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Measuring Output Noise

General Description

Accurately measuring output noise and ripple requires a basic understanding of the high frequency nature of noise. Very often, "noise" (as commonly measured) is actually the vector sum of common- and differential-mode noise.

Common mode noise is common to both outputs (that is, to +OUT and -OUT) with respect to chassis or earth ground. Differential mode noise is found at one output with respect to the other.

While the system load can be affected by differential mode noise, it is seldom affected by common mode noise. The latter is often only created in the process of measuring the former.

Noise can be measured as RMS or peak-to-peak. Low frequency noise with a low peak-to-average ratio is often measured as RMS. High frequency spike noise is more meaningfully measured with an oscilloscope as peak-to-peak noise. The following information pertains to measuring high frequency spike noise.

Implementation

The preferred test setup includes a custom probe made from a length of RG58 A/U coaxial cable. It is connected to the oscilloscope with a BNC "T" connector, which is terminated with a 47Ω carbon composition resistor in series with a 0.68µF Z5U capacitor. The other end of the coax is left bare. See *Figure 8a.*

Measure noise as closely as possible to the converter's output terminals to reduce noise pickup.

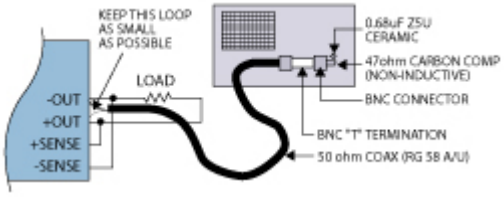

Figure 8a Output noise test setup. The 47Ω resistor in series with the 0.68µF capacitor decouples the DC while terminating high frequencies with 50Ω (47Ω). The -3dB frequency is 5 kHz.

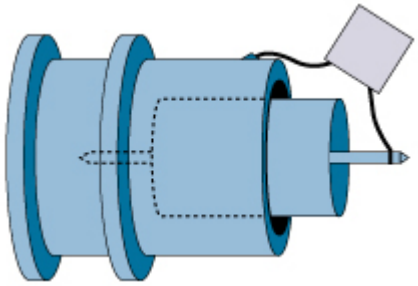

Figure 8b Detail of BNC termination, showing the 47Ω carbon composition (non-inductive) resistor in series with the 0.68µF Z5U capacitor.

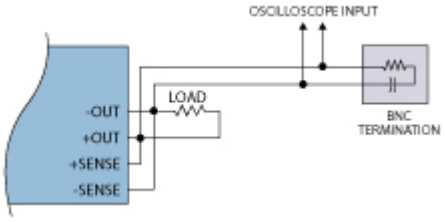

Figure 8c Schematic diagram of noise test setup.

Using an oscilloscope probe
If an oscilloscope probe must be used, it must be properly prepared for high

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frequency measurements.

The greatest error source is usually the unshielded portion of the oscilloscope probe. Error voltages induced by magnetic radiation in the loop can easily swamp out the actual values. To reduce measurement errors, keep unshielded leads as short as possible.

Prepare the probe for high frequency measurements by first removing the clip-on ground wire and the probe body fishhook adapter. Attach a special tip and ground lead assembly as shown in *Figure 8d*. These assemblies are available from several manufacturers:

- Hewlett Packard
- Kikusui
- LeCroy

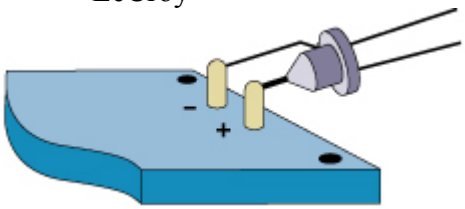

Figure 8d. *Prepare oscilloscope probe for high frequency measurements by removing the ground clip and fishhook adapter. Slip on a special oscilloscope probe tip and ground lead assembly, and contact the output terminals as shown.*

Determine if there is any common mode noise by simultaneously contacting the probe tip and ground lead to the -OUT pin. Any scope pattern indicates common mode noise, and must be eliminated before accurate measurements can be taken.
To eliminate the noise,

- Wrap the oscilloscope probe lead several times around a large-diameter ferrite toroid. This will act as a balun, or common-mode inductor. It increases common mode impedance without significantly increasing differential mode impedance.
- Isolate the oscilloscope power source from the line voltage with an isolation transformer, or
- Wrap the power source AC line cord several times around a large-diameter ferrite toroid. This also reduces common mode current.
- Try using another oscilloscope and/or probe

Precautions

Do not use the ground lead clipped to most common oscilloscope probes. The loop of wire will itself pick up high frequency radiated noise and give erroneous readings.