Agilent
Next Generation of WLAN Manufacturing Test Solutions

Application Note

Wireless LAN, or WLAN, is the fastest growing field in mobile communications. In the next few years, the majority of notebook computers and an increasing number of PCs, PDAs, cellphones, and other business enterprise products will be equipped with wireless technology. In recent years, IEEE 802.11b-based wireless networking has been an enormous success – its growth being fuelled by affordable Internet access at home and in the office. However, there is continued demand for higher capacity networks, with improved range and throughput. IEEE 802.11a and IEEE 802.11g technologies are well placed to meet these demands by providing higher data rates than 802.11b, with peak data rates up to 54 Mb/s compared to 11 Mb/s of 802.11b. The evolution of the standards has led to increased complexity of WLAN devices. These complex designs will require a more sophisticated and thorough manufacturing test methodology if performance expectations are to be met and the growth in dual band or multi-format devices is to continue in the marketplace.

This application note begins with a brief introduction to IEEE 802.11 technologies, followed by a description of the golden radio-based test system and its main limitations for WLAN manufacture. An overview of a system using an integrated test set follows, explaining the main differences and advantages over a golden radio-based approach.

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Introduction to WLAN

Wireless local area network (WLAN) is a system designed to transfer packets of digital data wirelessly and is basically an extension of the functionality of wired LAN. WLANs allow mobile computer users to connect to a network and access resources without being physically connected to the network.

Over the past few years, several different WLAN technologies and standards have been developed. The majority of devices being manufactured today are based on the IEEE 802.11 standards: 802.11a, 802.11b, and 802.11g.

There are various modulation schemes, data rates, and frequency ranges contained in the IEEE 802.11 WLAN standards, as summarized in the table below.

			Transmit scheme		**Modulation**			
IEEE standard	**Frequency band**	**Maximum data rate (Mb/s)**	**DSSS**	**OFDM**	**BPSK**	**QPSK**	**16QAM**	**64QAM**
802.11b	2.4 GHz	11			DIFF[1]	DIFF[1]		
802.11g	2.4 GHz	36 (Opt to 54)			DIFF[1]	DIFF[1]		
802.11a/h	5-6 GHz	36 (Opt to 54)						

1. DIFF = differential modulation encoding

These IEEE 802.11 systems use either direct sequence spread spectrum (DSSS) techniques or orthogonal frequency division multiplexing (OFDM) schemes.

There are also proprietary or region-specific schemes being employed for increased range or throughput. For example, 802.11j is being proposed in Japan to make use of unlicensed spectrum in the 4.9 to 5 GHz band, and contains channel and coding schemes intended to increase the range compared to the 802.11a/b/g standards.

IEEE 802.11b operates in the 2.4 GHz band and uses DSSS techniques to spread the energy in a single carrier over a wider spectrum. Two coding schemes are used in 802.11b to spread the spectrum of a single carrier. Complementary code keying (CCK) is mandatory, while packet binary convolutional coding (PBCC) is optional. CCK is used to increase the original 802.11 peak data rate to 11 Mb/s using DQPSK modulation. PBCC makes use of forward error correction to improve the link performance when noise is the limitation.

The 802.11g standard is an extension of the 802.11b standard. The 802.11g standard adds 802.11a OFDM transmission modes to the 802.11b standard. This provides the benefits of 802.11a throughput but in the 2.4 GHz band. In addition to the 802.11a OFDM modes, 802.11g also defines optional modes of increased throughput: PBCC utilizing 8PSK, and an optional CCK-OFDM mode, which combines the 802.11b preamble with an OFDM packet. The CCK-OFDM mode is rarely used in systems today.

802.11a operates in the 5 GHz band and, like 802.11g, uses OFDM as its transmission scheme. OFDM uses multiple carriers. For 802.11a there are 52 carriers in all, 48 of which are used to carry data and 4 that are used as pilots. 802.11h is an extension to the 802.11a standard to satisfy European regulatory requirements in the 5 to 6 GHz band.

The RF carriers in these schemes must be modulated. All the WLAN systems described here use fixed modulation formats for the preamble. Varying data rates are achieved by changing the modulation for the data transmission portion of a packet. Simpler modulation formats, such as BPSK, are often used in the early part of the burst. The burst area contains important information such as frequency and burst length, and is less prone to bit errors. 802.11b and 802.11g use (D)BPSK and (D)QPSK for data transmission. 802.11a/h and 802.11g OFDM modes map data symbols using BPSK and QPSK for lower data rates and quadrature amplitude modulation (QAM) schemes for faster bit rates.

For more detailed information on modulation schemes employed in WLAN standards, please refer to Application Note 1380-1 *RF Testing of Wireless LAN Products*.

Overview of WLAN Manufacturing

The manufacture of WLAN access points and network interface cards is largely performed by contract manufacturers (CMs) and original design manufacturers (ODMs). Maintaining a low cost-of-test, while delivering consistent performance in the WLAN radio, is very important to these CMs and ODMs. Some of the crucial factors in minimizing cost of test are:

- capital expenses for test equipment
- the number of different WLAN devices that can be tested on a system
- the number of passing devices under test (DUTs), or yield
- test system development and support (from getting tests up and running to calibration and maintenance)

For more detailed information on WLAN manufacturing test and processes, please refer to Application Note 1380-3 *802.11a/g Manufacturing Test – A Guide to Getting Started*.

WLAN Manufacturing Using Golden Radio-Based Systems

Many WLAN manufacturing test systems today use golden radio-based systems. A golden radio-based system comprises a known good, or "golden" WLAN radio, and typically a spectrum analyzer, power meter, and power supply. In addition, test control software is also required to put the DUT into proprietary test modes and to control the golden radio.

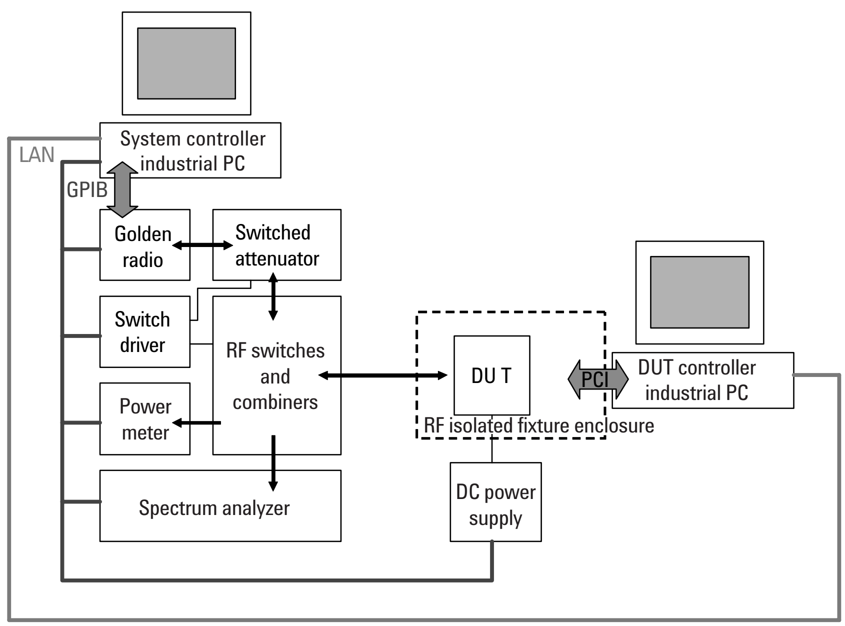


Figure 1. Golden radio-based manufacturing test system.

What is a golden radio?

The signal source and receiver for the system is provided by a golden radio. The golden radio is another WLAN device that is provided by the same manufacturer of the device to be tested. It is adapted to have the connections and test signals needed, and must be provided and supported by the chipset vendor. The golden radio is used to generate RF signals to test the DUT receiver, as well as to receive packets from the DUT. It must be contained in an RF-screened enclosure in order to give repeatable results. Power control for the golden radio is provided by a switched attenuator.

Two PCs are typically required in this system: one to control the golden radio and another to control the DUT and remaining system components.

The spectrum analyzer is the primary instrument for transmitter test and measures spectral mask and power levels. The power meter and sensor are used for total power measurement and calibration.

Although often viewed as an inexpensive test system in terms of capital expenditure, golden radio-based systems have some inherent problems that make them less suitable for dual-band/multi-format radios; namely they are proprietary, require a lot of system maintenance, and cannot measure EVM.

Golden radio-based test systems are specific to one WLAN chipset manufacturer

A golden radio-based system is inherently a proprietary system. It uses the same chipset/device as the DUT. The ODM and CM are reliant on the chipset vendor for support and the procedures required to calibrate, operate, and maintain these golden radio systems.

A production line that requires flexibility to test a variety of chipsets will need the same variety of golden radios and will need to be re-configured each time a different batch of chipsets comes through manufacturing.

Golden radio-based test systems can require a lot of maintenance

The amount of calibration required will depend on the performance of the golden radio, and on the associated RF cabling, attenuators, and combiners. The cost in engineering effort required to support these systems grows as the volume and variety of devices to be tested increases.

Golden-radio based test systems cannot measure EVM

The performance of 802.11b, which uses relatively simple modulation formats, is not extremely dependent on modulation quality. The data symbols can withstand quite a high degree of error before they lead to bit errors or packet errors. In low bit rate systems, degradation in transmitter performance typically shows up in the spectral mask before modulation accuracy test limits are reached.

With higher order formats used in 802.11a/g, such as 64QAM, modulation quality is more important. Error in the modulation can result in data symbols being misinterpreted and will ultimately lead to limited range or data throughput. For this reason, modulation accuracy testing is crucial for multi-format radios and the 802.11a/g specifications require testing the transmitter's modulation quality using error vector magnitude (EVM) measurements. EVM measures the difference between a modulated carrier and an ideal reference signal and is the measure of modulation accuracy used in the design and development of WLAN chipsets.

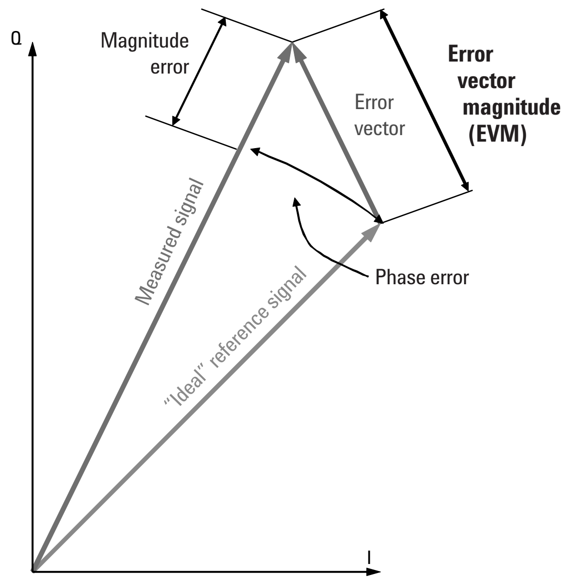


Figure 2. Error vector magnitude (EVM).

For dual-band or multi-format radios to interoperate successfully with other radios, the manufacturer must ensure that the transmitter quality is high, which means their EVM must be tested. The dilemma for cost-sensitive manufacturers has been that, until recently, the test equipment available in the market place to measure EVM over the wide bandwidths required for WLAN has been relatively expensive. Therefore, they have tried to adapt and extend the procedures used in their golden radio-based systems to test modulation quality.

Golden radio-based systems cannot measure EVM. Instead, they use a test called transmit packet error rate (TxPER). This test has a similar objective to EVM testing (to verify the quality of modulation on the transmitter). TxPER tests involve controlling the DUT to transmit a pre-determined stream of data packets and use the receiver in the golden radio to collect the data and check that the packet error rate (PER) has not been degraded with respect to the reference data. The problem with this approach is that it is vendor-specific and measurements can be difficult to reproduce with different golden radios. A change in the golden radio receiver performance can result in a different PER result, even though the transmitter performance is unchanged. This can lead to “false fails” in a production line (where a good device is failed), inconsistency between production lines, and variable production yields. These conditions present a significant challenge to manufacturers aiming to maintain predictable throughput and consistent product quality.

Golden radios cannot produce results consistent with measurements used in R&D

Before full volume manufacturing can start and after a design change, manual operation and debug is often needed in test system development to ensure the device is performing as expected. The results from a golden radio are not directly comparable with those from standard test equipment used in R&D or Qualification, making problem resolution more time consuming.

WLAN Manufacturing Using an Integrated Test Set

As an alternative to golden radio-based test systems, Agilent offers a cost effective, flexible integrated test set with the bandwidth required for measuring EVM. This integrated wideband test set for WLAN manufacturing systems facilitates the testing of chipsets from multiple vendors and provides higher quality and performance than the golden radio-based systems that are prevalent today.

In this system, the function of the golden radio, power meter, spectrum analyzer, and the associated cabling and RF switching are all integrated into one instrument, the N4010A wireless connectivity test set. This test set greatly reduces the complexity of the system, and overcomes the limitations associated with golden radio-based systems.

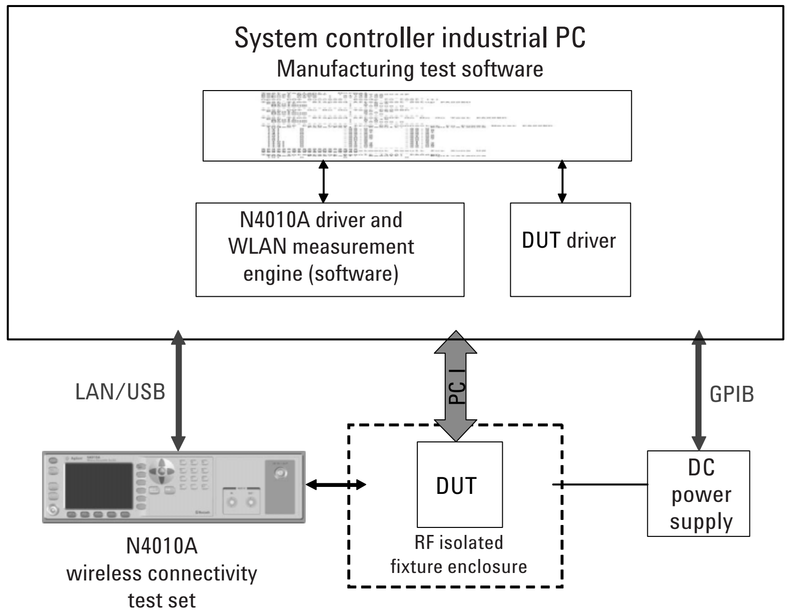


Figure 3. Integrated WLAN test set manufacturing system.

The N4010A wireless connectivity test set (with WLAN Options 102/103) consists of a programmable vector signal generator and wideband receiver with near power meter accuracy. The excellent RF performance of the test set removes the need for power meters and sensors that were traditionally used in golden radio-based systems.

The internal vector signal generator produces the data patterns to test the DUT receiver and can be programmed to emulate a variety of signals, thereby providing an extremely flexible stimulus for receiver test.

The wideband receiver (22 MHz digitizer) enables accurate capture of the transmitted signal during calibration and final test, with the WLAN measurement engine and driver calculating and reporting transmitter performance.

This system requires only one PC, which hosts the DUT control software, the N4010A driver, and WLAN measurement engine. The fixture for RF isolation will usually still be required. A DC power supply is included in the test system to carry out transmit and receive current tests.

Benefits of a programmable vector signal generator

Having a programmable vector signal generator means the same signal generator can be used to generate any test sequence so it is not tied to the proprietary sequences of the golden radio. This independence makes the test set adaptable to many chipsets and means it can replace a number of golden radios.

Flexible signal generation is an extremely powerful tool. For example, it would be possible to create a signal that includes impairments to test the receiver operation under non-ideal conditions. This capability is ideal for design verification, module integration, and interoperability testing and creates the opportunity for more effective manufacturing test.

Benefits of a wideband receiver

The 22 MHz wideband receiver in the integrated test set has the benefit of being able to capture an entire 802.11a, b, or g channel. This means that the system is guaranteed to measure any distortions, roll-off across the channel, or unwanted spurious signals that will affect the performance of the DUT.

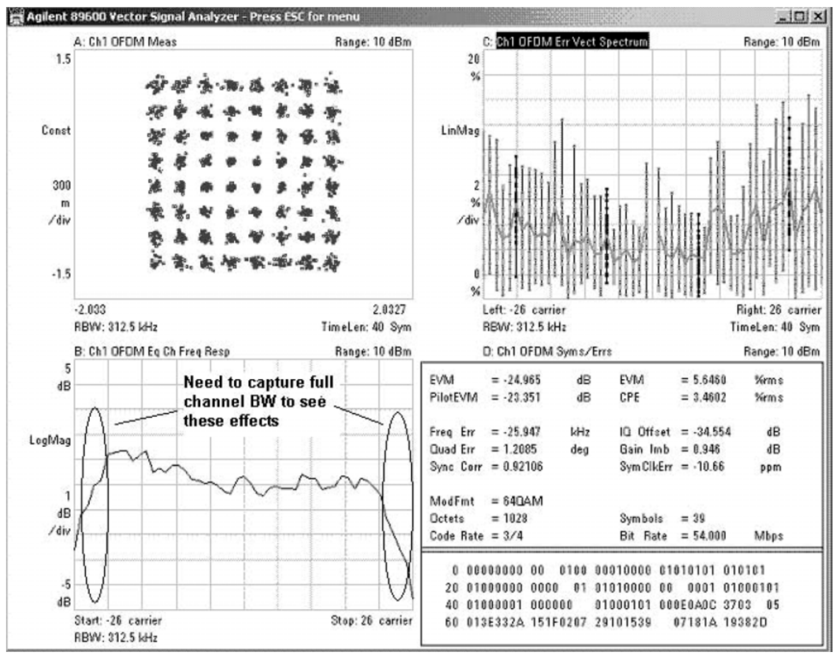


Figure 4. Using full channel bandwidth to measure WLAN.

The measurements shown above, taken on a real DUT using the N4010A test set and the 89601A vector signal analysis software, demonstrate that in order to see the full characteristics of the WLAN signal, the entire channel must be captured. Using a more restricted bandwidth would mean that the effects of distortion or power versus time characteristics (such as compression) could not be captured and diagnosed.

The wideband receiver in the wireless connectivity test set allows actual “bursted” WLAN signals to be used in production. Evaluating the DUT using signals with power versus time characteristics, or with the device switching between Tx and Rx paths, gives a true assessment of the DUT’s performance in real operating conditions.

The N4010A test set can also be used with the 89601A vector signal analysis software to analyze and troubleshoot a wide variety of signal formats and conditions. The 89601A adds flexible digital demodulation and transmitter analysis to the core capabilities of the N4010A wireless connectivity test set

Measurements available in an integrated test system

A system using the integrated test set can make the following measurements:

Transmitter measurements	
	Modulation accuracy/Constellation error (EVM)
	Output power
	Spectrum mask
	Center frequency tolerance
	Spectral flatness
	Carrier suppression
	Center frequency leakage
	Antenna diversity
	Transmit mode current[1]
Receiver measurements	
	Sensitivity
	RSSI calibration
	Antenna diversity
	Sleep mode current[1]
	Receive mode current[1]

1. Current measurements made using DMM/PSU in test system

Figure 5. WLAN tests covered with integrated test system.

Comparison of an Integrated Test Set and Golden Radio-Based Systems

There are several differences between measurements made using a golden radio-based system and those made using the integrated test system.

Transmit modulation accuracy: EVM versus PER

As described in the first section, EVM is a critical transmitter quality measurement used to ensure that dual-band or multi-format radios will interoperate successfully with other radios. However, until recently, the test equipment available in the market place to measure EVM over the wide bandwidths required for WLAN has been relatively expensive. Therefore, manufacturers have used transmit packet error rate (TxPER) in their golden radio-based systems to test modulation quality. TxPER tests involve controlling the DUT to transmit a pre-determined stream of data packets and use the receiver in the golden radio to collect the data and compare it to the reference data packets to check that the packet error rate (PER) has not been degraded. A packet error is reported when the WLAN receiver fails to correct all the errors it sees in the incoming signal.

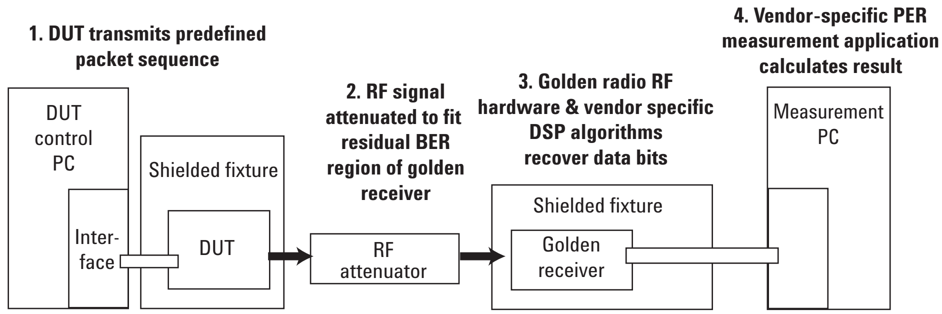


Figure 6. Measuring transmit packet error rate.

PER only indicates an error somewhere in the communications link; it does not give information on burst errors versus individual bit errors. A consequence of this is that in order to have high confidence in the results, many packets should be analyzed for low PER. This can lead to long test times.

PER also is used as a semi-functional go/no-go check. EVM does not provide this end-to-end functional test, however, Rx PER results obtained during the Rx sensitivity test could be used for go/no-go checking.

EVM is designed to measure modulation quality. It is an industry-proven measurement. The N4010A test set uses the techniques pioneered in the 89601A vector signal analysis software for WLAN EVM measurements. This measure of transmitter modulation quality also gives a sense of how well a receiver is able to receive and interpret the signal. Overall, low EVM is correlated with a low bit error rate (BER). Degradation of the transmitter EVM will cause more errors at the receiver leading to interoperability and quality of service problems.

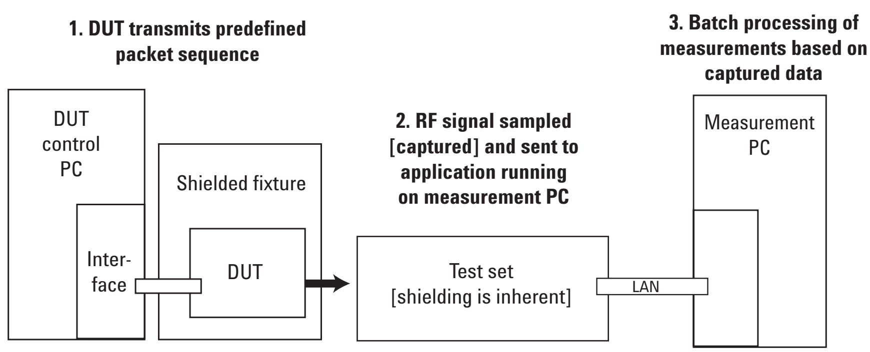


Figure 7. Measuring transmitter EVM.

EVM is a more predictable measurement than PER for modulation quality. Figure 8 shows measurements taken from an 802.11g device (54 Mbps, 64QAM, OFDM signal). As the power level and distortion, of the DUT output signal is increased, TxPER changes very abruptly from a relatively low level to a high level. EVM changes more linearly and is, therefore, more predictable to use in production test.

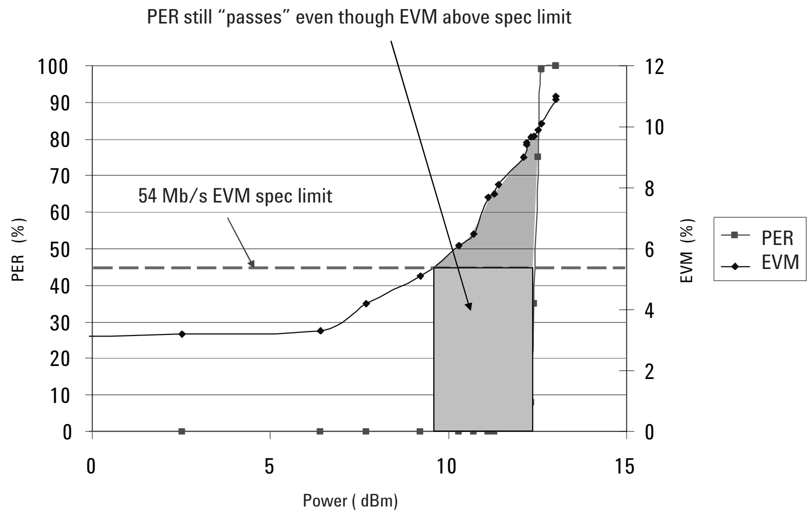


Figure 8. Characteristics of Tx PER and EVM versus power level from an 802.11g WLAN device.

The IEEE 802.11 standard specifies that the relative constellation error for 54 Mb/s data rates should not exceed –25 dB. This equates to an EVM reading of ~5.6 percent. Note from the plot above that even when the EVM limit of 5.6 percent is exceeded, the PER is still very low. If PER is used to determine transmitter quality, the test system simply may not detect devices that fail specification. This could lead to interoperability and quality of service problems.

EVM measurements will become increasing important in the calibration process

WLAN devices require calibration over various power levels, frequency channels, and bit rates, which is the most time consuming part of the manufacturing process. The calibration step primarily involves calibrating the power amplifier (PA) in the DUT by adjusting the output power either to a specified absolute level, or until a maximum allowable level of distortion is reached.

In golden radio-based systems this distortion measurement usually entails increasing the power level of the DUT until some characteristic of the transmitted signal, such as the spectral side-lobes, reaches a pre-determined limit. Because this test method is generally less accurate and predictable than a direct measure of EVM, particularly for higher bit rate 802.11a/g systems, the power level usually has to be "backed off" from the maximum level. While this ensures the device operates satisfactorily, it does not optimize the device's performance.

With the integrated test set, power, and EVM, along with other measurements such as IQ offset and frequency error, the signal can be measured in one data capture providing a quick and accurate measure of the transmitter performance. This improvement in accuracy and repeatability means that the full range of the DUT amplifier can be used and the quality of transmissions can be optimized. High accuracy and repeatability also results in lower measurement uncertainty. This means that guard bands on test limits can be lowered leading to higher production yields.

The following table summarizes the main differences between PER and EVM.

	TxPER	Tx EVM
Test objective	1. DUT modulation OK 2. Semi-functional check	1. DUT modulation OK 2. Interoperability
Feedback from results	No information on individual bit errors from packets that do not fail. Need to capture many packets to avoid undue measurement variation	Every burst gives performance data. In some cases, one or two bursts give sufficient information
Industry-wide support	Results are vendor-specific and depend on the performance of the golden radio	Result that gives consistency across designs

Measuring EVM in production also means that it is easier to correlate modulation accuracy measurements across production lines and production sites, and measurements will be consistent with those made in the R&D lab during the design stage of the module.

Spectrum emissions mask test

The spectrum emissions test or spectral mask test specifies that the transmitted signal does not exceed a specified spectral mask. The spectral mask is relative to the maximum power spectral density in the region of the center frequency ±9 MHz (i.e. in the occupied channel). The mask specifies power limits up to ±30 MHz away from the central frequency carrier. This test is usually carried out on three frequency channels: for example at high, medium, and low frequencies in the band. When calibrating a WLAN device, a number of vendors recommend increasing the transmit power until either the spectrum mask limit or, for higher order modulation formats like 64QAM, the EVM limit is reached

In golden radio-based systems, a spectrum analyzer is used to sweep across the frequency channel and two adjacent channels (i.e. a 60 MHz sweep) and measure the power of the main lobe and the first and second side lobes. The DUT output power level is then adjusted to ensure the side lobe power levels do not exceed a predetermined limit. The integrated test set uses wideband capture and frequency-selective power measurements for in-band and adjacent channel measurements – it does not use a swept measurement.

For the spectral mask test, the tester captures the center channel and makes two additional captures (one higher and one lower than the central band), resulting in a 60 MHz span. Having measured the power level at the center frequency and two adjacent channels, the test set can then determine if the first and second side lobe limits have been exceeded. The test set can also compute the average output power and the occupied bandwidth over the central “in-band” capture.

A significant benefit is that, with the integrated test set, it is possible to do time-gated analysis on WLAN bursts. This means that the spectral analysis measurement is representative of actual performance under real operating conditions.

Time-gated analysis

With the integrated test set, we can move into a new era of time-gated analysis.

The plot in Figure 9 shows an OFDM burst spectrogram (a plot of spectrum versus time), taken using the 89601A Vector Signal Analysis software. The short sync part of the preamble can be clearly seen at the start of the burst – these are the isolated “fingers”.

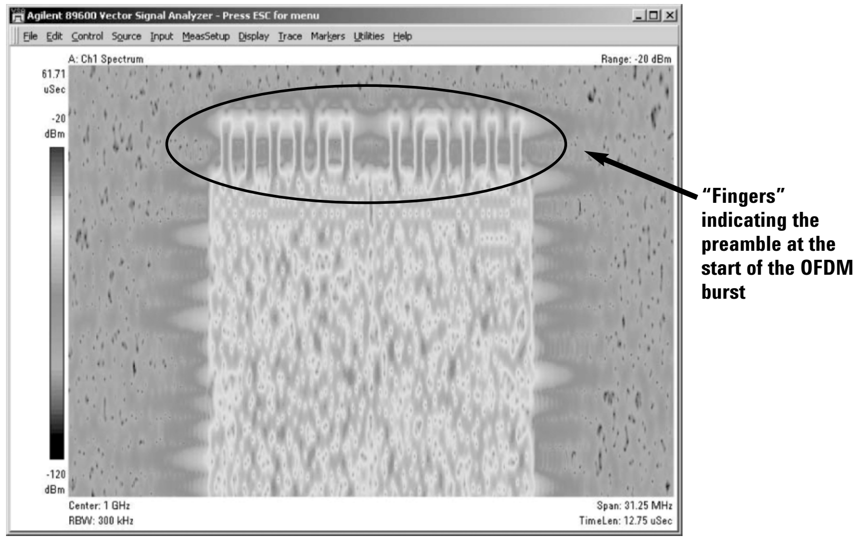
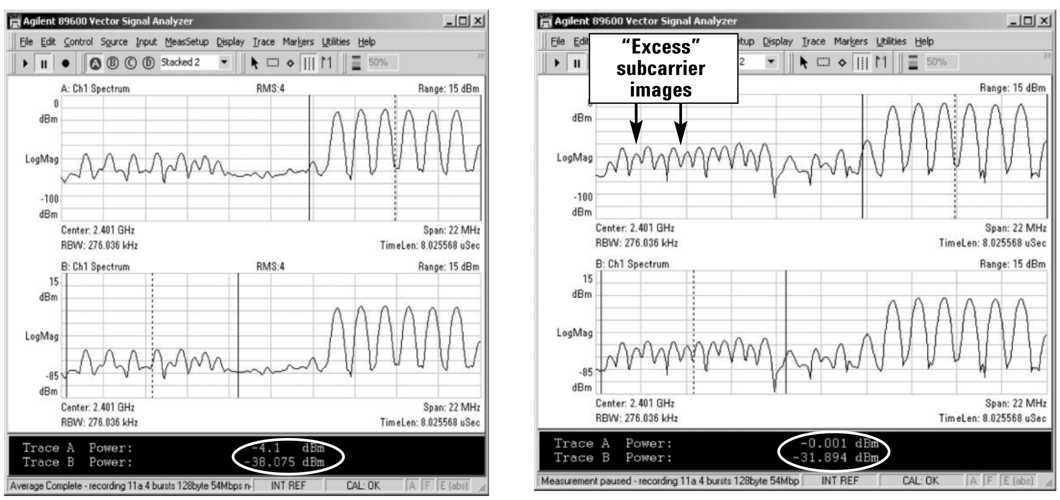


Figure 9. Spectrogram of an OFDM burst.

If a time-gated spectrum analysis is performed on this part of the sweep, at an offset from the center frequency, we can see the unwanted OFDM side-bands due to distortion in the transmit chain. These are shown in the two plots below.



(a) **(b)**

Figure 10. Time-gated spectrum measurements.

Using band power markers we have a way of making a simple sideband power measurement that indicates the level of distortion being created. Looking at Figure 10a, you can see how the sub-carrier spacing is reproduced in the sidebands. The ratio of unwanted/wanted power is –34 dB. In Figure 10b, the output power has been increased by 4 dB. The ratio of unwanted/wanted power is now –30 dB; note too, how “excess” sub-carriers images have formed in the sidebands.

Although the above plots of spectrogram and spectrum analysis would not be used in a production environment, the 89601A VSA software is a powerful tool to demonstrate that for OFDM spectrum analysis, a very short period of time (in this case, 8 µs to capture the preamble) may be used to successfully analyze sideband distortion. This has the potential to significantly reduce overall test times.

DSSS schemes do not have the same format but the DSSS preamble can look similar. In this case, a repetitive, deterministic signal is all that is required to ensure consistent results. The time gate length can then be selected and optimized so that the measured signal is the same on consecutive bursts. This gated spectrum measurement can be used to give a fast, but stable, measurement of sideband distortion levels in the same way as OFDM.

Multiple measurements from a single acquisition

The test set makes many of the transmitter measurements on a single acquisition of data. The following transmitter demodulation measurements can be made on one data capture:

- spectral flatness
- frequency error
- center frequency leakage
- EVM

These RF spectrum and power-oriented tests can also be made on the same data captures

- spectral mask
- average power
- occupied bandwidth

The ability to derive many measurement results from one data capture has the potential to change the way devices are tested. For example, it may be possible to significantly reduce the amount of data or bursts that are used in testing, leading to reduced test times.

Receiver sensitivity testing

Receiver sensitivity testing requires the receiver packet error rate to be measured at a particular data rate and power level. Golden radio-based systems use the golden radio transmitter to generate packets (e.g. 1000 packets) and uses the DUT receiver to receive them.

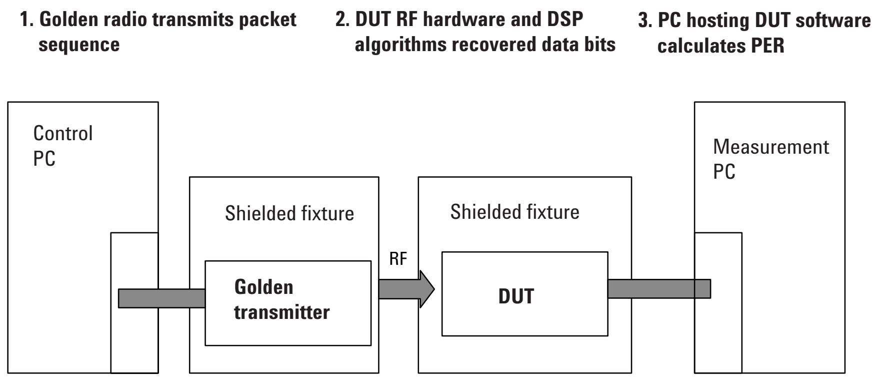


Figure 11. Using a golden radio for receiver sensitivity testing.

The DUT control and measurement software compares the transmitted and received packets and calculates the receiver packet error rate (Rx PER).

As described in the application note *Using the E4438C ESG Signal Generator and Signal Studio for 802.11 WLAN Receiver Testing* (literature number 5989-0075EN), PER is susceptible to changes in power level. Therefore, it is very important to use an accurate, calibrated RF level for PER testing.

The source in the integrated tester does essentially the same task as the golden radio transmitter except that it can be calibrated over power, frequency, and temperature to produce a known good signal.

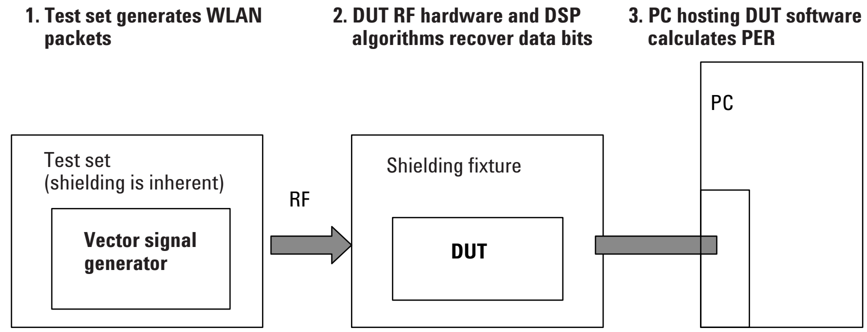


Figure 12. Using an integrated test set for receiver sensitivity testing.

With the flexibility to emulate any WLAN signal, the source in the integrated test set has the added benefit that it is not specific to any one WLAN chipset, making it an ideal replacement for the golden radio. The receiver PER can also be used to provide a functional test of the DUT, in much the same way as transmit PER test is used in golden radio-based systems.

Out-of-band spurious testing

Out-of-band spurious testing is done to ensure that unexpected component performance variations and interaction do not cause failure against spectrum regulatory limits. Although it may be carried out in initial manufacturing to help establish specifications, it is rarely performed in high volume production as it is time-consuming to run. If out-of-band spurious testing is required, a spectrum analyzer must be added to the integrated test set system to provide the required frequency coverage to 26.5 GHz.

Flexibility of the test system

Because the golden radio is a proprietary system, it is not easily adapted to cope with new technology or frequency extensions. A number of different golden radios will be required to match the mix of chipsets being tested. Additional hardware is likely to be needed which can further complicate the system configuration and adds to the calibration and support overhead.

The basic components of frequency range and bandwidth mean that a system using an integrated test set is a solution that can be easily adapted to changing or proprietary technologies, multiple formats, and future test needs. More consumer devices are integrating different technologies (such as *Bluetooth™* and WLAN). This will necessitate more thorough RF parametric testing of devices to ensure constituent components are not unduly affecting each other. A test system that can be used for multiple technologies (resulting in lower capital investment), is an attractive solution, particularly for contract manufacturers working on many technologies and devices.

When more RF analysis capability is required in module design or in re-work areas on the manufacturing floor, the N4010A test set can be used with Agilent's flexible 89601A VSA software to pinpoint the problem. The 89601A Option B7R is specifically designed with preset states to help demodulate WLAN (802.11a/b/g) signals to make complex measurements. This is an extremely powerful tool for troubleshooting WLAN designs and enables the link from R&D to manufacturing to be fully exploited.

Summary

A test system using an integrated test set, which maintains independence from any manufacturer's chipset and has the basic component requirements of accuracy, bandwidth, and frequency range, is ideal for the technologies used in WLAN manufacture today. Unlike a golden radio-based system, this solution:

- is not specific to one WLAN chipset provider
- provides cost effective EVM measurements
- reduces system complexity and calibration and maintenance overhead

The architecture is also well placed to provide new methods of testing WLAN devices and can be more easily adapted for future technologies. With flexibility of test being vital in many manufacturing environments, this is set to be an enduring solution for an evolving marketplace.

Recommended Agilent Equipment

GS-8300 N4993A WLAN manufacturing functional test system

The GS-8300 N4993A WLAN manufacturing functional test system is a test platform that can be tailored, allowing WLAN module manufacturers to quickly ramp up production, increase manufacturing product yields, and reduce overall cost of test. The GS-8300 N4993A is a fully integrated turnkey solution that tests a variety of 802.11b and g WLAN chipset designs. It can be tailored to meet application-specific needs and is supported worldwide. The GS-8300 minimizes cost of test while accelerating time-to-market, time-to-volume, and time-to-profit by using a standard platform that is extensible for future requirements. The system features an integrated one-box-tester, several fixturing options, and easy-to-use Wireless Test Manager software (or other test executives via system tailoring). It requires no golden unit and makes cost-effective EVM measurements for high throughput. Intended for broad application across many formats, the GS-8300 is designed for WLAN chipset and reference design manufacturers as well as for the development and manufacturing testing of WLAN modules.

Features

- standard 802.11b and g test platform tailorable to meet specific needs
- designed to support high volume RF production functional verification
- system software including measurement library, test plan template, graphical user interface, and self test
- system diagnostics software provided to resolve system issues
- no golden unit required; integrated one-box-tester and multiple fixturing options
- services; including capacity transfer, optimization, installation, training, RF expertise, consulting, and project management offering a single customer interface
- high system up-time; ensured by Agilent's worldwide, locally delivered support, with calibration, maintenance, and spare parts available

GS-8300 N4994A WLAN integrated bundle solution

The Agilent GS-8300 N4994A WLAN integrated bundle is designed for manufacturers looking to upgrade their existing systems or who are in need of a signal source and analyzer solution in a single box. The Agilent GS-8300’s one box tester brings an instrument-grade source and analyzer to WLAN manufacturing test at an affordable price. Its source utilizes a high quality modulator with low EVM. This provides optimum DUT Rx sensitivity measurements and reduces false failures. In addition to providing RF spectral analysis to guarantee transmission compliance with regulatory standards, the GS-8300’s RF analyzer also provides analysis of the modulation quality via EVM measurements. This allows direct testing for compliance against WLAN standards and is faster than alternate approaches.

The GS-8300 WLAN bundle can be tailored to help chipset and reference design 802.11b and g manufacturers reduce the overall cost of test, while improving time-to-market. The GS-8300 bundle uses many of the benefits of the fully-integrated GS-8300 WLAN test solution, including worldwide support. Support is also provided for a variety of WLAN chipsets and can be tailored to meet application specific needs.

N4010A WLAN test set Options 102/103

The N4010A WLAN test set Options 102/103 are used to verify that 802.11a/b/g modules and devices meet their RF design requirements.

The N4010A Options 102/103 include integrated hardware for testing RF transmitter and receiver measurements at 2.4 GHz (Option 102) and 4.8 to 5.875 GHz (Option 103) frequency bands. An external PC is required to host the wireless measurement engine, which is used for data analysis.

The N4010A also can be used to make *Bluetooth* measurements by adding Option 101. For a complete list of *Bluetooth* measurements and functionality see the N4010A product page at **www.agilent.com/find/n4010a**.

Features

- 2.4 GHz and 4.8 to 5.875 GHz frequency bands for transmitter and receiver testing
- 22 MHz digitizer bandwidth for full signal capture analysis
- wideband baseband generator (source) for WLAN signal emulation
- WLAN software measurement engine uses industry leading 89601A VSA software
- flexible hardware architecture to test the RF performance of WLAN and *Bluetooth* modules

86901A vector signal analysis software

The 89601A vector signal analysis software provides flexible tools for making RF and modulation quality measurements on digital communication signals.

Quickly evaluate and troubleshoot digitally modulated signals with the modulation analysis tools in the 89601A software. Examine symbol behavior with trellis/eye diagrams. Use the constellation and vector diagrams for an overall indication of signal behavior and to obtain clues to the cause of the problem. Take advantage of the EVM, EVM spectrum, and EVM time capabilities for more sensitive examination of signal errors.

Perform time domain analysis using the 89601A software RF scope capability. Evaluate pulse shape with the main time display, select specific portions of a burst for analysis with the time gating feature, and use statistical tools such as CCDF and CDF to characterize the noise-like behavior of your modern communication signal.

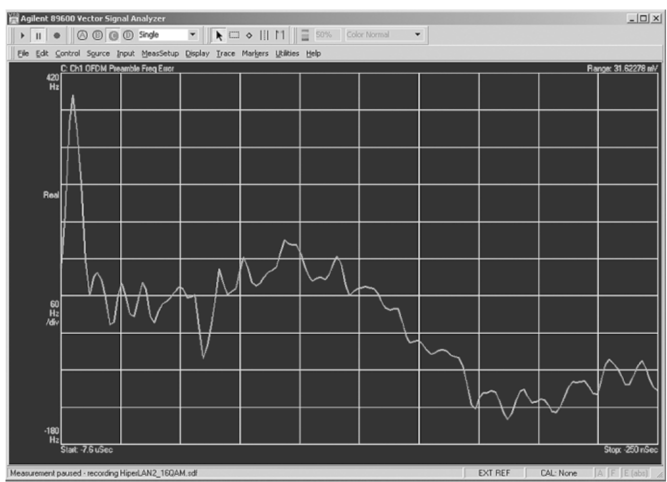
89601A Option B7R – WLAN modulation analysis

OFDM mode

Use OFDM mode to demodulate and analyze 802.11a, 802.11g, and HiperLAN2-compatible signals down to the bit level. A variety of displays include a compound constellation display that lets you view all modulation formats in the frame and a common pilot error display to view the phase and magnitude behavior of the pilot sub-carriers for every symbol in the frame.

DSSS/CCK/PBCC mode

Use the DSSS/CCK/PBCC mode to automatically detect, despread, descramble, and demodulate the payload in all 802.11b and 802.11g formats. Displays include a constellation diagram, EVM frequency error, and gain imbalance.



89601A Option B7R WLAN modulation analysis.

89607A WLAN test suite software

The 89607A standards-based test suite provides the convenience of automatic, one-button test set-up and execution with the confidence of knowing your design is being tested based on the techniques, parameters, and specifications set down in the IEEE 802.11a/b/g standards.

The 89607A WLAN test suite software is ideal for characterizing overall PHY layer performance of your WLAN transmitter. Evaluate your transmitter design against the IEEE standards. Take advantage of its standardized tests to qualify parts or do acceptance testing. Use the software for manufacturing test; you can even modify the pass/fail limits to add some margin between what IEEE requires and what test you do.

N4010A/89601A/89607A combination

With the N4010A and Option 89601A-B7R or 89607A software, the N4010A/89601A or 89607A combination can be used to test and troubleshoot WLAN modules and devices. The N4010A with Option 89601A-B7R can be used for flexible modulation analysis to quickly locate design problems. The N4010A with the 89607A software can be used test WLAN modules to the specifications set down in the IEEE 802.11a/b/g standards with one-button pass/fail testing.

The 89601A/89607A software runs on a PC connected to the N4010A via LAN or USB and provides hardware control, modulation analysis, evaluation, and troubleshooting along with complete results displays. The controls and display of the N4010A are disabled while operating the 89601A/89607A software.

Related Literature

Agilent GS-8300 WLAN Manufacturing Functional Test System, product overview, literature number 5989-0225EN

Agilent GS-8300 WLAN Manufacturing Functional Test System, datasheet, literature number 5988-9413EN

Agilent N4010A Wireless LAN Tx/Rx Option for the GS-8300 N4993A and N4994A, technical overview, literature number 5989-0145EN

RF Testing of Wireless LAN Products, application note 1380-1, literature number 5988-3762EN

IEEE 802.11 Wireless LAN PHY Layer (RF) Operation and Measurement, application note 1380-2, literature number 5988-5411EN

802.11a/g Manufacturing Test Application Note – A Guide to Getting Started, application note 1380-3, literature number 5988-6788EN

Making 802.11g Transmitter Measurements, Application Note 1380-4, literature number 5988-7813EN

Using the E4438C ESG Signal Generator and Signal Studio for 802.11 WLAN Receiver Testing, application note, literature number 5989-0075EN

Wireless LAN and Bluetooth™ *Test Products, Systems, and Services,* literature number 5988-4438EN

For more information on the GS-8300 WLAN manufacturing functional test system visit
www.agilent.com/find/gs-8300

For more information on the N4010A wireless connectivity test set visit
www.agilent.com/find/n4010a

For more information on Agilent's complete WLAN offerings visit
www.agilent.com/find/wlan

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Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

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