# Tips to Reduce RF Measurement Time

If you've ever configured an automated RF measurement system, you likely have faced the dilemma of trying to improve measurement speed. Measurement speed is a critical component of the overall performance and productivity of your RF automated test systems. Software-defined RF instrumentation PXI can assist you in significantly lowering your RF measurement times. Most software-defined RF instruments typically perform measurements five to 10 times faster than their traditional instrument counterparts. By examining the key factors that affect RF measurement time, you can increase the performance of your RF measurement systems using traditional or PXI-based RF instruments.

## From RF Signal Input to Measurement Result

A typical software-defined RF measurement system consists of a PXI RF signal analyzer and a PXI chassis and controller. While the analyzer-only system is the simplest configuration, many PXI RF measurement systems contain additional modules for RF signal generation and mixed-signal or DC input and output. Figure 1 illustrates the block diagram of a basic PXI RF signal analyzer.

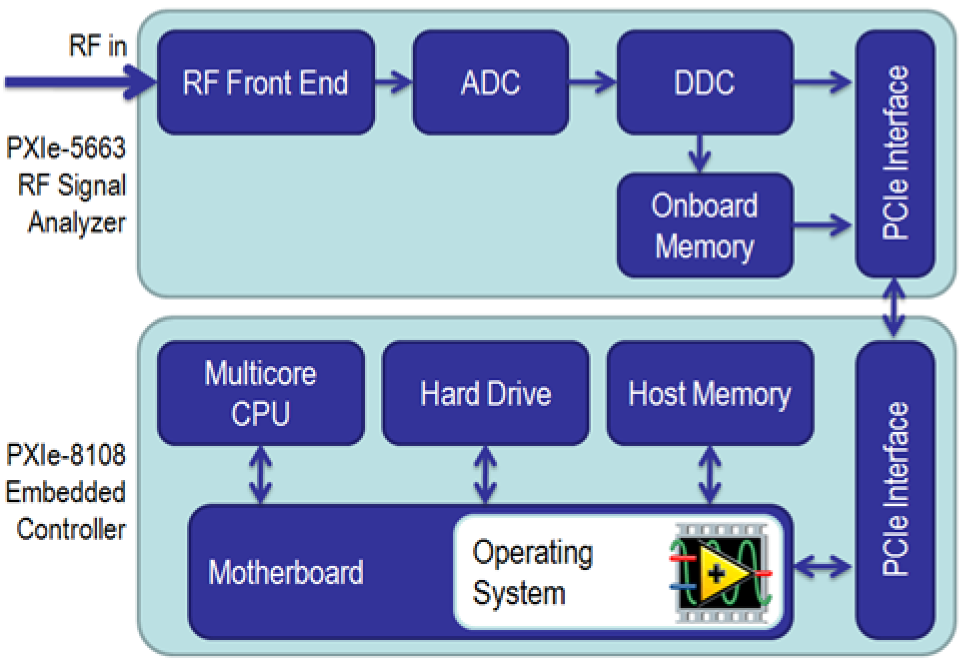


**Figure 1.** System Configuration

In a typical RF measurement system, the measurement begins when an RF vector signal analyzer such as the [NI PXIe-5663](#) 6.6 GHz analyzer begins to acquire the I/Q samples. Once acquired, these samples are processed in the analyzer's digital downconverter (DDC) before being stored in onboard memory. A PXI controller then fetches I/Q samples from the vector signal analyzer's onboard memory through a PCI or PCI Express data bus. When the I/Q samples are in the host controller's memory, a software-defined measurement algorithm produces the measurement result. Simply by using a different measurement algorithm, PC-based measurement systems can compute a wide range of time and frequency domain measurements including power, frequency, spectral mask margin, error vector magnitude (EVM), and many others.

Now that you have reviewed the process of performing an RF measurement, consider the primary contributors to measurement time in each of the three stages of the RF measurement process:

Stage 1: Acquire I/Q samples

Stage 2: Transfer I/Q samples to host PC

Stage 3: Perform measurement algorithm

This scenario uses a typical RF spectral measurement based on a 50 MHz frequency span and a 30 KHz resolution bandwidth (RBW) to evaluate the factors affecting measurement speed in each of the three stages. Note that the same basic three steps apply to both PXI instruments and traditional RF vector signal analyzers. In many ways, the process of producing a measurement result is the same for both types of instruments. The biggest difference is that with traditional instruments, a fourth step is required for the measurement result to be transferred (via GPIB, USB, or LAN) to the controlling PC. Breaking down these steps to learn what really goes on in an instrument helps you better understand the factors that affect measurement speed.

In stage 1, driver latency and the signal analyzer's internal firmware are the biggest sources of delay. Because each of these is a minor contributor to measurement time, a typical NI PXIe-5663 RF vector signal analyzer is capable of producing I/Q samples within 30 to 40 µs of the time that the acquisition was initiated in software.

In step 2, data bus bandwidth is the biggest contributor to measurement delays. With a PXI Express analyzer such as the NI PXIe-5663, you can transfer 2,000 samples (enough for a 50 MHz span, 30 kHz RBW) in approximately 50 µs.

Step 3, which involves the execution of the measurement algorithm, is fundamentally the largest contributor to overall measurement time. One way to evaluate the influence of signal processing time is to compare the results from steps 1 and 2 to the overall measurement time. Using an 2.53 GHz Dual-Core PXI controller, you can typically perform the 50 MHz spectral mask measurement (30 kHz RBW) in 2.8 ms. Given that steps 1 and 2 in the measurement process add up to a maximum of 90 µs, note that for this specific example, signal processing accounts for 97 percent (or more than 2.71 ms) of the total measurement time.

From the results of steps 1 through 3, you can clearly determine that the biggest bottleneck to faster measurement times is processing capability. Thus, to optimize your measurement system for faster results, you need to choose the most capable CPU available. This is an obvious contrast to traditional instruments, where the processing engine, usually a CPU or digital signal processor, is predetermined by the instrument vendor and cannot be upgraded over time.

## Making Spectral Measurements Faster

Experimentally, you can validate that signal processing time is the measurement time bottleneck by observing the effect of the CPU on overall measurement time. If the calculations from steps 1 through 3 are correct, measurement time should improve when you use a more powerful host PC (CPU). In addition, observe that more computationally intensive measurements take longer to compute. The results in Figure 2 demonstrate both relationships. Figure 2 shows the measurement time of an NI PXIe-5663 RF vector signal analyzer versus resolution bandwidth and PXI controller.

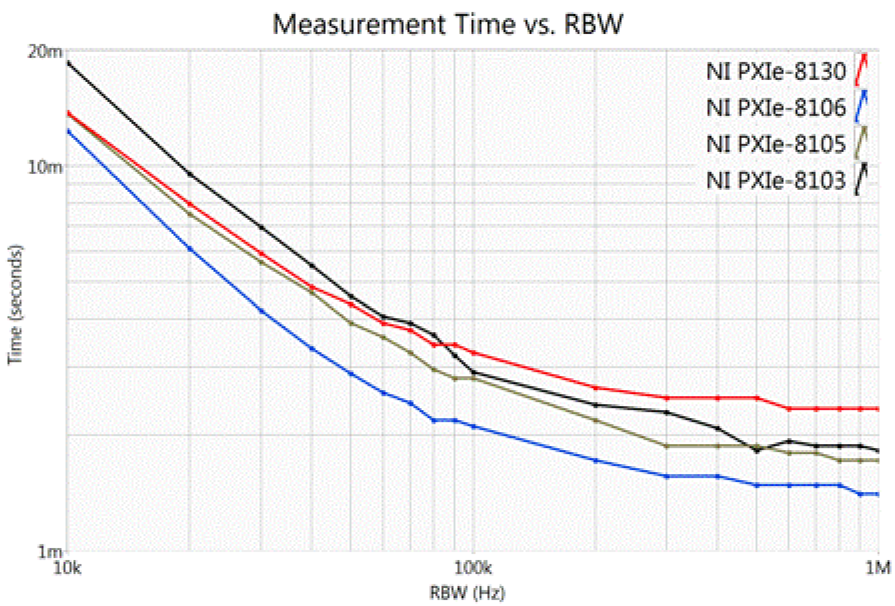


**Figure 2.** *Comparison of CPU Type vs Measurement Time.*

As you can see in Figure 2, measurements with a lower-resolution bandwidth – which are more computationally intensive – take significantly longer to perform than measurements with a higher-resolution bandwidth. For example, with the NI PXIe-8108 controller, decreasing the resolution bandwidth from 100 to 10 kHz increases measurement time by a factor of seven. You also see in Figure 2 that the type of CPU significantly affects measurement time. For example, consider the performance improvement when switching from an NI PXIe-8106 to an NI PXIe-8108 controller. While each controller features a similar Intel CPU architecture, one key difference between the two is clock speed. The NI PXIe-8108 operates at 2.53 GHz versus the clock speed of 2.16 GHz for the NI PXIe-8106. As Figure 2 shows, measurements performed with the faster PXI controller are anywhere from 30 to 40 percent faster than the next closest CPU. For example, with a 30 kHz RBW, measurement time decreases from just over 4 to 2.8 ms (a decrease of 30 percent) simply by using a faster CPU.

It should also be noted that a traditional RF spectrum analyzer typically takes significantly longer than either PXI system to perform a similar measurement. In fact, the same 30 MHz measurement span (30 kHz RBW) typically takes tens to hundreds of milliseconds longer with a traditional analyzer whereas these same measurements can be anywhere from 10 to 20 times faster with a PXI implementation, depending on the CPU employed.

While many factors – from RBW to frequency span – affect RF measurement time, the easiest way to reduce measurement time without affecting measurement quality is to use the fastest CPU available. In fact, the availability of a high-performance CPU on a PXI measurement system is the main contributor to the speed of PXI measurements over traditional instrumentation.

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