MEASUREMENT TIPS
Volume 11, Number 2

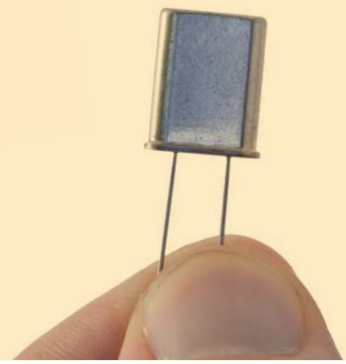
Make Faster Frequency Measurements with Your Universal Counter

Introduction

Whether you use your universal counter on the bench or in an automated test system, you want to get your data as fast as possible. There are several things you can do to accelerate the process of getting the data you want. Today's counters help you gain faster insight into your designs and get faster test results on the bench with capabilities such as front-panel display of histograms and trend charts. Increased bus speed improves test system throughput, and built-in features deliver more digits of resolution in less time. Faster frequency and time measurements are important in a diverse set of application areas such as crystal oscillator design and test, ceramic resonator test, data communications system test, and radar verification test. This measurement brief covers some of the techniques you can use to speed up the frequency and time measurements you make with a universal counter.

Snapshot: Testing crystal oscillators

A well-established crystal oscillator manufacturer was looking to expand its product line and wanted to increase test throughput. The manufacturer had many test stations, each containing multiple single-channel counters. By using Agilent Technologies' 53230A universal frequency counters/timers with two channels per counter, test engineers were able to more than double their test throughput per test station by performing parallel tests using two channels per counter instead of just a single channel. They made additional throughput improvements by choosing the shortest gate time possible that still gave them the number of digits they wanted and by using appropriate settings for auto-leveling, the front panel display, and data transfer.



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Gain faster insight with bench-top measurements

When using a counter on the bench, you want to be sure you have chosen the correct settings for the signal you are trying to measure. Seeing information about the signal displayed right on the front panel of the counter can increase your confidence that your measurement settings are correct. For example, peak-to-peak, minimum, and maximum voltage of the input signal displayed on your counter's front-panel display can help you correctly choose the input range and trigger levels.

Even more helpful are the front-panel charts you can use to display your measured data. These features are available on the Agilent 53200A Series universal frequency counters/timers. For example, the Agilent 53230A gives you a choice between a trend chart and a histogram. The trend chart shows how the measured data changes over time and the histogram shows how the data is distributed. The trend chart can help you quickly identify a drifting signal by showing you the direction and magnitude of drift. It also gives you information about how quickly the drift is occurring. See **Figure 1**.

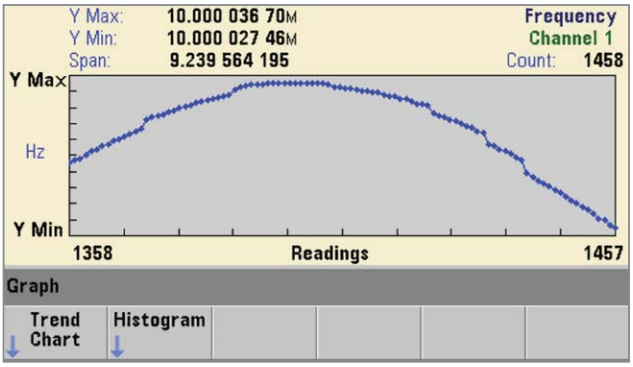

FIGURE 1: Trend chart on a 53230A

The histogram is useful to show you the distribution of a noisy signal. A Gaussian distribution might mean that the noise is as you would expect, meaning your measurements are normal. If the distribution shows a higher percentage of measurements at a frequency you do not expect, you may have identified an unwanted modulation effect on your signal that you can then trace to its source. See **Figure 2**. If these graphing functions were not so readily available, you would be forced to first recognize that there was a potential problem, configure a test to acquire large amounts of data, bring the data back to a computer, and perform an analysis on the data. With all of that capability built into the counter, you will gain insight faster and save yourself some time when you use a counter on the bench.

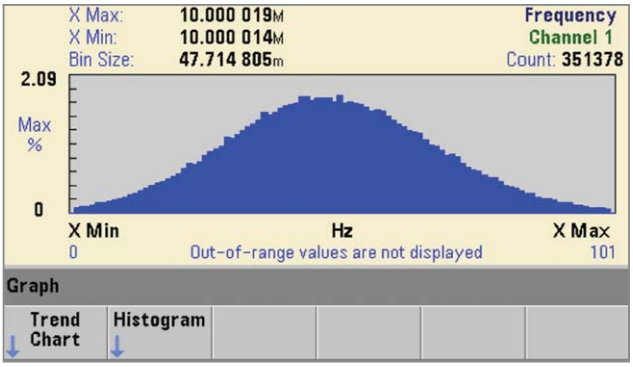

FIGURE 2: Histogram graph on a 53230A

Make faster system measurements

When you use a counter in an automatic test system, the total time it takes to get a reading consists of two major components: bus transaction time and measurement time. Bus transaction time also can be broken into two parts: the time required for the commands to configure a measurement and the time required for the commands to bring the measurement back to the computer. Over the last few years, test instrument designers have made significant improvements in bus transaction times. Bus transaction speeds of the most recent Agilent counters are roughly 100 times faster than the previous generation of counters. Programming commands can be processed faster and measurements can be moved from the counter to the computer in less time.

With bus transaction times greatly reduced in the newest counters, the dominant factor in the speed of a frequency reading becomes the measurement time. There are a variety of things you can do to reduce your measurement times.

- **Choose the correct gate time**
  Perhaps the most obvious way to speed up your counter measurements is to use the lowest gate time setting that still produces the required number of digits of resolution for your test. Longer gate times produce more digits of resolution, but they clearly take more time. Modern reciprocal counters use techniques that can add digits of resolution without adding proportionally longer gate time. For example, if a counter has a 10-MHz reference oscillator, the reference alone produces 7 digits of resolution for a measurement time of 1 second. With the addition of resolution-enhancing techniques, a 10-MHz clock can produce up to 10 digits of resolution. So be sure to check the specifications of your counter and match your choice of gate time to your requirement for resolution.
- **Use the fastest interface**
  Some counters offer the flexibility of multiple interfaces to connect the counter to your PC. For example, the Agilent 53200A Series has LAN and USB as standard interfaces, and GPIB is offered as an option. If speed is critical in your application, be sure to select the fastest interface. Single measurement and block reading throughput rates are affected by your choice of interface. Refer to **Tables 1 and 2** for more information.

		Data transfer command	
		Using READ?	**Using *TRG;DATA:REM? 1, WAIT**
Interface Type	**LAN (VXI-11)**	150 readings/s	145 readings/s
	LAN	210 readings/s	350 readings/s
	USB	210 readings/s	380 readings/s
	GPIB	240 readings/s	400 readings/s

TABLE 1: Single measurement throughput rates for an Agilent 53230A based on interface type and data transfer command

		Data transfer command	
		Using READ?	Using *TRG;DATA:REM? 1, WAIT
Interface Type	LAN (VXI-11)	9,800 readings/s	48,000 readings/s
	LAN	10,500 readings/s	66,500 readings/s
	USB	10,900 readings/s	66,500 readings/s
	GPIB	4,800 readings/s	17,200 readings/s

TABLE 2: Block reading throughput rates for an Agilent 53230A based on interface type and data transfer command

- **Choose the right command to transfer data back to your PC**
  Your counter may provide you with more than one way to read data back to the PC. These different methods may have different data transfer rates associated with them. As you can see from Tables 1 and 2 showing 53230A throughput rates, the data transfer command has an impact on the reading rate. So, if you are making a significant number of readings and want to minimize the total time, be sure to choose the fastest method for transferring data to your PC.
- **Turn off auto-level**
  Auto-level is a feature that automatically determines the trigger level to be used on your measurement. The counter looks at the input signal, measures the maximum and minimum voltages, calculates the peak-to-peak voltage from those measurements, and sets the trigger level to 50% of the peak-to-peak value. Of course, this takes time. To eliminate the time it takes to automatically find a trigger level, you can set the trigger level yourself if you have information about your signal. Turn off auto-level and set the trigger to the desired value.

MEASUREMENT TIP

You can set auto-level to "ONCE". This setting will cause the counter to perform an auto-leveling function once, and then it will disable the auto-leveling feature. This is useful when you don't know the trigger setting you want for a measurement, but you plan to leave the setting unchanged once it is determined. The counter will determine the setting and subsequently use it for additional measurements. You will save time by auto-leveling only once.

- **Turn off the front-panel display**
  Turning off the front-panel display of some instruments can help speed up measurements. The internal microprocessors must divide their time between making measurements, handling bus transactions, and providing information to the front-panel display. If the display is turned off, the processor can spend all of its time on making the measurement and processing the data. For example, with the front-panel display turned on, the Agilent 53230A counter can perform 75,000 frequency measurements and store them in internal memory in 1.35 seconds. With the display turned off, the counter can perform the same transaction in 1.22 seconds. Since measurement time is essentially determined by the selected gate time, that portion of the transaction is not affected by the state of the display. However, the counter has to internally process the measurements and store them in memory. These functions share time with the internal microprocessor that is servicing the front-panel display, so turning the display off will speed up the data processing.

MEASUREMENT TIP

To reduce overall measurement time, if possible, group like measurements together. For example, perform all frequency measurements and then all period measurements instead of changing from one measurement type to another, and minimize range and level changes. Changing a measurement configuration takes time -- typically 50 ms for 53200A Series counters.

Conclusion

Whether you are using your universal counter for measurements on the bench or in an automated test system, you can choose counter features and use various techniques to reduce your time to insight and total test time. On the bench, improvements in time to insight come from using a counter with helpful front-panel display features such as information about the input signal voltage and triggering. Trend charts and histograms displayed right on the front panel will also help you quickly understand the measurements you make. You can make system measurements faster by choosing the proper interface and data transfer method, as well as choosing appropriate settings for parameters such as gate time, auto-leveling, and the front-panel display. If you frequently need to make frequency measurements, you can count on Agilent counters to provide you with fast, stable, and accurate measurements.

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