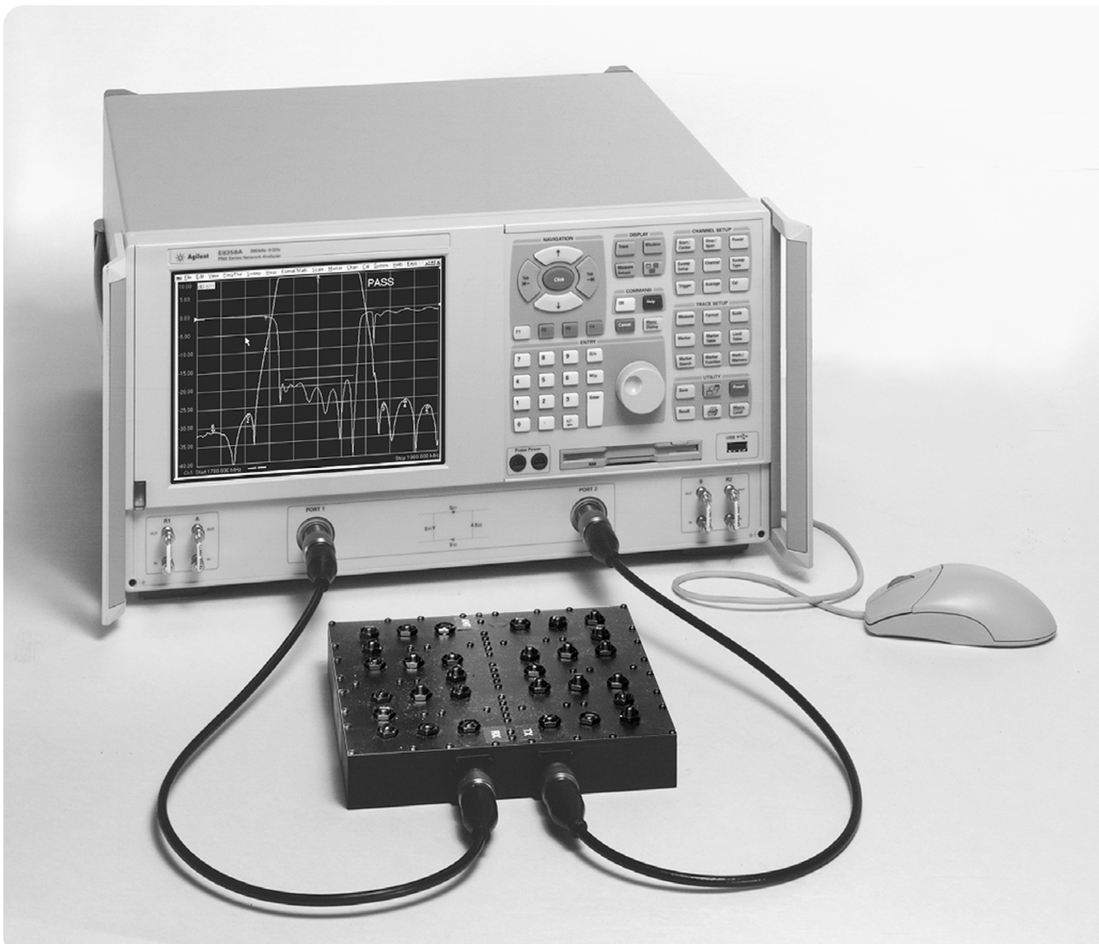
The 'Need for Speed' in Component Manufacturing Test

Product Note



Agilent Technologies

Innovating the HP Way

Introduction

The challenges that have driven the computer-components market for decades are now a reality for the wireless component industry. The explosion of demand for wireless services has driven RF component volumes to unprecedented levels. Manufacturers are being pressed to dramatically increase volume while improving quality and decreasing cost. This is being done in an environment of shortening design cycles, reducing the time available to develop new test processes for the manufacturing environment.

The problems are made worse given that most manufacturers are already running near capacity. For popular products, running additional shifts has already been used to meet existing demand. New demand means adding new production and test capacity. That involves additional floor space and additional staff. With a growing organization, these are in short supply.

Production test is often the bottleneck to increased capacity. Because tuning and test are in line with the manufacturing process, capacity problems there limit the entire production line. The challenge is to enable test to keep pace with the increasing demands of the marketplace.

The Agilent PNA Series has the potential to dramatically decrease test times and increase the capacity of manufacturing test. The improvements in performance are sufficient to directly impact the productivity of the entire manufacturing process. To realize this potential, it is important to understand the elements of test speed and how they impact capacity in component manufacturing.

Faster Sweep Times

Aside from eliminating unnecessary test, the simplest way to reduce test time is to improve measurement speed. The PNA Series of network analyzers can sweep 6 to 35 times faster than the 8753ES for comparable measurements. When the sweep speed is not limited by dynamic range considerations, it can provide over 80 trace updates per second.

Faster sweeps mean less time waiting for the analyzer to complete a measurement. It makes the analyzer much easier to use in tuning applications. In automated applications, speed will cut through a large volume of tests quickly. Speed reduces the time the product stays in the production process, reducing inventory and cost.

Using Improved Dynamic Range to Increase Measurement Speed

Measurement speed is often limited by noise in an instrument. For a given RF source power, to increase dynamic range the user must decrease the IF bandwidth. Trace noise drops as ten times the log of the IF bandwidth change. Increasing measurement dynamic range by 10 dB requires reducing the IF bandwidth by a factor of 10. Maximum sweep speed is inversely proportional to the IF bandwidth. Reducing the IF bandwidth by a factor of 10 increases the sweep time by approximately a factor of 10. Thus an instrument with a lower noise floor can be made to sweep much faster for a given dynamic range.

The inherent noise performance of the PNA Series of network analyzers is much better than the 8753. Measurements with the same dynamic range can be made using wider IF bandwidths which result in much faster sweep speeds. For example, measurements requiring 100 dB of instrument dynamic range can use the 35 KHz bandwidth on the PNA Series, instead of the 1 kHz bandwidth of the 8753. This results in sweeps that are 16 times faster. For measurements that require 120 dB of instrument dynamic range, the PNA Series is 35 times faster than the 8753. Sweeps that took 43 seconds on the 8753 only take 1.2 seconds on the PNA Series network analyzer.

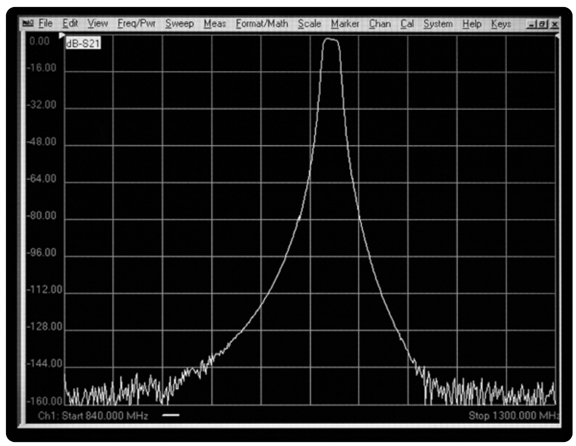


Figure 1.

Enabling Fast Calibrations

One of the most time consuming elements in component test is calibration. Traditional calibration methods using mechanical standards require numerous connections to the test ports for a single calibration. These processes require intensive operator interaction, which can be prone to error. The numerous connections also tend to wear out the test port connectors and the mechanical calibration standards.

Electronic calibration (ECal) is a precision, single-connection, one-or two-port calibration technique. ECal modules are fully traceable and verifiable electronic impedance standards. The modules are solid-state devices with programmable and highly repeatable impedance states. With ECal, a full two-port calibration can be accomplished in seconds with a single connection to the ECal module. The PNA Series features a calibration wizard, which controls the ECal module to help guide you through the calibration process. Control of the ECal module is provided through a single USB cable. This provides fast and repeatable calibrations, with less wear on connectors.

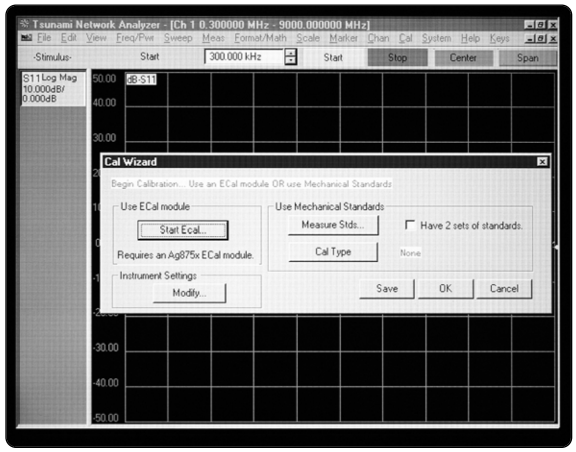


Figure 2.

Simple Calibrations for Non-Insertable Devices

Most common RF components are non-insertable devices; for example, devices with female connectors on both input and output ports. These devices require an adapter to connect to the network analyzer – which typically has a female connector on the input port. Most modern vector network analyzers provide an adapter removal technique, which compensates for adapter-caused errors. However, these techniques are complicated and time consuming. On the manufacturing floor, the errors introduced by adapters are often ignored with disastrous results.

ECal provides a simple solution for this problem. ECal modules are available with connectors that match your device. The adapter removal problem is dealt with when the ECal module is manufactured. The result is a simple, fast calibration process that provides accurate and reliable results.

When the device is non-insertable, because the input and output connectors are different, the PNA Series supports the use of different calibration kits for the various ports. For example, if the device uses a SMA connector on the input and an N-type connector on its output, the user would use a SMA calibration kit to calibrate the reference plane for S11 and an N-type kit to calibrate the reference plane for S22. The analyzer may also be used to characterize a through connection for the non-insertable device, providing a complete calibration solution.

Save Time by Using Internal Measurement Features

In manufacturing test, a lot of time is spent taking data that no one needs. A good way to improve test throughput is to only take the data that is required to verify device specifications. Devices tend to have specifications at either a single frequency point or clustered in bands. Sweeping only the frequencies that provide relevant data will directly reduce the measurement time. The segmented sweep feature in the PNA Series is ideal for this application.

Segmented sweep enables the break down of the linear sweep into non-sequential parts, in the network analyzer. Each segment may have different start/stop frequencies and instrument parameters to optimize the sweep time. Limit lines may be used in conjunction with segmented sweep to provide pass/fail testing.

Test time may be reduced by using the PNA Series multiple measurement channels. Within a single instrument state up to four measurement channels can be stored. Each measurement channel contains all the information to configure the instrument. Instead of recalling separate instrument states, one instrument state containing several measurement channels may be recalled. It is faster to change measurement channels than recall instrument states. Recalling only one instrument state for an entire production run, instead of several per device. When dealing with a large number of devices, the time saved can be very significant.

Using these ideas, a typical scenario for tuning a filter might go something like this. First, set up two measurement channels: one with a narrow span containing the passband of the filter and the other a segmented sweep to provide wide frequency coverage. Set up limit lines based on device specifications for both channels. With the narrow span channel, tune the filter to optimize flatness and group delay. The limit lines provide pass/fail feedback to the technician as the filter is tuned. Having aligned the filter, trigger the segmented sweep in the second instrument channel to verify the broadband specifications. Again, the limit lines provide pass/fail feedback to the technician. Save the performance data and ship the product.

Automation

While manual processes can be improved to increase throughput, there is a point where pushing buttons dominates test time. Depending upon the complexity of the device under test (DUT) and measurements, the introduction of automation on a component test line can easily double throughput. Complex processes tend to benefit more from automation than simple ones.

In addition to speed, automation provides other benefits. Reducing manual interaction with the test equipment tends to reduce errors. Processes that have been automated exhibit more consistency and control over time. Automated processes tend to exhibit less variation from operator to operator. Since automation enables the archival of measurement data, statistical quality control methods may be used to monitor and improve the manufacturing process.

The PNA Series provides several powerful alternatives to build automated test solutions. Built on top of the familiar Windows® 2000 operating system, the analyzer provides standard GPIB, LAN, serial, and parallel interfaces. The system may be controlled from an external workstation using familiar SCPI commands via the GPIB or LAN interface. An alternative may be to command the instrument through its COM/DCOM interface via the LAN interface or by developing executable files stored inside the analyzer. Programming examples using common languages such as Visual Basic, Visual C++, Agilent VEE, or LabView are available from Agilent. The freedom to choose the programming tool and interface enables quick solutions to capacity problems.

Data transfer time (ms)[a]

	Number of points			
	51	201	401	1601
SCPI over GPIB (program executed on external PC)[b]				
32-bit floating point	4	7	13	41
64-bit floating point	7	14	24	81
ASCII	25	98	189	804
SCPI over 10 Mbit/s LAN (program executed on external PC)[c]				
32-bit floating point	5	6	8	21
64-bit floating point	5	9	22	38
ASCII	18	53	98	362
SCPI over 100 Mbit/s LAN (program executed on external PC)[c]				
32-bit floating point	3	5	6	12
64-bit floating point	4	6	9	20
ASCII	17	51	92	339
SCPI (program executed in the analyzer)[d]				
32-bit floating point	2	3	4	7
64-bit floating point	4	5	6	15
ASCII	26	99	198	781
COM (program executed in the analyzer)[e]				
32-bit floating point[g]	1	1	1	2
Variant type[h]	1	3	4	19
DCOM over 10 Mbits/s LAN (program executed on external PC)[f]				
32-bit floating point[g]	2	3	5	14
Variant type[h]	5	14	26	100
DCOM over 100 Mbits/s LAN (program executed on external PC)[f]				
32-bit floating point[g]	2	2	2	4
Variant type[h]	3	5	9	35

a. Typical performance.
b. Measured using a VEE 5.0 program running on a 600 MHz HP Kayak, National Instruments™ GPIB card. Transferred complex S_{11} data, using "CALC:DATA? SDATA".
c. Measured using a VEE 5.0 program running on a 600 MHz HP Kayak. Transferred complex S_{11} data, using "CALC:DATA? SDATA". Speed dependent on LAN traffic, if connected to network.
d. Measured using a VEE 5.0 program running inside PNA Series analyzer. Transferred complex S_{11} data, using "CALC:DATA? SDATA".
e. Measured using a Visual Basic 6.0 program running inside PNA Series analyzer. Transferred complex S_{11} data.
f. Measured using a Visual Basic 6.0 program running on a 600 MHz HP Kayak. Transferred complex S_{11} data. Speed dependent on LAN traffic, if connected to network.
g. Used Iarray transfer (getComplex) for 32-bit floating point.
h. Used meas.GetData for Variant type.

Table 1.

Automation – continued

For the ultimate in speed, control the analyzer through its Common Object Model (COM) software interface. COM is the name of the specification for Microsoft's® basic object technology. The specification defines what it means to be a COM object and how a COM object is called. Following those specifications, the analyzer's firmware exposes many entry points that respond very fast to commands. The COM interface may be accessed directly from a program running on the analyzer or across the LAN. Working directly with COM bypasses the SCPI command parser, which provides faster performance. In some instances, COM-based programs execute the same instrument commands and data transfers up to five times faster than SCPI in the PNA Series of network analyzers.

COM is being developed into a standard for test and measurement applications. Common software development environments not only support COM, but also provide special tools to browse the interface and probe the syntax of the command set. Colleges are teaching engineers and computer science majors how to develop applications using COM. Local bookstores contain shelves of self-paced training material on the use of COM with Visual Basic and Visual C++. Both Agilent's VEE and National Instrument's LabView enable the use of COM objects within their environments. The IEEE is currently developing an instrument driver standard based on COM technology. The PNA Series of network analyzers is one of the first instruments to use this technology.

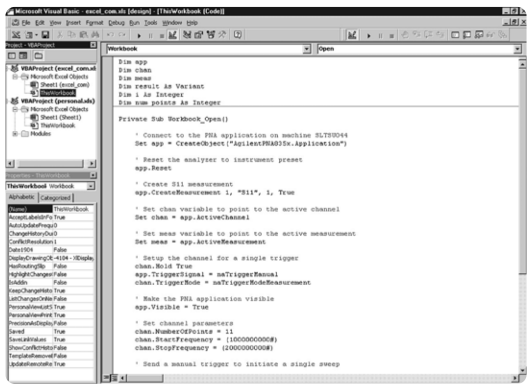


Figure 3.

Better Connectivity

In many production facilities, test stations are small islands of workflow. Test and alignment processes vary between technicians causing variations in the quality of the product. In some cases, problems are solved in isolation and learning within the organization is very slow. Resources such as printers are sometimes jealously guarded. Because the PNA Series of network analyzers is built on the Windows 2000 operating system, the synergy between measurement, computation, and communication has the potential to dramatically enhance productivity on the production floor and eliminate many of these problems.

Putting the analyzers on the local LAN enables information and resource sharing. Assume the analyzers will be networked together and the network will be connected to the Internet through a local gateway. Printers may be installed on the analyzers or servers and shared. Thus any analyzer or server can print to any printer enabling efficient resource sharing. Programs, test procedures, and troubleshooting guides may be posted in one location and made immediately available to every user. Measurement data may be directly saved on the central server, enabling DUT performance archival and statistical quality control applications.

Given that each analyzer supports Microsoft's Outlook Express, each operator will have access to email at his or her test station. This enables quick distribution of information on the floor. Schedule and process update notifications may be easily distributed. For production facilities operating over multiple shifts or remote locations, email becomes an easy way to share identification of problems and solutions. Easy access to email can make sharing information much more efficient and enhance communication within the organization.

Better Connectivity –continued

With Microsoft's Internet Explorer available on each analyzer's firmware, help-system updates and FAQs will be directly available from Agilent's web site. Product data sheets and instrument information will be available to download and print. The extensive built in help system provides a quick way to investigate the instrument capabilities and learn how to accomplish measurement tasks. Web based training will become available as the market for the service grows. The changes in how operators work and learn will transform manufacturing test, improving both efficiency and throughput.

Using the application Virtual Network Computing (VNC) by AT&T, remote control of the analyzer from any computer on the network can be achieved. The remote screen enables control of almost all features of the analyzer. With a fast network connection (10BaseT or better), trace updates are real-time and the human interface very responsive. This capability enables the remote troubleshooting of problems.

Final thoughts

Any computer that is used to process email or to accesses the Internet is susceptible to viruses. Precautions should be taken to protect the analyzer's operating system by installing and maintaining virus protection software.

All measurements of instrument speed were taken with the network analyzer as the primary application running on the internal computer. Running other programs on the internal computer while performing measurements may reduce the analyzers speed and throughput.

Summary

The PNA Series of network analyzers raises the bar in component manufacturing for throughput and productivity. The improvements in measurement speed and connectivity will enable manufacturers to meet the challenges of increased volume and reduced product cycle time. Profitable growth awaits those organizations that embrace the changes that will enable them to meet the market demands.

For more assistance with your test and measurement needs or to find your local Agilent office to to:

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Printed in U.S.A. 10/00
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