The benefits of using non-isolated DC-DC converters

The DC power requirement for electronic industrial equipment often consists of a 24V high power output and a number of lower power, lower voltages. Traditionally these requirements have been achieved by a number of power architectures, depending upon the amount of system power required.

This white paper is intended for electronics engineers and designers working with power systems for the industrial environment, and assesses the benefits of using non-isolated DC-DC converters.

References

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The DC power requirement for electronic industrial equipment often consists of a 24V high power output and a number of lower power, lower voltages. Traditionally these requirements have been achieved by a number of power architectures, depending upon the amount of system power required.

For applications requiring low power, 300W or less, a standard multiple output power supply is usually selected. Dual, triple and quad versions can be purchased off-the-shelf at cost effective prices. Models with a wide combination of 5V, +/-12, +/-15V and 24V outputs are available.

For mid to high power requirements, 350W to 1500W, modular or configurable power supplies are often chosen. Here a high power 24V module can be selected and the desired combination of other voltages satisfied by single or dual output modules. These build-to-order power supplies are available with short lead-times as they are assembled using pre-built assemblies. TDK-Lambda's NV, Vega or Alpha series are examples of these types of power supplies, featuring wide range adjustable outputs for non-standard voltages. For convenience all connections can be made to one package with integrated fan cooling.

NV700

An alternative for mid to high power is to use a single output high power unit for the 24V and isolated DC-DC converters to supply the other voltages. Single, dual and triple output converters can also be purchased off-the-shelf in a variety of the commonly used voltages. Being board mount they can be located close to the load to avoid cabling and improve load regulation. For power levels greater than 100W, heat dissipation can be difficult to manage, requiring the use of heatsinks or fan cooling. Cost can also become an issue as well as product choice as higher power converters tend to cater for 48V nominal DC inputs.

The communications and computer industries initially used isolated converters, but as FPGAs required lower and lower voltages at higher currents, their power architecture changed. Now the use of non-isolated POL (Point of Load) converters is commonplace. These devices typically provide wide-range adjustable voltages between 0.6 and 5V with currents as high as 100A, and are designed to operate from input voltages between 3V and 14V.

Recently, non-isolated DC-DC converters like TDK-Lambda's i6A series have been launched, targeting the industrial market. Featuring wide-range input voltages of 9V to 40V, the converters are capable of being adjusted from 3.3V to 24V. Up to 250W or 20A outputs can be delivered.

i6A DC-DC Converter

So what is the difference between an isolated and non-isolated converter? Figure 1 shows the basic schematic for an isolated converter, and figure 2 the non-isolated.

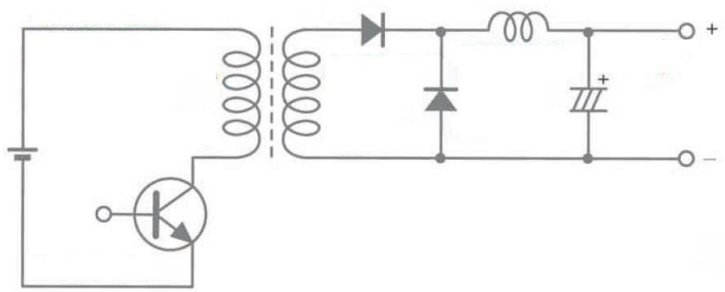

Figure 1 – isolated converter

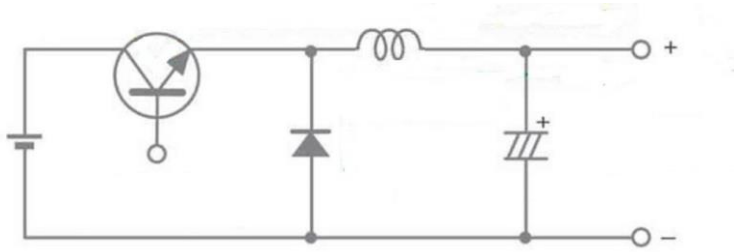

Figure 2 – non-isolated buck converter

Both circuits operate by switching at high frequencies, but it can be seen that the fundamental difference is that the non-isolated converter does not use a transformer and has one less output rectifier. Without the transformer the overall size of the converter can be reduced, not only by the absence of a bulky component, but wasted heat from switching and copper losses is minimised.

The simplified circuitry enable operating efficiencies for the 250W rated TDK-Lambda i6A model to as high as 98%, when operated at 20V output, 24V input and full load. The package size and pin-out is the industry standard sixteenth brick format, measuring just 33 x 22.9 x 12.7mm. Comparably rated isolated models would have efficiencies of 92% and be in the quarter brick size of 60 x 36.8 x 13.2mm. This equates to a 75% reduction in waste heat and 65% reduction in size.

The higher efficiency allows operating at higher temperatures without airflow and any need for an additional heatsink. The derating curves on the i6A, without forced air, allows operation at 50°C ambient temperatures or higher, a similar level to most AC-DC power supplies.

The lower cost makes another good reason for choosing a non-isolated product, with up to 50% savings. The topology of the buck converter allows wide range output adjustment; in the case of the i6A from 3.3V to 24V. This can generate additional savings in inventory carrying costs by stocking just one part, and also allow purchasing in higher volumes to gain discounts.

As a note of caution, a buck converter can only reduce the input voltage, and is often referred to as a step-down converter. It cannot produce 20V output if the input voltage is 12V for example. Isolated DC-DC converters can be used to produce positive or negative outputs, depending on how the positive and negative terminals are connected. TDK-Lambda's i6AN model however, has a slightly different circuit and is configured to produce negative voltages of between -3.3V and -30V at 75W or 8A.

This interesting power architecture is quickly gaining popularity, appealing to those who want cost reduction, size reduction and energy savings.

For more information and to access our world-leading power supply experience and comprehensive product range, please visit:
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Ref: 05/16 LA007017