



## MEASUREMENT TECHNIQUES

### Line Regulation

Measure the output voltage at rated load and at 25 Deg C ambient. Record output voltage with input voltage at low line, nominal and high line. Line regulation is defined as the maximum of the two deviations of output from the value at nominal input. This value is typically specified in percent. Measurements should be taken as quickly as possible so that internal temperature changes do not affect the accuracy.

### Load Regulation

At nominal line and 25 Deg C ambient, measure the output voltage at rated load and at minimum load. Load regulation is the difference between the two outputs as a percent of output voltage at rated load. Measurements should be taken as quickly as possible so that internal temperature changes do not affect accuracy.

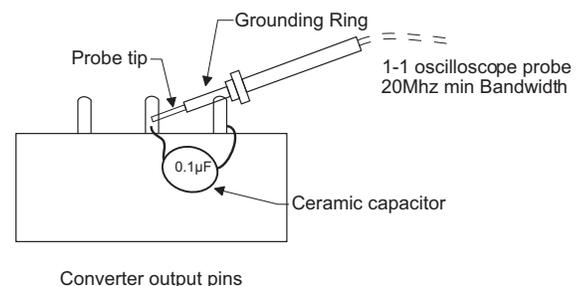
### Temperature Coefficient

Measure the output voltage at nominal ambient temperature (usually 25 Deg C), nominal input voltage and rated load, and then vary the ambient temperature to each limit. Note the voltage change at each extreme and divide it by the corresponding temperature change. The temperature coefficient is the greater of the numbers.

### Output Ripple and Noise

Because of the high frequency content in the output noise waveform, and the proximity of radiated emissions from the converter, it is impossible to make valid measurements without special considerations.

Using an oscilloscope with a 20 MHz bandwidth or one with a 20 MHz filter engaged, use a 1 to 1 oscilloscope probe, with at least 20 MHz probe bandwidth. Remove the probe tip and grounding lead touch the probe tip to the pin of the output being measured and the grounding ring near the tip to the common pin. There is still a small antenna loop created by the probe tip and output terminals. Residual pick up can be reduced by connecting a 0.1 $\mu$ F ceramic capacitor across the output terminals if necessary.



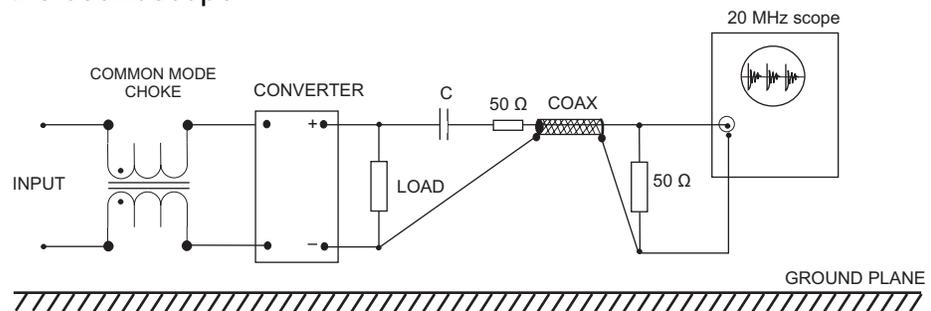
Note: A probe with a conventional ground clip connection will not work for this measurement.



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Another method which can be used to obtain accurate measurements is to use a 50 Ohm terminated coaxial cable between the converter and the oscilloscope.

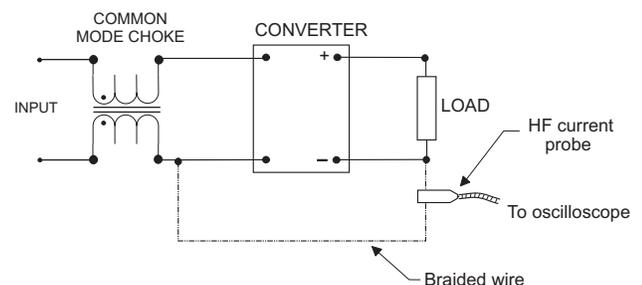
With a high quality conductive ground plane (a sheet of copper or aluminum is acceptable) in place between the converter and the oscilloscope, the shielded low impedance interconnecting wires will pick up very little extraneous noise. To minimize the effects of common mode noise a common mode choke is connected to the converter input. With this method of measurement the actual noise is double the peak to peak value displayed on the oscilloscope, since the terminated coax divides the signal by 2. To obtain accurate measurements the load must have a very low reactance at the switching frequency, preferably below 2%. The coupling capacitor C can be a low ESR electrolytic type, not less than 10 $\mu$ F.



Note use of common mode choke to attenuate common mode noise.

### Common Mode Noise Current

Attach a common mode choke between the input power source and the converter under test. Attach a short conductor between the input common pin and the output common pin. A piece of braid or solderwick will work well. Clamp a current probe onto this conductor, and measure the peak to peak current. Use a filter to establish the 20 MHz bandwidth.



### Reflected Ripple Current

This is an important parameter for DC/DC converters because they are sometimes supplied from relatively high impedance sources, or they are at the end of long supply wires. It occurs in all switched mode converters because during switching action very short duration high current pulses are demanded.

A typical measurement technique is to use a wideband current probe and oscilloscope.

