

INTUNE Version 5

Process Performance Monitoring, Reporting, Tuning, & Diagnostic Tool

INTUNE V5 is a plant management and engineering tool that combines process control monitoring functions with powerful diagnostic and tuning tools. The software monitors all plant/process loops without intruding on the process, and can automatically generate reports that identify poorly performing loops. In its diagnostic capability, INTUNE V5 generates reports that will notify managers, engineers, or operators via e-mail, phone call, or alarm, if process performance violates certain pre-set conditions. INTUNE V5 then provides a tool to resolve process issues quickly and easily.

MANTRA

Advanced Process Control System

MANTRA is a state-of-the-art advanced control system. It is a full-blown, configurable control system with more than 90 function blocks, configurable faceplates, and very easy to use, intuitive, drag-and-drop type of function block programming. The advanced control functions in MANTRA include our patented model-based control suite—IMC (Internal Model Control), CC (Coordinated Control), and MMC (Modular Multivariable Control). MANTRA allows users to build all necessary logic on top of the multivariable predictive control functions to take care of any operation or control needs. It also allows users to switch the control back and forth between MANTRA and their existing control system.

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PID Loop Tuning Pocket Guide Version 2.0

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DESCRIPTION OF PROCESSES

Fast Loops (flow, pressure)

P - Little [Too much will cause cycling]
I - More
D - Not needed

Integrating (level & insulated temp)

P - More
I - Little [Will cause cycling]
D - Must [If D is not used, the loop will cycle.]

Slow Loops (temperature)

P - More
I - Some [Too much will cause cycling]
D - Some

Noisy Loops (any PID loop where the measurement is constantly changing)

P - Low [Will cause cycling]
I - Most [Accumulated error]
D - Off [Will cause cycling]

DESCRIPTION OF PID UNITS

Proportional Term is the amount added to the output based on the current error.

Proportional Gain is a Multiplier.

If the error is 10 and the Gain is .8, then the 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 $(10 * (100/125)) = 8\%$.

Conversion between P-Gain and P-Band:

$P\text{-Band} = 100/P\text{-Gain}$

Integral Term is the amount added to the output based on the sum of the error.

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.

Reset Rate 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 $.1 * 8$ every second and take 10 seconds for the full repeat of the P-Term of 8%.

Integral Gain is the same as the Reset Rate multiplied by the P-Gain.

Conversion between Time and Reset Rate:

$\text{Reset Rate} = 1 / \text{Time Constant}$

$I\text{-Gain} = (1 / \text{Time Constant}) * P\text{-Gain}$

Derivative Term is the amount subtracted from the output based on the rate of change of the error.

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.

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GE PID BLOCKS

Series 90/30/70 PID Block ISA
P Gain (Gain * 100)
I Reset Rate (Repeats/sec * 1000)
D Time Constant (Sec * 100)

Series 90/30/70 PID Block Independent
P Gain (Gain * 100)
I Reset Rate (Repeats/sec * 1000)
D Gain (Gain * 100)

OMRON PID BLOCKS

PID Block
P Gain (Gain * 1)
I Time Constant (Sec * 10)
D Time Constant (Sec * 10)

SIEMENS TI PID BLOCKS

PID Block
P Gain (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)

MANTRA PID BLOCKS

PID Block Series
P Gain (Gain * 1)
I Time Constant (Sec * 1)
D Time Constant (Sec * 1)

PID Block Parallel
P Gain (Gain * 1)
I Reset Rate (Repeats/sec * 1)
D Gain (Gain * 1)

PID Block Non-Interacting
P Gain (Gain * 1)
I Time Constant (Sec * 1)
D Time Constant (Sec * 1)

SQUARE D PID BLOCKS

PID Block
P Gain (Gain * 100)
I Reset Rate (Repeats/min * 100)
D Time Constant (Min * 6000)

WESTINGHOUSE

WFDP PID Block
P Gain (Gain * 100)
I Time Constant (Sec * 1)
D Gain (Gain * 1)

Ovation PID Block
P Gain (Gain * 1)
I Time Constant (Sec * 1)
D Gain (Gain * 1)

MODICON PID BLOCKS

KPID Block
P Gain (Gain * 1)
I Time Constant (Sec * 1)
D Time Constant (Sec * 1)

PID Block
P Gain (Gain * 1)
I Time Constant (Sec * 1)
D Time Constant (Sec * 1)

PID2 Block
P Band (Gain * 1)
I Reset Rate (Repeats/min * 100)
D Time Constant (Min * 100)

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 8 for contact information).

AB PID BLOCKS

PLC5 Integer Block ISA
P Gain (Gain * 100)
I Time Constant (Min * 100)
D Time Constant (Min * 100)

PLC5 Integer Block Independent Gains
P Gain (Gain * 100)
I Reset Rate (Repeats/sec * 1000)
D Gain (Gain * 100)

PLC5 PD Block ISA
P (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)

PLC5 PD Block Independent Gains
P Gain (Gain * 1)
I Reset Rate (Repeats/sec * 1)
D Gain (Gain * 1)

PLC5 PCO Block Dependent Gains
P Gain (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)
PLC5 PCO Block Independent Gains
P Gain (Gain * 1)
I Reset Rate (Repeats/sec * 1)
D Gain (Gain * 1)

SLC PID Block with RG bit on
P Gain (Gain * 100)
I Time Constant (Min * 100)
D Time Constant (Min * 100)

SLC PID Block with RG bit off
P Gain (Gain * 10)
I Time Constant (Min * 10)
D Time Constant (Min * 10)

ControlLogix PID Block Independent
P Gain (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)

ControlLogix PID Block Dependent
P Gain (Gain * 100)
I Reset Rate (Repeats/sec * 1)
D Gain (Gain * 1)

ControlLogix PIDE Block Independent
P Gain (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)

ControlLogix PIDE Block Dependent
P Gain (Gain * 100)
I Reset Rate (Repeats/sec * 1)
D Gain (Gain * 1)

BAILEY INFI90 PID BLOCKS

156,0 PID Block
P Gain (Gain * 1)
I Reset Rate (Repeats/min * 1)
D Time Constant (Min * 1)

156,1 PID Block
P Gain (Gain * 1)
I Reset Rate (Repeats/min * 1)
D Time Constant (Min * 1)

156,2 PID Block
P Gain (Gain * 1)
I Reset Rate (Repeats/min * 1)
D Time Constant (Min * 1)

156,3 PID Block
P Gain (Gain * 1)
I Time Constant (Min * 1)
D Time Constant (Min * 1)

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CLOSED LOOP TUNING PROCEDURE

CLOSED LOOP STEP 1: KNOW THE PROCESS

Identify the loop you intend to tune and determine the speed of the loop. A rough categorization is as follows:

Fast loop has response time from less than one second to about 10 seconds, such as a flow loop. Use of PI controller is sufficient.

Medium loop has response time of several seconds up to about 30 seconds, such as flow, temperature, and pressure. Use either PI or PID controller

Slow loop has response time of more than 30 seconds, such as many temperature loops and level loops. Use of PID controller is recommended.

CLOSED LOOP STEP 2: KNOW THE CONTROLLER

Identify the units of your PID controller,

Proportional term (P-Term) is either a Proportional Gain (P-Gain) or Proportional Band (P-Band).

Integral term (I-Term) can be a Time Constant (in minutes or seconds), Reset Rate (1/second or 1/minute), or I-Gain (Reset rate * Proportional gain).

Derivative term (D-Term) can be Time Constant (in seconds or minutes) or Derivative Gain (derivative time constant * proportional gain).

In this document, Proportional Gain, Integral Reset Rate, and Derivative Gain are assumed.

Convert back to your controller units if necessary.

The Reference section is a summary of many of the more common controllers available on the market.

For units of other controllers, please contact ControlSoft.

CLOSED LOOP STEP 3: WATCH THE RESPONSE

Make a small change of setpoint (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 setpoint or no apparent overshoot (over damped), increase your proportional gain by 50%.
- If the 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 setpoint, reduce Integral Reset Rate by 30% and increase Derivative Gain by 50%.
- If PV stays fairly flat and below (or above) the setpoint for a long time, after change of setpoint 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.

OPEN LOOP TUNING PROCEDURE

OPEN LOOP STEP 1: KNOW THE PROCESS

Identify the loop you intend to tune and determine the speed of the loop. A rough categorization is as follows:

Fast loop has response time from less than one second to about 10 seconds, such as a flow loop. Use of PI controller is sufficient.

Medium loop has response time of several seconds up to about 30 seconds, such as flow, temperature, and pressure. Use either PI or PID controller

Slow loop has response time of more than 30 seconds, such as many temperature loops and level loops. Use of PID controller is recommended.

OPEN LOOP STEP 2: KNOW THE CONTROLLER

Identify the units of your PID controller, Proportional term (P-Term) is either a Proportional Gain (P-Gain) or Proportional Band (P-Band).

Integral term (I-Term) can be a Time Constant (in minutes or seconds), Reset Rate (1/second or 1/minute), or I-Gain (Reset rate * Proportional gain).

Derivative term (D-Term) can be Time Constant (in seconds or minutes) or Derivative Gain (derivative time constant * 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 Reference section (starting on page 6) is a summary of many of the more common controllers available on the market.

For units of other controllers, please contact ControlSoft.

OPEN LOOP STEP 3: OPEN LOOP TEST FOR NON-INTEGRATING LOOPS

- a. Put loop in manual control mode, keep control output constant, and wait for process to stabilize.
- b. Make a small step change on control output (say 5 or 10%), and watch the response.
- c. 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.
- d. Select initial PID values such that
 $P = 2 * (\text{Deadtime} + \text{Time constant}) / \text{Model gain}$
 $I = (\text{Deadtime} + \text{Time constant})$
 $D = (\text{Deadtime} / 3) \text{ or } (\text{Time constant} / 6)$
 For slow loop, select whichever is greater.
 For fast loop, select smaller value.
- e. These initial PID values should give you a reasonable closed-loop response. Fine-tune the controller by using the closed-loop tuning method (see Step 3 on page 3) to get your desired response.

**Figure 1.
First Order
Non-Integrating
Model
Calculation**

