TECHNICAL TERMS

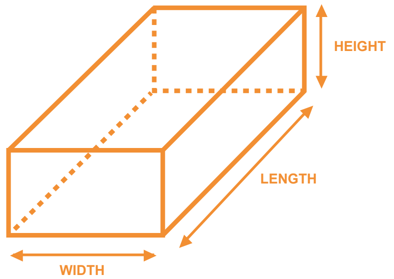
AIRFLOW/CFM

CFM (cubic feet per minute) indicates the volume of air that a fan will move in one minute at zero static pressure. It is important to note that CFM specifications are stated at zero static pressure because this is the point at which airflow is highest. As static pressure increases, airflow decreases. As a general guideline you should provide a vent hole area that is equal to approximately 1.5x the area of the fan venturi to prevent excessively high static pressure (the venturi is the opening, either intake or exhaust, where air passes through the fan.) Air volume is sometimes stated as “M3/m” (cubic meters per minute) or other alternative units. These alternate airflow units can be translated into CFM by the application of simple equations. When you are trying to figure out how much air your fan needs to move to serve your purpose you can make an educated guess using simple math.

Here is how:

1) Measure the inside volume of your application.

2) Multiply the measurements in inches like this:



$$\frac{L \times W \times H = V}{1728} = CFM$$

The result is the volume of your application expressed in cubic feet. Using the CFM specifications of a particular fan you can estimate how many times the air will be “turned over” in your application in 1 minute. In a home entertainment center with the standard array of equipment you may need to simply “keep the air moving” (1 or 2 times per minute) and can use a smaller, quieter fan. In a cramped server room you may need to turn the air over 10 or 12 times per minute or more. Greater heat load will require more air flow to dissipate sufficient heat. Every application is a little different and only a thermometer placed in your application’s hotspot will tell you whether you need more or less cooling.

BEARINGS

A bearing is a mechanical component that supports the rotating shaft of the fan allowing it to spin smoothly while reducing fiction. Ball bearings are generally considered to be the highest quality bearing option for fans. Under normal operating conditions at a comfortable room temperature, you can expect 90% of a given group of ball bearing fans to still be operating within specifications after 8 years* of continuous use. In addition, ball bearings have the highest temperature ratings (-70°C ~ +80°C) available. It is a common belief that ball bearing fans are noisier than other bearing alternatives, but in our testing we have found any difference to be insignificant (<1dBA) in most cases, and we make no noise distinction on our specification sheets between ball bearing vs. other bearing types. Please be aware that some manufacturers utilize a single ball bearing as opposed to the more common dual ball bearing in order to reduce costs. Not all are up front about this practice and the fans have a shorter life expectancy as natural vibration will wear out a single bearing faster. Verify that what you are getting is a dual ball bearing should you choose to purchase your fans elsewhere.

Sleeve bearing fans are a less expensive and less robust alternative to ball bearing fans. You can expect 90% of your sleeve bearing fans to be operating within specifications after 3 - 4 years* of continuous use. Sleeve bearing-type fans should only be mounted vertically (Air stream parallel to the ground). Mounting them in other orientations can cause the bearing lubricant to leak out and will cause premature failure.

Sealed sleeve bearing is a standard sleeve bearing with an oil collection cup that catches the lubricant as it exits the bearing and recirculates it back into the fan thereby extending the fan life. It is slightly more expensive than a standard sleeve and slightly less expensive than a ball bearing and has a life expectancy somewhere between the two. It provides more flexibility with mounting orientation, while still providing some cost savings compared to ball bearing options.

* Always consult product datasheets to compare exact model specifications when making comparisons.

LIFE EXPECTANCY

The life expectancy of a fan is almost entirely dependent upon the bearing system, and to a lesser extent, operating conditions. In the fan industry, life expectancy is normally rated using a system called L10. In the case of a ball bearing fan an engineer can expect a useful operating life of 60,000 - 70,000 hours (L10) under normal controlled conditions (-25°C ~ +65°C at 75% RH). As a general rule however, life expectancy will increase when the temperature of the environment is cooler.

Many manufacturers will quote a ±200,000 hour life expectancy by referring to Mean Time Before Failure (MTBF) curves rather than the more common L10 curve. The difference between the two types of curves is the calculated failure rate. L10 specifically refers to the amount of time it takes for 10% of a group of fans to fail during testing. In other words, at the end of the specified life expectancy, 90% of a given fan population will still be operating within stated specifications.

MTBF as it relates to the fan industry refers to a 50% failure rate. MTBF curves usually extend into the hundreds of thousands of hours for ball bearing fans. (Sleeve bearing fans typically have a life expectancy that is one half of what one would expect from an equivalent ball bearing unit.) Orion Fans typically have a MTBF rating of 250,000 - 300,000 hours.

The main problem with MTBF curves in relation to fans is that the calculations were originally designed to project the life expectancy of components that exhibit a random failure pattern. In most other components MTBF actually calculates a 63.2% failure rate. Fans in contrast experience increased frequency of failures as a given fan population ages.

MTBF calculations as provided by most fan manufacturers are actually “L50” calculations. That is to say that at the end of the stated life expectancy at least one half (50%) of a given population of fans will have failed.

Life expectancy curves are approximations and variations in environment will affect how long a fan will run. For instance, two identical fans will have vastly different life expectancies if one is run at or near maximum static pressure and the other is run in open air. Each environmental variation will affect lifespan in a positive or negative way.
Also note that the curves assume that a fan will be run 24 hours per day - 7 days per week at a specific temperature. If you instead run a fan for only 8 hours per day, you have effectively tripled the life expectancy of your fan in real terms, assuming that you only run the fan at a specific temperature.

Also note that “ball bearing” for Orion Fans usually refers to a “dual ball - double sealed bearing”. Single, ball bearing units will have a life expectancy that is somewhere between dual ball and sleeve.

NOISE

The human ear's response to sound level is roughly logarithmic (based on powers of 10), and the decibel (dB) scale reflects that fact. An increase of 3dB doubles the sound intensity produced by a noise source, but a 10dB increase is required before a sound is perceived to be twice as loud by humans. Therefore a small increase in decibels represents a large increase in intensity. For example, 10dB is 10 times more intense than 1dB, while 20dB is 100 times more intense than 1dB. The sound intensity multiplies by 10 with every 10dB increase. Following is a list of dB readings from various sources to act as a non-scientific point of reference: 130dB: Jack Hammer (at 5ft), 120dB: Rock Concert / Pain threshold, 110dB: Riveter or a heavy truck at 50ft, 90dB: heavy traffic (at 5ft), 70dB: department store or a noisy office, 50dB: light traffic, 30dB: quiet auditorium or library, 20dB: faint whisper (at 5ft), 10dB: soundproof room / anechoic chamber.

There are a number of factors that can contribute to the relative noisiness of a fan. Fans are usually tested in a noiseless anechoic chamber, in free air (zero static pressure) with the sound pressure level microphone positioned one meter from the inlet side of the fan. This is the most common way that fan manufacturers gather noise ratings because it is reproducible and ensures that no other external bias factors are present. There are several factors that could affect the noise characteristics of your fan and make it seem louder than it is.

1) Inadequate venting can increase the noise produced by a fan. The efficiency of the fan is degraded by having to overcome a high pressure differential. It decreases the effectiveness of the impeller, causes noise (dB) to increase and causes airflow (CFM) to drop. Increasing the vent area to 1.5x the fan venturi (the big hole in the middle) should alleviate the noise if this is the problem.

2) Airflow obstructions can also increase fan noise. If there is an obstacle such as a PC board or light ballast within an inch or two of the fan inlet or outlet and directly in the airstream this can cause a localized increase (between the impeller and the obstruction) in static pressure. The effect is the same as if there was inadequate venting generally and can cause an increase in noise as the air has to attempt to flow around the obstruction, leading to turbulence and increased noise.

3) Vibration can cause fan noise to increase. Often this is due to loose mounting screws. Other times it is caused by the fan being mounted on a thin metal, laminate, or wooden surface. The fan will vibrate against the surface and the surface can act like a sound board, amplifying otherwise soft noise. This problem can often be solved by adding plastic or rubber grommets between the fan and mounting surface and which are commonly available at most home improvement stores. Alternatively, adding thickening plates to the enclosure walls where the fan mounts can reduce cabinet vibration noise.

4) Rattles, hums, squeals, or clicking are usually balance or bearing issues. If your fan is a few years old and has been run continuously, the bearings may simply be worn out. If your fan has been running for less than 12 months and you experience any of these problems you should arrange for a replacement from the place where you purchased it (assuming that the unit has not been mishandled in some way). Orion Fans guarantees our products against defects in materials and workmanship for 1 year from date of purchase.

The "A" in dBA stands for A-weighting, which is a method used to adjust sound measurements to reflect the sensitivity of human hearing at different frequencies. This means that dBA measurements give more importance to sounds in the frequency range that humans hear best.

SPEED

The RPM (revolutions per minute) of a fan’s impeller blade when operated at or near nominal voltage. This is simply a statement of raw data. Fans from multiple manufacturers cannot be compared effectively against each other using RPM data, because the blade geometry has the greatest effect on performance, regardless of speed. Five equivalent fans from five different manufacturers can all have the same CFM but different RPM. Differences in aerodynamic blade designs have a profound impact on air performance. In other words, equivalent fans from different manufacturers can have identical RPM ratings but different CFM specifications. Orion Fans has improved CFM specifications on several fan models simply by changing the impeller designs - in one case by as much as 12% - without changing any other specifications, including RPM.

STANDARD WIRE COLORS FOR ORION FANS

AC FANS

Black - Wire lead fans

DC FANS

Black - Ground

Red - VCC (power input to fan)

Blue - PWM input to fan. Provide a square wave with variable duty cycle to control the speed. Fan will run at 100% speed if the blue wire is left unconnected or at high state, typically +5V. The fan will run at the lowest speed or halt rotation if the wire is grounded. Do not let the blue wire come into contact with the DC+ wire if the fan has an operating voltage greater than 5v or permanent damage can occur.

White - Tachometer output from fan. Open collector/open drain models with “A” in the part number must be wired with an external pull-up resistor, typically 10K Ohm or greater. The fan outputs a square wave signal at 50% Duty Cycle. Typical models output two cycles per rotation. Measure the frequency then multiply by 30 for an RPM calculation. If the fan uses a different number of cycles per rotation, divide the measured frequency by the number of cycles per rotation, then multiply times 60 for an RPM calculation. Consult the data sheet for individual fan interfacing requirements. Do not let the white wire come into contact with the DC+ wire without a current limiting resistor in series while operating or permanent damage can occur.

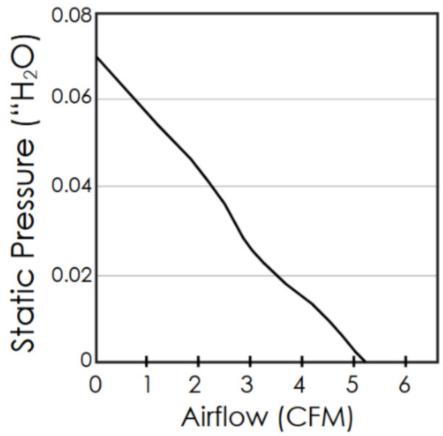
Yellow - Locked rotor alarm. Open collector/open drain models with “A” in the part number must be wired with an external pull-up resistor, typically 10K Ohm or greater. Standard output models fans will hold line low (0V DC) when operating. If the impeller is completely stopped this line will go high to either 5V or the external pull-up voltage, depending on the option type (open collector/open drain vs TTL). Inverted alarm outputs are available where HIGH is running and LOW is failure.

Note: tachometer and alarm outputs are digital signal types and cannot source large amounts of current to directly operate indicator lights or relays.

There are occasional variations to this rule but not as a standard.

STATIC PRESSURE

Static pressure is usually stated either in inches of water column (“H_2O) or in millimeters of water (mmH_2O). It is essentially a measure of the differential air pressure between the air pressure inside an application vs ambient air pressure outside of an application, which for airflow calculation purposes is usually zero. There is an inverse relationship between airflow and static pressure. As the pressure differential rises, airflow drops.



The vertical axis labeled Static Pressure (“H_2O) describes relative air pressure. The horizontal axis labeled “Airflow (CFM)” describes airflow volume in relation to air pressure. The curve tells the user approximately how much air a fan will move for a given pressure reading. For instance, the curve meets the horizontal line at the bottom of the graph at about 5.2 (cubic feet/minute). Look left along the bottom horizontal axis and notice that the static pressure is zero (no pressure difference at all between the inlet and outlet side of the fan) where the CFM is maximum. Notice that the curve meets the vertical axis at about 0.07 “H_2O and that airflow is zero, meaning the fan is pushing air with a force to create a differential of 0.07”, but no actual air flow is occurring. When employing a fan for cooling purposes, the designer must remember that air is the medium that provides the cooling, so maximum air flow is paramount. If static pressure is high due to poor airflow design with many obstructions, little cooling will be achieved. Best practice when choosing a fan solution dictates that the fan should operated in the lowest third of its operating curve where CFM and efficiency is the greatest, and noise the lowest. Many times cooling requirements can be reduced through careful cooling design in the enclosure.

TESTING

LIFE TESTING

1) Thirty (50 ~ 200) samples are selected at random and tested to verify conformity to design specifications. They are evaluated on appearance, speed, current draw, start-up voltage, and noise (dBA). Data is then recorded for each fan to establish baseline performance.

2) The samples are then run at rated voltage in a environmentally controlled chamber at 40°C to 80°C, depending on the intended application environment. Samples are reevaluated and data recorded at 24 hours, 48 hours, 96 hours, 192 hours, 384 hours, 500 hours, 1000 hours, 1500 hours, 2000 hours, 3000 hours, 4000 hours and 5000 hours. Performance metrics like current draw and RPM are continually measured during the test to ensure the fans meet published specifications.

3) Data for each fan is plotted on a graph to verify normal operation. If any abnormality is detected during the testing process the sample fan in question is immediately removed and tested separately. A >10% deviation from baseline specifications is defined as failure and the sample fan is removed for further testing.

MECHANICAL PROTECTION

Orion Fans have integrated protection against rotor lock. Fans shall suffer no damage to windings or electrical components after 72 hours in rotor lock condition.

DROP TEST

Fans will withstand a 30cm drop on any face onto a 10mm thick wooden board.

ENVIRONMENTAL OPERATING TEMPERATURE

-20°C ~ +65°C at 75% RH (high temperature and waterproof fans are available.)

STORAGE TEMPERATURE

Fans will operate normally after storage at -40°C ~ +75°C at 75% RH with a 24 hour acclimation time at room temperature.

HUMIDITY & THERMAL SHOCK

Fans will operate within specifications after 96 hours in 95% RH at 40°C per MIL-STD202F, method 103B. Thermal shock determined per MIL-STD-202F, method 107D.

MEASUREMENT PARAMETERS RATED CURRENT

Current is measured after 30 minutes of continuous operation at rated voltage. Some fans can exhibit inrush currents when power is first provided, while others rise gradually.

RATED SPEED

Speed is measured after 30 minutes of continuous operation at rated voltage.

STARTUP VOLTAGE

Minimum voltage required for fan startup.

INPUT POWER

Input power is measured after 30 minutes of continuous operation at rated voltage.

LOCKED CURRENT

Locked current is measured after 30 minutes of continuous operation and within one minute after rotor is locked.

AIRFLOW

Airflow and static pressure is measured in accordance with AMCA standards or DIM 24163 specifications in a double-chamber test with intake-side measurement.

NOISE LEVEL

Noise level is measured in accordance with DIM 45635 standards in a fully-anechoic chamber with the microphone positioned 1 meter from the air intake.

VOLTAGE

VOLTAGE AND VOLTAGE RANGE

Voltage or “Rated Voltage” refers to the nominal voltage at which the units will most closely follow the stated specifications (e.g. 230VAC.) “Voltage Range” indicates the minimum and maximum voltages at which the fan will operate continuously without degradation. (e.g. 160VAC ~ 240VAC for a 230VAC fan.) It should be noted that in most cases if you run a fan at lower than nominal voltage the fan will slow down and if you run at a higher than nominal voltage the fan will speed up. Operating the fan below or above the listed voltage range can result in damage to the fan through insufficient self-cooling or electrical component damage.

AC & DC VOLTAGE

Standard AC voltages in North America are currently 120V (standard household, outlet current) and 240V (standard household, large appliance current) in most areas. Note that 110, 115, and 120V are considered equivalent for most applications as are 220, 230, and 240V. Power delivered from a public grid varies from place to place. In rural areas you may measure 110VAC from a wall outlet with a volt meter while in a city you may be able to measure AC power at levels as high as 127VAC. There is no need to be concerned about these minor differences however, as most electrical devices operate over a voltage range with varying efficiency levels. Other custom AC voltages are available by special order. The range of custom AC voltages is approximately 12VAC ~ 480VAC. Standard DC voltages are 5, 12, 24, and 48VDC. Custom DC voltages are available by special order.

AC FREQUENCY

Standard AC frequencies around the world are 50 or 60 Hertz, and 400 Hertz in some maritime applications. Traditional shaded pole and capacitor induction motor types will provide different performance depending on the frequency of power available. The datasheet will provide specifications for each rated power frequency. Electronically commutated (EC)fans will provide identical performance at 50 or 60 Hz, due to their efficient AC to DC internal conversion technology.