Selecting a Cooling Fan

As an assistance in selecting the proper cooling device for your electronic system, it might be useful to understand the performance differences among the various types of axial flow devices. Figure 1 compares the performance curves of the four types, all of the same diameter and operating at the same speed.

Device Characteristics

Axial Flow Devices — propeller fans, tubeaxial fans, vaneaxial fans, and multi-stage axial blowers have essentially the same performance characteristics. All are distinguished by the fact that pressure is proportional to lift produced by the rotating airfoils of the impeller. As for any airfoil, there is a point (B on Figure 2) beyond which the impeller stalls, that is, the pressure (lift) decreases with decreasing flow. This explains the dip in the performance curves of each of these types. It is virtually impossible to operate satisfactorily in this region, B to C. Flow pulsations, increased audible noise, and reduced efficiency occur. Stable performance and maximum efficiency are in the A to B range. The optimal operating range is between A1 and B. This is where the fan operates best and longest life is to be expected.

Typical Axial Fan Performance

Propeller Fan — consists of a propeller rotating within a mounting ring or orifice and includes provision for motor supports. These are sometimes supplied without the mounting ring, in which case the customer mounting panel serves as the fan orifice. Propeller fans are the simplest, most economical, and least efficient axial flow devices.

Tubeaxial Fan — consists of an impeller rotating within a full cylindrical housing, which also provides motor support struts. The term tubeaxial, as presently used by manufacturers, implies more efficient airfoil blades, closer tip clearance, and generally cleaner flow patterns than the propeller fan. This results in greater pressure capability and higher efficiency.

Vaneaxial Blower — is the sophisticated brother of the tubeaxial, just as the tubeaxial represents an improvement over the propeller fan. Guide vanes are inclined on either the inlet or outlet side of the propeller. The vanes reduce the rotational or "whirl" pattern of the air stream which results in:

1. Higher pressure before stall

2. Increased efficiency

Multi-Stage Axial Blower — is essentially two or more vaneaxial fans mounted on a common shaft and housing in series. The first vaneaxial fan, or stage, feeds the second stage with axial flow at the design point. Static pressure available is roughly the product of the number of stages and stall pressure of a single stage. Multi-stage units are capable of the highest pressures attainable by an axial device for a given size and speed. They are necessarily somewhat heavier and more expensive than the other axial units.

For most industrial applications, a tubeaxial fan provides the best mix of cooling performance, low noise level, and long, reliable operation. The fans in this catalog are tubeaxial. On the following pages, we provide a simplified approach to selecting the proper Globe tubeaxial cooling fan for your system. Globe Motors will provide technical assistance in solving your cooling fan requirements that exceed the capabilities of these tubeaxial fans.

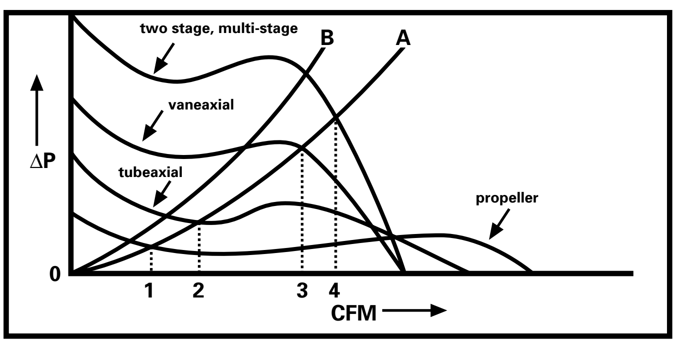
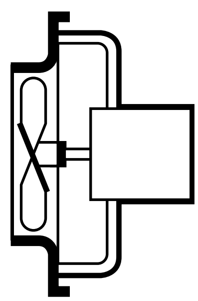
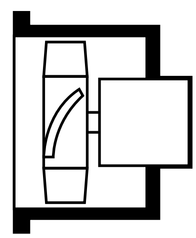


Figure 1.



Propeller Fan



Tubeaxial Fan

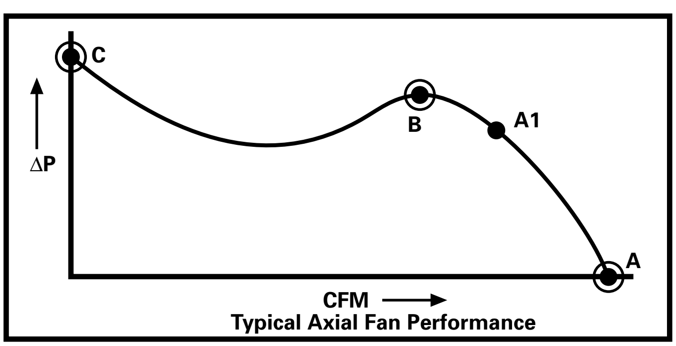
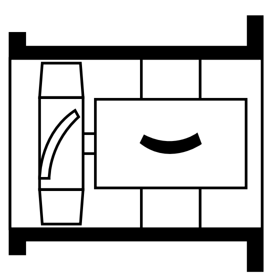
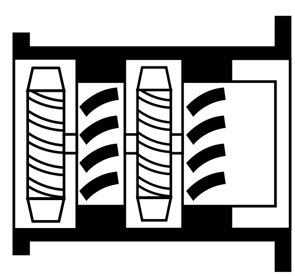


Figure 2.



Vaneaxial Blower



Multi-Stage Axial Blower

 Specifications subject to change without notice.

Considerations for the Cooling Fan Location

A key criterion for fan selection is the location of the fan in your system. This has a very important impact on airflow effectiveness and cooling efficiency.

Globe provides you flexibility with our use of precision ball bearings. They allow you to mount our fans in either the horizontal of vertical position (or somewhere in between) without negatively impacting bearing wear and, therefore, life and noise.

Without trying to design your system layout, here are some general guidelines which we hope you find helpful:

1. Keep the airflow path as unobstructed as possible. The air should flow across components and circuit boards and not into them. The air entry and exit points should especially be kept free of interference to airflow.

2. There are two ways to treat your greatest sources of heat dissipation. In a tight cabinet, placing this heat source near the air exit will have the least heating effect on the air cooling your lower power areas. If you have a large cabinet, like an office copier, whose interior is relatively uncluttered but has a significant hot spot, placing the hot component by the air inlet will ensure the best cooling. As the air mixes in the large open cabinet, it will cool somewhat before exiting past the other components.

3. To utilize vertical airflow through your cabinet, place the cooling fan to assist the natural convection airflow that moves upward.

4. If you intend to use a filter or an RFI screen, you must consider the additional resistance to airflow that these items create.

By carefully considering your cooling fan location, you can possibly avoid requiring a larger fan which would increase your noise level and power dissipation.

Table 1
Typical Airflow Requirements by End Use Equipment

	CFM					
	0 to 25	**26 to 50**	**51 to 75**	**76 to 100**	**101 to 125**	**126 and Up**
Office Copiers	X	X	X	X	X	X
Power Supplies	X	X	X	X		
Micro Computers	X	X	X	X		
Receivers	X	X				
Terminals	X	X				
Audio Amps	X					
Pos Terminals			X	X	X	
Office Equipment			X	X	X	
Recording Equipment			X	X	X	
P.A. Systems			X	X		
TV Cameras & Monitors			X	X		
Instrumentation			X	X	X	
Medical Equipment			X	X	X	
Mini Computers					X	X
Telecom Equipment					X	X
Lab Equipment			X	X	X	
Computer Peripherals	X	X	X	X	X	
Mainframe Computers				X	X	X
Disc Drives						X
Industrial Controls						X
Computer Consoles						X
Relay Racks						X
Instrument Cabinets						X
Transmitter Cabinets						X

How to Select a Globe Cooling Fan

To aid you in determining your cooling fan requirements, we would like to provide a simplified approach to fan selection. Table 1 provides a general starting point for typical airflow requirements of industrial equipment. The following discussion will enable the user to apply a clear understanding of airflow in selecting a suitable unit.

The Essentials

To properly select a particular fan for a specific application, the detailed requirements must be known. These include the normal motor specifications and those peculiar to air-moving devices, your system's power dissipation, your system's resistance to airflow, and the allowable temperature of your system's internal air.

Cooling Air Required

The values established by the method described below tend to be conservative. For example, the method treats laminar airflow only. When turbulent flow conditions exist, the cooling is improved further.

$$\text{CFM} = \frac{\text{watts dissipated x a constant}}{\text{allowable temperature minus inlet temperature °F}}$$

Standard Air Conditions — Air density, for many applications, is taken at standard conditions (70°F at 29.92" of mercury). The constant 3.16 is a function of the specific heat of air at these standard conditions. The formula for standard air conditions is:

Equation 1.

$$\text{CFM} = \frac{\text{watts}}{\text{Temp. Rise °F}} \times 3.16$$

Variable Density — When standard air conditions cannot be assumed, you may use the constant 0.1784 as a function of the specific heat of air near sea level. Change in the specific heat due to pressure and temperature changes has not been considered, and in most cases it is negligible. However, you might want to consider high altitude usage, such as in Denver. To calculate CFM for these non-standard air conditions, use the formula:

Equation 2.

$$\text{CFM} = \frac{\text{watts} \times \text{T°R}}{\text{Temp. Rise °F} \times \text{Pb}} \times 0.1784$$

watts = watts dissipated
T°R = Temperature in °Rankine
temperature = 459.6 + °F
Pb = barometric pressure in inches of mercury

Example: You need to keep the internal air temperature of your system at 80°F in a normal room temperature operating environment of 70°F. Since the system has 175 watts of power dissipation, application of Equation 1 computes an airflow requirement of 55 CFM.
Using Equation 1,

$$CFM = \frac{175 \times 3.16}{80°F - 70°F} = 55.3$$

Using Equation 2,

$$CFM = \frac{175 \times (459.6 + 70)}{(80 - 70) \times 29.9} \times 0.1784 = 55.3$$

Static Pressure

The key to determining your airflow requirements is knowing your system airflow resistance.

The static pressure or pressure drop the fan must work against can sometimes be estimated from experience with similar situations. To design for an assumed static pressure, however, is risky unless requirements are not critical.

It is preferable to construct a test setup and measure actual static pressure at a known flow rate. The pressure drop (P) is a function of the velocity squared (V^2) and the density of the fluid (ρ). Knowing one point of flow and pressure makes possible the plotting
of the system resistance curve by using the formula:

Equation 3.

$$\frac{\Delta P2}{\Delta P1} = \frac{\rho_2 [V_2]^2}{\rho_1 [V_1]^2}$$

$$\frac{\Delta P2}{\Delta P1} = \frac{[CFM_2]^2}{[CFM_1]^2}$$

where subscript 1 represents measured values. A simple test can be conducted using a manometer and a cooling fan for which you have a performance curve showing static pressure versus airflow (See Figure 3).

Example: It has been determined, using Equation 1, that 55 CFM of air is required to maintain safe operating temperatures in your system. If you don't know your system airflow resistance, it is suggested that you use one of our fans in a "back pressure" test setup as shown in Figure 3. It requires a manometer and simply moving the static pressure tap around to identify the system's maximum back pressure. The test unit should be running at measured voltage.
In our example, we are guessing your system needs a 4.70" fan because of your small allowable temperature rise.
To provide overkill as a safety precaution, we will use our most powerful model, A47-B15A-15T3. The "back pressure" test indicates the maximum static pressure is 0.133" of water. Referring to Figure 4 and the fan performance curve marked A47-B15A-15T3, the airflow corresponding to 0.133" of water is 75 CFM.

Given this data point, you can build your system "airflow resistance" curve by applying Equation 3A. Figure 4 shows this curve plotted and sweeping up from left to right. Your cooling requirements point is indicated by the "★". This curve will serve as your major check point as you select the proper Globe fan for your system.

Static pressure required at the required flow rate of 55 CFM is from Equation 3A:

Equation 3A.

$$\Delta P^2 = \frac{(55)^2}{(75)^2} \times .133 = 0.072" \; H_2O$$

To further assist you in airflow analysis and Globe cooling fan selection, we want to make you aware of the following relationships:

For a Given Fan — Change of Speed

$$\frac{CFM_1}{CFM_2} = \frac{RPM_1}{RPM_2}$$

$$\frac{P_1}{P_2} = \left[\frac{RPM_1}{RPM_2}\right]^2$$

$$\frac{BHP_1}{BHP_2} = \left[\frac{RPM_1}{RPM_2}\right]^3$$

Change of Air Density ρ at Constant Speed

$$\frac{CFM_1}{CFM_2} = 1$$

$$\frac{\Delta P1}{\Delta P2} = \frac{\rho_1}{\rho_2}$$

$$\frac{BHP_1}{BHP_2} = \frac{P_1}{P_2}$$

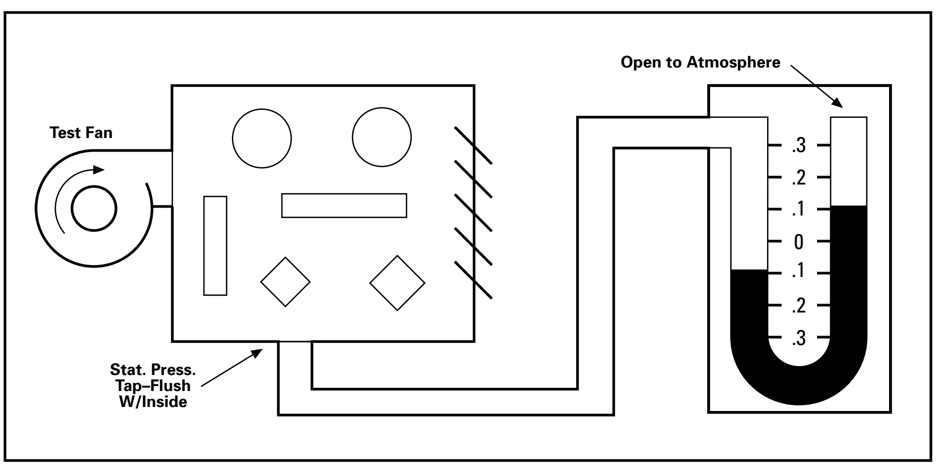


Figure 3.

Noise Considerations

Acoustic noise level is almost always a consideration in fan selection. Globe believes that the special attention that has been given to the acoustical aspects of our fan designs will provide you with superior performance and long life without paying an acoustical penalty.

Our noise measurements are conducted in an anechoic chamber in accordance with DIN 45635. The fan is running in free air with the microphone located at 90° to the air intake at a distance of 39" (1 meter). All noise measurements are given on the A-weighted sound level scale.

It is important that the least possible turbulence be created in the airflow. The more turbulence the more noise, especially anything obstructing the air intake. This includes finger guards, filters, and panel cutouts. In almost all cases, finger guards and filters will not increase noise by any discernible amount. For panel cutouts, we recommend those shown at the back of this catalog.

Mounting of the fan can be the greatest source of incremental noise. A fan hard-mounted to a resilient surface could introduce a sympathetic vibration. The surface will become a vibrating membrane acting as a speaker membrane to amplify noise. The fact that we dynamically balance our rotors and impellers helps alleviate this situation. However, strong consideration should still be given to fan mounting.

The following table provides an indication of the effect of dB changes:

dB Change	Apparent Change in Loudness
3 dB	Barely Noticeable
5 dB	Noticeable
10 dB	Twice as loud

Common Sound Levels in Your Home

Here are sound levels in decibels taken at the distance you usually hear them:

Lowest audible sound	0 dB
Breathing	10 dB
Whisper	30 dB
Refrigerator	45 dB
Normal conversation	60 dB
Dishwasher	70 dB
Garbage disposal	80 dB
Knife sharpener	80 dB
Cocktail party	80 dB
Vacuum cleaner	87 dB
Food blender	90 dB
Noisy exhaust fan	90 dB
Power lawn mower	95 dB
Noisy kitchen	100 dB
Amplified rock band	120 dB
Jet airport	130 dB
Shotgun blast	140 dB

Noise Ranges

0 to 20 dB — Very faint
20 to 40 dB — Faint
40 to 60 dB — Moderate
60 to 80 dB — Loud
80 to 100 dB — Very loud
100 to 140 dB — Deafening

Figure 4.