

How to Analyze Digital Waveforms with the SC61 Waveform Analyzer

Digital waveforms can be found in almost every modern electronic device built today. Many consumer products are using digital to analog and analog to digital converters. Computers work almost entirely with digital waveforms. All digital waveforms have a critical level which represents the high and low levels. The high and low must be above a certain reference level from ground to match the logic type used in the circuit (CMOS or TTL for example).

In this Tech Tip, you will see how to use the SC61 Waveform Analyzer to help analyze digital waveforms. We will look at digital waveform defects like ringing or overshoot, glitches, amplitude, and frequency.

Monitoring Waveshapes

One of the first steps to analyzing a digital signal with the SC61 is to get a clean locked-in trace on the CRT. The dual trace feature of the SC61 is very important in digital troubleshooting. Use it to view both the input signal and the output signal simultaneously (cause and effect). If the input signal is correct, the output signal should also be correct. If not, you have found the area of your problem.

You can make some digital circuits continuously output a signal by locking the device into a specific mode. For example, to view the output of a VCR's front panel key encoder IC, you need to press and hold one of the function buttons.

Measuring Digital Signal Levels

Knowing the total peak-to-peak amplitude of digital signals is not enough. Figure 2 shows the requirements of a TTL waveform for correct operation. Note that

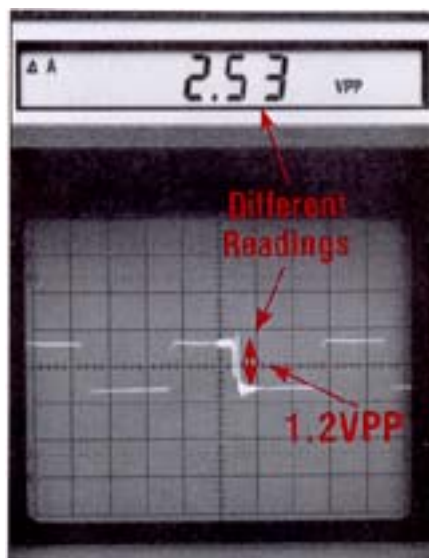


Fig. 1: Use the SC61 to analyze digital waveforms for ringing, glitches, amplitude, and frequency.

the logic 0 (low) must be below 0.8 volts DC and the logic 1 (high) must be above 2.0 volts DC from the ground reference. The area between 2.0 and 0.8 volts DC is called the questionable zone, and the operation of the IC is not guaranteed by the manufacturer with signal levels in this zone.

To analyze digital waveforms for proper level with the SC61:

1. Set the SC61's TIMEBASE and VOLTS/DIVISION control to display both the high and low levels of the waveform.
2. Move the INPUT COUPLING switch to the ground position, and adjust the vertical position control so the line on the CRT is set to the bottom graticule on the CRT.
3. Set the SC61's INPUT COUPLING switch to the DC position. Count the

number of divisions the logic low level is above the ground reference set in step 2 above. Multiply the reading by the VOLT/DIVISION setting.

4. Press the DIGITAL READOUT VPP button. Add the displayed reading to the answer found in step 3 above.
5. The logic low (step 3) should be less than 0.8 volts, and the logic high (step 4) should be greater than 2.0 volts. (see chart in figure 2)

Catching Glitches with the SC61

A glitch can cause many wasted hours of troubleshooting and good parts to be replaced. Use the SC61 Waveform Analyzer to catch glitches on digital waveforms.

A good digital waveform should look like the one shown in figure 3. The highs and lows should be flat without ringing or overshoot and should either be above or below the questionable area. Ringing and overshoot can be caused by switch contacts, bad feedback, or defective coupling.

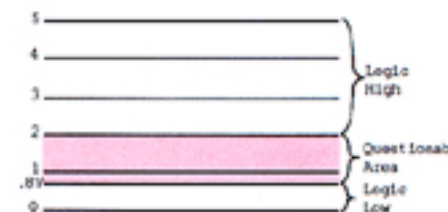


Fig. 2: A digital waveform using TTL logic levels should not fall within the questionable area.

Glitches typically will not cause problems, unless they extend into the questionable area for the logic family used. If you are not looking for a glitch or ringing on an



Fig. 3: Use the SC61's CRT and digital readout to identify good digital waveforms.

input signal, it may appear to be normal, but the circuit's output signal may not be correct. This often causes good ICs to be replaced.

Many glitches have a very short rise time, and are difficult to see on a CRT. Use the digital readout VPP function to locate the high frequency glitches not visible on the displayed waveform. (see Tech Tip 136 for more information)

To view glitches with the SC61:

1. Set the SC61's TIMEBASE AND VOLTS/DIVISION to display both the logic high and logic low levels on the CRT.
2. Increase the INTENSITY control to maximum. Look for any signs of ringing or glitches.
3. Press the DIGITAL READOUT VPP button. Compare the digital readout to the displayed levels on the CRT. If there are differences, suspect a high frequency glitch.

Measure the Frequency with the SC61

When troubleshooting synchronous digital circuits the waveforms are typically related to a master oscillator (clock). In order for the digital circuits to function properly, the clock must work and run at

the correct frequency. Test the clock's frequency with the SC61's DIGITAL READOUT.

To measure the frequency of a signal with the SC61:

1. Set the SC61's TIMEBASE, VOLTS/DIVISION, and TRIGGERING controls to display a triggered waveform viewable on the CRT.
2. Press the DIGITAL READOUT FREQ button for the channel you wish to measure. (Trigger source should be set to the channel you are measuring.)
3. Read the digital display.



Fig. 4: Press the FREQ button to measure the frequency of digital waveforms.

Measure the Ratio of Input to Output Frequency

Many circuits will use a countdown chip to divide the clock or other input signal to a lower frequency output. The SC61's A/B or B/A feature automatically calculates the difference between the frequencies of the two signals, and displays the answer on the digital readout.

To measure ratios with the SC61:

1. Set the SC61's TIMEBASE, VOLTS/DIVISION, AND TRIGGERING controls to display two triggered waveforms with the high and low levels visible on the CRT.
2. Press the DIGITAL READOUT A/B OR B/A button.

3. Read the digital display.

Analyzing Asynchronous Waveforms with the SC61

An asynchronous waveform typically has many different frequencies or signals. When viewed with the SC61, you may see many pulses with different duty cycles. These types of digital waveforms are difficult to trigger. Adjust the TRIGGER LEVEL control for best possible triggering to the waveform.

Use the SC61's CRT and DIGITAL READOUT VPP function to give clues to any defects on this type of waveform. The waveform should still be tested under the same criteria as a synchronous waveform. The levels must be less than 0.8 (low) volts DC and greater than 2.0 (high) volts DC for TTL circuits. Use the peak-to-peak meter to determine if there are any glitches on the waveform.

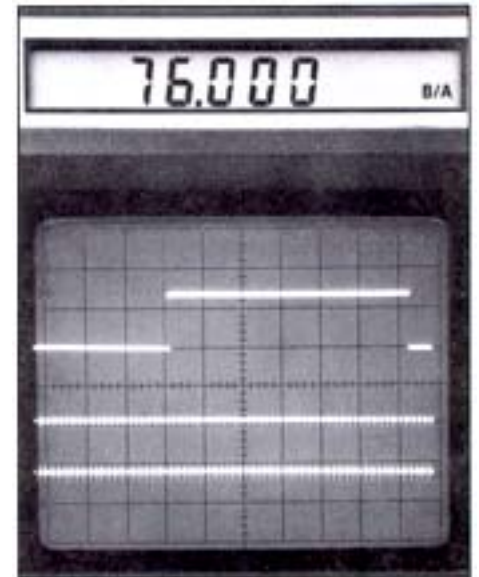


Fig. 5: Press the A/B or B/A button to read the frequency ratio between the channel A and B waveforms.

For More Information
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