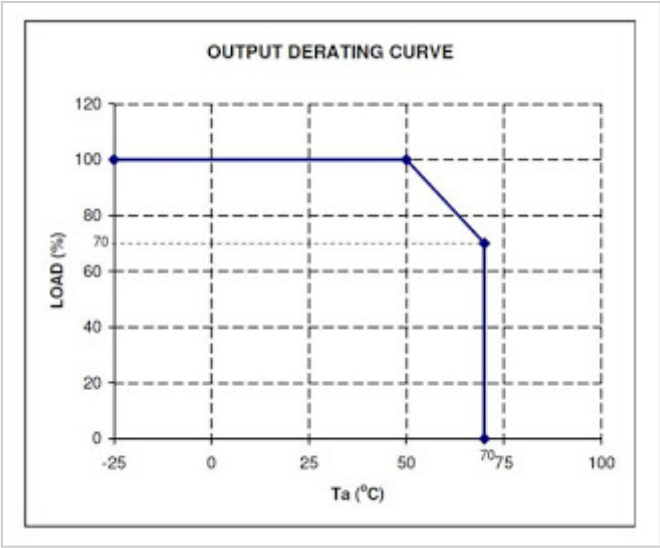
Tuesday, June 30, 2015

Comparing DC-DC Converter's Usable Power

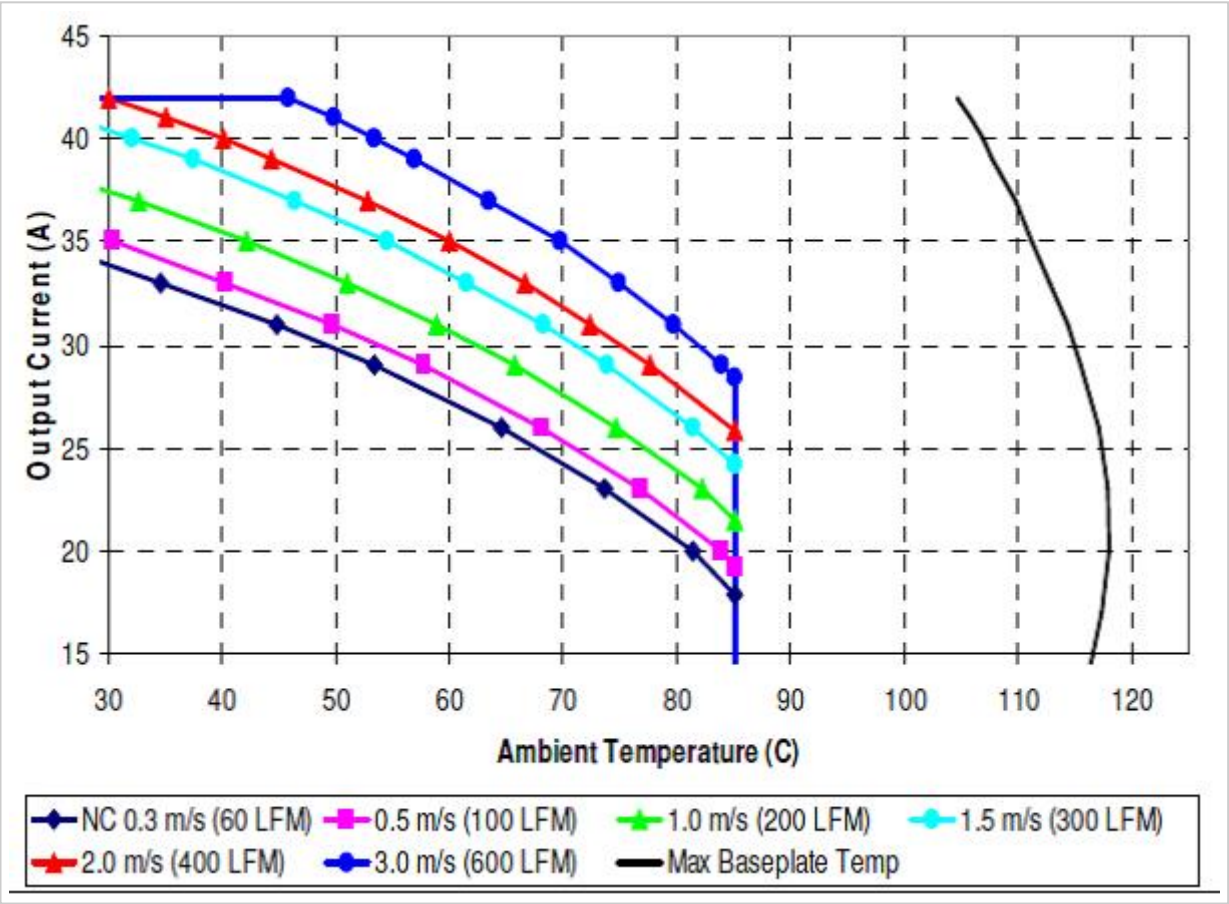
Power supply manufacturers rarely use the term "usable power" in their AC-DC product literature, but it is used frequently when referring to a DC-DC converter's performance against temperature. Is it just a fancy reference to a de-rating curve? As usual, before we answer that question, we need to look a little deeper.

An AC-DC power supply, like the TDK-Lambda's LS50 series, has a de-rating "curve" as shown below. It can deliver full power at 50C ambient and it de-rates linearly to 70% load at 70C. (The knee points of the chart vary from product to product but not normally dramatically between competitors of like products.)

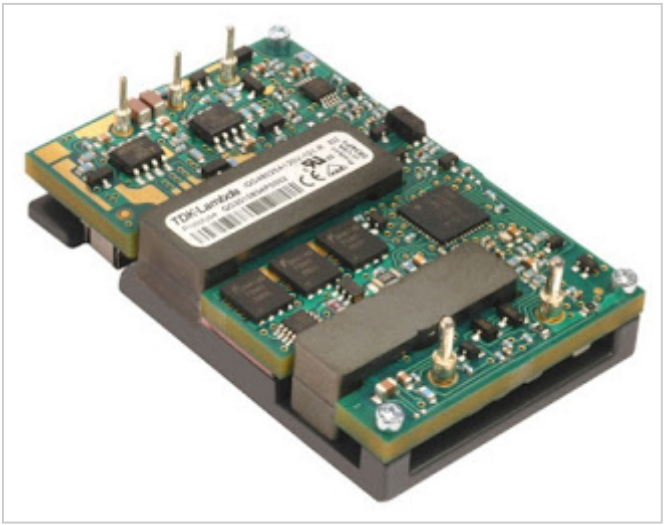


The chart is very simple because the LS50 does not require any forced air, and has a metal case that is used as a heat sink and to provide a level of physical protection.

Looking at TDK-Lambda's iQG ¼ brick DC-DC converter, we can see a much more complex set of de-rating curves.



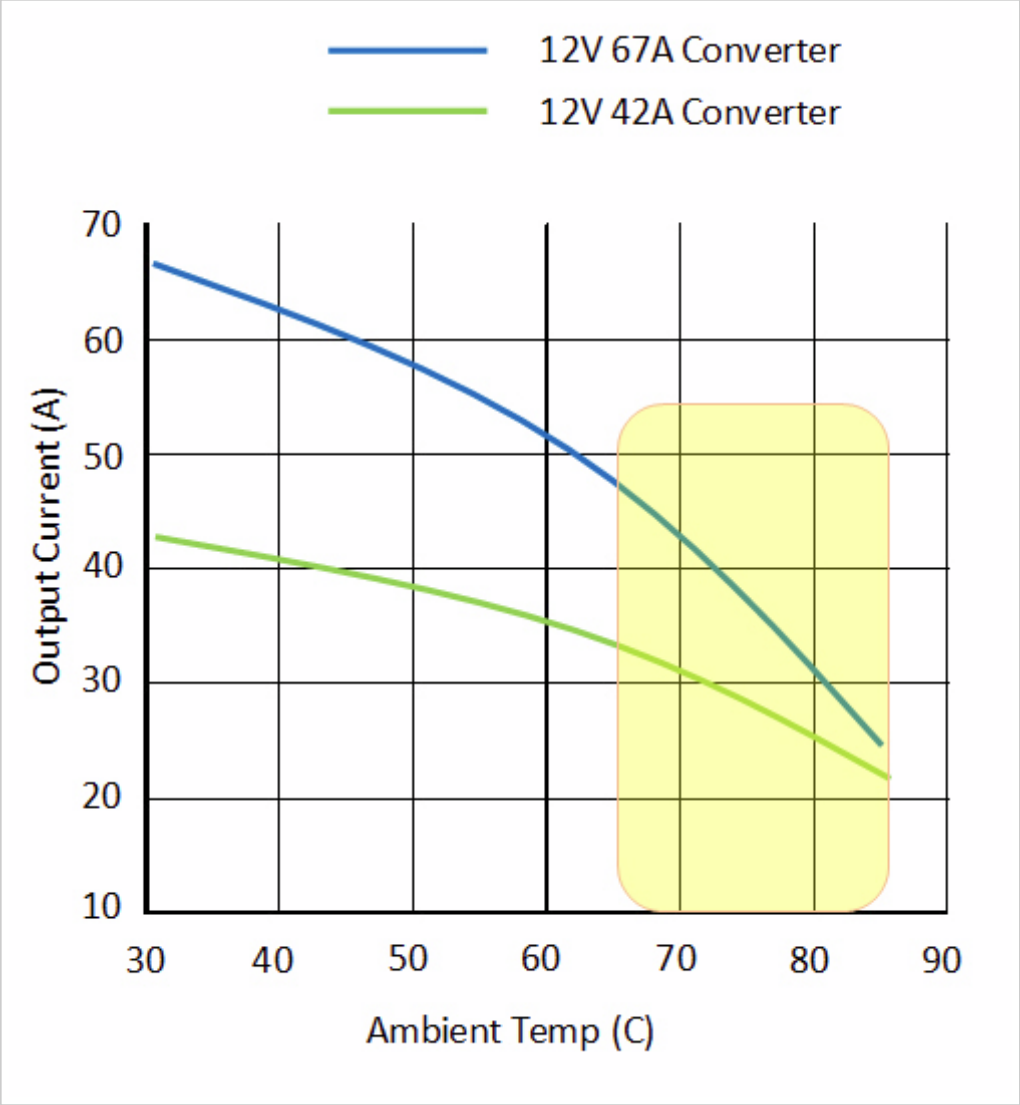
To be fair, the industry standard ¼ brick has migrated from a product where 50W output power was leading edge, to products that are fast approaching 1000W. The emphasis for DC-DC converters has been put on package size. Even when fitted with an integral baseplate, like TDK-Lambda's iQG ¼ brick (shown below), the iQG's volume is 1.6 cubic inches, compared to the LS50's 21 cubic inches. That is 10 times the output power in less than a 1/10th of the volume.



The "brick" style DC-DC converters are designed to be either conduction cooled (to a cold plate), or forced air cooled, often without an external heat sink. The rate of airflow available will depend on the user's application, and so a number of performance curves are provided. It can be noticed that in some cases for low airflow conditions, de-rating has already occurred already at 30C ambient.

Usable power really refers to the slope and start point of the de-rating curve. Often Engineers will focus on the output current of the converter, and choose a higher power, more expensive product, expecting to significantly better performance. This is where “usable power” comes into play.

Below is a simplified pair of curves for 2m/s airflow. The blue line is for a 12V 67A (800W) DC-DC converter, and the green line for the TDK-Lambda 12V 42A (500W) converter. The 800W model is 1.6 times more powerful at low ambient temperatures, but in the yellow area at higher ambient the ratio drops to 1.35 times at 70C and 1.24 times at 75C. (Typically customers operate DC-DC converters in the 65 to 80C range.)



Although the 800W converter has more available power, the 500W unit has more usable power, demonstrated by a much less steep de-rating curve. It can be seen that at higher ambient temperatures, it would be more cost effective to use the 500W converter.