7.6 PID CONTROL Instruction (PID)

Function:

The PID instruction executes a PID control operation according to the contents of a previously set parameter table. The input (*Input*) to the PID operation must be integer or real number data. Double-length integer data cannot be used. The configurations of the parameter tables for integer and real number data are different. Operations are performed by processing each parameter as an integer consisting of the lower-place 16 bits.

Table of Integer Type PID Instruction Parameters

ADR	Type	Symbol	Name	Specification	I/O
0	W	RLY	Relay I/O	Relay input, relay output *[1]	IN/OUT
1	W	Kp	P gain	Gain of the P correction (a gain of 1 is a multiplier of 1)	IN
2	W	Ki	I gain	Gain of the integration circuit input (a gain of 1 is a multiplier of 1)	IN
3	W	Kd	D gain	Gain of the differentiation circuit input (a gain of 1 is a multiplier of 1)	IN
4	W	Ti	Integration time	Integration time (ms)	IN
5	W	Td1	Divergence differentiation time	The differentiation time (ms) used in the case of diverging input.	IN
6	W	Td2	Convergence differentiation time	The differentiation time (ms) used in the case of converging input.	IN
7	W	IUL	Upper integration limit	Upper limit for the I correction value	IN
8	W	ILL	Lower integration limit	Lower limit for the I correction value	IN
9	W	UL	Upper PID limit	Upper limit for the P+I+D correction value	IN
10	W	LL	Lower PID limit	Lower limit for the P+I+D correction value	IN
11	W	DB	PID output dead band	Width of the dead band for the P+I+D correction value	IN
12	W	Y	PID output	PID correction output (also sent to the Output Register.)	OUT
13	W	Yi	I correction value	Storage of the I correction value	OUT
14	W	IREM	I remainder	Storage of the I remainder	OUT
15	W	X	Input value storage	Storage of the present deviation input value	OUT

*1: Relay I/O Bit Assignment

BIT	Symbol	Name	Specification	I/O
0	IRST	Integration reset	"ON" is input when integration is reset.	IN
1 to 7	Kp	(Reserved)	Reserve relay for input IN	IN
8 to F	Ki	(Reserved)	Reserve relay for input OUT	OUT

Table of Real Type PID Instruction Parameters

ADR	Type	Symbol	Name	Specification	I/O
0	W	RLY	Relay I/O	Relay input, relay output *1	IN/OUT
1	W	-	(Reserved)	Reserved Register	-
2	F	Kp	P gain	Gain of the Proportional correction	IN
4	F	Ki	I gain	Gain of the Integration circuit input	IN
6	F	Kd	D gain	Gain of the Differentiation circuit input	IN
8	F	Ti	Integration time	Integration time (s)	IN
10	F	Td1	Divergence differentiation time	The differentiation time (s) used in the case of diverging input.	IN
12	F	Td2	Convergence differentiation time	The differentiation time (s) used in the case of converging input.	IN
14	F	IUL	Upper integration limit	Upper limit for the I correction value	IN
16	F	ILL	Lower integration limit	Lower limit for the I correction value	IN
18	F	UL	Upper PID limit	Upper limit for the P+I+D correction value	IN
20	F	LL	Lower PID limit	Lower limit for the P+I+D correction value	IN
22	F	DB	PID output dead band	Width of the dead band for the P+I+D correction value	IN
24	F	Y	PID output	PID correction output (also sent to the Output Register.)	OUT
26	F	Yi	I correction value	Storage of the I correction value	OUT
28	F	X	Input value storage	Storage of the present deviation input value	OUT

*1: Relay I/O Bit Assignment

BIT	Symbol	Name	Specification	I/O
0	IRST	Integration reset	"ON" is input when integration is reset.	IN
1 to 7	Kp	(Reserved)	Reserve relay for input IN	IN
8 to F	Ki	(Reserved)	Reserve relay for input OUT	OUT

Here, the PID operation is expressed as follows:

$$\frac{\mathrm{Y}}{\mathrm{X}} = \mathrm{K}p + \mathrm{K}i \times \frac{1}{\mathrm{T}i \times S} + \mathrm{K}d \times \mathrm{T}d \times S$$

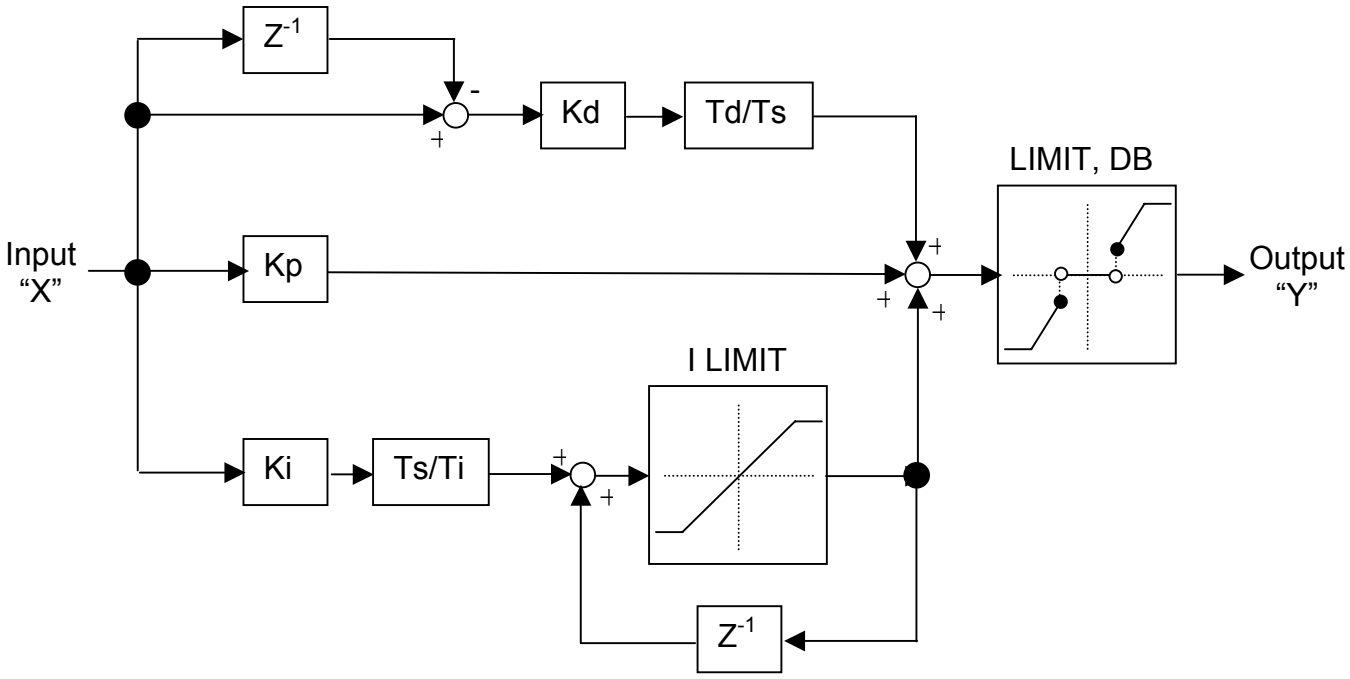
X: Error (deviation) input value
Y: Output value
S: Scans

The following operation is performed within the PID instruction:

$$\mathrm{Y} = \mathrm{K}p \times \mathrm{X} + \{\overbrace{(\mathrm{K}i \times \mathrm{X} + IREM)/\frac{\mathrm{T}i}{\mathrm{T}s} + \mathrm{Y}i'}^{\mathrm{Y}i}\} + \mathrm{K}d \times (\mathrm{X} - \mathrm{X}') \times \frac{\mathrm{T}d}{\mathrm{T}s}$$

X': previous input value
Yi: I correction value
Yi': previous I output value
IREM: remainder of previous Ti/Ts calculation.
Ts: scan time set value (ms or s)

Block Diagram:



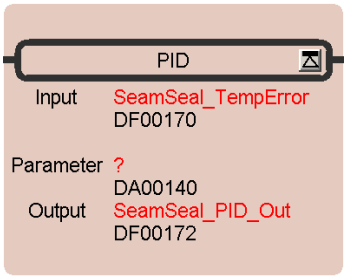
- When the P+I+D correction value reaches the upper or lower PID limit (UL, LL) or the PID dead band (DB) and the present P and I correction values have the same sign (diverging), the I correction value is not updated but is kept at the pervious value. Conversely, when the P and I correction values have different signs (converging towards 0), the I correction value is updated with the present value.

- When the change in error input (X-X') and the previous error input (X') have the same sign (diverging) in the derivative (D) operation, the divergence derivative time (Td1) is used as the derivative time. (Td = Td1)

- When the change in error input (X-X') and the previous error input (X') have different signs (converging) in the derivative (D) operation, the convergence derivative time (Td2) is used as the derivative time. (Td= Td2)

- When the Integration reset (IRST) is "ON," Yi = 0 and IRST = 0 are output.

Format:



Symbol: PID

Full Name: PID Control

Control Category: DDC

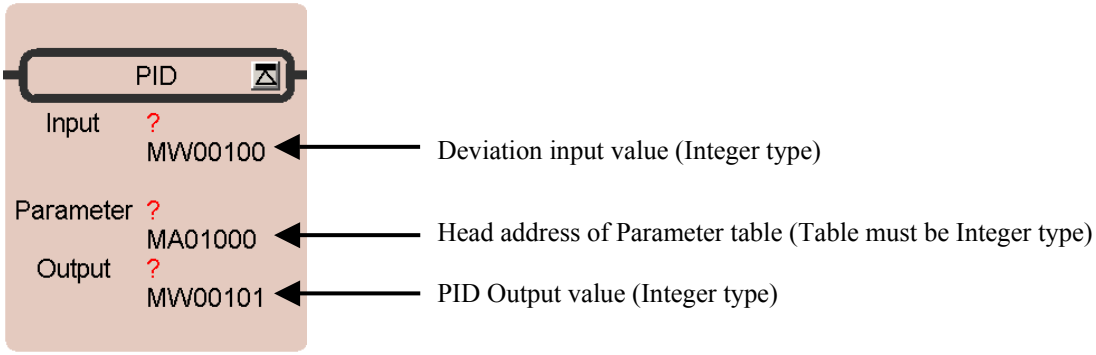
ICON: 

Field Parameters:

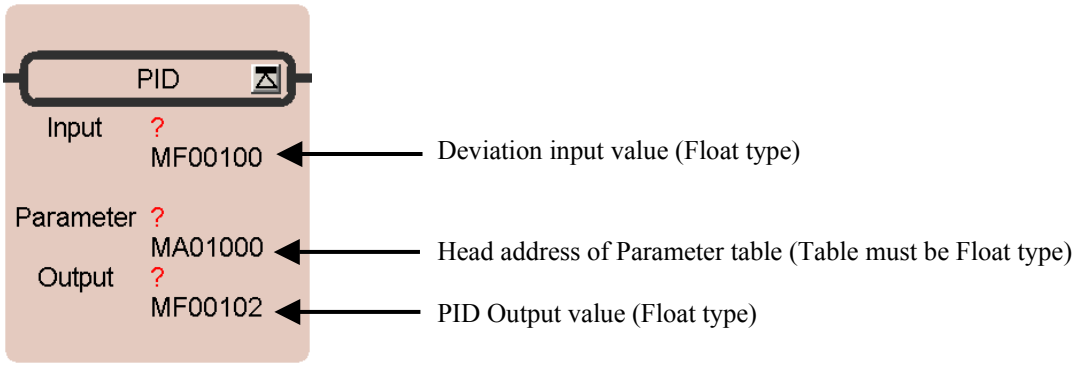
Field	Full Name	Setting
Input	PID Input	• Any integer type and real number type register. • Any integer type and real number type register with subscript. • Subscript register • Constant
Parameter	Parameter Table Head Address	• Register address (except for # and C registers) • Register address with subscript (except for # and C registers)
Output	PID Output	• Any integer and real number type register (except for # and C registers) • Any integer and real number type register with subscript (except for # and C registers) • Subscript Register • Constant

Programming example:

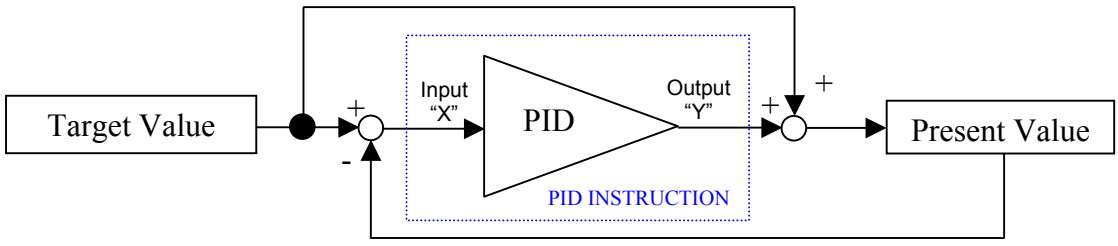
Integer type operation:
MW01000 to MW010015 are used for the parameter table.



Float type operation:
MF01000 to MF010028 are used for the parameter table.



Notes:
1. The Input to This PID Instruction is the "difference" between the external system's "Present Value" and "Target Value." The input is not the Target Value the system must obtain.



2. If the Input is Integer type, the controller's operating system expects the Parameter Table to be Integer type. If the Input is Float type, the controller's operating system expects the Parameter Table to be float type.