Wednesday, September 5, 2012

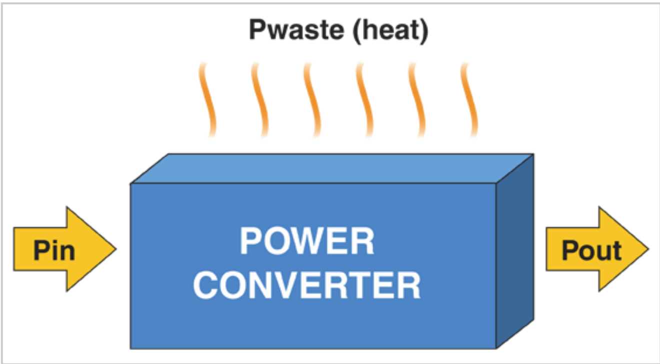
Efficiency Calculations for Power Converters

A power converter's efficiency (AC-DC or DC-DC) is determined by comparing its input power to its output power. More precisely, the efficiency of the converter is calculated by dividing the output power (Pout) by its input power (Pin). The Greek symbol Eta "η" is usually used to represent "Efficiency." Here is the formula for determining a power converter's Efficiency (η).

η = Pout / Pin

For example, the efficiency of a converter that provides 500W of output power (Pout) and requires 625W for the input power (Pin), would be 80% (500W/625W=0.80). In this case, the input power exceeds the output power by 125W or 20%, which is lost/wasted power. Therefore, 20% of the input power is converted to heat energy that must be removed from the converter by some means of cooling (conduction, convection, and/or radiation).

Since all power converters have inherent conversion losses, the output power is always less than the input power. Most often, the manufacturer of the power converter specifies its efficiency and maximum output power on the product's datasheet. When the efficiency (η) and output power (Pout) is known, the end-user can determine how much input power (Pin) will be required and how much power will be wasted (Pwaste) and converted to heat energy under full load conditions.



Here are the formulas to determine Pwaste and Pin with sample calculations using the examples listed above.

Pwaste = (Pout/η) – Pout
Pwaste = (500W/0.80) – 500W = 625W - 500W = 125W

Pin = Pout + Pwaste
Pin = 500W + 125W = 625W

Obviously, with a higher efficiency converter, Pwaste is reduced. Using the example above, but with an improved efficiency of 90% (instead of 80%), here are the revised calculations:

Pwaste = (Pout/η) – Pout
Pwaste = (500W/0.90) – 500W = 555.5W - 500W = 55.5W

Per the examples above, by employing a more efficient power converter it reduces Pwaste from 125W to 55.5W, which provides a substantial savings to the user in both electric energy and cooling costs.

Here are alternate formulas for calculating the factors associated with power converter efficiencies:

Pin = Pout/η
Pwaste = Pin – Pout
Pwaste = Pout (1/η - 1)

In some formulas, **Pwaste** is referred to as **Pd**, where “**Pd**” means the power dissipated (in the form of heat) within the power converter. **Pwaste = Pd**.

When dealing with AC-DC power supplies, not only is “Efficiency” important, but so is the power supply’s “Power Factor.” Information about the effect and importance of the power factor in power supplies is covered in the following article.

Power Factor Correction

http://power-topics.blogspot.com/search/label/Power%20Factor%20Correction

More information about power converter efficiencies and cooling methods/techniques can be found at these web links:

Power Converter Efficiencies

http://power-topics.blogspot.com/2011/06/power-supply-losses-and-impact-of.html
http://us.tdk-lambda.com/lp/ftp/other/cost-savings-high-efficiency.pdf
http://us.tdk-lambda.com/lp/news/2012_release05.htm

Cooling Methods

http://power-topics.blogspot.com/2009/01/what-size-fan-do-i-need.html
http://us.tdk-lambda.com/lp/ftp/Other/cooling_bricks_ecn.pdf

Posted by Power Guy