Hint 6

Check the common mode rejection

One of the most misunderstood issues with probing is that common mode rejection can limit the quality of a measurement. With either a single-ended or differential probe, it is always worthwhile to connect both probe tips to the ground of the DUT and see if any signals appear on the screen.

If signals appear, they show the level of signal corruption that is due to lack of common mode rejection. Common mode noise currents caused by sources other than the signal being measured can flow from ground in the DUT through the probe ground and onto the probe cable shield. Sources of common mode noise can be internal to the DUT or external to it, such as power line noise, EMI or ESD currents.

A long ground lead on a single- ended probe can make this problem very significant. A single-ended probe does suffer from lack of common mode rejection. Differential active probes provide much higher common-mode rejection ratios, typically as high as 80 dB (10,000:1).

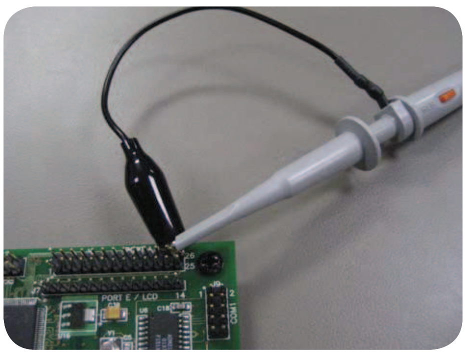

Figure 6-1. Connect both probe tips to the ground and see if any signals appear on the screen.

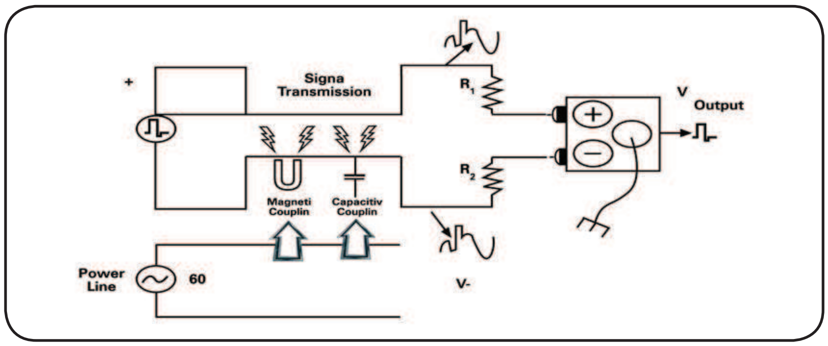

Figure 6-2. Differential active probe provides much higher common mode rejection ratio effectively eliminating common mode noise current.

Hint 7

Check the probe coupling

With your probe connected to a signal, move the probe cable around and grab it with your hands. If the waveform on the screen varies significantly, energy is being coupled onto the probe shield, causing this variation. Using a ferrite core on the probe cable may help improve probing accuracy by reducing the common mode noise currents on the cable shield. A ferrite core on the probe cable generates a series impedance in parallel with a resistor in the conductor. The addition of the ferrite core to the probe cable rarely affects the signal because the signal passes through the core on the center conductor and returns through the core on the shield, resulting in no net signal current flowing through the core.

The position of the ferrite core on the cable is important. For convenience, you may be tempted to place the core at the scope end. This would make the probe head lighter and easier to handle. However, the core's effectiveness would be reduced substantially by locating the core at the probe interface end of the cable.

Reducing the length of the ground lead on a single-ended probe will help some. Switching to a differential probe will typically help the most. Many users don’t understand that the probe cable environment can cause variations in their measurements, especially at higher frequencies, and this can lead to frustration with the repeatability and quality of measurements.

Figure 7-1. Using a ferrite core on the probe cable may help improve probing accuracy

8 Hint

Damp the resonance

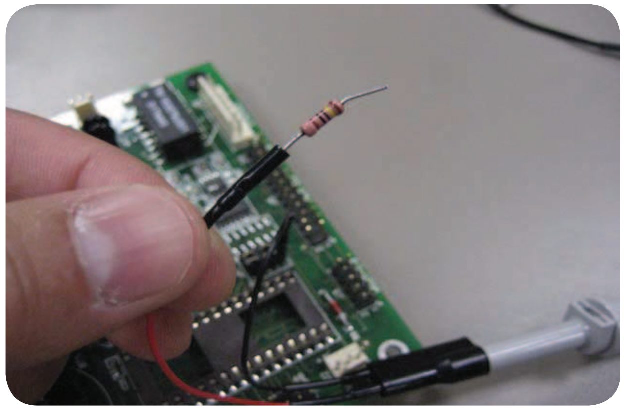

Figure 8-1. Put a resistor at the tip to damp the resonance of the added wire.

The performance of a probe is highly affected by the probe connection. As the speeds in your design increase, you may notice more overshoot, ringing, and other perturbations when connecting an oscilloscope probe. Probes form a resonant circuit where they connect to the device. If this resonance is within the bandwidth of the oscilloscope probe you are using, it will be difficult to determine if the measured perturbations are due to your circuit or the probe.

If you have to add wires to the tip of a probe to make a measurement in a tight environment, put a resistor at the tip to damp the resonance of the added wire.

For a single-ended probe, put the resistance only on the signal lead and try to keep the ground lead as short as possible. For a differential probe, put resistors at the tip of both leads and keep the lead lengths the same. The value of the resistor can be determined by first probing a known step signal through a fixture board like the Agilent E2655B into a scope channel. Then probe the signal with your proposed wire with a resistor at the tip. When the resistance value is right, you should see a step shaped much like the test step, except it may be low-pass filtered. If you see excessive ringing, increase the resistor value.

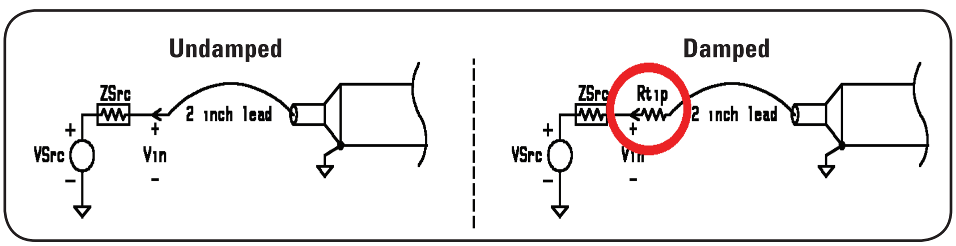

Figure 8-2. With a properly damped probe input, the loading/input impedance will never drop below the value of the damping resistor.

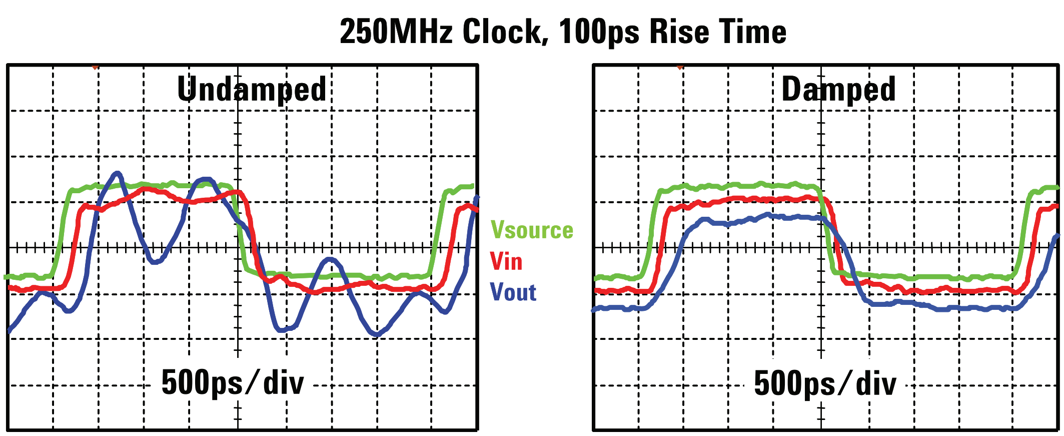

Figure 8-3. As the speeds in your design increase, you may notice more overshoot, ringing and other perturbations. Overcome the resonance formed by the connection of a probe by adding a damp resistor to your probe tip.