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Using Today's Test Equipment: Suggestions for New Engineers

This tutorial is intended for new engineers and students who will be using modern test equipment, with measurement capabilities and operating convenience features not found in older instruments.

Today's test equipment includes an impressive array of features intended to make testing faster, easier and more accurate than before. This tutorial is directed to inexperienced engineers and engineering students. The suggestions listed here are intended to help them avoid problems and make the best use of modern instruments and the internal "intelligence" built into them.

1. Understand the Fundamentals of the Measurement Being Made

More than 20 years ago, setting test parameters was a manual process using the instruments' front-panel knobs. It was simply not possible to make measurements without knowing which settings were required for a given procedure. However, manual processes, particularly for a series of measurements over frequency, amplitude, etc., are extremely tedious, as any "old timer" will tell you!

Those manual setups then became semi-automated using a computer interface and instrument control software. Since this work was done in-house, defining the setup and programming the controller still required full knowledge of the process.

Today's instruments now have internally-programmed setups for typical test routines, particularly those used with various industry standards. With these preset routines, it is now possible to select the desired setup and run a series of tests without a full understanding of the process. Taking this shortcut is a good way to get bad data without realizing it!

It is much better to use these preset routines as a learning tool. After all, they were developed by the finest test engineers. Take the time to understand exactly how the preset test setups and automated measurements are defined and how they relate to the associated application or published standard.

2. Understand the Tradeoffs for Speed Versus Accuracy

Another valuable feature in the current generation of test instruments is enhanced measurement speed. This is a necessity for characterizing the device under test (DUT) over a range of parameters, such as frequency, amplitude, or with various types of impairment scenarios. Speed is valuable for both laboratory and production testing.

Speed enhancements are achieved in several different ways. Faster controllers and more responsive generation and detection circuitry are part of the solution. There are also a number of other methods, such as a variable number of measurement points, or applying different frequency or amplitude resolution to a portion of the sweep. These techniques are often combined, allowing fast measurement outside of critical frequency or amplitude ranges, while applying the slower full resolution measurements within the most important ranges.

When applied wisely, these methods are highly effective, but it is essential to understand how they are applied and what effect they have. For example, faster sweeps may have higher noise content, and too few measurement points can miss spurious responses. You must also know how they are utilized in preset measurement routines, so you can properly interpret the results.

3. Learn to Use Data Capture and Post-Processing Capabilities

The power of today's instruments can help you accomplish more from your measurements. An important feature is the ability to create a digital record of the results. Data can be compared to past results and/or saved as a reference for future measurements. Multiple measurements can be analyzed for statistical variations. Additional mathematical analysis can be performed on the collected measurement data using high frequency EDA software, math software, or custom routines. Some instruments have built-in Fast Fourier Transform (FFT) capability as part of their narrow bandwidth "digital IF" signal processing.

For many engineers, the ease of data capture and ability to apply any imaginable type of post-processing is one of the most important changes in test equipment design over the past several years. These functions have been available since the inception of computer control of instruments, but the increasing use of an internal PC —just like your desktop or laptop PC—as the controller for each instrument greatly simplifies saving, sharing and analyzing measurement results. Many models now include the keyboard, mouse and interface ports provided with any PC, directly supporting network connection and external peripherals such as a monitor for large-size display. Some even support direct operation via the Internet for remote operation or factory updates or troubleshooting.

An extension of this ease-of-interface is the support of instrument operation within major EDA software tools. Simulated waveforms can be downloaded to signal generators, while measurements from spectrum and network analyzers (and oscilloscopes or data analyzers) can be ported to the software. This ability to combine simulation and measurement can greatly improve the speed and reliability of product development.

4. Managing the Results

One result of increased test equipment capabilities, along with the continually increasing complexity of signal waveforms, is that a massive amount of data is generated from the testing process. Engineers now have the added task of organizing and indexing this data for both sharing and archiving.

The issue of complexity extends to the engineering team, each of whom may have responsibility for a different portion of the project. A single test sequence may involve anywhere from one person to the entire team, and even when only one member's contribution is being evaluated, the results are certain to affect the work of others.

After documentation and collaboration, there are likely to be reports generated for company management, or for submission to compliance agencies. All the collected information must be readily available and clearly identified, so any member of the team has ready access to the necessary data for his or her reports. Recordkeeping has evolved far beyond the traditional spiral-bound engineering notebook!

5. Low-Budget Test Equipment

Not every company has the latest instruments available to each member of the engineering staff. In every lab, there is usually some combination of new equipment, older equipment, and budget equipment with lower precision and fewer features.

Although older instruments may have few speed and flexibility enhancements, they are often a cost-effective means to get quality measurements. These units will usually have GPIB/IEEE-488 bus capability for computer control and data acquisition, and with proper driver software, measurements from these instruments can be effectively automated and collected for analysis and archiving.

The lowest priced instruments from both established and newer test equipment manufacturers are more accurate and more capable than ever. The same internal computing power that enables high-end equipment to reach new levels of performance and flexibility is being applied to the entire range of products. In some instruments, that computing power is moved to the user's PC, which saves the cost of an internal controller and display. These "virtual instruments" can be an economical option.

An engineer needs to understand the differences between these budget instruments and their top-of-the-line counterparts. What tradeoffs have been made in the basic signal generation or measurement engines? Which operating features have been omitted to cut costs? Does it require an external controller? Is the interface compatible with other instruments? Can the unit handle factory or user-generated "personalities" for compliance with important standards?

Summary

Obtaining accurate and reliable test results has always required close attention to setup and operation of the equipment, but today's high frequency test instruments have greater capabilities for control and data than their older counterparts. Understanding these new features is essential for obtaining trustworthy results.