How 20 to 60 Watt Converters outperform higher rated competitors

Some DC/DC-Converters like it hot

All across the electronics industry, the demand for higher operating temperatures has increased throughout the past decade - not only for complete assemblies but especially for power modules. The working specifications are very much influenced by the ambient temperatures they operate in, so that price/performance comparisons are often rather difficult to make. This whitepaper compares performance and price of RECOM's revolutionary *PowerlinePlus-C*onverters to its conventional *Powerline* products for use at high ambient temperatures.

A recently conducted anonymous market study across the electronics industry revealed that nearly 60% of future hardware designs are for higher ambient temperature conditions than present. Requirements for ambient temperatures of +65°C to +85°C accounted for 45% of the designs, whilst those without any increased temperature requirement were recorded at 43%. Temperatures up to +105°C or more were required in an astonishing 12% of cases.

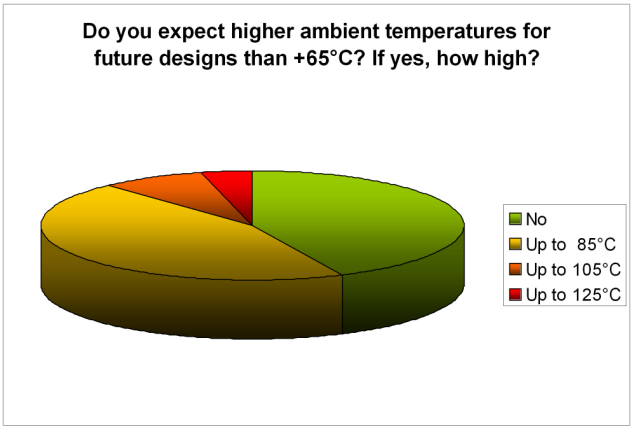

Fig.1: More than 50% of development engineers expect ambient temperatures beyond +65°C for future designs (Source:RECOM).

If we assume that the answers of approximately 100 design engineers can be regarded as representative of the general market, it can confidently be said that the use of conventional converters may prove problematic in future. For example, an industry standard 60W DC/DC converter has a derating curve that starts at only +40°C, so for operation at +75°C, the output power output must be reduced to 50% or only 30W of useful power. Therefore, applications with higher ambient temperatures require conventional converters with double or treble the power rating of what is actually required. The "over-specified" converters require more board space and their inefficiency increases the power consumption of the whole assembly

powered by the converter. Furthermore, the cost per Watt of effective power increases by a factor of 2 to 3. *PowerlinePLUS* converters, newly introduced to the market in mid 2009 and which have been specifically designed for those conditions, may be the much better solution for such applications.

Revolutionary Design reduces Power Losses

The *PowerlinePLUS* family was consequently designed to meet maximized efficiency criteria. By using innovative design features it was possible to increase efficiency by 3% points, up to 92%.This may not appear spectacular but it reduces losses within the converter by up to 20%, thereby significantly increasing the maximum permissible operating temperature.

The construction of these converters allows for all hot-spot components, such as transformers, synchronous rectifiers and switching FET´s to be positioned as close as possible to the converter housing. The case is manufactured from special aluminium, normally used in the aircraft industry and possessing excellent heat conductivity characteristics. The top side of the case is configured as a heat-sink having 150 cooling fins (fig.2), significantly improving the natural convection cooling of the converter.

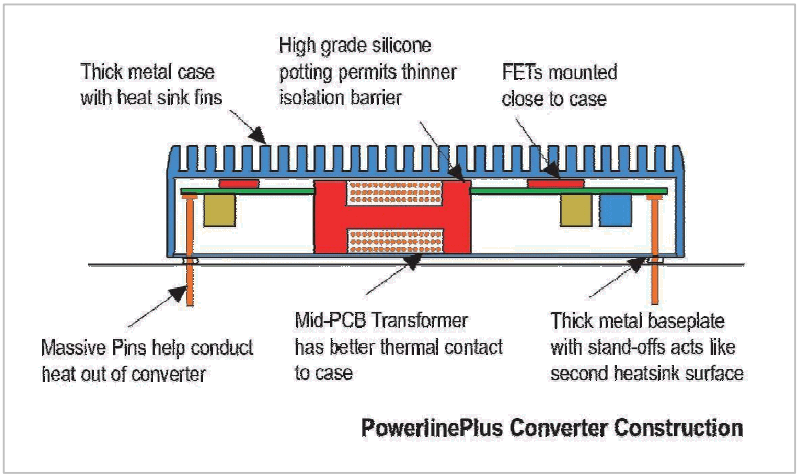

Fig.2: Basic design concept of PowerlinePLUS- Converters: The "hot" components are being placed close to the metal case which is designed to work as a heat-sink.

The improved thermal design and use of high temperature rated components permit a maximum case temperature rating of 120°C and a full power operation that extends close to +100°C (natural cooling and vertical mounting, as can be seen in fig.3). The *PowerlinePLUS* family is also suited for COTS applications in the military field, which hitherto has been the domain of much more expensive converters, specially developed for these high-grade applications.

For comparison purposes, let us examine the *RP60- Powerline* family which follows the standard characteristics of industrial converters available in the market. As shown in Fig.3 (next page), derating starts at ambient temperatures of +40°C with natural cooling. Although such converters can be operated without problems at up to +85°C, their output power is reduced down to less than 30% of the rated value at this temperature, in other words, the output of the 60 Watt converter is reduced to only 17 Watts and the price-per-Watt ratio is increased more than threefold.

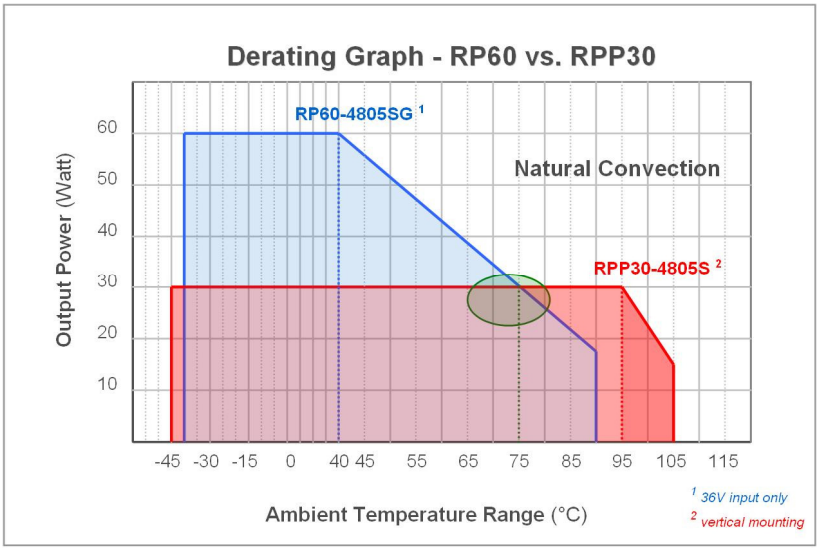

Fig.3 Whilst conventional converters such as the RP60 (blue curve - designed for 60 Watts output) can operate at +75°C ambient temperature with 50% rated power only, the new RPP30 (red curve) can be operated with full output power of 30 Watts up to +95°C.

PowerlinePLUS – the better choice at +65°C and above

Although the cost for the new *PowerlinePLUS* family is easily twice that of conventional converters on a Watt by Watt basis, they are pricewise the more attractive alternative at ambient temperatures of +75°C upwards, due to the lack of derating.

Even at +65°C, *PowerlinePLUS* is the better alternative having additional advantages besides the derating issue. All of these products have an integrated Class B filter to meet the requirements of EN55022. The short track lengths and minimal gap between the built-in filter and the source of the interference within the converter ensure a physically smaller filter size compared to external filter circuits. Reduced board space requirement, easier and much reduced EMV testing for product approval and improved efficiency are significant positives of this design philosophy.

Also applicable for very low temperature environment

The *PowerlinePLUS* family makes exclusive use of high temperature grade components to extend the maximum case temperature from the industry standard 100°C to 120°C. The case temperature is monitored by a precision thermistor circuit, so if the temperature exceeds the operational limit, the converter will shut down to avoid damage to the converter. The converter restarts automatically as soon as it has sufficiently cooled down.

So far we have concentrated on comparisons at high operating temperatures – however the new *PowerlinePLUS* converter generation is also suitable for operation at ambient temperatures as low as – 45°C.

No load power consumption

Conventional industrial grade converters are designed to operate most efficiently at full load. Under no-load conditions, the converters deliver no useful power but still draw current from the supply as the internal oscillator is still running. Sometimes the inefficiency of the oscillator drive circuit under no-load conditions can be significant and results in the converter running warm. The heat generated under these conditions is wasted and is likely to contribute to additional thermal stress in adjacent

components. *PowerlinePLUS* converters draw between half and two thirds quiescent current compared to conventional converters and run cold under no-load conditions. The efficiency of this new converter generation is also relatively stable across the whole input voltage range and operating temperature range, in contrast to conventional converters.

Four power ranges in two case styles

PowerlinePLUS converters are available in output powers of 20, 30, 40 and 50 Watts. Taking into account that there is typically no derating required at ambient temperatures above 75°C, these converters offer equivalent performance to standard products of up to 100 Watts which need to be de-rated to 50% or more of their nominal output performance at high operating temperatures.

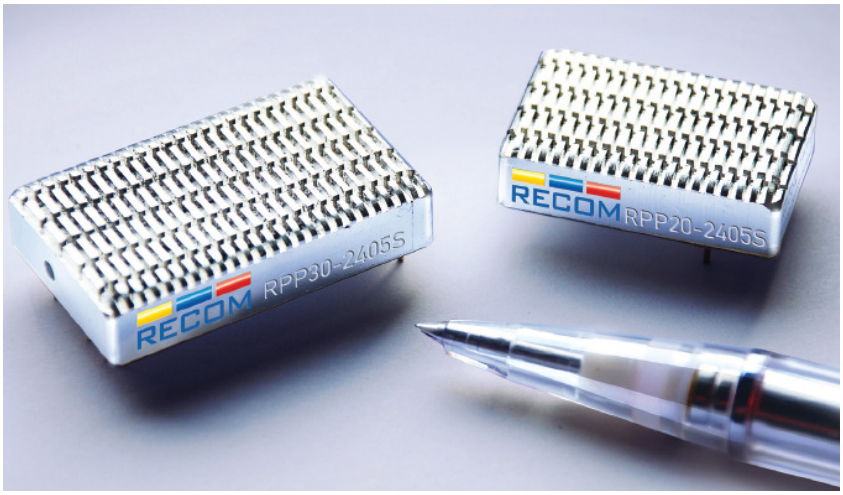

Fig.4: PowerlinePlus converters are „branded" by a unique case style with cooling protrusions at the top of the metal case. This contributes significantly to a very high efficiency of up to 92%.

The 20 Watts version with dimensions of 1.6 x 1 inch is smaller than the higher power variants with a foot print of 2 x 1.2 inch and the same height of 0,48 inch. The converters are available with standard input ranges of 2:1 (9-18V, 18-36V and 36-75V), or wide inputs of 4:1 (9-36V and 18-72V). They are available with single and dual outputs. All models are fully isolated. The 20 Watt modules feature an isolation voltage of 2kVDC (1.6kVDC for 1 minute) while the larger models are isolated to 3kVDC (2,25kVDC for 1 minute).

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