

# PID Loop Tuning Pocket Guide

## Version 6

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## PID Controller Terms

A PID controller continuously calculates an error value as the difference between a measured process variable and a desired setpoint. By tuning three parameters, a PID controller can deal with specific process requirements.

### Proportional Term (P)

The amount added to the output based on the current error.

Tuning parameters for Proportional Term are:

- **Proportional Gain** is a Multiplier.  
If the error is 10% and the Gain is 0.8, then output will move 8%.
- **Proportional Band** is a Divider as a percentage.  
If the error is 10% and the Band is 125, then output is  $(10\% \times (100/125))=8\%$
- **Conversion between P-Gain and P-Band:**  $P\text{-Band} = 100/P\text{-Gain}$

### Integral Term (I)

The amount added to the output based on the sum of the error.

Tuning parameters for Integral Term are:

- **Time Constant** is the time for one full repeat of P-Term.  
If the P-Term is 8% and the Time Constant is 10 seconds, then the output will ramp up 8% every 10 seconds.
- **Inverse Time Constant** is amount the output will move in one second.  
If the P-Term is 8% and the Reset Rate is .1 repeat/sec, then the output will move  $0.1 \times 8\%$  every second and take 10 seconds for the full repeat of the P-Term of 8%.
- **Reset Rate (I-Gain)** is the same as Inverse Time Constant multiplied by P-Gain.
- **Conversion between Time and Reset Rate:**  
 $\text{Inverse Time Constant} = 1/\text{Time Constant}$ ,  $\text{Reset Rate} = (1/\text{Time Constant}) \times P\text{-Gain}$

### Derivative Term (D)

The amount added to the output based on the rate of change of the error. Tuning parameters for Derivative Term are:

- **Time Constant** is the amount of time the controller will look forward.
- **Derivative Gain** is the amount of time the controller looks forward multiplied by the P-Gain.

## Types of PID Loops

### Fast Loops (flow, pressure)

P Little (Too much will cause cycling.)  
I More  
D Not needed

### Slow Loops (temperature)

P More  
I Some (Too much will cause cycling.)  
D Some

### Integrating Loops

#### (level & insulated temperature)

P More  
I Little (Will cause cycling.)  
D Must (If D is not used, the loop will cycle.)

### Noisy Loops

#### (measurement constantly changing)

P Low (Will cause cycling.)  
I Most (Accumulated error.)  
D Off (Will cause cycling.)

## Tuning Closed Loops

### 1 Know the Process.

Identify the loop you intend to tune and determine the speed of the loop.

Fast Loop	Response time < 1s to about 10s (e.g., a flow loop). Use of PI controller is sufficient.
Medium Loop	Response time of several seconds up to about 30s (e.g., flow, temperature, and pressure). Use either PI or PID controller.
Slow Loop	Response time of > 30s (e.g., many temperature loops and level loops). Use of PID controller is recommended.

### 2 Know the Controller.

Identify the units of your PID controller:

- **Proportional term (P-Term)** - tuning parameter is either a Proportional Gain (P-Gain) or Proportional Band (P-Band).
- **Integral term (I-Term)** - tuning parameter can be a Time Constant (in minutes or seconds), Reset Rate (1/second or 1/minute), or I-Gain (Reset rate x Proportional gain).
- **Derivative term (D-Term)** - tuning parameter can be Time Constant (in seconds or minutes) or Derivative Gain (Derivative Time Constant x Proportional Gain).

In this document, Proportional Gain, Integral Reset Rate, and Derivative Gain are assumed. Convert back to your controller units if necessary.

### 3 Watch the Response.

Make a small change of setpoint (SP), say 5%, or wait for a disturbance in the process. Then watch for process variable (PV) and control output (CO) responses.

- If no visible instantaneous change of CO upon the change of SP or no apparent overshoot (over damped), increase proportional gain by 50%.
- If PV is unstable or has sustained oscillation, with overshoot greater than 25%, reduce Proportional Gain by 50% and reduce Integral Reset Rate by 50%.
- If PV oscillation persists with tolerable overshoot, reduce Proportional Gain by 20% and reduce Integral Reset Rate by 50%.
- If 3 or more consecutive peaks occur upon the change of SP, reduce Integral Reset Rate by 30% and increase Derivative Gain by 50%.
- If PV stays fairly flat and below (or above) the SP for a long time, after change of SP or beginning of disturbance (long tail scenario), increase Integral Reset Rate by 100%.
- Repeat step 3 until the closed-loop response is satisfactory to you.

## Tuning Open Loops

### 1 Know the process.

Identify the loop you intend to tune and determine the speed of the loop.

Fast Loop	Response time < 1s to about 10s (e.g., a flow loop). Use of PI controller is sufficient.
Medium Loop	Response time of several seconds up to about 30s (e.g., flow, temperature, and pressure loops). Use either PI or PID controller.
Slow Loop	Response time > 30s (e.g., many temperature loops and level loops). Use of PID controller is recommended.

### 2 Know the controller.

Identify the units of your PID controller:

- **Proportional term (P-Term)** - tuning parameter is either a Proportional Gain (P-Gain) or Proportional Band (P-Band).
- **Integral term (I-Term)** - tuning parameter can be a Time Constant (in minutes or seconds), Reset Rate (1/second or 1/minute), or I-Gain (Reset rate x Proportional gain).
- **Derivative term (D-Term)** - tuning parameter can be Time Constant (in seconds or minutes) or Derivative Gain (derivative time constant x proportional gain).

In this document, Proportional Gain, Integral Time Constant (in seconds), and Derivative Time Constant (in seconds) are assumed. Convert back to your controller units if necessary.

The PID Controller Reference (starting on page 8) is a summary of many common controllers available on the market.

*For units of other controllers, please contact ControlSoft.*

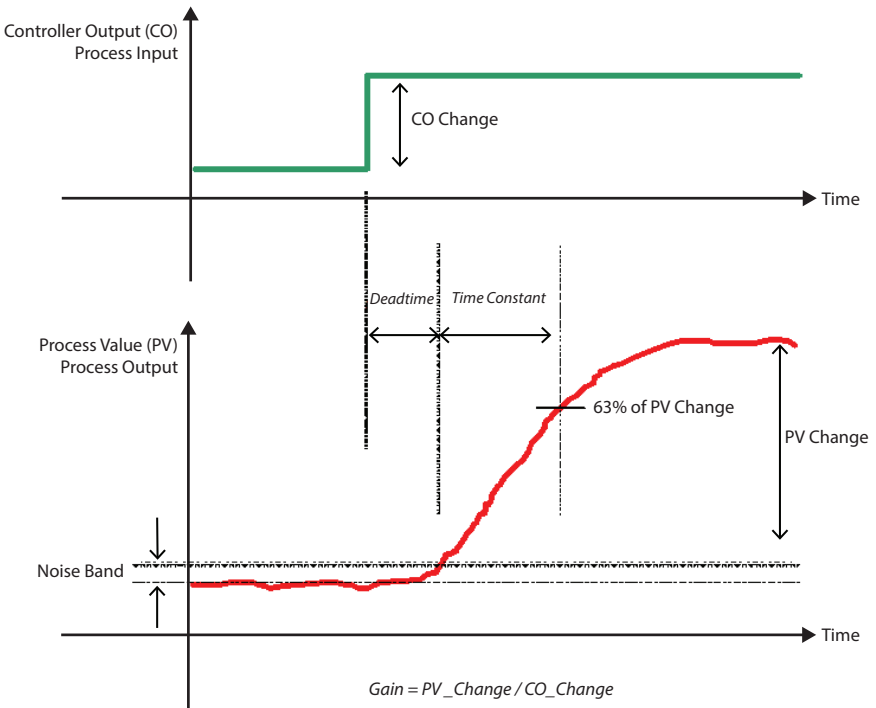
### 3 Test the loop.

#### Non-Integrating Processes

- Put loop in manual control mode, keep control output constant, and wait for process to stabilize.
- Make a small step change on control output (say 5 or 10%), and watch the response.
- Estimate process model according to Figure 1:  
 Model gain = PV change / CO change.  
 Deadtime = time lapse between change of CO and observable changes on PV.  
 Time constant = the time it takes for PV to reach about 63% of total changes.
- Select initial PID values using applicable equation:

Non-interacting (ISA) or Series	Parallel
$P_{NI} = 1 / \text{Model Gain}$ $I_{NI} = (\text{Deadtime} + \text{Time Constant})$ $D_{NI}^1 = (\text{Deadtime} / 3) \text{ or } (\text{Time Constant} / 6)$	$P_P = P_{NI}$ $I_P = P_{NI} / I_{NI}$ $D_P = P_{NI} \times D_{NI}$
<sup>1</sup> For slow loop, select whichever is greater. For fast loop, select smaller value.	

Figure 1 Non-Integrating Process Model



### 3 Test the loop (cont.).

#### Integrating Processes

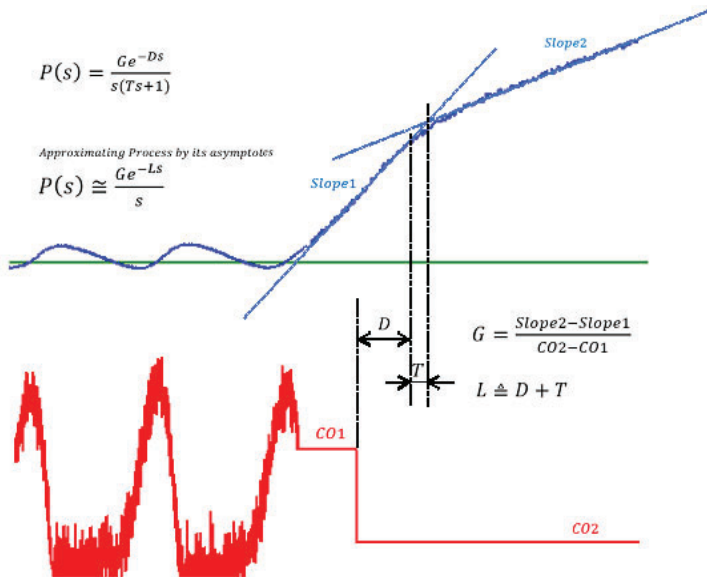
- a. Put loop in manual control mode, keep control output constant, wait for a steady slope in PV.
- b. Make a small step change on control output (say 5 or 10%) and watch the response. Slope of PV changes. Place a close watch on PV, integrating nature of the process causes PV to continuously change. Stop the test once enough data is collected.
- c. Estimate process model according to Figure 2:  
 Model Gain (MG) = (slope2 -slope1) / CO change.  
 Observed Dead Time (L) = time between change of CO till the time when slope 1 and slope2 intersect each other
- d. Select initial PID values using applicable equation:

Non-interacting (ISA) or Series <sup>1</sup>	Parallel
$P_N^2 = 0.45 / (\text{Model Gain} \times \text{Observed Dead Time})$	$P_P = P_{NI}$
$I_{NI} = 8 \times (\text{Observed Dead Time})$	$I_P = P_{NI} / I_{NI}$
$D_{NI} = 0.5 \times (\text{Observed Dead Time})$	$D_P = P_{NI} \times D_{NI}$

<sup>1</sup> Acknowledgment: tuning formula for integrating process of this pocket guide is a modified version of one given in Advanced PID Control (2006), by Karl J. Åström and Tore Hägglund, ISA.org.

<sup>2</sup> For calculation of P term, time units for observed dead time (L) should be consistent with the time units used to calculate model gain (MG).

Figure 2 Integrating Process Model

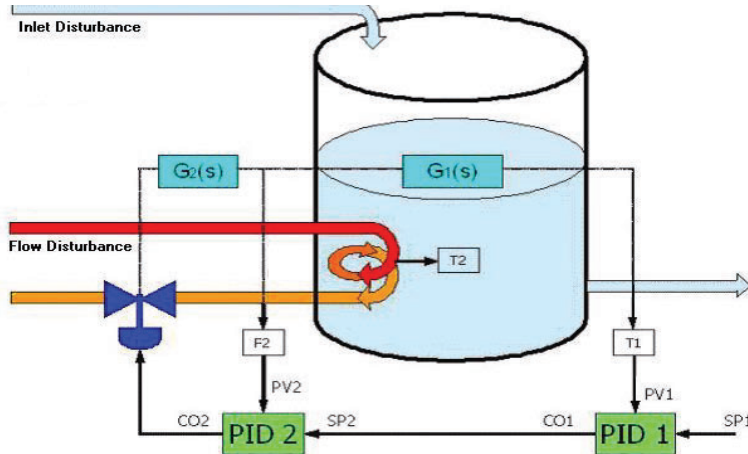


## Tuning Cascade Loops

We are frequently asked "What's the best way to tune a cascade loop?" The simple answer is, "tune the inner loop first and the outer loop second."

Figure 3 shows a cascaded control application, a tank heated by a steam valve, with a goal of controlling the outlet temperature  $T_1$  by the steam valve.

Figure 3 Cascaded PID Control of Tank Outlet Temperature



In this example, PID 1 is the Master, Primary, or Outer Loop; PID 2 is the Slave, Secondary, or Inner Loop. The temperature controller, PID 1, determines the desired amount of flow to control the temperature. Instead of controlling temperature directly, the valve is controlling the flow of the steam to the process from PID 2.

In applying loop tuning to a cascade control configuration, you need to tune one loop at a time due to interaction of inner loop dynamics on the outer loop. (Note that the inner loop must be tuned first before tuning the outer loop unless using a one-shot cascade tuning tool.)

- 1 Put the outer loop in Manual.
- 2 Do a regular loop tuning procedure on the inner loop.
- 3 Put the inner loop in Auto.
- 4 Wait for the outer loop to stabilize.
- 5 Do a regular loop tuning procedure on the outer loop.

## PID Controller Reference

Following is a summary of many of the more common controllers available on the market. For units of other controllers, please contact ControlSoft (see page 16 for contact information).

### Controller Reference Key

#### Non-integrating Process

- DT = Deadtime
- MG = Model Gain
- Ext. Reset = External Reset
- Man. Reset = Manual Reset
- LagTC = Lag Time Constant
- Reps = Repeats

#### Integrating Process

- L = Observed Deadtime
- MG = Model Gain
- Ext. Reset = External Reset
- Man. Reset = Manual Reset
- Reps = Repeats

## ABB

### Symphony Harmony INFI 90 Controllers

18 and 19 PID Block

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (1 / MG) x (DT / 3) [Min x 1]$$

156,0 PID Block - Classical

$$P = (1 / MG) [x 1]$$

$$I = 1 / (DT + LagTC) [1 / Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

156,1 PID Block - Non-Interacting

$$P (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (1 / MG) x (DT / 3) [Min x 1]$$

156,2 PID Block - Classical w/ Ext. Reset

$$P = (1 / MG) [x 1]$$

$$I = 1 / (DT + LagTC) [1 / Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

156,3 PID Block - Classical w/ Man. Reset

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (1 / MG) x (DT / 3) [Min x 1]$$

18 and 19 PID Block

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Min x 1]$$

156,0 PID Block – Classical

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = 1 / (8 x L) [1 / Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

156,1 PID Block - Non-Interacting

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Min x 1]$$

156,2 PID Block - Classical w/ Ext. Reset

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = 1 / (8 x L) [1 / Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

156,3 PID Block - Classical w/ Man. Reset

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Min x 1]$$



## ControlSoft

### MANTRA

PID Block - Series

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

PID Block - Parallel

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

PID Block - Non-Interacting

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

PID Block - Series

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

PID Block - Parallel

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

PID Block - Non-Interacting

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

## Emerson

### Ovation Controllers

PID, PIDFF Blocks

$$P = (1 / MG) [x 1]$$

$$I = (MG) x (DT + LagTC) [Sec / Reps x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

PID, PIDFF Blocks

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) x (8 x L) [Sec / Reps x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

### Westinghouse WDPF

PID Block

$$P = (1 / MG) [x 100]$$

$$I = (DT + LagTC) x MG [Sec/Reps x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

PID Block

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = ((8 x L) x (MG x L) / 0.45) [Sec / Reps x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

## GE

### Series 90-30 & 90-70 Controllers

PID Block - ISA

$$P = (1 / MG) [x 100]$$

$$I = 1 / (DT + LagTC) [1 / Sec x 1000]$$

$$D = (DT / 3) [Sec x 100]$$

PID Block - ISA

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = 1 / (8 x L) [1 / Sec x 1000]$$

$$D = (0.5 x L) [Sec x 100]$$

PID Block - Independent

$$P = (1 / MG) [x 100]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1000]$$

$$D = (1 / MG) x (DT / 3) [Sec x 100]$$

PID Block - Independent

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1000]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 100]$$

## GE

### RX3i/RX7i Controllers

#### PID\_ISA

$$P = (1 / MG) [x 100]$$

$$I = 1 / (DT + LagTC) [1 / Sec x 1000]$$

$$D = (DT / 3) [Sec x 100]$$

#### PID\_IND

$$P = (1 / MG) [x 100]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1000]$$

$$D = (1 / MG) x (DT / 3) [Sec x 100]$$

#### ADV\_PID Block - Parallel

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

#### ADV\_PID Block - Series

$$P = (1 / MG) [x 1]$$

$$I = 1 / (DT + LagTC) [1 / Min x 1]$$

$$D = (DT / 3) [Sec x 1]$$

#### PID\_ISA

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = 1 / (8 x L) [1 / Sec x 1000]$$

$$D = (0.5 x L) [Sec x 100]$$

#### PID\_IND

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1000]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 100]$$

#### ADV\_PID Block - Parallel

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

#### ADV\_PID Block - Series

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = 1 / (8 x L) [1 / Min x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

### Mark VI

#### PID, PID Basic, PID\_MA\_ENH

$$P = (1 / MG) [x 1]$$

$$I = 1 / (DT + LagTC) [1 / Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

#### PID, PID Basic, PID\_MA\_ENH

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = 1 / (8 x L) [1 / Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

## Honeywell

### TDC3000 Controllers

Interactive A, Interactive B, Interactive C,  
Interactive D, Non-Interactive A,  
Non-Interactive B, Non-Interactive C,  
Non-Interactive D

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

Interactive A, Interactive B, Interactive C,  
Interactive D, Non-Interactive A,  
Non-Interactive B, Non-Interactive C,  
Non-Interactive D

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

### Experion Controllers

#### PID, PIDFF, PIDER

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

#### PID, PIDFF, PIDER

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

## Honeywell

### UDC Controllers

Interactive A, Interactive B,  
Non-Interactive A, Non-Interactive B

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

PID

$$P = (MG x 100) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

Interactive A, Interactive B,  
Non-Interactive A, Non-Interactive B

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

PID

$$P = (((MG x L) / 0.45) x 100) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

## Metso

Series, Ideal PID Block

$$P = (1 / MG) [x 1]$$

$$I = 1 / (DT + LagTC) [1 / Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

Parallel PID Block

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

Series, Ideal PID Block

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = 1 / (8 x L) [1 / Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

Parallel PID Block

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

## Modicon

PID, KPID Blocks

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

PID2 Block

$$P = (MG x 100) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 100]$$

$$D = (DT / 3) [Min x 100]$$

PID, KPID Blocks

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

PID2 Block

$$P = (((MG x L) / 0.45) x 100) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 100]$$

$$D = (0.5 x L) [Min x 100]$$

## Rockwell Automation

### CompactLogix & ControlLogix Controllers

#### PID Block - Independent

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

#### PID Block - Dependent

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

#### PIDE Block - Independent

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min x 1]$$

$$D = (1 / MG) x (DT / 3) [Min x 1]$$

#### PIDE Block - Dependent

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

#### PID Block - Independent

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

#### PID Block - dependent

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

#### PIDE Block - Independent

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Min x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Min x 1]$$

#### PIDE Block - Dependent

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

### Micro800 Controllers

#### IPID

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

#### IPID

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

### MicroLogix Controllers

#### PID Block with RG bit on

$$P = (1 / MG) [x 100]$$

$$I = (DT + LagTC) [Min x 100]$$

$$D = (DT / 3) [Min x 100]$$

#### PID Block with RG bit off

$$P = (1 / MG) [x 10]$$

$$I = (DT + LagTC) [Min x 10]$$

$$D = (DT / 3) [Min x 100]$$

#### PID Block with RG bit on

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (8 x L) [Min x 100]$$

$$D = (0.5 x L) [Min x 100]$$

#### PID Block with RG bit off

$$P = (0.45 / (MG x L)) [x 10]$$

$$I = (8 x L) [Min x 10]$$

$$D = (0.5 x L) [Min x 100]$$

## Rockwell Automation

### PLC-5 Controllers

#### Integer Block ISA

$$P = (1 / MG) [x 100]$$

$$I = (DT + LagTC) [Min x 100]$$

$$D = (DT / 3) [Min x 100]$$

#### Integer Block Independent Gains

$$P = (1 / MG) [x 100]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1000]$$

$$D = (1 / MG) x (DT / 3) [Sec x 100]$$

#### PD Block ISA

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

#### PD Block Independent Gains

$$P = (1 / MG) [x 1]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Sec x 1]$$

$$D = (1 / MG) x (DT / 3) [Sec x 1]$$

#### Integer Block ISA

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (8 x L) [Min x 100]$$

$$D = (0.5 x L) [Min x 100]$$

#### Integer Block Independent Gains

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1000]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 100]$$

#### PD Block ISA

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

#### PD Block Independent Gains

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (0.45 / (MG x L)) / (8 x L) [Reps / Sec x 1]$$

$$D = (0.45 / (MG x L)) x (0.5 x L) [Sec x 1]$$

### SLC Controllers

#### PID Block with RG bit on

$$P = (1 / MG) [x 100]$$

$$I = (DT + LagTC) [Min x 100]$$

$$D = (DT / 3) [Min x 100]$$

#### PID Block with RG bit off

$$P = (1 / MG) [x 10]$$

$$I = (DT + LagTC) [Min x 10]$$

$$D = (DT / 3) [Min x 100]$$

#### PID Block with RG bit on

$$P = (0.45 / (MG x L)) [x 100]$$

$$I = (8 x L) [Min x 100]$$

$$D = (0.5 x L) [Min x 100]$$

#### PID Block with RG bit off

$$P = (0.45 / (MG x L)) [x 10]$$

$$I = (8 x L) [Min x 10]$$

$$D = (0.5 x L) [Min x 100]$$

## Siemens

### TI

#### PID Block

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Min x 1]$$

$$D = (DT / 3) [Min x 1]$$

### TI

#### PID Block

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Min x 1]$$

$$D = (0.5 x L) [Min x 1]$$

### S7 Controllers

FB41 CONT\_C, FB41 CONT\_S,  
FB61 CTRL\_PID, FB61 CTRL\_S,  
PID\_CP, PID\_ES, FB 1874 PIDConL

$$P = (1 / MG) [x 1]$$

$$I = (DT + LagTC) [Sec x 1]$$

$$D = (DT / 3) [Sec x 1]$$

### S7 Controllers

FB41 CONT\_C, FB41 CONT\_S, FB61  
CTRL\_PID, FB61 CTRL\_S, PID\_CP, PID\_ES,  
FB 1874 PIDConL

$$P = (0.45 / (MG x L)) [x 1]$$

$$I = (8 x L) [Sec x 1]$$

$$D = (0.5 x L) [Sec x 1]$$

## Schneider Electric

### Eurotherm Controllers

PID Block

$$P = (MG \times 100) [x 100]$$

$$I = (DT + LagTC) [Sec \times 100]$$

$$D = (DT / 3) [Sec \times 100]$$

### Invensys Foxboro I/A Series Blocks

PID, PIDA, PIDE, PIDX, PIDXE

$$P = (MG \times 100) [x 1]$$

$$I = (DT + LagTC) [Min \times 1]$$

$$D = (DT / 3) [Min \times 1]$$

### Square D Controllers

PID Block

$$P = (1 / MG) [x 100]$$

$$I = (1 / MG) / (DT + LagTC) [Reps / Min \times 100]$$

$$D = (1 / MG) \times (DT / 3) [Sec \times 100]$$

## Yokogawa

CS1000/CS3000 I-PD, PD-MR, PI-BLEND,  
PID, P-ID, PID-BSW, PID-TP, PI-HLD, PI-STC

$$P = (MG \times 100) [x 1]$$

$$I = (DT + LagTC) [Sec \times 1]$$

$$D = (DT / 3) [Sec \times 1]$$

### Eurotherm Controllers

PID Block

$$P = (((MG \times L) / 0.45) \times 100) [x 100]$$

$$I = (8 \times L) [Sec \times 100]$$

$$D = (0.5 \times L) [Sec \times 100]$$

### Invensys Foxboro I/A Series Blocks

PID, PIDA, PIDE, PIDX, PIDXE

$$P = (((MG \times L) / 0.45) \times 100) [x 1]$$

$$I = (8 \times L) [Min \times 1]$$

$$D = (0.5 \times L) [Min \times 1]$$

### Square D Controllers

PID Block

$$P = (0.45 / (MG \times L)) [x 100]$$

$$I = (0.45 / (MG \times L)) / (8 \times L) [Reps / Min \times 100]$$

$$D = (0.45 / (MG \times L)) \times (0.5 \times L) [Sec \times 100]$$

CS1000/CS3000 I-PD, PD-MR, PI-BLEND,  
PID, P-ID, PID-BSW, PID-TP, PI-HLD, PI-STC

$$P = (((MG \times L) / 0.45) \times 100) [x 1]$$

$$I = (8 \times L) [Sec \times 1]$$

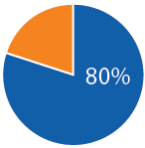
$$D = (0.5 \times L) [Sec \times 1]$$

## INTUNE Tuning Tools

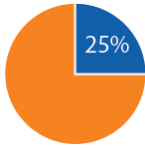
A well-tuned PID controller, in a properly designed control loop, can satisfy the control objectives for most process control applications.



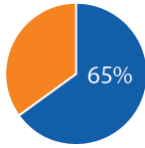
### Control Loop Performance Today



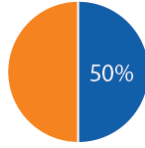
not optimally tuned



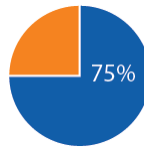
still using factory-default settings



set in automatic mode but less variation in manual mode



performance declines in 6 months



performance declines in one year (without maintenance)

### Why Use Tuning Software

Investing in tuning software to tune your process control PID loops (temperature, level, pressure and flow) will make sure that your control loops operate efficiently, rather than just being functional.



Reduce tuning time by up to 70%



Generate tuning reports (history of PID optimization)



Build repeatable, robust tuning parameters



Monitor tuning and make adjustments without disturbing your process

### Connectivity

Provides real-time updates at specified intervals

Shares performance calculations and measures

Maps parameters for common controllers

Quickly responds to process disturbances

### Support

#### 1<sup>ST</sup> YEAR TECHNICAL SUPPORT

First year free with software purchase. Maintenance support agreements available for subsequent years.



### Contact Us Today

☎ 1 (440) 443-3900

✉ [info@controlsoftinc.com](mailto:info@controlsoftinc.com)



## Services

Our in-depth expertise and understanding of process control technologies enables us to take on your toughest challenges and bring predictable success anytime, anywhere. Our services include:

- Consulting and technology development services
  - Project development
  - Economical and technical feasibility studies
  - Project management
  - Engineering and design
  - Commissioning and start-up
  - Training of operations and maintenance personnel
  - Maintenance support
- 



## Training

We offer classroom and web-based training to help you learn the basic terminology and building blocks of process control as well as advanced process control techniques using our award-winning control solutions

View our current class schedule, detailed outline, and registration form at [www.controlsoftinc.com/training.shtml](http://www.controlsoftinc.com/training.shtml).

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## Support

Building relationships with productivity-driven businesses, we've built a reputation for excellence in delivering not only technical support, but strategic direction in evolving technology environments.

Call us at 1 (440) 443-3900 or email [tech-support@controlsoftinc.com](mailto:tech-support@controlsoftinc.com).

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## Partnerships

ControlSoft is proud to partner with some of the best known names in leading industries. Our strong partnerships allow us to deliver the best process control solutions for our clients.

As a partner, we carefully guard all proprietary technologies and confidential information shared with us. We continue to seek these partnerships, forged on our values of integrity, professionalism, mutual respect and understanding.

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