Chapter5. FUNCTIONS AND SYSTEM CONFIGURATION

5 - 1 Outline of Functions

DigitroniK SDC40B operations can be divided into the three following types of functions.

- Input processing functions
- Computational processing functions, and
- Output processing functions

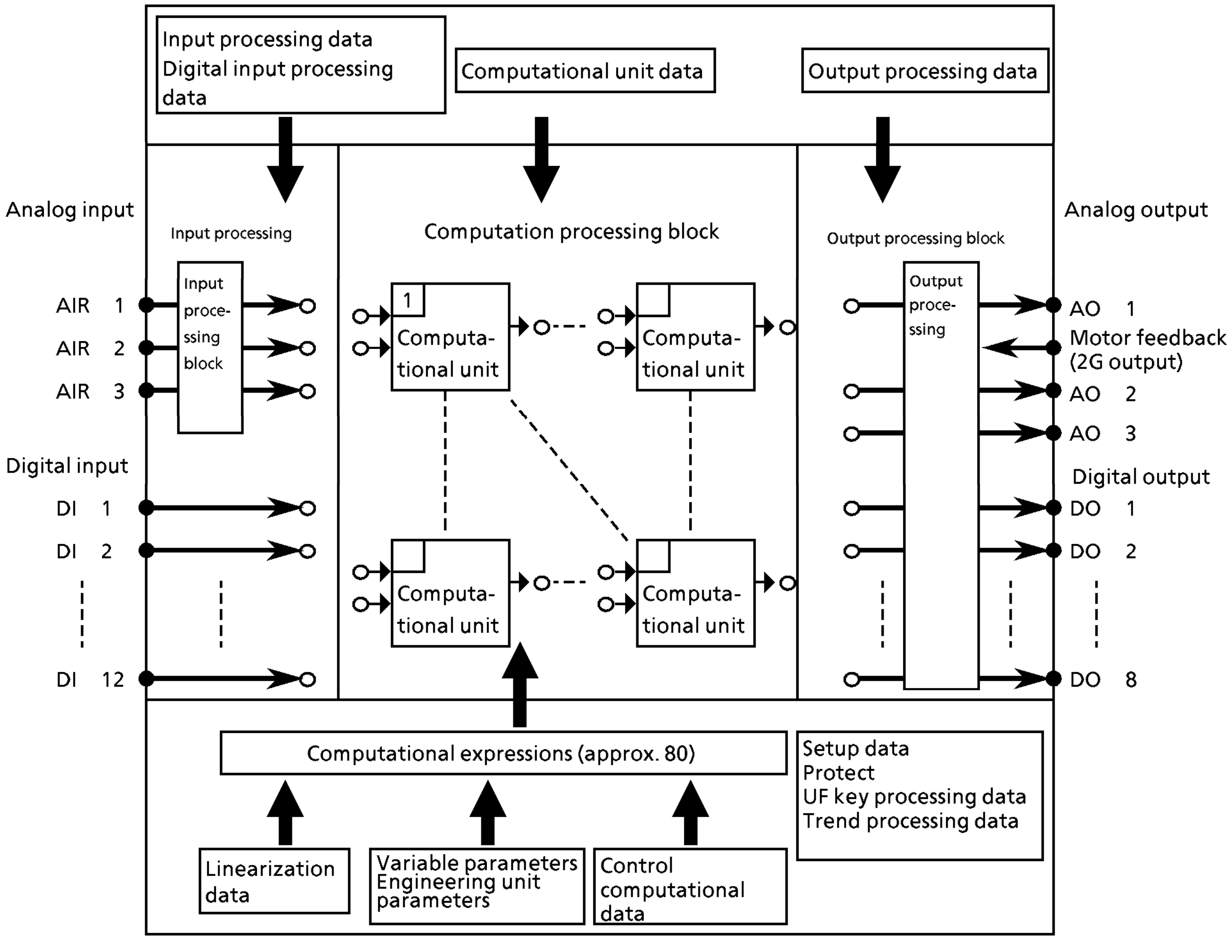
Each of these basic types of functions has its own built-in, specialized processing functions that allow SDC40B users to select the processing that suits their applications and individual instrumentation specifications.

The SDC40B's computational processing functions consist of 50 computation processing blocks called "Computational units". These computational units are assigned a total of 80 types of computational expressions (described in Chapter 6. COMPUTATIONAL EXPRESSIONS), and are interconnected in a configuration that enables them to execute a variety of computation control functions.

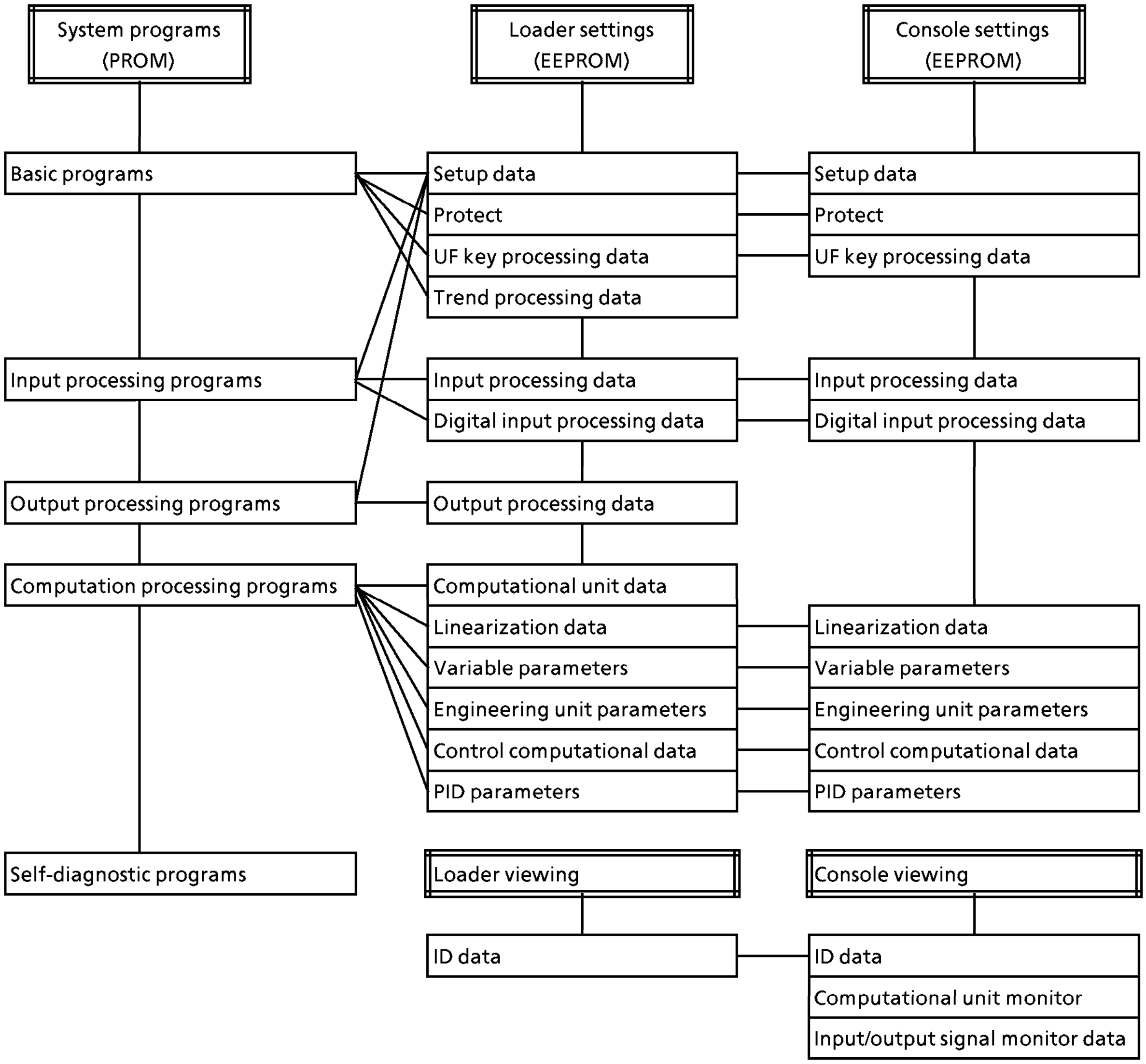
Data used to select the different computations is called "Configuration data" and is divided into the categories shown on the following page. "Configuration data" is written to the SDC40B's memory(EEPROM) by the loader. In addition to "Configuration data" there is "Monitor data", used to monitor actual system input and output.

The figure below shows the relationship between Configuration data and the various processing units.

The figure on the following page shows the relationships between the SDC40B's internal programs and computational data. System programs are stored in the SDC40B's system PROM. Configuration data, generated according to instrumentation specifications in the loader, is stored in the SDC40B's EEPROM. Configuration data that requires updating, such as operation conditions data, is updated from consoles as required during operation and retained in the EEPROM, even when power outages occur.

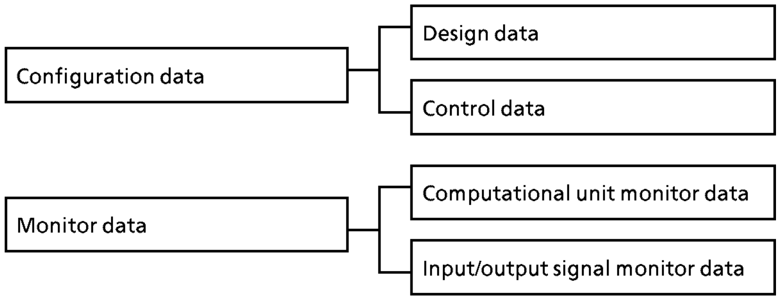


- **Program configuration**



5 - 2 Types of System Data

The SDC40B's system data is arranged according to the following categories.



● Design data

"Design data" is divided into the computational unit data and output processing data categories. The former specifies types of computational expressions and the connection configurations for computational units and the latter specifies the types of signals to be output.
These data types can be set only from a personal computer (PC) loader, they cannot be set or viewed from the system console.

● Control data

"Control data" is mainly used for computation processing.
It can be set from both the loader and console, although certain types can be viewed only.
Trend processing data is set by the PC loader, and cannot be set or viewed from system consoles.

● Computational unit monitor data

Used to monitor actual values being input to computational units, "Computational unit monitor data" is also used for configuration data debugging operations.
Computational unit monitor data can be viewed from the system console and with the data trend function of the PC loader.

● Input/output signal monitor data

"Input/output signal monitor data" is used to monitor the analog input/output signals, digital input/output signals and PID controller input/output signals. It can be viewed from the system console and with the data trend function of the PC loader.

Categories of configuration data

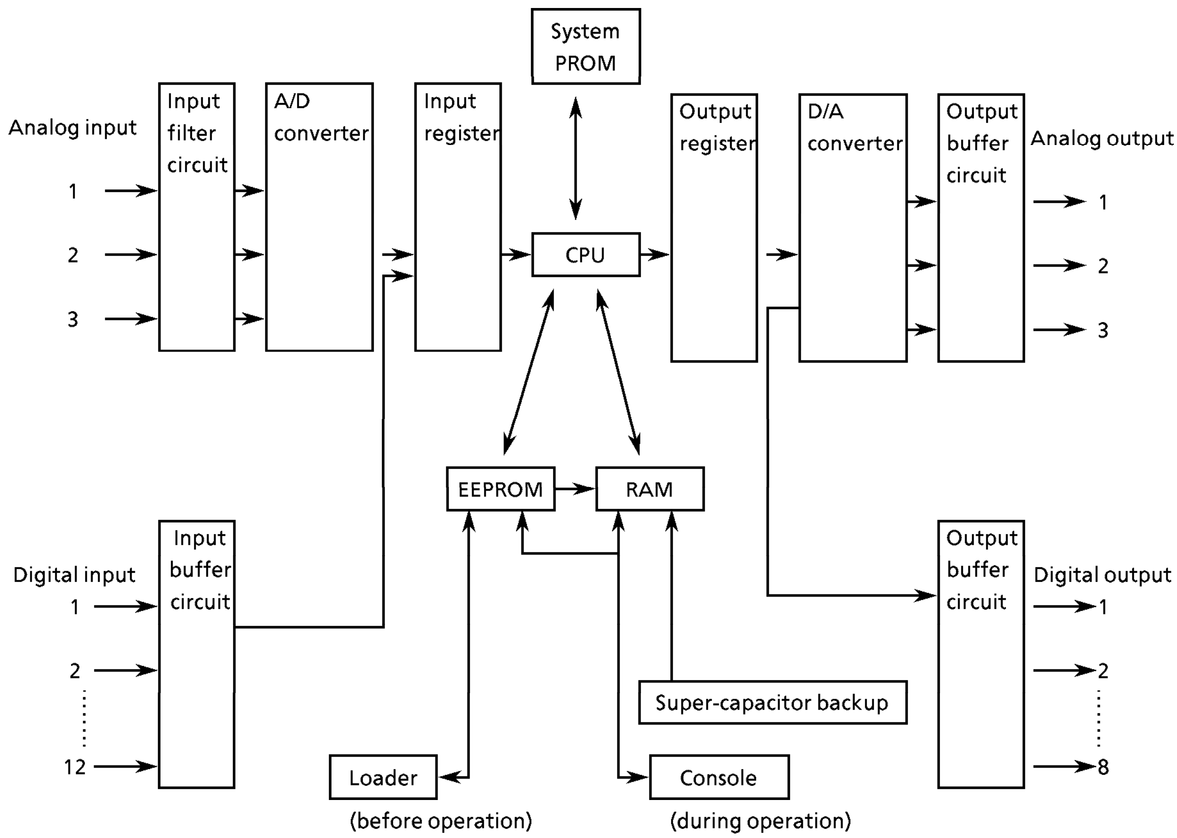
- Configuration data
  - Design data
    - Computational unit data — Specifies computational expressions and connection configurations
    - Output processing data — Specifies configurations for outputting signals.
  - Control data
    - Setup data — Specifies control type and computation cycle.
    - Input processing data — Specifies input processing type
    - Control Computational data — Specifies PID groups and types of PID computation.
    - PID parameters — Specifies control parameters for PID groups 0 to 7.
    - Linearization data — Specifies line shape and three table types; linearization, PTB and TTB.
    - Variable parameters — Specifies coefficients and constants used in computation processing. Four parameter types; percentage, time, flag and index.
    - Engineering unit parameters — Parameters for making settings in engineering units. Done internally using percentage (%). Specifies either of two functions assigned to each UF key.
    - UF key processing data — Specifies DI1 to DI12 for use as index data.
    - Digital input processing data — Specifies data items not contained in EEPROM such as hardware type, ROM ID, ROM item and ROM revision number.
    - ID data — Specifies keylock settings.
    - Protect
    - Trend processing data — Specified using the PC loader's data trend function.

Categories of monitor data

- Monitor data
  - Computational unit monitor data
  - Input/output signal monitor data

5 - 3 Principles of Operation

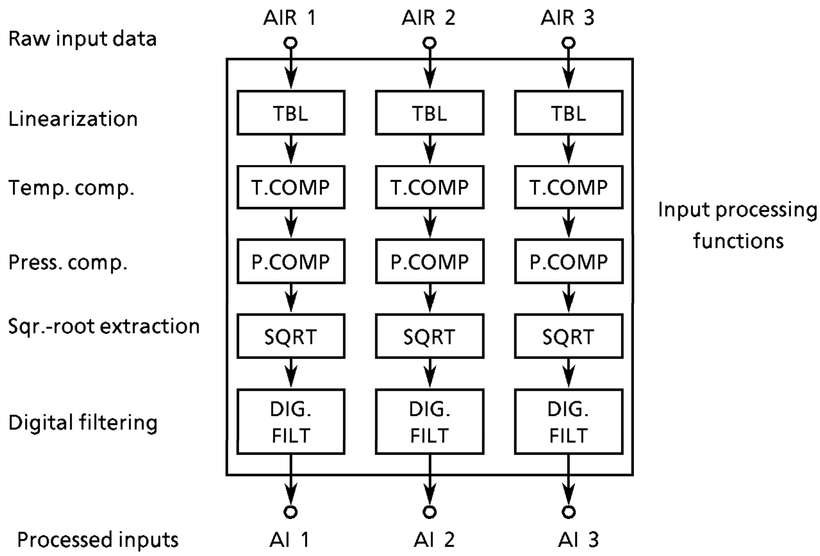
Noise in the analog signals is removed by the input filter circuit. The signals then undergo A/D conversion and are stored in the input register. Noise is removed from the digital signals in the input buffer and the input values are then stored in the input register.
The CPU performs computation processing according to system programs, configuration programs and input register data, and outputs results, which are stored in the output register.
Analog signals are output in two forms, current output and position proportional output. After D/A conversion, current output is output in the 4 to 20mA range via the output buffer.
With position proportional output, the CPU compares the output values and motor opening input values and operates the relays (on/off) to ensure they both match.



5 - 4 Input Processing Functions

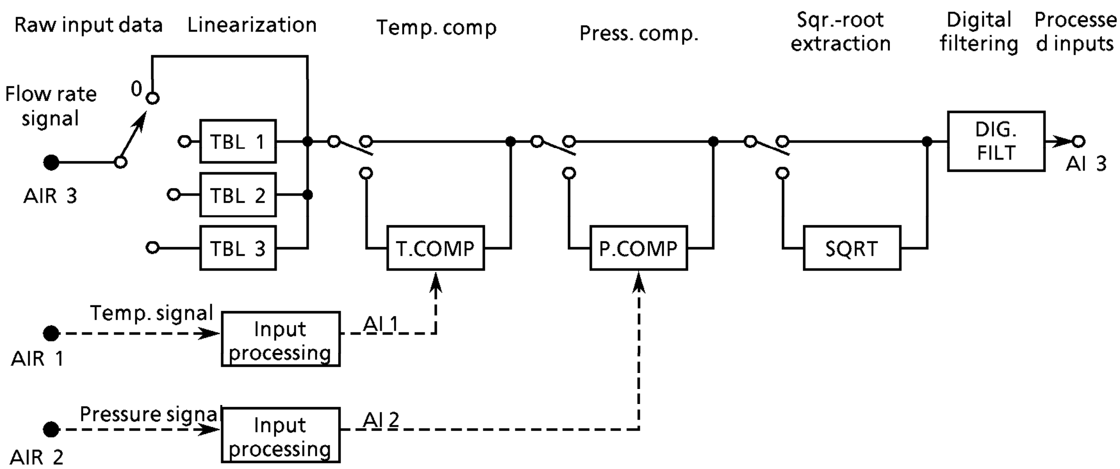
The SDC40B can connect up to three analog input signals having the following functions. Input processing can be inhibited by specifying the not used setting in "Input processing data".

- Example of temperature and pressure compensation



The figure below shows an example of applying temperature compensation and pressure compensation operations to flow rate input signals during the measuring of gas flow rates.
Whether or not processing is enabled and the data settings used for the processing performed by the various input processing functions are determined by "Setup data" and "Input processing data" settings.

- Example of temperature and pressure compensation

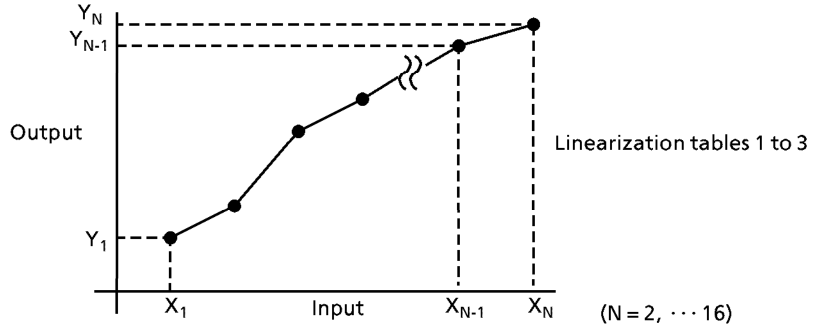


Approximation by linearization table(TBL)

Linearization table approximation can be used to express analog inputs AI1 to AI3 in line form.

Three linearization table operations are provided as computational expressions and the table to be utilized is selected according to the computation. A maximum of 16 points can be defined for each linearization table (TBL1 to TBL3).

Two or more linearization tables can be connected in chain format to function as a single table. The definitions for point coordinates (X:input, Y:output) and chain-connections are selected using “Linearization table data” settings which can be modified from the console, even during SDC40B operation.



Temperature compensation (T. COMP)

The following expression is used to calculate temperature compensation for the flow rate signal during flow rate measurement.

$$\text{Compensated flow rate signal} = \frac{\text{Design temp. (target temp.)} + \text{constant}}{\text{“Current temp.”} + \text{constant}} \times \text{“Flow rate signal”}$$

As indicated by the expression above and by the example on the preceding page, a current temperature signal is needed to calculate compensation. An analog input number (from 1 to 3) is selected as the temperature compensation input value when making the “Input processing data” setting. Select "0" as the temperature compensation input value if temperature compensation is not being applied

The SDC40B processes the three analog signals ordered from AI1 to AI3.

Temperature signals must be processed prior to flow rate signals. This means earlier numbers must be assigned to temperature signals in order to effectively compensate the temperature of flow rate signals. If the flow rate signal is AI2, for example, the temperature signal must be AI1.

The design temperature (target temp.) is also set using “Input processing data”. Temperature compensation can be selected using either of the following two types of engineering units, shown below with their computational constants.

°C : constant = 273.15
°F : constant = 459.7

Current temperature signal settings are also of importance. “Setup data” is used to select the unit (°C or °F) for the temperature signal’s AI1 thermocouple range and resistance temperature detector (RTD) range. In this case, the “Input processing data” setting that specifies the engineering unit for temperature compensation for the flow rate signal cannot be set, as it rendered invalid. When the current temperature signal is in the AI1, AI2 and AI3 linear range, set it as the temperature signal by specifying the decimal point position of the displayed measuring unit, the lower limit (0%) and the upper limit (100%) in “Input processing data”.

■ Pressure compensation (P. COMP)

The following expression is used to calculate pressure compensation for the flow rate signal during flow rate measurement.

$$\text{Compensated flow rate signal} = \frac{\text{“Current pressure”} + \text{constant}}{\text{Design pressure (target pressure)} + \text{constant}} \times \text{“Flow rate signal”}$$

As indicated by the expression above and by the example on page 5-6, a current pressure signal is needed to calculate compensation. An analog input number (from 1 to 3) is selected as the pressure compensation input value when making the “Input processing data” setting. Select "0" as the pressure compensation input value if pressure compensation is not being applied.

The SDC40B processes the three analog signals ordered as AI1 to AI3.

Pressure signals must be processed prior to flow rate signals. This means that earlier numbers must be assigned to pressure signals, in order to effectively compensate the pressure of flow rate signals. Thus, in a case where both temperature and pressure compensation are applied, assign the temperature signal to AI1, the pressure signal to AI2 and the flow rate signal to AI3.

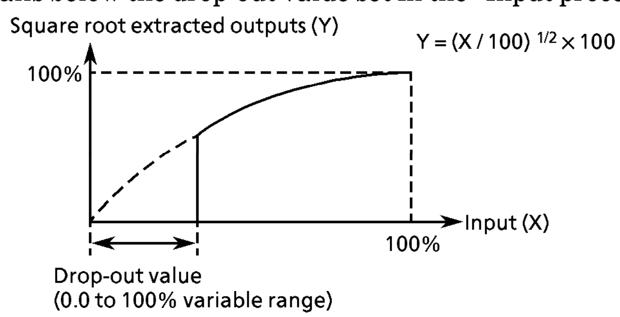
The design pressure (target pressure) is also set using “Input processing data”.Pressure compensation can be selected using the following five types of engineering units, which are shown below with their computation constants.

MPa : constant = 0.101325
kPa : constant = 101.325
Pa : constant = 101325
kgf / cm^2 : constant = 1.03323
mmH_2O : constant = 10332.3

Current pressure signal settings are also of importance. Set the pressure signal in the AI1, AI2 and AI3 linear range by specifying the decimal point position of the displayed measuring unit, the lower limit (0%) and the upper limit (100%) in “Input processing data”. Do not set the pressure signal in the AI1 thermocouple range and resistance temperature detector (RTD) range.

■ Square root extraction (SQRT)

The differential pressure measured at the orifice of a differential pressure flow meter is normally directly proportional to the second power of the flow rate signal, so square root extraction is used to calculate fractional signals when required. Whether or not square root extraction is applied is specified in “Input processing data”. Square root extraction comes with a drop-out function, which outputs 0% when the square root extraction input falls below the drop-out value set in the “Input processing data”.



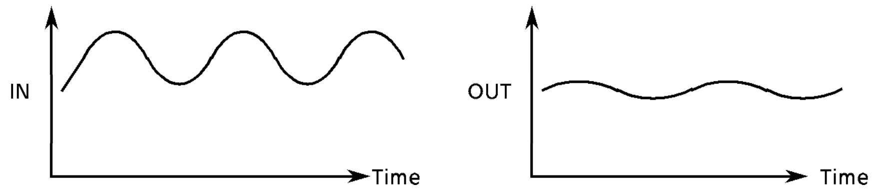
■ Digital filtering (DIG.FILT)

The digital filter is used to remove the process noise that gets impressed on the input signal. As shown in the expression below, the digital filter is based on the following primary delay operation.

$$\text{Output} > \frac{1}{1+T\times S}\times \text{Input}$$

T: filter constant
S: Laplacian

The filter constant is set using “Input processing data” settings. Entering 0.0s as the constant disables digital filter operation.

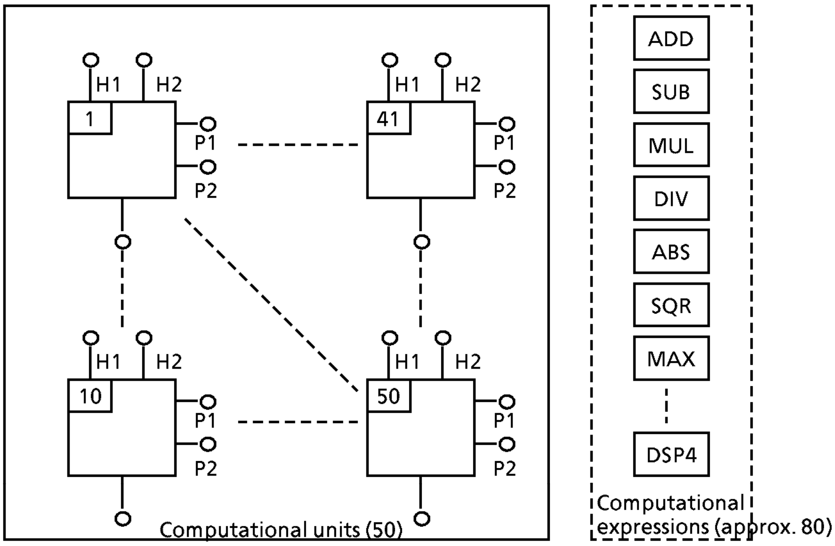


Handling Precautions

- The engineering units that can be used for processed inputs (AI1 to AI3) are limited to the -10.0 to + 110.0% range.
- Temperature and pressure compensation computations are calculated using values expressed as engineering units.

5 - 5 Computational Processing Functions

The SDC40B contains 50 computational units capable of executing approximately 80 computational expressions that can be used in any desired combination.



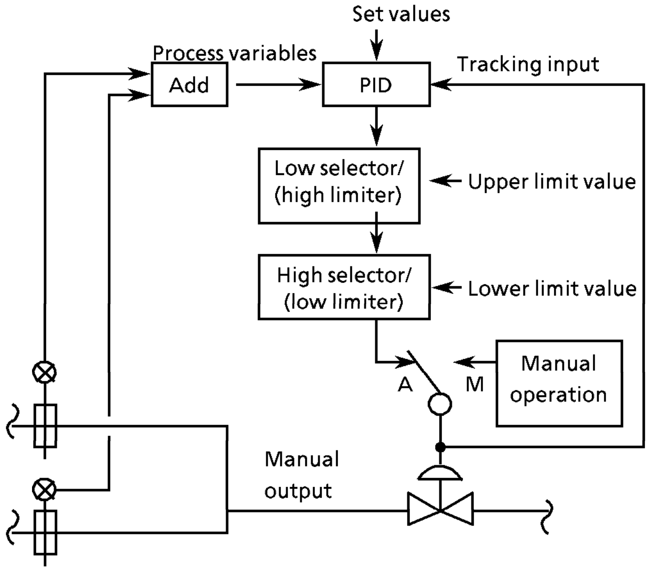
The various computational units are designed with four input lines (H1, H2, P1 and P2) and a single output line. How many of its lines an computational unit uses depends on the computational expression assigned to it. Refer to Chapter 6. COMPUTATIONAL EXPRESSIONS for descriptions of the lines and their individual functions.

The computational units are named according to the computational expression they are assigned. A computational unit assigned the ADD computational expression, for example, is referred to as an [ADD computational unit].

■ Determining computational functions (computational unit data settings)

Configuring the desired computational functions requires deciding on which computational units to assign which functions.

The sample control operation shown below requires the computational unit configuration illustrated on page 5-11. Being able to configure operation in this manner allows a single SDC40B computational unit to perform the processing normally done by systems that combine controllers, computation devices and other auxiliary units.

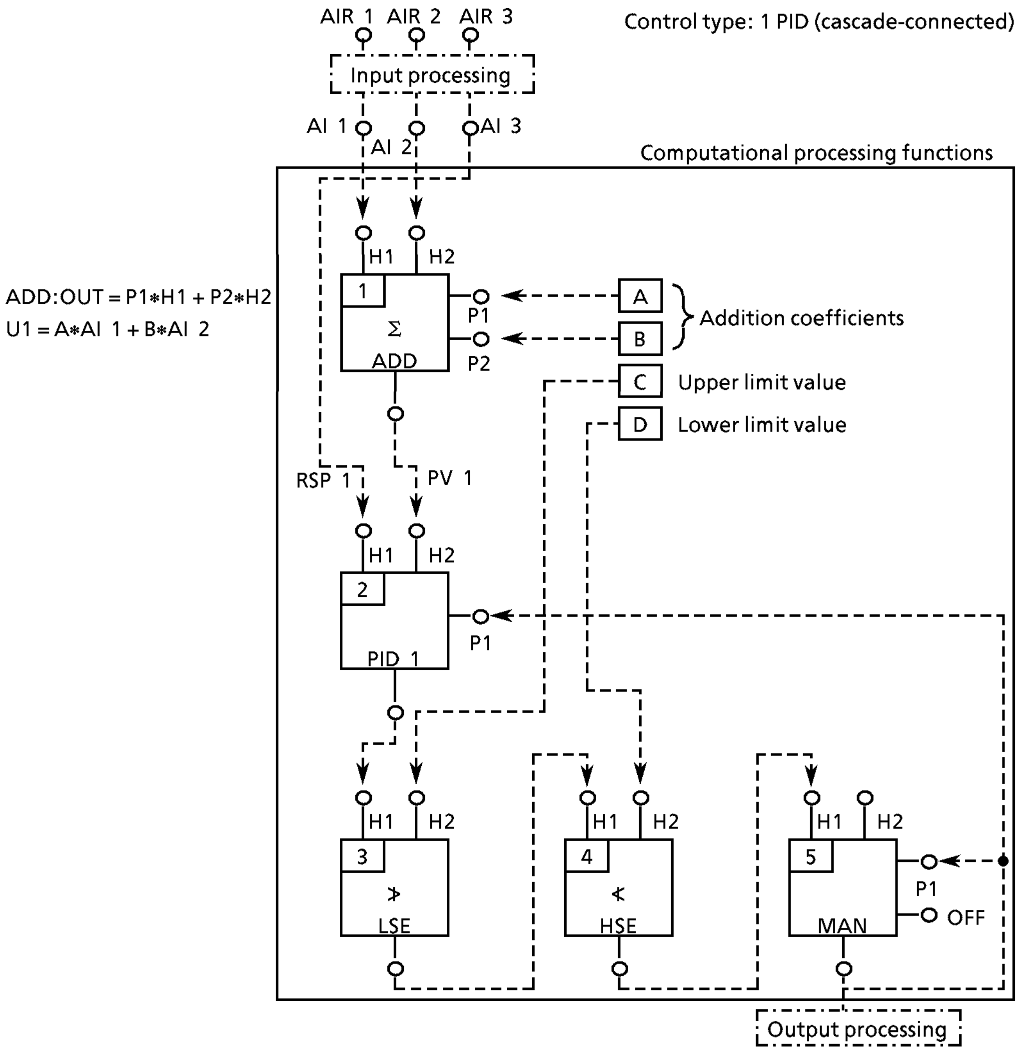


Control operation

The example shows a loop configuration in which PID, based on an external signal, is performed on control variables comprising the sum of two signals.

- Upper and lower limits are applied to automatic control output.
- Manual operation can be performed regardless of these limit values.
- Final stage output, required to enable smooth changeover from manual to automatic operation, is fed back to the PID computational unit.

- Design sheet (computational unit configuration)



The following page shows a sample of a filled-in design sheet. Once computational unit configuration (see figure above) has been determined, the names of computations assigned to each computational unit and the names of input signals connected to individual input lines are entered for each operation unit included in the design sheet's "Computational unit data". The formats for signals connected to individual input lines varies with each computational expression.

Such system constants as the coefficients and limit values, represented by A through D in the figure above, that can be modified during operation are set as "Variable parameters" and "Engineering unit parameters". The following page shows a sample of how variable parameters are filled in.

The SDC40B provides 40 percentage parameters (-999.9 to +999.9%), 10 time parameters (0.0 to 6,000.0s), 20 flag parameters (Off, On), 10 index parameters (0 to 30,000) and 16 engineering unit parameters.

Constants for A to D above, which are set only once and not modified during operation, are referred to as fixed parameters.

There is no restriction on their number and they can be used whenever required. The fixed parameters also come in the 4 percentage (-999.9 to +999.9%), 10 time (0.0 to 6,000.0s), 20 flag (Off, On) and 10 index (0 to 30,000) types, which are selected for input lines according to requirements of the individual computational expression.

- Sample filled-in design sheet

Computational unit No.	Computational expression		H1 input signal name	H2 input signal name	P1 input signal name	P2 input signal name
	Name	No.				
1	ADD	1	AI1	AI2	PPA01	PPA02
2	PID1	19	AI3	UOV01	UOV05	OFF*
3	LSE	11	UOV02	90.0*	—	—
4	HSE	10	UOV03	10.0*	—	—
5	MAN	18	UOV04	0.0*	AO1	OFF*
6						

* Fixed parameters

NOTE

Refer to ■ List of computational expressions (page6-2 to 6-4) for a detailed description.

- Sample of variable parameters filled-in

Variable parameter name	Value
PPA01	30.0(%)
PPA02	70.0(%)
∫	
TPA01	300.0(s)
TPA02	6.0(s)
∫	

The internal signals that can be used as input for the computational units used to configure computational expression functions are shown in the ■ List of internal signals (page6-5). They possess the percentage, time, flag and index data formats.

As with the variable and fixed parameters, the data formats for internal signals connected to input lines are determined by the type of computation expression. Although the preceding example shows an computational unit assigned an arithmetic computation, the SDC40B also includes logical computations, as well as logic circuits (including relays) normally configured externally, which can be configured using the computational functions.

■ Control computation settings

The SDC40B provides two PID computational expressions, PID1 and PID2. Only one of the available 50 computational units can be assigned to each computation. The computational unit assigned to PID1 becomes controller 1 and the unit assigned to PID2 is controller 2. The two units together are referred to as either the PID computational units or simply the controllers.

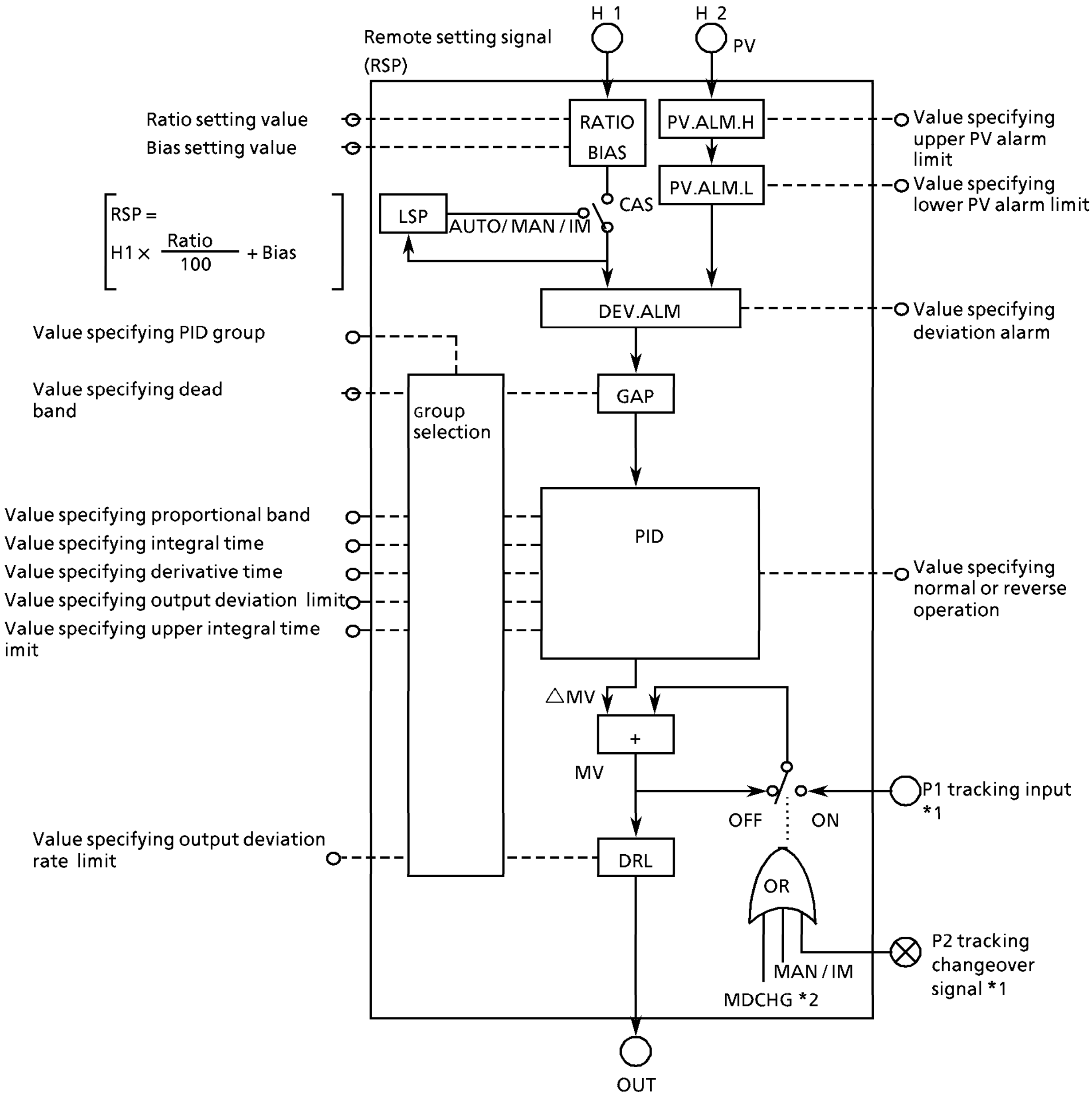
In addition to it's principle control computation, PID computational expressions include such added functions as PV, deviation alarm detection and ratio computations. The PID computation modes, control methods and added functions must be specified using "Control computational data" settings. "PID parameters" must also be used to specify PID control codstants. The following two PID computational modes can be specified using "Control computational data" settings.

· Normal PID (deviation derivative)

· Derivative-based (measured value derivative) PID

- Normal (deviation derivative) control computation mode

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).

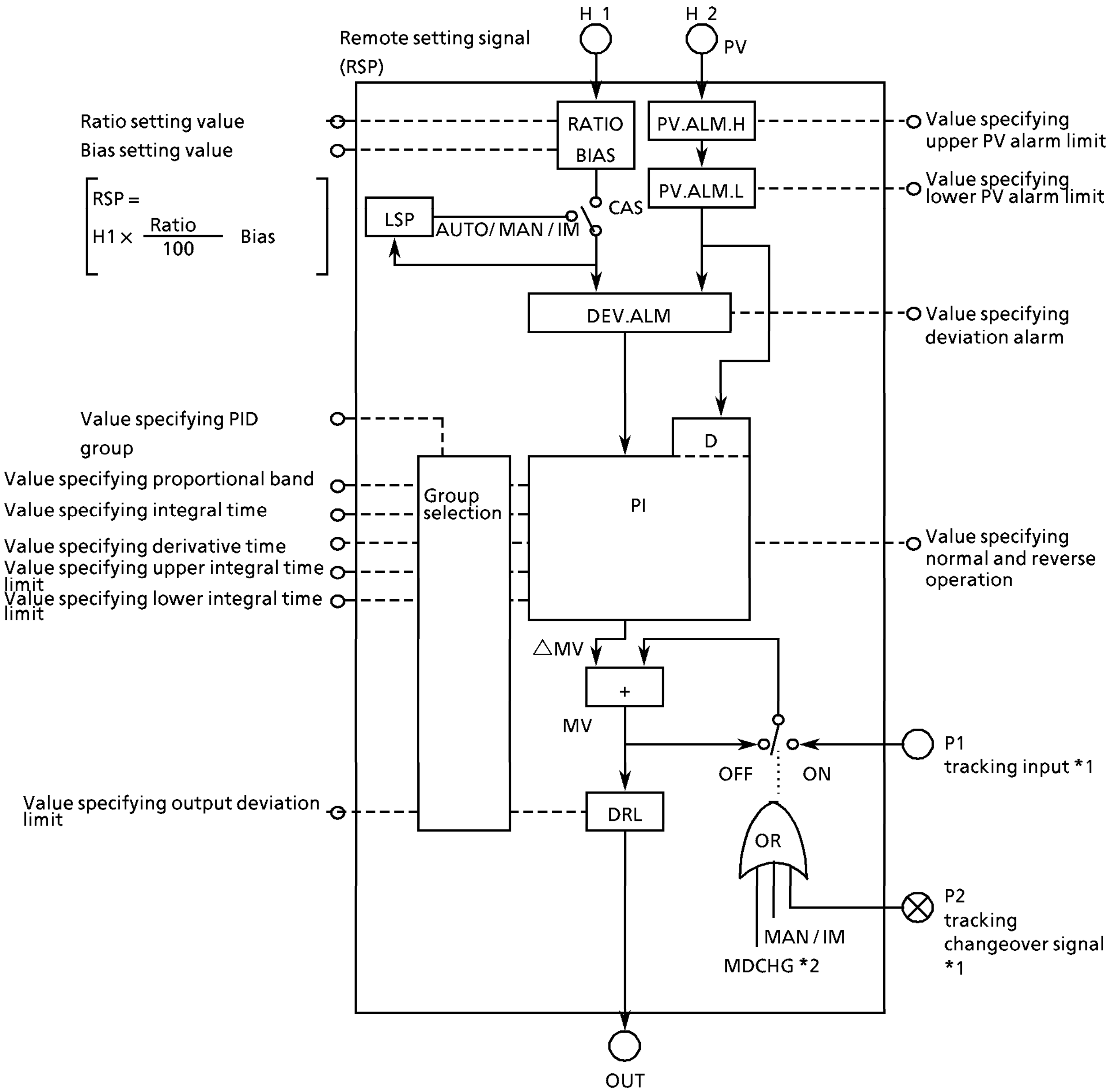


*1 Used for configuring the auto-tracking function.

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

- Derivative-based (measured value derivative) control computation mode

As shown in the figure below, derivative-based (measured value derivative) 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.

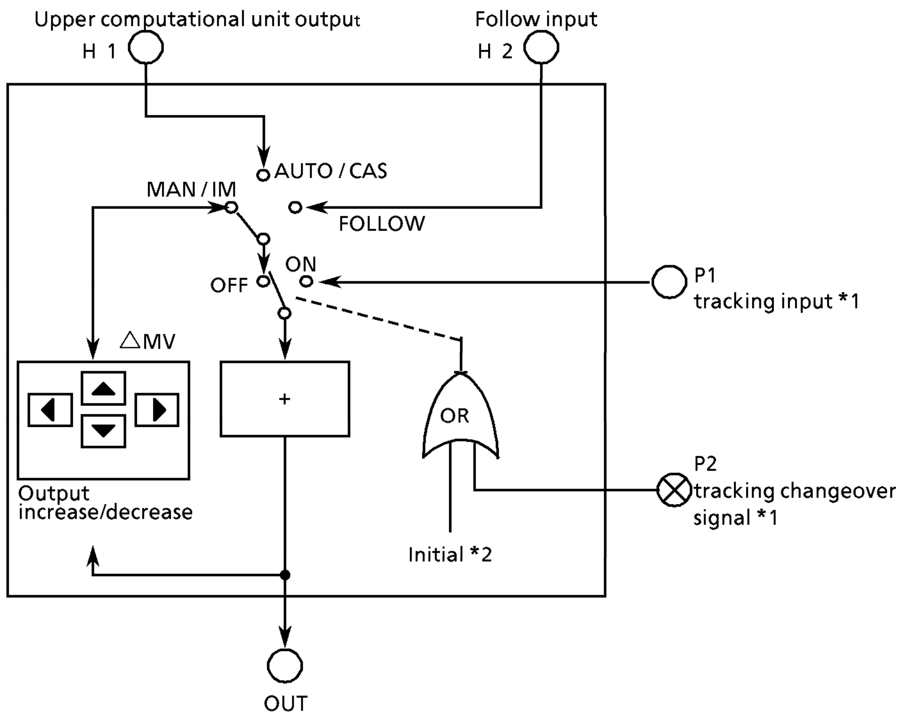


*1 Used for configuring the auto-tracking function.
*2 Mode change(Auto, Manual, Cascade, Follow, Interlock manual)

■ Manual output computation settings

The SDC40B provides a manual output computational expression that enables output to be controlled manually from the system console. This computation is also referred to as MAN, or manual computation.

Only one of the 50 computational units can be assigned to the MAN computation. The figure below shows the configuration of a MAN computational unit.



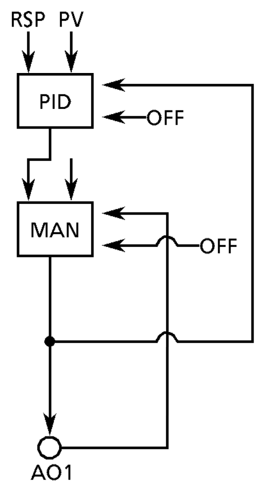
*1 Used for configuring the auto-tracking function.

*2 Power ON

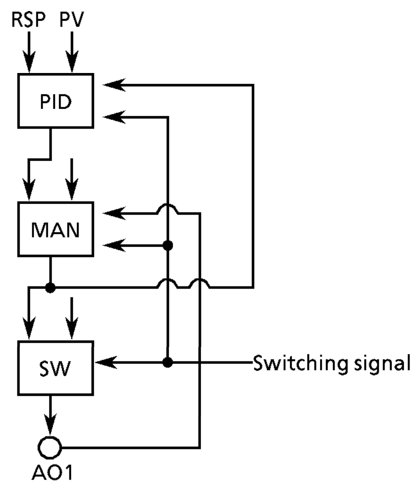
- Examples of MAN computational unit and analog output (AO) connections

  The diagrams below show examples of PID computational unit, MAN computational unit and analog output (AO) connections.

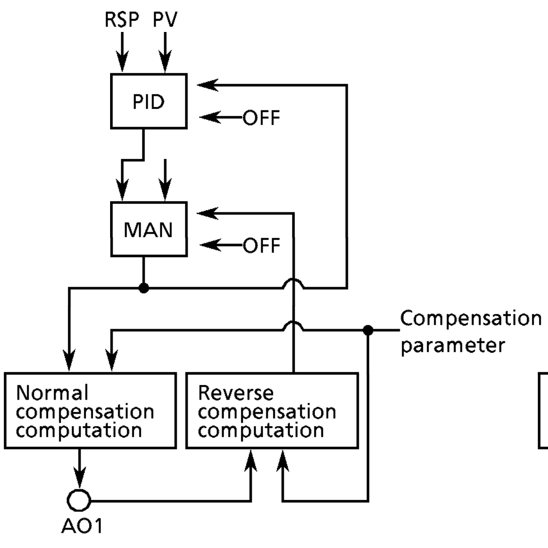
1.MAN computational unit directly connecting AO1



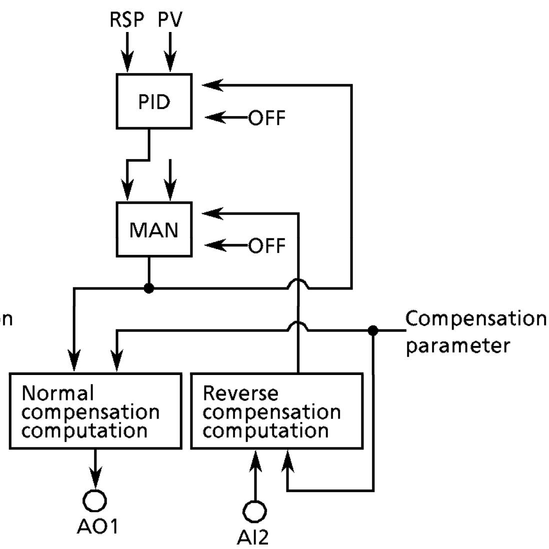
2.MAN computational unit connected to AO1 via switch



3.Computations inserted between MAN computational unit and AO1



4.Computations inserted between MAN computational unit and AO1 (when AI provides output feedback)



With compensation parameters, normally the same values are input for both normal compensation computations and reverse compensation computations.

■ Determining the computation processing cycle

The SDC40B performs computation processing according to fixed cycles. The computation cycle is set by entering the code number (see table below) of the desired cycle length in [setup data]. Note that the processing times (an absolute number) must fall within the allowable processing time (an absolute number) set for every SDC40B processing cycle. Otherwise, actual processing times will exceed computation processing cycles and may result in a computational overload error.

① The total processing time (an absolute number) of all computational units is calculated.Processing times vary according to computational expression; refer to Chapter 6. COMPUTATIONAL EXPRESSIONS for details.

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

② The total analog input processing time (an absolute number) specified by the input processing function is calculated according to the table below. If the input is set to not used, temperature compensation, pressure compensation, square-root extraction and linearization table approximation processing times are all set to "0".

	Input processing 1		Input processing 2		Input processing 3	
	No	Yes	No	Yes	No	Yes
Input used	0	18	0	12	0	12
Temperature compensation	0	2	0	2	0	2
Pressure compensation	0	2	0	2	0	2
Square-root extraction	0	3	0	3	0	3
Linearization table approximation	0	6	0	6	0	6

5 - 6 Output Processing Functions

The SDC40B is capable of multiple analog and digital outputs.
Models capable of 5G output (current output) are designed to output three analog signals in the 4 to 20mA range.
Analog output signal 1 (AO1) is referred to as the control output and analog outputs 2 and 3 (AO2 and AO3) as auxiliary outputs.
Models capable of 2G output (position proportional output) are designed to output a set of two types of digital relay outputs used for motor control and one analog signal in the 4 to 20mA range.
Analog output signal 1 (AO1) is referred to as the control output and analog signal 2 (AO2) is not installed. Analog signal 3 (AO3) is referred to as the auxiliary output.
There are three digital relay and five digital open collector output signals.

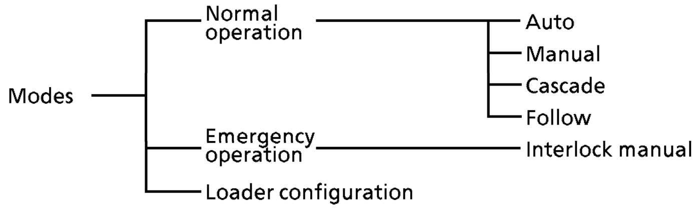
Signal type	Signal name	Description	
		5G control output	2G control output
Analog output signals	AO1	4 to 20mA current output	Position proportional output
	AO2	4 to 20mA current output	Not installed
	AO3	4 to 20mA current output	4 to 20mA current output
Digital output signals	DO1 DO2	Relay output (contact 1a)	Relay output (contact 1a, 1b)
	DO3	Relay output (contact 1a, 1b)	Relay output (contact 1a, 1b)
	DO4 ~ DO8	Open collector output	Open collector output

The following signals are output when power is turned on (until display and control start) and during the loader configuration mode

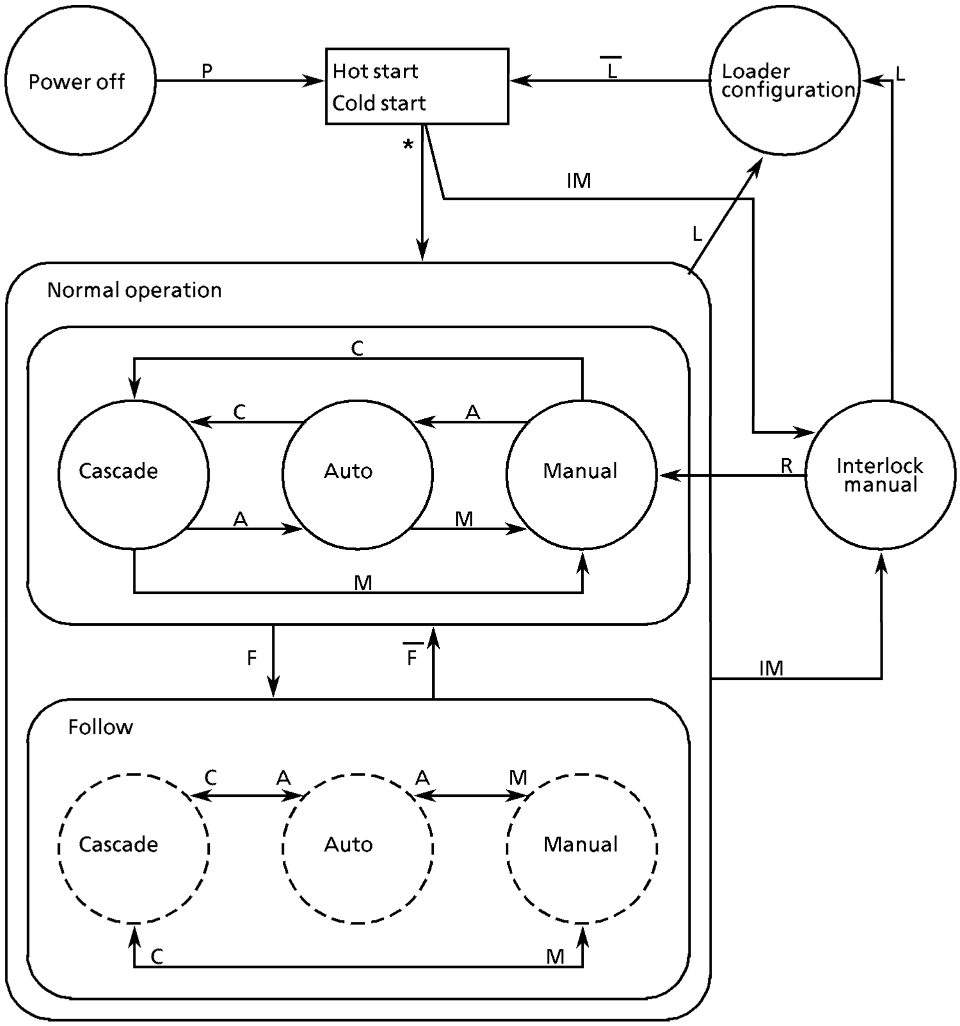
Signal type	Signal name	Output state	
		5G control output	2G control output
Analog output signals	AO1	2.4mA max.	Relay 1 off Relay 2 off
	AO2	2.4mA max.	Not installed
	AO3	2.4mA max.	2.4mA max.
Digital output signals	DO1 ~ DO8	all off	all off

5 - 7 Modes

The SDC40B possesses the following operating modes.



■ Mode transitions



A : AUTO key or auto mode selection signal
M : MAN key or manual mode selection signal
C : CAS key or cascade mode selection signal
F : follow mode selection signal
$\overline{F}$: follow mode disabling signal
IM : self-diagnostic based failure detection
R : reset signal
L / $\overline{L}$: starts and terminates configurations when loader is connected
P : power ON

* : See Section 7-1 Operating the SDC40B (page7-1).

■ Normal operating modes

● Auto mode (AUTO)

A "Fixed value control mode", in this mode the PID computational unit performs PID computations using LSP (local SP) values, set by the console's ▲key, ▼key, ▶key and ◀key, as target values.
The console's AUTO LED lights while the auto mode is active.

● Manual mode (MANUAL)

In this mode, the PID computational unit performs only integral operations, the MAN computational unit's output is latched and the console's ▲key, ▼key, ▶key and ◀key can be used to modify output values. The console's MAN LED lights while the manual mode is active.
The manual mode cannot be enabled unless the MAN computational unit has been registered.

● Cascade mode (CASCADE)

A "Cascade control mode", in this mode the PID performs PID computations using the RSP (remote SP) values, input via line H1, as target values.
This mode allows output from other computational units or external signals to be input through the PID computational unit's H1 line and used as remote SP (RSP) values.
The console's CAS LED lights while the cascade mode is active.

● Follow mode (FOLLOW)

In this mode, the MAN computational unit directly outputs the signal (follow signal) input through its H2 line.
In a configuration where an analog signal is input via the MAN computational unit's H2 line, the follow mode can be used to allow the analog signal to alter the MAN computational unit's output.
Enabling the follow mode requires a follow mode changeover signal (external contact signal or internal flag data signal) and the signal to be followed (follow input).
The console's FLW LED lights while the follow mode is active and indicators for the preceding auto, manual and cascade modes remain unchanged. The auto, manual and cascade modes can also be enabled during follow mode operation.

■ Emergency operating modes

The interlock manual mode is available as an emergency operating mode.

● Interlock manual mode

The SDC40B switches to this mode when self-diagnostic functions detect analog input over-range, computational overflow or computational overload during normal operation (in the auto, manual, cascade or follow modes).
Once the SDC40B switches to the interlock manual mode it cannot return to normal operation until one of the following conditions is satisfied.

- Setup's C 0 4 is set to 0.
- Cause is corrected and RST computation resets the system.
- In the case of cold start, power is applied after the cause is removed.

The manual mode is the default mode when normal operation is reenabled. However, if the MAN computational unit is not registered, the SDC40B defaults to the auto mode.

■ Loader configuration mode

This mode is used to transfer and store configuration data when a loader unit is connected to the SDC40B.

The loader configuration mode is automatically controlled from the loader. Refer to the User's Manual SLPC4B Smart Loader Package CP-UM-1681 for a detailed description.

5 - 8 Control Types

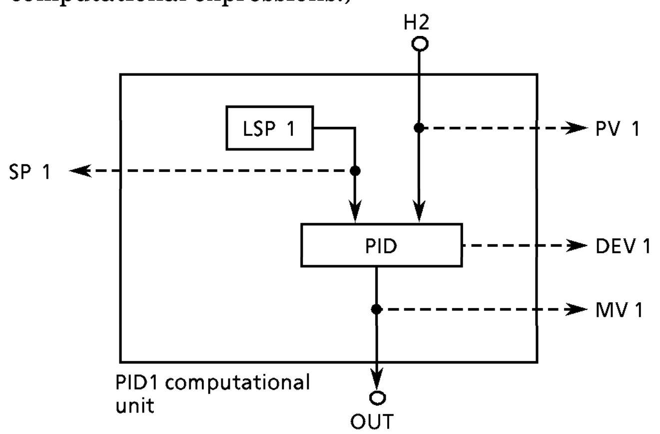
The SDC40B provides the following control types.

Control type	Control type 0	PID1 (local) format
	Control type 1	PID1 (cascade) format
	Control type 2	PID2 (controller 1 for R/L switching) format
	Control type 3	PID2 (controller 2 for R/L switching) format

The different types are selected using “Setup data” settings. LSP (local SP/local setting) values refer to the PID computational unit’s internal SP values. RSP (remote SP/remote setting) values refer to the PID computational unit’s externally input SP values.

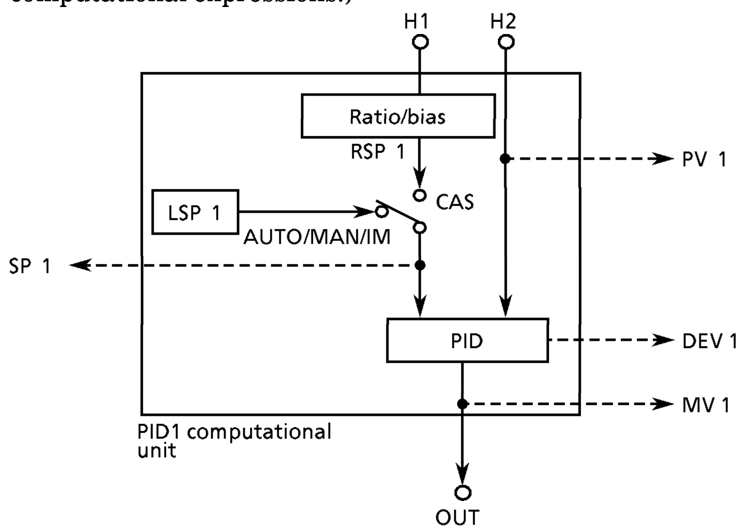
■ Control type 0

- PID1 (local) format
  Switches between LSP and RSP values to control measuring devices equipped with a single PID computational unit.
  (Assigns only one of the 50 computational units to perform PID1 computational expressions.)



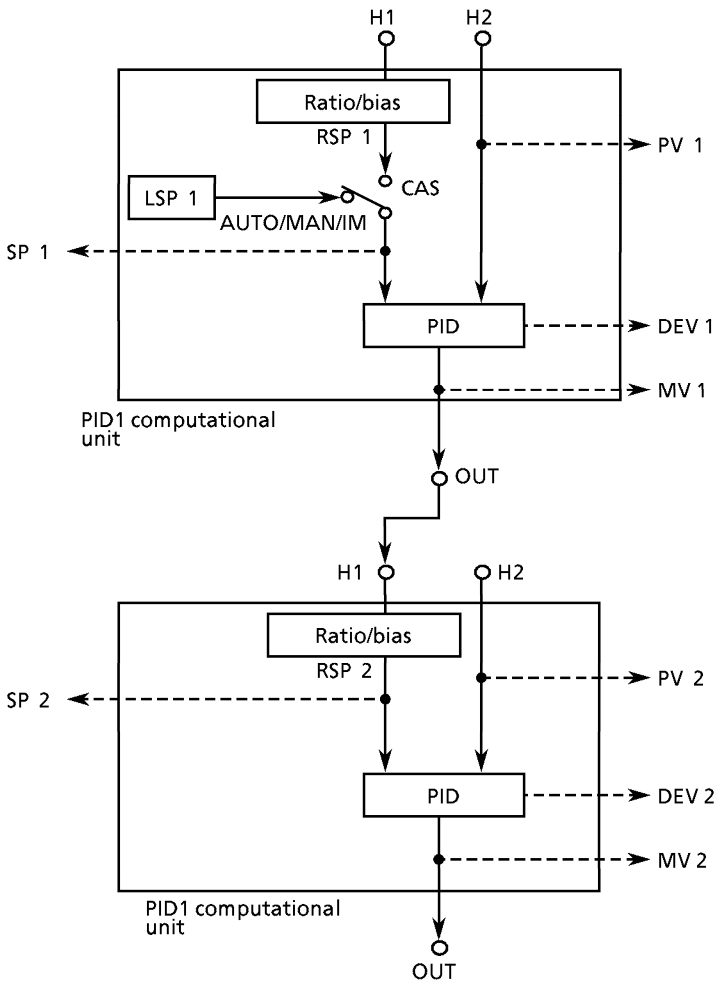
■ Control type 1

- PID1 (cascade) format
  Switches between LSP and RSP values to control measuring devices equipped with a single PID computational unit.
  (Assigns only one of the 50 computational units to perform PID1 computational expressions.)



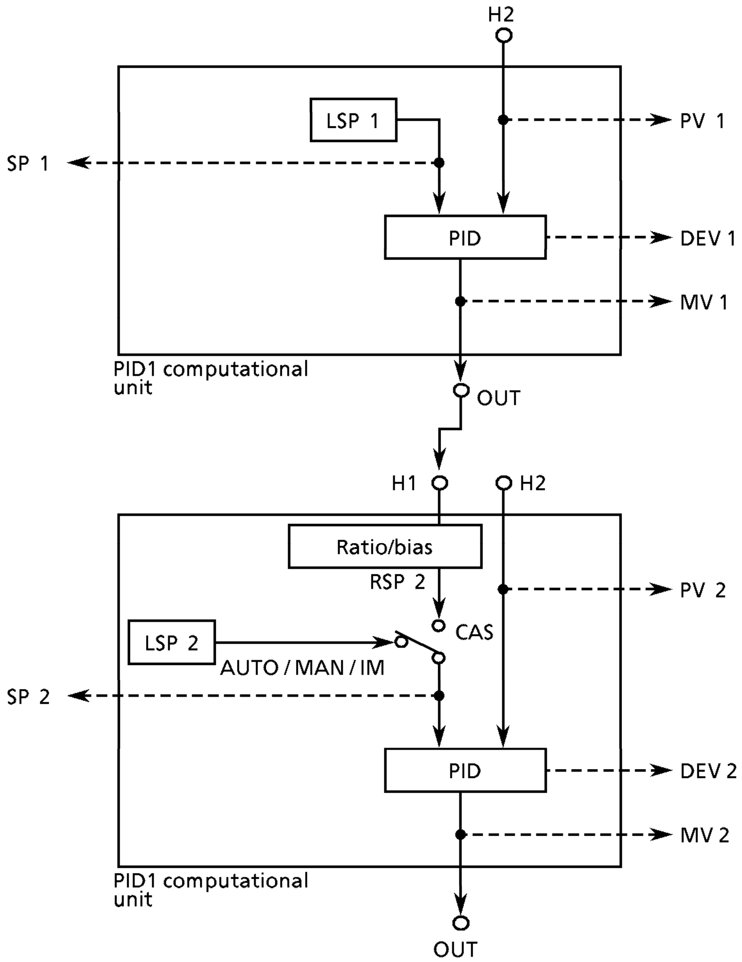
■ Control type 2

- PID2 (controller 1 for R/L switching) format
  Establishes 2 PID computational units in a single measuring device. Controller 1 of the PID computational units switches between LSP and RSP values to perform control, while controller 2 uses only RSP values to perform control.
  (Assigns two of the 50 computational units to perform PID computational expressions.)



■ Control type 3

- PID2 (controller 2 for R/L switching) format
  Establishes 2 PID computational units in a single measuring device. Controller 1 of the PID computational units uses LSP values to perform control, while controller 2 switches between LSP and RSP values to perform control
  (Assigns two of the 50 computational units to perform PID computational expressions.)

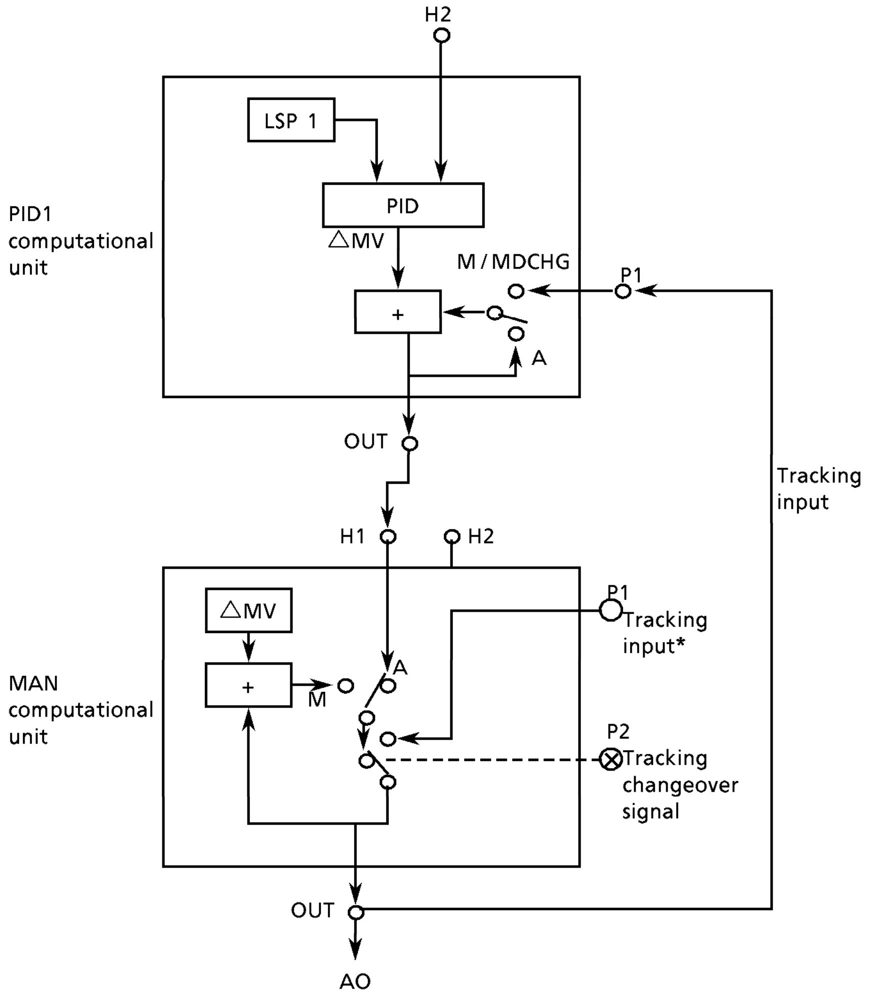


5 - 9 Auto Balance Functions

The SDC40B allows creation of auto balancing functions to prevent output shear that develops with some PID and MAN computational unit feedback input configurations when modes (auto, manual and cascade) are changed.

■ Auto balancing control type 0

As shown in the figure below, connecting the MAN computational unit's output to the PID1 computational unit's P1 (tracking signal input) line balances output in both the auto and manual mode directions.

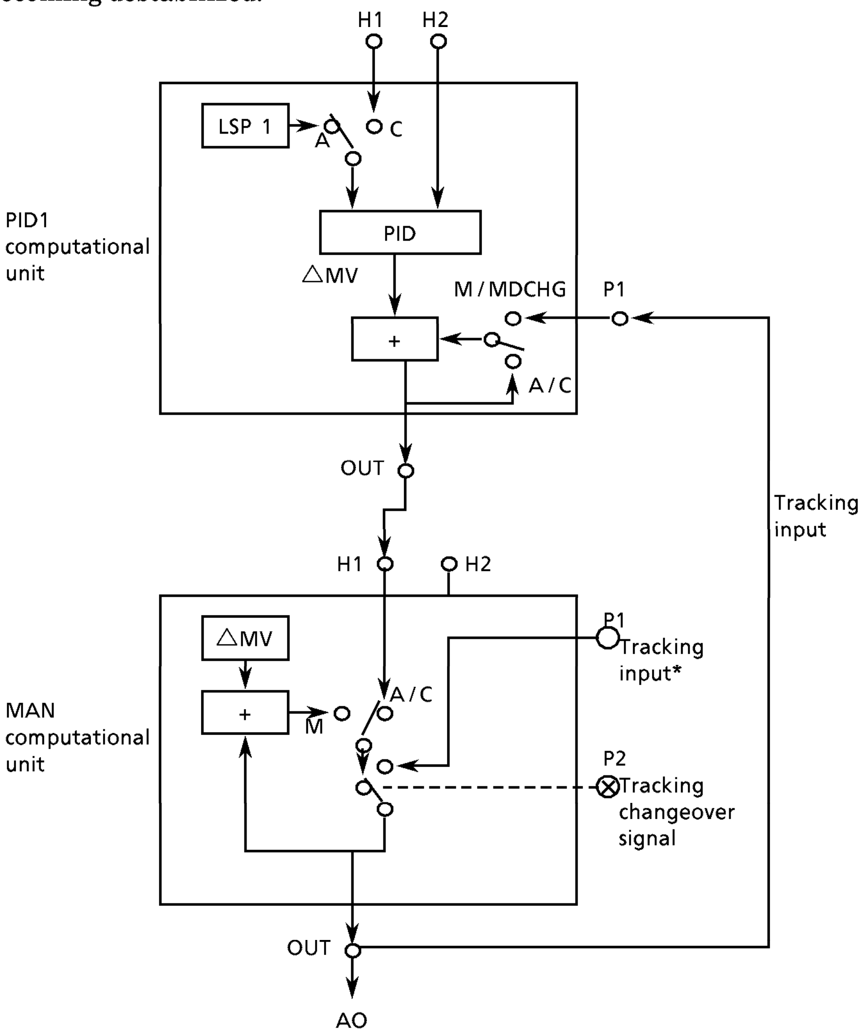


* Refer to page 5-16.

■ Auto balancing control type 1

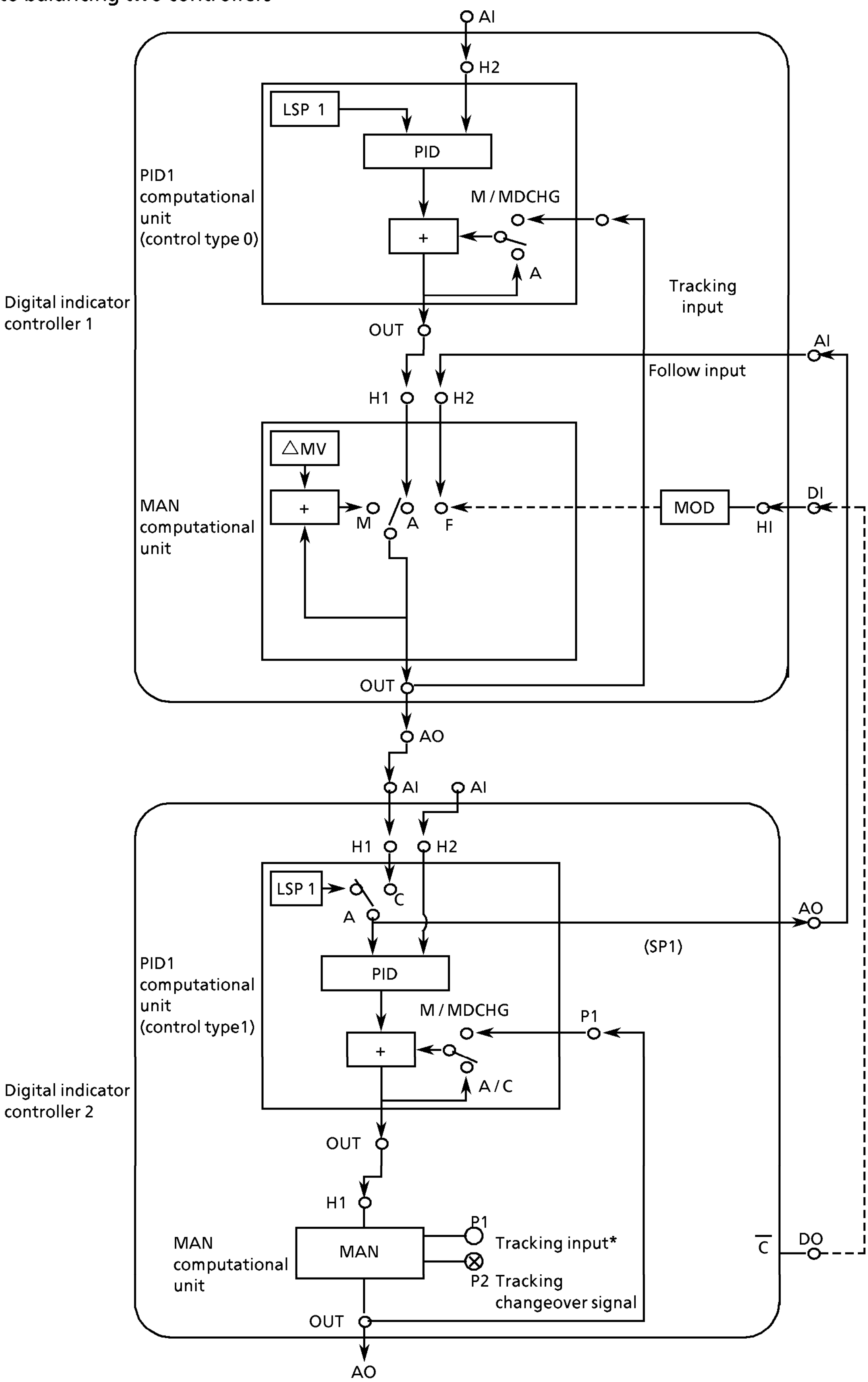
As shown in the figure below, connecting the MAN computational unit's output to the PID1 computational unit's P1 (tracking signal input) line balances output in both the auto and manual mode directions.

The figure on the next page shows an example of an instrumentation arrangement using two SDC40B units, with one unit operating under control type 0 and the other under control type 1. The first unit (operating in auto and manual modes) and second unit (auto, manual and cascade modes) can be operated in any combination of modes without their outputs becoming destabilized.



* Refer to page 5-16.

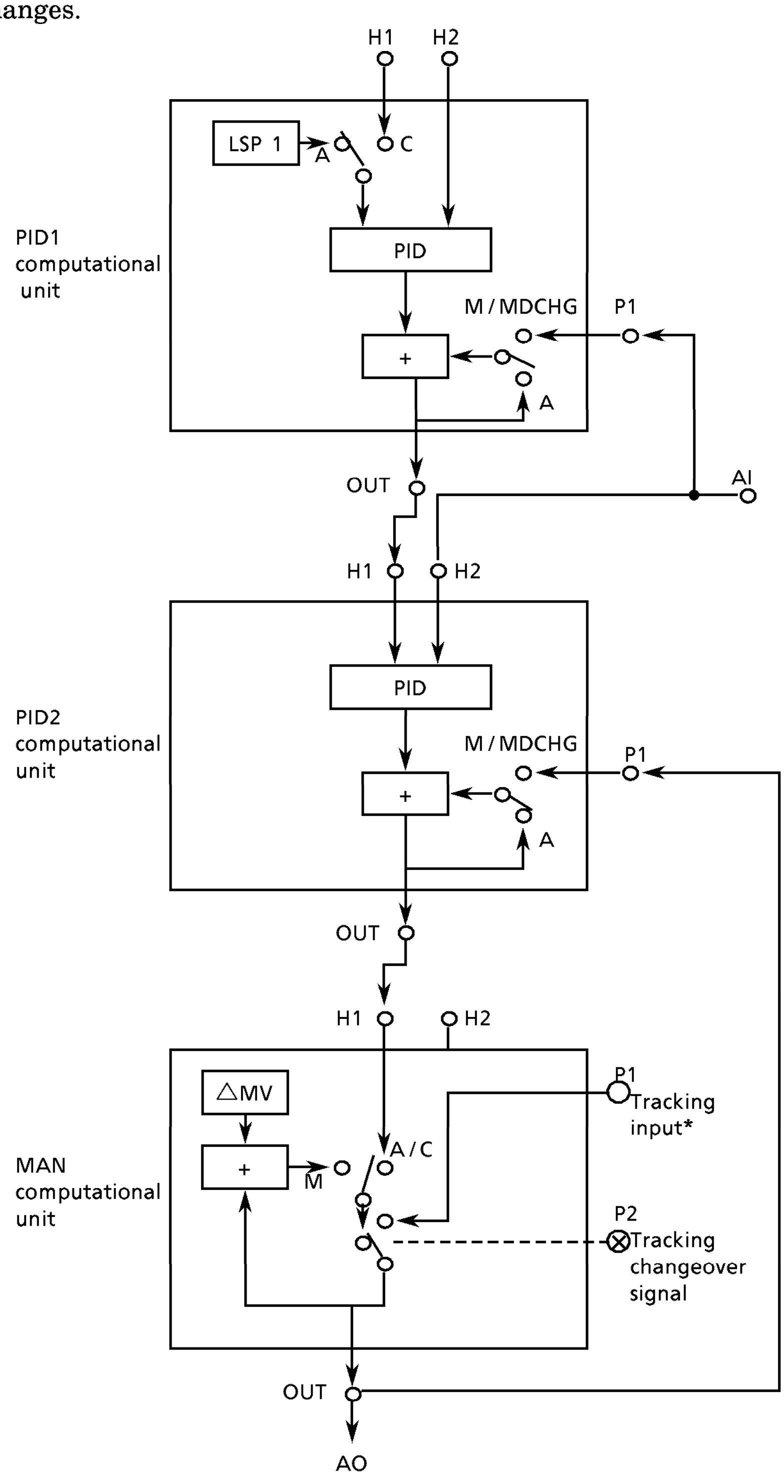
- Auto balancing two controllers



* Refer to page 5-16.

■ Auto balancing control type 2

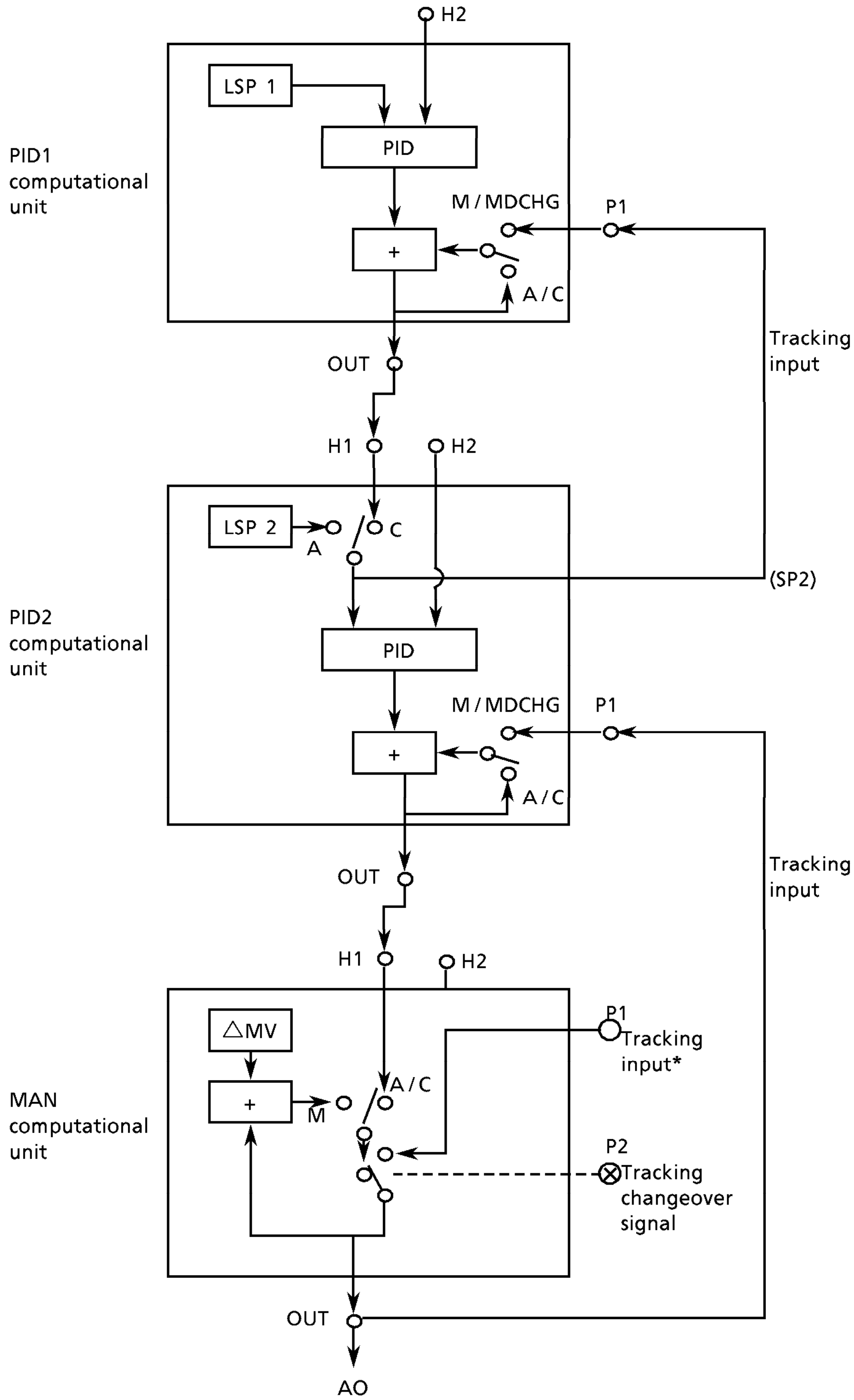
Connecting the various units in the configuration shown in the figure below effectively balances output during mode (auto, manual and cascade) changes.



* Refer to page 5-16.

■ Auto balancing control type 3

Connecting the various units in the configuration shown in the figure below effectively balances output during mode (auto, manual and cascade) changes.



* Refer to page 5-16.

5 - 10 Self-Diagnostic Functions

The SDC40B is equipped with the self-diagnostic functions described below.
Alarm codes are displayed when self diagnostics detects failures and the interlock manual (IM) mode is triggered according to the type of failure.

■ Power ON self-diagnostic routines

● PROM failure (Alarm code : 99)

This routine is designed to detect errors in system programs stored in the SDC40B PROM. Not totally infallible, there are cases where errors go undetected and result in measuring device operation failure.
Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

● Configuration data failure (Alarm code : 97)

This routine detects errors in configuration data stored in the EEPROM. Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

● Adjustment data failure (Alarm code : 98)

This routine detects errors in adjustment data stored in the adjustment data EEPROM. Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

■ Self-diagnostic routines performed each processing cycle

● Analog input failure (Alarm code : 01 to 09)

Failures are detected when the analog input signal designated for use as a failure diagnostic signal and set for diagnostics to be performed lies outside the -10.0 to +110.0% range.
Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

● Computational overflow (Alarm code : 82)

Designed for use with computations with overflow checking functions, this routine detects failures when computation results lie outside the -999.9 to +999.9% range.
Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

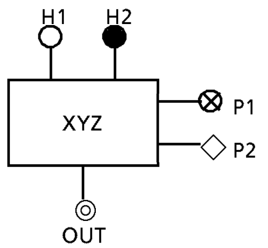
● Computational overload (Alarm code : 83)

This routine detects failures when all computation processing does not complete within the computation cycle.
Alarm codes are displayed when errors are detected and, if specified, the SDC40B changes to the IM mode.

Chapter6. COMPUTATIONAL EXPRESSIONS

6 - 1 Computational units

There are a selection of approximately 80 computational expressions that can be used by a maximum of 50 computational units.
Computations are processed according to the computation order registered to the loader for each computation processing cycle.
Refer to the Computational Functions CP-UM-1680E of the SDC40B User's Manuals for detailed descriptions of computational expressions.
The computational units are designed with four input lines (H1, H2, P1 and P2) and a single output line (OUT). Depending on the computational expression assigned to the computational unit, some of the lines may be left unused.
When a computational function is expressed by the function f, its computational unit's input/output configuration is represented by the equation below.
OUT = f(H1, H2, P1, P2)
The active conditions of a computational unit's input/output lines and their data formats are defined by the computational expression registered for use with the unit.
To illustrate this, let's assume that computational expression XYZ is registered for use with the computational unit shown below.



○ H1 line: percent data
The range is -999.9 to +999.9% and data is processed in units of 0.1%.

● H2 line: time data
The range is 0.0 to 6,000.0 sec and data is processed in units of 0.1s.

⊗ P1 line: flag data
The data specifies either Off or On only.

◇ P2 line: index data
The range is 0 to 30,000 and data is processed in units of "1".

◎ OUT line: composite format data
ndicates that data can be in any of the percentage, time, flag or index formats.

- Fixed values can be set for all four input lines (H1, H2, P1 and P2).
- The range for percentage format output is -999.9 to +999.9%. Exceeding this range results in computational overflow.

The following is an example in which the multiplication expression (MUL) is used to apply a 50.0% coefficient to percent data.

Example

The percent data is input to H1 and the 50.0% coefficient to H2.
H2 can be either a fixed value or a variable parameter.
Multiplication (MUL) is used to perform an OUT = H1 × H2 computational expression. The resulting input condition of H1 = 80.0% and H2 = 50.0% is shown in the expression below.

$$OUT = H1 \times H2 = \frac{80.0}{100.0} \times \frac{50.0}{100.0} = \frac{40.0}{100.0} = 40.0\%$$

6 - 2 List of Computational Expressions

■ List of Computational Expressions

No.	Computational expression	Mnemonic	Input				Output	Dynamic area	computa-tional time [absolute No.]	Initial value			
			H1	H2	P1	P2				H1	H2	P1	P2
1	Addition	ADD	○	○	○	○	○	N	3	0.0	0.0	100.0	100.0
2	Subtraction	SUB	○	○	○	○	○	N	3	0.0	0.0	100.0	100.0
3	Multiplication	MUL	○	○	–	–	○	N	2	100.0	100.0	–	–
4	Division	DIV	○	○	○	–	○	N	3	100.0	100.0	0.0	–
5	Absolute value	ABS	○	–	–	–	○	N	1	0.0	–	–	–
6	Square-root extraction	SQR	○	–	○	–	○	N	8	0.0	–	0.0	–
7	Maximum value	MAX	○	○	○	○	○	N	2	0.0	0.0	0.0	0.0
8	Minimum value	MIN	○	○	○	○	○	N	2	100.0	100.0	100.0	100.0
9	4-point addition	SGM	○	○	○	○	○	N	2	0.0	0.0	0.0	0.0
10	High selector/low limiter	HSE	○	○	–	–	○	N	1	0.0	0.0	–	–
11	Low selector/high limiter	LSE	○	○	–	–	○	N	1	100.0	100.0	–	–
12	High/low limiter	HLLM	○	–	○	○	○	N	2	0.0	–	100.0	0.0
13	High monitor	HMS	○	○	–	○	⊗	N	2	100.0	100.0	–	0.0
14	Low monitor	LMS	○	○	–	○	⊗	N	2	0.0	0.0	–	0.0
15	Deviation monitor	DMS	○	○	○	○	⊗	N	3	0.0	0.0	100.0	0.0
16	Deviation rate limiter	DRL	○	○	○	–	○	S	3	0.0	0.0	0.0	–
17	Deviation rate monitor	DRM	○	○	○	○	⊗	L	5	0.0	0.0	0.0	0.0
18	Manual output	MAN*	○	○	○	⊗	○	N	3	0.0	0.0	0.0	OFF
19	Controller 1	PID1*	○	○	○	⊗	○	N	36	0.0	0.0	0.0	OFF
20	Controller 2	PID2*	○	○	○	⊗	○	N	36	0.0	0.0	0.0	OFF
21	Dead time	DED	○	–	●	–	○	L	4	0.0	–	0.0	–
22	Lead/lag	L/L	○	–	●	●	○	S	5	0.0	–	0.0	0.0
23	Derivation	LED	○	–	●	●	○	S	4	0.0	–	0.0	0.0
24	Integration	INT	○	○	●	⊗	○	S	4	0.0	0.0	0.0	OFF
25	Moving average	MAV	○	–	●	–	○	L	11	0.0	–	0.0	–
26	Flip-flop	RS	⊗	⊗	–	–	⊗	N	1	OFF	OFF	–	–
27	Logical product	AND	⊗	⊗	⊗	⊗	⊗	N	1	OFF	OFF	OFF	OFF
28	Logical OR	OR	⊗	⊗	⊗	⊗	⊗	N	1	OFF	OFF	OFF	OFF
29	Exclusive OR	XOR	⊗	⊗	–	–	⊗	N	1	OFF	OFF	–	–
30	Inversion	NOT	⊗	–	–	–	⊗	N	1	OFF	–	–	–
31	2-position transfer switch	SW	○	○	⊗	–	○	N	1	0.0	0.0	OFF	–
32	Softening transfer switch	SFT	○	○	⊗	○	○	S	3	0.0	0.0	OFF	100.0
33	Time format switch	TSW	●	●	⊗	–	●	N	1	0.0	0.0	OFF	–
34	Flag format switch	FSW	⊗	⊗	⊗	–	⊗	N	1	OFF	OFF	OFF	–
35	Alternate switch	ALSW	⊗	–	⊗	–	⊗	S	2	OFF	–	OFF	–
36	Timer	TIM	⊗	–	●	–	⊗	S	2	OFF	–	0.0	–
37	ON delay timer	ONDT	⊗	–	●	–	⊗	S	2	OFF	–	0.0	–
38	OFF delay timer	OFDT	⊗	–	●	–	⊗	S	2	OFF	–	0.0	–
39	One-shot timer	OST	⊗	–	●	–	⊗	S	2	OFF	–	0.0	–
40	Integration pulse output I	CPO	○	–	○	⊗	⊗	S	4	100.0	–	100.0	OFF

Input/ / output ○ : percent data ● : time data ⊗: flag data

Dynamic area N : unused L : large (up to 8) S : small (up to 20)

* : Can use only one computational expression of the same type.

No.	Computational expression	Mnemonic	Input				Output	Dynamic area	Computational time [absolute No.]	Initial value			
			H1	H2	P1	P2				H1	H2	P1	P2
41	Integration pulse outputII	CPX	○	◇	◇	⊗	⊗	S	4	0.0	1	1	OFF
42	Pulse width modulation	PWM	○	–	●	–	⊗	S	2	0.0	–	0.0	–
43	Ramp signal generation	RMP	⊗	⊗	●	○	○	S	3	OFF	OFF	0.0	100.0
44	Logarithm	LOG	○	–	⊗	–	○	N	8	0.0	–	OFF	–
45	Exponent	EXP	○	–	⊗	–	○	N	18	0.0	–	OFF	–
46													
47													
48													
49													
50													
51	Control variable change 1	PMD1	◎	–	⊗	◇	○	N	2	0.0	–	OFF	I *2
52	Control variable change 2	PMD2	◎	–	⊗	◇	○	N	2	0.0	–	OFF	I *2
53	Mode selection (status detection)	MOD*1	⊗	⊗	⊗	⊗	–	N	2	OFF	OFF	OFF	OFF
54	Mode selection (edge detection)	MODX*1	⊗	⊗	⊗	⊗	–	N	2	OFF	OFF	OFF	OFF
55	Auto-tuning start/stop 1	AT1*1	⊗	–	⊗	◇	–	N	1	OFF	–	OFF	1
56	Auto-tuning start/stop 2	AT2*1	⊗	–	⊗	◇	–	N	1	OFF	–	OFF	1
57	Data hold	HOLD	◎	–	–	◇	◎	N	1	0.0	–	–	1
58	Raise/lower unit	RL	⊗	⊗	○	⊗	○	S	3	OFF	OFF	0.0	OFF
59	Reset unit	RST*1	⊗	–	–	–	–	N	1	OFF	–	–	–
60													
61	Linearization table 1	TBL1	○	–	–	–	○	N	8	0.0	–	–	–
62	Linearization table 2	TBL2	○	–	–	–	○	N	8	0.0	–	–	–
63	Linearization table 3	TBL3	○	–	–	–	○	N	8	0.0	–	–	–
64	Inverse linearization table 1	TBR1	○	–	–	–	○	N	8	0.0	–	–	–
65	Inverse linearization table 2	TBR2	○	–	–	–	○	N	8	0.0	–	–	–
66	Inverse linearization table 3	TBR3	○	–	–	–	○	N	8	0.0	–	–	–
67	Time → % conversion	TTP	●	–	●	●	○	N	2	0.0	–	0.0	0.0
68	% → time conversion	PTT	○	–	●	●	●	N	2	0.0	–	0.0	0.0
69	Engineering unit parameter selection 1	EGP1*1	◇	–	–	–	○	N	1	0	–	–	–
70	Engineering unit parameter selection 2	EGP2*1	◇	–	–	–	○	N	1	0	–	–	–
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													

Input / output ○ : percent data ● : time data ⊗ : flag data
◇ : index data ◎ : composite format data

Dynamic area N : unused L : large (up to 8) S : small (up to 20)

*1 : Can use only one computational expression of the same type.

*2 : A 'P' is displayed on the loader screen.

No.	Computational expression	Mnemonic	Input				Output	Dynamic area	Computational time [absolute No.]	Initial value			
			H1	H2	P1	P2				H1	H2	P1	P2
81	%→%table 1	PTB1	○	–	–	–	○	N	5	0.0	–	–	–
82	%→%table 2	PTB2	○	–	–	–	○	N	5	0.0	–	–	–
83	%→%table 4	PTB3	○	–	–	–	○	N	5	0.0	–	–	–
84	%→%table 4	PTB4	○	–	–	–	○	N	5	0.0	–	–	–
85	%→time table 1	TTB1	○	–	–	–	●	N	5	0.0	–	–	–
86	%→time table 2	TTB2	○	–	–	–	●	N	5	0.0	–	–	–
87	%→time table 3	TTB3	○	–	–	–	●	N	5	0.0	–	–	–
88	%→time table 4	TTB4	○	–	–	–	●	N	5	0.0	–	–	–
89													
90													
91	User lamp output 1	UF1 *	⊗	–	⊗	–	–	N	1	OFF	–	OFF	–
92	User lamp output 2	UF2 *	⊗	–	⊗	–	–	N	1	OFF	–	OFF	–
93	User lamp output 3	UF3 *	⊗	–	⊗	–	–	N	1	OFF	–	OFF	–
94	Bar graph display switch	BLED *	○	–	⊗	◇	–	N	2	0.0	–	OFF	1
95	Additional display unit 1	DSP1 *	○	○	◇	◇	–	N	4	0.0	0.0	0	0
96	Additional display unit 2	DSP2 *	○	○	◇	◇	–	N	4	0.0	0.0	0	0
97	Additional display unit 3	DSP3 *	○	○	◇	◇	–	N	4	0.0	0.0	0	0
98	Additional display unit 4	DSP4 *	○	○	◇	◇	–	N	4	0.0	0.0	0	0
99													

Input / output ○ : percent data ● : time data ⊗ : flag data
◇ : index data ◎ : composite format data
Dynamic area N : unused L : large (up to 8) S : small (up to 20)

* : Can use only one computational expression of the same type.

NOTE

- The asterisk (*) next to names listed in the Mnemonic column of the List of computational expressions table designate computational units capable of using only one computational expression of the same type.
- The SDC40B is equipped with 8 large dynamic areas and 20 small dynamic areas. This means that computational expressions in the table with an L in their Dynamic area column can utilize up to 8 dynamic areas and those with an S can use up to 20.

■ List of internal signals

Signal name	Data format	Description
SP1	○	SP of PID1 computational unit (-10.0 to +110.0%)
PV1	○	PV of PID1 computational unit (-10.0 to +110.0%)
DEV1	○	Deviation (SP1 to PV1) of PID1 computational unit (-12.0 to +120.0%)
PB1	○	Proportional band of PID1 computational unit
RATIO1	○	SP ratio of PID1 computational unit
BIAS1	○	RSP bias of PID1 computational unit
ALMH1	⊗	PV upper limit alarm of PID1 computational unit
ALML1	⊗	PV lower limit alarm of PID1 computational unit
ALMD1	⊗	Deviation alarm of PID1 computational unit
PID1NO	◇	PID group number (0 to 7) of PID1 computational unit
SP2	○	SP of PID2 computational unit (-10.0 to +110.0%)
PV2	○	PV of PID2 computational unit (-10.0 to +110.0%)
DEV2	○	Deviation (SP1 to PV1) of PID computational unit (-12.0 to +120.0%)
PB2	○	Proportional band of PID2 computational unit
RATIO2	○	SP ratio of PID2 computational unit
BIAS2	○	RSP bias of PID2 computational unit
ALMH2	⊗	PV upper limit alarm of PID2 computational unit
ALML2	⊗	PV lower limit alarm of PID2 computational unit
ALMD2	⊗	Deviation alarm of PID2 computational unit
PID2NO	◇	PID group number (0 to 7) of PID2 computational unit
MV	○	MV output of MAN computational unit
AI1	○	Input processed analog input value 1
AI2	○	Input processed analog input value 2
AI3	○	Input processed analog input value 3
AIR1	○	Raw analog input value 1
AIR2	○	Raw analog input value 2 (-10.0 to +110.0%)
AIR3	○	Raw analog input value 3 (-10.0 to +110.0%)
AO1	○	Analog output value 1 (-10.0 to +110.0%)
AO2	○	Analog output value 2 (-10.0 to +110.0%) (Uninstalled and fixed at 0.0% on 2G output models.)
AO3	○	Analog output value 3 (-10.0 to +110.0%)
MFB	○	Motor feedback value (-50.0 to +150.0%) (Uninstalled and fixed at 0.0% on 5G output models.)
IM	⊗	Interlock manual mode
AUT	⊗	Auto mode
MAN	⊗	Manual mode
CAS	⊗	Cascade mode
FLW	⊗	Follow mode
IMCHG	⊗	Changes to interlock manual mode
ACHG	⊗	Changes to auto mode
MCHG	⊗	Changes to manual mode
CCHG	⊗	Changes to cascade mode
FCHG	⊗	Changes to follow mode
MDCHG	⊗	Mode has changed

○ : percent data ● : time data ⊗ : flag data ◇ : index data
◎ : composite format data

Signal name	Data format	Description
RESTRT	⊗	Restart flag (On for 1 cycle at restart)
AT1	⊗	Auto-tuning for PID1 in progress
AT2	⊗	Auto-tuning for PID2 in progress
MFBES	⊗	Assessing motor control position
MFBAT	⊗	Assessing motor control position
DI01~DI12	⊗	Digital inputs 01 to 12
DI01CG~DI12CG	⊗	Changes digital input 01 from Off to On Changes digital input 12 from Off to On
DIX01~DIX06	◇	Digital input computational units 01 to 06
COMEERR	⊗	CPL transmission error
SENS	⊗	Analog input error
COVF	⊗	Computational overflow
OVLD	⊗	Computational time overload
MEMERR	⊗	Memory-related error
UF1KY	⊗	UF1 key input
UF2KY	⊗	UF2 key input
MKY	⊗	MAN key input
AKY	⊗	AUTO key input
CKY	⊗	CAS key input
ATKY	⊗	AT key input
PPA01~PPA40	○	Variable parameters (% format) 01 to 40
TPA01~TPA10	●	Variable parameters (time format) 01 to 10
FPA01~FPA20	⊗	Variable parameters (flag format) 01 to 20
IPA01~IPA10	◇	Variable parameters (index format) 01 to 10
EP1-0~EP2-7	○	Engineering unit parameters 1-0 to 2-7
UOV01~UOV50	◎	Output of computational units 01 to 50

○ : percent data ● : time data ⊗ : flag data ◇ : index data
◎ : composite format data