Output Noise Measurement for Switch Mode Power Supplies

APPLICATION NOTE

Introduction

Power supply output noise has two parts, the “Ripple” and the “Noise.” The “Ripple” portion is a measurement of the voltage fluctuation on the output of the supply. It is caused by the switching elements turning on and providing a little more energy and ripple current to the output filter (output voltage increases). It then turns off, and the output load is supplied by the output capacitance and inductance (output voltage decreases). The output filter has impedance at the switching frequency, which due to the ripple current results in the ripple voltage. The frequency of these fluctuations is typically in line with or a multiple of the switching frequency of the power supply. The “Noise” portion is caused by ringing during the switching portion of the cycle. It shows up as small high frequency (MHz range) bursts at the transitions of the switching cycles and of the ripple current. These high frequencies can radiate, causing induced voltages and also measurement imbalance, which will cause reading errors.

Probing Technique

Proper measurement of Output Ripple and Noise requires good probing techniques. The biggest mistake made while measuring Ripple and Noise is having a large ground loop. The ground loop will act like a loop antenna and pick up any additional noise in the area. The connections to the output should be kept as short as

possible to the measurement tip and the ground connection on the scope probe.

The best way to minimize the ground loop during Ripple and Noise measurement is to either laying the scope probe directly across the output leads (Fig. 1) or by creating a very short ground lead by wrapping bare wire around the ground connection on the scope probe (Fig. 2).

Figure 1: Scope probe across leads.

Figure 2: Wrapping bare wire to form a ground

Measurement

The Ripple and Noise measurement is best performed using an oscilloscope. The scope should be set to restrict the bandwidth to 20MHz to limit radiated pickup. The, channel that the scope probe is attached to should be set to AC coupling. Additional components may need to be added across the output to minimize any additional ambient noise and emulate the termination impedance of the load. Check the power supply specification for the exact values if required. Typically an internal type power supply will use a 0.1uF Ceramic Capacitor and a 10uF low ESR Electrolytic Capacitor in parallel with the output as close to the output connection as possible. Typically, an external type power supply, because of the long output cable, will use a 0.1uF Ceramic Capacitor and a 47uF low ESR Electrolytic Capacitor in parallel with the output as close to the output connector as possible (see Figure 3 below).

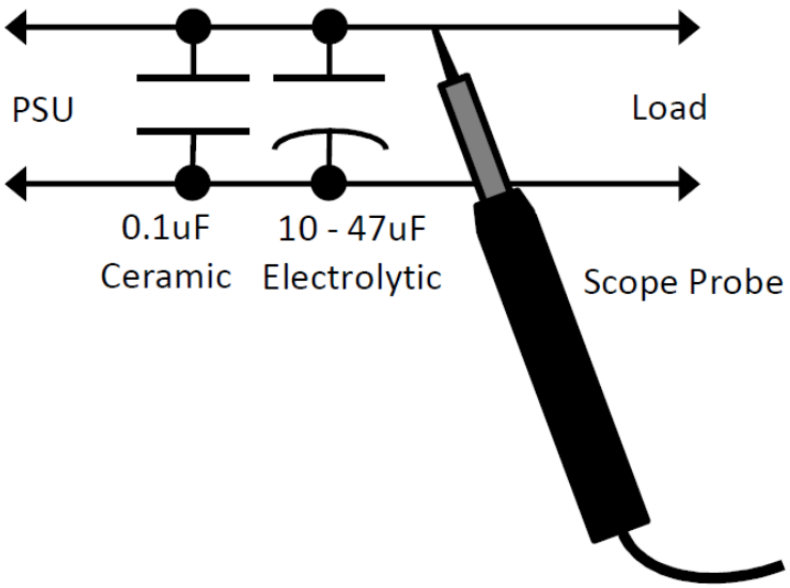

Figure 3: Scope probe across the additional capacitors in parallel with the output.

Note: the voltage rating of the capacitors should be in excess of the maximum output voltage of the power supply under test to prevent any damage to the capacitors.