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tech tips

Why The SC61's Triggering Circuits Exceed Those Of Other Scopes

The developments of new advanced circuits found in TVs, VCRs, stereos, and computers, to name a few, have caused oscilloscopes to become an essential part of an efficient service area. However, before you are to be able to use any of the information from the waveform effectively you must be able to lock onto it with the scope's triggering circuits. One of the most important features on any scope would be that it have stable triggering. In order to understand the requirements for an oscilloscope to produce stable triggering, we must first identify some sources of triggering problems.

What Causes Triggering Errors?

A common cause of triggering errors in many scopes is noise generated in the triggering circuits. Noise of this type often goes unnoticed when viewing a square wave signal, but may cause problems in other waveforms, such as sine waves. A sine wave is one of the most difficult waveforms to trigger on because the amplitude is constantly changing. The scope should trigger at exactly the same amplitude point on the signal each time it begins its sweep to prevent jitter or instability.

Inherent noise in the trigger circuits can cause small changes in the triggering point on the signal, which cause the scope to begin its sweep at a slightly different point on the waveform each time. This causes the sine wave to jitter horizontally because the sweep is shifting horizontally by a small amount on each succeeding sweep. Triggering errors may appear as a thickening of the trace horizontally or, in an extreme case, as a "ghost" image. These "ghost" images are the result of the scope triggering at extremely different levels on succeeding trace sweeps, creating multiple images after several cycles have been displayed.

Inherent noise in the triggering circuits is not the only major cause of sync instability.

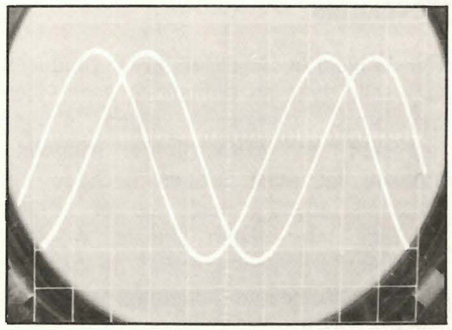

Fig. 1: False triggering due to inherent scope noise can cause a sine wave to develop a ghost.

Another key factor is the trigger response time of the trigger circuits themselves. The triggering circuits must respond faster than the waveform you are measuring in order for the trigger circuit to "see" the signal it must trigger on. To "see" the signal, the trigger circuit's response must be faster than the frequency you are measuring. In the case of the SC61 Waveform Analyzer, this meant that the trigger circuits had to respond to signals above 100 MHz range.

Sencore incorporated the latest state-of-the-art technology in the triggering circuits of the Waveform Analyzer to produce rock-solid sync. We use differential amplifiers to virtually eliminate inherent noise in the triggering circuits and ECL logic to meet the high speed trigger circuit response requirements for today's circuits. Let's examine closely how these circuits produce superior triggering and sync.

Differential Amplifiers Reduce Noise Pickup

First, let's look at the use of the differential amplifier circuits in the SC61. The main advantage of differential amplification is that many interference sources cancel each other. Let's compare a differential circuit with a non-differential circuit (commonly called a "single-ended" circuit) to see how this is done.

The most common source of interference in single-ended circuits is ground currents caused by magnetic fields that induce small signals in the printed circuit board. Figure 2 shows how the induced noise affects a single-ended circuit. These magnetic fields may come from circuits near the amplifier stage, such as an oscillator or power supply, or strong RF fields entering through the case of the scope. These noise signals are amplified by the various stages and can cause the noise-induced sync instability we discussed earlier.

The differential amplifier shown in figure 3 ignores these ground currents because an equal, but opposite, polarity signal is produced in the second leg of the differential circuit. The two opposite signals cancel each other so that only the desired signal (that is applied at the differential amplifier input) appears at the amplifier output. The use of differential amplifiers significantly reduces the amount of self-induced noise in the triggering circuits.

Most other scopes use several single-ended stages in their trigger circuits, resulting in less internal noise immunity. By using differential amplifiers through the entire triggering circuits of the SC61, we virtually eliminated sync instability due to internal noise. But what about providing

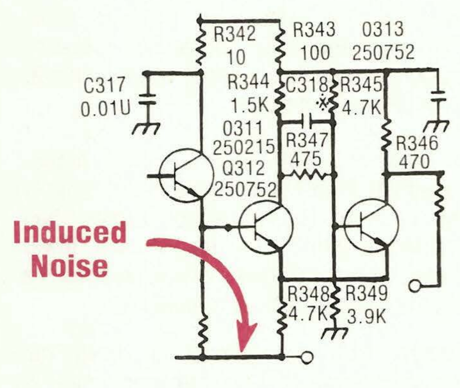

Fig. 2: Single-ended trigger stages are susceptible to induced noise.

extremely fast triggering response time for rock-solid sync through the entire SC61 100 MHz bandwidth?

ECL Provides Much Faster Trigger Response

We found the use of Emitter Coupled Logic (ECL) had several advantages compared to other digital logic families in high frequency applications. Most other brands of oscilloscopes use the Transistor Transistor Logic (TTL) logic family in their triggering circuits. Let's compare the

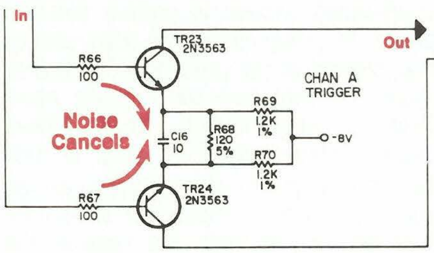

Fig. 3: Ground current noise in differential amplifiers cancels, resulting in more stable triggering.

characteristics of ECL and TTL as they apply to oscilloscope triggering circuits.

ECL's main advantage is that it is a much faster logic family than TTL. The practical upper limit for TTL chips is about 50 MHz. ECL, on the other hand, is the type of logic used for frequency counters, phase-locked loops, and other high frequency circuits. This made ECL use ideal for the fast triggering requirements of the SC61. Also, ECL has several other key advantages compared to TTL.

TTL tends to be a very noisy logic family. Each TTL logic gate produces a switching transient every time the output swings from one logic state to another. These transients can cause noise problems within their own circuit, or the noise may be radiated to other circuits through inductive coupling. ECL does not produce noise transients and uses differential operation (which we just discussed) offering better internal noise immunity.

In addition, ECL has a much higher sensitivity than TTL because the IC input is the base of the transistor rather than emitter as with TTL. Thus, we need fewer stages of amplification, which reduces the chance of noise pickup or generation.

Finally, ECL has almost 8 times the dynamic range of TTL. Dynamic range is simply the operating limits, from the smallest to the largest input signal, that will result in reliable operation. This extended dynamic range means that you don't have to reset the triggering controls as often when the amplitude of the input signal changes.

The Waveform analyzer fits the bill of today's digital and conventional circuits when it comes to rock-solid sync. But video circuits seem to be cropping up everywhere. How does the Waveform analyzer sync on video circuits?

Special Video Sync Separators Provide Rock-Solid Video Waveforms

The Waveform Analyzer even produces rock-solid sync on difficult to sync video waveforms. Composite video signals represent an extraordinary triggering problem for most scopes because the signal is actually made up of several different, inter-related signals. A video waveform is usually specified by the sync pulses, both the rate (horizontal or vertical) and the polarity.

The SC61 has special features for video waveform interpretation to give you extra stability. The secret of this stability is that the Waveform Analyzer uses dynamic IC type sync separators, just like the TV receiver. The sync separators are automatically controlled in either of two ways.

First, the fastest video mode takes advantage of an extra position on the horizontal sweep speed switch called the video preset. When you move the switch to this position, the two pushbuttons below the horizontal time base switch are activated, and the sync separators are automatically switched into the SC61 triggering circuits whether the "TRIGGER MODE" switch is in the AUTO, NORM, or TV position. Now, you simply press the VIDEO VERT or VIDEO HORIZ button to select the proper sync separator mode and sweep rate. The preset sweep rate produces approximately two waveforms at the vertical or horizontal sweep rate to match the waveforms shown on most schematics.

Second, there are many times when you want to view the waveform in more detail than what is shown with the preset buttons. The horizontal time base is then used for these applications by simply moving the TRIGGER MODE switch to the TV position. The sync separators will automatically switch to the vertical mode on slower sweep speeds, or horizontal on the higher speeds.

The SC61 Waveform Analyzer's differential amplifiers, ECL circuits, and video sync separators all work together to provide one of the easiest to use oscilloscopes. The SC61's triggering circuits let you concentrate on the circuit you are servicing and not the scope. For the majority of the applications, you leave the triggering level control set to the zero level and switch the mode and polarity controls only, putting an end to frustration.

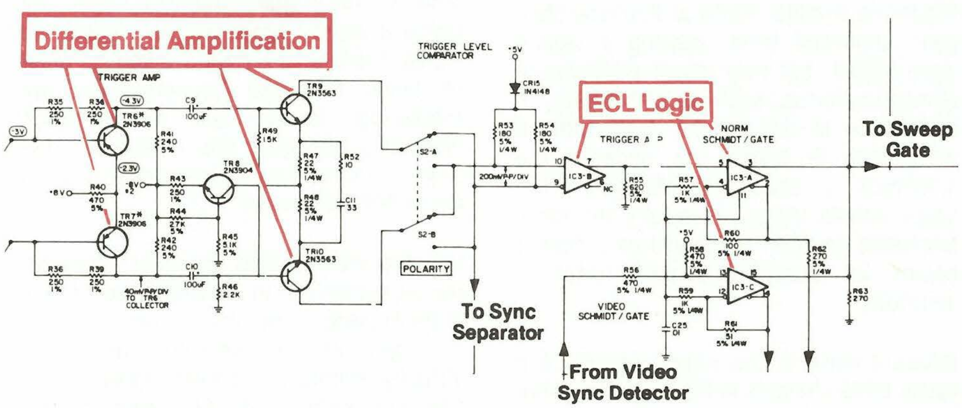

Fig. 4: The use of differential amplifiers and ECL logic throughout the trigger circuits produce rock-solid sync even under the most adverse signal conditions.