last value	Last value

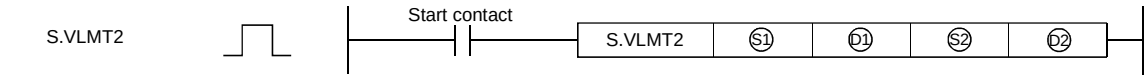
Error

- When an operation error occurs — Error code: 4100
- When HS1 < 0 or HS2 < 0 — Error code: 4100

9.19 Change rate limiter 2 (S.VLMT2)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

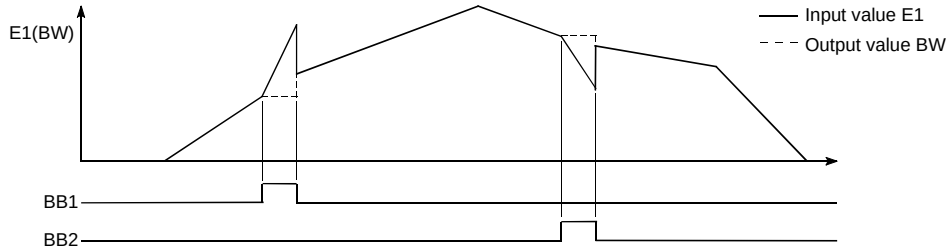


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Limits the varying speed of the output value.



Control data

(1) Data specified in S.VLMT2 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Positive direction restriction alarm	b15 b12 b8 b4 b0 (BB2, BB1) (0: Without alarm) (1: With alarm)	—	BIN 16Bit	—	S
		BB2	Negative direction restriction alarm					
Operation constant	(S2)+0 +1	V1	Positive direction limit value	0 to 999999	%/s	Real number	100.0	U
	+2 +3	V2	Negative direction limit value	0 to 999999	%/s	Real number	100.0	U
	+4 +5	HS1	Positive direction hysteresis	0 to 999999	%	Real number	0.0	U
	+6 +7	HS2	Negative direction hysteresis	0 to 999999	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) The S.VLMT2 instruction performs the following operation.

	Condition	BW	BB1	BB2
Positive direction When E1 ≧ BW	(E1 − BW) ≧ (V1 × ΔT)	BW = BW	1	0
	(E1 − BW) < (V1 × ΔT − HS1)	BW = E1	0	0
	Others	BW = BW	Last value	Last value
Negative direction When E1 < BW	(BW − E1) ≧ (V2 × ΔT)	BW = BW	0	1
	(BW − E1) < (V2 × ΔT − HS2)	BW = E1	0	0
	Others	BW = BW	Last value	Last value

Error

- When an operation error occurs — Error code: 4100
- When HS1 < 0 or HS2 < 0 — Error code: 4100

9.20 2-position ON/OFF (S.ONF2)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]

Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

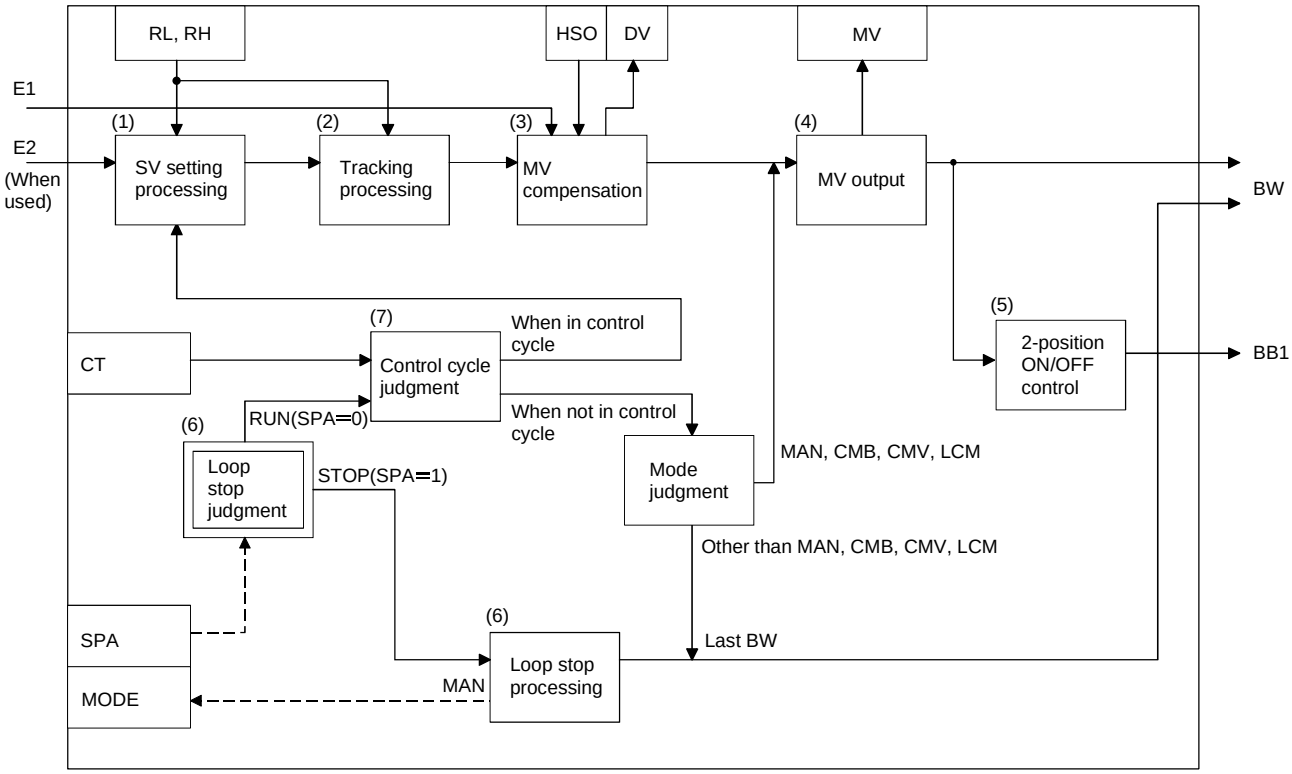
Functions

Performs 2-position ON/OFF control (ON/OFF of one contact) when the specified control cycle is reached.

Also performs SV setting processing, tracking processing, MV compensation and MV output processing at this time.

Block diagram

The processing block diagram of the S.ONF2 instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 84

Control data

(1) Data specified in S.ONF2 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	ⓢ1+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	ⓓ1+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Operation result	b15 b12 b8 b4 b0 (BB1) (0: |BW| < 50%) (1: |BW| ≧ 50%)	—	BIN 16bit	—	S
Operation constant	ⓢ2+0	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+1	TRK	Tracking bit	0: Without tracking 1: With tracking	—	BIN 16bit	0	U
	+2	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U
Loop tag memory *4	ⓓ2+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA SPA 0: Loop RUN 1: Loop STOP	—	BIN 16bit	4000H	S/U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).
*4: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+4	INH	Alarm detection inhibit	0 to FFFFH b15 b12 b8 b4 b0 TRKF TRKF (0: Without tracking) (1: With tracking)	—	BIN 16Bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+18 +19	HS0	Hysteresis	0 to 999999	—	Real number	0.0	U
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
Loop tag past value memory *2 *3	+96 +97	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH - RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH - RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) MV compensation

After the deviation (DV) is calculated from the input value (E1) and the set value after tracking processing (SVn'), the MV compensation value (MV') is calculated.

(a) Calculation of deviation (DV)

The deviation (DV) is calculated under the following condition.

Condition	DV
Forward operation (PN = 1)	E1 − SVn'
Reverse operation (PN = 0)	SVn' − E1

(b) Calculation of MV compensation value (MV')

The MV compensation value (MV')is calculated under the following condition.

Condition	MV'
DV ≧ HS0	100%
DV ≦ − HS0	0%
− HS0 < DV < HS0	Last value (BW value)

(4) MV output

The manipulated value (MV(BW)) is calculated under the following condition.

Condition	BW
CMV, MAN, CMB, LCM	BW = MVn
CSV, CCB, CAB, CAS, AUT, LCC, LCA	BW = MV' MVn = BW

(5) 2-position ON/OFF control

BB1 of BB is output under the following condition.

Condition	BB1
|BW| ≧ 50%	1
|BW| < 50%	0

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.ONF2 instruction.
1) BW and BB1 retain the last values.
2) The operation mode (MODE) is changed to MAN.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached
1) When the operation mode (MODE) is any of CSV, CCB, CAB, CAS, AUT, LCC and LCA, BW is retained and the S.ONF2 instruction is terminated.
2) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM, BW is made equal to MV and the processing of "(5) 2-position ON/OFF control" is performed.

(b) If the specified control cycle is reached, "(1) SV setting processing" is performed.

Error

• When an operation error occurs — Error code: 4100

9 - 88

9.21 3-position ON/OFF (S.ONF3)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					
ⓢ3	—	○		—					

[Instruction symbol] [Execution condition]

Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop tag memory head device
ⓢ3	When set value (E2) is used: Set value head device When set value (E2) is not used: Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

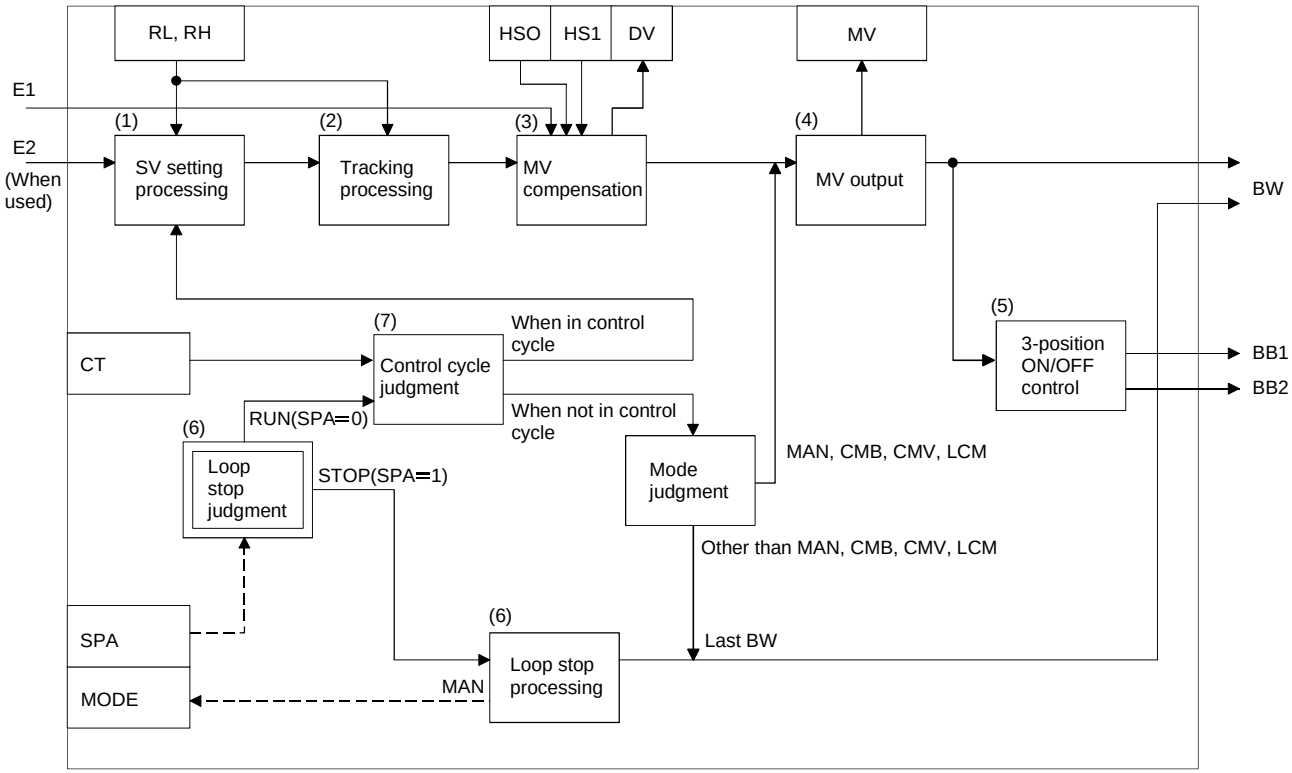
Functions

Performs 3-position ON/OFF control (ON/OFF of two contact) when the specified control cycle is reached.

Also performs SV setting processing, tracking processing, MV compensation and MV output processing at this time.

Block diagram

The processing block diagram of the S.ONF3 instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 90

Control data

(1) Data specified in S.ONF3 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Operation result	b15 b12 b8 b4 b0 BB2 BB1	—	BIN 16bit	—	S
		BB2	Operation result	(0, 0: 25%≦BW＜75%) (0, 1: BW＜25%) (1, 0: BW≧75%)				
Operation constant	(S2)+0	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
	+1	TRK	Tracking bit	0: Without tracking 1: With tracking	—	BIN 16bit	0	U
	+2	SVPTN	Set value pattern	0 to 3 b15 b12 b8 b4 b0 Set value pattern *3 0: E2 is upper loop MV 1: E2 is not upper loop MV Set value used *2 0: E2 is used 1: E2 is not used	—	BIN 16bit	3	U
Loop tag memory *4	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA SPA 0: Loop RUN 1: Loop STOP	—	BIN 16bit	4000H	S/U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Specify whether the set value (E2) is to be used or not.
*3: Specify whether the MV of the upper loop is to be used or not as the set value (E2).
*4: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

9 - 91

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+4	INH	Alarm detection inhibit	0 to FFFFH b15 b12 b8 b4 b0 TRKF TRKF (0: Without tracking) (1: With tracking)	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+14 +15	SV	Set value	RL to RH	—	Real number	0.0	U
	+16 +17	DV	Deviation	(-110 to 110)	%	Real number	0.0	S
	+18 +19	HS0	Hysteresis 0	0 to 999999	—	Real number	0.0	U
	+20 +21	HS1	Hysteresis 1	0 to 999999	—	Real number	0.0	U
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+46 +47	CT	Control cycle	0 to 999999 Note that $\frac{CT}{\Delta T} \leqq 32767$	s	Real number	1.0	U
Loop tag past value memory *2 *3	(D2)+96 +97	—	—	Used by the system as a work area.	—	—	—	S
Set value *4	(S3)+0 +1	E2	Set value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

*3: The applications of the loop tag past value memory are indicated below.

Specified position	Description
(D2)+96	Control cycle counter initial preset flag
+97	Control cycle counter

When control is to be started from the initial status, the data must be cleared with the sequence program.

*4: The set value (E2) becomes valid when the set value pattern (SVPTN) is set to "E2 is used".
When using the MV of the upper loop as the set value (E2), specify the device where the manipulated value (MV) of the upper loop is set (offset + 12: MV).
When not using E2 as the set value, make sure to specify a dummy device.
(Special register SD1506 can be specified as a dummy device.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

9 - 92

Processing contents

(1) SV setting processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of CAS, CCB and CSV

1) When the set value (E2) is specified, engineering value conversion is performed with the following expression and then "(2) Tracking processing" is performed.

$$SV_n = \frac{RH - RL}{100} \times E2 + RL$$

2) When the set value (E2) is not specified, "(2) Tracking processing" is performed without the engineering value conversion being performed.

(b) When the operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC, "(2) Tracking processing" is performed.

(2) Tracking processing

(a) The set value (SV) is converted reversely from the engineering value with the following operation expression to calculate SVn'.

$$SV_n' = \frac{100}{RH - RL} \times (SV_n - RL)$$

(b) When all of the following conditions hold, tracking processing is performed.

1) The tracking bit (TRK) of the operation constant is 1.
2) The set value (E2) is used.
3) The operation mode (MODE) is any of MAN, AUT, CMV, CMB, CAB, LCM, LCA and LCC.

$$E2 = SVn'$$

(c) When the set value (E2) is the manipulated value (MV) of the upper loop, the tracking flag (TRKF) of the alarm detection inhibition (INH) in the upper loop turns to 1.

(3) MV compensation

After the deviation (DV) is calculated from the input value (E1) and the set value after tracking processing (SVn'), the MV compensation value (MV') is calculated.

(a) Calculation of deviation (DV)

The deviation (DV) is calculated under the following condition.

Condition	DV
Forward operation (PN = 1)	E1 − SVn'
Reverse operation (PN = 0)	SVn' − E1

9 - 93

(b) Calculation of MV compensation value (MV')

The MV compensation value (MV')is calculated under the following condition.

Condition	MV′
DV ≧ (HS1 + HS0)	100%
DV ≦ − (HS1 + HS0)	0%
(− HS1 + HS0) < DV < (HS1 − HS0)	50%
Other than above	Last value (BW value)

(4) MV output

The manipulated value (MV(BW)) is calculated under the following condition.

Condition	BW
CMV, MAN, CMB, LCM	BW = MVn
CSV, CCB, CAB, CAS, AUT, LCC, LCA	BW = MV' MVn = BW

(5) 3-position ON/OFF control

BB1 and BB2 of BB are output under the following condition.

Condition	BB1	BB2
BW ≧ 75%	1	0
25% ≦ BW < 75%	0	0
BW < 25%	0	1

(6) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.ONF3 instruction.

1) BW, BB1 and BB2 retain the last values.

2) The operation mode (MODE) is changed to MAN.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(7) Control cycle judgment".

(7) Control cycle judgment

(a) If the specified control cycle is not reached

1) When the operation mode (MODE) is any of CSV, CCB, CAB, CAS, AUT, LCC and LCA, BW is retained and the S.ONF3 instruction is terminated.

2) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM, BW is made equal to MV and the processing of "(5) 3-position ON/OFF control" is performed.

(b) If the specified control cycle is reached, "(1) SV setting processing" is performed.

Error

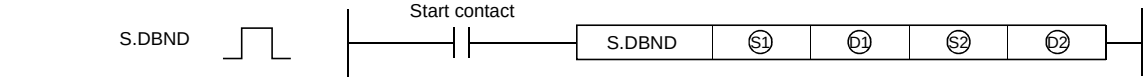
• When an operation error occurs — Error code: 4100

9 - 94

9.22 Dead zone (S.DBND)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

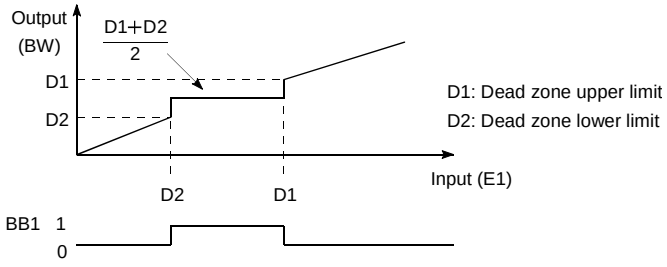


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Provides a dead zone and performs output processing.



9 - 95

Control data

(1) Data specified in S.DBND instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB	—					
		BB1	Dead zone action	b15 b12 b8 b4 b0 BB1 (0: Outside the dead zone range) (1: Within the dead zone range)	—	BIN 16bit	—	S
Operation constant	(S2)+0 +1	D1	Dead zone upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	D2	Dead zone lower limit	-999999 to 999999	—	Real number	0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.DBND instruction performs the following processing.

Condition	BW	BB1
$D2 \leqq E1 \leqq D1$	$\frac{D2+D1}{2}$	1
$(E1 < D2)$ or $(E1 > D1)$	E1	0

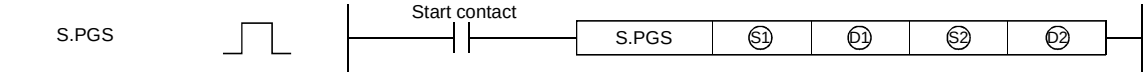
Error

• When an operation error occurs — Error code: 4100

9.23 Program Setting Device (S.PGS)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Dummy device *1
ⓓ1	Block memory head device
ⓢ2	Dummy device *1
ⓓ2	Loop tag memory head device

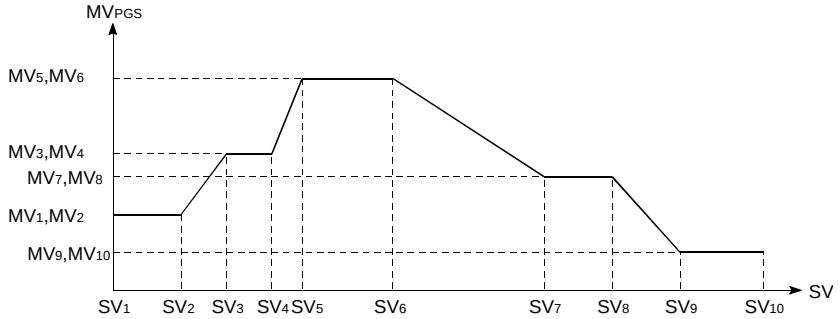
*1: Special register SD1506 can be specified as a dummy device.

Functions

Provides a control output according to the SV and MV pattern.

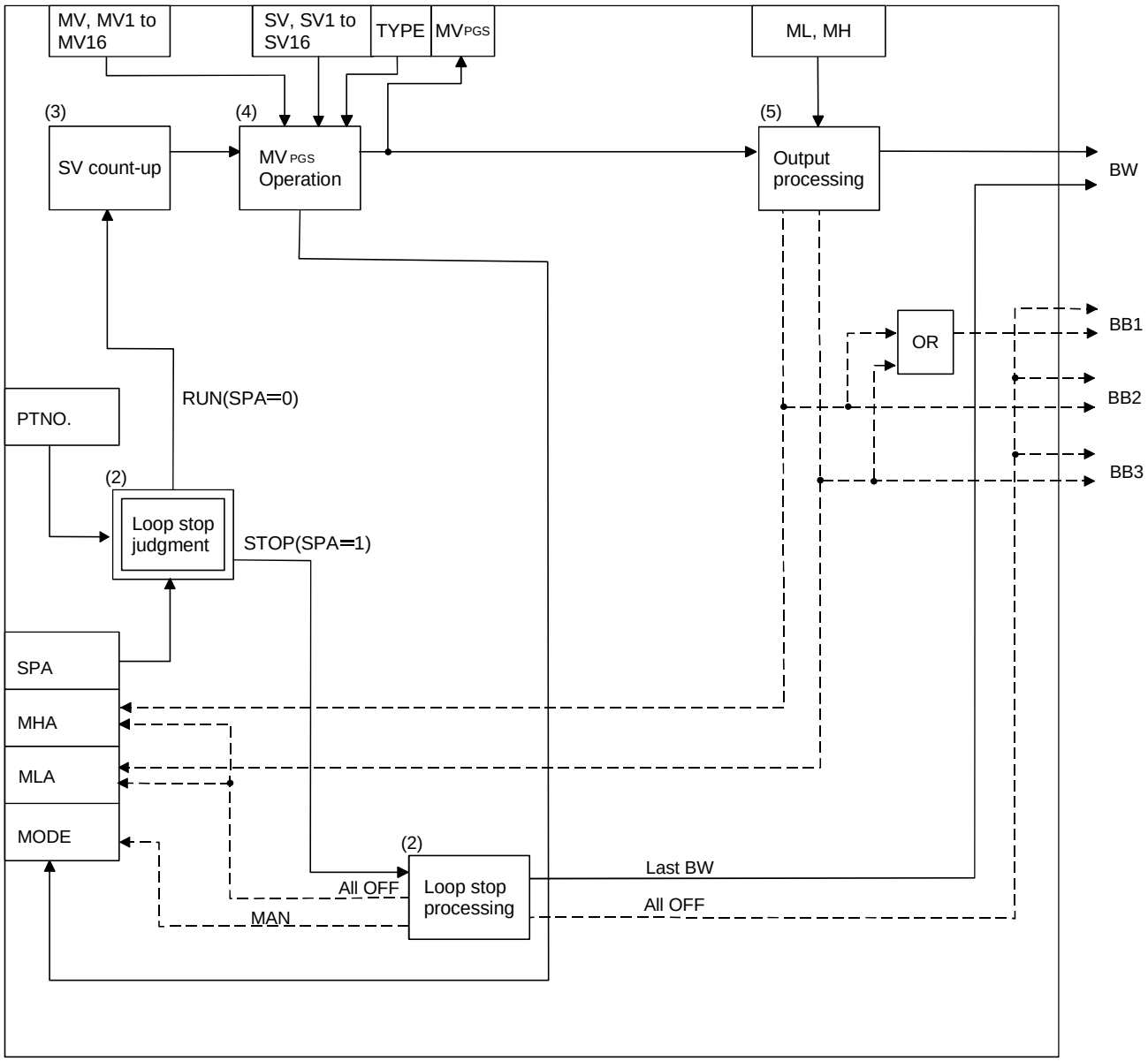
As the output types of the S.PGS instruction, there are three types of the "hold type", "return type" and "cyclic type".

- Hold type : Output is provided with the SV10 value held.
- Return type : The set value (SV) is set to 0 and the last value is output as the manipulated value (MV).
- Cyclic type : After SV1 to SV10 have been processed, processing is restarted from SV1 and the output is provided.



Block diagram

The processing block diagram of the S.PGS instruction is shown below.
(The numerals (2) to (5) in the diagram indicate the order of the processing.)



Control data

(1) Data specified in S.PGS instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Block memory	ⓓ1+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
	+2	BB		—				
		BB1	Alarm	b15 b12 b8 b4 b0 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Output upper limit alarm					
		BB3	Output lower limit alarm					
Loop tag memory *2	ⓓ2+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA MHA MLA SPA: 0: Loop RUN, 1: Loop STOP MHA, MLA: (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI MHI MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+10	PTNO	Number of operation constant polygon points	0 to 16	—	BIN 16bit	0	U
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+14 +15	SV	Set value	0 to 999999	s	Real number	0.0	U
	+16	TYPE	Operation type	0: Hold type operation (When operation mode is AUT or CAB) 1: Return type operation (When operation mode is AUT or CAB)	—	BIN 16bit	0	U
	+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

9 - 99

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+22 +23	SV1	Setting time 1	0 to 999999	s	Real number	0.0	U
	⋮	⋮	⋮					
	+52 +53	SV16	Setting time 16					
	+54 +55	MV1	Setting output 1	-10 to 110	%	Real number	0.0	U
	⋮	⋮	⋮					
	+84 +85	MV16	Setting output 16					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Output type

The output type is determined by the combination of the operation mode (MODE) and operation type (TYPE) as indicated below.

Operation mode (MODE)	Operation type (TYPE)	Operation
MAN, CMB, CMV, LCM, LCA, LCC	—	Operation stopped at current SV and MV
AUT, CAB	0	Hold type operation
	1	Return type operation
CAS, CCB, CSV	—	Cyclic type operation

(2) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.
A loop stop performs the following processing and terminates the S.PGS instruction.
1) BW retains the last value.
2) MHA and MLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB3 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.
A loop run performs "(3) SV count-up processing".

(3) SV count-up processing

SV count-up is performed with the following expression in each execution cycle.

$$SV' = SV + \Delta T$$

(4) MV_{PGS} operation

Type		Hold	Return	Cyclic
Mode		AUT, CAB		CAS, CCB, CSV
MV_{PGS} operation	$SV < SV_1$	MV_1		
	$SV_{n-1} \leqq SV < SV_n$	$\frac{MV_n - MV_{n-1}}{SV_n - SV_{n-1}} \times (SV - SV_{n-1}) + MV_{n-1}$		
Processing when $SV' > SV_n$	Mode change	MAN	MAN	Not moved
	SV	Last value	0	0
	MV	Last value	Last value	MV_1
	Restart method	After SV is set, mode is changed from MAN to AUT.	Mode is changed from MAN to AUT.	Automatic restart

(5) Output processing

Condition	Manual			Automatic		
	MAN, CMB, CMV, LCM, LCA, LCC			AUT, CAB, CAS, CCB, CSV		
	BW	BB2, MHA	BB3, MLA	BW	BB2, MHA	BB3, MLA
$MV_{PGS} > MH$	MV_n	0	0	$MV_n = MH$	1 *1	0
$MV_{PGS} < ML$	MV_n	0	0	$MV_n = ML$	0	1 *2
Others	MV_n	0	0	$MV_n = MV_{PGS}$	0	0

*1: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB2 show 0 since the alarm is prohibited.

*2: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB3 show 0 since the alarm is prohibited.

9.24 Loop Selector (S. SEL)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					
(S3)	—	○		—					

[Instruction symbol] [Execution condition]

Set data	Description
(S1)	Input data 1 head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Loop tag memory head device
(S3)	Input data 2 head device

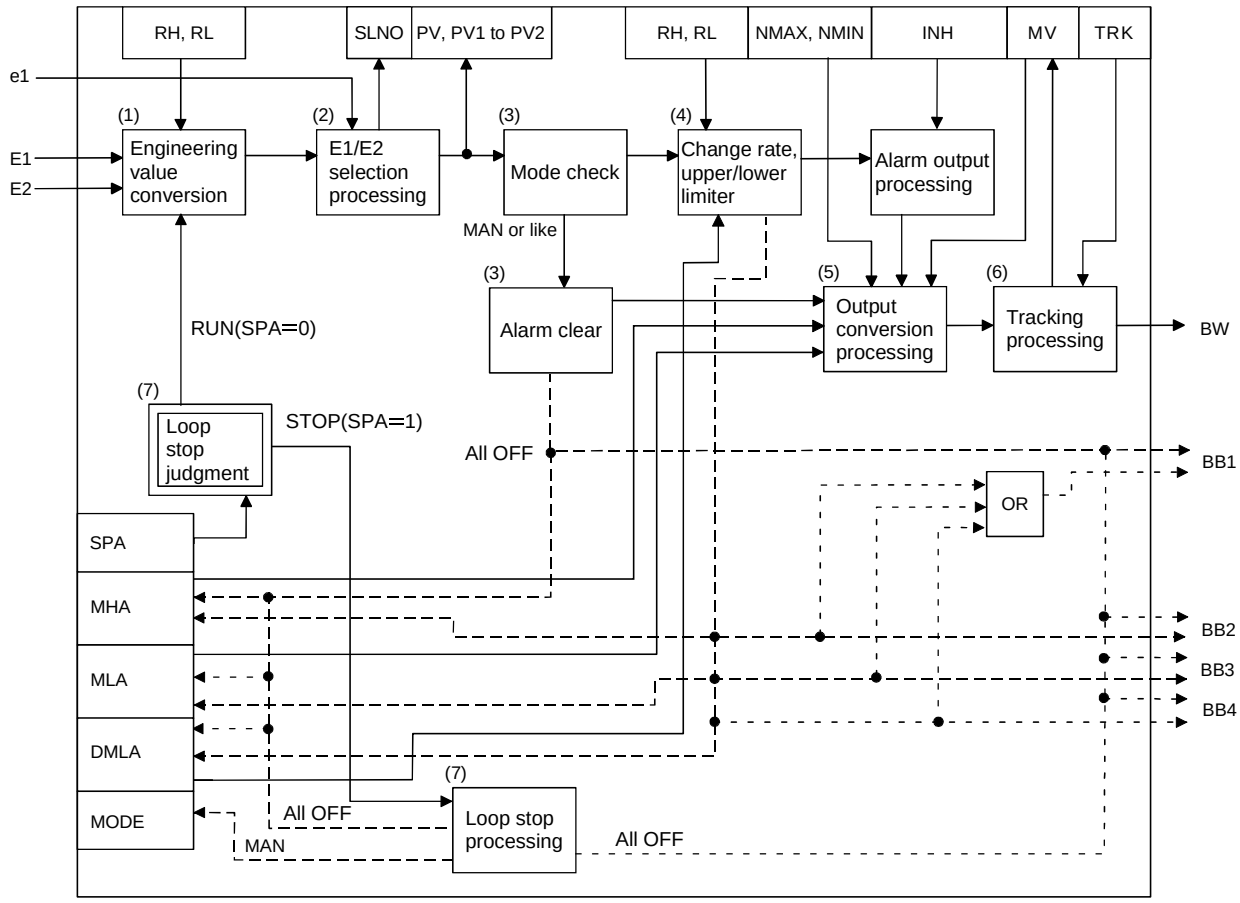
Functions

Provides an output in the specified mode (automatic mode/manual mode).

- In the automatic mode, the input value 1 (E1) or input value 2 (E2) selected by the selection signal (e1) is output.
- In the manual mode, the manipulated value (MV) is output.

Block Diagram

The processing block diagram of the S. SEL instruction is shown below.
(The numerals (1) to (7) in the diagram indicate the order of the processing.)



9 - 103

Control data

(1) Data specified in S. SEL instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data 1	(S1)+0 +1	E1	Input value 1	-999999 to 9999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 9999999)	—	Real number	—	S
	+2	BB		—				
		BB1	Alarm	b15 b12 b8 b4 b0 — BB4 BB3 BB2 BB1 (0: Without alarm) (1: With alarm)	—	BIN 16bit	—	S
		BB2	Output upper limit alarm					
		BB3	Output lower limit alarm					
		BB4	Output change rate alarm					
Operation constant	(S2)+0 +1	NMAX	Output conversion upper limit	-999999 to 9999999	—	Real number	100.0	U
	+2 +3	NMIN	Output conversion lower limit	-999999 to 9999999	—	Real number	0.0	U
	+4	TRK	Tracking bit	0: Without tracking 1: With tracking	—	BIN 16it	0	U
	+5	SVPTN	Set value pattern	b15 b0 Input value selection *2 0: E1 1: E2 Input value 1 (E1) used *3 0: Used 1: Not used Input value 2 (E2) used *4 0: Used 1: Not used Input value 1 (E1) pattern *5 0: E1 is upper loop MV 1: E1 is not upper loop MV Input value 2 (E2) pattern *6 0: E2 is upper loop MV 1: E2 is not upper loop MV	—	BIN 16bit	1EH	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: Select E1 or E2 for the input value.
*3: Specify whether the input value 1 (E1) is to be used or not.
*4: Specify whether the input value 2 (E2) is to be used or not.
*5: Specify whether the MV of the upper loop is to be used or not as the input value 1 (E1).
*6: Specify whether the MV of the upper loop is to be used or not as the input value 2 (E2).

9 - 104

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	0 to FFFFH b15 b12 b8 b4 b0 SPA DMLA MHA MLA SPA: 0: Loop RUN, 1: Loop STOP DMLA, MHA, MLA: (0: Without alarm) (1: With alarm)	—	BIN 16bit	4000H	S/U
	+4	INH	Alarm detection inhibition	0 to FFFFH b15 b12 b8 b4 b0 ERRI DMLI MHI MLI 0: Alarm enable 1: Alarm inhibit	—	BIN 16bit	4000H	S/U
	+10 +11	PV	Selection value	RL to RH	—	Real number	0.0	S
	+12 +13	MV	Manipulated value	(-10 to 110)	%	Real number	0.0	S
	+14 +15	PV1	Process value 1	RL to RH	—	Real number	0.0	S
	+16 +17	PV2	Process value 2	RL to RH	—	Real number	0.0	S
	+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U
	+22 +23	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+24 +25	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U
	+26	SLNO	Selection No.	b15 b0 Input value 1 (E1) selection 0: Not selected 1: Selected Input value 2 (E2) used 0: Not selected 1: Selected	—	BIN 16bit	0	S
Loop tag memory *2	+48 +49	DML	Output change rate limit value	0 to 100	%	Real number	100.0	U
Input data 2	(S3)+0 +1	E2	Input value 2	-999999 to 999999	%	Real number	0.0	U

*1: The data of the item where the recommended range values are indicated within the parentheses is stored by the system. The user cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Processing contents

(1) Engineering value conversion

Engineering value conversion is performed with the following expression.

$$PV_n = \frac{RH - RL}{100} \times E_n + RL$$

(2) Input value 1 (E1) or input value 2 (E2) selection processing

Whether the input value 1 (E1) or input value 2 (E2) will be used is selected depending on the e1 setting of the set value pattern (SVPTN).

- e1 = 0: Input value 1 (E1) is used PV = PV_1
- e1 = 1: Input value 2 (E2) is used PV = PV_2

SLN0: The bit corresponding to the input value 1 (E1) or input value 2 (E2) is turned to 1.

(3) Mode check

The following processing is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM

1) "(5) Output conversion processing" is performed.
2) MHA, MLA and DMLA of the alarm detection (ALM) are turned to 0.
3) BB1 to BB4 of BB are turned to 0.

(b) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC

1) Engineering value reverse conversion is performed with the following expression.

$$T = \frac{100}{RH - RL} \times (PV - RL)$$

2) "(4) Change rate, upper/lower limiter" is performed.

(4) Change rate, upper/lower limiter

Change rate and upper/lower limit value checks are performed on the input value 1 (E1) or input value 2 (E2).

(a) Change rate limiter

Condition	T'	BB4, DMLA
$\lvert T - MV_n \rvert \leqq DML$	T' = T	0
$(T - MV_n) > DML$	T' = MV_n + DML	1 *1
$(T - MV_n) < -DML$	T' = MV_n − DML	1 *1

*1: When DMLI or ERRI in the alarm detection inhibition (INH) is set to 1, DMLA and BB4 show 0 since the alarm is inhibited.

(b) Upper/lower limiter

Condition	MV	BB2, MHA	BB3, MLA
T' > MH	MV_n = MH	1 *2	0
T' < ML	MV_n = ML	0	1 *3
ML ≦ T' ≦ MH	MV_n = T'	0	0

*2: When MHI or ERRI in the alarm detection inhibition (INH) is set to 1, MHA and BB2 show 0 since the alarm is inhibited.

*3: When MLI or ERRI in the alarm detection inhibition (INH) is set to 1, MLA and BB3 show 0 since the alarm is inhibited.

(5) Output conversion processing

Engineering value conversion is performed with the following expression.

$$BW = \frac{NMAX - NMIN}{100} \times MV_n + NMIN$$

(6) Tracking processing

(a) When all of the following conditions hold, the BW value is output to the input value 1 (E1) or input value 2 (E2).

1) The operation mode (MODE) is any of MAN, CMB, CMV and LCM.
2) The tracking bit (TRK) is 1.

$$E_n = MV_n$$

(b) When all of the following conditions hold, the BW value is output to the input value 1 (E1) or input value 2 (E2).

1) The operation mode (MODE) is any of AUT, CAS, CAB, CCB, CSV, LCA and LCC.
2) The tracking bit (TRK) is 1.
3) BB1 of BB is 1

$$E_n = MV_n$$

(7) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S.SEL instruction.

1) BW retains the last value.
2) DMLA, MHA and MLA of the alarm detection (ALM) are turned to 0.
3) The operation mode (MODE) is changed to MAN.
4) BB1 to BB4 of BB are turned to 0.

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(1) Engineering value conversion ".

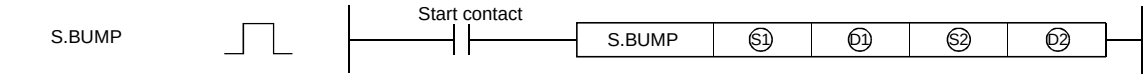
ERROR

• When an operation error occurs — Error code: 4100

9.25 Bump-less transfer (S.BUMP)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

Functions

Brings the output value (BW) closer to the output set value (E1) from the output control value (E2) at the fixed rate when the operation mode is switched from the manual mode to the automatic mode.

Brings the output value (BW) closer to the output set value (E1) with a primary delay when the output value (BW) falls within the range specified as the delay zone (a) relative to the output set value (E1).

Control data

(1) Data specified in S. BUMP instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	ⓢ1+0 +1	E1	Output set value	-999999 to 999999	%	Real number	—	U
	+2 +3	E2	Output control value	-999999 to 999999	%	Real number	—	U
	+4	e1	Mode switching signal	0: Manual mode 1: Automatic mode	—	BIN 16Bit	—	U
Block memory	ⓓ1+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
Operation constant	ⓢ2+0 +1	T	Delay time	0 to 9999999	s	Real number	1.0	U
	+2 +3	a	Delay zone	0 to 9999999	%	Real number	1.0	U
Local work memory *2	ⓓ2+0 +1	Xq	Initial deviation value	Used by the system as a work area.	—	Real number	1.0	S
	+2 +3	Xp	Deviation					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Either of the following processings is performed depending on the mode select signal (e1) setting of the input data.

(a) In the manual mode (e1 = 0), the output value (BW), initial deviation value (Xg) and deviation (Xp) are calculated with the following expressions.

- BW = output control value (E2)
- Xq = output control value (E2) − output set value (E1)
- Xp = output control value (E2) − output set value (E1)

(b) In the automatic mode (e1 = 1), the output value is calculated with the following expression.

Condition	$\lvert Xp\rvert > a$	$\lvert Xp\rvert \leqq a$
Xp	$X_p = X_{p'} - \frac{\Delta T}{T} X_q$	$X_p = \frac{T}{T+\Delta T} X_{p'}$
BW	BW = E1 + Xp On the assumption that $\lvert Xp\rvert \leqq \frac{\Delta T}{T}\lvert Xq\rvert$ • BW = E1 • Xp = Xp'	BW = E1 + Xp On the assumption that $\lvert Xp\rvert \leqq 10^{-4}$ • BW = E1 • Xp = Xp'

However, when $T \leqq \Delta T$ in the automatic mode, BW = E1, Xp = Xp'

Error

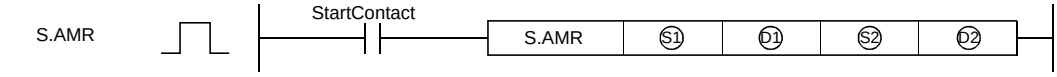
- When an operation error occurs — Error code: 4100

9 - 109

9.26 Analog memory (S.AMR)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction Symbol] [Execution Condition]

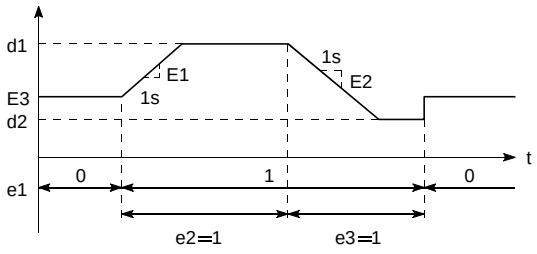


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Increases or decreases the output value at the fixed rate.



Control Data

(1) Data specified in S.AMR instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Output addition value	-999999 to 9999999	—	Real number	—	U
	+2 +3	E2	Output subtraction value	-999999 to 9999999	—	Real number	—	U
	+4 +5	E3	Output set value	-999999 to 9999999	—	Real number	—	U
	+6	e1	Operation select signal	b15 b12 b8 b4 b0 (e3 e2 e1) e1: 0: Manual mode 1: Automatic mode e2: 0: Not added 1: Added e3: 0: Not subtracted 1: Subtracted	—	BIN 16Bit	—	U
		e2	Output addition signal					
		e3	Output subtraction signal					
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 9999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	d1	Output upper limit value	0 to 9999999	—	Real number	1.0	U
	+2 +3	d2	Output lower limit value	0 to 9999999	—	Real number	1.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) Either of the following processings is performed depending on the settings of the operation select signal (e1), output addition signal (e2) and output subtraction signal (e3).

(a) In the manual mode (e1 = 0), BW = E3.

(b) In the automatic mode (e1 = 1), any of the operations in the following table is performed depending on the settings of the output addition signal (e2) and output subtraction signal (e3).

e2	e3	BW
1	0	BW = BW + |E1| × ΔT On the assumption that d1 ≦ BW: BW = d1
0	1	BW = BW − |E2| × ΔT On the assumption that BW ≦ d2: BW = d2
1	1	BW = BW
0	0	

Error

• When an operation error occurs — Error code: 4100

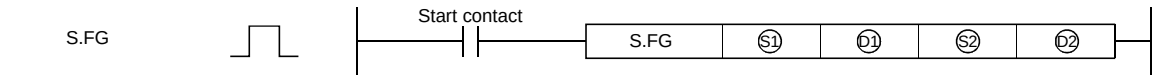
9 - 111

10 COMPENSATION OPERATION INSTRUCTIONS

10.1 Polygon (S.FG)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

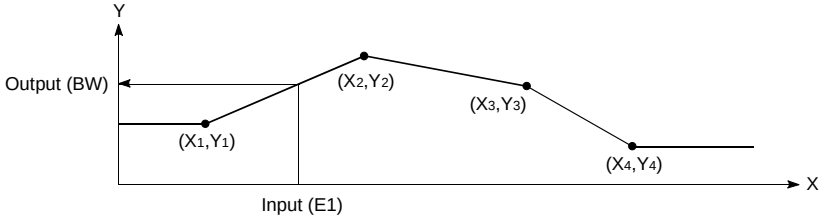
[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

Functions

In response to the input value (E1), outputs the value following the polygon pattern that consists of n pieces of polygon points specified as the operation constants.



Control data

(1) Data specified in S.FG instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0	SN	Number of polygon points	0 to 48	—	BIN 16Bit	0	U
Local work memory	(D2)+0 +1	X1	Polygon point coordinates	-999999 to 999999	—	Real number	—	U
	+2 +3	Y1	Polygon point coordinates					
	+4 +5	X2	Polygon point coordinates					
	+6 +7	Y2	Polygon point coordinates					
	⋮	⋮	⋮					
	+4SN-4 +4SN-3	Xn	Polygon point coordinates					
	+4SN-2 +4SN-1	Yn	Polygon point coordinates					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.FG instruction performs the following operation.

Condition	Output value (BW)
$E1 \leqq X1$	$BW = Y1$
$X_{i-1} < E1 \leqq X_i$ ($i = 2$ to n)	$BW = \frac{Y_i - Y_{i-1}}{X_i - X_{i-1}} \times (E1 - X_{i-1}) + Y_{i-1}$
$Xn < E1$	$BW = Yn$

(2) When $n = 0$ there is no processing.

(3) When $X_{i-1} > X_i$, the value is cut off to $n = i-1$ (Data after that is ignored.)
When there are multiple Y_i for the same X_i, the lowest i is selected.

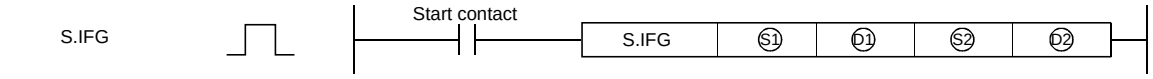
ERROR

- When an operation error occurs — Error code: 4100
- When ($n < 0$) or ($n > 48$) — Error code: 4100

10.2 Inverted Polygon (S.IFG)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

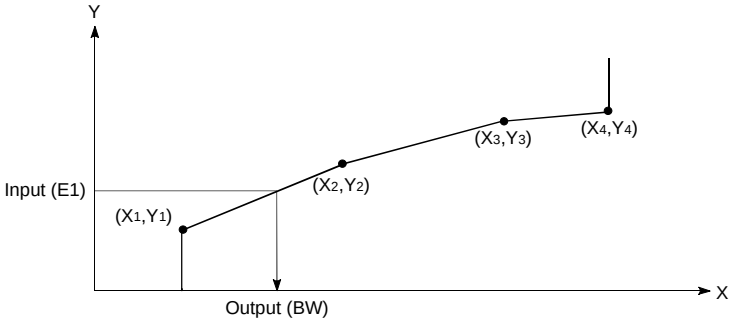
[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Loop work memory head device

Functions

In response to the input value (E1), outputs the value following the polygon pattern that consists of n pieces of polygon points specified as the operation constants.



Control data

(1) Data specified in S.IFG instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0	SN	Number of polygon points	0 to 48	—	BIN 16Bit	0	U
Local work memory	(D2)+0 +1	X1	Polygon point coordinates	-999999 to 999999	—	Real number	—	U
	+2 +3	Y1	Polygon point coordinates					
	+4 +5	X2	Polygon point coordinates					
	+6 +7	Y2	Polygon point coordinates					
	⋮	⋮	⋮					
	+4SN-4 +4SN-3	Xn	Polygon point coordinates					
	+4SN-2 +4SN-1	Yn	Polygon point coordinates					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.IFG instruction performs the following operation.

Condition	Output value (BW)
$E1 \leqq Y1$	$BW = X1$
$Y_{i-1} < E1 \leqq Y_i$ $(i = 2 \text{ to } n)$	$BW = \frac{X_i - X_{i-1}}{Y_i - Y_{i-1}} \times (E1 - Y_{i-1}) + X_{i-1}$
$Yn < E1$	$BW = Xn$

(2) When $n = 0$ there is no processing.

(3) When $Y_{i-1} > Y_i$, the value is cut off to $n = i-1$ (Data after that is ignored.)
When there are multiple X_i for the same Y_i, the lowest i is selected.

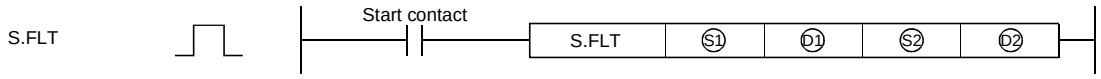
ERROR

- When an operation error occurs — Error code: 4100
- When $(n < 0)$ or $(n > 48)$ — Error code: 4100

10.3 Standard Filter (S.FLT)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Local work memory head device

Functions

Stores SN pieces of input values (E1) sampled at the data collection intervals (ST) into the dead time table, and outputs the average of those SN pieces of data.

Control data

(1) Data specified in S.FLT instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
	+2	BB	—					
		BB1	Data sufficiency bit	b15 b12 b8 b4 b0 (BB1) (0: Data sufficiency) (1: Data insufficiency)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	ST	Data collection interval	0 to 999999	s	Real number	1.0	U
	+2	SN	Sampling count	0 to 48	—	BIN 16Bit	0	U
Local work memory *2	(D2)+0 +1	ST'	Last data collection interval	Used by the system as a work area.	—	Real number	—	S
	+2	SN'	Last sampling count		—	BIN 16Bit	—	S
	+3	i	Cycle counter		—	BIN 16Bit	—	S
	+4	n1	Number of stored data		—	BIN 16Bit	—	S
	+5	n2	Store		—	BIN 16Bit	—	S
	+6 +7	—	—	—	—	—	—	—
	+8 +9	1	Dead time table 1	Used by the system as a work area.	—	Real number	—	S
	+10 +11	2	Dead time table 2					
	⋮	⋮	⋮					
	+2SN+6 +2SN+7	SN	Dead time table SN					

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) The data update cycle is $\frac{ST}{\Delta T}$. (The decimal is rounded down.)

(2) The data sufficiency bit (BB1) turns to 0 when the dead time table is filled with SN pieces of data.
It turns to 1 when the dead time table is not filled.

POINT
• When the sampling count (SN) is 0, BW and BB are cleared and the instruction is terminated. • Until the dead time table is filled with data, the average of the data provided until then is output. • Processed using $ST = n \times \Delta T$. (n is an integral)

ERROR

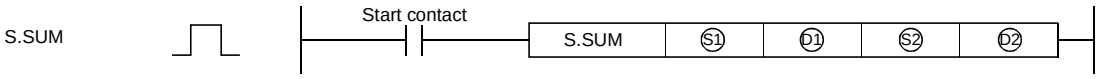
• When an operation error occurs	Error code: 4100
• When (SN < 0) or (SN > 48)	Error code: 4100

10 - 7

10.4 Retentive (S.SUM)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Integrates and outputs the input value (E1) when the integration start signal (e1) turns from 0 to 1.

Control data

(1) Data specified in S.SUM instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
	+2	e	—					
		e1	Integration start signal	b15 b12 b8 b4 b0 (e1) 0: Integration not executed 1: Integration executed	—	BIN 16Bit	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	ILC	Input low cut value	-999999 to 999999	—	Real number	0.0	U
	+2 +3	A	Initial value	-999999 to 999999	—	Real number	0.0	U
	+4	RANGE	Input range	1: /Second 2: /Minute 3: /Hour	—	BIN 16Bit	1	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as real numbers.

Processing contents

(1) The S.SUM instruction performs the following processing.

e1	E1	Output (BW)
0	—	The initial value (A) of the operation constant is output.
1	E1 ≦ ILC	The last value is output unchanged.
	E1 > ILC	$BW = E1 \times \frac{\Delta T}{T} +$ Last value

(2) The T value used for the operation changes depending on the input range (RANGE) setting.

- When RANGE = 1, T = 1
- When RANGE = 2, T = 60
- When RANGE = 3, T = 3600

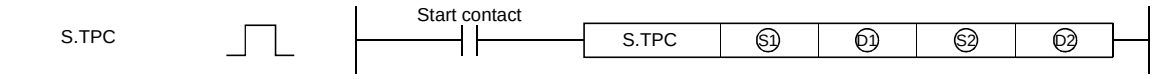
ERROR

- When an operation error occurs — Error code: 4100
- When the RANGE setting is other than 1 to 3 — Error code: 4100

10.5 Temperature/Pressure Compensation (S.TPC)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1) is subject to temperature pressure compensation (temperature or pressure) and output.

Control data

(1) Data specified in S.TPC instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Differential pressure	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Measurement temperature	-999999 to 999999	—	Real number	—	U
	+4 +5	E3	Measured pressure	-999999 to 999999	—	Real number	—	U
	+6	e		—				
		e1	E2 use flag	b15 b12 b8 b4 b0 (e2, e1)	—	BIN 16Bit	—	U
		e2	E3 use flag	0: Unused 1: Used				
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	TEMP	Design temperatureT' (Engineering value)	-999999 to 999999	℃	Real number	0.0	U
	+2 +3	B1	Bias (Temperature)	-999999 to 999999	℃	Real number	273.15	U
	+4 +5	PRES	Design pressureP' (Engineering value)	-999999 to 999999	—	Real number	0.0	U
	+6 +7	B2	Bias (Pressure)	-999999 to 999999	—	Real number	10332.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.TPC instruction calculates the temperature/pressure compensation value with the following expression.

$$BW = E1 \times A1 \times A2$$

(2) A1 and A2 use the values calculated with the following expressions.

Input		A1	A2
E2	E3		
Used	Used	$\frac{T' + B1}{E2 + B1}$	$\frac{E3 + B2}{P' + B2}$
Not used	Used	1.0	$\frac{E3 + B2}{P' + B2}$
Used	Not used	$\frac{T' + B1}{E2 + B1}$	1.0

ERROR

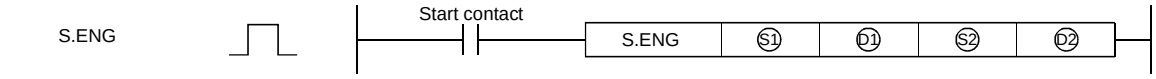
• When an operation error occurs — Error code: 4100

10 - 11

10.6 Engineering Value Conversion (S.ENG)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

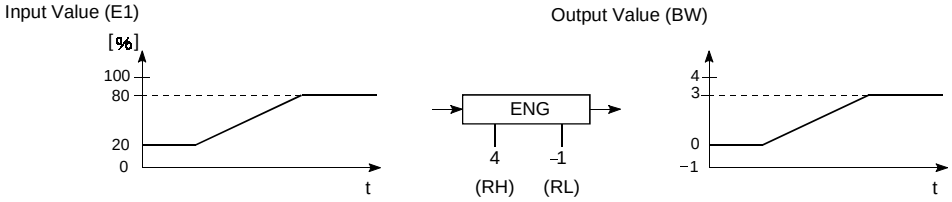


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1) is output by the engineering conversion.



Control data

(1) Data specified in S.ENG instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.ENG instruction performs the following operation.

$$BW = \frac{RH-RL}{100} \times E1 + RL \quad (E1 = 0 \text{ to } 100\%)$$

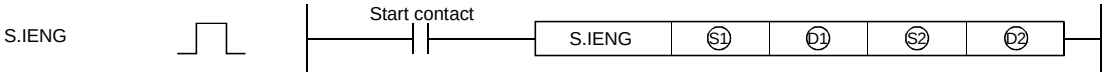
ERROR

• When an operation error occurs — Error code: 4100

10.7 Engineering Value Reverse Conversion (S.IENG)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]

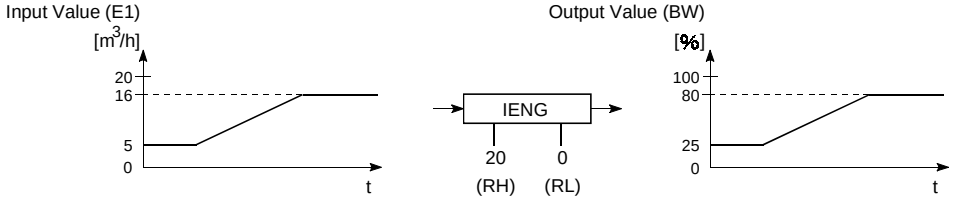


Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1) is converted to % value and output.



Control data

(1) Data specified in S.IENG instruction

Specified Position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	%	Real number	—	S
Operation constant	(S2)+0 +1	RH	Engineering value upper limit	-999999 to 999999	—	Real number	100.0	U
	+2 +3	RL	Engineering value lower limit	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.IENG instruction performs the following operation.

$$BW = \frac{100}{RH-RL} \times (E1-RL) \quad (\%)$$

(2) Make setting to satisfy RH > RL.

(3) If RH ≦ RL, the processing is executed unchanged but engineering value reverse conversion is not performed.

(4) If RH = RL, BW = 0.

ERROR

• When an operation error occurs — Error code: 4100

10 - 15

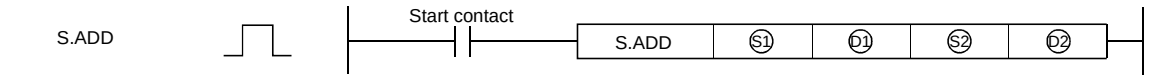
11 ARITHMETIC OPERATION INSTRUCTIONS

11

11.1 Addition (S.ADD)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (El to En) data is added by attaching a coefficient.

Control Data

(1) Data specified in S.ADD instruction

Specification position		Symbol	Name	Recommended range*1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	0 to 5	—	BIN 16Bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	+2n-1 +2n	En	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0	n	Number of coefficients	0 to 5	—	BIN 16Bit	0	U
	+1 +2	K1	Coefficient 1	-999999 to 999999	—	Real number	1.0	U
	+3 +4	K2	Coefficient 2					
	⋮	⋮	⋮					
	+2n-1 +2n	Kn	Coefficient n					
	+2n+1 +2n+2	B	Bias	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.ADD instruction performs the following operation.

$$BW = (K1 \times E1) + (K2 \times E2) \cdots + (Kn \times En) + B$$

(2) When n is 0, BW = B.

Error

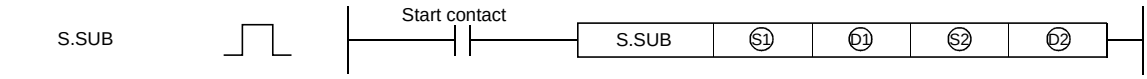
- When an operation error occurs — Error code: 4100
- When not n = 0 to 5. — Error code: 4100

11 - 2

11.2 Subtraction (S.SUB)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1 to En) data is subtracted by attaching a coefficient.

Control Data

(1) Data specified in S.SUB instruction

Specification position		Symbol	Name	Recommended range*1	Unit	Data format	Standard value	Store
Input data	(S1)+0	n	Input count	0 to 5	—	BIN 16Bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	+2n-1 +2n	En	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0	n	Number of coefficients	0 to 5	—	BIN 16Bit	0	U
	+1 +2	K1	Coefficient 1	-999999 to 999999	—	Real number	1.0	U
	+3 +4	K2	Coefficient 2					
	⋮	⋮	⋮					
	+2n-1 +2n	Kn	Coefficient n					
	+2n+1 +2n+2	B	Bias	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.SUB instruction instructs the following operation.

$$BW = (K1 \times E1) - (K2 \times E2) \cdots - (Kn \times En) + B$$

(2) When n is 0, BW = B.

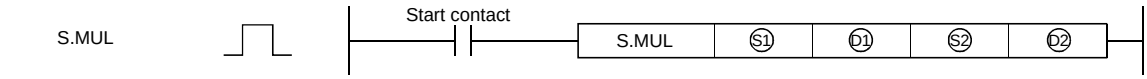
Error

- When an operation error occurs — Error code: 4100
- When not n = 0 to 5. — Error code: 4100

11.3 Multiplication (S.MUL)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
ⓢ1	—	○		—					
ⓓ1	—	○		—					
ⓢ2	—	○		—					
ⓓ2	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
ⓢ1	Input data head device
ⓓ1	Block memory head device
ⓢ2	Operation constant head device
ⓓ2	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1 to En) data is multiplied by attaching a coefficient.

Control Data

(1) Data specified in S.MUL instruction

Specification position		Symbol	Name	Recommended range*1	Unit	Data format	Standard Value	Store
Input data	(S1)+0	n	Input count	0 to 5	—	BIN 16Bit	—	U
	+1 +2	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+3 +4	E2	Input value 2					
	⋮	⋮	⋮					
	+2n-1 +2n	En	Input value n					
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0	n	Number of coefficients	0 to 5	—	BIN 16Bit	0	U
	+1 +2	K1	Coefficient 1	-999999 to 999999	—	Real number	1.0	U
	+3 +4	K2	Coefficient 2					
	⋮	⋮	⋮					
	+2n-1 +2n	Kn	Coefficient n					
	+2n+1 +2n+2	B	Bias	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.MUL instruction performs the following operation.

$$BW = (K1 \times E1) \times (K2 \times E2) \cdots \times (Kn \times En) + B$$

(2) When n is 0, BW = B.

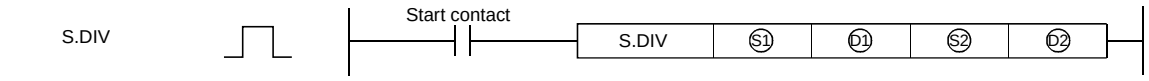
Error

- When an operation error occurs — Error code: 4100
- When not n = 0 to 5. — Error code: 4100

11.4 Division (S.DIV)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Divides the input value 1 (E1) by the input value 2 (E2).

Control Data

(1) Data specified in S.DIV instruction

Specification position		Symbol	Name	Recommended range*1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value 1 (Minute)	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value 2 (Denominator)	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(-999999 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	A	Coefficient 1	-999999 to 999999	—	Real number	1.0	U
	+2 +3	K1	Coefficient 2	-999999 to 999999	—	Real number	1.0	U
	+4 +5	K2	Coefficient 3	-999999 to 999999	—	Real number	1.0	U
	+6 +7	B1	Bias 1	-999999 to 999999	—	Real number	0.0	U
	+8 +9	B2	Bias 2	-999999 to 999999	—	Real number	0.0	U
	+10 +11	B3	Bias 3	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.DIV instruction performs the following operation.

$$BW = A \times \frac{K1 \times E1 + B1}{K2 \times E2 + B2} + B3$$

(2) When the denominator is 0, BW = B3.

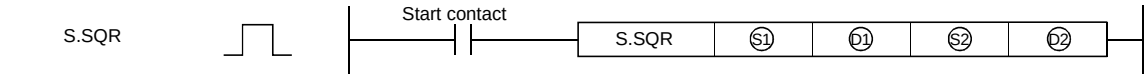
Error

• When an operation error occurs — Error code: 4100

11.5 Extraction (S.SQR)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The $\sqrt{}$ of input value (El) is output.
When the input value is negative, 0 is output.

Control Data

(1) Data specified in S.SQR instruction

Specification position		Symbol	Name	Recommended range*1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value	0 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(0 to 999999)	—	Real number	—	S
Operation constant	(S2)+0 +1	OLC	Output low cut value	0 to 999999	—	Real number	0.0	U
	+2 +3	K	Coefficient	0 to 999999	—	Real number	10.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.SQR instruction performs the following operation.

$$BW = K \times \sqrt{(E1)}$$

(2) When $K \times \sqrt{(E1)} \leqq 0$LC, BW = 0.
Also, when (E1 < 0), BW = 0.

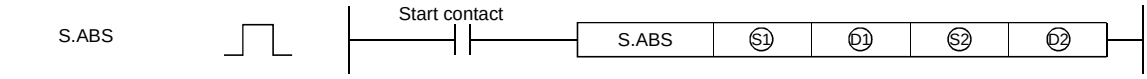
Error

• When an operation error occurs — Error code: 4100

11.6 Absolute Value (S.ABS)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]

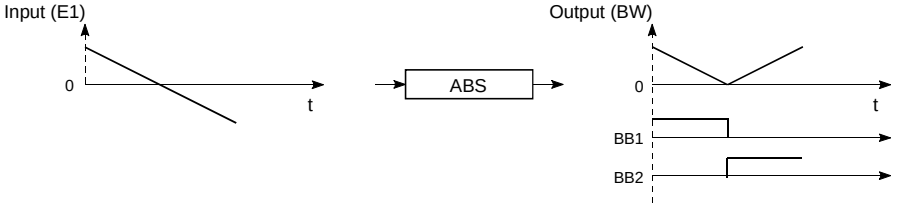


Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Dummy device*1
(D2)	Dummy device*1

*1: Special register SD1506 can be specified as a dummy device.

Functions

The input value (E1) absolute value is output.



Control Data

(1) Data specified in S.ABS instruction

Specification Position		Symbol	Name	Recommended range*1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(0 to 999999)	—	Real number	—	S
	+2	BB	—					
		BB1 BB2	Judgment of input value (E1) sign	b15 b12 b8 b4 b0 (BB2, BB1) When E1 > 0: BB1 = 1 When E1 < 0: BB2 = 1 When E1 = 0: BB1 = BB2 = 0	—	BIN 16Bit	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) The S.ABS instruction performs the following operation.

BW = |E1|

(2) The sign of the input value 1 (E1) is judged and the result is output to BB1 and BB2.

E1 Status	BB1	BB2
E1 > 0	1	0
E1 < 0	0	1
E1 = 0	0	0

Error

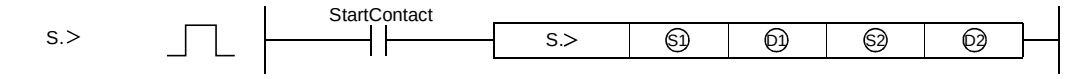
• When an operation error occurs — Error code: 4100

12 COMPARISON OPERATION INSTRUCTIONS

12.1 Comparison(S. >)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction Symbol] [Execution Condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value 1 (E1) and input value 2 (E2) and outputs the result of comparison.

12 - 1

Control data

(1) Data specified in S. > instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value 2	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(The same value as the input value 1 (E1) is stored)	—	Real number	—	S
	+2	BB	—					
		BB1	Comparison output	b15 b12 b8 b4 b0 BB1 (The result of comparison between E1 and E2 is stored.)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	K	Set value	-999999 to 999999	—	Real number	0.0	U
	+2 +3	HS	Hysteresis	0 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system.
Users cannot set the data.

Processing contents

(1) Compares the input value 1 (E1) with the input value 2 (E2), and outputs the result of the comparison to BB1 of the block memory.

Condition	BB1
E1 > (E2 + K)	1
E1 ≦ (E2 + K − HS)	0
(E2 + K − HS) < E1 ≦ (E2 + K)	Last value is output

Error

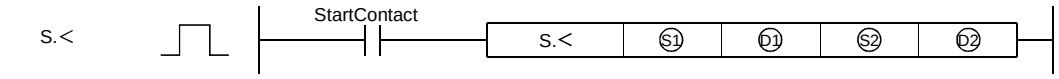
• When the hysteresis value is negative — Error code: 4100

12 - 2

12.2 Comparison(S. <)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction Symbol] [Execution Condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value 1 (E1) and input value 2 (E2) and outputs the result of comparison.

Control data

(1) Data specified in S. < instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value 2	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(The same value as the input value 1 (E1) is stored)	—	Real number	—	S
	+2	BB	—					
		BB1	Comparison output	b15 b12 b8 b4 b0 BB1 (The result of comparison between E1 and E2 is stored.)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	K	Set value	-999999 to 999999	—	Real number	0.0	U
	+2 +3	HS	Hysteresis	0 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system.
Users cannot set the data.

Processing contents

(1) Compares the input value 1 (E1) with the input value 2 (E2), and outputs the result of the comparison to BB1 of the block memory.

Condition	BB1
E1 < (E2 + K)	1
E1 ≧ (E2 + K + HS)	0
(E2 + K) ≦ E1 < (E2 + K + HS)	Last value is output

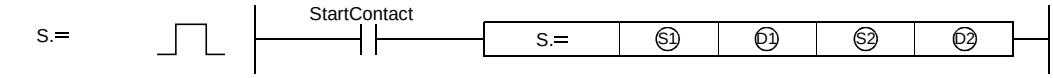
Error

• When the hysteresis value is negative — Error code: 4100

12.3 Comparison(S. =)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction Symbol] [Execution Condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value 1 (E1) and input value 2 (E2) and outputs the result of comparison.

Control data

(1) Data specified in S. = instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value 2	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(The same value as the input value 1 (E1) is stored)	—	Real number	—	S
	+2	BB	—					
		BB1	Comparison output	b15 b12 b8 b4 b0 BB1 (The result of comparison between E1 and E2 is stored.)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	K	Set value	-999999 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system.
Users cannot set the data.

Processing contents

(1) Compares the input value 1 (E1) with the input value 2 (E2), and outputs the result of the comparison to BB1 of the block memory.

Condition	BB1
E1 = (E2 + K)	1
E1 ≠ (E2 + K)	0

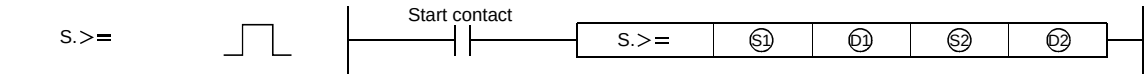
Error

• When an operation error occurs — Error code: 4100

12.4 Comparison(S. >=)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value 1 (E1) and input value 2 (E2) and outputs the result of comparison.

Control data

(1) Data specified in S. >= instruction

Specification Position		Symbol	Name	Recommended range *1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value 1	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value 2	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(The same value as the input value 1 (E1) is stored)	—	Real number	—	S
	+2	BB	—					
		BB1	Comparison output	b15 b12 b8 b4 b0 BB1 (The result of comparison between E1 and E2 is stored.)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	K	Set value	-999999 to 999999	—	Real number	0.0	U
	+2 +3	HS	Hysteresis	0 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.

Processing contents

(1) Compares the input value 1 (E1) with the input value 2 (E2), and outputs the result of the comparison to BB1 of the block memory.

Condition	BB1
E1 ≧ (E2 + K)	1
E1 < (E2 + K − HS)	0
(E2 + K − HS) ≦ E1 < (E2 + K)	Last value is output

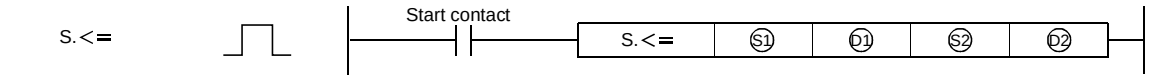
Error

• When the hysteresis value is negative — Error code: 4100

12.5 Comparison(S. <=)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Dummy device *1

*1: Special register SD1506 can be specified as a dummy device.

Functions

Compares the input value 1 (E1) and input value 2 (E2) and outputs the result of comparison.

Control data

(1) Data specified in S. <= instruction

Specification	Position	Symbol	Name	Recommended range *1	Unit	Data format	Standard Value	Store
Input data	(S1)+0 +1	E1	Input value1	-999999 to 999999	—	Real number	—	U
	+2 +3	E2	Input value2	-999999 to 999999	—	Real number	—	U
Block memory	(D1)+0 +1	BW	Output value	(The same value as the input value 1 (E1) is stored)	—	Real number	—	S
	+2	BB	—					
		BB1	Comparison output	b15 b12 b8 b4 b0 BB1 (The result of comparison between E1 and E2 is stored.)	—	BIN 16Bit	—	S
Operation constant	(S2)+0 +1	K	Set value	-999999 to 999999	—	Real number	0.0	U
	+2 +3	HS	Hysteresis	0 to 999999	—	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system.
Users cannot set the data.

Processing contents

(1) Compares the input value 1 (E1) with the input value 2 (E2), and outputs the result of the comparison to BB1 of the block memory.

Condition	BB1
E1 ≦ (E2 + K)	1
E1 > (E2 + K + HS)	0
(E2 + K) < E1 ≦ (E2 + K + HS)	Last value is output

Error

• When an operation error occurs — Error code: 4100

13 AUTO TUNING

Auto tuning is designed to make the initial setting of the PID constants.
The auto tuning of the QnPHCPU can be used for processes that can be approximated with a primary delay plus dead time represented by the following expression.
Example: Process with relatively slow response such as temperature adjustment

$$\frac{K}{1+Ts}e^{-Ls}$$

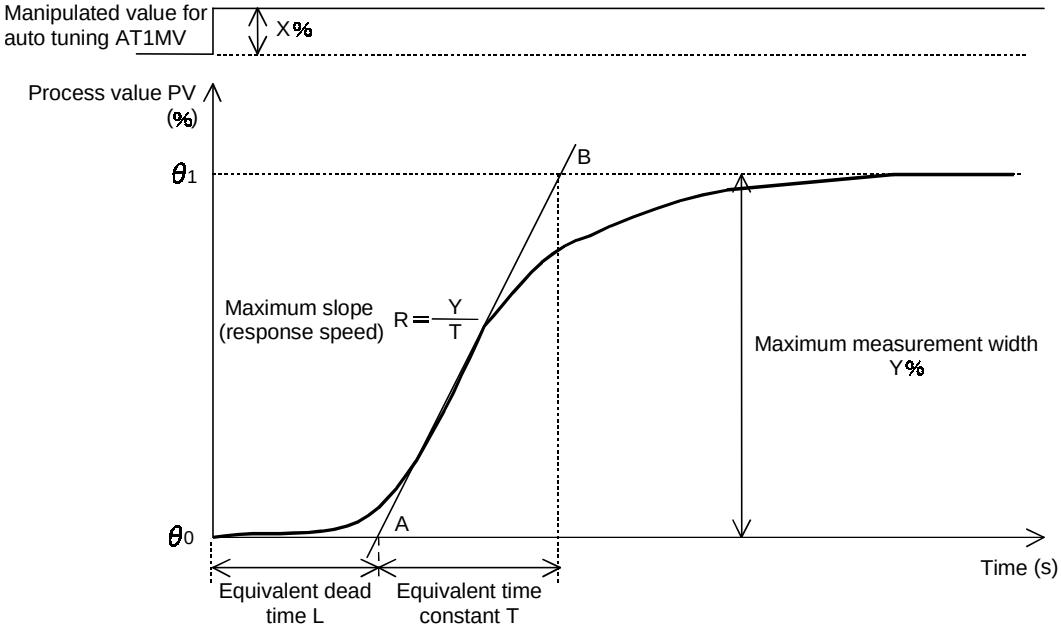
K: Gain, T: Time constant, L: Dead time, s: Laplace operator

Auto tuning can be used for the loop that uses the S. PID or S. 2PID instruction.

Auto tuning is performed in the ZN process: stepped response process of Ziegler and Nichols.
[Outline of stepped response process]

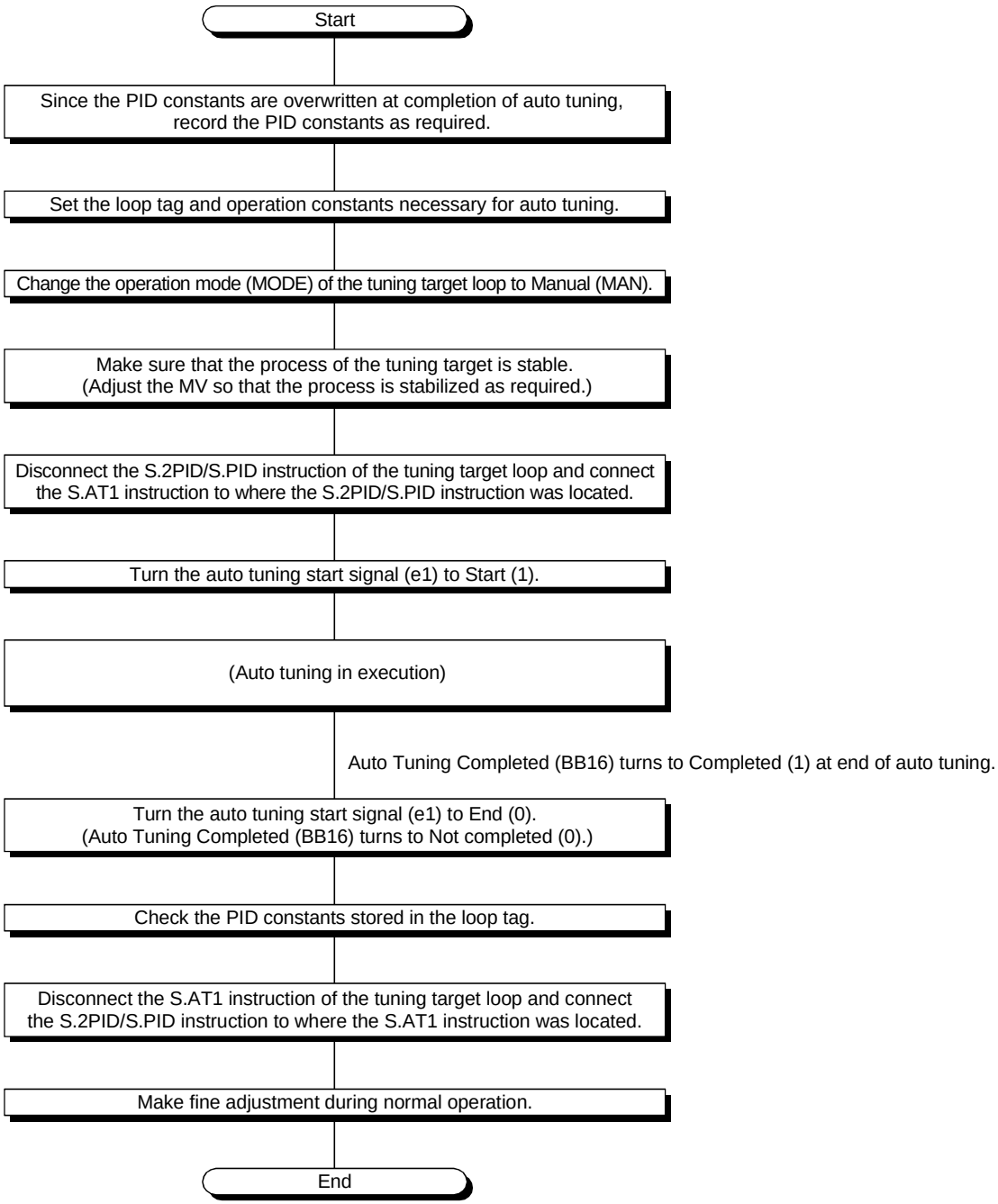
With no control operation being performed, change the manipulated value (MV) step by step and look how the process value (PV) varies.

1) When the manipulated value (MV) is changed step by step, the process value (PV) begins to vary slowly.
   Soon, the PV will vary faster, then vary slowly again, and finally settle at a fixed value.
2) Draw a tangent line at the place where the process value (PV) varies fastest, and find the points of intersection A, B where this tangent line crosses the horizontal axis corresponding to the first process value (θ_0) and last process value (θ_1).
   This provides the equivalent dead time (L) and equivalent time constant (T) as shown below.
3) From the equivalent time constant (T) and maximum process value width (Y), calculate the maximum slope (response speed) R = Y/T.
   Apply the equivalent dead time (L) and maximum slope (R) to the Ziegler and Nichols' adjustment rule, and calculate the proportional gain Kp (P), integral constant T_I (I) and derivative constant T_D (D).



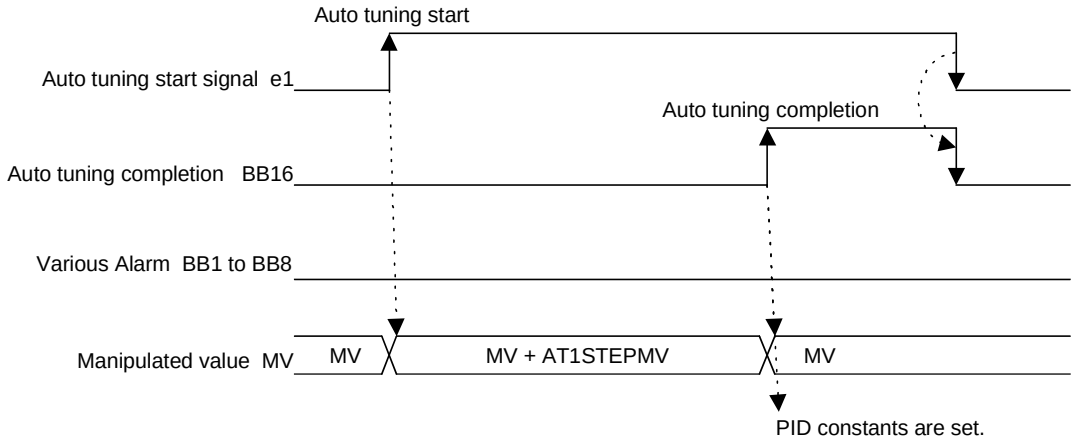
13 - 1

Auto tuning procedure

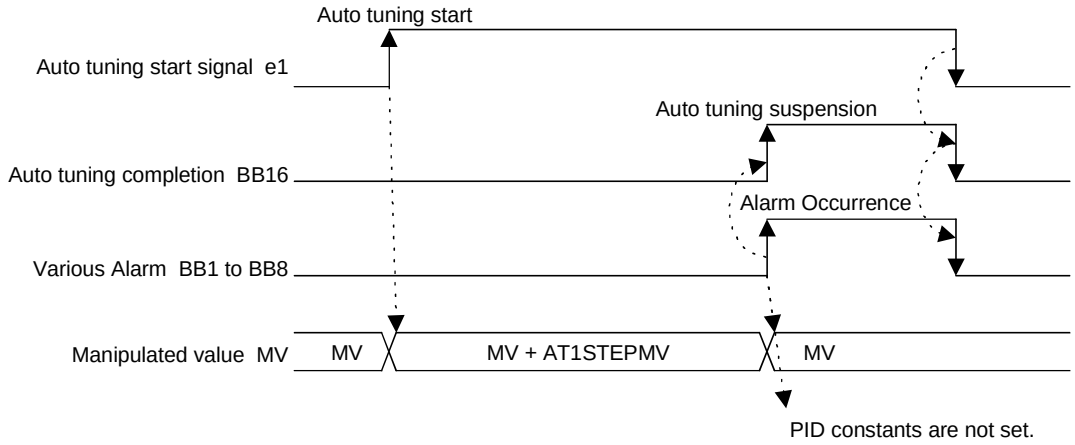


13 - 2

(1) Time chart from auto tuning start until normal completion



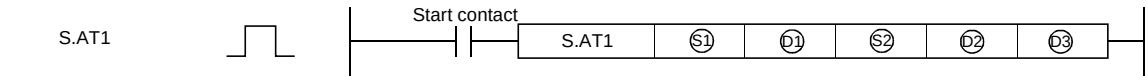
(2) Time chart from auto tuning start until stop due to alarm occurrence



13.1 Auto tuning instruction (S. AT1)

Setting data	Usable devices								
	Internal devices (System, user)		File register	MELSECNET/H direct J□\□		Intelligent function module U□\G□	Index register Zn	Constant K, H	Other
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(D1)	—	○		—					
(S2)	—	○		—					
(D2)	—	○		—					
(D3)	—	○		—					

[Instruction symbol] [Execution condition]



Set data	Description
(S1)	Input data head device
(D1)	Block memory head device
(S2)	Operation constant head device
(D2)	Loop tag memory head device
(D3)	Local work memory head device

Functions

Performs auto tuning and makes the initial setting of the PID constants.

Control data

(1) Data specified in S. AT1 instruction

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Input data	(S1)+0 +1	E1	Input value	-999999 to 999999	%	Real number	—	U
	+2	e1	Auto tuning start signal	b15 b12 b8 b4 b0 e1 0: Stop/end 1: Start	—	BIN 16bit	0	U
Block memory	(D1)+0	BB		—				
		BB1	Alarm	b15 b12 b8 b4 b0 BB16 BB8 BB7 BB6 BB5 BB4 BB3 BB2 BB1 BB16 (0: Incomplete, 1: Complete) BB1 to BB8 (0: Without alarm, 1: With alarm)	—	BIN 16bit	—	S
		BB2	Input upper limit alarm					
		BB3	Input lower limit alarm					
		BB4	Output upper limit alarm					
		BB5	Output lower limit alarm					
		BB6	Out time alarm					
		BB7	Operation mode alarm					
		BB8	Identification alarm					
		BB16	Auto tuning completion					
Operation constant	(S2)+0	PN	Operation mode	0: Reverse operation 1: Forward operation	—	BIN 16bit	0	U
Loop tag memory *2	(D2)+1	MODE	Operation mode	0 to FFFFH b15 b12 b8 b4 b0 CSV CMV CCB CAB CMB CAS AUT MAN LCC LCA LCM	—	BIN 16bit	8H	S/U
	+3	ALM	Alarm detection	b15 b12 b8 b4 b0 SPA HHA LLA PHA PLA SPA (0: Loop RUN, 1: Loop STOP) HHA, LLA, PHA, PLA (0: Without alarm, 1: With alarm)	—	BIN 16bit	4000H	S/U
	+12 +13	MV	Manipulated value	-10 to 110	%	Real number	0.0	U
	+18 +19	MH	Output upper limit value	-10 to 110	%	Real number	100.0	U
	+20 +21	ML	Output lower limit value	-10 to 110	%	Real number	0.0	U

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)

Specified position		Symbol	Name	Recommended range *1	Unit	Data format	Standard value	Store
Loop tag memory *2	(D2)+52 +53	P	Gain	0 to 999999	—	Real number	1.0	S/U
	+54 +55	I	Integral constant	0 to 999999	s	Real number	10.0	S/U
	+56 +57	D	Derivative constant	0 to 999999	s	Real number	0.0	S/U
	+70 +71	AT1 STEP MV	Step manipulated value for AT1	-100 to 100	%	Real number	0.0	U
	+72 +73	AT1ST	Sampling cycle for AT1	0 to 999999 Note that $\frac{AT1ST}{\Delta T} \leqq 32767$	s	Real number	1.0	U
	+74 +75	AT1 TOUT1	Time-out time for AT1	0 to 999999 Note that $\frac{AT1TOUT1}{\Delta T} \leqq 32767$	s	Real number	100.0	U
	+76 +77	AT1 TOUT2	After maximum slope time-out time for AT1	0 to 999999 Note that $\frac{AT1TOUT2}{\Delta T} \leqq 32767$	s	Real number	10.0	U
Local work memory *3	(D3)+0 ⋮ +21	—	System area	Used by the system as a work area.	—	—	—	S

*1: The data of the item(s) where the values within the recommended range are given in the parentheses are stored by the system. Users cannot set the data.
*2: The loop tag memory and loop tag past value memory occupy a total of 128 words. (Refer to Section 3.3.1 for details.)
*3: The applications of the loop tag past value memory are indicated below.

Specified position	contents
(S3)+0	Sampling cycle counter initial preset flag
+1	Sampling cycle counter
+2	Time-out time counter initial preset flag
+3	Time-out time counter
+4	After maximum slope time-out time counter initial preset flag
+5	After maximum slope time-out time counter
+6	Step manipulated value preset flag
+7	Counter from auto tuning start
+8 +9	Auto tuning start-time PV0
+10 +11	PV_{n-1} (Last process value)
+12 +13	Maximum slope value
+14 +15	Maximum slope-time counter
+16 +17	Maximum slope-time PV
+18 +19	R (Response speed)
+20 +21	L (Equivalent dead time)

When control is to be started from the initial status, the data must be cleared with the sequence program.

(2) Execution cycle (ΔT)

Set the execution cycle in SD1500 and SD1501 as a real number.

Processing contents

(1) Start signal judgement processing

Any of the following processings is performed depending on the statuses of the auto tuning start signal (e1) and auto tuning completed (BB16).

e1	BB16	Processing
0	0	BB2 to BB8 of BB are turned to 0. When the stepped manipulated value preset flag is 1, the following processing is performed. MV ← MV − AT1STEPMV The S. AT1 instruction is terminated.
1	0	"(2) Loop stop processing" is performed.
0	1	BB16 of BB is turned to 0. The S. AT1 instruction is terminated.
1	1	The S. AT1 instruction is terminated.

(2) Loop stop processing

(a) Setting 1 in SPA of the alarm detection (ALM) selects a loop stop.

A loop stop performs the following processing and terminates the S. AT1 instruction.

1) The auto tuning completed (BB16) is turned to 1.
2) When the stepped manipulated value preset flag is 1, the following processing is performed.

```
MV ← MV − AT1STEPMV
```

(b) Setting 0 in SPA of the alarm detection (ALM) selects a loop run.

A loop run performs "(3) Mode judgement processing".

(3) Mode judgement processing

Either of the following processings is performed depending on the operation mode (MODE) setting.

(a) When the operation mode (MODE) is any of AUT, CAB, CAS, CCB, CSV, LCA and LCC, the following processing is performed and the S. AT1 instruction is terminated.

1) The operation mode alarm (BB7) is turned to 1.
2) The auto tuning completed (BB16) is turned to 1.
3) When the stepped manipulated value preset flag is 1, the following processing is performed.

```
MV ← MV − AT1STEPMV
```

(b) When the operation mode (MODE) is any of MAN, CMB, CMV and LCM, "(4) Input check processing" is performed.

(4) Input check processing

Either of the following processings is performed depending on the alarm detection (ALM) setting.

(a) If either of PHA and HHA of the alarm detection (ALM) is 1, the following processing is performed and the S. AT1 is terminated.
1) The input upper limit alarm (BB3) is turned to 1.
2) The auto tuning completed (BB16) is turned to 1.

(b) If either of PLA and LLA of the alarm detection (ALM) is 1, the following processing is performed and the S. AT1 is terminated.
1) The input lower limit alarm (BB3) is turned to 1.
2) The auto tuning completed (BB16) is turned to 1.

(5) Time-out judgement processing

Whether the auto tuning processing has reached the AT1 time-out time (AT1TOUT1) or not is judged.

(a) If the AT1 time-out time (AT1TOUT1) is reached, the following processing is performed and the S. AT1 is terminated.
1) The time-out alarm (BB6) is turned to 1.
2) The auto tuning completed (BB16) is turned to 1.

(b) If the AT1 time-out time (AT1TOUT1) is not reached, "(6) After maximum slope time-out judgment processing" is performed.

(6) After maximum slope time-out judgment processing

Whether the auto tuning processing has reached the AT1 after maximum slope time-out time (AT1TOUT2) or not is judged.

However, if the after maximum slope time-out time counter initial preset flag is 0, the processing in (c) is performed.

(a) If the AT1 after maximum slope time-out time (AT1TOUT2) is reached, "(10) Identification processing" is performed.

(b) If the AT1 after maximum slope time-out time (AT1TOUT2) is not reached, "(7) Stepped manipulated value set processing" is performed.

(c) If the after maximum slope time-out time counter initial preset flag is 0, "(7) Stepped manipulated value set processing" is performed.

(7) Stepped manipulated value set processing

Whether the stepped manipulated value is "set (1)" or "not set (0)" is judged from the stepped manipulated value preset flag.

(a) If the stepped manipulated value preset flag is 0, the following processing is performed and the S. AT1 is terminated.
1) The AT1 stepped manipulated value (AT1STEPMV) is added to the manipulated value (MV).

$$T1 = MV + AT1STEPMV$$

In the upper/lower limiter, the following operation is performed and the result of the operation is output to BB4 and BB5.

Condition	Result				Processing after upper/lower limiter
	BB4	BB5	BB16	MV	
T1 > MH	1	0	1	Original MV unchanged	S. AT1 instruction is terminated.
T1 < ML	0	1	1	Original MV unchanged	
ML ≦ T1 ≦ MH	0	0	0	T1	The processing in 2) and later is performed.

2) The stepped manipulated value preset flag is turned to 1.
3) The counter from auto tuning start is cleared to 0.
4) The input value (E1) is stored into the auto tuning start-time PV0.
5) The input value (E1) is stored into the last process value (PV_{n-1}).
6) The maximum slope value, maximum slope-time counter, maximum slope-time PV, response speed (R) and equivalent dead time (L) are cleared to 0.

(b) If the stepped manipulated value preset flag is 1 "(8) Sampling cycle judgement processing" is performed.

(8) Sampling cycle judgment processing

Whether the sampling cycle is reached or not is judged from the AT1 sampling cycle (AT1ST).
(a) If the sampling cycle is not reached, the S. AT1 instruction is terminated.

(b) If the sampling cycle is reached, "(9) Response waveform observation processing" is performed.

(9) Response waveform observation processing

The following processing is performed for the input value (E1).
(a) Response waveform observation
1) The counter from auto tuning start is incremented.
2) The following processing is performed according to the input value (E1) and last process value (PV_{n-1}).

Reverse operation (PN = 0)	$T2 = E1 - PV_{n-1}$
Forward operation (PN = 1)	

3) The input value (E1) is stored into the last process value (PV_{n-1}).

(b) Maximum slope value

Depending on the slope (T2), the following processing is performed and the S. AT1 instruction is terminated.

1) If reverse operation is performed (PN = 0) and AT1 stepped manipulated value (AT1STEPMV) ≧ 0 or forward operation is performed (PN = 1) and AT1 stepped manipulated value (AT1STEPMV) < 0

Condition	Processing
Maximum slope value slope ≦ (T2)	• Maximum slope value = slope (T2) • Maximum slope-time counter = counter from auto tuning start • Maximum slope-time PV = input value (E1) • After maximum slope time-out count value is reset and count is restarted.
Maximum slope value > Slope(T2)	Maximum slope value remains unchanged from the last value.

2) If forward operation is performed (PN = 1) and AT1 stepped manipulated value (AT1STEPMV) ≧ 0 or reverse operation is performed (PN = 0) and AT1 stepped manipulated value (AT1STEPMV) < 0

Condition	Processing
Maximum slope value ≧ Slope(T2)	• Maximum slope value = slope (T2) • Maximum slope-time counter = counter from auto tuning start • Maximum slope-time PV = input value (E1) • After maximum slope time-out count value is reset and count is restarted.
Maximum slope value < Slope(T2)	Maximum slope value remains unchanged from the last value.

(10) Identification processing

Using the maximum slope value, the following processing is performed.

(a) Response speed

1) The response speed for calculation (R') and response speed (R) are calculated with the following expression.

$$R' = \frac{\text{Maximum slope value}(\%)}{\text{AT1ST}},\ R = \frac{|R'|}{100}\ (/s)$$

2) If R ≦ 0, the following processing is performed and the S. AT1 instruction is terminated.
The identification alarm (BB8) is turned to 1.
The auto tuning completed (BB16) is turned to 1.
When the stepped manipulated value preset flag is 1, the following processing is performed.

$$MV = MV - AT1STEPMV$$

(b) Equivalent dead time

1) The segment (b) made by the Y axis and the equivalent dead time (L) provided when the tangent line is drawn at the response speed for calculation (R') are calculated with the following expression.

$$b = (\text{maximum slope-time PV}) - R' \times (\text{maximum slope counter}) \times AT1ST$$

$$L = \frac{(\text{Auto tuning start-time PV0})-b}{R'}$$

2) If $L \leqq 0$, the following processing is performed and the S. AT1 instruction is terminated.
The identification alarm (BB8) is turned to 1.
The auto tuning completed (BB16) is turned to 1.
When the stepped manipulated value preset flag is 1, the following processing is performed.

$$MV = MV - AT1STEPMV$$

(11) PID constant calculation processing

The response speed (R), equivalent dead time (L) and AT1 stepped manipulated value (AT1STEPMV) are assigned to the adjustment rule to calculate the PID constants.

(a) Control system

The control system is selected according to the integral constant T_I (I) and derivative constant T_D (D).

Integral constant T_I (I)	Derivative constant T_D (D)	Control method
$T_I \leqq 0$	—	Proportional control (P operation) only
$T_I > 0$	$T_D \leqq 0$	PI control (PI operation)
	$T_D > 0$	PID control (PID operation)

(b) Adjustment rule

The ZN process: adjustment rule based on the stepped response of Ziegler and Nichols is used.

Control method	Rate example gain Kp (P)	Integral constant T_I (I)	Derivative constant T_D (D)
P	$\frac{1}{R \times L} \times \frac{\lvert AT1STEPMV \rvert}{100}$	0	0
PI	$\frac{0.9}{R \times L} \times \frac{\lvert AT1STEPMV \rvert}{100}$	3.33 × L	0
PID	$\frac{1.2}{R \times L} \times \frac{\lvert AT1STEPMV \rvert}{100}$	2 × L	0.5 × L

(c) PID constant storage

The following processing is performed and the S. AT1 instruction is terminated.

1) The PID constants are stored into the gain (P), integral constant (I) and derivative constant (D).
2) The auto tuning completed (BB16) is turned to 1.
3) The AT1 stepped manipulated value (AT1STEPMV) is subtracted from the manipulated value (MV), and the result is stored into the manipulated value (MV).

$$MV = MV - AT1STEPMV$$

ERROR

When an operation error occurred. Error code: 4100

14 ERROR CODE

This chapter describes the definitions of the errors that will occur in the QnPHCPU and the compensation operation to be taken for the errors.

14.1 Error code list

There is the following process control instruction error.
• Error occurred midway through operation Error code: 4100

When an operation error occurs (error code: 4100), a detailed error code is stored into SD1502 and SD1503.
• SD1502: Error code that occurred in process control instruction
• SD1503: Processing number of corresponding instruction where error occurred

If "OPERATION ERROR (error code: 4100)" occurred in the process control instruction, confirm its details in the above special registers.

Table 14.1 Error Codes That Occurred in Process Control Instructions (Stored in SD1502)

Error code	Error definition	Cause	Processing
1	There is either a non-numeric or non-normalized number.	Set data, such as operation constant, loop tag memory, loop tag past value memory or execution cycle, has a problem.	Check/correct the set data.
2	Symbol error (The number is negative)		
3	Number error (The number is outside the range)		
4	Integer range is exceeded		
5	Tried to divide by 0.		
6	An overflow occurred.		

Table 14.2 Processing Numbers of Instructions where Error Occurred (Stored in SD1503)

Processing No. / Instruction	1	2	3	4	5	6	7	8
S. IN	Range check	Input limiter	Engineering value reverse conversion	Digital Filter				
S. OUT1	Input addition processing	Change rate, upper/lower limiter	Reset windup	Output conversion				
S. OUT2		Change rate, upper/lower limiter		Output conversion				

14 - 1

Table 14.2 Processing Numbers of Instructions where Error Occurred (Stored in SD1503)

Instruction \ Processing No.	1	2	3	4	5	6	7	8
S. DUTY	Input addition processing	Change rate, upper/lower limiter	Reset windup	Output ON time conversion	Output conversion			
S. BC	Upper limit check	Change rate check	Output conversion					
S. PSUM	Input value increment operation	Retentive value operation	Output conversion					
S. PID	Control cycle judgment	SV setting processing	Tracking processing	Gain (Kp) operation	PID operation	Deviation check		
S. 2PID	Control cycle judgment	SV setting processing	Tracking processing	Gain (Kp) operation	PID operation 1) *1	PID operation 2) *2	PID operation 3) *3	Deviation check
S. PIDP	Control cycle judgment	SV setting processing	Tracking processing	Gain (Kp) operation	PIDP operation	Deviation check	Change rate, upper/ lower limiter	Output conversion
S. SPI	Operation time monitor	SV setting processing	Tracking processing	Gain (Kp) operation	SPI operation	Deviation check		
S. IPD	Control cycle judgment	SV setting processing	Tracking processing	Gain (Kp) operation	IPD operation	Deviation check		
S. BPI	Control cycle judgment	SV setting processing	Tracking processing	Gain (Kp) operation	BPI operation	Deviation check		
S. R	Control cycle judgment	Engineering value conversion	Tracking processing	Change rate limiter	Rate operation			
S. PHPL	Engineering value reverse conversion	Upper/lower limit check	Change rate check	Engineering value conversion	Loop stop			
S. ONF2	Control cycle judgment	SV setting processing	Tracking processing	MV compensa-tion	MV output	2-position ON/OFF control		
S. ONF3	Control cycle judgment	SV setting processing	Tracking processing	MV compensa-tion	MV output	3-position ON/OFF control		
S. PGS	Operation constant check	SV count up	MVPGS operation	Output processing				
S. SEL	Engineering value conversion	E1, E2 selection	Engineering value reverse conversion	Change rate, upper/ lower limiter	Output conversion	Tracking processing		
S. AT1	Input check	Time out judgment	After maximum slope time-out time	Step manipulated value set	Sampling cycle judgment	Response waveform observation	Identification processing	PID constant calculation

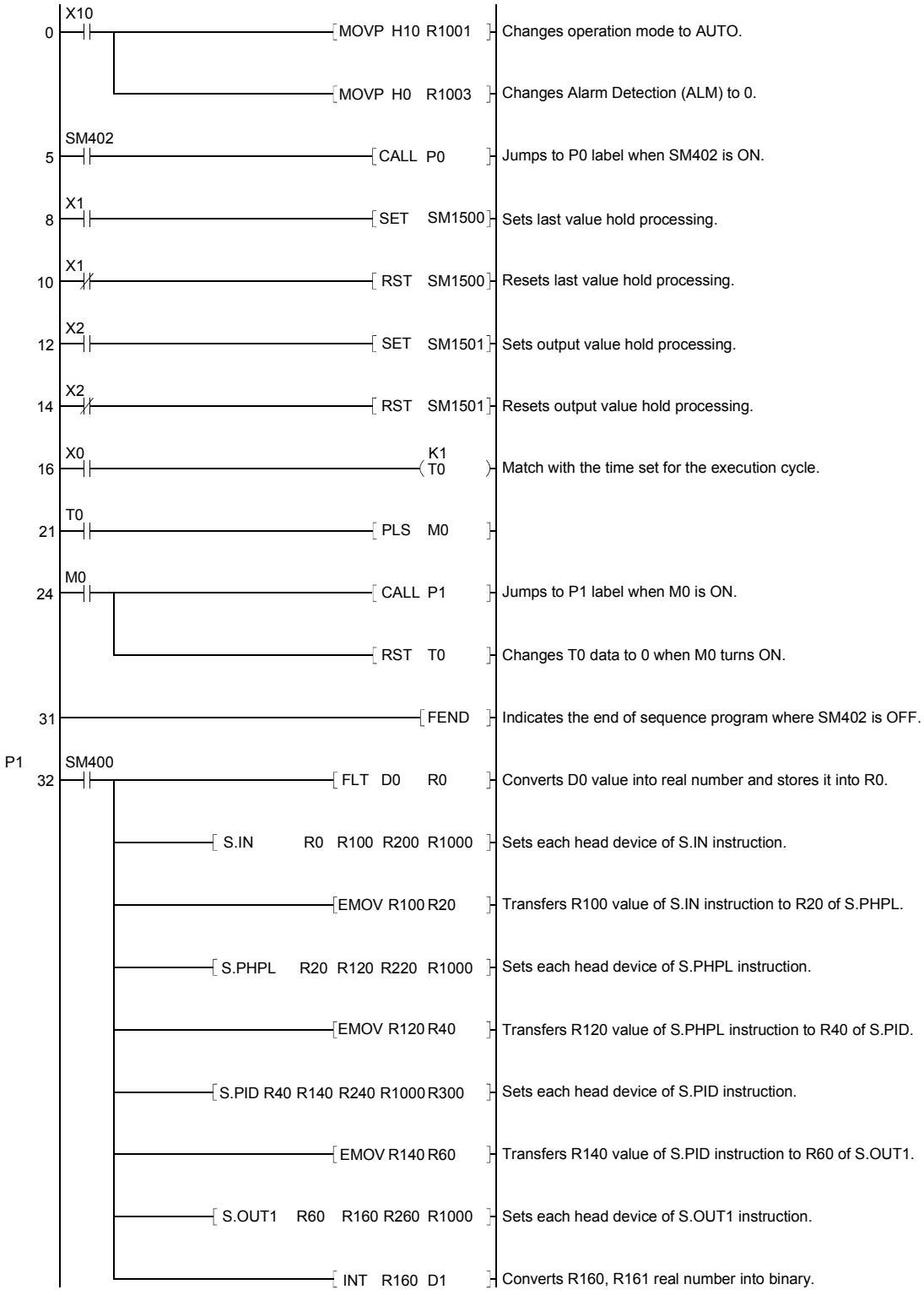
*1: Indicates the operation processing of Bn or Cn.
*2: Indicates the operation processing of Dn.
*3: Indicates the operation processing of ΔMV.

Processing No. 1 is stored if an error occurs in the instruction that is not indicated in the above table.

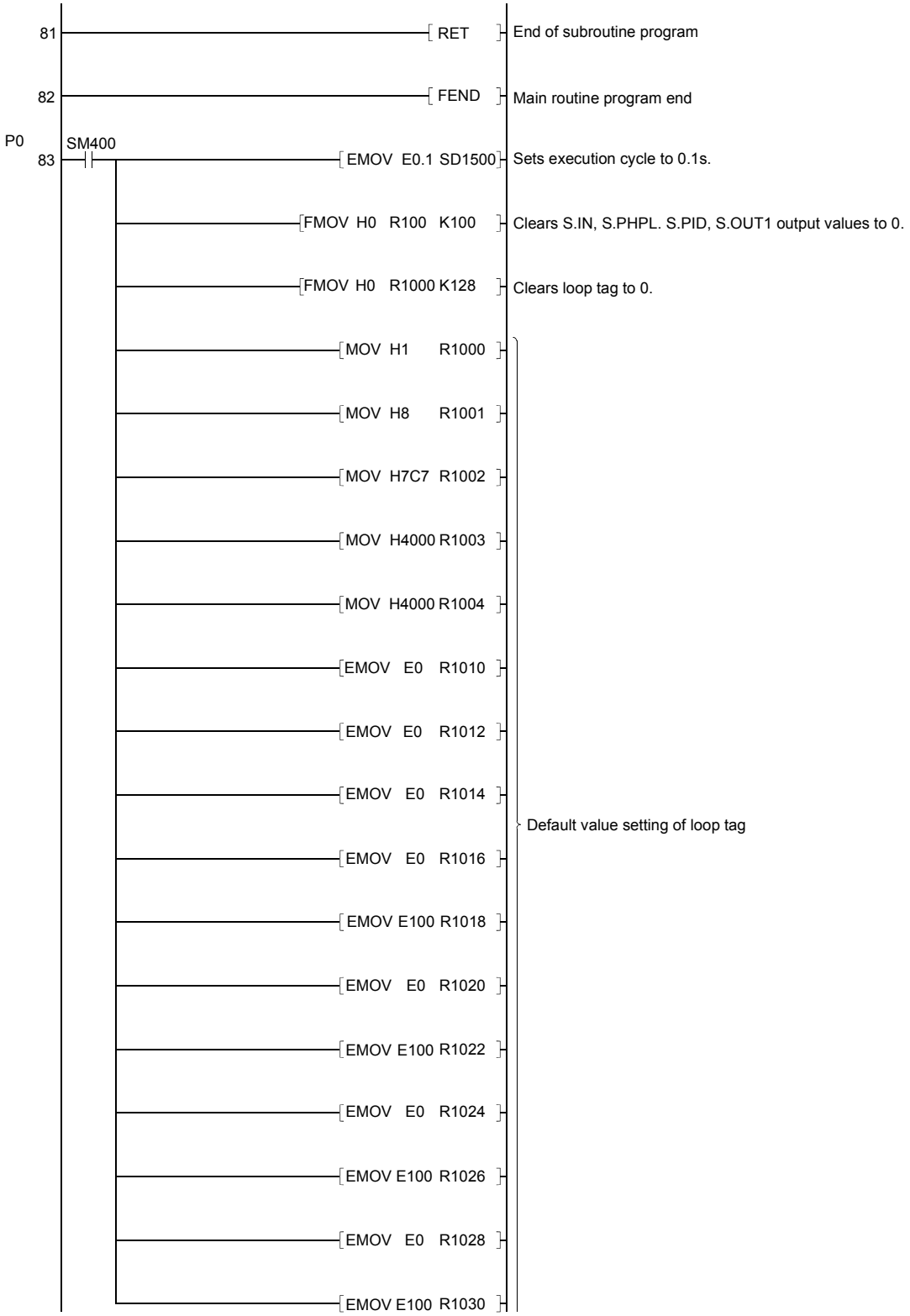
APPENDIX

Appendix 1 EXAMPLE PROGRAM

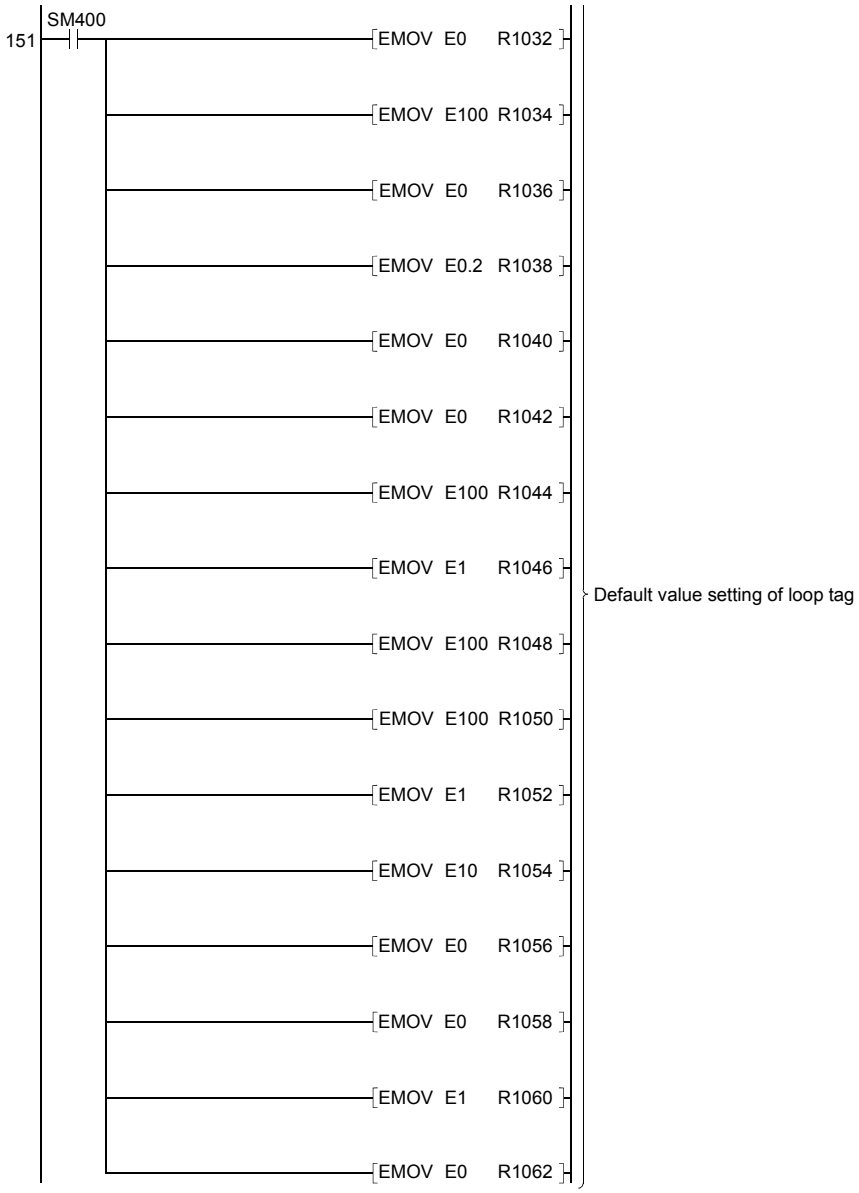
In the following program, the operation mode switches to the manual mode at power-on. Turning X10 ON selects AUTO (automatic mode), starting PID control.



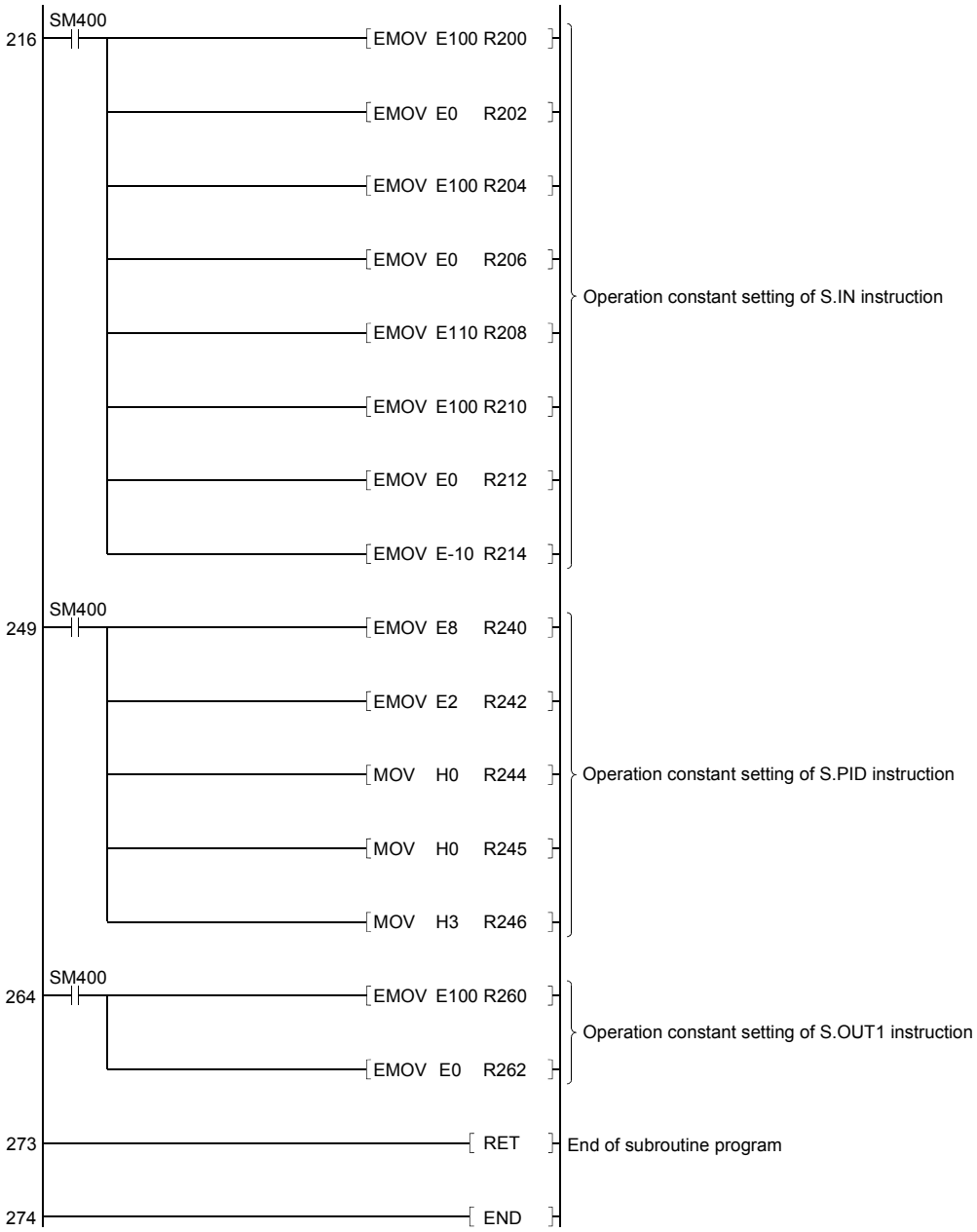
App


81
RET
End of subroutine program
82
FEND
Main routine program end
P0
SM400
83
EMOV E0.1 SD1500
Sets execution cycle to 0.1s.
FMOV H0 R100 K100
Clears S.IN, S.PHPL. S.PID, S.OUT1 output values to 0.
FMOV H0 R1000 K128
Clears loop tag to 0.
MOV H1 R1000
MOV H8 R1001
MOV H7C7 R1002
MOV H4000 R1003
MOV H4000 R1004
EMOV E0 R1010
EMOV E0 R1012
EMOV E0 R1014
Default value setting of loop tag
EMOV E0 R1016
EMOV E100 R1018
EMOV E0 R1020
EMOV E100 R1022
EMOV E0 R1024
EMOV E100 R1026
EMOV E0 R1028
EMOV E100 R1030

App


SM400
151
EMOV E0 R1032
EMOV E100 R1034
EMOV E0 R1036
EMOV E0.2 R1038
EMOV E0 R1040
EMOV E0 R1042
EMOV E100 R1044
EMOV E1 R1046
EMOV E100 R1048
EMOV E100 R1050
EMOV E1 R1052
EMOV E10 R1054
EMOV E0 R1056
EMOV E0 R1058
EMOV E1 R1060
EMOV E0 R1062
Default value setting of loop tag

App - 3


SM400
216
EMOV E100 R200
EMOV E0 R202
EMOV E100 R204
EMOV E0 R206
EMOV E110 R208
EMOV E100 R210
EMOV E0 R212
EMOV E-10 R214
Operation constant setting of S.IN instruction
SM400
249
EMOV E8 R240
EMOV E2 R242
MOV H0 R244
MOV H0 R245
MOV H3 R246
Operation constant setting of S.PID instruction
SM400
264
EMOV E100 R260
EMOV E0 R262
Operation constant setting of S.OUT1 instruction
273
RET
End of subroutine program
274
END

Appendix 2 Loop Tag Memory List

Appendix 2.1 PID control (SPID) 2-degree-of-freedom PID control (S2PID) Sample PI control (SSPI)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SPID S2PID	SSPI
	+0	—	—	—	—	—	—
	1	MODE *1	Operation mode	0 to $FFFF_H$	-	S/U	S/U
	2	—	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to $FFFF_H$	-	S/U	S/U
	4	INH *1	Alarm detection inhibition	0 to $FFFF_H$	-	S/U	S/U
	5	—	—	—	—	—	—
	6	—	—	—	—	—	—
	7	—	—	—	—	—	—
	8	—	—	—	—	—	—
	9	—	—	—	—	—	—
S. PHPL	10 11	PV	Process value	(RL to RH)	—	S	S
S. OUT1/S. DUTY	12 13	MV	Manipulated value	(-10 to 110)	%	S	S
S. PID/S. 2PID/ S. SPI	14 15	SV	Set value	RL to RH	—	U	U
S. PID/S. 2PID/ S. SPI	16 17	DV	Deviation	(-110 to 110)	%	S	S
S. OUT1/S. DUTY	18 19	MH	Output upper limit value	-10 to 110	%	U	U
S. OUT1/S. DUTY	20 21	ML	Output lower limit value	-10 to 110	%	U	U
S. PHPL/S. PID/ S. 2PID/S. SPI	22 23	RH	Engineering value upper limit	-999999 to 999999	—	U	U
S. PHPL/S. PID/ S. 2PID/S. SPI	24 25	RL	Engineering value lower limit	-999999 to 999999	—	U	U
S. PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	U	U
S. PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	U	U
S. PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	U	U
S. PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	U	U
	34 35	—	—	—	—	—	—
	36 37	—	—	—	—	—	—
S. IN	38 39	α	Filter coefficient	0 to 1	—	U	U
S. PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	U	U
S. PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U	U
S. PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	U	U
S. PID/S. 2PID/ S. SPI	46 47	CT/ST	Control cycle/Operation time	0 to 999999	s	U (Set CT)	U (Set ST)

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SPID S2PID	SSPI
S. OUT1/S.DUTY	48 49	DML	Output change rate limit value	0 to 100	%	U	U
S. PID/S. 2PID/ S. SPI	50 51	DVL	Change rate limit value	0 to 100	%	U	U
S. PID/S. 2PID/ S. SPI	52 53	P	Gain	0 to 999999	—	U	U
S. PID/S. 2PID/ S. SPI/S. OUT1/ S. DUTY	54 55	I *2	Integral constant	0 to 999999	s	U	U
S. PID/S. 2PID/ S. SPI	56 57	D/STHT	Derivative constant/Sample cycle	0 to 999999	s	U (D Setting)	U (STHT Setting)
S. PID/S. 2PID/ S. SPI	58 59	GW	Gap width	0 to 100	%	U	U
S. PID/S. 2PID/ S. SPI	60 61	GG	Gap gain	0 to 999999	—	U	U
S. PID/S. 2PID/ S. SPI/S. OUT1/S. DUTY	62 63	MVP	MV inside operation value	(-999999 to 999999)	%	S	S
S. 2PID	64 65	α	2Degree-of-freedom parameter α	0 to 1	—	U	—
S. 2PID	66 67	β	2Degree-of-freedom parameter β	0 to 1	—	U	—
S. DUTY	68 69	CTDUTY	Control output cycle	0 to 999999	s	U	—

POINT

- MODE, ALM and INH marked *1 are shared among the instructions.
- I marked *2 shares the same value between the following instructions.
  - S. PID instruction and S. OUT1 instruction
  - S. PID instruction and S. DUTY instruction
  - S. 2PID instruction and S. OUT1 instruction
  - S. 2PID instruction and S. DUTY instruction
  - S. SPI instruction and S. OUT1 instruction

App - 6

Appendix 2.2 I-PD Control (SIPD), Blend PI control (SBPI)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SIPD	SBPI
	+0	—	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	—	S/U	S/U
	2	—	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	S/U	S/U
	5	—	—	—	—	—	—
	6	—	—	—	—	—	—
	7	—	—	—	—	—	—
	8	—	—	—	—	—	—
	9	—	—	—	—	—	—
S. PHPL	10 11	PV	Process value	(RL to RH)	—	S	S
S. OUT1	12 13	MV	Manipulated value	(-10 to 110)	%	S	S
S. IPD/S. BPI	14 15	SV	Set value	RL to RH	—	U	U
S. IPD/S. BPI	16 17	DV	Deviation	(-110 to 110)	%	S	S
S. OUT1	18 19	MH	Output upper limit value	-10 to 110	%	U	U
S. OUT1	20 21	ML	Output lower limit value	-10 to 110	%	U	U
S. PHPL/S. IPD/ S. BPI	22 23	RH	Engineering value upper limit	-999999 to 999999	—	U	U
S. PHPL/S. IPD/ S. BPI	24 25	RL	Engineering value lower limit	-999999 to 999999	—	U	U
S. PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	U	U
S. PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	U	U
S. PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	U	U
S. PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	U	U
	34 35	—	—	—	—	—	—
	36 37	—	—	—	—	—	—
S. IN	38 39	α	Filter coefficient	0 to 1	—	U	U
S. PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	U	U
S. PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U	U
S. PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	U	U
S. IPD/S. BPI	46 47	CT	Control cycle	0 to 999999	s	U	U

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SIPD	SBPI
S. OUT1	48 49	DML	Output change rate limit value	0 to 100	%	U	U
S. IPD/S. BPI	50 51	DVL	Change rate limit value	0 to 100	%	U	U
S. IPD/S. BPI	52 53	P	Gain	0 to 999999	—	U	U
S. IPD/S. BPI S. OUT1	54 55	I *2	Integral constant	0 to 999999	s	U	U
S. IPD/S. BPI	56 57	D/SDV	Derivative constant/DV cumulative value	D:0 to 999999	s	U	—
				SDV:-999999 to 999999	%	—	S
S. IPD/S. BPI	58 59	GW	Gap width	0 to 100	%	U	U
S. IPD/S. BPI	60 61	GG	Gap gain	0 to 999999	—	U	U
S. IPD/S. OUT1	62 63	MVP	MV inside operation value	(-999999 to 999999)	%	S	—

POINT

- MODE, ALM and INH marked *1 are shared among the instructions.
- I marked *2 shares the same value between the S. IPD and S. OUT1 instructions and between the S. BPI and S. OUT1 instructions.

App - 8

Appendix 2.3 Manual output (SMOUT), Monitor (SMON)

Loop tag memory list

Instruction used	Offset	Item	Name	Setting/Store range	Unit	Data storage	
						SMOUT	SMON
	+0	—	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	-	S/U	S/U
	2	—	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	-	S/U
	5	—	—	—	—	—	—
	6	—	—	—	—	—	—
	7	—	—	—	—	—	—
	8	—	—	—	—	—	—
	9	—	—	—	—	—	—
S. PHPL	10 11	PV	Process value	(RL to RH)	—	—	S
S. MOUT	12 13	MV	Manipulated value	-10 to 110	%	U	—
	14 15	—	—	—	—	—	—
	16 17	—	—	—	—	—	—
	18 19	—	—	—	—	—	—
	20 21	—	—	—	—	—	—
S. PHPL	22 23	RH	Engineering value upper limit	-999999 to 999999	—	—	U
S. PHPL	24 25	RL	Engineering value lower limit	-999999 to 999999	—	—	U
S. PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	—	U
S. PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	—	U
S. PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	—	U
S. PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	—	U
	34 35	—	—	—	—	—	—
	36 37	—	—	—	—	—	—
S. IN	38 39	α	Filter coefficient	0 to 1	—	—	U
S. PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	—	U
S. PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	—	U
S. PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	—	U
	46 47	—	—	—	—	—	—

POINT

• MODE, ALM and INH marked *1 are shared among the instructions.

App - 9

Appendix 2.4 Manual output with monitor(SMWM), PIDP Control (SPIDP)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SMWM	SPIDP
	+0	—	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	—	S/U	S/U
	2	—	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	S/U	S/U
	5	—	—	—	—	—	—
	6	—	—	—	—	—	—
	7	—	—	—	—	—	—
	8	—	—	—	—	—	—
	9	—	—	—	—	—	—
S. PHPL	10 11	PV	Process value	(RL to RH)	—	S	S
S. MOUT/S. PIDP	12 13	MV	Manipulated value	-10 to 110	%	U	S
S. PIDP	14 15	SV	Set value	RL to RH	—	—	U
S. PIDP	16 17	DV	Deviation	(-110 to 110)	%	—	S
S. PIDP	18 19	MH	Output upper limit value	-10 to 110	%	—	U
S. PIDP	20 21	ML	Output lower limit value	-10 to 110	%	—	U
S. PHPL/S. PIDP	22 23	RH	Engineering value upper limit	-999999 to 999999	—	U	U
S. PHPL/S. PIDP	24 25	RL	Engineering value lower limit	-999999 to 999999	—	U	U
S. PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	U	U
S. PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	U	U
S. PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	U	U
S. PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	U	U
	34 35	—	—	—	—	—	—
	36 37	—	—	—	—	—	—
S. IN	38 39	α	Filter coefficient	0 to 1	—	U	U
S. PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	U	U
S. PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U	U
S. PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	U	U
S. PIDP	46 47	CT	Control cycle	0 to 999999	s	—	U

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SMWM	SPIDP
S. PIDP	48 49	DML	Output change rate limit value	0 to 100	%	—	U
S. PIDP	50 51	DVL	Change rate limit value	0 to 100	%	—	U
S. PIDP	52 53	P	Gain	0 to 999999	—	—	U
S. PIDP	54 55	I	Integral constant	0 to 999999	s	—	U
S. PIDP	56 57	D	Derivative constant	0 to 999999	s	—	U
S. PIDP	58 59	GW	Gap width	0 to 100	%	—	U
S. PIDP	60 61	GG	Gap gain	0 to 999999	—	—	U

POINT

• MODE, ALM and INH marked *1 are shared among the instructions.

App - 11

Appendix 2.5 2 Position ON/OFF Control (SONF2), 3 Position ON/OFF Control (SONF3)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage	
						SONF2	SONF3
	+0	—	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	—	S/U	S/U
	2	—	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	S/U	S/U
	5	—	—	—	—	—	—
	6	—	—	—	—	—	—
	7	—	—	—	—	—	—
	8	—	—	—	—	—	—
	9	—	—	—	—	—	—
S.PHPL	10 11	PV	Process value	(RL to RH)	—	S	S
S.ONF2/S.ONF3	12 13	MV	Manipulated value	(-10 to 110)	%	S	S
S.ONF2/S.ONF3	14 15	SV	Set value	RL to RH	—	U	U
S.ONF2/S.ONF3	16 17	DV	Deviation	(-110 to 110)	%	S	S
S.ONF2/S.ONF3	18 19	HSO	Hysteresis	0 to 999999	—	U	U
S.ONF3	20 21	HS1	Hysteresis	0 to 999999	—	—	U
S.PHPL	22 23	RH	Engineering value upper limit	-999999 to 999999	—	U	U
S.PHPL	24 25	RL	Engineering value lower limit	-999999 to 999999	—	U	U
S.PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	U	U
S.PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	U	U
S.PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	U	U
S.PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	U	U
	34 35	—	—	—	—	—	—
	36 37	—	—	—	—	—	—
S.IN	38 39	α	Filter coefficient	0 to 1	—	U	U
S.PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	U	U
S.PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U	U
S.PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	U	U
S.ONF2/S.ONF3	46 47	CT	Control cycle	0 to 999999	s	U	U

POINT

• MODE, ALM and INH marked *1 are shared among the instructions.

Appendix 2.6 Batch counter (SBC)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage
						SBC
	+0	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	—	S/U
	2	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	S/U
	5	—	—	—	—	—
	6	—	—	—	—	—
	7	—	—	—	—	—
	8	—	—	—	—	—
	9	—	—	—	—	—
S. PSUM	10 11	SUM1	Retentive value (Integer part)	(0 to 2147483647)	—	S
S. PSUM	12 13	SUM2	Retentive value (Fraction part)	(0 to 2147483647)	—	S
S. BC	14 15	SV1	Set value 1	0 to 2147483647	—	U
S. BC	16 17	SV2	Set value 2	0 to 2147483647	—	U
	18 19	—	—	—	—	—
	20 21	—	—	—	—	—
	22 23	—	—	—	—	—
	24 25	—	—	—	—	—
S. BC	26 27	PH	Upper limit alarm set value	0 to 2147483647	—	U
	28 29	—	—	—	—	—
	30 31	—	—	—	—	—
	32 33	—	—	—	—	—
	34 35	—	—	—	—	—
	36 37	—	—	—	—	—
	38 39	—	—	—	—	—
	40 41	—	—	—	—	—
S. BC	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U
S. BC	44 45	DPL	Change rate alarm value	0 to 2147483647	—	U
	46 47	—	—	—	—	—

POINT

• MODE, ALM and INH marked *1 are shared among the instructions.

Appendix 2.7 Rate control (SR)

Loop tag memory list

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage
						SR
	+0	—	—	—	—	—
	1	MODE *1	Operation mode	0 to FFFF$_H$	—	S/U
	2	—	—	—	—	—
	3	ALM *1	Alarm detection	0 to FFFF$_H$	—	S/U
	4	INH *1	Alarm detection inhibition	0 to FFFF$_H$	—	S/U
	5	—	—	—	—	—
	6	—	—	—	—	—
	7	—	—	—	—	—
	8	—	—	—	—	—
	9	—	—	—	—	—
S. PHPL	10 11	PV	Process value	(RL to RH)	—	S
S. OUT2	12 13	MV	Manipulated value	(-10 to 110)	%	S
S. R	14 15	SPR	Set value	-999999 to 999999	—	U
S. R	16 17	BIAS	Bias	-999999 to 999999	%	U
S. OUT2	18 19	MH	Output upper limit value	-10 to 110	%	U
S. OUT2	20 21	ML	Output lower limit value	-10 to 110	%	U
S. PHPL	22 23	RH	Engineering value upper limit	-999999 to 999999	—	U
S. PHPL	24 25	RL	Engineering value lower limit	-999999 to 999999	—	U
S. PHPL	26 27	PH	Upper limit alarm set value	RL to RH PL < PH	—	U
S. PHPL	28 29	PL	Lower limit alarm value	RL to RH PL < PH	—	U
S. PHPL	30 31	HH	Upper upper limit alarm value	RL to RH PH ≦ HH	—	U
S. PHPL	32 33	LL	Lower lower limit alarm value	RL to RH LL ≦ PL	—	U
	34 35	—	—	—	—	—
	36 37	—	—	—	—	—
S. IN	38 39	α	Filter coefficient	0 to 1	—	U
S. PHPL	40 41	HS	Upper/lower limit alarm hysteresis	0 to 999999	%	U
S. PHPL	42 43	CTIM	Change rate alarm check time	0 to 999999	s	U
S. PHPL	44 45	DPL	Change rate alarm value	0 to 100	%	U
S. R	46 47	CT	Control cycle	0 to 999999	s	U

Instruction used	Offset	Item	Name	Recommended range	Unit	Data storage SR
S. OUT2	48 49	DML	Output change rate limit value	0 to 100	%	U
S. R	50 51	DR	Change rate limit value	0 to 999999	—	U
S. R	52 53	RMAX	Rate upper limit value	-999999 to 999999	—	U
S. R	54 55	RMIN	Rate lower limit value	-999999 to 999999	—	U
S. R	56 57	Rn	Rate current value	(-999999 to 999999)	—	S

POINT

• MODE, ALM and INH marked *1 are shared among the instructions.

App - 15

Appendix 3 OPERATION PROCESSING TIME

Appendix 3.1 The Operation Processing Time of Each Instruction

The operation processing time of each instruction is indicated in the table on this page and later. Since the operation processing time changes depending on the setting conditions, refer to the value in the table as the guideline of the processing time.

Instruction	Condition	Processing time(μs)
S.IN	Condition where ALM does not turn ON during loop run	69
S.OUT1	Condition where ALM does not turn ON during loop run in AUT mode	44
S.OUT2	Condition where ALM does not turn ON during loop run in AUT mode	29
S.MOUT	Executed during loop run in MAN mode	27
S.DUTY	Execution cycle = 1, Control output cycle = 10 Condition where ALM does not turn ON during loop run in AUT mode	53
S.BC	Condition where ALM does not turn ON during loop run in AUT mode	29
S.PSUM	Integration start signal = ON Integration hold signal = OFF	23
S.PID	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Integral constant ≠ 0 Derivative constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	94
S.2PID	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Integral constant ≠ 0 Derivative constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	135
S.PIDP	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Integral constant ≠ 0 Derivative constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	115
S.SPI	Set value pattern = 3(Without cascade) Tracking bit = 0 Operating time = Sample cycle (ST = STHT) Integral constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	87
S.IPD	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Integral constant ≠ 0 Derivative constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	76
S.BPI	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Integral constant ≠ 0 Condition where ALM does not turn ON during loop run in AUT mode	72

Instruction	Condition	Processing time(μs)
S.R	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Executed during loop run in AUT	58
S.PHPL	Condition where ALM does not turn ON during loop run in AUT mode	100
S.LLAG	Input data = 50, With lead/lag guarantee Lead time = 1, Delay time = 1	27
S.I	Input data = 50, Integral time = 1 Output initial value = 0	14
S.D	Input data = 50, Derivative time = 1 Output initial value = 0	16
S.DED	Input data = 50 Operation control signal 0 → 1 Data collection interval = 1 Sampling count = 10 Output initial value = 0 Initial output switching = 0	17
S.HS	Input number = 5 Input data = 50, 100, 150, 200, 250	29
S.LS	Input number = 5 Input data = 50, 100, 150, 200, 250	32
S.MID	Input number = 5 Input data = 50, 100, 150, 200, 250	39
S.AVE	Input number = 2, Input data = 50, 100	24
S.LIMT	Input data = 50 Upper limit value = 100 Lower limit value = 0 Upper limit hysteresis = 0 Lower limit hysteresis = 0	30
S.VLMT1	Input data = 50 Positive direction limit value = 100 Negative direction limit value = 100 Positive direction hysteresis = 0 Negative direction hysteresis = 0	25
S.VLMT2	Input data = 50 Positive direction limit value = 100 Negative direction limit value = 100 Positive direction hysteresis = 0 Negative direction hysteresis = 0	27
S.ONF2	Input data = 10 Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Executed during loop run in MAN mode	52
S.ONF3	Input data = 10 Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = Control cycle = 1 Executed during loop run in MAN mode	59
S.DBND	Input data = 50 Dead zone upper limit = 100, Dead zone lower limit = 0 Input low cut value = 0, Initial value = 0 Input range = 1	26

Instruction	Condition	Processing time(μs)
S.PGS	Number of operation constant polygon points = 16 Operation type = 0(Hold type) Execution cycle = 1 Set value = 10 Condition where ALM does not turn ON during loop run in AUT mode	18
S.SEL	Set value pattern = 18H(E1, E2 Used, Without cascade) Tracking bit = 0 Condition where ALM does not turn ON during loop run in AUT mode	68
S.BUMP	Output set value = 0, Output control value = 50 Mode selection signal = 1 Delay time = 1, Delay zone = 1	18
S.AMR	Output addition value = 50, Output subtraction value = 50 Output set value = 0, Output signal = 1 Output addition signal = 1, Output subtraction signal = 0 Output upper limit value = 50, Output lower limit value = 0	17
S.FG S.IFG	Input data = 50, Number of polygon points = 2 Polygon coordinates (30, 40), (60, 70)	33
S.FLT	Input data = 50, Data collection interval = 1 Sampling count = 10	36
S.SUM	Input data = 50 Input low cut value = 0, Initial value = 0 Input range = 1	16
S.TPC	Both temperature and pressure are corrected. Differential pressure = 100, Measurement temperature = 300 Measured pressure = 10000, Design temperature = 0 Bias (Temperature) = 273.15 Design pressure = 0 Bias pressure = 10332.0	39
S.ENG S.IENG	Input data = 50, Engineering value upper limit = 100 Engineering value lower limit = 0	25
S.ADD	Input number = 2, Input data = 50, 100 Number of coefficients = 2, Coefficient = 1, 1, Bias = 0	25
S.SUB	Input number = 2, Input data = 50, 100 Number of coefficients = 2, Coefficient = 1, 1, Bias = 0	26
S.MUL	Input number = 2, Input data = 50, 100 Number of coefficients = 2, Coefficient = 1, 1, Bias = 0	23
S.DIV	Input data = 50, 100 Coefficient = 1, 1, 1, Bias = 0, 0, 0	26
S.SQR	Input data = 50 Output low cut value = 0, Coefficient = 10	30
S.ABS	Input data = 50	13
S.>	Input data = 50, 100 Set value = 0, Hysteresis = 0	18
S.<	Input data = 50, 100 Set value = 0, Hysteresis = 0	18
S.=	Input data = 50, 100 Set value = 0	16
S.>=	Input data = 50, 100 Set value = 0, Hysteresis = 0	18
S.<=	Input data = 50, 100 Set value = 0, Hysteresis = 0	18
S.AT1	Set value pattern = 3(Without cascade) Tracking bit = 0 Execution cycle = 1 Executed during loop run in MAN mode	67

Appendix 3.2 Operation processing time of 2-degree-of-freedom PID control loop

This section gives an example of the operation constant of each instruction and the processing times taken when actual values are stored into the loop tag memory.

(1) Loop type and used instructions

(a) Loop type: S2PID

(b) Used instructions: S.IN, S.PHPL, S.2PID, S.OUT1

(2) Operation constants

(a) S.IN instruction

Name	Item	Setting
Engineering conversion upper limit	EMAX	100.0
Engineering conversion lower limit	EMIN	0.0
Input upper limit	NMAX	100.0
Input lower limit	NMIN	0.0
Upper limit range error occurrence	HH	95.0
Upper limit range error return	H	80.0
Lower limit range error return	L	20.0
Lower limit range error occurrence	LL	5.0

(b) S.PHPL instruction: Without operation constant

(c) S.2PID instruction

Name	Item	Setting
Derivative gain	MTD	4.0
Deviation large alarm hysteresis	DVLS	3.0
Operation mode	PN	0
Tracking bit	TRK	0
Set value pattern	SVPTN	3

(d) S.OUT1 instruction

Name	Item	Setting
Output conversion upper limit	NMAX	100.0
Output conversion lower limit	NMIN	0.0

(3) Loop tag memory

Offset	Item	Name	Recommended range	Setting
+0	—	—	—	0
+1	MODE	Operation mode	0 to FFFFH	10H
+2	—	—	—	0
+3	ALM	Alarm detection	0 to FFFFH	0
+4	INH	Alarm detection inhibition	0 to FFFFH	0
+5	—	—	—	0
+6	—	—	—	0
+7	—	—	—	0
+8	—	—	—	0
+9	—	—	—	0
+10	PV	Process value	RL to RH	0.0
+12	MV	Manipulated value	-10 to 110	0.0
+14	SV	Set value	RL to RH	55.0
+16	DV	Deviation	-110 to 110	7
+18	MH	Output upper limit value	-10 to 110	100.0
+20	ML	Output lower limit value	-10 to 110	0.0
+22	RH	Engineering value upper limit	-999999 to 999999	100.0
+24	RL	Engineering value lower limit	-999999 to 999999	0.0
+26	PH	Upper limit alarm set value	RL to RH	80.0
+28	PL	Lower limit alarm value	RL to RH	20.0
+30	HH	Upper limit alarm value	RL to RH	90.0
+32	LL	Lower limit alarm value	RL to RH	10.0
+34	—	—	—	0
+36	—	—	—	0
+38	α	Filter coefficient	0 to 1	0.0
+40	HS	Upper/lower limit alarm hysteresis	0 to 999999	3.0
+42	CTIM	Change rate alarm check time	0 to 999999	8.0
+44	DPL	Change rate alarm value	0 to 100	30.0
+46	CT	Control cycle	0 to 999999	1.0
+48	DML	Output change rate limit value	0 to 100	100.0
+50	DVL	Change rate limit value	0 to 100	25.0
+52	P	Gain	0 to 999999	3.0
+54	I	Integral constant	0 to 999999	8.0
+56	D	Derivative constant	0 to 999999	5.0
+58	GW	Gap width	0 to 100	15.0
+60	GG	Gap gain	0 to 999999	2.0
+62	MVP	MV inside operation value	-999999 to 999999	0.25
+64	α	2-degree-of-freedom parameter α	0 to 1	0.0
+66	β	2-degree-of-freedom parameter β	0 to 1	1.0

(4) Processing time

(a) Processing times of used instructions

- S.IN : 69μs
- S.PHPL : 100μs
- S.2PID : 135μs
- S.OUT1 : 44μs

(b) Processing time of loop type

- S2PID : 348μs

MEMO

App - 21

INDEX

Index - 1

Index - 2

Index - 3

WARRANTY

Please confirm the following product warranty details before starting use.

1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the dealer or Mitsubishi Service Company. Note that if repairs are required at a site overseas, on a detached island or remote place, expenses to dispatch an engineer shall be charged for.

[Gratis Warranty Term]

The gratis warranty term of the product shall be for one year after the date of purchase or delivery to a designated place.

Note that after manufacture and shipment from Mitsubishi, the maximum distribution period shall be six (6) months, and the longest gratis warranty term after manufacturing shall be eighteen (18) months. The gratis warranty term of repair parts shall not exceed the gratis warranty term before repairs.

[Gratis Warranty Range]

(1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.

(2) Even within the gratis warranty term, repairs shall be charged for in the following cases.

1. Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.
2. Failure caused by unapproved modifications, etc., to the product by the user.
3. When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.
4. Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.
5. Failure caused by external irresistible forces such as fires or abnormal voltages, and Failure caused by force majeure such as earthquakes, lightning, wind and water damage.
6. Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.
7. Any other failure found not to be the responsibility of Mitsubishi or the user.

2. Onerous repair term after discontinuation of production

(1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued. Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.

(2) Product supply (including repair parts) is not possible after production is discontinued.

3. Overseas service

Overseas, repairs shall be accepted by Mitsubishi's local overseas FA Center. Note that the repair conditions at each FA Center may differ.

4. Exclusion of chance loss and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to damages caused by any cause found not to be the responsibility of Mitsubishi, chance losses, lost profits incurred to the user by Failures of Mitsubishi products, damages and secondary damages caused from special reasons regardless of Mitsubishi's expectations, compensation for accidents, and compensation for damages to products other than Mitsubishi products and other duties.

5. Changes in product specifications

The specifications given in the catalogs, manuals or technical documents are subject to change without prior notice.

6. Product application

(1) In using the Mitsubishi MELSEC programmable logic controller, the usage conditions shall be that the application will not lead to a major accident even if any problem or fault should occur in the programmable logic controller device, and that backup and fail-safe functions are systematically provided outside of the device for any problem or fault.

(2) The Mitsubishi general-purpose programmable logic controller has been designed and manufactured for applications in general industries, etc. Thus, applications in which the public could be affected such as in nuclear power plants and other power plants operated by respective power companies, and applications in which a special quality assurance system is required, such as for Railway companies or National Defense purposes shall be excluded from the programmable logic controller applications.

Note that even with these applications, if the user approves that the application is to be limited and a special quality is not required, application shall be possible.

When considering use in aircraft, medical applications, railways, incineration and fuel devices, manned transport devices, equipment for recreation and amusement, and safety devices, in which human life or assets could be greatly affected and for which a particularly high reliability is required in terms of safety and control system, please consult with Mitsubishi and discuss the required specifications.

HEADQUARTERS

MITSUBISHI ELECTRIC EUROPE B.V. — EUROPE
German Branch
Gothaer Straße 8
D-40880 Ratingen
Phone: +49 (0) 2102 / 486-0
Fax: +49 (0) 2102 / 486-1120
e mail: megfamail@meg.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — FRANCE
French Branch
25, Boulevard des Bouvets
F-92741 Nanterre Cedex
Phone: +33 1 55 68 55 68
Fax: +33 1 55 68 56 85
e mail: factory.automation@fra.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — IRELAND
Irish Branch
Westgate Business Park, Ballymount
IRL-Dublin 24
Phone: +353 (0) 1 / 419 88 00
Fax: +353 (0) 1 / 419 88 90
e mail: sales.info@meir.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — ITALY
Italian Branch
Via Paracelso 12
I-20041 Agrate Brianza (MI)
Phone: +39 039 6053 1
Fax: +39 039 6053 312
e mail: factory.automation@it.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — SPAIN
Spanish Branch
Carretera de Rubí 76-80
E-08190 Sant Cugat del Vallés
Phone: +34 9 3 / 565 3131
Fax: +34 9 3 / 589 2948
e mail: industrial@sp.mee.com

MITSUBISHI ELECTRIC EUROPE B.V. — UK
UK Branch
Travellers Lane
GB-Hatfield Herts. AL10 8 XB
Phone: +44 (0) 1707 / 27 61 00
Fax: +44 (0) 1707 / 27 86 95
e mail: automation@meuk.mee.com

MITSUBISHI ELECTRIC CORPORATION — JAPAN
Office Tower "Z" 14 F
8-12,1 chome, Harumi Chuo-Ku
Tokyo 104-6212
Phone: +81 3 6221 6060
Fax: +81 3 6221 6075

MITSUBISHI ELECTRIC AUTOMATION — USA
500 Corporate Woods Parkway
Vernon Hills, IL 60061
Phone: +1 847 / 478 21 00
Fax: +1 847 / 478 22 83

MIDDLE EAST REPRESENTATIVE

TEXEL Electronics Ltd. — ISRAEL
Box 6272
IL-42160 Netanya
Phone: +972 (0) 9 / 863 08 91
Fax: +972 (0) 9 / 885 24 30
e mail: texel_me@netvision.net.il

EUROPEAN REPRESENTATIVES

GEVA — AUSTRIA
Wiener Straße 89
AT-2500 Baden
Phone: +43 (0) 2252 / 85 55 20
Fax: +43 (0) 2252 / 488 60
e mail: office@geva.at

TEHNIKON — BELARUS
Oktjabrskaya 16/5, Ap 704
BY-220030 Minsk
Phone: +375 (0)17 / 22 75 704
Fax: +375 (0)17 / 22 76 669
e mail: tehnikon@belsonet.net

Getronics b.v. — BELGIUM
Control Systems
Pontbeeklaan 43
B-1731 Asse-Zellik
Phone: +32 (0) 2 / 467 17 51
Fax: +32 (0) 2 / 467 17 45
e mail: infoautomation@getronics.com

TELECON CO. — BULGARIA
4, A. Ljapchev Blvd.
BG-1756 Sofia
Phone: +359 (0) 2 / 97 44 05 8
Fax: +359 (0) 2 / 97 44 06 1
e mail: —

INEA CR d.o.o. — CROATIA
Drvinje 63
HR-10000 Zagreb
Phone: +385 (0) 1 / 36 67 140
Fax: +385 (0) 1 / 36 67 140
e mail: —

AutoCont — CZECH REPUBLIC
Control Systems s.r.o.
Nemocnicni 12
CZ-702 00 Ostrava 2
Phone: +420 59 / 6152 111
Fax: +420 59 / 6152 562
e mail: consys@autocont.cz

louis poulsen — DENMARK
industri & automation
Geminivej 32
DK-2670 Greve
Phone: +45 (0) 70 / 10 15 35
Fax: +45 (0) 43 / 95 95 91
e mail: lpia@lpmail.com

UTU Elektrotehnika AS — ESTONIA
Pärnu mnt.160i
EE-11317 Tallinn
Phone: +372 (0) 6 / 51 72 80
Fax: +372 (0) 6 / 51 72 88
e mail: utu@utu.ee

Beijer Electronics OY — FINLAND
Ansatie 6a
FIN-01740 Vantaa
Phone: +358 (0) 9 / 886 77 500
Fax: +358 (0) 9 / 886 77 555
e mail: info@beijer.fi

UTECO A.B.E.E. — GREECE
5, Mavrogenous Str.
GR-18542 Piraeus
Phone: +302 (0) 10 / 42 10 050
Fax: +302 (0) 10 / 42 12 033
e mail: sales@uteco.gr

Meltrade Automatika Kft. — HUNGARY
55, Harmat St.
HU-1105 Budapest
Phone: +36 (0)1 / 2605 602
Fax: +36 (0)1 / 2605 602
e mail: office@meltrade.hu

SIA POWEL — LATVIA
Lienes iela 28
LV-1009 Riga
Phone: +371 784 / 22 80
Fax: +371 784 / 22 81
e mail: utu@utu.lv

EUROPEAN REPRESENTATIVES

UAB UTU POWEL — LITHUANIA
Savanoriu pr. 187
LT-2053 Vilnius
Phone: +370 (0) 52323-101
Fax: +370 (0) 52322-980
e mail: powel@utu.lt

INTEHSIS SRL — MOLDOVA
Cuza-Voda 36/1-81
MD-2061 Chisinau
Phone: +373 (0)2 / 562 263
Fax: +373 (0)2 / 562 263
e mail: intehsis@mdl.net

Getronics b.v. — NETHERLANDS
Control Systems
Donauweg 2 B
NL-1043 AJ Amsterdam
Phone: +31 (0) 20 / 587 67 00
Fax: +31 (0) 20 / 587 68 39
e mail: info.gia@getronics.com

Beijer Electronics AS — NORWAY
Teglverksveien 1
N-3002 Drammen
Phone: +47 (0) 32 / 24 30 00
Fax: +47 (0) 32 / 84 85 77
e mail: info@beijer.no

MPL Technology Sp. z o.o. — POLAND
ul. Sliczna 36
PL-31-444 Kraków
Phone: +48 (0) 12 / 632 28 85
Fax: +48 (0) 12 / 632 47 82
e mail: krakow@mpl.pl

Sirius Trading & Services srl — ROMANIA
Str. Biharia No. 67-77
RO-013981 Bucuresti 1
Phone: +40 (0) 21 / 201 1146
Fax: +40 (0) 21 / 201 1148
e mail: sirius@siriustrading.ro

INEA d.o.o. — SLOVENIA
Stegne 11
SI-1000 Ljubljana
Phone: +386 (0) 1-513 8100
Fax: +386 (0) 1-513 8170
e mail: inea@inea.si

Beijer Electronics AB — SWEDEN
Box 426
S-20124 Malmö
Phone: +46 (0) 40 / 35 86 00
Fax: +46 (0) 40 / 35 86 02
e mail: info@beijer.se

ECONOTEC AG — SWITZERLAND
Postfach 282
CH-8309 Nürensdorf
Phone: +41 (0) 1 / 838 48 11
Fax: +41 (0) 1 / 838 48 12
e mail: info@econotec.ch

GTS — TURKEY
Darülaceze Cad. No. 43 Kat. 2
TR-80270 Okmeydani-Istanbul
Phone: +90 (0) 212 / 320 1640
Fax: +90 (0) 212 / 320 1649
e mail: gts@turk.net

CSC Automation Ltd. — UKRAINE
15, M. Raskova St., Fl. 10, Office 1010
UA-02002 Kiev
Phone: +380 (0) 44 / 238-83-16
Fax: +380 (0) 44 / 238-83-17
e mail: csc-a@csc-a.kiev.ua

EUROPEAN REPRESENTATIVES

Avtomatika Sever Ltd. — RUSSIA
Lva Tolstogo St. 7, Off. 311
RU-197376 St Petersburg
Phone: +7 812 / 11 83 238
Fax: +7 812 / 11 83 239
e mail: as@avtsev.spb.ru

CONSYS — RUSSIA
Promyshlennaya St. 42
RU-198099 St Petersburg
Phone: +7 812 / 325 36 53
Fax: +7 812 / 147 20 55
e mail: consys@consys.spb.ru

Electrotechnical Systems Siberia — RUSSIA
Partizanskaya St. 27, Office 306
RU-121355 Moscow
Phone: +7 095/ 416-4321
Fax: +7 095/ 416-4321
e mail: info@eltechsystems.ru

Electrotechnical Systems Siberia — RUSSIA
Shetinkina St. 33, Office 116
RU-630088 Novosibirsk
Phone: +7 3832 / 22-03-05
Fax: +7 3832 / 22-03-05
e mail: info@eltechsystems.ru

Elektrostyle — RUSSIA
ul. Garschina 11
RU-140070 Moscow
Phone: +7 095 / 514 9316
Fax: +7 095 / 514 9317
e mail: info@estl.ru

Elektrostyle — RUSSIA
Krasnij Prospekt 220-1
Office No. 312
RU-630049 Novosibirsk
Phone: +7 3832 / 10 66 18
Fax: +7 3832 / 10 66 26
e mail: info@estl.ru

ICOS — RUSSIA
Industrial Computer Systems Zao
Ryazanskij Prospekt 8a, Office 100
RU-109428 Moscow
Phone: +7 095 / 232 - 0207
Fax: +7 095 / 232 - 0327
e mail: mail@icos.ru

NPP Uralelektra — RUSSIA
ul. Sverdlova 11a
RU-620027 Ekaterinburg
Phone: +7 34 32 / 53 27 45
Fax: +7 34 32 / 53 27 45
e mail: elektra@etel.ru

SSMP Rosgidromontazh Ltd. — RUSSIA
23, Lesoparkovaya Str.
RU-344041 Rostov On Don
Phone: +7 8632 / 36 00 22
Fax: +7 8632 / 36 00 26
e mail: —

STC Drive Technique — RUSSIA
ul. Bajkalskaja 239, Office 2 - 23
RU-664075 Irkutsk
Phone: +7 3952 / 24 38 16
Fax: +7 3952 / 23 02 98
e mail: privod@irk.ru

STC Drive Technique — RUSSIA
Poslannikov Per. 9, str.1
RU-107005 Moscow
Phone: +7 095 / 790-72-10
Fax: +7 095 / 790-72-12
e mail: info@privod.ru

AFRICAN REPRESENTATIVE

CBI Ltd. — SOUTH AFRICA
Private Bag 2016
ZA-1600 Isando
Phone: +27 (0) 11/ 928 2000
Fax: +27 (0) 11/ 392 2354
e mail: cbi@cbi.co.za