YAMATAKE

No. CP-UM-1680E

Digitronik
Digital Indicating Controller
SDC40B

User's Manual

Computational Functions

This manual explains the computational units of the SC40B in detail and also serves as an instrumentation design guide in that it gives control computation examples.
Control computational functions can be loaded onto the SDC40B according to the application being used. We strongly urge that this manual be read by persons responsible for equipment design utilizing the SDC40B, as well as those involved in creating control programs.

Yamatake Corporation

RESTRICTIONS ON USE

When using this product in applications that require particular safety or when using this product in important facilities, pay attention to the safety of the overall system and equipment. For example, install fail-safe mechanisms, carry out redundancy checks and periodic inspections, and adopt other appropriate safety measures as required.

IMPORTANT

The manual gives the most common application examples. Each application differ in the concepts involved and the combinations required. The combinations given in the manual are therefore only a guide to the capabilities of the instrument.
Yamatake Corporation shall not be held liable for any damage that may arise from the use of the examples given in this manual.

REQUEST

Make sure that this User's Manual is handed over to the user before the product is used.

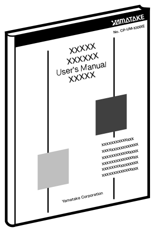
Copying or duplicating this User's Manual in part or in whole is forbidden. The information and specifications in this User's Manual are subject to change without notice.

Considerable effort has been made to ensure that this User's Manual is free from inaccuracies and omissions.
If you should find any inaccuracies or omissions, please contact Yamatake Corporation.

In no event is Yamatake Corporation liable to anyone for any indirect, special or consequential damages as a result of using this product.

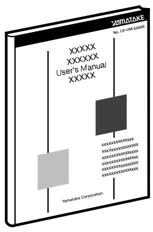
The Role of This Manual

In all, three manuals have been prepared for the SDC40B. Read the manual according to your specific requirements. The following lists all the manuals that accompany the SDC40B and gives a brief outline of the manual. If you do not have the required manual, contact Yamatake Corporation or your dealer.



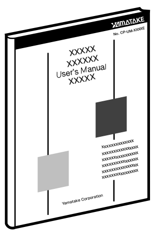
User's Manual: Basic Operations **Manual No.CP-UM-1679E**

This manual is provided with the SDC40B unit. We strongly urge persons responsible for device design, operations, and maintenance on the SDC40B read this manual. It describes how to mount the unit to an operation console or other location, wire and configure the unit; it also contains maintenance and inspection information, troubleshooting tips and specifications.



User's Manual: Computational Functions (This manual)
Manual No.CP-UM-1680E

This is the manual you are now reading. We strongly urge persons responsible for device design and control programming development on the SDC40B read this manual. Control computational functions can be loaded onto the SDC40B according to the application being used. This manual explains computational expressions in detail. It also serves as an instrumentation design guide in that it contains control computational examples.



User's Manual: DigitroniK CPL Communications
SDC40B **Manual No.CP-UM-1683E**

We strongly urge persons using the SDC40B CPL Communications functions read this manual. This manual overviews CPL communications, and explains wiring and communications procedures. It also provides a list of communications data for the SDC40B, troubleshooting measures, and communications specifications.

Organization of This User's Manual

This manual is organized as follows.

Chapter 1. COMPUTATIONAL UNITS

This chapter provides detailed descriptions o how each computational expression is processed.

Chapter 2. USING COMPUTATIONAL UNITS

This chapter describes combinations of computational units using standard procedures.

Chapter 3. APPLICATION EXAMPLES

This chapter offers examples of applications utilizing the SDC40B and how to develop design sheets.

Chapter 4. PRECISION

This chapter gives the precision of each computational expression.

Chapter 5. DATA SHEETS

This chapter provides data sheets that can be photocopies as required.

Conventions Used in This Manual

The following conventions are used in this manual.

◆Important : The preceded by "**◆Important**" alerts the reader to points of note when operating the unit.

◇Note : Text preceded by "**◇Note**" alerts the reader to supplementary explanations or reference materials.

Contents

Chapter 5. DATA SHEETS

Chapter 1. Computational Units

1-1 General

The DigitroniK SDC40B is a general-purpose, single-loop controller designed to control temperatures, pressures, flow rates, levels, pH values and other varying physical conditions. It combines PID control and about 80 auxiliary functions in a single unit which can be assigned to as many as 50 computational units. This chapter gives detailed descriptions of computation processing.

■ Data formats of input lines used for computational expressions

○ : % data
● : time data
⊗ : flag (ON/OFF) data
◇ : index (1, 2 and similar numeric values) data
◎ : composite (%, time, flag or index) data

■ Computation time

The computation times given below are absolute numbers and do not have units. The total operation time of all computational units and the input processing time is calculated, and the use or non-use of communication options is monitored to determine SDC40B processing cycle time.

Code	Processing cycle time	Allowable processing time (an absolute number)	
		Without CPL	With CPL
1	0.1 sec	110	90
2	0.2 sec	260	220
3	0.3 sec	410	350
4	0.4 sec	560	480
5	0.5 sec	710	610

Refer to 5-5, “Computation Processing Functions” in Chapter 5 in Basic Operations (Manual No. CP-UM-1679E or CP-UM-1699E) for further information on how the computation processing cycle is determined.

■ Dynamic area

This indicates the extent of RAM used by a computational expression.

N: No RAM is used.

L: Indicates that a large amount of RAM is used. Thus up to 8 computational units with an “L” in their “Dynamic area” column can be used.

S: Indicates that a small amount of RAM is used. Thus up to 20 computational units with an “S” in their “Dynamic area” column can be used.

Using combinations of “L” and “S” computational units does not reduce the total number of either type that can be simultaneously used.

■ Computational overflow check

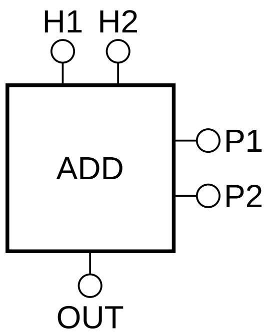
Computational units with “Computational overflow check” in the “Remarks” column can be moved to IM (interlock manual) mode when an overflow occurs.

Refer to Section 5-7, “Modes” in Chapter 5 in Basic Operations (Manual No. CP-UM-1679E or CP-UM-1699E) for details.

1-2 Computational Expressions

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
1	Addition	ADD	3	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	100.0
OUT	○	% format	−999.9 to 999.9	—

Computation

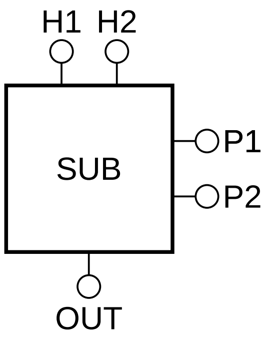
Computational expression:

$OUT = H1 \times P1 + H2 \times P2$

$OUT < -999.9\%$ or $OUT > 999.9\%$ generates a computational overflow.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
2	Subtraction	SUB	3	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	100.0
OUT	○	% format	−999.9 to 999.9	—

Computation

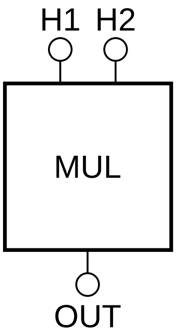
Computational expression:

$$OUT = H1 \times P1 - H2 \times P2$$

OUT $<$ −999.9% or OUT $>$ 999.9% generates a computational overflow.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
3	Multiplication	MUL	2	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

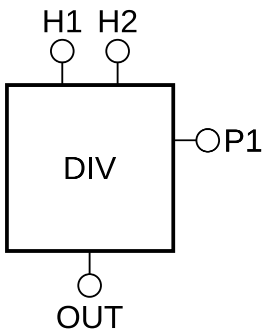
Computational expression:

OUT = H1 × H2

OUT < −999.9% or OUT > 999.9% generates a computational overflow.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
4	Division	DIV	3	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	100.0
H2	○	% format	−999.9 to 999.9	100.0
P1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

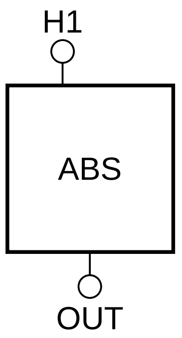
Computational expression:

OUT = (H1 ÷ H2) + P1

OUT < −999.9% or OUT > 999.9% generates a computational overflow.
When H2 is 0.0% and,
H1 is positive, OUT is 999.9%
H1 is negative, OUT is −999.9%
an overflow is generated.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
5	Absolute value	ABS	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	0.0 to 999.9	—

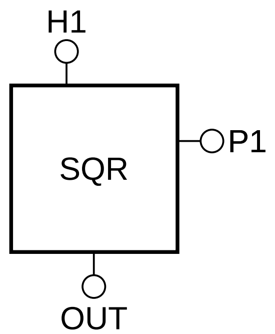
Computation

Computational expression:

$$OUT = |H1|$$

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
6	Square-root extraction	SQR	8	N	

Configuration

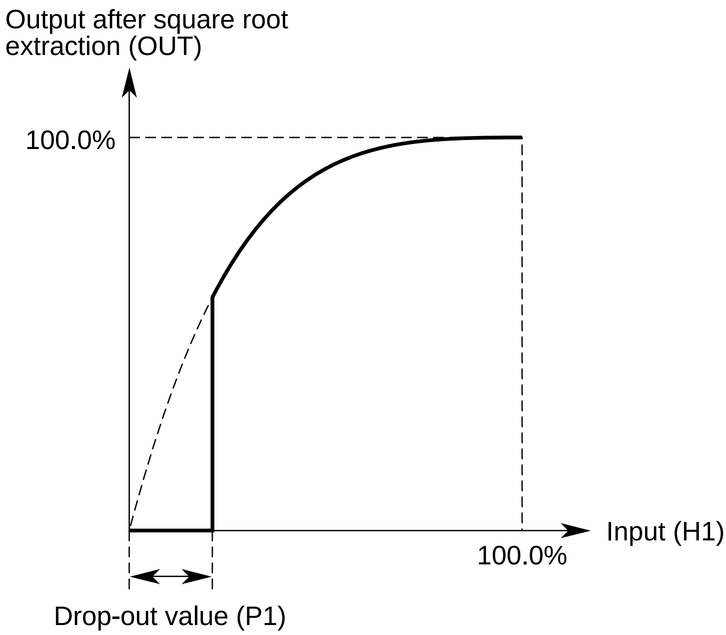


Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	0.0 to $\sqrt{10}$	—

Computation

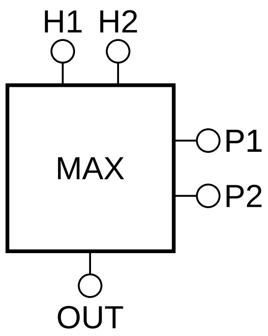
Computational expression:

P1 is the drop-out value.
P1 ≧ 0. When set to P1 < 0, P1 is assumed to be 0.
When H1 > P1, OUT is $\sqrt{H1}$
When H1 ≦ P1, OUT is 0.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
7	Maximum value	MAX	2	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

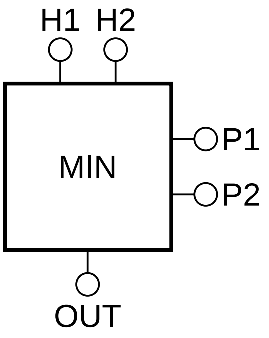
Computation

Computational expression:

OUT is the maximum value (H1, H2, P1, P2)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
8	Minimum value	MIN	2	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	100.0
H2	○	% format	−999.9 to 999.9	100.0
P1	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	100.0
OUT	○	% format	−999.9 to 999.9	—

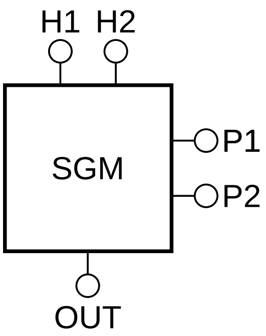
Computation

Computational expression:

OUT is the maximum value (H1, H2, P1, P2)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
9	4-point addition	SGM	2	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

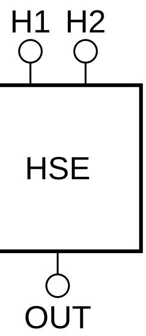
Computational expression:

OUT = H1 + H2 + P1 + P2

OUT < −999.9% or OUT > 999.9% generates a computational overflow.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
10	High selector (low limiter)	HSE	1	N	

Configuration



Input lines		Data format	Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	0.0

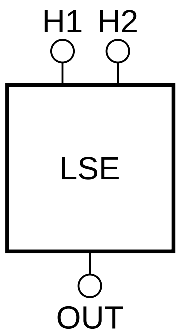
Computation

Computational expression:

When H1 ≧ H2, OUT is H1.
When H1 ＜ H2, OUT is H2.
When used as a low limiter, H2 is the low limit value.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
11	Low selector (high limiter)	LSE	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	100.0
H2	○	% format	−999.9 to 999.9	100.0
OUT	○	% format	−999.9 to 999.9	—

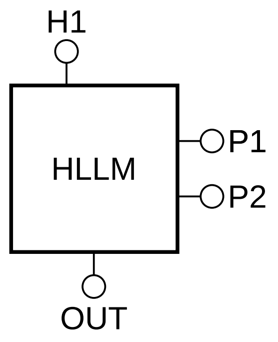
Computation

Computational expression:

When H1 ≧ H2, OUT is H2.
When H1 < H2, OUT is H1.
When used as a high limiter, H2 is the high limit value.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
12	High and low limiter	HLLM	2	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

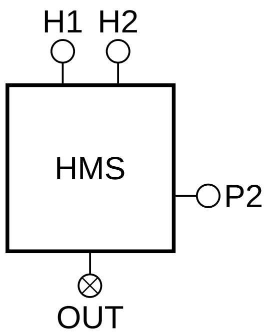
Computation

Computational expression:

When P1 is the high limiter and P2 is the low limiter, P1 ＞ P2.
When H1 ＞ P1, OUT is P1.
When H1 ＜ P1, OUT is P2.
When P1 ≧ H1 ≧ P2, OUT is H1.
When P1 ≦ P2 is set, OUT is P2.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
13	High monitor	HMS	2	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	100.0
H2	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

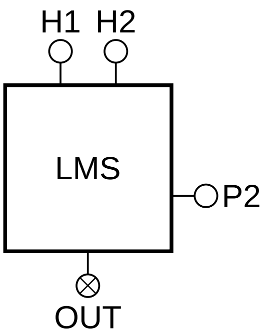
Computation

Computational expression:

H2 is the high monitor value and P2 is the hysteresis width setting.
$P2 \geqq 0$. When $P2 < 0$ is set, P2 is assumed to be 0.
When $H1 \geqq H2$, OUT is ON.
When $H1 < (H2 - P2)$, OUT is OFF.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
14	Low monitor	LMS	2	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

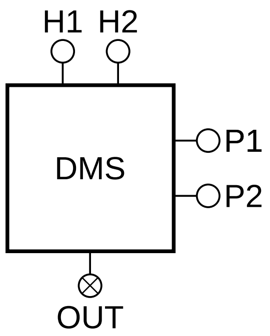
Computation

Computational expression:

H2 is the low monitor value and P2 is the hysteresis width setting.
$P2 \geqq 0$. When $P2 < 0$ is set, P2 is assumed to be 0.
When $H1 \leqq H2$, OUT is ON.
When $H1 > (H2 + P2)$, OUT is OFF.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
15	Deviation monitor	DMS	3	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	100.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

Computational expression:

The deviation between H1 and H2 is assessed using monitor setting value P1. P2 is the hysteresis width setting.

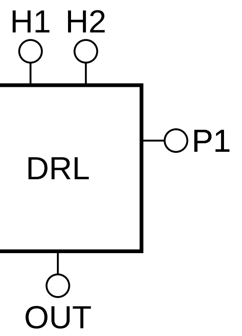
$P1 \geqq 0$; $P2 \geqq 0$. When $P1 < 0$ and $P2 < 0$, they are both assumed to be 0. When $P1 < P2$, OUT is always OFF.

When $|H1 - H2| \geqq P1$, OUT is ON.

When $|H1 - H2| < (P1 - P2)$, OUT is OFF.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
16	Deviation rate limiter	DRL	3	S	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

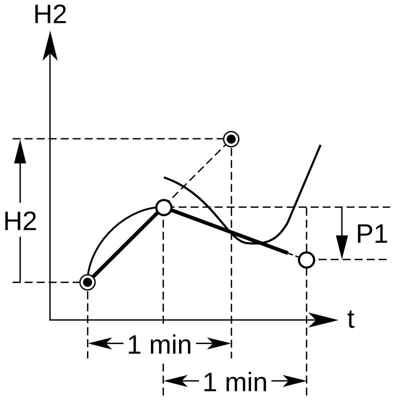
Computational expression:

Limits deviation rate per minute of input H1 to positive H2% and negative P1%.
H2 is the positive deviation rate limit.
(H2 $>$ 0. When H2 $\leqq$ 0, the positive deviation rate limit does not operate.)
P1 is the negative deviation rate limit.
(P1 $<$ 0. When P1 $\geqq$ 0, the negative deviation rate limit does not operate.)

When H1 $\leqq$ OUT $_{(-1)}$ $+$ H2' and H1 $\geqq$ OUT $_{(n-1)}$ + P1', OUT is H1.
When H1 $>$ OUT $_{(-1)}$ $+$ H2', OUT is OUT $_{(-1)}$ + H2'.
When H1 $<$ OUT $_{(-1)}$ $+$ P1', OUT is OUT $_{(-1)}$ + P1'.

H2': Converted computation cycle value of positive deviation rate limit setting value H2 ($>$ 0)
P1': Converted computation cycle value of negative deviation rate limit setting value P1 ($<$ 0)
OUT $_{(-1)}$: Previous output value

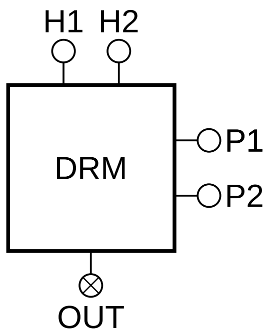
The limit operation is not available in initial state (during the first minute after starting).



◆**Important:** This deviation rate limiter does not check and limit deviation rates for each input computation cycle.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
17	Deviation rate monitor	DRM	5	L	

Configuration



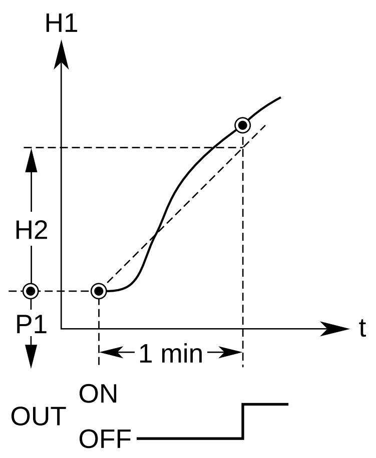
Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
P2	○	% format	−999.9 to 999.9	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

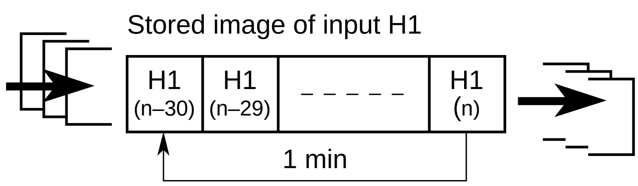
Computation

Computational expression:

Output is asserted when input H1 exceeds positive H2% or drops below negative P1% compared to inputs made one minute earlier.
H2 is the positive deviation rate monitor value.
($H2 \geqq 0$. When $H2 < 0$, H2 is assumed to be 0.)
P1 is the negative deviation rate monitor value.
($P1 \leqq 0$. When $P1 > 0$, P1 is assumed to be 0.)
P2 is the hysteresis value.
($P2 \geqq 0$. When $P2 < 0$, P2 is assumed to be 0.
Conditions of $P2 < H2$ and $P2 < |P1|$ are required.)
$(H1 - H1_{(n)}) \geqq H2$ or when $(H1 - H1_{(n)}) \leqq P1$, OUT is ON.
When $(H1 - H1_{(n)}) < (H2 - P2)$ or $(H1 - H1_{(n)}) > (P1 + P2)$, OUT is OFF.

Since only 30 data items (every 2 seconds) can be stored in the dynamic area, H1 is actually the value of an input made between 59 to 61 seconds earlier.
The monitor operation is not available in initial state (during the first minute after starting).

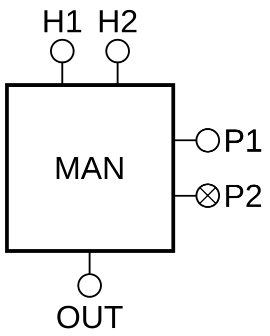




$H1_{(n)}$ is compared with $H1_{(n-30)}$.
Output is asserted when input H1 exceeds positive H2% or drops below negative P1%.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
18	Manual output	MAN	3	N	Only 1 unit can be used

Configuration

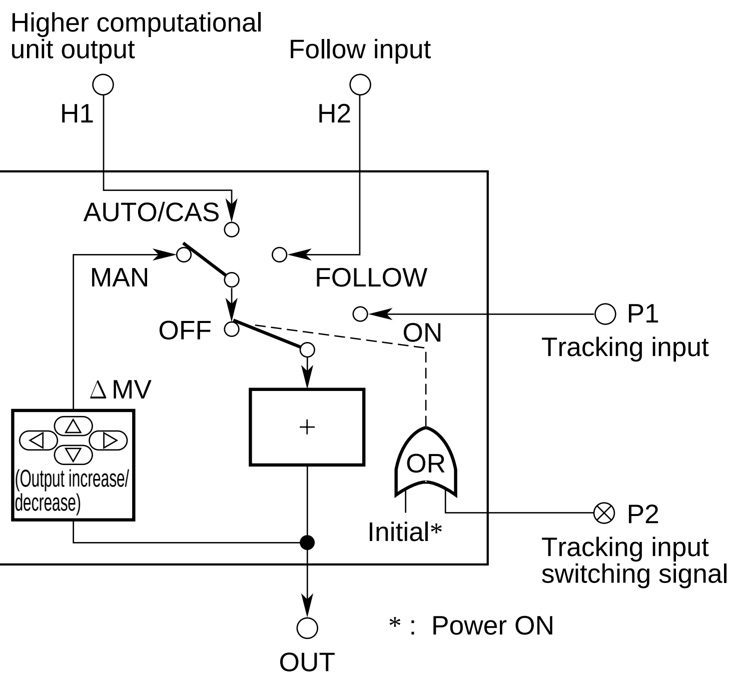


Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

Computation

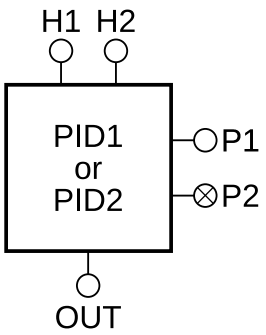
Computational expression:

H2 is the follow input.
P1 is the tracking input.
P2 is the tracking switch signal.
In manual mode (includes interlock manual mode), OUT is $OUT_{(-1)}$ + ΔMV
When P2 is ON or in initial state, OUT is P1 unconditionally.
In follow mode, OUT is H2.
In auto and cascade modes, OUT is H1.
ΔMV is justified using the ◁ and ▷ keys and manipulated with the △▽ keys when MMI is in the manual ouput setting state. When the △▽ keys are used, OUT is limited to the range −10.0 to 110.0% (up to that point H1 and H2 inputs are output in the range −999.9% to 999.9%).



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
19	Controller #1	PID1	36	N	Only 1 unit can be used
20	Controller #2	PID2			Constraints depending on controller type

Configuration



Input lines		Data format	Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	○	% format	−999.9 to 999.9	0.0
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

H1 is the remote setting signal and H2 is PV.
P1 is the tracking input and P2 is the tracking switching signal.
Each controller (PID1 or PID2) can be either of the following two PID computation types which are selected using the [control computational data (contl)] settings. Both PID computation types offer speed operations and the position output format.

- Normal PID (deviation derivative)
- Derivative-based (measured value derivative) PID

◆**Important:**

- AT (auto-tuning) and overshoot control and smart tuning for overshoot control and neural network tuning can be performed only in normal PID (deviation derivative). Derivative-based (measured value derivative) PID cannot be used for these functions or for the creation of a dead band.
- Computations are initialized according to the conditions listed in the table below.

Condition	Normal PID	Derivative-based PID
MAN mode	P.D item is deleted	P.D item is deleted
Mode change	$D_{(n)} = D_{(n-1)} = E_{(n)}$	$D_{(n)} = PV$, $V_{(n-1)} = V_{(n)}$
P2 = ON	$C_{(n)} =$ limit (P1)	$C_{(n)} =$ limit (P1)

Note: P1 is limited within the range –10.0 to +110.0%.

- LSP is limited to the range 0.0 to 100.0% during PV and RSP tracking.
- After ration and bias computations, RSP is limited to the range −10.0 to +110.0%.
- PV is limited to the range −10.0 to +110.0%

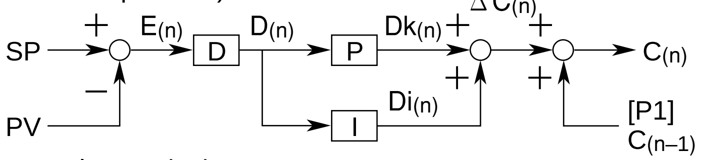
(continued)

Computation

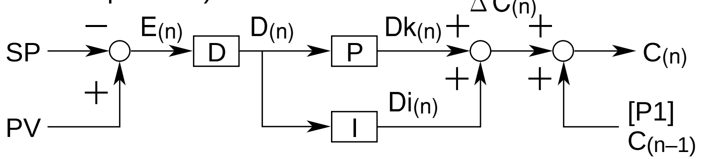
Normal PID:

Control block diagram

(Reverse operation)



(Normal operation)



Computational expression

- When P2 is ON, $C_{(n)} = [P1] + \Delta C_{(n)}$
- When P2 is OFF, $C_{(n)} = C_{(n-1)} + \Delta C_{(n)}$

$$\Delta C_{(n)} = \mathrm{PID}(SP, PV)$$

- $C_{(n)} = \dfrac{100}{PB}\left(1 + \dfrac{1}{TiS}\right)\left(\dfrac{1 + TcS}{1 + \frac{1}{8}TcS}\right)$

A conversion of the above equation gives the following.

$C_{(n)} = C_{(n-1)} + \Delta C_{(n)} = C_{(n-1)} + Dk_{(n)} + Di_{(n)}$

$\because \quad Dk_{(n)} = Kg \times (D_{(n)} - D_{(n-1)})$

$Di_{(n)} = Kig \times D_{(n)}$

$D_{(n)} = D_{(n-1)} + Kd\,(E_{(n)} - D_{(n-1)}) + Kd2\,(E_{(n)} - E_{(n-1)})$

PB = proportional band

Ti = integral time

Td = derivative time

$E_{(n)}$ = deviation

$D_{(n)}$ = derivative block output

$Dk_{(n)}$ = proportional block output

$Di_{(n)}$ = integrating block output

$C_{(n)}$ = control output

(n-1) = previous value of each (value of previous sample)

Ts = sampling time

$$Kg = \frac{100}{PB}, \; Kig = Kg\frac{Ts}{Ti}$$

$$Kd = \frac{Ts}{Ts + \frac{1}{8}Td}$$

$$Kd2 = \frac{Td}{Ts + \frac{1}{8}Td}$$

(The PID computational algorithm is equivalent to our SDC40A and operation A used by DCP550 instruments.)

(continued)

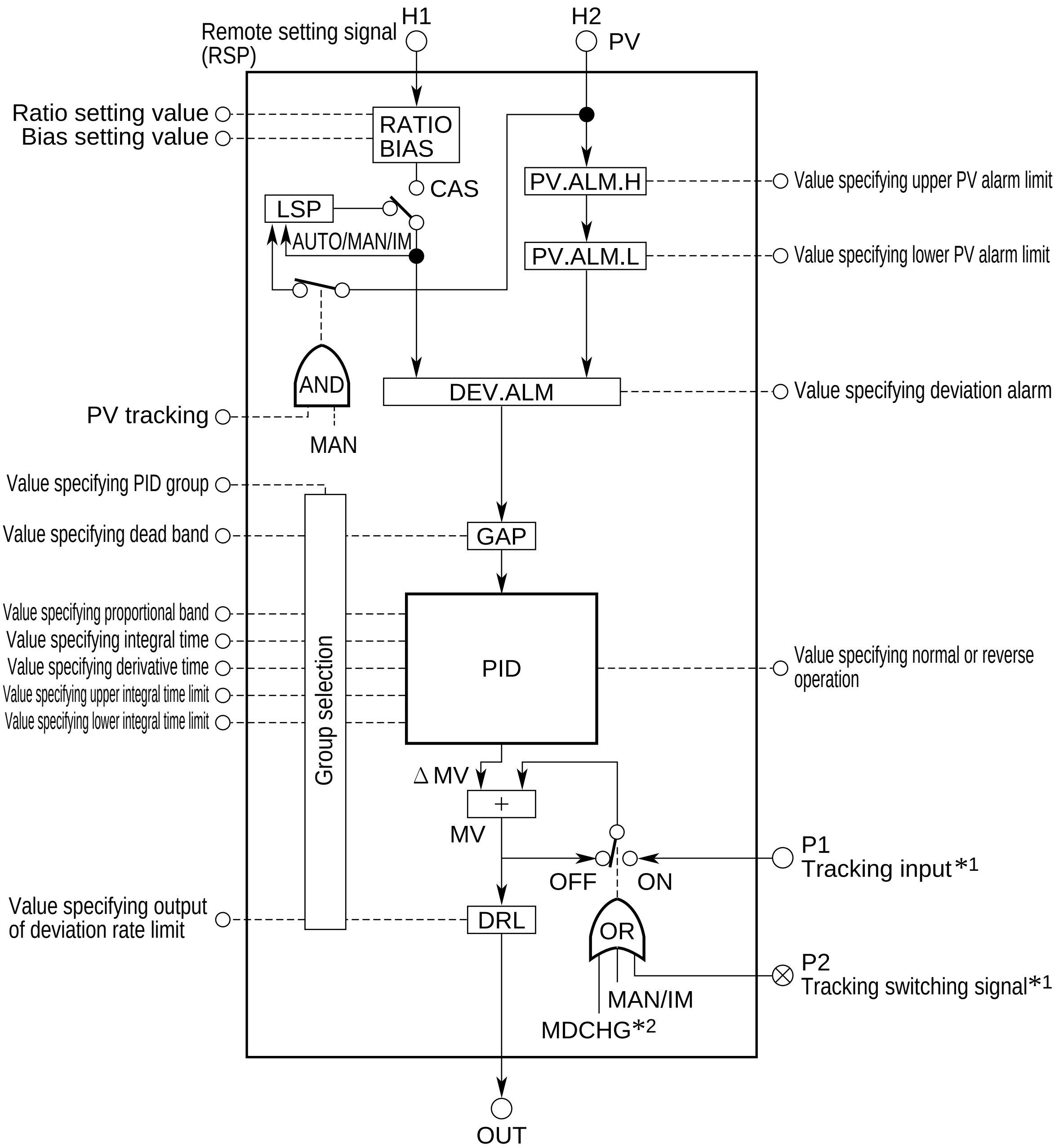
Computation

(Continued from previous page)

Normal PID control computation block

Normal PID performs derivative operations on deviations (SP–PV).

This type also allows creation of a dead band by setting a deviation level limit below which PID computation is not performed (held).



*1 : Used for configuring the auto-balance function.

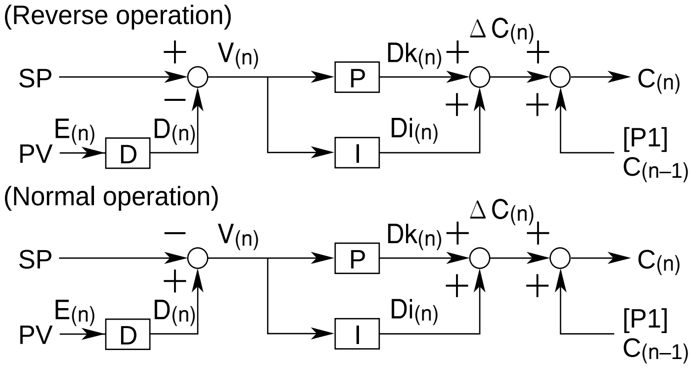
*2 : Mode change (Auto, Manual, Cascade, Follow, Interlock manual)

(continued)

Computation

Derivative-based PID:

Control block diagram



Computational expression

- When P2 is ON, $C_{(n)} = [P1] + \Delta C_{(n)}$
- When P2 is OFF, $C_{(n)} = C_{(n-1)} + \Delta C_{(n)}$

$$\Delta C_{(n)} = PID(SP, PV)$$

- $C_{(n)} = \frac{100}{PB}(1 + \frac{1}{TiS})\ \{SP - (\frac{1 + TdS}{1 + \frac{1}{8}TdS})\ PV\}$

A conversion of the above equation gives the following.

$$C_{(n)} = C_{(n-1)} + \Delta C_{(n)} = C_{(n-1)} + Dk_{(n)} + Di_{(n)}$$

$\because$ $Dk_{(n)} = Kg \times (V_{(n)} - V_{(n-1)})$

$Di_{(n)} = Kig \times V_{(n)}$

$V_{(n)} = SP - D_{(n)}$

$D_{(n)} = D_{(n-1)} + Kd\ (PV_{(n)} - D_{(n-1)})$

$+ Kd2\ (PV_{(n)} - PV_{(n-1)})$

PB = proportional band, Ti = integral time, Td = derivative time

$E_{(n)}$ = PV

$D_{(n)}$ = derivative block output

$Dk_{(n)}$ = proportional block output

$Di_{(n)}$ = integrating block output

$C_{(n)}$ = control output

(n-1) = previous value of each (value of previous sample)

Ts = sampling time

$$Kg = \frac{100}{PB},\ Kig = Kg\frac{Ts}{Ti}$$

$$Kd = \frac{Ts}{Ts + \frac{1}{8}Td}$$

$$Kd2 = \frac{Td}{Ts + \frac{1}{8}Td}$$

(The PID computational algorithm is equivalent to operation B used by our DCP550 instruments.)

(continued)

Computation

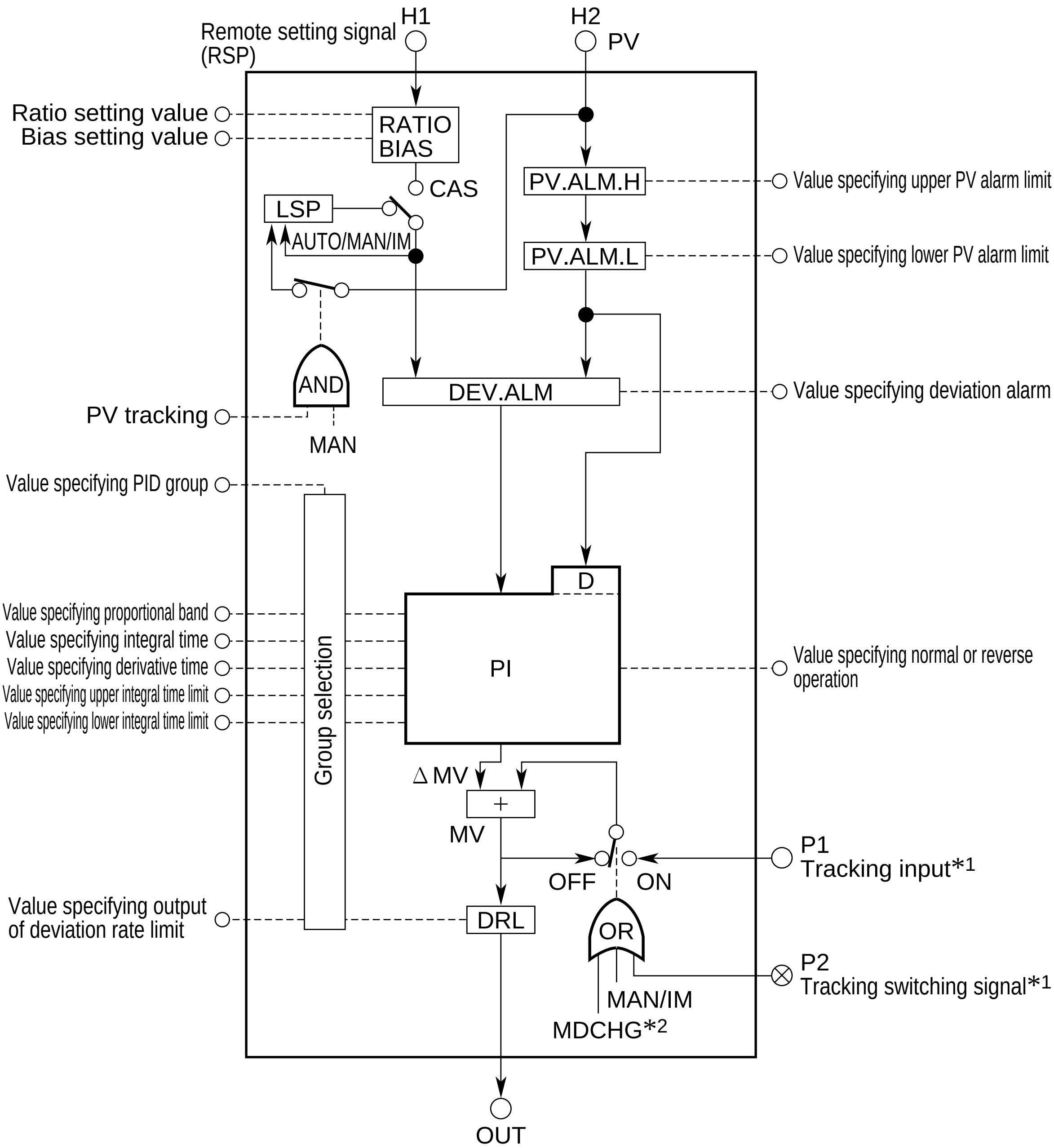
(Continued from previous page)

Derivative-based PID control computation block

Derivative-based PID performs only derivative operations on measured values (PV). It does not perform derivative operations on set values (SP).

In addition, the derivative-based PID has no dead band processing capability.

Smart tuning and neural network tuning cannot be executed to accomplish AT (auto-tuning) and overshoot suppression.

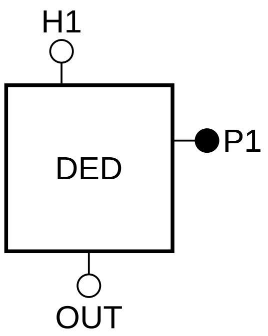


*1 : Used for configuring the auto-balance function.

*2 : Mode change (Auto, Manual, Cascade, Follow, Interlock manual)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
21	Dead time	DED	4	L	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
OUT	○	% format	−999.9 to 999.9	—

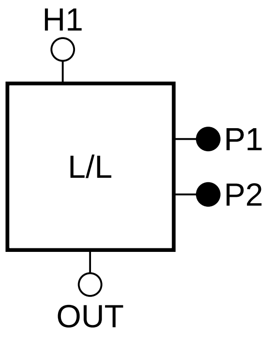
Computation

Computational expression:

Input H1 is output after the dead time, P1 seconds.
During initialization (P1 second period from start), OUT becomes H1.
P1 is dead time (seconds)
OUT $= e^{-P1 \cdot s} \times$ H1
Internal computations input data into the buffers of the 30 dynamic areas (P1/30) and shifts it between these buffers. Thus if the dead time setting is long, the output is performed staircase fashion. For example, if dead time P1 is set to 60 seconds, the output is changed only every 2 seconds since P1/30 is 2.
However, if the P1/30 is lower than the sampling time, the output changes every sampling time.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
22	Lead/lag	L/L	5	S	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
P2	●	Time format	0 to 6000.0	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

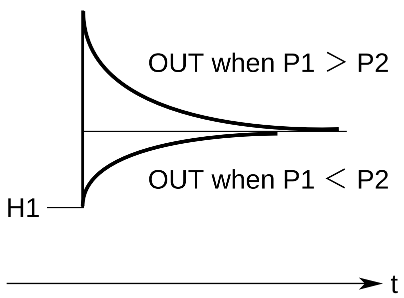
P1 is lead time (sec).
P2 is lag time (sec).

$$\text{OUT} = \frac{1 + \text{P1} \cdot \text{S}}{1 + \text{P2} \cdot \text{S}} \times \text{H1}$$

Internal computations calculate sampling time Ts, previous inputs and outputs, $\text{H1}_{(-1)}$ and $\text{OUT}_{(-1)}$ respectively according to the following equation.

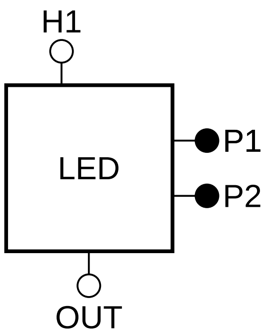
$$\text{OUT} = \text{OUT}_{(-1)} + \frac{\text{Ts}}{\text{Ts} + \text{P2}} \times (\text{H1} - \text{OUT}_{(-1)}) + \frac{\text{P1}}{\text{Ts} + \text{P2}} \times (\text{H1} - \text{H1}_{(-1)})$$

However, when P2 $<$ Ts, P2 is limited to Ts.
When P1 $>$ 16 x P2, P1 is automatically 16 $\times$ P2.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
23	Derivation	LED	5	S	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
P2	●	Time format	0 to 6000.0	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

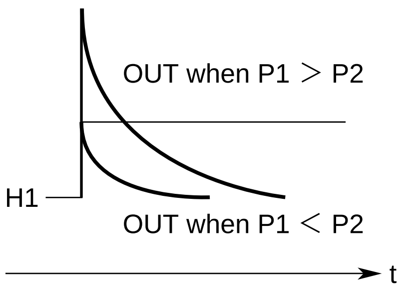
P1 is lead time (sec).
P2 is lag time (sec).

$$OUT = \frac{P1 \cdot S}{1 + P2 \cdot S} \times H1$$

Internal computations calculate sampling time Ts, previous inputs and outputs, $H1_{(-1)}$ and $OUT_{(-1)}$ respectively according to the following equation.

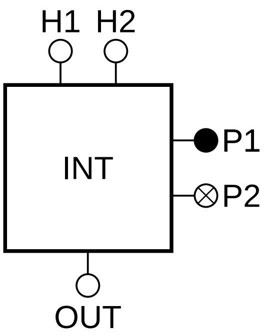
$$OUT = \frac{Ts}{Ts + P2} \times (H1 - OUT_{(-1)}) + \frac{P1}{Ts + P2} \times (H1 - H1_{(-1)})$$

However, when $P2 < Ts$, P2 is limited to Ts.
When $P1 > 16 \times P2$, P1 is automatically $16 \times P2$.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
24	Integration	INT	4	S	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

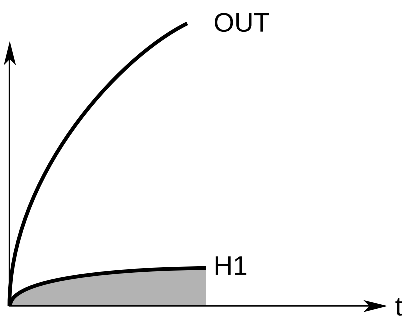
P1 is the integral time (sec).

When P2 is OFF, OUT is H2.

When P2 is ON, $OUT = \frac{H1}{P1 \cdot S}$

Internal computation: $OUT = OUT_{(-1)} + \frac{Ts}{P1} \times H1$

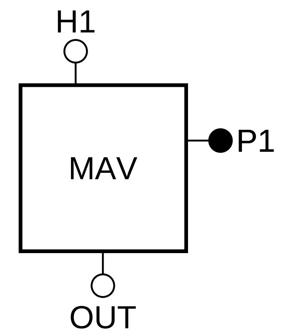
S: Laplacian
$OUT_{(-1)}$: Previous OUT value
Ts: Sampling value



◆Important: The resolution of computational units H1, H2 and OUT is 0.033%. Thus an error is generated if integration is performed on H1 or other inputs where meaning is assigned to digits below 0.1%.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
25	Moving average	MAV	11	L	

Configuration



Input lines		Data format	Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
OUT	○	% format	−999.9 to 999.9	—

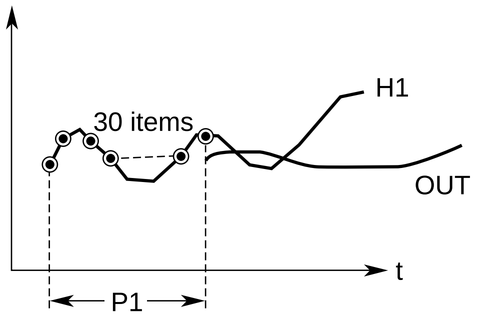
Computation

Computational expression:

This computational unit outputs the arithmetical mean of 30 data items from the start of P1 (sec).

$$OUT=\frac{1}{30}\sum_{i=1}^{30} H1\left(\frac{i}{30}P1\right)$$

However, when P1 is 0, OUT is H1.
When $P1 \leqq 30 \times Ts$, P1 is $30 \times Ts$. (Ts is the sampling time.)



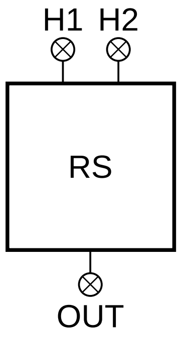
◆**Important:** When the P1 input changes greatly, maximum P1 time has to elapse before a moving average of P1 time can be calculated.

Example:

When H1 is 50.0%, P1 is 60.0 sec and H1 changes to 100.0% and P1 to 600.0 sec, the output does not change after 20 sec, but after 20 × n sec.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
26	Flip-flop	RS	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

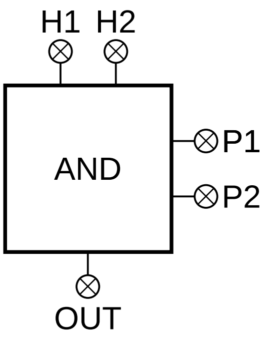
Computation

Computational expression:

This computational unit holds ON/OFF data for set input H1 and uses the H2 input to perform a reset.
When H2 is ON, OUT is unconditionally OFF.
When H2 is OFF and H1 is ON, OUT is ON.
When H1 is ON, OUT is ON.
During initialization OUT is OFF.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
27	Logical product	AND	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

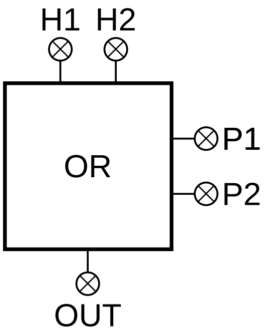
Computational expression:

This computational unit performs an AND operation on the four line ON/OFF data.

$OUT = H1 \wedge H2 \wedge P1 \wedge P2$

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
28	Logical OR	OR	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

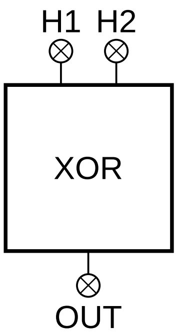
Computational expression:

This computational unit performs an OR operation on the four line ON/OFF data.

$OUT = H1 \vee H2 \vee P1 \vee P2$

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
29	Exclusive OR	XOR	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

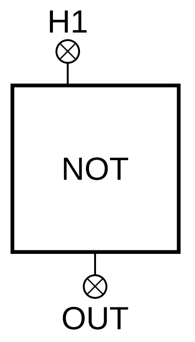
Computational expression:

This computational unit performs an XOR operation on the two line ON/OFF data.
OUT ＝ H1 ∀ H2

H1	H2	OUT
ON	ON	OFF
OFF	ON	ON
ON	OFF	ON
OFF	OFF	OFF

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
30	Invert	NOT	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

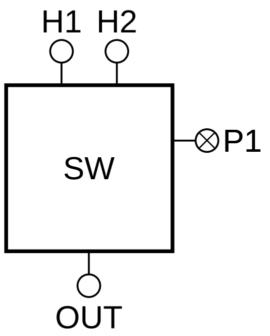
Computational expression:

This computational unit inverts the ON/OFF data.

$OUT = \overline{H1}$

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
31	2-position transfer switch	SW	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

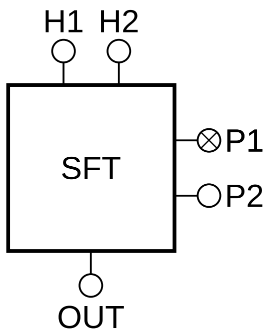
Computation

Computational expression:

This computational unit uses P1 to switch inputs H1 and H2.
When P1 is OFF, OUT is H1.
When P1 is ON, OUT is H2.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
32	Softening transfer switch	SFT	3	S	

Configuration

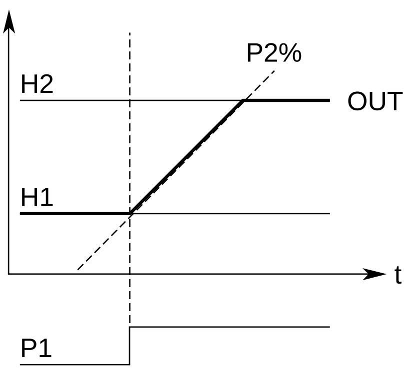


Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

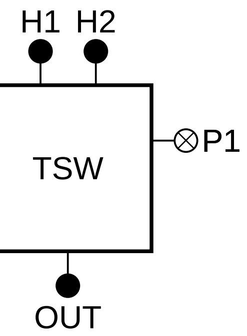
Computational expression:

This computational unit switches between H1 and H2 for one cycle using a P2 (%) slope for smooth switching when P1 rises.
When P1 goes from ON to OFF (when a trailing edge is detected), OUT goes from H2 to H1.
When P1 goes from OFF to ON (when a rising edge is detected), OUT goes from H1 to H2.
The P2 (%) slope loses its effect when it reaches H1 or H2.
When P1 is constantly OFF, OUT is H1.
When P1 is constantly ON, OUT is H2.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
33	Timer switch	TSW	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	●	Time format	0 to 6000.0	0.0
H2	●	Time format	0 to 6000.0	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	●	Time format	0 to 6000.0	—

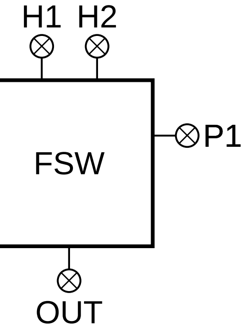
Computation

Computational expression:

This computational unit switches between H1 and H2 using P1 time data.
When P1 is OFF, OUT is H1.
When P1 is ON, OUT is H2.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
34	Flag switch	FSW	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	OFF

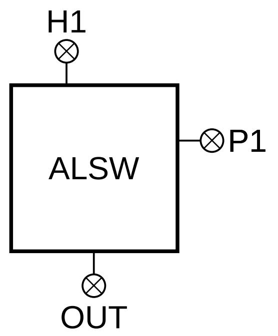
Computation

Computational expression:

This computational unit switches between H1 and H2 using P1 flag data.
When P1 is OFF, OUT is H1.
When P1 is ON, OUT is H2.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
35	Alternate switch	ALSW	2	S	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

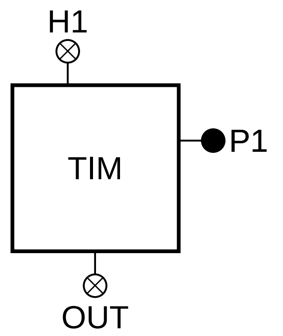
Computation

Computational expression:

This computational unit inverts the output when the rising edge of H1 is detected.
When P1 is ON, OUT is OFF.
When P1 is OFF, OUT is inverted when the rising edge of H1 is detected.
During initializing, OUT is OFF.
The trailing edge cannot be detected.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
36	Timer	TIM	2	S	

Configuration

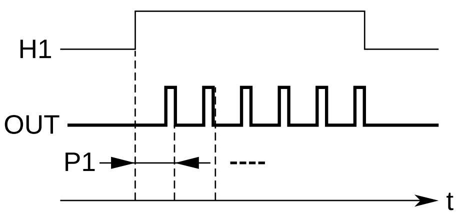


Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	●	Time format	0 to 6000.0	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

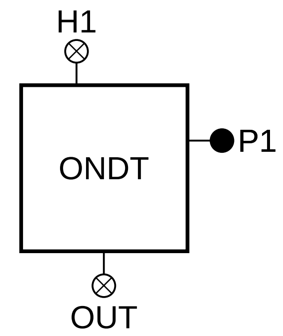
Computational expression:

This computational unit generates a pulse for P1 seconds.
The pulse width is the same as the computation cycle time.
When H1 is OFF, OUT is OFF (reset).
When H1 is ON, OUT generates a fixed cycle pulse;.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
37	On delay timer	ONDT	2	S	

Configuration

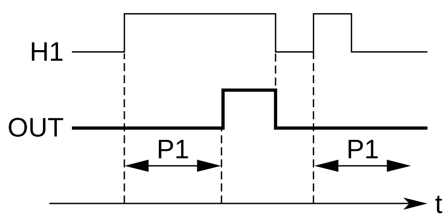


Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	●	Time format	0 to 6000.0	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

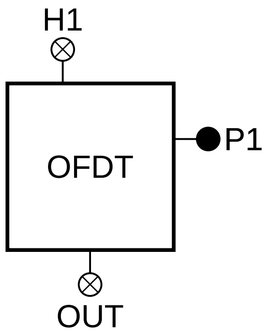
Computational expression:

When H1 changes to ON, OUT goes ON after P1 seconds.
When H1 changes to OFF, OUT goes OFF unconditionally.
Thus if H1 goes OFF before P1 seconds elapse, OUT stays OFF.
However, during initialization OUT is H1 and if H1 is ON, the delay does not operate with the result that the output goes ON.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
38	Off delay timer	OFDT	2	S	

Configuration

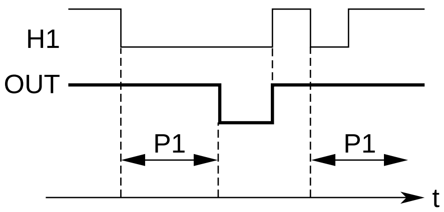


Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	●	Time format	0 to 6000.0	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

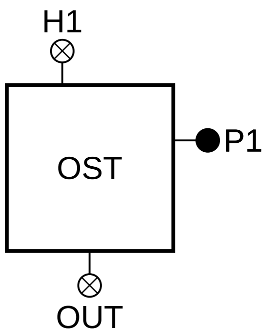
Computational expression:

When H1 changes to OFF, OUT goes OFF after P1 seconds.
When H1 changes to ON, OUT goes ON unconditionally.
Thus if H1 goes ON before P1 seconds elapse, OUT stays ON.
However, during initialization OUT is H1 and if H1 is OFF, the delay does not operate with the result that the output goes OFF.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
39	One-shot timer	OST	2	S	

Configuration

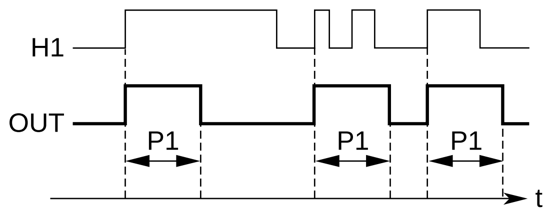


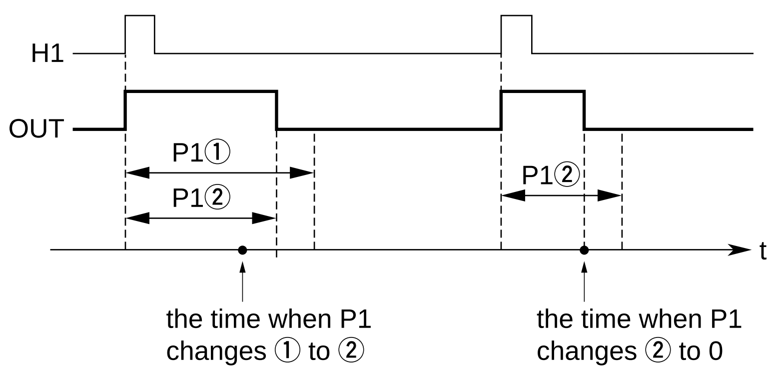
Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	●	Time format	0 to 6000.0	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

Computational expression:

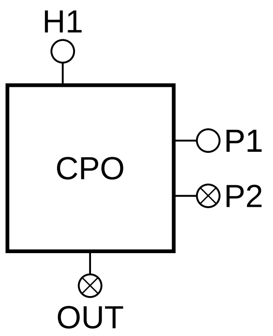
This computational unit outputs a pulse during pulse width P1 when the rising edge of H1 is detected. Since a second rising edge is not detected during pulse output, it cannot be retriggered and the pulse is output for P1 seconds from the time the first rising edge is detected. When OUT is ON and P1 changes, output pulse width changes.





No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
40	Integration pulse output I	CPO	4	S	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	100.0
P1	○	% format	−999.9 to 999.9	100.0
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

Computational expression:

This computational unit outputs input H1 percentage (%) data converted to pulse/hour.

OUT = 1000 × P1 × H1 (pulse/time)

The output pulse width is the same as the computation cycle.

When P2 is OFF, OUT goes OFF unconditionally.

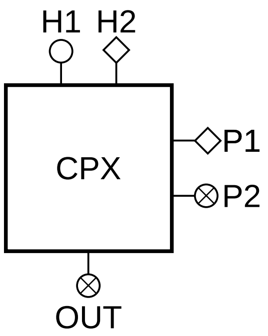
Example:

When H1 is a fixed input of 50.0% and P1 is set to P1 = 100.0%,
the OUT pulse is as follows:

OUT = 1000 × 1.000 × 0.500 = 500 (pulse/hour)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
41	Integration pulse output II	CPX	4	S	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	◇	Index format	0 to 30000	1
P1	◇	Index format	0 to 30000	1
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

Computational expression:

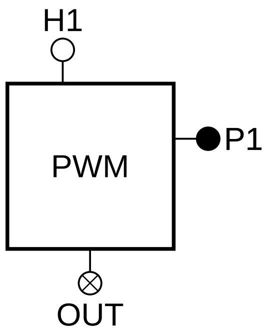
This computational unit performs integration on input H1 each computation cycle and outputs the number of pulses per hour corresponding to the integration range set by H2 and P1.
The output pulse width is the same as the computation cycle.
When P2 is ON, the internal integrating data is cleared.
The integrating range is set using index data H2 and P1. This index format does not display an index but integer data in the range 0 to 30000 used to set variable parameters (index format).
OUT = H1 × (H2/P1) (pulse/hour)
H2 is the input range (input range per hour)
P1 is the output pulse weight (weight of output pulse).

Example:

When H1 is a fixed input of H1 = 50.0%, H2 is 10000 and P1 is 100, the output is as follows:
OUT = H1 × (H2/P1)
= 0.500 × (10000 ÷ 100) = 50 (pulse/hour)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
42	Pulse width modulation	PWM	4	S	

Configuration



Input lines		Data format	Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
OUT	⊗	Flag format	ON = 1, OFF = 0	—

Computation

Computational expression:

P1 is the cycle time (sec).

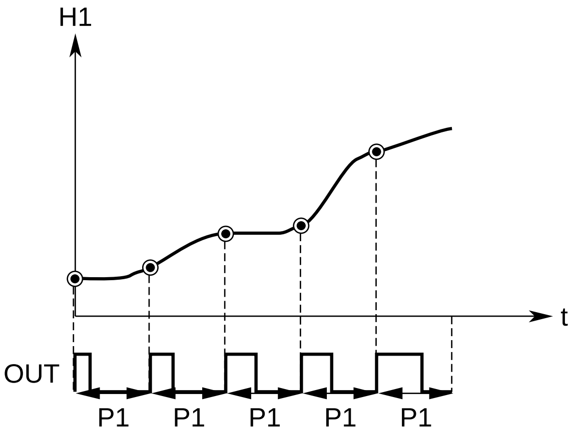
The frequency of OUT going ON during cycle P1 (sec) is proportional to input H1.

When H1 $\leqq$ 0% or P1 $<$ (2 $\times$ computation cycle), OUT is forced to OFF.

When H1 $\geqq$ 100%, OUT is forced to ON.

The resolution of ON/OFF is computation cycle/P1.

H1 is sampled once during the P1 cycle and an H1 change during the P1 cycle is ignored.



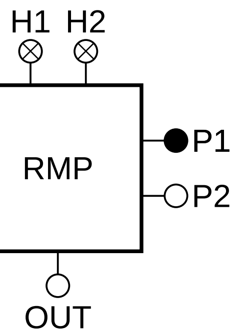
Example:

When the computation cycle is 0.1 sec and P1 is 10 sec,
the resolution is 0.1 ÷ 10 = 0.01 i.e. a resolution of 1%.

◆Important: This computational unit generates time proportional control which can be output to DO. However, note that attention is required in setting resolution, H1 sampling cycle and handling DO characteristics (relay outputs, open collector outputs and their service life).

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
43	Ramp signal generation	RMP	3	S	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	●	Time format	0 to 6000.0	0.0
P2	○	% format	−999.9 to 999.9	100.0
OUT	○	% format	−999.9 to 999.9	—

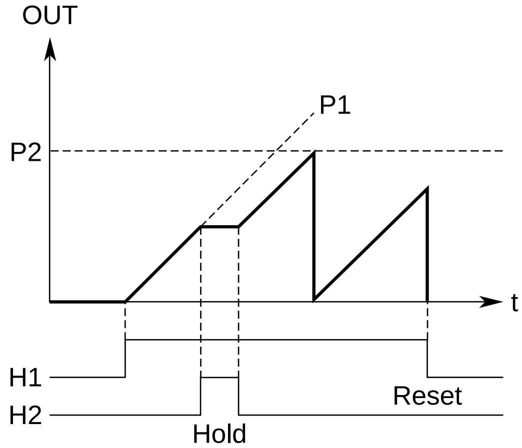
Computation

Computational expression:

When H1 is OFF, the output is reset and OUT becomes 0.0%.
When H2 is ON, the output is held.
Setting the time required for P1 to from 0.0% to 100.0%.
When P2 reaches the output value, it is automatically reset to 0.0% after which the output starts increasing again.

$$\text{Rate of increase} = \frac{100}{P1 \times 60} \quad (\%/\text{min})$$

Thus the time it takes to go from 0% to 100% is P1.

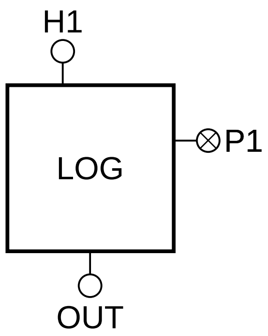


Example:

In a P1 setting of 10.0 (sec), it takes 10 minutes to go from 0% to 100% while it takes 120 minutes to do this when P1 is set to 120.0 (sec). Maximum slope is accomplished when P1 is set to 0.1 (sec) in which case 100% is reached in 0.1 min (6 sec). The increase per computation cycle is 100 ÷ (60 ÷ 5) or 8.333% at an computation cycle setting of 0.5 sec. Minimum slope is achieved when P1 is set to 6000.0 (sec) when 100% is reached in 6000 minutes (100 hours). The increase per computation cycle is 1/36000 or 0.000027778% at a computation cycle setting of 0.1 sec. Thus the internal computations use the floating point notation for higher precision, however, as the output is rounded off there is a discrepancy between the results of internal processing and data displayed on the unit monitor. For example, when P1 is 6000.0 (when an increase to 0.1% takes 6 minutes), the monitor will start from 0.0% but display a value of 0.05% as 0.1% (since 0.05% is rounded up to 0.1%) which will then seem to be reached in 3 minutes.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
44	Logarithm	LOG	8	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

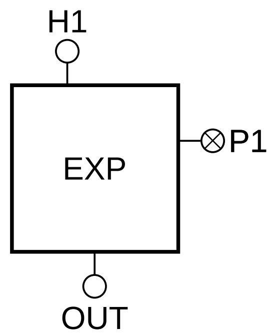
Computation

Computational expression:

When H1 ≦ 0, OUT is 0.
When P1 is OFF, OUT is LOG_{10} (H1).
When P1 is ON, OUT is LOG_e (H1).

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
44	Exponent	EXP	18	N	

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

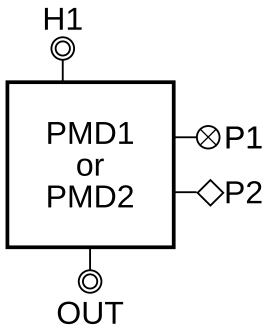
Computation

Computational expression:

When P1 is OFF, OUT is 10^{H1}. (When H1 ≧ 100 %, OUT is limited.)
When P1 is ON, OUT is e^{H1}. (When H1 ≧ 230 %, OUT is limited.)

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
51	Control variable change I	PMD1	8	N	No limit on numbers used
52	Control variable change II	PMD2			

Configuration



Input lines	Data format		Range	Initial value
H1	◎	Composite format	−999.9 to 6000.0	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	◇	Index format	1 to 17	1
OUT	◎	Composite format	−999.9 to 6000.0	—

Computation

Computational expression:

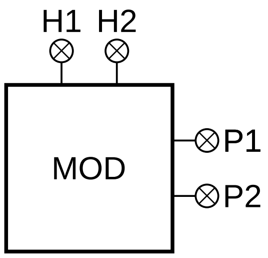
PMD1 changes PID1 control variables while PMD2 changes PID2 control variables. They interpret input H1 as a control variable specified by index data P2 and change the output depending on the state of P1 and the corresponding PID unit.
When P1 is OFF, control variables are not changed (OUT is the previously held value).
When P1 is ON, control variables are changed (OUT is H1).
When a control variable specified by P2 is either 2 : integral time or 3 : derivative time, time data has to be input to input line H1. When the specified control variable is 16 : PID group number, index data has to be connected to input line H1. In other cases percentage format (%) data has to be connected to input line H1.

◆Important: Make sure that the inputs are limited to the ranges listed below.

P2 exponent	Control variables	Input range
1	Proportional band	0.1 to 999.9 %
2	Integral Time	0.0 to 6000.0 sec
3	Derivative Time	0.0 to 6000.0 sec
4	Upper integral time limit	−200.0 to 200.0 %
5	Lower integral time limit	−200.0 to 200.0 %
6	Gap	0.0 to 100.0 %
7	Output rate of change limit	0.0 to 100.0 %
10	Ratio	−999.9 to 999.9 %
11	Bias	−999.9 to 999.9 %
12	Deviation monitor	0.0 to 100.0 %
13	Upper PV monitor limit	−10.0 to 110.0 %
14	Lower PV monitor limit	−10.0 to 110.0 %
16	PID group number	0 to 7
17	LSP	0.0 to 100.0 %

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
53	Mode select (status detection)	MOD	2	N	Only one unit can be used

Configuration



Input lines		Data format	Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	⊗	Flag format	ON = 1, OFF = 0	OFF

Computation

Computational expression:

This computational unit changes instrument modes (follow, cascade, auto and manual).

H1 is follow mode.
When ON, the follow mode is selected.
When OFF, follow mode is canceled.

H2 is manual mode.
When ON, the manual mode is selected.

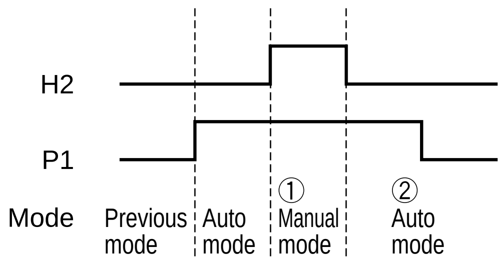
P1 is auto-mode.
When ON, the auto-mode is selected.

P2 is cascade mode.
When ON, the cascade mode is selected.

When H2, P1 and P2 are all ON, the following priority is observed: H2 > P1 > P2. When all are OFF, the previous state is held.

Example:

When H2 goes ON after the auto mode was activated by P1 going ON, the manual mode is activated (①). When subsequently H2 goes OFF, the auto mode is reactivated (as long as P1 is still ON) (②).

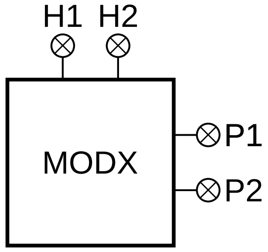


◆**Important:**

- Only one unit of this computational expression can be used and edge detection (no. 54) cannot be used to change modes.
- The mode switching keys (MAN, AUTO and CAS) are not available.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
54	Mode select (edge detection)	MODX	2	N	Only one unit can be used

Configuration



Input lines		Data format	Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	⊗	Flag format	ON = 1, OFF = 0	OFF

Computation

Computational expression:

This computational unit changes instrument modes (follow, cascade, auto and manual).

H1 is follow mode.

When ON, the follow mode is selected.

When OFF, follow mode is canceled.

H2 is manual mode.

When H2 goes from OFF to ON, the manual mode is selected.

P1 is auto-mode.

When P1 goes from OFF to ON, the auto-mode is selected.

P2 is cascade mode.

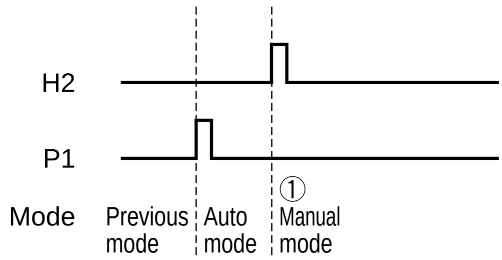
When P2 goes from OFF to ON, the cascade mode is selected.

Lines other than H1 use edge detection. Thus the instrument will go from the present mode to a new mode when a rising edge is detected.

When H2, P1 and P2 are all ON, the following priority is observed: H2 > P1 > P2. When all are OFF, the previous state is held.

Example:

When H2 goes from OFF to ON after the auto mode was activated by P1 going from OFF to ON, the manual mode is activated (①). If H2 subsequently goes OFF, the instrument stays in the manual mode (②).

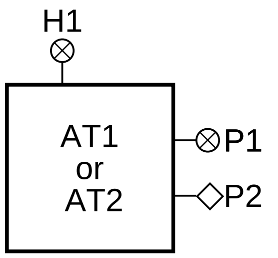


◆**Important:**

- Only one unit of this computational expression can be used and status detection (no. 53) cannot be used to change modes.
- The mode switching keys (MAN, AUTO and CAS) are not available. These keys can be made available through input of internal mode switching signals (MKY, AKY and CKY) to the input lines.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
55	Auto-tuning start/stop 1	AT1	1	N	Only one unit can be used
56	Auto-tuning start/stop 2	AT2			

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	◇	Index format	0 to 30000	1

Computation

Computational expression:

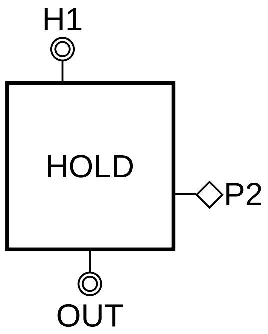
AT1 computational unit performs auto-tuning on PID1 unit.
AT2 computational unit performs auto-tuning on PID2 unit.
H1 starts auto-tuning (edge detection)
  Auto-tuning starts when H1 goes from OFF to ON.
P1 stops auto-tuning.
  When P1 goes OFF, auto-tuning stops unconditionally (and does not start again.)
P2 specifies the auto-tuning startup mode.
  0: does not start up
  1: normal auto-tuning
  2: auto-tuning protected from overshoots
  3: neural network auto-tuning

◆Important:

- Auto-tuning is performed according to the limit cycle. The lower limit on a PID unit output (OUT) is 0% and the upper limit is 100%. The output can be limited during auto-tuning by connecting a high and low limiter after the PID unit. However, since auto-tuning is based on a limit cycle of 0 ⟷ 100%, the written PID parameters will not operate optimally and manual adjustment is required.
- When this unit is used, the auto-tuning key (AT) on the instrument is disabled. It can be enabled by inputting an internal signal (ATKY) via the input line.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
57	Data hold	HOLD	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	◎	Composite format	−999.9 to 3600.0	0.0
P2	◇	Index format	0 to 30000	1
OUT	◎	Composite format	−999.9 to 3600.0	—

Computation

Computational expression:

H1 is interpreted as data format specified by index data P2. H1 data or status persist outages and is output when the system is restarted.

When RAM backup is normal,

OUT is the HOLD value for 1 cycle at restart.

OUT is H1 from second cycle after restart.

When RAM backup fails,

OUT is H1 for 1 cycle at restart.

P2 specifies the data format of input H1.

1: percentage format

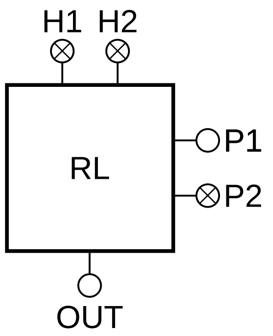
2: time format

3: flag format

4: index format

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
58	Raise/lower unit	RL	3	S	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
H2	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	○	% format	−999.9 to 999.9	0.0
P2	⊗	Flag format	ON = 1, OFF = 0	OFF
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

When H1 is ON (raise), the output increases.
When H2 is ON (lower), the output decreases.

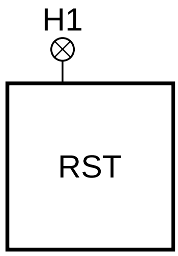
When H1 is ON and H2 is OFF, OUT = $OUT_{(-1)} + \Delta$
When H1 is OFF and H2 is ON, OUT = $OUT_{(-1)} - \Delta$
When H1 and H2 are ON, OUT = $OUT_{(-1)}$
When H1 and H2 are OFF, OUT = $OUT_{(-1)}$
When P2 is OFF, $OUT_{(-1)}$ is the previous OUT value, but at the first time of cold start, $OUT_{(-1)}$ is 0.0 %.
When P2 is ON, $OUT_{(-1)}$ is P1 value.

There are two speeds for the raise/lower process.

Less than one second after H1 or H2 goes ON	$\Delta = 0.1$ %
1 second or longer after H1 or H2 goes ON	$\Delta = 10 \times Ts$ %

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
59	Reset	RST	1	N	

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF

Computation

Computational expression:

This computational unit cancels the interlock function.

When H1 is OFF, no operation is performed (control is unaffected).

When H1 is ON, the interlock function is canceled when the following conditions are met.

① When the sensor check does not turn up any input errors.

② When no computation time overloads are generated.

③ When no overflows have occurred.

◆**Important:** The conditions for going to the interlock manual mode are specified at setup. (The initial value is 0.)

0: the mode is not invoked

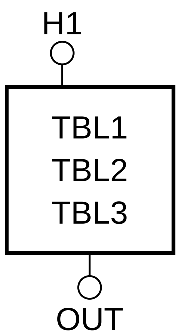
1: invokes the mode when memory related error occurs

2: invokes the mode when memory related or analog input error occurs

3: invokes the mode when memory related, analog input or a computation error occurs

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
61	Linearization table 1	TBL1	8	N	
62	Linearization table 2	TBL2			
63	Linearization table 3	TBL3			

Configuration

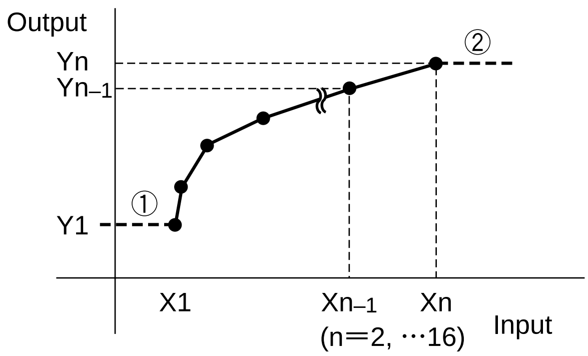


Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

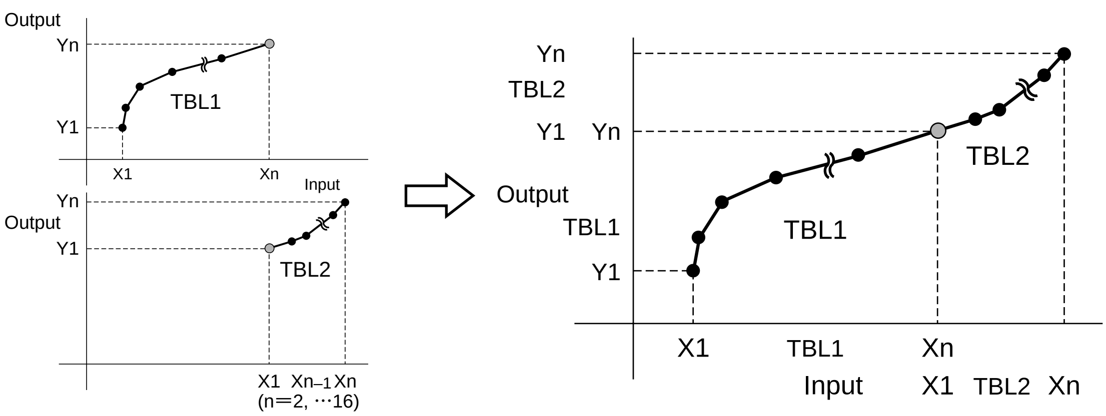
Computation

Computational expression:

These tables consist of an X1 and Y1 origin and 15 segments (16 points) which are used for converting (approximation by linearization table) X (H1: input) to Y (OUT: output).
The X and Y axes can be both positive or negative.
When H1 ≦ X1, OUT is Y1 …①
When H1 ≧ X (last point), OUT is Y (last point) …②

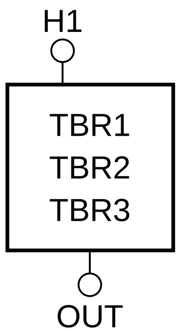


Two or more linearization tables can be chained to form a single table. To join two tables, place X1 on the second table over X16 of the first table (see below). Thus X (last point) must be less than X1 in the second table.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
64	Inverse linearization tables 1	TBR1	8	N	
65	Inverse linearization tables 2	TBR2			
66	Inverse linearization tables 3	TBR3			

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

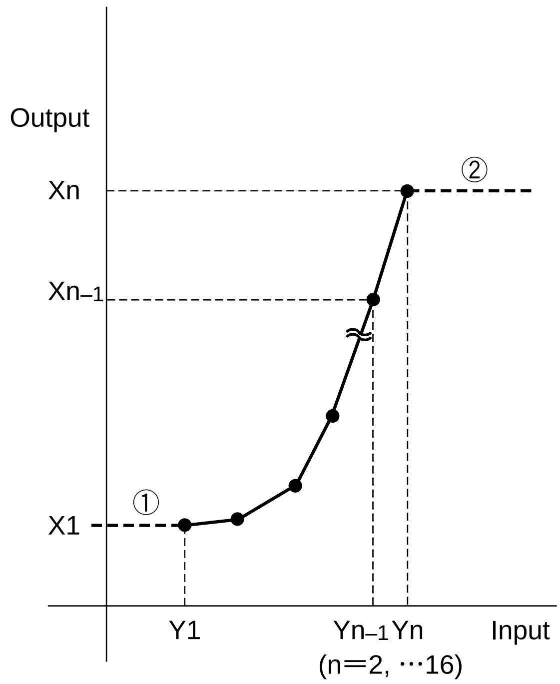
Computation

Computational expression:

These tables consist of an X1 and Y1 origin and 15 segments (16 points) which are used for converting (approximation by linearization table) Y (H1: input) to X (OUT: output). The X and Y axes can be both positive or negative.

When H1 ≦ Y1,
OUT ＝ X1 …①

When H1 ≧ Y (last point),
OUT ＝ X (last point) …②

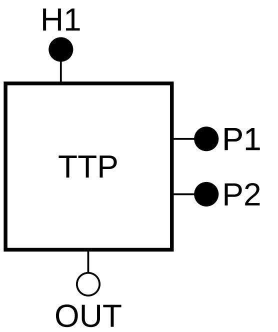


Two or more linearization tables can be chained to form a single table. To join two tables, place Y1 on the second table over Y16 of the first table (see below). Thus Y (last point) must be less than Y1 in the second table.

◆**Important:** Linearization and inverse linearization tables #1, #2 and #3 can be used together. When both types of table are used to make one table, the conditions $X_{n+1} > X_n$ and $Y_{n+1} > Y_n$ must be met to allow correct conversion between normal and inverse conversions.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
67	Time → % conversion	TTP	2	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	●	Time format	0 to 6000.0	0.0
P1	●	Time format	0 to 6000.0	0.0
P2	●	Time format	0 to 6000.0	0.0
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

This computational unit converts the time format of input H1 in a span where time format input P1 is the lower limit and P2 is the upper limit to the percentage (%) format.

$$OUT = \frac{H1 - P1}{P2 - P1}$$

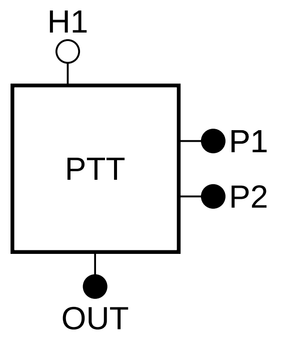
Example:

P1 is 0.0 sec.
P2 is 600.0 sec.
When H1 is 300.0, OUT is 0.5 (50.0%).

When P1 − P2 is 0, the sign of H1 − P1 causes OUT to become ±999.9% and overflow.
However, when H1 − P1 is 0, OUT is 0.0% and no overflow is generated.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
68	% → Time conversion	PTT	2	N	Computational overflow check

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	●	Time format	0 to 6000.0	0.0
P2	●	Time format	0 to 6000.0	0.0
OUT	●	Time format	0 to 6000.0	—

Computation

Computational expression:

This computational unit converts the percentage (%) format of input H1 in a span where time format input P1 is the lower limit and P2 is the upper limit to the time format.

$$OUT = H1 \times (P2 - P1) + P1$$

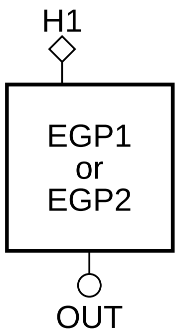
Example:

P1 is 0.0 sec.
P2 is 600.0 sec.
When H1 is 50% (0.5), OUT is 300.0 sec.

When the result of the computation is negative, OUT is 0.0 sec and an overflow is generated.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
69	Engineering unit parameter selection 1	EGP1	1	N	Only one unit can be used
70	Engineering unit parameter selection 2	EGP2			

Configuration



Input lines	Data format		Range	Initial value
H1	◇	Index format	0 to 30000	0
OUT	○	% format	−999.9 to 999.9	—

Computation

Computational expression:

This computational unit performs internal computations in the percentage (%) format. The use of engineering units is limited to the operator and directly related PV and SP indications and settings. These units are automatically converted to the percentage format in the course of internal computations. However, engineering units cannot be used to set multi-SP, high monitors or low monitors so the user has to convert these to the percentage format which is time-consuming. The engineering unit parameter selection and engineering unit parameter setting (E. PARA) have been provided to cope with this problem. Engineering unit parameters (E PARA) set by the engineering units and whose numbers are specified by index format input H1 are converted to the percentage format by the engineering unit parameter selection unit. In the conversion from engineering units to the percentage format, the engineering unit decimal point position set by the input processing data setting (IN), lower limit and upper limit values (lower and upper limit span) are used as data in the conversion to convert engineering unit parameters (E. PARA) into the percentage format.

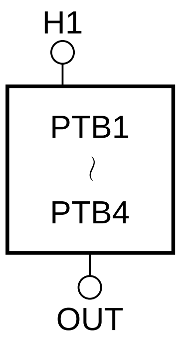
Engineering unit parameter setting (E. PARA)				Percentage format output after EGP selection	
No.	Item code	Item	Setting value	→	Percentage format
1	EP1-0	Engineering unit parameter PID1 related items	66.0U	①→	55.0%
2	EP1-1	Engineering unit parameter PID1 related items	70.5U	①→	58.75%
:	:	:	:	:	:
8	EP1-7	Engineering unit parameter PID1 related items	115.0U	①→	95.833···%
9	EP2-0	Engineering unit parameter PID2 related items	2.00U	②→	10.0%
10	EP2-1	Engineering unit parameter PID2 related items	6.48U	②→	32.4%
:	:	:	:	:	:
16	EP2-7	Engineering unit parameter PID2 related items	10.50U	②→	52.5%

①: These are settings using input processing data (IN [1]) involving decimal point position [1], lower limit [0.0] and upper limit [120.0]. For example (66 ÷ 120.0) × 100 = 55%, etc.
②: These are settings using input processing data (IN [2]) involving decimal point position [2], lower limit [0.0] and upper limit [20.00]. For example (2.00 ÷ 20.00) × 100 = 10.0%, etc.

EGP1 is used for PID1 units and EGP2 is used for PID2 units. The item code of the engineering units consists of 8 numbers from 0 to 8, so 0 is used in specifying indexes beyond 8 (1-0 or 2-0). Unused PID units can be combined with input processing data setting (IN) 4 to 6 to call up set values.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
81	% → % table #1	PTB1	5	N	
82	% → % table #2	PTB2			
83	% → % table #3	PTB3			
84	% → % table #4	PTB4			

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
OUT	○	% format	−999.9 to 999.9	—

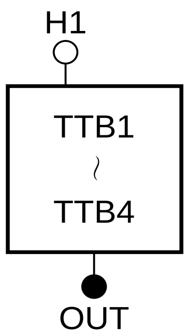
Computation

Computational expression:

These tables consist of an X1 and Y1 origin and 15 segments (16 points) which are used for converting (approximation by linearization table) X (H1 : input) to Y (OUT : output).
The X and Y axes can be both positive or negative. This function is identical to the linearization table function with the exception that tables cannot be chained.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
85	% → time table #1	TTB1	5	N	
86	% → time table #2	TTB2			
87	% → time table #3	TTB3			
88	% → time table #4	TTB4			

Configuration

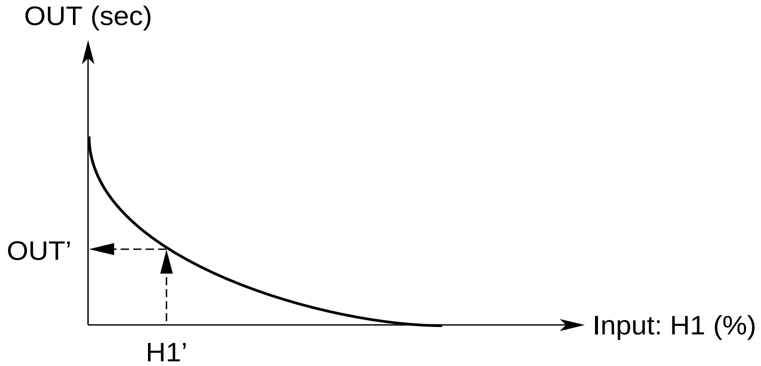


Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
OUT	●	Time format	0 to 6000.0	—

Computation

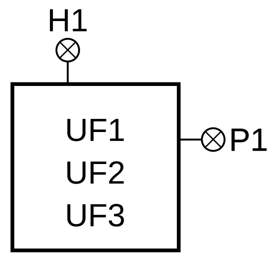
Computational expression:

This computational unit converts percentage (%) data to time data using a linearization table. Tables cannot be chained.



No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
91	User lamp output #1	UF1	1	N	Only one unit can be used
92	User lamp output #2	UF2			
93	User lamp output #3	UF3			

Configuration



Input lines	Data format		Range	Initial value
H1	⊗	Flag format	ON = 1, OFF = 0	OFF
P1	⊗	Flag format	ON = 1, OFF = 0	OFF

Computation

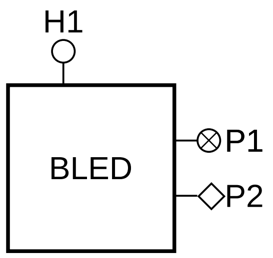
Computational expression:

This computational unit controls the UF display LED (user lamp) on the display panel.
When P1 is OFF, the lamps are OFF unconditionally.
When P1 is ON and H1 is also ON, the lamps are lit.
When P1 is ON but H1 is OFF, the lamp are not lit.

Units #1 to #3 correspond to UF1 to UF3 lamps.
When this unit is not used, the lamps are OFF.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
94	Bar graph display switch	BLED	2	N	Only one unit can be used

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
P1	⊗	Flag format	ON = 1, OFF = 0	OFF
P2	◇	Index format	0 to 30000	1

Computation

Computational expression:

This computational unit selects bar graph data using index data P2.

When P1 is OFF, the bar graph is OFF unconditionally.

When P1 is ON, P2 is 0 and the bar graph displays H1 %.

However, there is a limit of $0 \leqq H1 \leqq 100$.

When P1 is ON and P2 is 1, the bar graph displays DI.

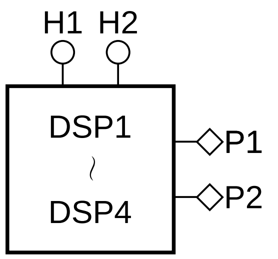
DI 1 to 12 are assigned to each LED from the left of the bar graph and the LEDs go ON when DI goes ON.

When P1 is ON and P2 is 2, the bar graph displays DO.

DO 1 to 8 are assigned to each LED from the left of the bar graph and the LEDs go ON when DO goes ON.

No.	Computational expression	Mnemonic	Computation time	Dynamic area	Remarks
95	Additional display unit #1	DSP1	4	N	Only one unit can be used
96	Additional display unit #2	DSP2			
97	Additional display unit #3	DSP3			
98	Additional display unit #4	DSP4			

Configuration



Input lines	Data format		Range	Initial value
H1	○	% format	−999.9 to 999.9	0.0
H2	○	% format	−999.9 to 999.9	0.0
P1	◇	Index format	0 to 30000	0
P2	◇	Index format	0 to 30000	0

Computation

Computational expression:

This computational unit adds normal display patterns that are displayed on display panel 1 (PV) and 2 (SP). Percentage (%) format input data H1 is converted according to engineering unit scaling with analog input numbers specified by index data P1. The data is displayed on display panel 1. Similarly, input H2 is converted according to engineering unit scaling with the analog input numbers specified by P2 and the data is displayed on display panel 2.

1 ≦ P1, P2 ≦ 6

(Data is displayed in the percentage format when 0 or a figure of 7 or more is specified.)

H1 and H2 are limited within the range −10.0 to 110.0% before scaling (however, −19999 or less is displayed as −19999).

Press the DISP key to cycle through displays #1 to #4 to add data to the normal display mode.

Chapter 2. Using Computational Units

2-1 Overview of Combinations

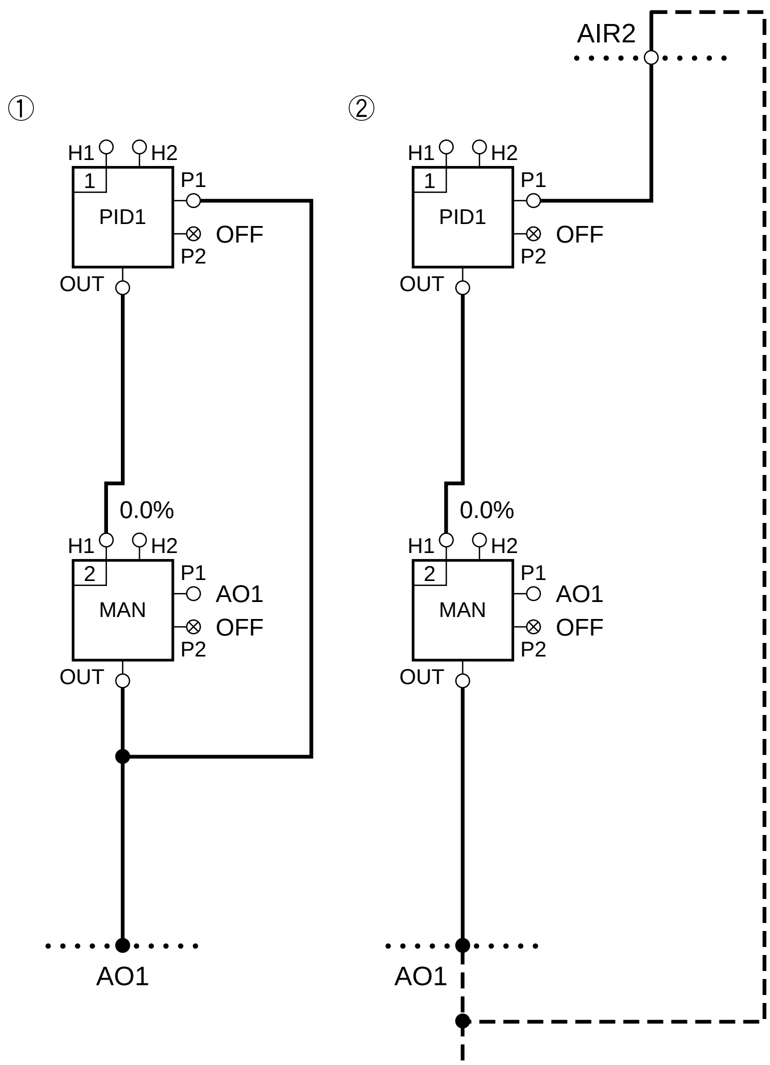
A great number of computations can be performed by combining different computational units. This chapter describes combinations of computational units using standard procedures as examples which can be used to build more complex configurations. For information on the meaning of internal signals and setting data, refer to SDC40B Basic Operations (Manual No. CP-UM-1679E or CP-UM-1699E).

2-2 Basic Combinations of Computational Units

Basic Combinations of MAN and PID units (with auto-balance)

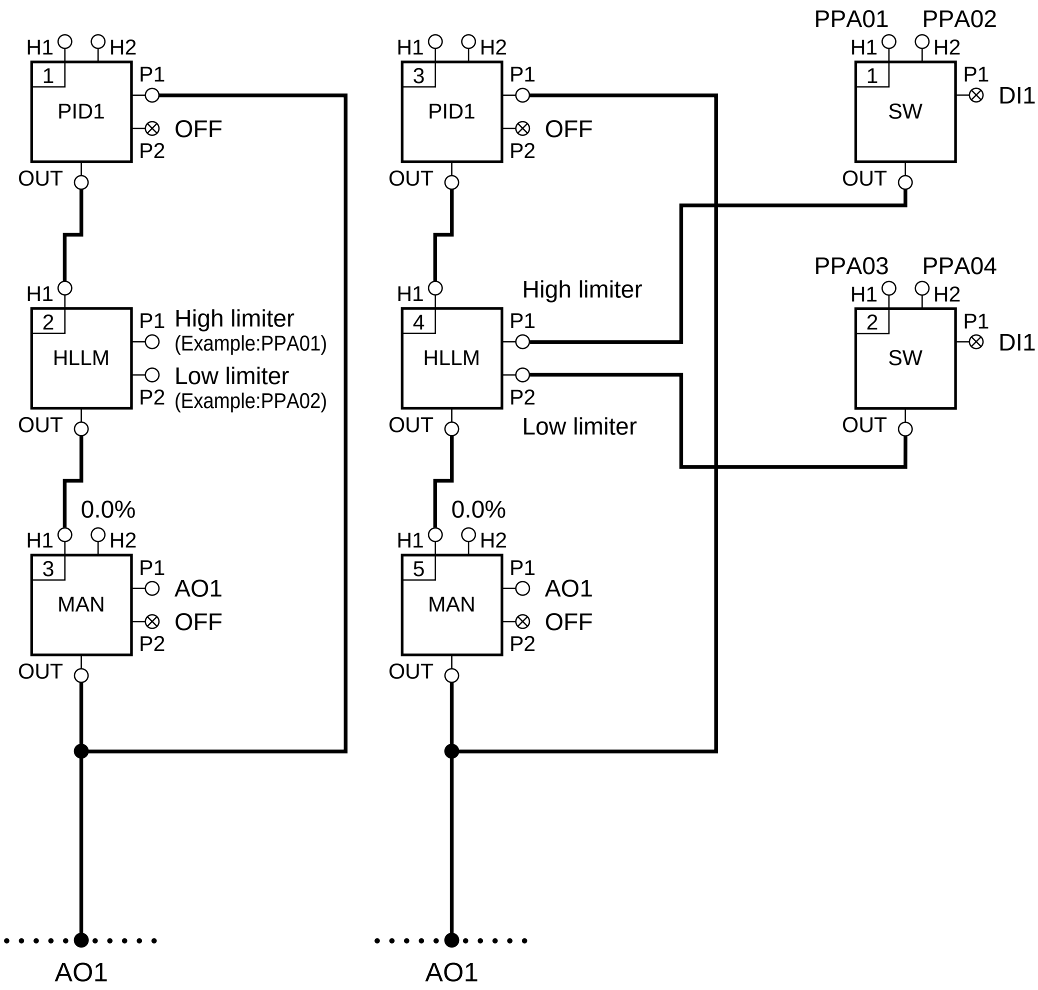
① To ensure smooth switching between modes, the output from the MAN unit is fed back to PID unit P1 (tracking input). In manual mode, the PID unit automatically receives the tracking input and the output changes according to MAN unit operations. When the mode changes back to auto mode, PID calculates the most recently received tracking input for smooth switching.

② The tracking input is not received internally, instead the output signal is input to AIR2 (analog input 2) and AIR3 (analog input 3; but this requires a converter resistor) which are connected externally. However, this means that one analog input is occupied.



Inserting HLLM units (high/low limiter) between PID and MAN units (with auto-balance)

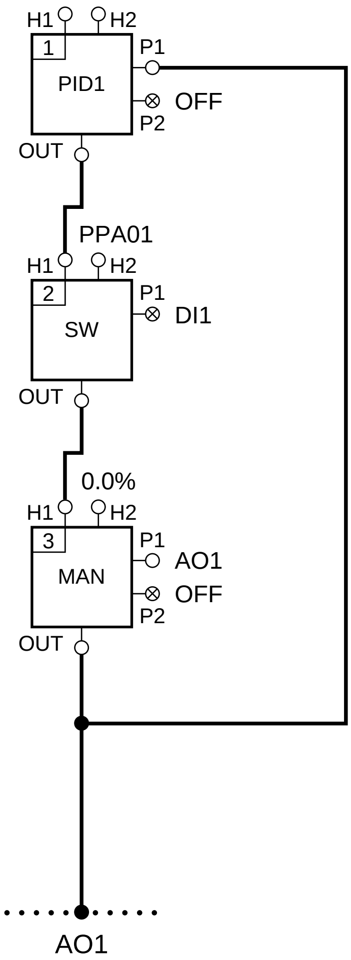
An HLLM unit (high/low limiter) can be used to limit PID unit output. PPA is shown in the example below, but a variable internal signal could be input instead, in which case the DI input can be used to change the limit value.



Inserting SW (2-position transfer switch) units between PID and MAN units (with auto-balance)

The preset output can be extracted by inserting a switch unit between the PID unit and MAN unit to switch percentage data. Although it is possible to install the switch after the MAN unit, this should be avoided as it may disable manual operation in an emergency.

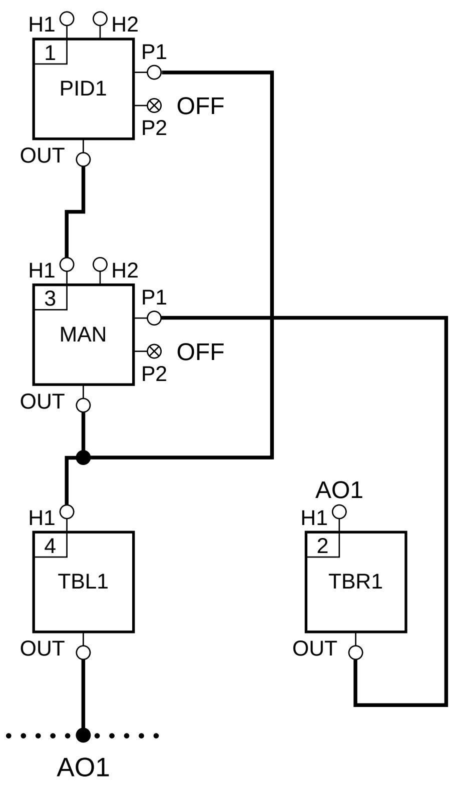
In the figure below, DI performs the switching operation and PPA01 sets the preset value. When the preset value has to be adjusted on-site, store the set PPA value in the UF key to simplify subsequent access.



Inserting computations between MAN and AO1 (with auto-balance)

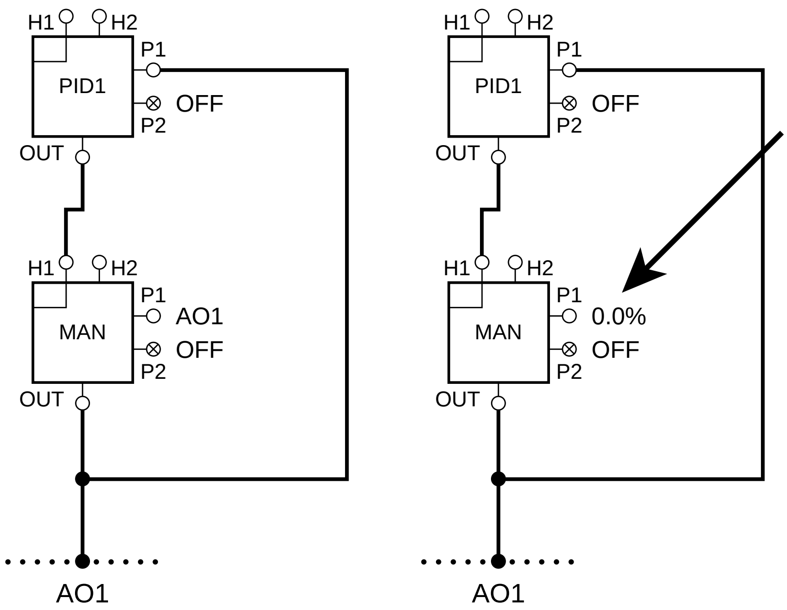
To perform characteristics compensation of operations and other computations involving linearization tables, the tracking input to the MAN unit is returned after performing a reverse computation.

◆ Important: The output of a reverse computation must be fed to a unit ahead of the one it is connected to. In the example below, 2; TBR unit is connected to 3; MAN unit.



Ensuring preset output during cold start

In a cold start, a preset output value entered at setup is written to AO1 before the first computation process. This value is inherited by the computation process. In order to start from the actual output before the preset value, AO1 has to be registered in the tracking output in the MAN unit. The preset mode setting is enabled in manual mode only. In auto and cascade mode, the AO1 value is soon overwritten by the PID computation result or other units and targeted preset output cannot be obtained. By entering a value other than AO1 in the tracking input of the MAN unit shown in the lower right figure, it is possible to start output from this value in manual mode regardless of hot or cold start.



■ Ratio bias computation

The ADD unit facilitates ratio bias computation. The ADD unit computational expressions are as follows

OUT = H1 × P1 + H2 × P2

If H2 in this equation is replaced by a fixed parameter, 100.0% (1.000),

OUT = H1 × P1 + 1.000 × P2

This means that P1 is set as PPA01 and P2 as PPA02.

OUT = H1 × PPA01 + PPA02

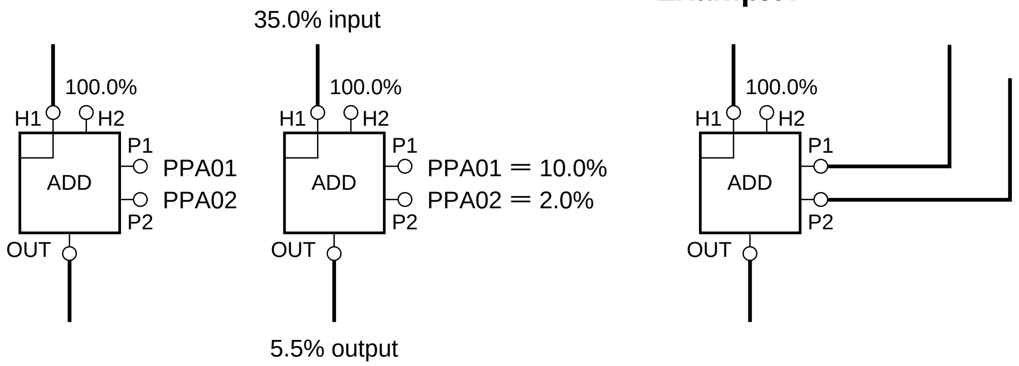
Input H1 can be replaced by the following,

PPA01 is ratio (－999.9 to 999.9%)

PPA02 is bias (－999.9 to 999.9%)

Instead of a PPA setting, a variable signal can be entered as shown in the example given below to calculate variable ratios and biases.

Example:



Multi-SP setting 1

The keys on the front panel can be used to directly set the local SP of the instrument. There are no parameters for storing local SPs. For this reason, to store several local SPs and switch between multiple SPs like the SDC40A, local SP values are rewritten using the control variable change unit (PMD 1 or 2). If the engineering unit parameter selection unit (EGP 1 or 2) is used in the previous stage, it is possible to directly set engineering units. However, when the PMD1 P1 line goes ON, the PMD1 setting is always enabled and settings made with the front panel keys are ignored. Read the “Multi-SP setting 2” on the following page for information on how to avoid this problem.

Outline of settings:

- DI is converted to index data with the digital input processing data setting (in the example, DI 1 to 3 are converted to index data 0 to 7).
- Local SPs are set in engineering units using engineering unit parameter selection unit (EGP 1 or EGP 2) (66.0U... in the example).
- The output from EGP 1 is connected to H1 on PMD 1.
- LSP is selected and registered in P2 on PMD1.

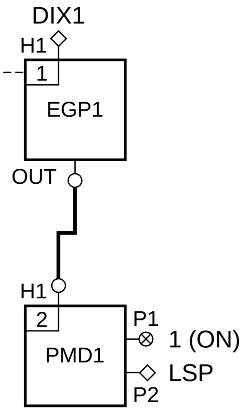
Digital input processing data setting

No. 1 digital input process 1 start; 1
No. 7 digital input process 1 units; 3

A digital input is converted to index data and output to DIX1.

DI01 is the starting point. Three DI inputs are handled as binary data. (0,1, ···,7)

Controller internal signal index format



The numbers (0 to 7) of the engineering unit parameter specified in index data are converted to percentage data and output (the conversion process uses floating point notation).

Digital inputs	No. of engineering unit parameters
DI1	1 EP1-0; 66.0
DI2	2 EP1-1; 70.5
DI3	3 EP1-2; :
	4 EP1-3;
	5 EP1-4;
	6 EP1-5;
	7 EP1-6;
	8 EP1-7;

Example:

In the above example, when DI1, DI2 and DI3 are all OFF, DIX1 is 0. EP1-0 66.0U is used to convert the decimal place, upper and lower limit of the input set with the input processing data setting to percentage data which is output. PMD1 automatically changes the LSP value in the PID1 unit according to LSP set in P2 according to input H1.

Multi-SP setting 2

In “Multi-SP setting 1,” above the PMD setting was used. However, in order to use the front panel keys and local SP settings, multi-SP is assigned to a remote setting. Local SP can still be modified using the front panel keys.

Outline of settings:

- Select the control types (control type 1, 2 or 3) that can accept remote setting inputs (in the example control type 1 is selected).
- DI is converted to index data using digital input processing data settings (in the example, DI4 to 6 is converted to index data 0 to 7).
- The engineering unit parameter selection unit (EGP1 or EGP 2) is used to set remote SP (or multi-SP) using engineering units (70.5U in the example).
- Controller internal signal index format DIX2 is set in EGP1 H1.
- When the auto mode is invoked with the AUTO key, local SP can be modified with the keys and when the cascade mode is invoked with the CAS key, a DI input can be used to select SP.

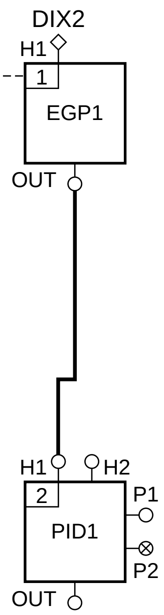
Digital input processing data setting

No. 2 digital input process 1 start; 4
No. 8 digital input process 1 units; 3

A digital input is converted to index format data and output to DIX2.

DI4 is the starting point. Three DI inputs are handled as binary data. (0,1, ⋯,7)

Controller internal signal index data



The numbers (0 to 7) of the engineering unit parameter specified in index data are converted to percentage data and output (the conversion process uses floating point notation).

Digital inputs	No. of engineering unit parameters
DI4	1 EP1-0; 66.0
DI5	2 EP1-1; 70.5
DI6	3 EP1-2; :
	4 EP1-3;
	5 EP1-4;
	6 EP1-5;
	7 EP1-6;
	8 EP1-7;

Example:
In the above example, when DI4 is ON and DI5 and DI6 are OFF, DIX2 is 1. EP1-1 70.5U is used to convert the decimal place, upper and lower limit of the input set with the input processing data setting to percentage data which is output.

PID group changes

The PMD unit is used to change PID group numbers to DI inputs.

Digital input processing data setting

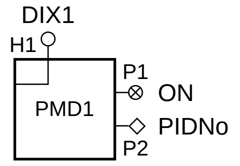
No. 1 digital input process 1 start; 1

No. 7 digital input process 1 units; 3

A digital input is converted to index data and output to DIX1.

DI01 is the starting point. Three DI inputs are handled as binary data. (0,1, ⋯,7)

Controller internal signal index data



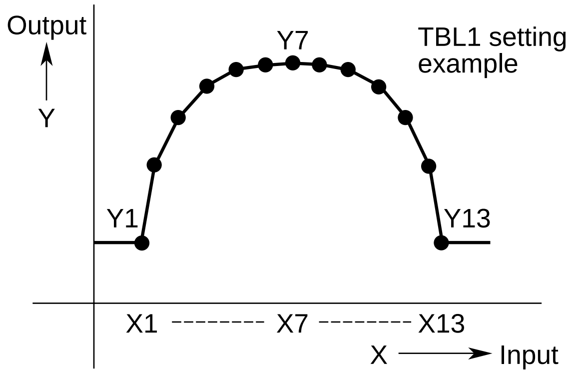
Digital inputs

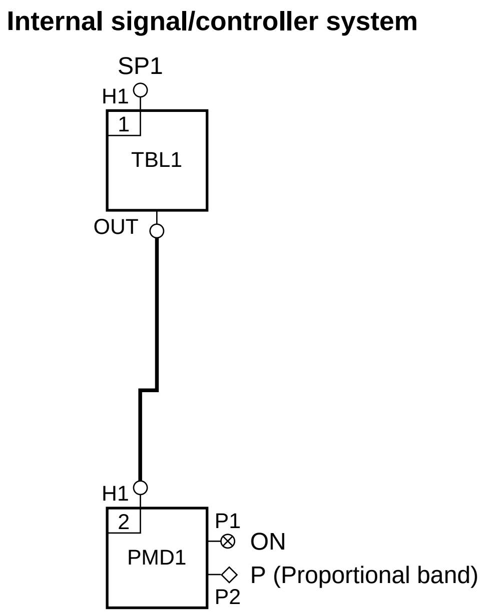
DI1
DI2
DI3

Example:
In the above example, when DI1 is OFF, DI2 and DI3 are ON, DIX1 is 2 and 2 is entered in H1. PMD1 automatically converts this to group number 2 (in the same way as PID group numbers used by the PID1 unit are entered in input H1) according to the value (here a PID group number) of the P2 control variable.

■ Changing proportional band continuously to suit settings or other factors

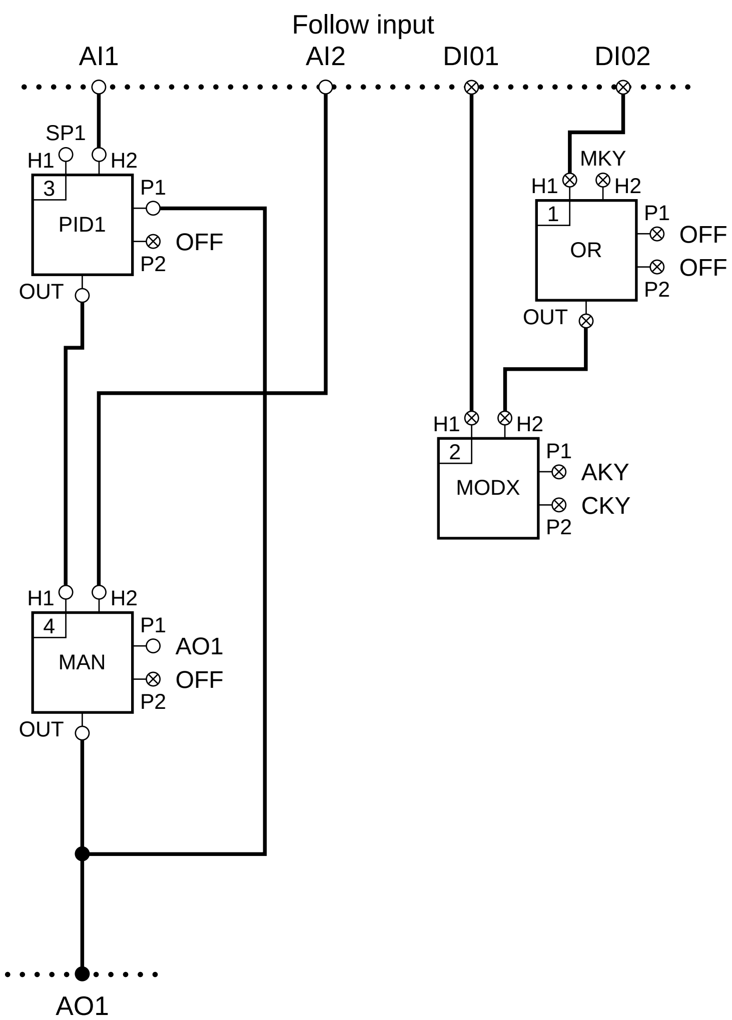
When the response characteristics of the control system are not uniform, the linearization table unit and PMD unit are used to change a proportional band with a set value. When internal signal SP (1 or 2) is registered, it is possible to extract the set value (local or remote SP) used by the PID 1 or 2 unit.
When a PV value is used instead of an SP setting value in the registration of an internal signal, continuous changes can be made to the proportional band using the PV value. And when a DEV value is used, continuous changes can be made to the proportional band using the deviation between SP and PV values.





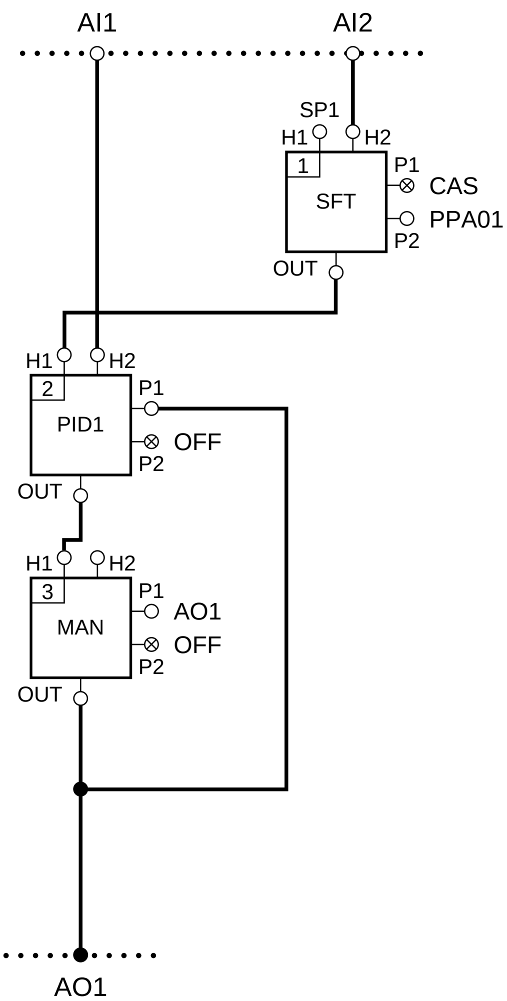
Using follow mode

Normally, the control signal from the host computer is input “as is” (follow mode) and control and output operations are performed only when required. In the example shown below, the MAN key MAN on the front panel or mode switching using DI02 are used to manipulate the output.



Smoothing changes from auto to cascade mode

When a change is made from the auto mode to the cascade mode, the sudden change in the SP value causes a surge in the output. In the example given below, the SFT unit (softening transfer switch) is used to suppress SP changes and ensure smooth switching. SP1, a PID1 unit internal signal, is stored in input H1 of the SFT unit. This means that the SP1 is initial value used in the transition from the auto mode to the cascade mode. Similarly, a CAS internal signal is stored in input P1. This signal starts a synchronized remote SP value change when a control mode is switched. The speed of switching from SP1 to remote setting value AI2 is determined by PPA01 (variable parameter 1) and performed in PPA01% slope per computation cycle.



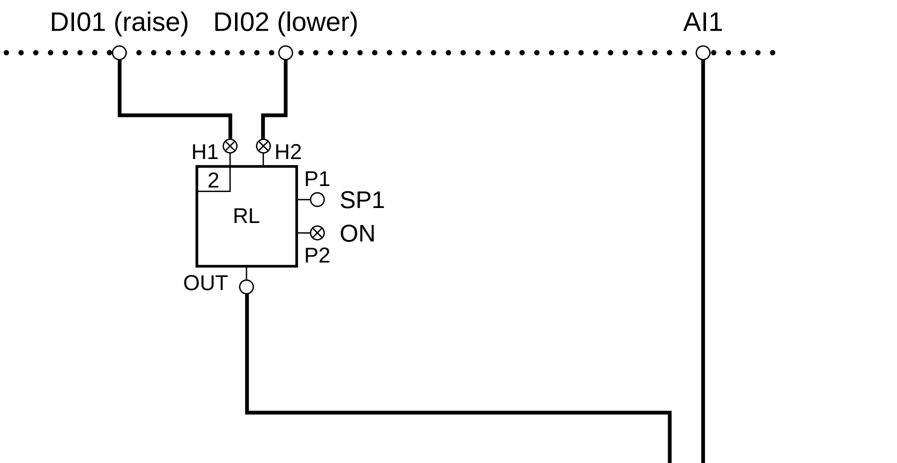
Analog changes of remote setting signals using external contacts

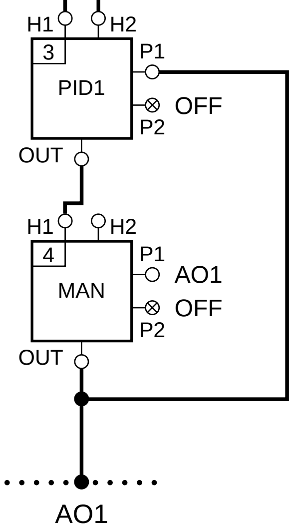
The DI input raises or lowers remote setting signals by analog means. The speed of the raise/lower process is determined by the RL unit and continuous changes are possible when a contact is installed.

Less than 1 sec after going ON: deviation rate = 0.1%

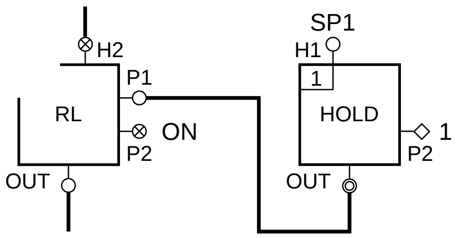
1 sec or more after going ON: deviation rate = 10 × Ts%

To start a remote setting value from SP1, input P2 on the RL unit must go ON. Note that this requires the processing sequence illustrated below.



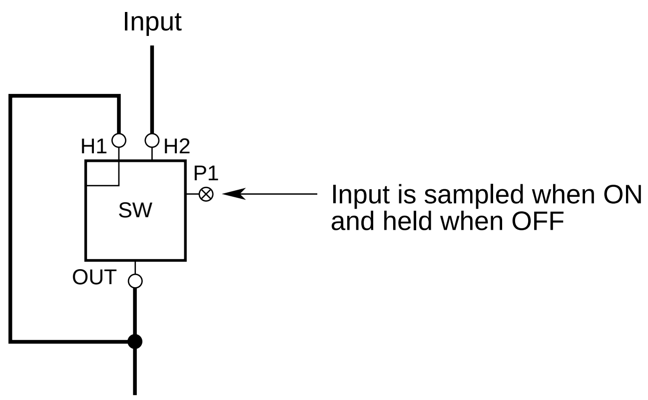


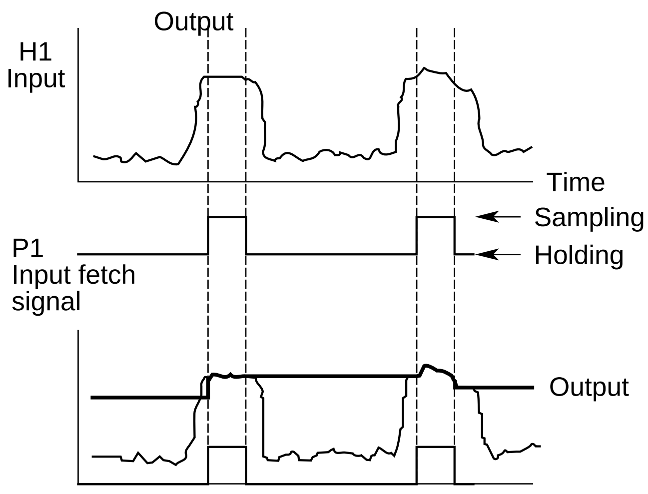
In the above example, when the power is turned on in cascade mode, SP1 is 0.0%. A HOLD unit has to be installed to retain SP1 value during hot start.



■ Sample hold

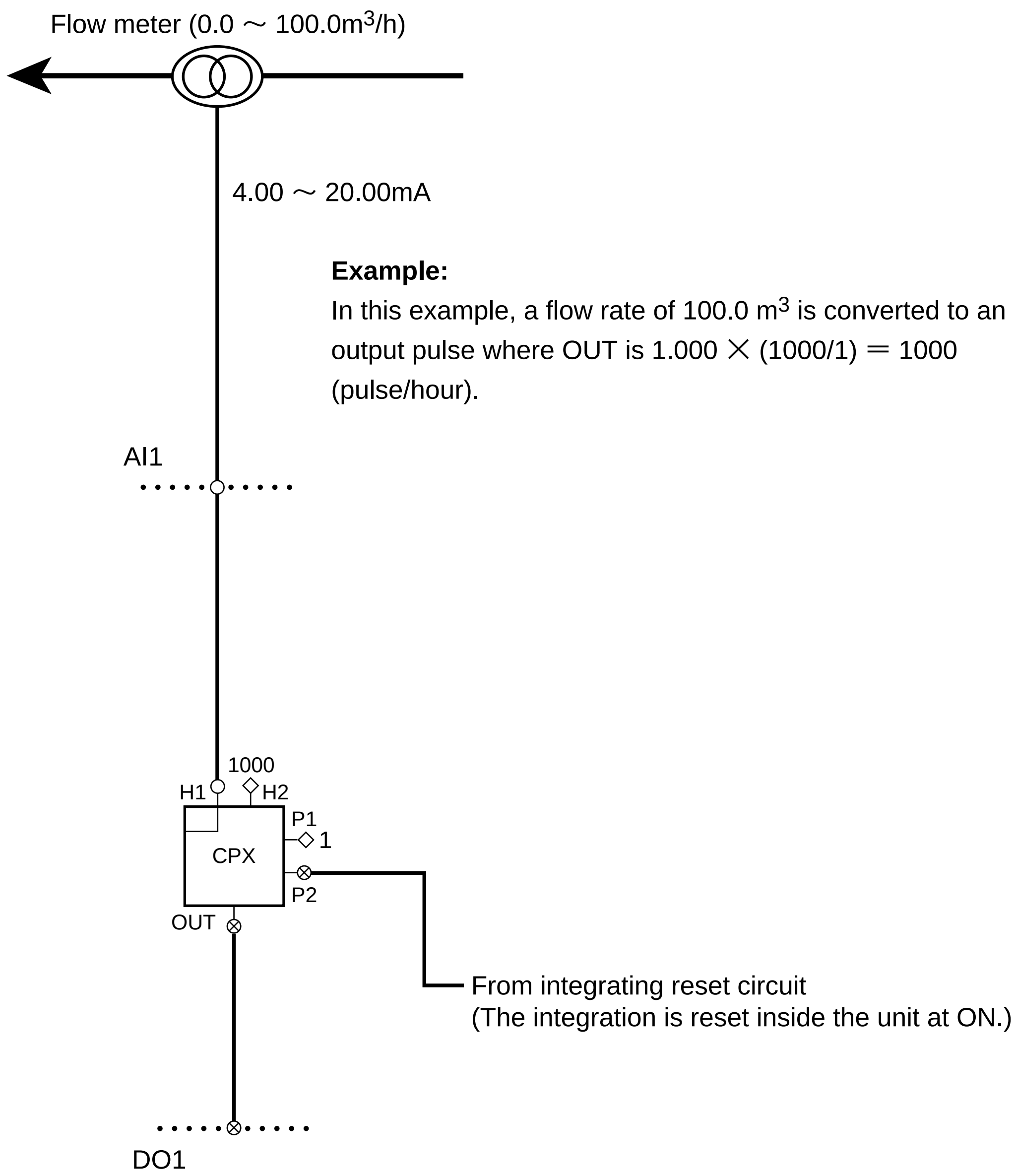
The SW unit is used to configure the sample hold function provided by sample value P1 control.





Integration pulse output

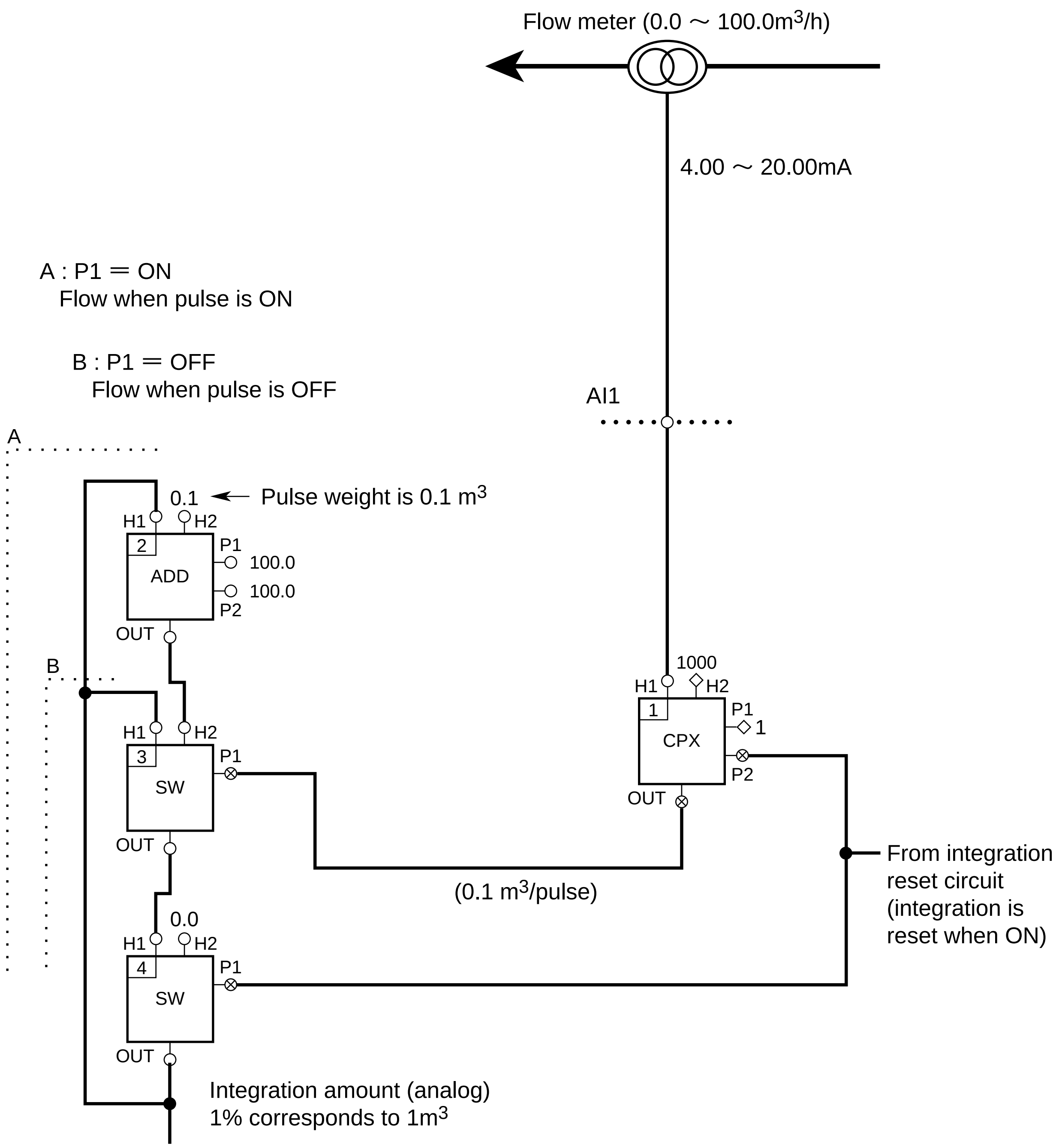
Analog amounts are converted to pulse outputs.



Example:
In this example, a flow rate of 100.0 m^3 is converted to an output pulse where OUT is 1.000 × (1000/1) = 1000 (pulse/hour).

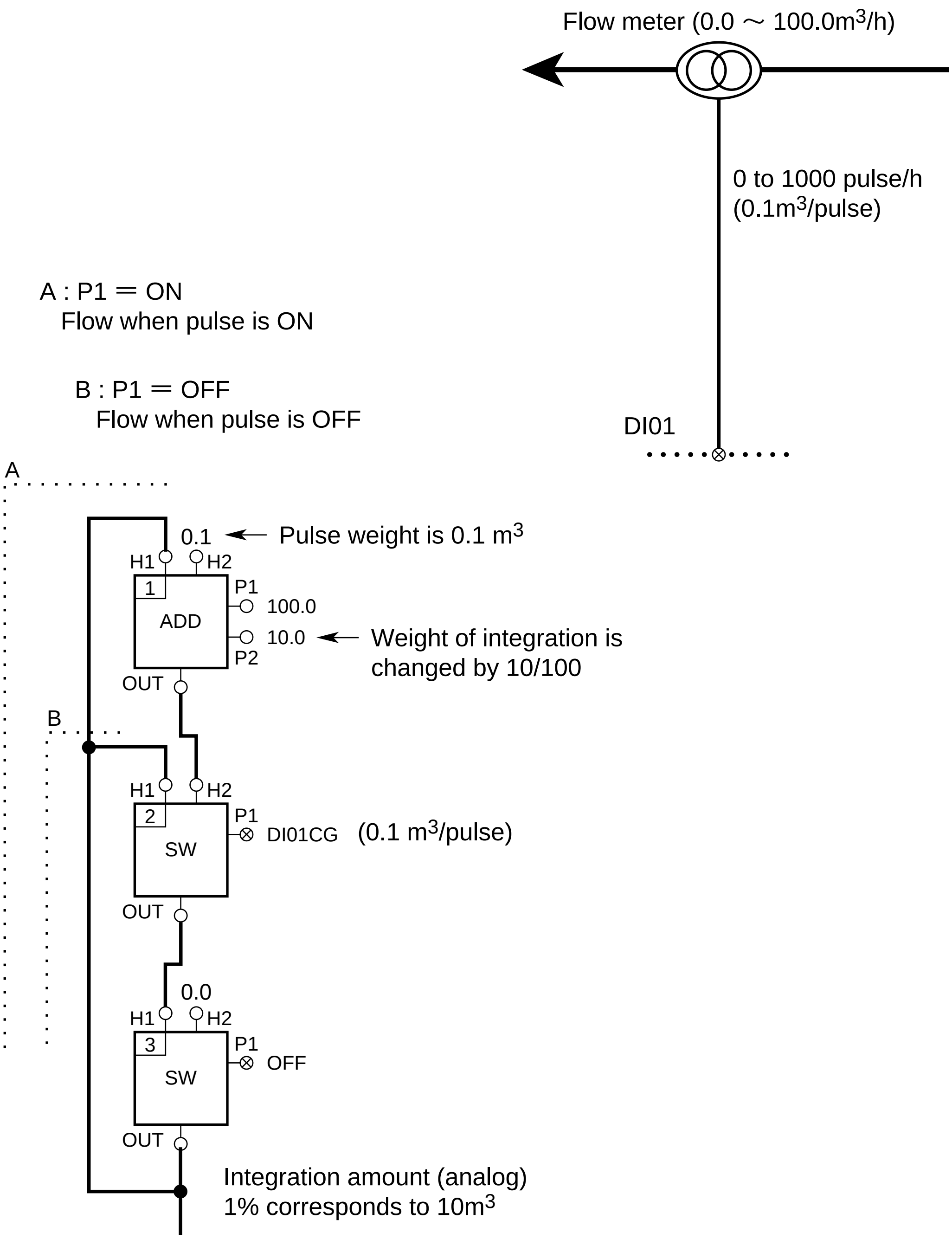
Analog integration

Analog integration is performed internally using an integration pulse output. Percentage data is handled internally in the IEEE floating point notation which can process 6 to 7 digit decimals and thus has a resolution of 0.01% or more. However, the second decimal is rounded off to (×××. ×). The output resolution when integrating values are converted to analog output equals the resolution of the D/A (digital → analog) converter or 1/10000, which requires that the result of integration has to be handled with care in terms of integration accuracy and integration scale.



Pulse to analog integration

The sampling cycle of the digital input unit of this instrument is the same as the computation cycle and is therefore not a high-speed cycle. As a result, only reasonably slow pulses can be converted to analog signals. Pulses should be (1/(computation cycle × 2) Hz (1 to 5 Hz) or less.



Chapter 3. Application Examples

3-1 Overview

This chapter provides a number of examples of SDC40B applications. Use them together with the computational unit applications described in Chapter 2.

◆ **Important:**

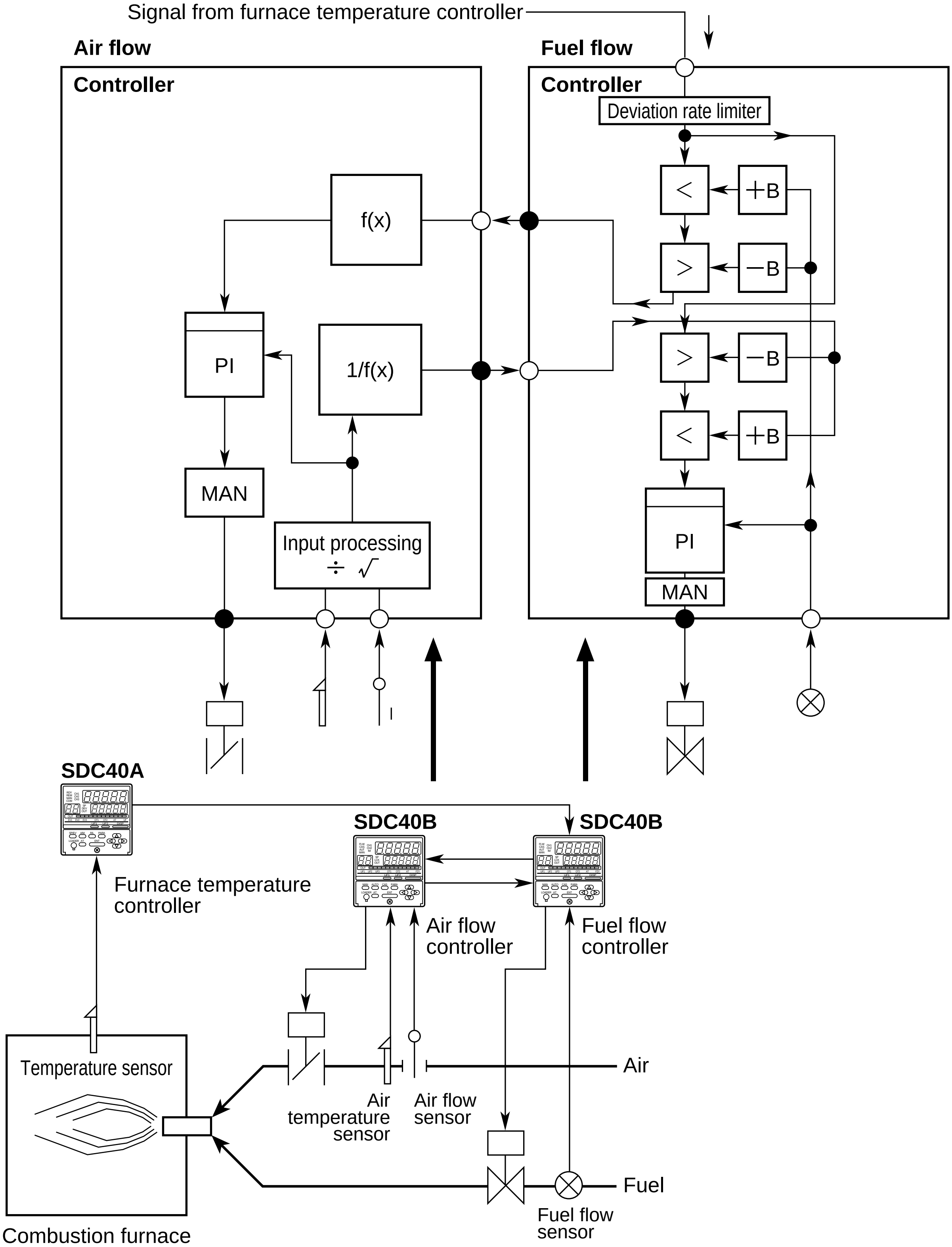
Typical application examples are given in this chapter. However, each application is based on different concepts and many situations call for combinations of several computational units, thus the combinations configured here are given only as a guide.
Yamatake Corporation shall not be held liable for any damage that may arise from the use of the examples given in this manual.

3-2 Automatic Combustion Control for Saving Energy and Reducing Pollution

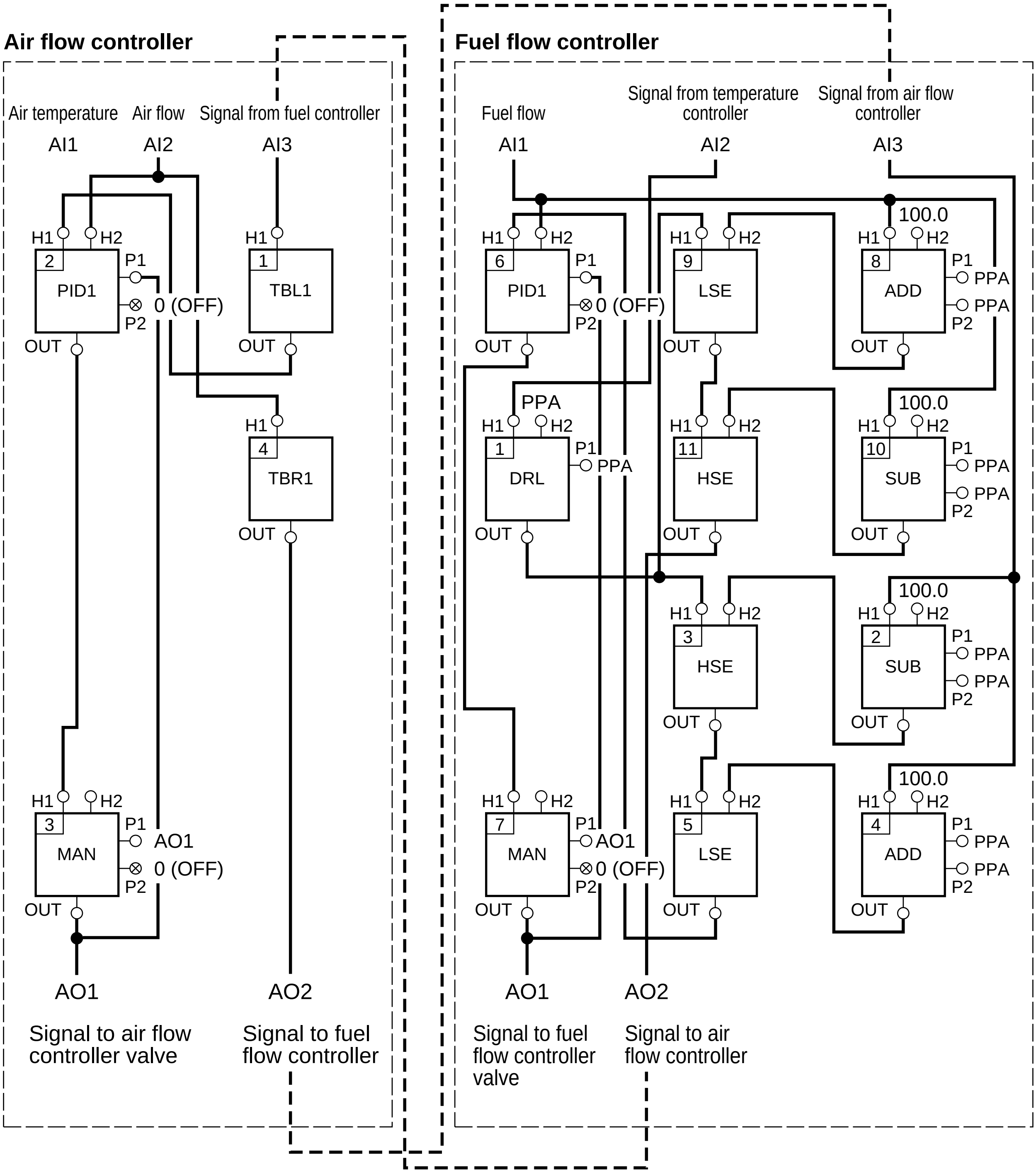
General

- Cross-limit control to prevent generation of black smoke during load changes.
- Air fuel ratio control for low excess air control in combustion
- Recuperator for temperature compensation of air flow

Instrumentation examples



Computation design



Hints

- ○ In temperature compensation of air flow, temperature inputs are assigned lower numbers than flow inputs due to the computation sequence.
- ○ AIR3 is a 1 to 5 V input so a 250 Ω precision conversion capacitor is required in the above wiring diagram.

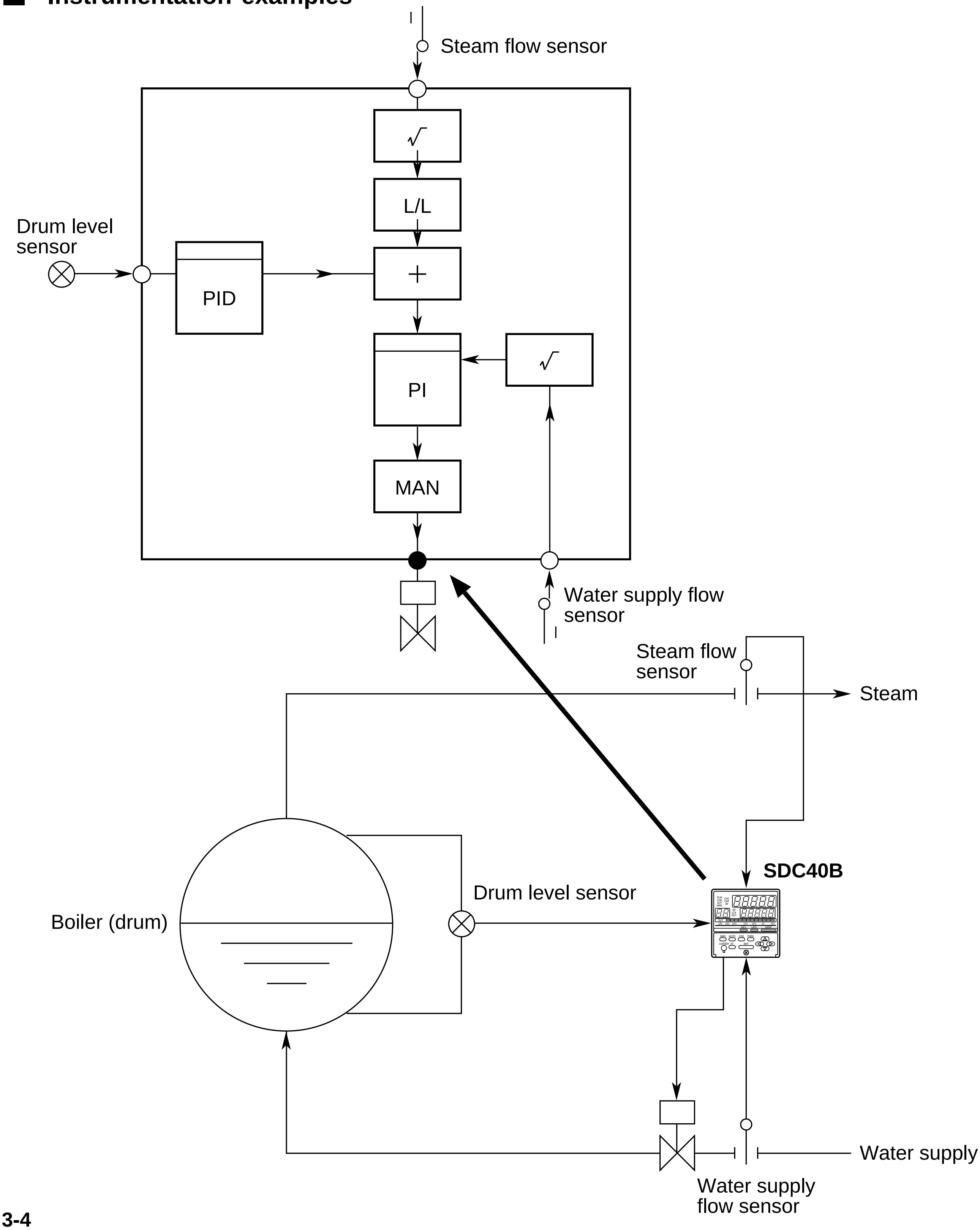
  Capacitor Part No. 81401325 (one capacitor, precision ±0.02%)

3-3 Feed-forward Control of Boiler Liquid Level Control

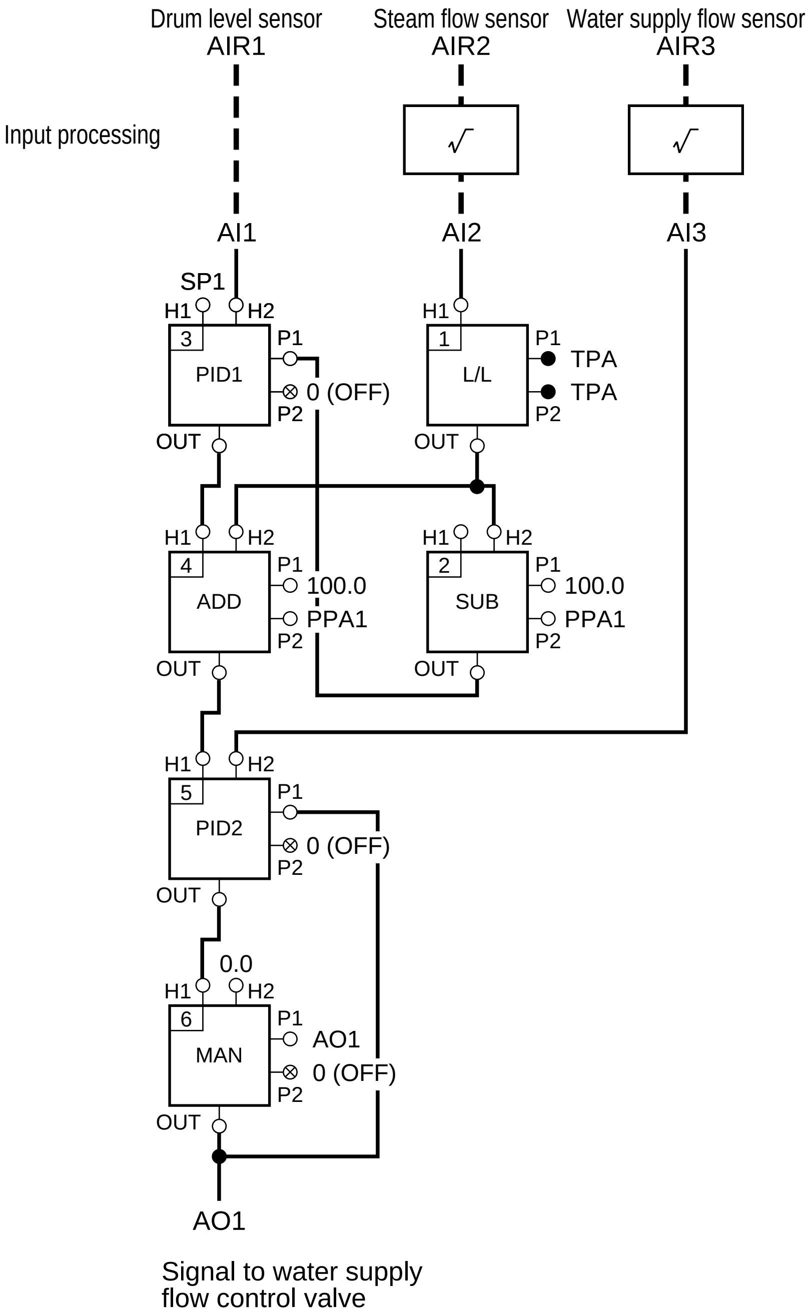
General

- **Steam flow fluctuations are anticipated and controlled to compensate for lag in load characteristics.**
- **Cascade control of water supply flow compensates for lag in load characteristics and prevents overshoots during level control.**

Instrumentation examples



Computation design



Hints

○ Tracking input P1 to the PID1 unit is returned after processing in the reverse computational SUB unit in the ADD unit.

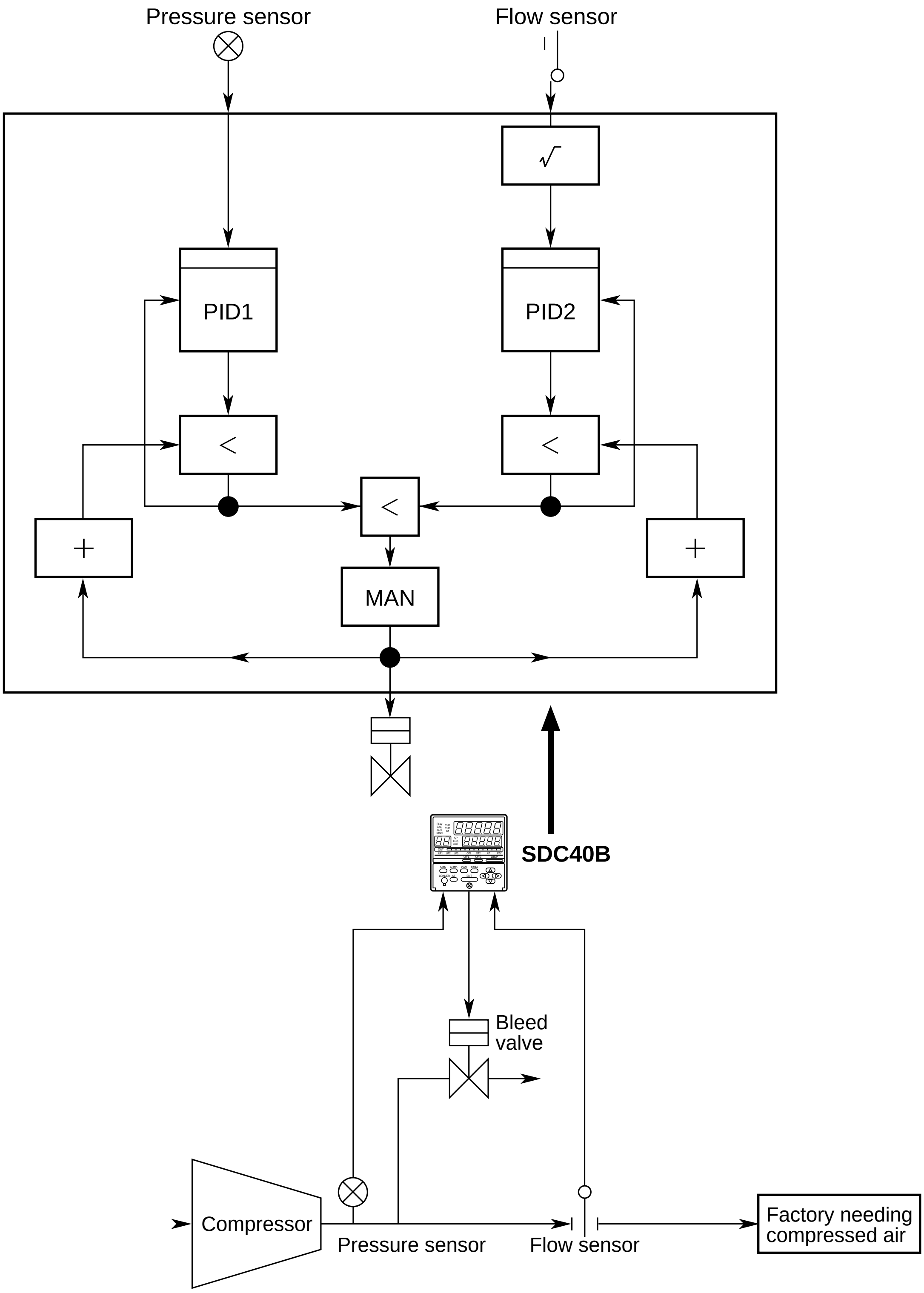
○ SP2 is input to input line H1 on the SUB unit to perform auto-balance when modes change from auto to cascade mode.

3-4 Compressor Over-ride Control

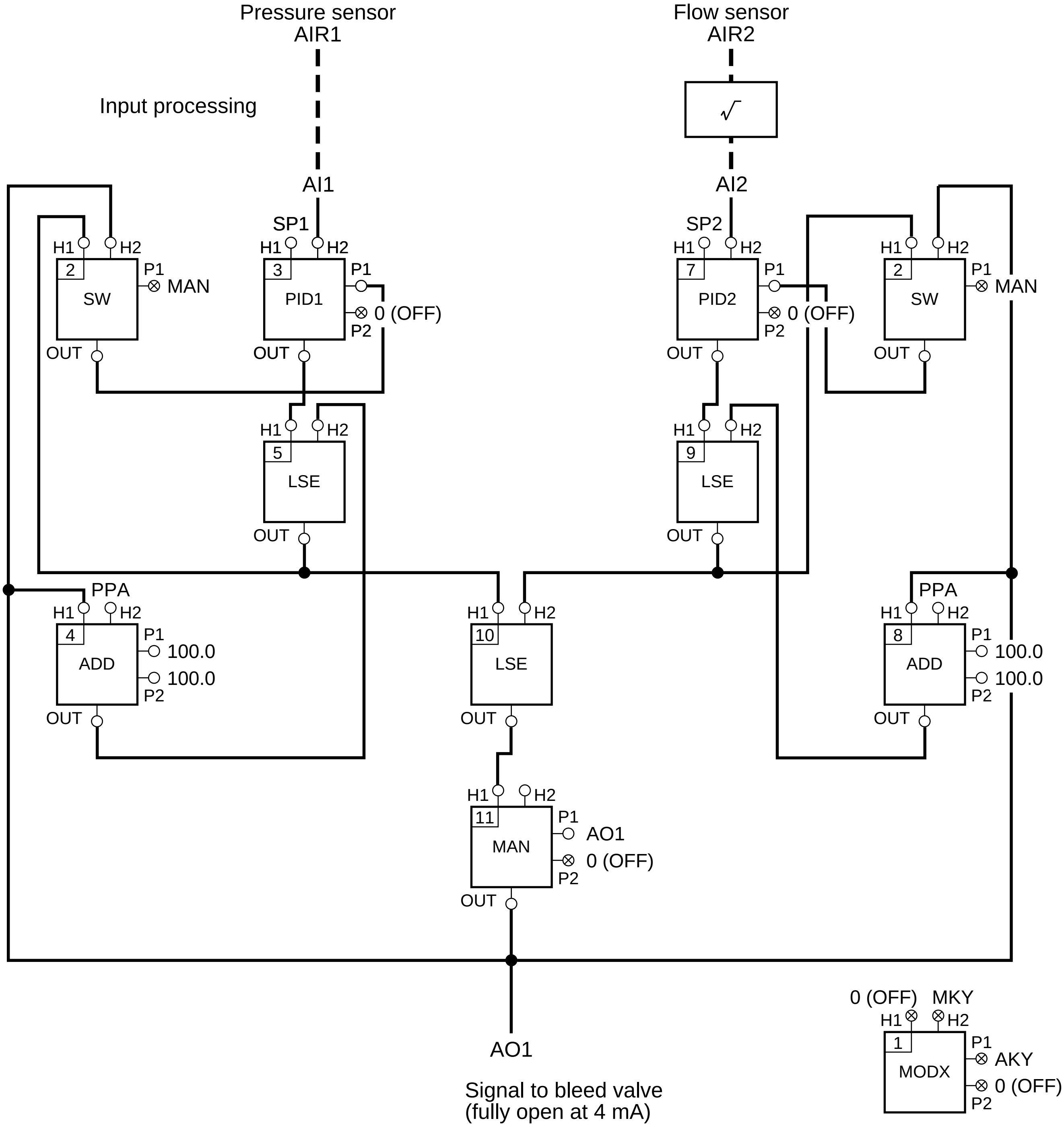
General

- **Unified control of pressure and flow rates**
- **Smooth switching from auto to manual**
- **PID calculations of pressure and flow control can be added to the manipulate signal using a fixed deviation.**

Instrumentation examples



Computation design



Hints

- ◯ Since LSP is input to each PID, controller type 3 was selected. As shown above, the MODX unit was used but only in the auto and man modes since the CAS mode was not used.
- ◯ PID1 performs reverse processing and PID2 performs normal processing.

Chapter 4. Precision

4-1 General

The SDC40B is a single loop controller which offers high-speed and highly accurate computation processing. The precision of a computational unit does not normally require special attention, but when different types of computations are combined and special applications are used, care is needed. This chapter provides a list of computational units giving the precision provided by SDC40B and their conditions.

■ Precision of floating point computations

The percentage data used in internal computations are processed as single-precision floating point representation. Although multiplication and division do not involve a restriction on the decimal point position, addition and subtraction sometimes do.

Example: Computation deviations that occur in the ADD unit

ADD : OUT = (H1 × P1) + (H2 × P2)

H1 = 100.0%	(internal data = 1.000)
P1 = 100.0%	(internal data = 1.000)
H2 = 0.1%	(internal data = 0.001)
P2 = 0.1%	(internal data = 0.001)

The above inputs are handled by the ADD unit.
(H1 × P1) becomes 1.000 × 1.000 = 1.000000 (Note that: 100% × 100% = 100%).
(H2 × P2) becomes 0.001 × 0.001 = 0.000001 (Note that: 0.1% × 0.1% = 0.0001%).
The mantissa in IEEE single-precision floating point representation is 24 bits, giving 2^{23} significant digits, or 6 to 7 significant decimal digits. Consequently, when decimals with 7 different digits are added, an error occurs as additions involving 8 different digits are not performed. In the above example, adding 1.000000 and 0.000001 where the difference is greater than 7 digits will generate an error. In the above example, "H2 = 0.01%" (not a possible setting, but a possible input from a unit in a previous stage) and if one more digit is added, there will be more than 8 different digits causing the addition to be aborted and OUT becomes 100%.
Note that it is not that figures such as 0.0001% (0.00001) cannot be used, the problem occurs when the 8 digits of the mantissa and non-mantissa differ. Incidentally, adding 10% (0.1) to 0.0001% (0.000001) does not produce an error.

◆ Important: The range of percentage data used in the SDC40B is –999.9 to 999.9% and digits less than 0.01% can produce numbers of 7 digits. Thus, it is recommended practice not to assign meaning to digits below 0.001% to prevent computation errors.

■ Precision of time computations

In internal computations time data is processed at a resolution of 0.1 sec. As a result, smaller time values are rounded up.

4

Other items requiring consideration

● Analog input

Precision of analog input: ±0.1% FS + 1U
(depends on standard conditions, indication conversion and ranges)

Input resolution: 1/20000

● Analog output (4 to 20 mA output)

Output precision: ±0.1% FS or less (depends on operating conditions)

Output resolution: 1/10000

● Absolute time (precision of internal quartz oscillator)

Absolute time precision: ±0.01% (depends on operating conditions)
Max ±0.36 sec/hour (3600 sec)
Max ±8.64 sec/day (24 hours)

Calculating computation precision

● System precision Z for n number of computations is shown below.

$$Z = \sqrt{(X1)^2 + (X2)^2 + \cdots + (Xn)^2}$$

X_1, X_2, ⋯, Xn indicates the precision of each computational expression.

4-2 List of Computational Unit Precision

No.	Computational expression	Mnemonic	Precision	Conditions
1	Addition	ADD	±0.01%	P1 and P2 must be fixed
2	Subtraction	SUB	±0.01%	P1 and P2 must be fixed
3	Multiplication	MUL	±0.01%	
4	Division	DIV	±0.01%	P1 must be fixed
5	Absolute value	ABS		
6	Square-root extraction	SQR	±0.01%	
7	Maximum value	MAX		Resolution 0.001% or greater
8	Minimum value	MIN		Resolution 0.001% or greater
9	4-point addition	SGM	±0.01%	
10	High selector (low limiter)	HSE		Resolution 0.001% or greater
11	Low selector (high limiter)	LSE		Resolution 0.001% or greater
12	High and low limiter	HLLM		Resolution 0.001% or greater
13	High monitor	HMS		Resolution 0.001% or greater
14	Low monitor	LMS		Resolution 0.001% or greater
15	Deviation monitor	DMS		Resolution 0.001% or greater
16	Deviation rate limiter	DRL	±0.006/Ts%	Controls outputs 1 min later
17	Deviation rate monitor	DRM	(0 to P1/30) min.	Precision of check time
18	Manual output	MAN*		Set resolution is 0.1%
19	Controller #1	PID1*		
20	Controller #2	PID2*		
21	Dead time	DED	(0 to P1/30) min.	However P1 ＞ computation cycle
22	Lead/lag	L/L	±Ts × 2	Ts is the computation cycle
23	Derivation	LED	±Ts × 2	Ts is the computation cycle
24	Integration	INT		Output resolution is 0.033%, digits lower than 0.1% of H1 input cannot be guaranteed.
25	Moving average	MAV	(0 to P1/30) min.	However P1 ＞ computation cycle
26	Flip-flop	RS		
27	Logical product	AND		
28	Logical OR	OR		
29	Exclusive OR	XOR		
30	Invert	NOT		
31	2-position transfer switch	SW		
32	Softening transfer switch	SFT		
33	Timer switch	TSW		
34	Flag switch	FSW		
35	Alternate switch	ALSW		
36	Timer	TIM	±Ts	
37	On delay timer	ONDT	±Ts	
38	Off delay timer	OFDT	±Ts	
39	One-shot timer	OST	±Ts	
40	Integration pulse output I	CPO	±0.1%	
41	Integration pulse output II	CPX	±0.1%	
42	Pulse width modulation	PWM	Ts/P1 × 100%	Resolution of ON/OFF comparison
43	Ramp signal generation	RMP	±Ts	
44	Logarithm	LOG	±0.01%	
45	Exponent	EXP	±0.01%	
46				
47				
48				
49				
50				

Ts: computation cycle, *: Only one computation with the same computation cycle can be used.

No.	Computational expression	Mnemonic	Precision	Conditions
51	Control variable change I	PMD1*		
52	Control variable change II	PMD2*		
53	Mode select (status detection)	MOD*		
54	Mode select (edge detection)	MODX*		
55	Auto-tuning start/stop 1	AT1*		
56	Auto-tuning start/stop 2	AT2*		
57	Data hold	HOLD		
58	Raise/lower unit	RL		
59	Reset	RST*		
60				
61	Linearization table 1	TBL1	±0.01%	
62	Linearization table 2	TBL2	±0.01%	
63	Linearization table 3	TBL3	±0.01%	
64	Inverse linearization tables 1	TBR1	±0.01%	
65	Inverse linearization tables 2	TBR2	±0.01%	
66	Inverse linearization tables 3	TBR3	±0.01%	
67	Time → % conversion	TTP	±0.01%	
68	% → Time conversion	PTT	±0.1 sec.	
69	Engineering unit parameter selection 1	EGP1*		
70	Engineering unit parameter selection 2	EGP2*		
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81	% → % table #1	PTB1	±0.01%	
82	% → % table #2	PTB2	±0.01%	
83	% → % table #3	PTB3	±0.01%	
84	% → % table #4	PTB4	±0.01%	
85	% → time table #1	TTB1	±0.1 sec.	
86	% → time table #2	TTB2	±0.1 sec.	
87	% → time table #3	TTB3	±0.1 sec.	
88	% → time table #4	TTB4	±0.1 sec.	
89				
90				
91	User lamp output #1	UF1*		
92	User lamp output #2	UF2*		
93	User lamp output #3	UF3*		
94	Bar graph display switch	BLED*		
95	Additional display unit #1	DSP1*		
96	Additional display unit #2	DSP2*		
97	Additional display unit #3	DSP3*		
98	Additional display unit #4	DSP4*		
99				
100				

*: Only one computation with the same computation cycle can be used.

Chapter 5. Data Sheets

5-1 General

The data sheets in this chapter have been provided as a summary of applications (a reference for computation design, etc.). Although they can be used as documents that are to be submitted or filed, the PC loader should be used for this to prevent transcription errors. Refer to the “Smart Loader Package SLPC4B User’s Manual” (Manual No. CP-UM-1681E) for information on how to create data sheets.

5-2 Data that Can be Changed after Operation

Data items that can be modified by the SDC40B are indicated by an asterisk (∗).

Data sheets for the SDC40B Digital Indicating Controller

Customer Name		Date	
Control Device		Manufacturer	
Control Specification No.		Approval	
Tag No.		Modifications	
Model	C40B ☐ 2G4AS06 ☐ 5G4AS09 ☐ 1 (no communications) ☐ Other information ( )	☐ D0 (data enclosed) ☐ Other information ( )	

■ Setup data

SDC40B code	Item	Description
* C01	C40B management No.	(0 to 30000)
C02	Computation cycle	☐ 1:100ms, ☐ 2:200ms, ☐ 3:300ms, ☐ 4:400ms, ☐ 5:500ms
C03	Control type	☐ 0:1PID(A/M), ☐ 1:1PID(A/M/C), ☐ 2:2PID(A/M/C), ☐ 3:2PID(A/M/C)
* C04	IM mode transition condition settings	☐ 0:no transitions, ☐ 1:memory error, ☐ 2:memory/AI error, ☐ 3:memory/AI/computation error
* C05	Startup procedure	☐ 0:cold start, ☐ 1:hot start
* C06	Preset mode	☐ 0:auto (AUTO), ☐ 1:manual (MAN), ☐ 2:cascade (CAS)
* C07	Preset output	(−10.0 to +110.0%)
* C08	Preset LSP1	(0.0 to 100.0%)
* C09	Preset LSP2	(0.0 to 100.0%)
* C10	Input range type 1	
* C11	Input 1 temperature units	☐ 0:°C, ☐ 1:°F
* C12	Input 1 cold junction compensation	☐ 0:Internal compensation, ☐ 1:External compensation
* C13	Input 1 line break operation	☐ 0:up scale, ☐ 1:down scale
* C14	Input 2 range type	☐ 0:4 to 20mA, ☐ 1:1 to 5V
* C15	LSP1 setting method	☐ 0:with direct change, ☐ 1:no direct change, ☐ 2:LSP1 changes inhibited
* C16	LSP2 setting method	☐ 0:with direct change, ☐ 1:no direct change, ☐ 2:LSP2 changes inhibited
* C17	PV/AI indication selection	☐ 0:PV1(PID1), ☐ 1:PV2(PID2), ☐ 2:AIR1, ☐ 3:AIR2, ☐ 4:AIR3
* C18	Auto tuning method selection	☐ 0:AT is not performed ☐ 1:General AT (PID1), ☐ 2:Overshoot protected AT (PID1), ☐ 3:Neural network AT (PID1) ☐ 4:General AT (PID2), ☐ 5:Overshoot protected AT (PID2), ☐ 6:Neural network AT (PID2)
* C19	Motor control method selection	☐ 0:MFB (conventional) + estimated position control performed, ☐ 1:MFB (conventional), ☐ 2:estimated position control performed
* C20	Automatic adjustment of motor opening	☐ 0:no adjustment, ☐ 1:adjustment
* C21	Motor opening control (fully closed)	(0 to)
* C22	Motor opening control (fully open)	(to 10000)
* C23	Motor fully open/fully closed time (sec.)	(5.0 to 240.0 sec.)
* C24	Positional proportional control dead zone	(0.5 to 25.0%)
* C25	CPL transmission address	(0 to 127)
* C26	CPL transmission rate, code	☐ 0:9600 bps, even parity, 1 stop bit, ☐ 1:9600 bps, no parity, 2 stop bits, ☐ 2:4800 bps, even parity, 1 stop bit, ☐ 3:4800 bps, even parity, 2stop bits
* C27	CPL transmission write enable/prevent	☐ 0:write enable, ☐ 1:write disable

■ Input processing data

SDC40B code	Item	Description	Input1 [1]	Input2 [2]	Input3 [3]	Virtual4 [4]	Virtual5 [5]	Virtual6 [6]
In 01	Input use	0:not used 1:used						
In 02	Engineering unit display Decimal point position	0 to 4						
* In 03	Engineering unit display Lower limit 0%	−19999 to +26000 U						
* In 04	Engineering unit display Upper limit 100%	−19999 to +26000 U						
In 05	Linearization table No.	0:not used 1:TBL1, 2:TBL2, 3:TBL3				-------	-------	-------
In 06	Temperature compensation input No.	0:no temperature compensation 1:input 1, 2:input 2, 3:input 3				-------	-------	-------
In 07	Temperature units for temperature compensation	0:°C 1:°F				-------	-------	-------
* In 08	Design temperature for temperature compensation	−19999 to +26000 U				-------	-------	-------
In 09	Pressure compensation input No.	0:no pressure compensation 1:input 1, 2:input 2, 3:input 3				-------	-------	-------
In 10	Pressure units for pressure compensation	0:MPa, 1:kPa, 2:Pa 3:kgf/cm^2, 4:mmH_2O				-------	-------	-------
* In 11	Design pressure for pressure compensation	−19999 to +26000 U				-------	-------	-------
In 12	Square-root extraction computation	0:not performed 1:performed				-------	-------	-------
* In 13	Drop-out value for square-root extraction	0.0 to 100.0%				-------	-------	-------
* In 14	Digital filter	0.0 to 120.0 sec.				-------	-------	-------
In 15	Input error diagnosis	0:not performed 1:performed				-------	-------	-------

■ Control computational data

SDC40B code	Item	Description	PID1 computational unit [1]	PID2 computational unit [2]
PID.tp	PID computation type	0:Normal PID 1:Derivative-based PID		
* PID.no	PID group setting	0 to 7		
* ACT	Control operation	0:reverse operation 1:normal operation		
PV-In	Engineering unit number specification	1 to 6		
PV-tr	PV tracking	0:none, 1:yes		
* rR	Ratio	−999.9 to +999.9%		
* BIAS	Bias	−999.9 to +999.9%		
* DEV.AL	Deviation alarm	0.0 to 100.0%		
* PVL.AL	PV lower alarm	−10.0 to +110.0%		
* PVH.AL	PV upper alarm	−10.0 to +110.0%		
* AL.HYS	Alarm hysteresis	0.0 to 100.0%		
* IOUT	Initial PID computation cycle procedure	0.0 to 100.0%		
* rPID	PID initialization method	0:automatic initialization 1:initialization when LSP1 is changed 2:no initialization		
* St	Smart tuning method selection	0:no smart tuning 1:uses fixed break value 2:updates break value		
* 2PID	PID with two degrees of freedom	0:2 degrees of freedom not used 1:2 degrees of freedom used		

PID parameters

SDC40B code	Item	Description	Group No. 0	Group No. 1	Group No. 2	Group No. 3	Group No. 4	Group No. 5	Group No. 6	Group No. 7
* P	Proportional band	0.1 to 999.9%								
* I	Integral time	0.0 to 6000.0 sec.								
* D	Derivative time	0.0 to 6000.0 sec.								
* rL	Lower integral limit	−200.0 to upper limit%								
* rH	Upper integral limit	Lower limit to +200.0%								
* GAP	Dead band	0.0 to 100.0%								
* OTL	Output deviation rate limit	0.0 to 100.0% /computation cycle								
* rE	Manual reset	0.0 to 100.0%								
* br	Break	0 to 30								
* dP	Disturbance suppressing proportional band	0.1 to 999.9%								
* dI	Disturbance suppressing integral time	0.0 to 6000.0 sec.								
* dD	Disturbance suppressing derivative time	0.0 to 6000.0 sec.								

Linearization table data (% → %)

Specification range: X axis Y axis: −999.9 to +999.9%

(TBL1)

	SDC40B code	X axis (%)	SDC40B code	Y axis (%)
*	tL.A01		tL.B01	
*	tL.A02		tL.B02	
*	tL.A03		tL.B03	
*	tL.A04		tL.B04	
*	tL.A05		tL.B05	
*	tL.A06		tL.B06	
*	tL.A07		tL.B07	
*	tL.A08		tL.B08	
*	tL.A09		tL.B09	
*	tL.A10		tL.B10	
*	tL.A11		tL.B11	
*	tL.A12		tL.B12	
*	tL.A13		tL.B13	
*	tL.A14		tL.B14	
*	tL.A15		tL.B15	
*	tL.A16		tL.B16	
	Table connection No.		CAIN.I	

(TBL2)

SDC40B code	X axis (%)	SDC40B code	Y axis (%)
tL.A01		tL.B01	
tL.A02		tL.B02	
tL.A03		tL.B03	
tL.A04		tL.B04	
tL.A05		tL.B05	
tL.A06		tL.B06	
tL.A07		tL.B07	
tL.A08		tL.B08	
tL.A09		tL.B09	
tL.A10		tL.B10	
tL.A11		tL.B11	
tL.A12		tL.B12	
tL.A13		tL.B13	
tL.A14		tL.B14	
tL.A15		tL.B15	
tL.A16		tL.B16	
Table connection No.		CAIN.I	

(TBL3)

SDC40B code	X axis (%)	SDC40B code	Y axis (%)
tL.A01		tL.B01	
tL.A02		tL.B02	
tL.A03		tL.B03	
tL.A04		tL.B04	
tL.A05		tL.B05	
tL.A06		tL.B06	
tL.A07		tL.B07	
tL.A08		tL.B08	
tL.A09		tL.B09	
tL.A10		tL.B10	
tL.A11		tL.B11	
tL.A12		tL.B12	
tL.A13		tL.B13	
tL.A14		tL.B14	
tL.A15		tL.B15	
tL.A16		tL.B16	
Table connection No.		CAIN.I	

(The instrument cannot specify table connection no.)

■ PTB table data (% → %)

Specification range: X axis Y axis: −999.9 to +999.9%

	(PTB1)				(PTB2)				(PTB3)				(PTB4)			
	SDC40B code	X axis (%)	SDC40B code	Y axis (%)	SDC40B code	X axis (%)	SDC40B code	Y axis (%)	SDC40B code	X axis (%)	SDC40B code	Y axis (%)	SDC40B code	X axis (%)	SDC40B code	Y axis (%)
*	pt.A01		pt.B01		pt.A01		pt.B01		pt.A01		pt.B01		pt.A01		pt.B01	
*	pt.A02		pt.B02		pt.A02		pt.B02		pt.A02		pt.B02		pt.A02		pt.B02	
*	pt.A03		pt.B03		pt.A03		pt.B03		pt.A03		pt.B03		pt.A03		pt.B03	
*	pt.A04		pt.B04		pt.A04		pt.B04		pt.A04		pt.B04		pt.A04		pt.B04	
*	pt.A05		pt.B05		pt.A05		pt.B05		pt.A05		pt.B05		pt.A05		pt.B05	
*	pt.A06		pt.B06		pt.A06		pt.B06		pt.A06		pt.B06		pt.A06		pt.B06	
*	pt.A07		pt.B07		pt.A07		pt.B07		pt.A07		pt.B07		pt.A07		pt.B07	
*	pt.A08		pt.B08		pt.A08		pt.B08		pt.A08		pt.B08		pt.A08		pt.B08	
*	pt.A09		pt.B09		pt.A09		pt.B09		pt.A09		pt.B09		pt.A09		pt.B09	
*	pt.A10		pt.B10		pt.A10		pt.B10		pt.A10		pt.B10		pt.A10		pt.B10	
*	pt.A11		pt.B11		pt.A11		pt.B11		pt.A11		pt.B11		pt.A11		pt.B11	
*	pt.A12		pt.B12		pt.A12		pt.B12		pt.A12		pt.B12		pt.A12		pt.B12	
*	pt.A13		pt.B13		pt.A13		pt.B13		pt.A13		pt.B13		pt.A13		pt.B13	
*	pt.A14		pt.B14		pt.A14		pt.B14		pt.A14		pt.B14		pt.A14		pt.B14	
*	pt.A15		pt.B15		pt.A15		pt.B15		pt.A15		pt.B15		pt.A15		pt.B15	
*	pt.A16		pt.B16		pt.A16		pt.B16		pt.A16		pt.B16		pt.A16		pt.B16	

■ TTB table data (% → time)

Specification range: X axis: −999.9 to +999.9%
Y axis: 0.0 to 6000.0 sec.

	(TTB1)				(TTB2)				(TTB3)				(TTB4)			
	SDC40B code	X axis (%)	SDC40B code	Y axis (sec.)	SDC40B code	X axis (%)	SDC40B code	Y axis (sec.)	SDC40B code	X axis (%)	SDC40B code	Y axis (sec.)	SDC40B code	X axis (%)	SDC40B code	Y axis (sec.)
*	tt.A01		tt.B01		tt.A01		tt.B01		tt.A01		tt.B01		tt.A01		tt.B01	
*	tt.A02		tt.B02		tt.A02		tt.B02		tt.A02		tt.B02		tt.A02		tt.B02	
*	tt.A03		tt.B03		tt.A03		tt.B03		tt.A03		tt.B03		tt.A03		tt.B03	
*	tt.A04		tt.B04		tt.A04		tt.B04		tt.A04		tt.B04		tt.A04		tt.B04	
*	tt.A05		tt.B05		tt.A05		tt.B05		tt.A05		tt.B05		tt.A05		tt.B05	
*	tt.A06		tt.B06		tt.A06		tt.B06		tt.A06		tt.B06		tt.A06		tt.B06	
*	tt.A07		tt.B07		tt.A07		tt.B07		tt.A07		tt.B07		tt.A07		tt.B07	
*	tt.A08		tt.B08		tt.A08		tt.B08		tt.A08		tt.B08		tt.A08		tt.B08	
*	tt.A09		tt.B09		tt.A09		tt.B09		tt.A09		tt.B09		tt.A09		tt.B09	
*	tt.A10		tt.B10		tt.A10		tt.B10		tt.A10		tt.B10		tt.A10		tt.B10	
*	tt.A11		tt.B11		tt.A11		tt.B11		tt.A11		tt.B11		tt.A11		tt.B11	
*	tt.A12		tt.B12		tt.A12		tt.B12		tt.A12		tt.B12		tt.A12		tt.B12	
*	tt.A13		tt.B13		tt.A13		tt.B13		tt.A13		tt.B13		tt.A13		tt.B13	
*	tt.A14		tt.B14		tt.A14		tt.B14		tt.A14		tt.B14		tt.A14		tt.B14	
*	tt.A15		tt.B15		tt.A15		tt.B15		tt.A15		tt.B15		tt.A15		tt.B15	
*	tt.A16		tt.B16		tt.A16		tt.B16		tt.A16		tt.B16		tt.A16		tt.B16	

■ Variable parameters (% format)

Specification range: −999.9 to +999.9%

	SDC40B code	Name	Setting (%)	SDC40B code	Name	Setting (%)
*	PPA01			PPA21		
*	PPA02			PPA22		
*	PPA03			PPA23		
*	PPA04			PPA24		
*	PPA05			PPA25		
*	PPA06			PPA26		
*	PPA07			PPA27		
*	PPA08			PPA28		
*	PPA09			PPA29		
*	PPA10			PPA30		
*	PPA11			PPA31		
*	PPA12			PPA32		
*	PPA13			PPA33		
*	PPA14			PPA34		
*	PPA15			PPA35		
*	PPA16			PPA36		
*	PPA17			PPA37		
*	PPA18			PPA38		
*	PPA19			PPA39		
*	PPA20			PPA40		

■ Variable parameters (time format)

Specification range: 0.0 to 6000.0 sec.

	SDC40B code	Name	Setting (sec.)
*	TPA01		
*	TPA02		
*	TPA03		
*	TPA04		
*	TPA05		
*	TPA06		
*	TPA07		
*	TPA08		
*	TPA09		
*	TPA10		

■ Variable parameter (flag format)

Specification range: 0 (OFF), 1 (ON)

	SDC40B code	Name	Setting (0 or 1)	SDC40B code	Name	Setting (0 or 1)
*	FPA01			FPA11		
*	FPA02			FPA12		
*	FPA03			FPA13		
*	FPA04			FPA14		
*	FPA05			FPA15		
*	FPA06			FPA16		
*	FPA07			FPA17		
*	FPA08			FPA18		
*	FPA09			FPA19		
*	FPA10			FPA20		

Variable parameters (index format)

Specification range: 0 to 30000

	SDC40B code	Name	Setting
*	IPA01		
*	IPA02		
*	IPA03		
*	IPA04		
*	IPA05		
*	IPA06		
*	IPA07		
*	IPA08		
*	IPA09		
*	IPA10		

Engineering unit parameters

Specification range: Lower engineering unit limit to upper engineering unit limit

	SDC40B code	Name (PID1 related)	Setting (U)	SDC40B code	Name (PID2 related)	Setting (U)
*	EP1-0			EP2-0		
*	EP1-1			EP2-1		
*	EP1-2			EP2-2		
*	EP1-3			EP2-3		
*	EP1-4			EP2-4		
*	EP1-5			EP2-5		
*	EP1-6			EP2-6		
*	EP1-7			EP2-7		

UF key processing data

	SDC40B code	Name (UF1 key related)	Setting	SDC40B code	Name (UF2 key related)	Setting
	UF.SET	Basic UF1 key registration		UF.SET	Basic UF2 key registration	
*	UF-01			UF-01		
*	UF-02			UF-02		
*	UF-03			UF-03		
*	UF-04			UF-04		
*	UF-05			UF-05		
*	UF-06			UF-06		
*	UF-07			UF-07		
*	UF-08			UF-08		

Digital input processing data

Specification range: 0 to 12

SDC40B code	Digital input processing starting point	SDC40B code	Number of digital input processing units
DI.TOP(1)		DI.NBR(1)	
DI.TOP(2)		DI.NBR(2)	
DI.TOP(3)		DI.NBR(3)	
DI.TOP(4)		DI.NBR(4)	
DI.TOP(5)		DI.NBR(5)	
DI.TOP(6)		DI.NBR(6)	

■ ID data settings (for reference only)

SDC40B code	Item	Initial value
ID-01	Hardware type 1	
ID-02	Hardware type 2	
ID-03	ROM ID	
ID-04	ROM ITEM	
ID-05	ROM revision	

■ Protect settings

<table>
<tr><th>SDC40B code</th><th>Item</th><th>Description</th></tr>
<tr><td>SEL</td><td>Setting transition selection</td><td>
<table>
<tr><th></th><th>□0</th><th>□1</th><th>□2</th><th>□3</th><th>□4</th><th>□5</th></tr>
<tr><td>Protection</td><td>○</td><td>○</td><td>○</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Control computational data</td><td>×</td><td>○</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>PID parameter</td><td>×</td><td>○</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>Variable parameter</td><td>×</td><td>○</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>Engineering unit parameter</td><td>×</td><td>○</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>Linearization table data</td><td>×</td><td>×</td><td>○</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>PTB table data</td><td>×</td><td>×</td><td>○</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>TTB table data</td><td>×</td><td>×</td><td>○</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>Setup</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>Input processing data</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>UF key processing data</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>Digital input processing data</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>ID data</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>Computational unit monitor</td><td>×</td><td>×</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>Input signal monitor</td><td>×</td><td>×</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
</table>
○: transition possible, ×: transition not possible
</td></tr>
<tr><td>LOC</td><td>Key lock
1st digit: PARA key
2nd digit: CAS key
3rd digit: AUTO key
4th digit: MAN key
5th digit: AT key</td><td>Example: ××××× (0: no key lock, 1: key lock)
0 0 0 0 1
(Only PARA key lock)</td></tr>
</table>

■ Trend processing data

Item	Description	Setting
Data trend 1 assignment		
Data trend 2 assignment		
Data trend 3 assignment		
Data trend cycle	1 to 30000 sec.	

■ Computational unit data

No.	Computational expression		H1 input signal		H2 input signal		P1 input signal		P2 input signal	
	Name	Computation sequence	Signal	Code	Signal	Code	Signal	Code	Signal	Code
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
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49										
50										

	AIR1	AIR2	AIR3
Input name			
Input range type			
Lower engineering unit limit			
Upper engineering unit limit			
Linearization table No.			
Temperature compensation			
Pressure compensation			
Square-root extraction			
Digital filter			
	AI1	AI2	AI3

Management No.	Computation cycle	Control type	IM mode transitions	Startup	Preset mode

DI01	DI02	DI03	DI04	DI05	DI06
DI07	DI08	DI09	DI10	DI11	DI12

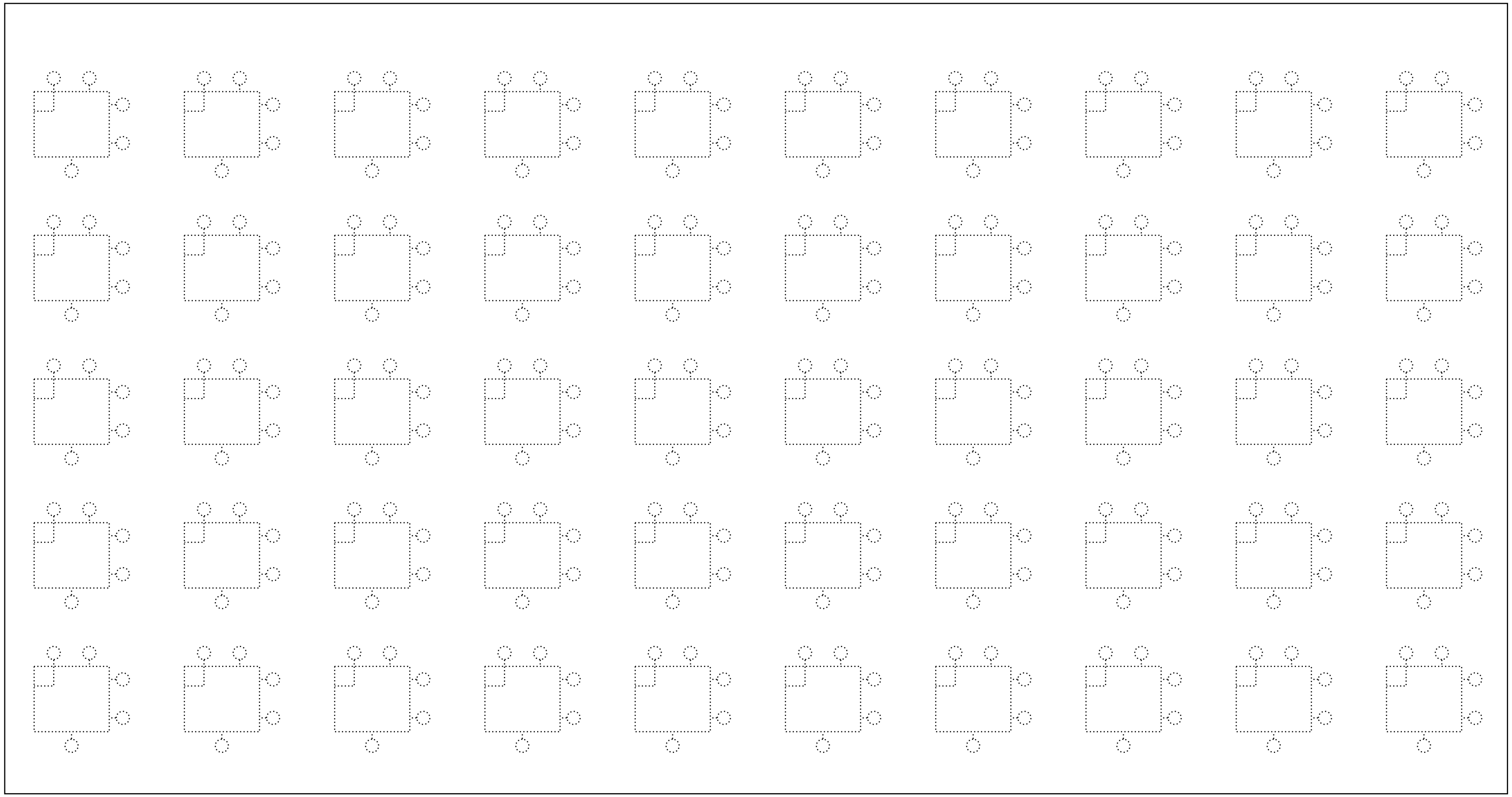
DIX1	DIX2	DIX3	DIX4	DIX5	DIX6

Customer name

Control device

Tag No.

PARA	Name	Setting



AO1	AO2	AO3

DO1	DO2	DO3	DO4	DO5	DO6	DO7	DO8

Revision History

Printed Date	Manual Number	Edition	Revised pages	Description
95-05	**CP-UM-1680E**	**1st Edition**		
01-02		**2nd Edition**	1-5 1-19 1-22 1-24 1-28 1-33 1-36 1-43 1-49 1-53 1-55 1-61 2-17 2-18	DVD corrected to DIV *Note added *Note 2 added *Note 2 added Graph curve corrected Table added Explanation added Explanation and timing chart added Conditions added AT2 expression added. P1: ON corrected to OFF Computational expression revised No.68 and 69 corrected to No.69 and 70 Initial value corrected from 1 to 0 ADD unit P2: 1.0 changed to 100.0. Description deleted. CPX unit OUT line: ($0.1m^2$/pulse) added ADD unit P2: 1/10 changed to 10/100 SW unit DI01CG: ($0.1m^3$/pulse) added
02-07		**3rd Edition**	1-18, 1-55 2-17	Computational expression added ($0.1m^2$/pulse) corrected to ($0.1m^3$/pulse)

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