Different Methods to Control Fan Speed

Introduction

At first glance, you may think, "It's just a fan". Why complicate something so simple. After all, it's just another component to deal with and anything extra adds additional cost to the system. This statement may be true for most typical applications, but applications that are sensitive to noise and power, this option adds value!

Fan noise and power are directly related to the output performance of the fan. If additional CFM is needed, an increase in noise and power will also be the result. In this world there is no free lunch. But what if we can reduce the amount of CFM during times where system loads are minimal. During these moments, we can reduce the CFM and consequently lower the emitted noise and power requirements. If the load increases, we can increase the CFM to meet the cooling requirements. The result is a win-win situation for today's thermal cooling needs.

There are many ways to control the speed of a fan. Controlling the speed of the fan can be as simple as regulating the input voltage to the fan to using more complicated digital microprocessor inputs. These methods are further addressed below and we offer guidelines to follow when considering each option for your application.

Voltage Regulation

The voltage regulation option is designed for applications where the input power may fluctuate at different voltage levels. An example would be a backup generator, or outdoor telecommunications equipment that periodically undergoes battery regeneration. In these applications, a change in input voltage would result in a change in the fan's rpm and thus, noise and power.

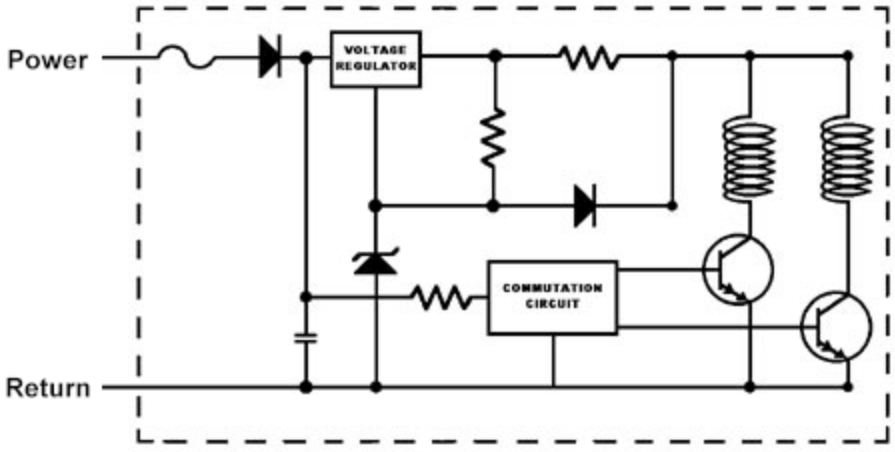

Figure 1: Voltage Regulation Circuit

To avoid unwanted fluctuations, Comair Rotron fans can be equipped with an internal regulating circuit that maintains a constant voltage source to the fan windings; regardless of how the input voltage changes. This is accomplished by using a voltage regulator and clamping the adjust leg with a zener diode. See Figure 1. Everything is built into the fan. There are no extra components or extra wires to deal with in your system. The Comair solution is simple and easy.

Programmable

A programmable fan allows you to control the speed of the fan to optimize cooling performance. This option can create new ideas in thermal management by developing simple circuits that can either pulse width modulate, vary the voltage, or vary the resistance. The amount of flexibility this option can provide is extensive.

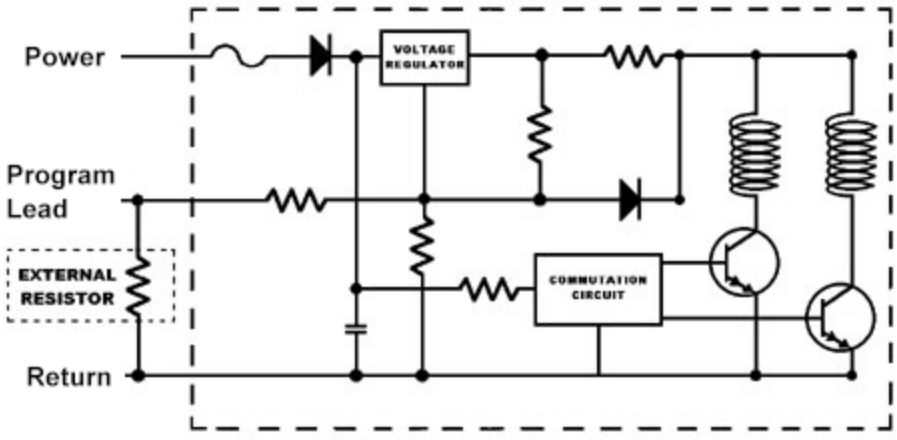

Figure 2: Programmable Fan Circuit

Because brushless DC fans rely on an electronic circuit to rapidly switch the magnetic fields, circuitry can be

added to enhance the fan's ability and add additional value to your system. The programmable option uses an internal voltage regulator to set the speed of the fan by means of a third lead wire tied to the adjust leg of the regulator. See Figure 2. The speed can be controlled two ways - controlling the voltage to the adjust lead or controlling the resistance between the adjust lead and the return. Either pulse width modulation or a variable voltage/resistance can accomplish either method.

For pulse width modulation (PWM), The pulse signal should be applied to the program lead (yellow wire) and referenced to the return lead. For PWM, by means of applying voltage on and off, the amplitude should be equal to the nominal voltage of the fan, the frequency should be held constant (20kHz recommended) and the duty cycle allowed to vary between 0 and 100%. The voltage must be current limited so that there is no more than 5mA to the program lead. For PWM by means of controlling resistance, the program lead should be cycled between an open and a short to the circuit return, with the frequency held constant.

Controlling the speed by varying the resistance or voltage is accomplished the same way as PWM. The difference is that the voltage/resistance is varied linearly instead of varying the duty cycle. Applying a direct voltage to the adjust leg will achieve the same results as varying the resistance. As you will notice in Figure 2, the resistors tied to the adjust leg create a voltage divider. By varying the external resistor, a voltage divider supplies the adjust leg with a varying voltage.

Each fan is different in the range of input voltage to fan speed. The rule of thumb is a zero voltage input will result in a minimum speed condition and an input equal to 50% of the fans nominal voltage will result in a maximum speed condition. For instance, a 24 Vdc fan will operate at full speed when 12 Vdc is applied to the program lead.

Unfortunately, the voltage range is preset. If your requirements call for a linear change from 0 to 10 volts, an op-amp can be used to customize the programmability input. This option is not available on all models and minimums do apply.

For controlling the speed by resistance, a closed circuit between the program lead and the return will result the fan operating at half speed. An open circuit will result in a full speed condition. Different resistance values will yield different fan speeds.

Thermal Speed Control

The thermal speed control option varies the speed similar to the programmable option, except it does not need any external input. This option uses a thermistor to monitor the temperature and regulate the speed accordingly. The thermistor's metal properties allow it to change its resistance at different temperatures, thus creating a variable voltage divider circuit at the adjust leg of the voltage regulator. The fan will automatically adjust its speed to optimize the airflow to the surrounding temperature. See Figure 3.

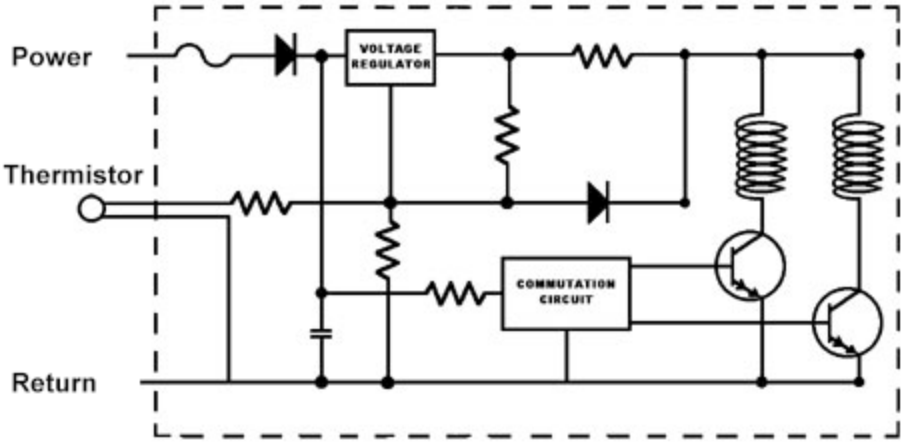

Figure 3: Thermal Speed Control

For conditions where power inputs are at a minimum, the fan operates at half speed, providing a minimal amount of CFM to those components still in need of cooling. This reduction in speed results in a significant reduction in noise and power consumption. As the power requirements increase, so does the internal temperature. The fan senses this increase and compensates for it. The fan will continue to increase in speed until it reaches full speed for maximum cooling. The temperature range is 25°C to 45°C. Any temperature below 25°C the fan will operate at half speed. Between 25°C and 45°C, the fan RPM changes linearly with temperature. Over 45°C, the fan will maintain full speed operation.

Fans equipped with this option use a thermistor tied to the adjust leg of the voltage regulator and the power return. The thermistor can be located on a zip cord and placed on hot spots such as processors, heatsinks, transformers, etc., or can be placed in the hub of the fan to monitor the air traveling through the fan. Mounting the thermistor in the hub of the fan is only recommended for applications where the fan will be exhausting the air from the system.

External Controllers

Sometimes more complicated cooling methods are needed. This may include using multiple temperature sensing, different set speeds per fan, or other combinations. For cases where complicated mapping functions are needed, the only choice is to use a microprocessor. This option is often expensive and may need additional mounting space. Each application needs to be dealt with on an individual basis. Please contact our Application Engineering department for more information on this option.

Conclusion

There are many ways to control the speed of a fan. After all, it is a simple component. But there are some considerations that must be addressed. For instance, pulse width modulating the power lead of a standard fan will also PWM the fragile ASIC circuitry that makes the fan work. This circuitry is not designed for rapid switching of power on and off. Comair Rotron's speed control fans are. They offer the flexibility and reliability that our customers have come to trust for over 50 years.