Conversion efficiency

by Martin O'Hara, Newport Components

Got a board-level power supply problem? Then, chances are that a dc/dc converter will help you solve it. Modern fully encapsulated converters are a far cry from their discrete component ancestors. They're tiny, dependable, inexpensive, easy to use and relatively tolerant of abuse. Nevertheless, a few hints can help users to make the most of the benefits which this useful little device can offer.

Versatile Isolation

DC-DC converters are available in two types, non-isolated and isolated. The latter, which forms, by far, the largest proportion of Newport Components' production, are much the more versatile. Even when considered only as voltage conversion devices, isolated converters offer a wide range of options. For example, the output positive rail can be grounded to produce a negative supply, or the output can be referenced to a voltage other than ground, to produce a voltage above that of the main supply. Figure I shows a few of the possibilities.

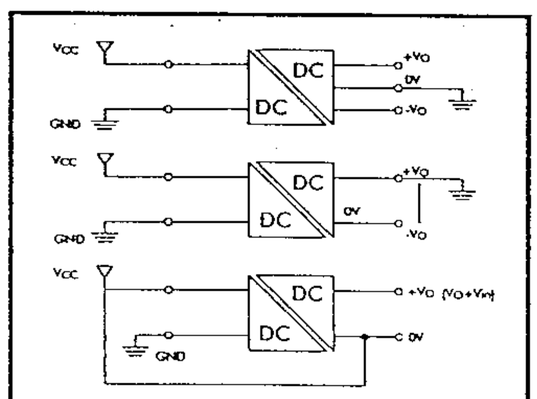

Figure 1 Alternative supply configurations

Fig. 1

These techniques are most useful with unregulated converters, as regulated types typically have a series regulator in the positive output rail only. Hence, referencing their negative output to a voltage other than ground is only satisfactory if all current returns via the converter.

Isolated converters also have other benefits, since they offer excellent noise isolation between load and input. Usually, the circuitry powered by the converter will generate predominantly common-mode noise. This is self-cancelling within the converter, ensuring that no noise is fed back to the main supply rails which feed it.

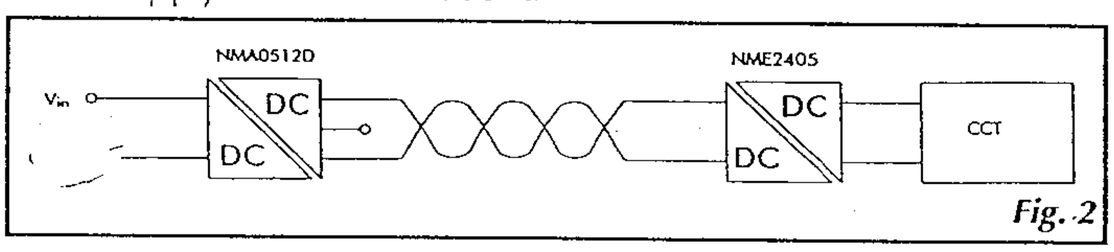

Fig. 2

Another way in which the noise eliminating properties of isolating converters can be put to good use is in supplying power over comparatively long distances. If the arrangement of Figure 2 is adopted, common-mode noise picked up by the cable will be cancelled by the converters. This arrangement also allows a higher voltage to be used for transmission, thereby further improving noise performance.

Don't rush in...

It is sometimes not appreciated that most dc/dc converters present an appreciable capacitive load to their power source. This means that, at the moment of switch-on, the inrush current is limited only by the impedance of the supply and connections. Often, this is not a problem but, in some situations, the transients generated can upset associated circuitry. Fortunately, the solution is simple - add a small inductor in series with the supply to the converter.

The value of the inductor depends upon the application.

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High-value inductors are most effective in limiting the current surge, but prolong the settling time of the output from the converter, and their inherent resistance may adversely affect supply regulation. Low-value inductors usually have lower resistance and may be physically smaller. It is this need to match the inductor to the application which prevents manufacturers from building them into the converters.

Taming overloads

Some miniature dc/dc converters provide limited protection against electrical abuse. Those offered by Newport Components, for example, will tolerate overloads and short circuits without damage for up to one second. This makes protection straightforward.

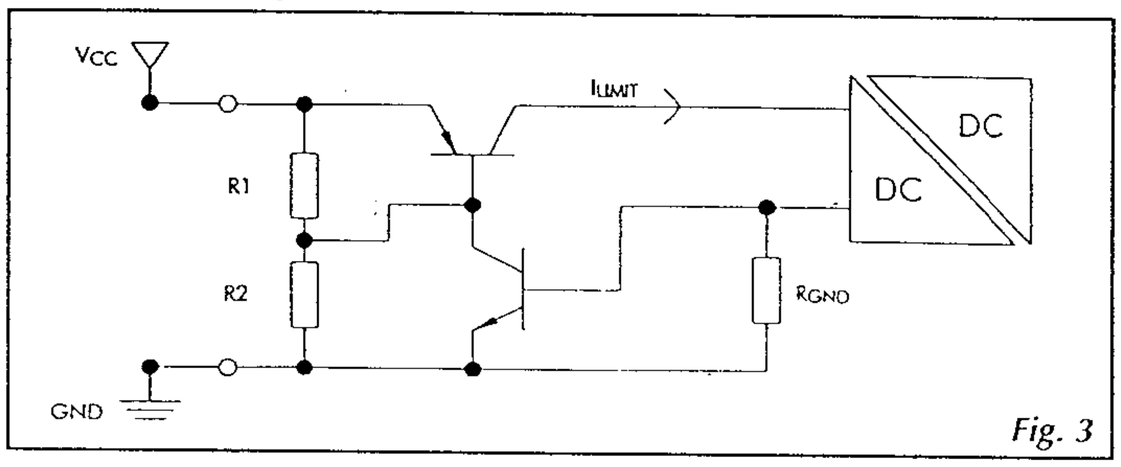

Fig. 3

The simplest method is to add a fuse or miniature circuit breaker in series with the supply to the converter. Care must be taken, however, to ensure that the protective device is not operated by the inrush current at switch-on. This may be avoided by carefully selecting the characteristics of the fuse or circuit breaker, or by adding a series inductor, as explained earlier.

More sophisticated methods of protection are also easily arranged. Figure 3, for example, shows a simple circuit which uses only a handful of inexpensive components. Simply choose R_{GND} so that $I_{LIMIT} \times R_{GND} = 0.7V$.

Where an intelligent power source is used to supply the dc/dc converter, it may be preferable to monitor output current directly, and generate a shutdown signal when this exceeds the maximum permitted value. A resistor in series with the converter output, plus a trigger circuit, is one solution, but it may result in loss of isolation. A circuit free from this defect uses an opto-isolator. When the converter output voltage falls as the result of an overload, the LED is extinguished, and the VOL line is pulled high. This arrangement has the benefit of adding no resistance to the output circuit of the converter.

Locking out underload

One final converter characteristic worthy of comment is no-load performance. The output voltage of even the best unregulated converter is poorly defined when the load falls to less than 10 percent of its nominal value. Where this is a problem, the most obvious solution is to add a permanent resistive load. This approach is however, wasteful of power.

A better alternative is to shunt the output with a zener diode, chosen to conduct at a voltage somewhat higher than the converter's maximum output under normal operating conditions. A series resistor or, where voltage drop is critical, a series inductor should preferably be included to avoid the possibility of a large current surge occurring when the zener is switched on.

DC/DC converters may not be quite a universal panacea for board-level power supply problems, but they are as close as any practical device is likely to come. So, next time power supplies are giving you a headache, think dc/dc converters. In virtually every application, you'll find them a lot more effective than an aspirin!

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