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tech tips

Making Differential Measurements With The SC61

Each input of the SC61 Waveform Analyzer is referenced to ground. This is often called a ''single-ended'' input. Nearly all oscilloscopes use single-ended inputs. They offer advantages for most measurements, since most circuits have a similar reference to a common ground point. A few circuits, however, need a non-grounded, ''differential'' connection. If so, the SC61 can be used to make ''differential'' measurements. This Tech Tip explains how to make these measurements.

Why The Inputs Are Grounded

The difference between differential and single-ended measurements is grounding. The inputs of most test equipment have one ''hot'' lead and one ''ground'' lead. Except for voltmeters and some signal generators, the ground lead is usually connected directly to the case of the instrument which, in turn, connects to earth ground through the grounding safety pin of a 3-wire AC plug.

This arrangement provides a combination of shielding and safety. The shielding prevents external AC signals from mixing with the signal you want to measure. By keeping the shielding continuous from the input connector, through the internal circuits, and then through the outside case, the chances of interference are reduced. Disabling the ground connector of the AC plug may reduce the instrument's shielding, in many cases.

The safety aspects are the same as with any grounded electrical appliance. Since all exposed metal on the instrument is connected to earth ground, it cannot be a source of electrical current. There is no chance of an electrical shock if you come between the instrument's case and a solid ground, such as a water pipe. This safety feature, is defeated if the AC plug is not properly grounded.

Connecting this ground may upset a few circuits. For example, some audio systems use balanced lines, meaning that neither side of the circuit is grounded. (Balanced lines reduce hum pickup, by preventing ground loops.) Or, you may need to determine the current through a resistor by connecting to either side, but the resistor may not connect to ground. Or, a circuit may have some power supplies which float above earth ground, and you do not want to tie the circuit to earth ground for a test. All these situations call for a way to make ''floating'' measurements.

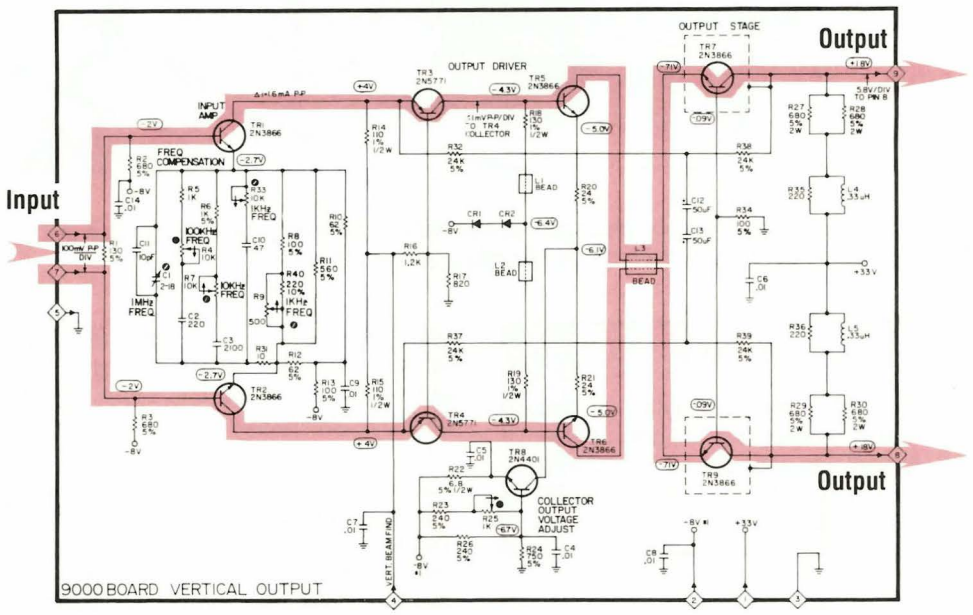

Fig. 1: Both sides of a differential amplifier are isolated from ground. If you connect a grounded scope probe to one side, it may cause incorrect operation.

How To Make Differential Measurements

You can connect the two SC61 inputs to provide a single differential input. This calls for you to electrically add the two channels and invert channel A. You will connect the ground clip of the channel A probe to the ground of the channel B probe to improve the shielding of each input circuit. *Do not connect the grounds to the circuit.* You then connect the tip of the channel A probe to one side of the circuit and the tip of the channel B probe to the second side.

You will use the CRT to determine amplitude. You cannot use the digital readout, when making differential measurements, because the measuring circuit senses the combination of the differential signal (showing on the CRT) and the signal being cancelled (which may be larger than the displayed amount). This is a meaningless number.

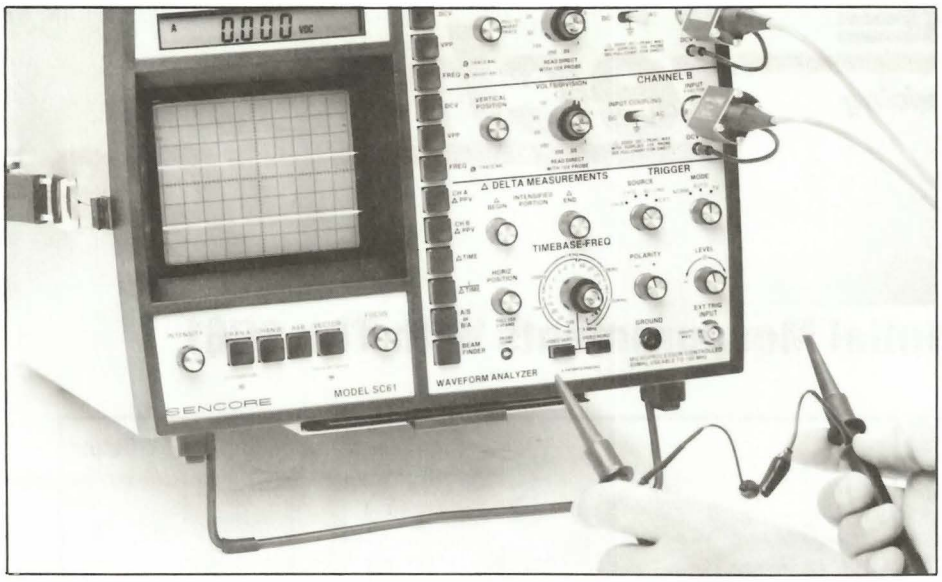

Fig. 2: Connect the two probe grounds together before connecting the SC61 probes to the circuit. Be certain that the grounds don't connect to the circuit.

WARNING

Differential measurements do not replace isolation transformers. Always use isolation when working on a circuit with a ''hot'' chassis, referenced directly to the AC line.

To make a differential measurement:

1. Connect the ground leads on the channel A and B probes together. **Do not connect the grounds to the circuit.**

2. Connect the channel A probe to one side of the circuit, and the channel B probe to the other side of the circuit. It doesn't matter which probe connects to which side of the circuit.

3. Place the SC61 into its ''Add'' mode by pressing the ''CHAN A'' and the ''CHAN B'' CRT selector buttons simultaneously. Make certain both buttons remain depressed.

4. Invert the channel A trace by pulling out on the ''VERT POSITION'' control. This now places the CRT into the ''subtract'' mode.

5. Set the vertical verniers (the small knobs in the center of the ''VOLTS/DIVISION'' switches) fully clockwise to the ''CAL'' position.

6. Set both ''VOLTS/DIVISION'' switches for the same amount of gain.

The CRT now shows the *difference* between the channel A and B inputs, while *cancelling* signals of the *same polarity* applied to both probes.

You calculate the peak-to-peak voltage using conventional scope techniques. Count the CRT divisions, and multiply by the setting of the ''VOLTS/DIVISION'' switch. Remember that the SC61 is calibrated to read directly with the supplied low-capacity probes, so you *do not multiply the results by ten.*

You *do not* have to multiply or divide by 2, even though you are using both inputs. The signal divides between the two inputs, so you simply multiply the setting of either ''VOLTS/DIVISION'' switch times the vertical divisions of deflection.

It is normal for the triggering to be somewhat touchy when a differential measurement is cancelling a large amount of interference. The trigger circuits will try to trigger from the larger, interference signal. Adjust the TRIGGER LEVEL control carefully to get the best triggering.

Sometimes, the external trigger input can be used to trigger the sweep circuit. Remember, however, that the SC61's external trigger input is grounded to the SC61 case. Be cautious to connect to a test point that can be grounded without affecting the differential connections. Use a standard shielded test lead, or a 10:1 scope probe to feed the external trigger input.

For More Information
Call Toll Free 1-800-SENCORE

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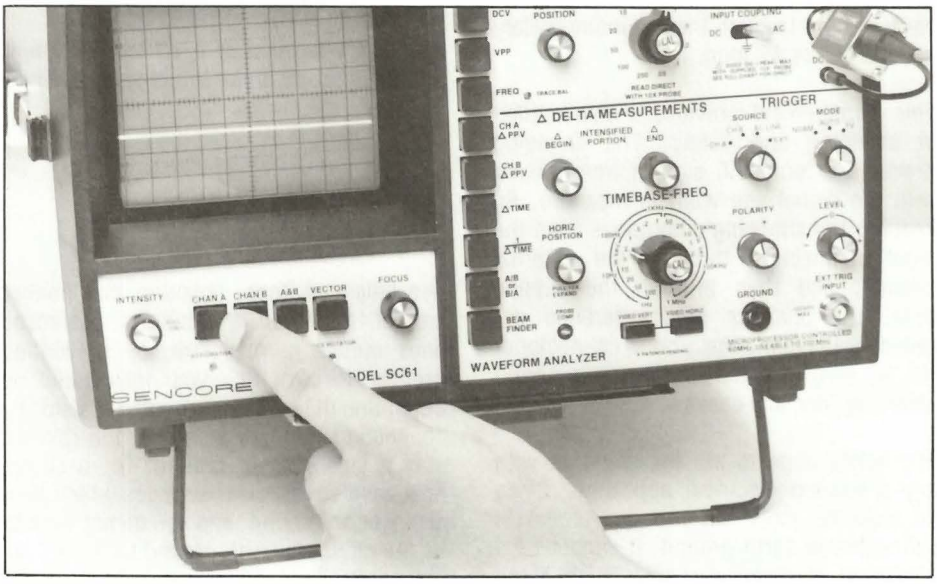

Fig. 3: Press the channel A and B CRT selector at the same time to add the two traces together. Be sure both buttons stay latched.

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