AirCare Variphase™
Setting and Implementing PID Control

Application Note -1002

PID Control for **AirCare** ***VariPhase***™ Closed Loop Operation

The AirCare VariPhase incorporates a proportional controller to precisely control motor speed using feedback from a tachometer sensor. Several times each second the control compares actual motor speed to desired motor speed and proportionally adjusts the output drive to the motor.

The PID function adjusts how the Variphase responds to differences between desired and actual motor speed. By adjusting the P, I and D-terms the response speed, overshoot and ultimate acceptable error can be controlled. For many applications the factory default values will be sufficient. If your system is showing undersirable closed-loop operation (ie. oscillation) adjustment of PID parameters will correct this.

PID Implementation in the AirCare VariPhase™ When Using Close Loop Control

- Possible PID values are 0-30000 as implemented in the AirCare VariPhase unit.
- Factory default (at time of printing -- P=4000, I=700, D=2000) give good results in most applications

Procedure for Setting PID Parameters

- Start with P-I-D set to factory defaults
- If Variphase is having difficultly achieving full-speed, increase the P-term until unstable behavior is observed, then back off slightly.
- If Variphase is not achieving the target speed (it settles at a speed different from the desired or set speed) try increasing the I-term. Again if response is oscillatory, reduce the I or P term slightly.
- If response to a change is desired speed is too slow, try increasing the D-term.
- At each PID term adjustment above, observe motor under abrupt speed changes from fast to slow and slow to fast. If response is oscillatory, back off.
- Note that the response speed is limited by the inertia of the fan/motor and by the phase-control method used in Variphase. Total reponse time for a 50% speed change is typically 30 seconds.

PID Output

The total PID output is the sum of the P, I and D contributions.

The P-Term (Proportional Contribution)

With proportional band, the controller output is proportional to the error or a change in measurement (depending on the controller).

Proportional Contribution to Output = PTerm * Error

With a proportional-only controller, offset (deviation from set-point) is present. Increasing the controller gain enough will make the loop go unstable. Integral action was included in controllers to eliminate this offset.

The D-Term (Derivative Contribution)

With derivative action, the controller output is proportional to the rate of change of the measurement or error. The controller output is calculated by the rate of change of the measurement with time.

Derivative Contribution to Output = DTerm * (dm/dt)

Where *m* is the measurement at time *t*.

The I-Term (Integral Contribution)

With integral action, the controller output is proportional to the amount of time the error is present. Integral action eliminates offset.

Integral Contribution to Output = ITerm * + $\int$ e(t)*d(t)

With integral contributions to the control, the response is somewhat oscillatory and can be stabilized some by adding derivative action.