Isolated Load for Testing DC/DC Converters

Application Note 7

Testing DC/DC converters is not as simple as adding a load and getting out the scope. The output noise of a converter can be very hard to measure if massive ground loops are present throughout the system. When the DC/DC converter switches, a common mode current is developed due to the fast internal switching waveform and the interwinding capacitance of the transformer. This current must find a path to flow, and this path is usually from the driving power supply through the measuring scope, into the AC line and back to the driving power supply. This path can easily be 5 to 10 feet long. The length of the ground loop path coupled with the 10 to 100 ns switching waveforms can play havoc in trying to measure true output noise.

Most active loads compound the problem because they are powered off of the AC line and, although they may be DC isolated from AC common, they can have 10nF to 0.1µF of load to ground capacitance. This capacitance makes the situation worse by adding yet another ground loop to the measurement system.

The ideal is to load the power supply with a fixed resistor. A single resistor has very little capacitance to AC common. This works fine for low power converters. When more than 1 or 2 amps of load current is involved, however, a simple resistor becomes less than desirable. If the load must be varied, several resistors must be found of the proper value and power rating. This causes scrambling around the lab looking for resistors and burnt fingers as the resistors get hot.

Circuit Description

The isolated load presented in Figure 1 is just the type of load needed for testing DC/DC converters. It has less than 100pF capacitance from the load to the input ground and can be connected for either positive of negative outputs. The load is programmable from 0 to 5 amps and with proper heat sinking, can load the DC/DC under test at greater than 50 watts.

The heart of the load is the DIONICS DIG-12-06-025 ISO-GATE driver. This device uses an LED light source and specially constructed output diodes to produce a floating voltage source from 0 to greater than 10 volts open circuit. The output of the ISO-GATE is connected directly to the MOSFET gate. The 10 megohm resistor provides a path to discharge the MOSFET's input capacitance, allowing the MOSFET to turn off.

The load current is sensed via a 50 milliohm shunt and amplified by a gain of 20 with the AD204K Isolation Amplifier (Iso-Amp). The Iso-Amp isolates the amplified sense voltage for use as DC current feedback to the LT1013 servo amplifier.

With the ISO-GATE driver and the AD204K Iso-Amp, the load has DC feedback and is truly floating from the control voltage and input side circuitry. This allows the load to be connected to any polarity output voltage or in series with other circuitry if desired.

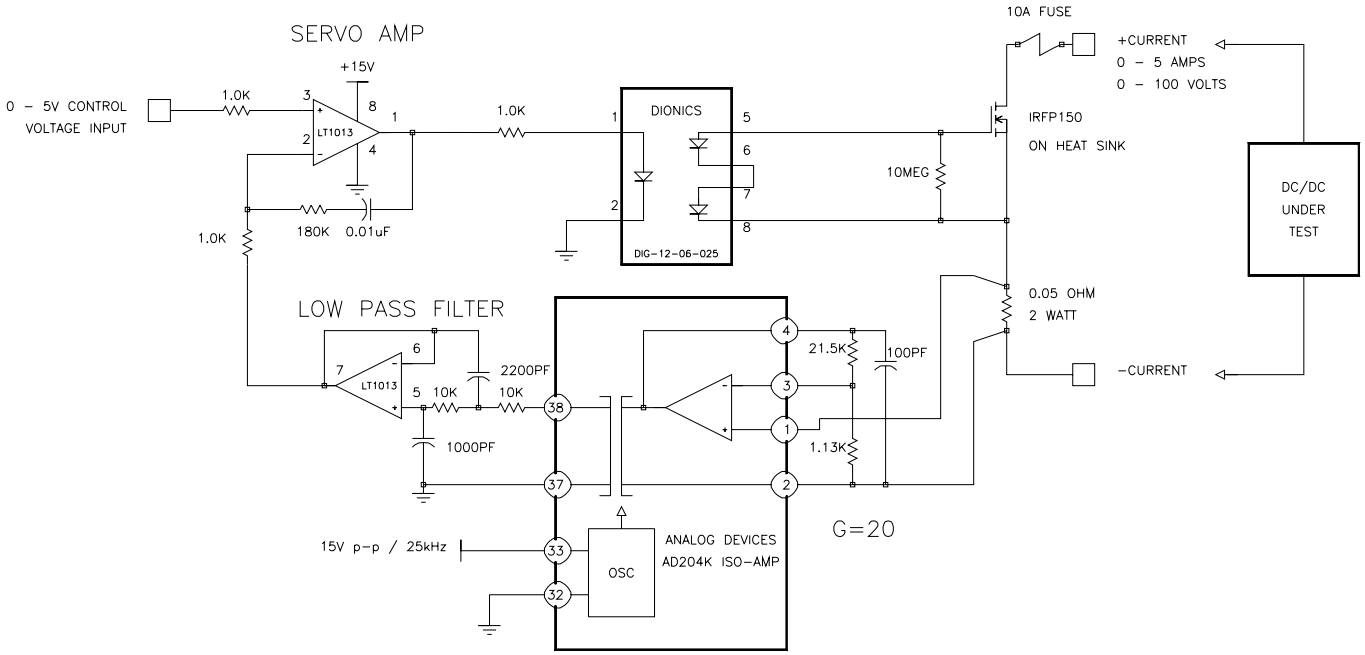

Figure 1.
This isolated load can be built with less than 100 pF capacitance to ground.

The Low Pass Filter on the output of the AD204K provides buffering and a 2 pole, 10 kHz filter to reduce chopper noise.

The Servo-Amplifier compares the filtered current feedback signal with the control voltage and adjusts the input current to the ISO-GATE driver LED for the required MOSFET Vgs. This amplifier also provides Lag Compensation to make the overall loop stable.

The dynamic response of the circuit is quite good. The speed is primarily limited to the time constant of the 10 megohm gate to source resistor and the input capacitance of the IRFP150 MOSFET. Even with this simple gate drive circuit the load slews at greater than 125 amps/second and has a control to output bandwidth of 1.8kHz.

The full specifications of the load are:

Output Current	0 - 5 amps
Output Voltage	0 - 100 V peak
Load Power	50 watts
Transconductance	1 amp/volt
Linearity	0.025% of Full Scale
+Slew Rate	400 amps/second
-Slew Rate	125 amps/second
Settling Time for 1 amp Step	2.5 µs to 5%
Small Signal Bandwidth	1.8 kHz
Small Signal Rise Time	300 µs
Load-Ground Capacitance	< 100 pF
Isolation Voltage	100 V peak

Modifications

With proper scaling of components, this basic circuit topology can be used to make an isolated 4-20 mA current sender or a 50 amp or larger constant current load. The speed of the circuit can be improved by using a FET source follower to isolate the ISO-GATE output from the large input capacitance of the MOSFET or a smaller MOSFET die size can be used if the full 50 watts is not required. The AD204 has isolated ± 7.5 volt power available on the load side for powering other circuitry if needed. For instance, an LP311 comparator could be powered on the load side to make an undervoltage lockout or over current limit circuit.