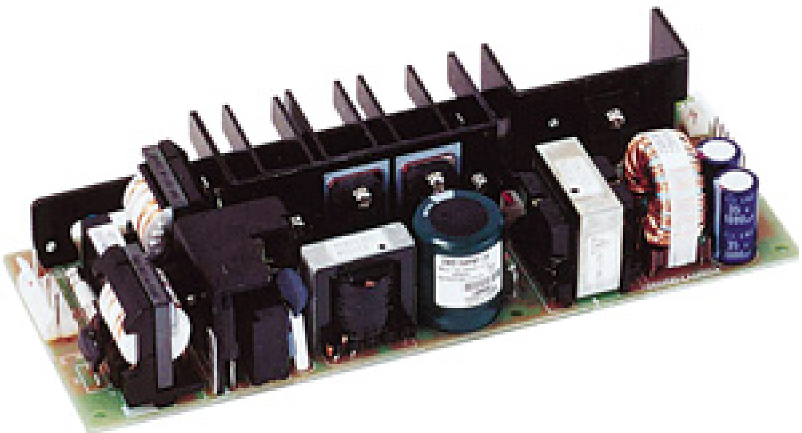
What Size Fan Do I Need?

Mel Berman, TDK Lambda Americas, www.us.tdk-lambda.com
There are many AC-DC power supplies and DC-DC converters with output power ratings that can vary dependant upon the type of air cooling provided. “Convection air cooling” usually refers to situations where a power supply or converter is cooled by the prevailing ambient air temperature, adjacent to the power device, without forced-air-flow from fans or blowers. If the power device has two output power ratings, the “convection cooled” (still-air) power rating is lower than the “forced-air convection cooled” rating.

For example, the power supply pictured above is an open frame switchmode supply with two output power ratings. For “convection cooled” applications, this supply can provide up to 151 W of output power. However, with “forced-air-cooling” it can provide up to 201 W of output power. The datasheet for this power supply indicates that for “forced-air-cooled” applications, 1.5 m/s (meters per second) must be provided by the user. To convert this to English units, 1.5 m/s equals 295 lfm (linear feet per minute). More conversion factors are shown below.



Most fans in North America are rated in cfm or cubic feet per minute of air “volume” flow. So, what size fan do you need to provide 295 lfm of air, which is measure of air “velocity” flow for the above application?

Most times the power supply is cooled by directing the air flow along its longest dimension; for example, from the input connector end to the output connector end (or vice versa). However, always refer to the power supply’s installation manual to determine the manufacturer’s recommended axis for the cooling air-flow.

The usual method for determining the required fan size is to first determine the height and width for the opening or port through which the cooling air will flow around and through the power supply. In this instance, the power supply is 3.15” wide and 1.46” high (and 8.2” long). We can consider the supply’s width times its height as the minimum area of the inlet “port” for forced air cooling of the supply. You can think it as the window opening. Then, we need to convert these dimensions in inches to feet by dividing by 12”. Therefore, 3.15” = 0.26’ and 1.46” = 0.12’. So, the minimum “area” of the “port” through which the air must flow to cool the power supply is 0.26’ x 0.12’ = 0.0312 square feet. It would be advantageous for the entry port to be larger than the “minimum” requirements if at all possible. The formula for determining the cfm (volume) rating of a fan when the required lfm (velocity) is known is as follows:

CFM = LFM x Port-Area (in square feet)

Therefore, in this example: cfm = 295 lfm x 0.0312 ft2 = 9.2 cfm (min. fan rating)

Fan ratings are based upon an expected free-flow of the air without obstructions, which could cause back-pressure and reduced air-flow. Of course, real world applications always include some obstructions. To ensure the least amount of back-pressure, it is best to have the exit “port” in the enclosure at least 1.5 times the area of the entry port. In most applications there are other heat loads and components that can obstruct the path or free-flow of the cooling air. It is therefore wise to select a fan with a higher rating than is calculated. Perhaps, in this example, a 10 cfm or larger fan should be used.

Tip: The use of a larger sized fan running at a slower speed can deliver the same airflow as a smaller fan running at a higher speed, but the larger fan will be much quieter.

Since most fans have round air outlets and square mounting patterns, the air-flow from the fan may require ducting within the end-product’s enclosure to direct the cooling air to the high power devices within the power supply and other heat producing components.

The same process would be used to determine the correct fan rating for AC-DC power modules or DC-DC converters, with or without heat sinks that require forced-air-cooling. When heat sinks are used, always direct the air flow in the same direction as the slots between the fins of the heat sink. In the second photo, the air should be directed horizontally.

In all situations, the system must be tested with the selected fan and all other devices in-place to confirm that the power supply or converter with the load it drives do not exceed their maximum operating temperature, under worst case conditions (maximum ambient inlet air temperature with 100 percent power load, etc.). If problems are observed, a higher cfm rated fan or multiple fans may be required.

In the metric world, fans are sometimes rated in “m3/hr” (cubic meters per hour) of air “volume” and m/s (meters per second) of air “velocity”. The following Metric to English conversion factors may be useful.

1 m3/hr = 36 ft3/hr ÷ 60 min. = 0.60 cfm (cubic feet per minute)
1 m/s = 3.28 ft/sec x 60 sec = 196.85 lfm (linear feet per minute)

Some fans and power supplies have dimensions in mm (millimeters).
Just remember that 1 inch = 25.4 mm, and 1 mm = 0.04”

There are a number of very good online calculators to assist you in determining the fan size and ratings required for various forced-air-cooling applications. Here are a few of those websites:

http://www.airperformancetech.com/conversion-tools.htm [1]
http://www.aavidthermalloy.com/technical/airflow.shtml [2]
http://www.calculatoredge.com/optical%20engg/air%20flow.htm [3]

Source URL (retrieved on *04/01/2015 - 1:56am*):
http://www.ecnmag.com/articles/2011/05/what-size-fan-do-i-need?qt-recent_content=0&qt-most_popular=0

Links:
[1] http://www.airperformancetech.com/conversion-tools.htm
[2] http://www.aavidthermalloy.com/technical/airflow.shtml
[3] http://www.calculatoredge.com/optical%20engg/air%20flow.htm