Typical examples of time jitter measurements include:

(a) Measuring the inter-period jitter of a repetitive signal source.

(b) Measuring the pretrigger-to-pulse jitter of a pulse generator.

(c) Determining the uncertainty of threshold crossing detectors (comparators) due to noise, etc.

(d) Verifying the oscilloscope's jitter specs.

SOME TERMINOLOGY

"Noise" is the term we shall use to describe a random broadening of the oscilloscope trace in the vertical direction, while "jitter" will be used to describe a random broadening in the horizontal direction. In the sampling oscilloscope, the apparent trace broadening occurs as individual display dots are misplaced along one or both axes.

The causes of noise and jitter are many and varied. Some are truly random, or aperiodic, in nature while others are uniformly periodic. Unless the noise or jitter source is synchronous or very nearly synchronous with the oscilloscope sweep rate (or scanning rate in a sampling oscilloscope), even periodic causes such as hum or RF often *appear* to result in random dot displacements. No matter how many or what the causes are, the result is a statistical distribution of dots along either a vertical or horizontal cross-section of the trace.

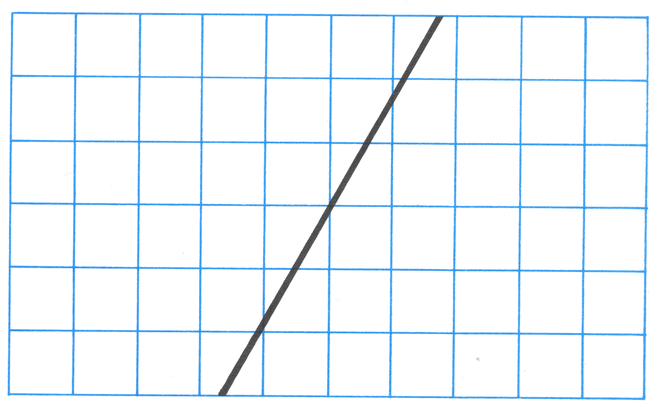
NOISE AND JITTER INTERACTION

When it comes to measuring jitter, a problem arises when noise is also present since these separately-caused effects tend to interact in the display. See drawing 1. *A sloping waveform will suffer both a vertical broadening and a horizontal broadening from either noise or jitter.* While one may always observe noise independently by displaying a horizontal baseline, the analogous operation for a completely independent jitter observation is impossible. In practice, jitter measurements with an oscilloscope must either *reduce the effect* of noise to the point of insignificance in the display *or* the jitter measurement *must be corrected* to remove the effect of noise.

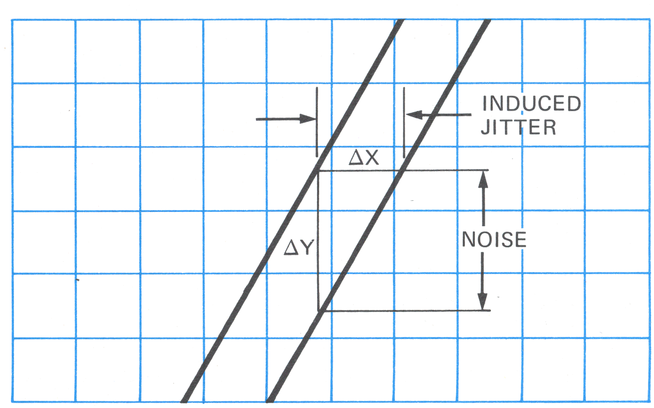
The *first approach* requires a large dV/dt for the input signal relative to vertical volts per division divided by horizontal seconds per division in the oscilloscope display. This produces a steep slope and may provide the required independence of noise and jitter in the display. Either the risetime of the available signal, the risetime of the oscilloscope, or the permissible signal amplitudes may impose the ultimate limit on the dV/dt which may be displayed, however.

It must also be noted that a large signal should be used relative to the inherent noise level of the oscilloscope. *Simply turning up the vertical sensitivity (volts/div) to get a steeper slope does NOT reduce the interactive effect of noise upon jitter.* Anything done to increase the signal-to-noise ratio DOES reduce the effect—at *ANY* sensitivity setting.

The *second approach* to a solution for this problem involves a subtractive correction to the observed jitter based on measurements of waveform slope and noise. Before we describe how to make such a correction, however, we need to look further into the question of how to measure the observed jitter from a noisy, jittery trace.

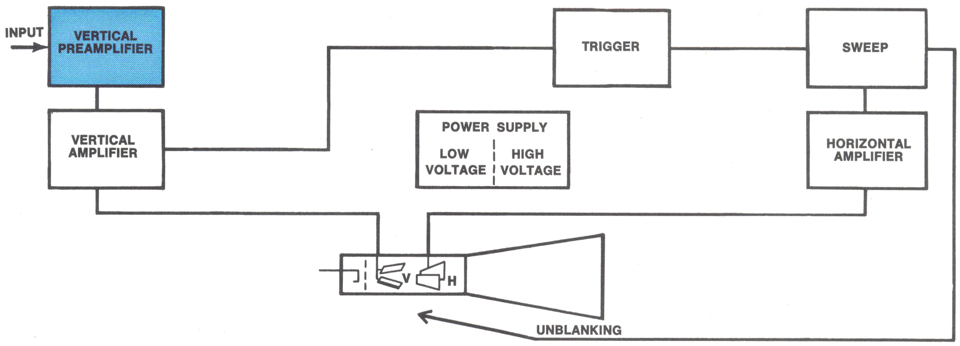


Drawing 1. No noise.



Drawing 2. Jitter induced by noise.

SERVICE SCOPE



TROUBLESHOOTING PREAMPLIFIERS

By Charles Phillips
Product Service Technician
Factory Service Center

This sixth article in a series discusses troubleshooting techniques in the preamplifiers of Tektronix instruments. For copies of the preceding five TEKSCOPE articles, please contact your local field engineer.

Substituting vertical preamplifier plug-in units is an excellent means of checking performance to the vertical amplifier input. Once a problem is isolated to a specific plug-in unit, plug-in circuit boards may isolate the problem even further. Once a problem has been traced to a specific block, a close visual check may pinpoint the problem. Often, burned components or loose leads can be spotted that shorten the troubleshooting job. Substituting the tubes or transistors offers a quick means of checking a suspected stage. **Always** return the original component to its place if the problem remains.

In the case of a plug-in, be certain the plug-in is seated properly and that there is no open connection. Plug-ins that use interlocks are particularly susceptible to this type of problem. Place the input selector to the DC position and turn off X10 amplifiers if they are available.

When troubleshooting a new instrument, take some time to familiarize yourself with the block diagram. Spending a few minutes with the instrument manual can give valuable insight into the particular problem.

When no spot is seen, use the trace finder or the position indicator to see which direction the spot is deflected. Use the position controls to see whether the display may be centered. Should the indicator lights show that the trace is deflected off screen, invert the display. If the display goes off screen in the other direction, the problem is before the invert switch.

For problems after the invert switch, use a shorting strap, and starting with the output stages of the preamplifier, work stage by stage towards the input amplifier. The stage is working normally when the signal short causes a trace near the vertical center line of the CRT. A defective stage is indicated by the short not centering the trace on the CRT.

If the amplifier is well-balanced, the position control will be close to midrange when the trace is centered. If a problem exists, switch the output stages to obtain balance near the potentiometer midrange point.