INFORMATION

No. **INF 99/37**

Date **06.00**

Product **All ABB Controllers**
Manual **Relevent Operating Instructions**

ABB Controller PID Settings and Input Specifications

1 Introduction

This Information Sheet contains a brief explanation of PID setting terminology together with a table of recommended settings.

2 Proportional, Integral and Derivitive Control Terminology

Proportional Band (PB) – The change in input required to produce a 100% change in output.

Gain – Calculated using the formula:

$$\text{Gain} = \frac{100}{PB}$$

Therefore if Proportional Band = 100%
then Gain = 1.

Where a 100% change in input causes a 100% change in the control output.

Integral Action (Reset) – An integral controller produces a steadily changing output as long as an error exists between the process variable (PV) and the setpoint (SP). The larger the error, the larger the rate of change of controller output.

Imagine a controller which is not connected to a process and at an initial condition of zero error. If an error (called a step change) is suddenly introduced the controller output will change to a new value.

Integral Action Time – After this initial movement, the controller output continues to move in the same direction. The time taken to move the same amount as the initial movement is called the *integral action time* or *reset time.* (i.e. *integral action time* is the time taken to repeat the change that was due to the **proportional action)**.

It can be expressed in the following ways:

- Repeats per minute
- Seconds per repeat

If the *integral action time* is set too short, the output will increase to its maximum almost immediately and cause the PV to overshoot the setpoint. If set too long the PV will not reach the setpoint before the next load change.

Derivative Action – As long as the process is running under a steady state the PI-controller works satisfactorily. Even if process disturbances occur, the PI-controller can handle these very well.

However, we know that the wider the PB and the greater the integral time, the less responsive the system becomes. A situation could occur whereby the optimum PI settings for normal conditions make a system unable to react to larger disturbances (e.g. under start-up conditons).

It is in these conditions that derivative action is useful because the output is proportional to the *rate* at which the error is changing.

The amount of corrective action (derivative component) required is dependent upon the *derivative action time*, which is defined as the time it would take for the proportional component to reach the same level as the proportional-plus-derivative component. A short derivative action time gives a small amount of derivative component correction, a long time gives a large amount.

⚠ **Caution.** Due to the extremely fast loop speed, derivative action should never be used in a Flow Loop.

Anti-Reset Wind-Up – Reset Wind-Up is a phenomenon that occurs in P+I controllers under large load change conditions (e.g. Cold Start Up). Under steady state conditions when a small load change (e.g. <20% of SP value) is applied to the system, the integral term calculation manipulates the output value and the process recovers to the control set point effectively. If a large load change (e.g. >20% of SP value) is applied to the system, the integral term causes the output to try and eliminate the error by over correcting the output value and overshoots the set-point. Integral then counters by overcorrecting the output value in the opposite direction and undershoots set-point. This series of over-corrections causes the error to continue to increase and the controller's output to saturate or “wind-up” to 100% (or 0% depending on control action) and the process becomes out of control.

This problem is often seen in pneumatic controllers and to some extent, analogue electronic controllers. The effect was caused by physical limitations within the controller.

Micro-processor based controllers have transparent internally fixed sets of algorithms that will modify or eliminate the integral calculation until the event returns to the defined limits. Then and only then, will the controller respond to process changes within the user defined control parameters.

Approach Band – The approach band limits when derivative action time is applied. When the process variable is outside the approach band, derivative action is not applied.

Derivative BW = Approach band X Proportional BW

Input Resolution – In microprocessor based controllers, the analog signal from the sensing element / transmitter is converted to a digital signal. The ability of the controller to accurately represent the analog input signal is determined by the input resolution.

e.g. with a 2-bit resolution, there are 4 different digital values to which a signal could be converted.

Calculated as:

$2^2 = 4$ (2 bit)
$2^8 = 256$ (8 bit)
$2^{10} = 1024$ (10 bit)
$2^{12} = 4096$ (12 bit)
$2^{14} = 16384$ (14 bit)
$2^{16} = 65536$ (16 bit)

The higher the input resolution, the better the representation of the analog signal.

Using a resolution of 16 bit as an example, a 4 to 20mA signal could be broken down into 65536 values.

Controller Setting Start Figures

Process	Gain (P)	Proportional Band (%)	Integral (I) reps/min	Integral secs/rep
Temperature	10	10	2	30
Pressure (Fast)	1	100	60	1
Pressure (Slow)	10	10	2	30
Level (Fast)	1	100	60	1
Level (Slow)	10	10	2	30
Flow	1	100	60	1
pH	0.5	200	0.05	1200

✶ **Note**. These figures are intended only for use as a guide. Settings vary between applications and an amount of fine tuning may be necessary.

	P		I		D		Anti-reset wind-up	Approach band	Sample Time	Input Resolution
	Stated as		Stated as		Stated as					
	% P. Band	Gain	Reset	Integral	Rate	Derivative				
MOD 30ML		0.01 to 125		0.01 to 125 reps/min		0.01 to 125	Std.	n.a.	50ms Digital 150ms Analog	16 bit
MODCELL MLP		0.01 to 125		0.01 to 125 reps/min		0.01 to 125	Std.	n.a.	50ms Digital 150ms Analog	16 bit
MODCELL 2050R		0.1 to 3000.0		0.1 to 120.0 reps/min		0 to 3000.0 secs	Std.	n.a.	250ms 500ms T/C or RTD	
MOD 30		0.01 to 125		0.01 to 125 reps/min		0.07 to 32 min	Std.	n.a.	250ms	16 bit
C1900R	0.1 to 999.9			0 to 7200 secs/rep		0 to 999.9 secs	Std.	0.1 to 3.0	250ms	18 bit
C350/C360/C500	0.1 to 999.9			0 to 7200 secs/rep		0 to 999.9 secs	Std.	0.1 to 3.0	125ms	16 bit
C300/310	0.1 to 999.9			0 to 7200 secs/rep		0 to 999.9 secs 0.1 to 16.67 min	Std.	0.1 to 3.0	160ms	12 bit
C200	0.1 to 999.9			0.1 to 120 reps/min		0 to 999.9 secs	Std.	n.a.	250ms	18 bit
C100/C250/V100 and V250	0.1 to 999.9			0 to 7200 secs/rep		0 to 999.9 secs	Std.	n.a.	250ms	16 bit
C50	0.0 to 999.9			off & 1s to 99m59s/rep		0 to 99m59s	Std.	n.a.	250ms	14 bit
200R	0.1 to 999.9			0.1 to 120.0 reps/min		0.1 to 999.9	Std.	n.a.	866ms	14 bit
500R	0.1 to 999.9			0.9 to 999.9 secs/rep		0.1 to 999.9	Std.	n.a.	866ms	14 bit
1900 ER/C	0.1 to 999.9			0.9 to 999.9 secs/rep		0.1 to 999.9	Std.	n.a.	866ms	14 bit
PXR 105	0.1 to 999.9			0 to 7200 secs/rep		0 to 999.9 secs	Std.	0.1 to 3.0	133ms	12 bit
PX105	2 to 500			0 to 600 secs/rep		0 to 600 secs	Std.	0.1 to 3.0	133ms	12 bit
120R	0.29 to 290		0.05 to 200 reps/min			0.1 to 20 mins	Option	n.a.	Analog	n.a.
440R		0.2 to 35	0.05 to 200 reps/min			0.1 to 20 mins	Option	n.a.	Analog	n.a.
ECA06/60/600		0.01 to 99.99		0.1 to 9999.9 secs/rep		0.0 to 9999.9	Std.	n.a.	30 to 500ms	12 bit
Protronic		0.001 to 1000		0 to 600 mins/rep		0 to 600 mins/rep	Std.	n.a.	100ms	14 bit
MicroMite and Micro DCI	2 to 1000			0.02 to 200 mins/rep		0.01 to 8 mins	Std.	n.a.	50ms	12 bit

Table 1 ABB Controller PID Settings and Input Specifications

Printed in UK (06.00)

IINF 99/37 Issue 1

ABB Instrumentation Ltd.
St. Neots
Cambs.
England, PE19 8EU
Tel: +44 (0) 1480 475321
Fax: +44 (0) 1480 217948

ABB Automation Inc.
Instrumentation Division
125 E. County Line Road
Warminster, PA 18974 USA
Tel: +1 215-674-6000
Fax: +1 215-674-7183

ABB Instrumentation
22016 Lenno
Como
Italy
Tel: +39 (0) 344 58111
Fax: +39 (0) 344 58278