Applying the Remote Sense and Trim Functions on DC DC Converters

The remote sense and trim functions of many DC DC converters seem easy enough to apply but, for optimum performance and minimum noise, some easily followed guidelines can prevent surprises in the customer's system.

Remote Sense

Remote sensing allows the customer to overcome voltage drops in the power lines by sensing the voltage directly at the point of load. The scheme really works well until applied to its natural conclusion. However, if the power supply is 10 feet from the sensed load and the load has a large amount of additional bypass capacitance, the extra inductance of the lines and load capacitance can cause additional phase shift in the converter's feedback loop causing instability. Fortunately, this situation can be solved by bypassing the output to the sense leads directly at the converter as shown in figure 1.

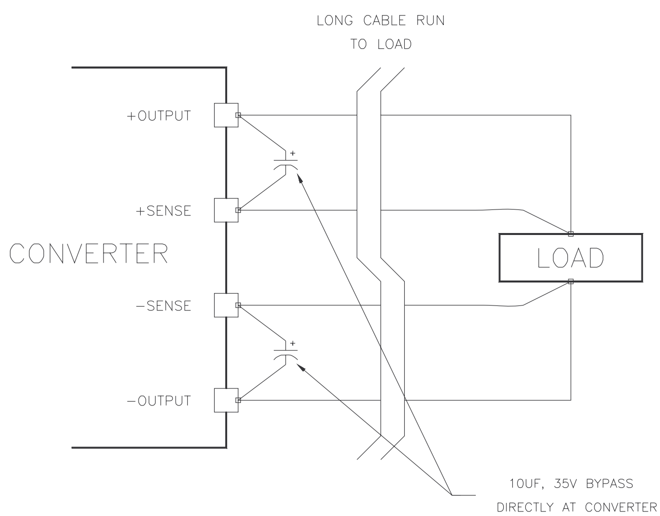

Figure 1.
Instability due to long remote sense cables can be overcome by bypassing directly at the converter module.

The bypassing provides local AC feedback right at the converter, effectively removing the long cable run and load capacitance from the converter's feedback loop. A 10 µF at 35 volt tantalum type capacitor seems to work well for most cases. A tantalum type is preferred over an aluminum electrolytic type because of it's ESR stability at low temperature and small size.

To verify the design, use a stepped load at the end of the cable and check to make sure that the converter is not overshooting or ringing excessively. If the problem persists, increase the capacitor's value and voltage rating (size) until the problem stops.

Another common problem when applying remote sensing is having so much drop in the main power lines that the remote sense cannot overcome it. In most designs, the designer internally ties a normally zero biased diode from the sense terminals to their respective outputs. This limits the remote sense capability to something less than 0.5 volts drop. This means that there must be less than a 0.5 volt drop as measured from the converter output to the sense pin.

At CALEX, we don't use the zero biased diode scheme. We have found that using a 10 to 100 ohm resistor connected from each output to its sense pin works better in practice. The principle advantage being that if the sense pins are disconnected, the converters output voltage will not jump 1.2 to 1.4 volts.

Usually, the data sheet will specify the maximum drop allowed, so it is best to carefully read for this specification or ask the manufacturer for recommendations.

The last common mistake in applying remote sense is unplugging the converter with the input power on and the load connected. If the outputs should disconnect before the sense lines, the full load current will flow down the sense lines. This can cause the output voltage to go so high as to trip any overvoltage protection or damage the internal overvoltage transient protector in the converter. So be sure to always power down the converter first or design your connectors to first disconnect the input power lines.

Remote Trim

The remote trim function is useful in matching the converter to a specific application and making up for voltage distribution losses when remote sensing cannot be directly or fully applied. Most designs use a summing resistor tied directly into the feedback loop's error amplifier to produce the trim function (see Figure 2). The trim pin is of very high impedance (usually 5 to 100k ohms) and quite sensitive (up to 2% output change per volt of pin change) to stray noise.

The difficulty in applying the trim pin occurs when the adjusting trimpot must be located some distance from the converter for ease of adjustment. The long unshielded trace running back to the converter can pick up a large amount of stray 60 Hz noise and modulate the output voltage of the converter significantly. The solution to this problem is to bypass the trim pin with a small capacitor directly at the converter's trim pins as shown in Figure 2. You, as a customer, might ask:

"Why isn't this capacitor included in the design of the converter?" and my response would be, "I would love to, but on occasion some customers want to drive the trim with a D/A converter or op amp. By including this capacitor, I might cause further problems by making these customer's circuits oscillate".

11/2001, eco#011101-1-2, eco#040223-1

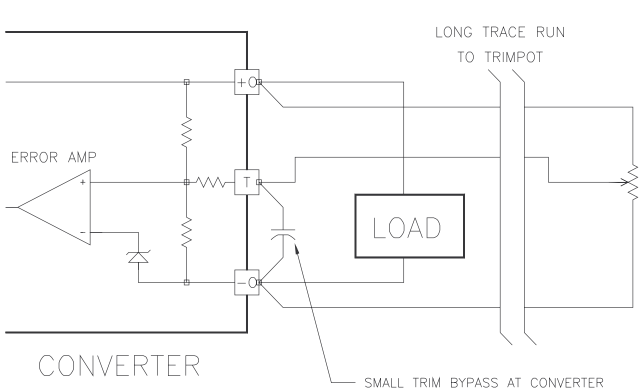

Figure 2.
Noise coupled into the converter's output through the trim pin can be eliminated by the use of a small bypass capacitor directly at the converter as shown.

To test the effectiveness of the trim pin bypassing, a small insulated metal plate, 2" x 2" or so in size, can be held in one's fingers (don't insulate the part you are holding) and passed over the trim traces while looking for modulation on the converter's output with a scope. This capacitively couples in a large amount of 60 Hz noise that your body is always conducting to the circuit in question. If no adverse modulation is seen, then the bypassing either is not needed or proves to be effective. Please be sure not to electrocute yourself when probing around with the insulated metal plate.

Beware of an excessive bypass capacitance value. If the bypass value is too large at turn-on, it will look like a short and may cause the converter to overshoot by the full trim amount until it charges up. So always check for turn-on overshoot and use the smallest value of capacitor possible. The bypass capacitor might also effect loop stability by either putting a pole or a zero in the converter's transfer function where the designer least expected it. So be sure to check for converter stability by using a stepped load test as previously described. Check the bypass capacitor while connected and disconnected for any drastic changes in step response or turn on overshoot.

Fixed Trim

If you only need to adjust the output voltage to a fixed value (Trim), use the following trim method:

(1)Trim up output voltage: Connect a resistor or potentiometer between "Trim" pin and "-Sense" pin, if there is remote sensing function. Or between "Trim" pin and "-Output" pin if there is no remote sensing function. See Fig. 3. Place the resistor or potentiometer as close to the two pins as possible.

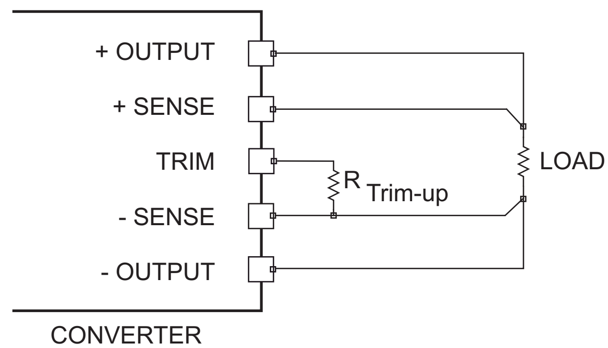

Figure 3.
Circuit configuration to increase Output Voltage.

(2)Trim down output voltage: Connect a resistor or potentiometer between "Trim" pin and "+Sense" pin, if there is remote sensing function. Or between "Trim" pin and "+Output" pin if there is no remote sensing function. See Fig. 4. Place the resistor or potentiometer as close to the two pins as possible.

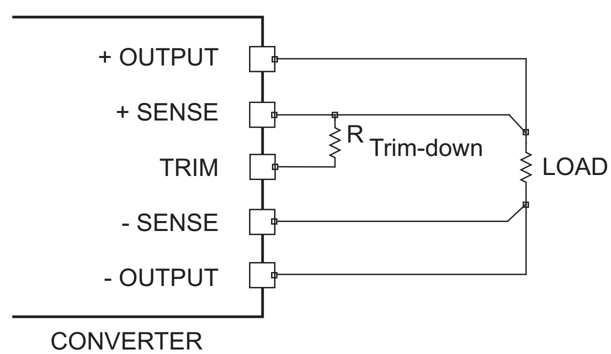

Figure 4.
Circuit configuration to decrease Output Voltage.

(3) If not using the trim feature, leave the "Trim" pin open.