

# Measuring Output Noise and Ripple

## 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 (+OUT and -OUT) with respect to chassis or earth ground. Differential mode noise is measured at one output with respect to the other. Differential mode noise is what is specified in Rantec datasheets.

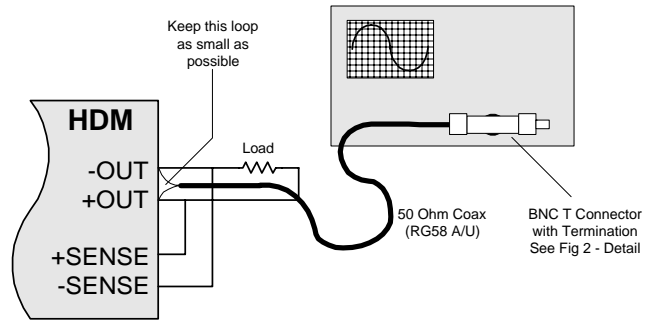
To measure differential noise accurately, care must be taken not to introduce errors due to common mode noise.

Noise can be measured as RMS or peak-to-peak. Low frequency noise, with a low peak-to-peak 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.

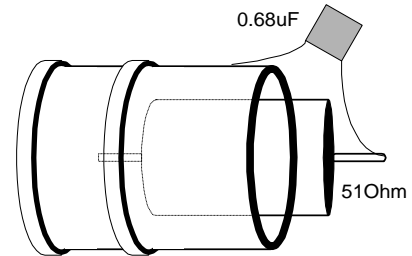
## Implementation

The preferred test setup (per IEEE-1515-2000) 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 51Ω carbon composition resistor in series with a 0.68μF X7R capacitor. The other end of the coax is left bare. See Figures 1 and 2.

Measure the noise as close as possible to the module's output terminals to reduce noise pickup. It is also highly recommended that the oscilloscope safety ground be lifted during these measurements to reduce common mode currents in the coax cable, which may introduce significant measurement errors.



**Figure 1:** Output noise test setup. The 51Ω resistor in series with the 0.68μF capacitor decouples the DC while terminating high frequencies with 50Ω (51Ω). The -3dB frequency is 4.6kHz.



**Figure 2:** Detail of BNC termination, showing the 51Ω carbon composition (non-inductive) resistor in series with the 0.68μF X7R capacitor.

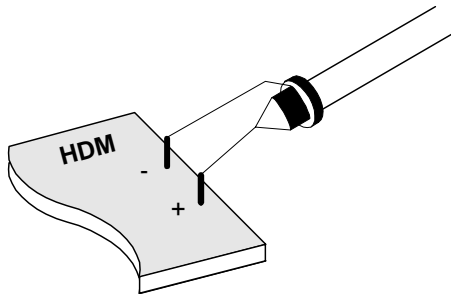
### Using an Oscilloscope Probe

If an oscilloscope probe must be used, it must be properly prepared for high frequency measurements.

The greatest source of error 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 3. These assemblies are available from several manufacturers:

- ◆ Hewlett Packard
- ◆ Kikusui
- ◆ LeCroy



**Figure 3:** 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. Keep these leads as short as possible.

Options to eliminate the common mode noise:

- ◆ Wrap the oscilloscope probe lead several times around a large-diameter, high  $\mu$ , ferrite toroid. This will act as a balun, or common mode inductor. It increases the common mode impedance without significantly increasing the differential mode impedance.
- ◆ Isolate the oscilloscope's power source from the line voltage with an isolation transformer.
- ◆ Wrap the oscilloscope's AC line cord several times around a large-diameter ferrite toroid.

### 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.