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tech tips

Troubleshooting Timing Circuits And Counters With Your Waveform Analyzer

Some of the most difficult electronic circuits to troubleshoot include timing and counter circuits. This Tech Tip deals with the waveforms found in these circuits and how to interpret them with your SC3100 Waveform Analyzer.

Timing And Counter Circuits Have Time Relationships

Both timing circuits and counter circuits have outputs which are related to the inputs. Whether the circuit is a dividing circuit or a multiplying circuit, the output must be directly related to the input. If the timing is off just slightly or the input frequency is not being divided exactly the way it should, some function of the unit may not work properly.

You can use your SC3100 to compare these timing or counter signals by monitoring the input of the circuit on channel A, and the output of the circuit on channel B. Then you can analyze the signals for timing or divide-by problems.

How To Trigger On Two Signals At The Same Time?

Some of our customers have told us that triggering on two signals is more difficult than triggering on a single waveform. That may be true if the two waveforms are not related in any way. If the two signals aren't time related to a common source, the SC3100 or any other single time-base scope will not trigger on both signals at the same time because they have no common reference point. However, if the signals are related, the triggering process is rather simple.

The SC3100 may appear to mistrigger on one signal when viewing two signals that are multiples of each other as shown in Figure 1. A digital flip-flop, for example, produces an output that is half the frequency of the input. Or, a frequency doubler is used in many FM receivers to step the 19 kHz pilot signal (sent from the station) up to the 38 kHz needed to separate the left and right audio information.

The TRIGGER SOURCE switch should always be set to trigger from the lower of the two frequencies. If it is set to trigger from the higher frequency, the second channel may be randomly displayed (Figure 1b) because the trigger circuits cannot tell where the lower frequency is in relationship to the higher frequency.

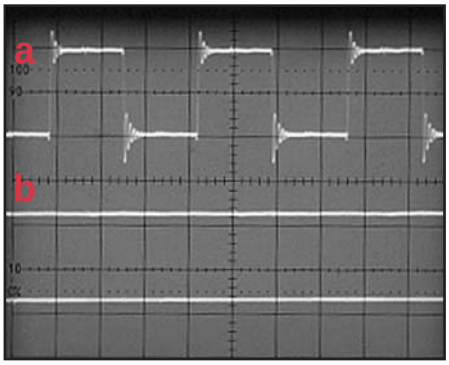

Fig. 1: Always trigger from the lower fequency signal, when two signals are multiples of each other, to prevent the lower frequency signal from double triggering.

For example, the head switching adjustment in a VCR requires two locked-in waveforms on the CRT to adjust the circuits properly. The two waveforms are the composite video waveform and the 30 Hz head switching reference.

In this case, use the 30 Hz pulse for the trigger source. If you use the video waveform to trigger from, the waveforms may go out of sync and will be unusable.

Anytime you're viewing two signals on the SC3100 and one of the waveforms doesn't sync, check the following controls on the SC3100:

1. Make sure the TRIGGER MODE switch is in AUTO unless you're troubleshooting video (TV mode) or a special application.

2. Check your TIMEBASE-FREQ control so it's set to AUTO or the correct approximate frequency.

3. Check the POLARITY switch. Most applications work equally well in both polarities except for composite video, in which case the polarity must be set according to the video's sync polarity.

4. Make sure the TRIGGER SOURCE control is referenced to the lower frequency waveform.

5. Adjust the trigger LEVEL control until both waveforms trigger.

How To Tell If There Is A Timing Problem

Once you have the two signals triggered on the CRT display, you can analyze each for timing or frequency problems. By adjusting the VERTICAL POSITION knobs for each channel, you can position the traces next to one another for a visual comparison.

Whether the output waveform has the wrong frequency, duty cycle, starting point, or ending point, you will be able to analyze

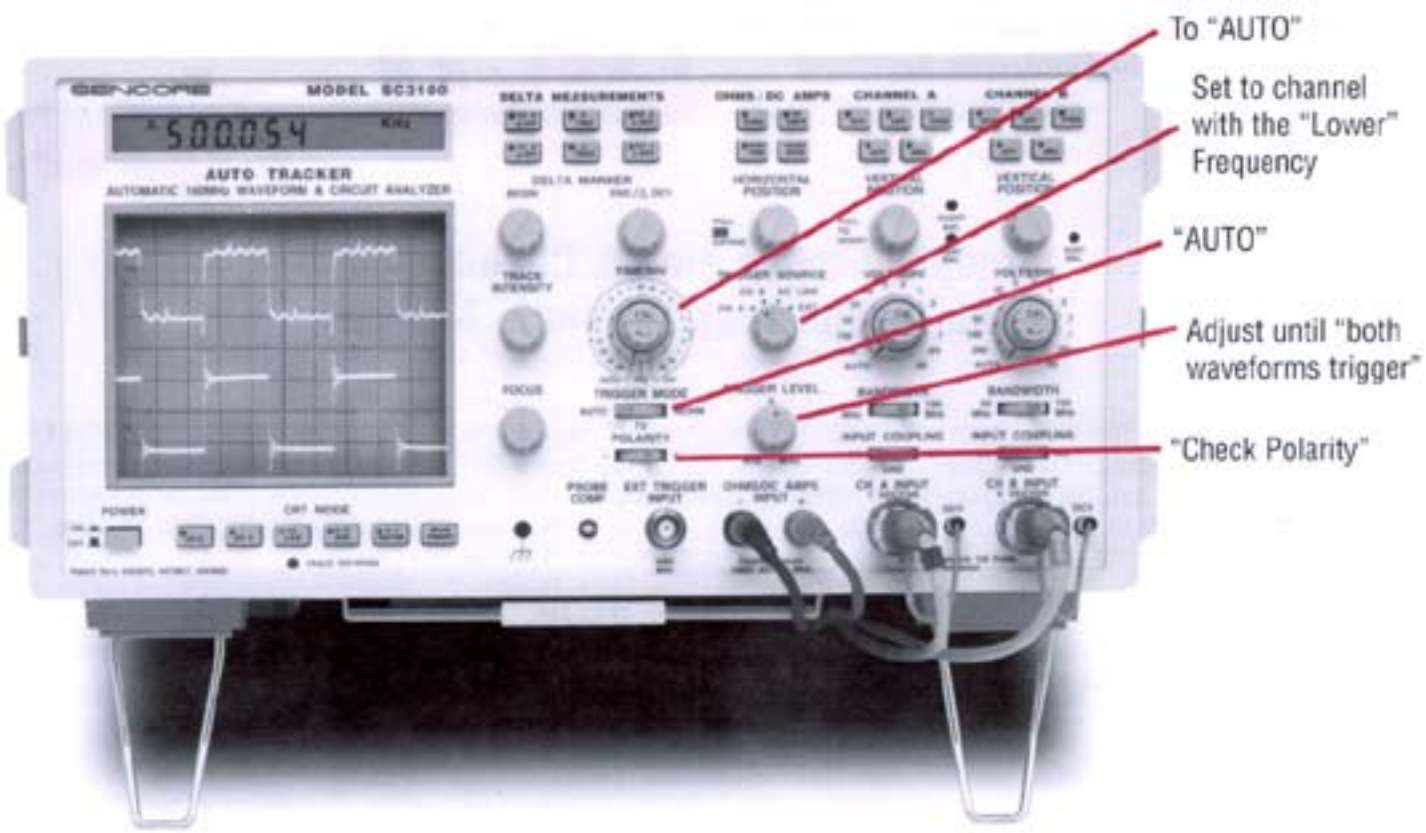

Fig. 2: If you can't sync one of both SC3100 waveforms, check these controls for the proper settings.

it easier with the dual traces adjacent to one another. If it is a frequency problem, the digital readout will find it for you. Simply take the Ch. A and divide by the Ch. B. Keep in mind you may have to trigger on the high frequency channel momentarily to read its frequency accurately.

A duty cycle problem can be found by using the SC3100's Delta Time function. Intensifying the on-portion of the waveform with the Delta Begin and Delta End controls will tell you the waveform's exact duty cycle without worrying about how you have the controls set. The SC3100 won't let you make a mistake here since everything is automatically compensated for.

If the waveforms have a bad starting or ending point, a visual comparison will show you this problem. If you want to find the specific delay in the signal, you can use the Delta Time function again to find the time delay between signals by intensifying the time span between waveforms and reading the time delay directly on the digital display.

Using The A + B Mode to Determine The Timing Of Two Signals

The A + B display mode may be used to simplify the comparison of the timing of two signals. Common applications include the time difference between two pulses or squarewaves or the comparison of a triggering pulse compared to an analog signal, such as a ramp. Combining the two traces into one trace eliminates the need of resetting the VERTICAL position controls if the amplitude of either of the two traces changes. Either the channel A or B VERTICAL POSITION control may be used to place the desired part of the waveform on the calibrated center graticule line, saving additional measurement time.

To determine the relationship of two signals:

1. Connect the two signals to the channel A and B inputs, using channel A as a reference.
2. Set the TIMEBASE-FREQ and TRIGGER controls to view two or three locked-in cycles of the reference signal. AUTO mode will display two locked-in cycles for you.
3. Depress the "A & B" display pushbutton and adjust the VOLTS/DIVISION switches until both signals are about the same amplitude on the CRT screen and occupy less than four vertical divisions.
4. Depress the A + B add button. The two signals are now algebraically added on the CRT.
5. Use the Delta Time digital function to determine the time delay between the two signals.

Using The External Triggering Function

Most signals require no special adjustments for stable triggering on the SC3100. Simply adjust the TRIGGER LEVEL control until the trace locks.

However, there are a few signals that may be a little bit more difficult to trigger on. In these cases, a stable signal of the desired frequency may be fed into the EXT TRIG INPUT jack on the SC3100.

Since you want the SC3100 to trigger to your reference signal going into the EXT TRIG INPUT jack, you set the TRIGGER SOURCE switch to “EXT”. Now the SC3100 will trigger to any signal applied to the EXT TRIG INPUT jack.

One example of a signal that needs external sync is unique to video signals. Many points in a TV receiver or video monitor contain the vertical and horizontal sync pulses needed by the SC3100 for proper triggering.

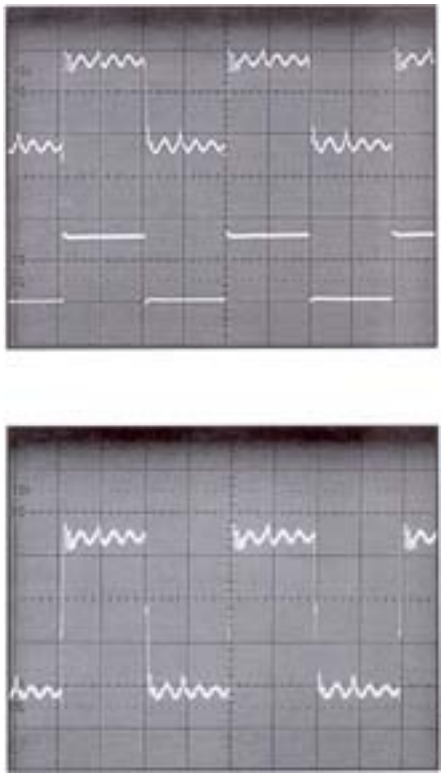

Fig. 3: The two waveforms in the top photo are added with the A+B function in the bottom photo to compare the timing.

A few points, however, do not have sync. One example is the output of the chroma bandpass amplifiers. The low frequency sync pulses are removed by the filtering action of these stages. These video signals without sync information may not lock solidly on the SC3100. The SC3100 must be triggered from another test point, such as the video detector or sync separator, to provide a stable trigger reference. This second trigger source may be fed to the external trigger input or to the second vertical channel.

Digital Data From Microprocessors

Analyzing the inputs or outputs of a microprocessor based system with any oscilloscope requires the system to be placed into a loop that repeats the same data on a continuous basis. Attempting to view a waveform with the system in full operation results in a blur of data because the data (and resulting waveform) will be different every time the electron beam sweeps across the CRT screen. At times, this is not a problem because you may only be interested in learning whether the signal is “toggling” (moving between highs and lows) rather than viewing a specific set of data instructions.

The service literature for the system should explain how to place the system into a loop for special tests. Sometimes, this is a special set of instructions designed for troubleshooting only. The special loop may require adjusting internal switches or jumpers to place the system into the loop. At other times, the loop may be produced by selecting a standard function that forces the system to repeat the same information over and over, such as a reset function.

After the loop has been established, the SC3100 needs a reference signal to insure that the trace begins its sweep at the same point in the digital data for each trace sweep. A “clock”, “reset”, or “enable” pulse may be used to trigger the SC3100 through the external trigger input or through the second vertical input.

For More Information,
Call Toll Free 1-800-SENCORE
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