a review of basic Counter Principles

By Ray Herzog, Assistant Program Supervisor

With the introduction of the 7D14 Digital Counter plug-in, Tektronix opened the door to the world of counter measurements for oscilloscope users. The convenience of having a digital counter as an integral part of the oscilloscope meant that, for the first time, many of you would be using this valuable tool to help solve your measurement problems.

As with any instrument, the more familiar one is with the basic operating principles of the counter, the better he can put it to use. To this end, we've prepared a review of basic counting principles and the common types of counters in use today.

BASIC COUNTER FUNCTIONS

Although there are many types of counters, all are basically designed to measure an unknown frequency or time by comparing it with a known frequency or time. Design differences account for variations in such areas as price, accuracy, and number of measurement modes. We will use the direct counting type of counter as a basis for our discussion of basic counter functions. Other types of counters will be mentioned later in the article.

In addition to a power supply and necessary switching circuitry, five main functions are essential to any counter. As shown in Figure 1 these are:

(1) Signal input conditioner
(2) Gate
(3) Gate control/Time base
(4) Decimal counting units (DCU's)
(5) Readout

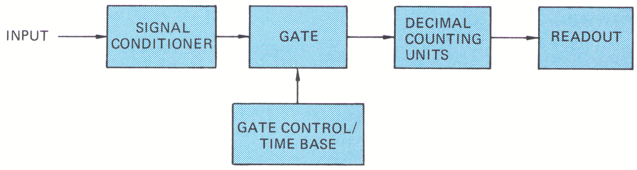


Fig. 1. Five main functions of an electronic counter.

The incoming signal to be counted, in going through the signal conditioner stage, receives the normal conditioning typical with any input stage: attenuation for large signals, amplification for weak signals, selection of coupling, impedance matching and so forth. But in addition to normal signal processing, the counter signal conditioner has another purpose; to transform the measured signal's waveform into a precisely shaped signal suitable for further counter functions. The conditioner, therefore, may also be referred to as a "shaper". The need for signal shaping arises from the fact that input signals, with varying shapes and amplitudes, are not suitable to drive the counting circuits.

Signal shaping is usually done with a Schmitt trigger circuit. Inherent with this Schmitt is a LEVEL/SLOPE control that selects the amplitude and slope on the signal where the counter is triggered. This control is much like that found on the conventional scope.

The conditioned signal is next passed through a gate for a time interval determined by another function—the Gate Control/Time Base. The gate is a "go/no go" device. How it is turned on and off via the control stage is basically determined by the operating mode. More will be said about the gate and its control later in the operating mode discussion.

Signal pulses from the gate, having been determined by the counting mode, are fed to the decimal counting units (DCU's). Here they are converted into a signal suitable to drive the readout. DCU's are usually flip-flops arranged to divide their input by 10; they drive the readout in binary coded decimal (BCD) form. The first DCU gives the "units" count, the second DCU, the "tens" count and so forth. And, as would be expected, the number of DCU's, as well as readout capacity, determines the magnitude of the displayed count. For example, eight DCU's and a corresponding number of readout units would give an 8-digit readout.

Readout, the last of the counter stages, provides a visual indication of the count. Typical readout devices include neon lamps, incandescent lamps, light emitting diodes, gas ionization tubes, and multi-segment/bar indicators. With the 7D14, readout is provided by the unique oscilloscope CRT readout. CRT readout gives an alphanumeric display of information on the CRT on a time-shared basis along with the analog waveform.

MODES OF OPERATION

The electronic counter is most often thought of as a device that totalizes (counts) input events. But this operation, in the totalize mode, is only one of seven common modes. A counter can also indicate an input signal's frequency or period, in frequency and period modes. It can compare two signals in the ratio mode. It can indicate the time between any two points on a waveform; when they represent an input signal's pulse width, the counter would be in a width mode. And

SERVICE SCOPE

A POTPOURRI OF SERVICING AIDS

By Charles Phillips
Factory Service Technician

Having the right tool for the job often makes the difference between a time-consuming frustrating task and a job quickly and expertly done. We would like to share with you some of the tools and other aids we find especially useful in our factory service center.

Thermal Shock Tools

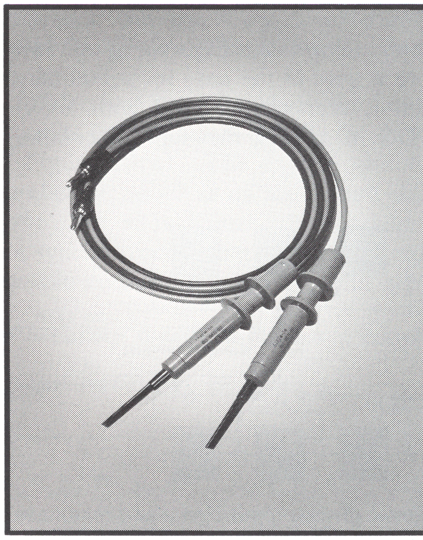
In a previous issue we discussed using circuit cooler and a hair dryer as aids in locating intermittent or temperature sensitive components and connections. These tools will usually get you to the general area of the trouble, but the heat or coolant is applied over too large an area to identify the specific component. You can cool individual components by spraying a cotton swab with coolant and applying the tip of the swab to the suspect component. Conversely, you can heat individual components by applying the tip of a small (15 watt) soldering iron directly to the component. The soldering iron should be unplugged to prevent damage to the component caused by leakage voltage from the iron.

Incidentally, in selecting a spray coolant, choose one with a temperature rating of —50°C such as Miller-Stephenson MS-240. Coolants going down to —70°C may cause stress cracks to occur in the Polyphenylene Oxide (PPO) boards used in the vertical attenuator area. These boards are translucent in appearance and were selected for their extremely low dielectric loss.

Test Leads and Cables

Test leads are like neckties in some respects. We usually have a lot of them hanging on the hook but find ourselves using a select few time after time while the rest just hang there in some degree of disarray. Here are some leads we've found to be especially useful.

Pictured at upper right is a hybrid set of test leads consisting of Triplett or (Simpson) meter leads with Tektronix probe tips installed on the probing end. These are handy to connect onto closely spaced components without shorting between them.



The photo at right shows what you will need, in addition to the basic meter leads, to build them. The small rubber grommet serves to hold the lead securely in the probe body when the rear set screw is tightened.

To facilitate fastening the stranded lead to the nose portion of the probe body, solder a short piece of solid wire to the lead (a straightened standard paper clip works well). This simplifies threading the lead through the probe body and provides a good solid contact against which to tighten the forward set screw. Clip off the excess solid wire protruding from the probe nose. All of the needed parts may be ordered from your Tektronix Field Office using the part numbers shown in the photo.