Agilent
E5515C Wireless Communications Test Set

Product Note

Get Measurement Accuracy and Repeatability with the Agilent 8960 Series Test Set

Achieve true cost-reduction benefits with fast measurements that are accurate and repeatable

8960 Series 10 E5515A wireless communications test set

Agilent Technologies

Table of contents

The Agilent 8960 Series 10 (E5515C) wireless communications test set provides a breakthrough in measurement speed using next generation, parallel measurement hardware coupled with intelligent internal test management. The result is greatly reduced test time along with a reduction in programming and test maintenance costs. However, these tremendous benefits would mean little if the measurement results were not repeatable and accurate. Test engineers usually overcome poor repeatability by adding multiple measurements and using averaging. This solves the repeatability issue, but greatly extends the test time. Poor accuracy causes false line failures or allows out-of-specification phones to leave your factory. With the 8960, you can be confident that the performance gains it offers are not compromised in terms of accuracy and repeatability.

What Agilent specifications mean

Agilent measurement products are known to have very conservative specifications. Many users find that when they measure the performance of Agilent products, the results are much better than the published specification. So the question arises, why is the actual performance so much better than the specification? The answer lies in Agilent's philosophy of quality. Agilent feels that our customers expect test equipment to meet published specifications over a wide range of conditions. In other words, you can count on Agilent test equipment to provide accurate results.

How Agilent 8960 specifications are determined

Agilent uses a stringent testing process to determine published specifications. The Agilent 8960's published specifications are set by three factors: the environmental changes in performance (delta environmental), the measurement error of the factory test system, and the measured performance of the device under test.

Environmental effects

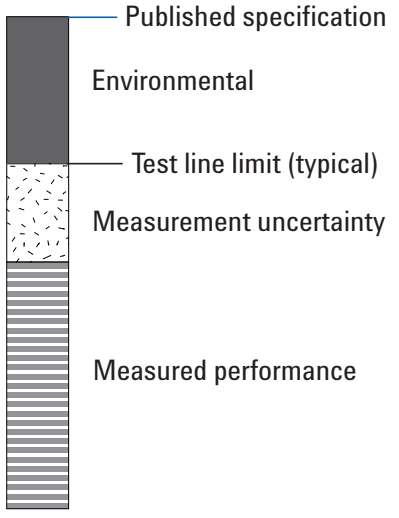
Agilent usually specifies performance of its product over the wide operating temperature range of 0°C to +55°C. To determine the effects of environment on performance, each new design is carefully tested across its specified operating range. Once the data is collected, the performance change is taken to be the delta-environmental component of the published specification. Usually, the greatest error points are at the temperature extremes. Thus, the typical performance over a broad range of environmental conditions is much better.

Measurement uncertainty

Agilent spends great effort in maintaining the highest level of test system performance in its factories. Each test system is carefully designed and tested to provide repeatable and traceable measurement results. All test stations results are traceable to the National Institute of Standards and Technology. For a given specification, the known, traceable measurement accuracy is determined and added to the delta environmental component.

Measured performance of the test set

The final component of a published specification is the measured performance of the unit under test. Since there is always some unit-to-unit variation, a number of units are tested at room temperature. Once the data is gathered, the distribution of results is determined. The measured performance component of the published specification is then taken to be the average performance plus a statistically valid range of variations determined from the test results distribution. This conservative approach ensures that almost 100% of the units built will meet this level of performance. Thus the test set's average performance is well below the measured performance used to set the published specification.



Agilent specification components

What "typical" means for the Agilent 8960

Once the published specification is set, then the factory must set a test line limit. Since Agilent insists that every 8960 leaving the factory is a quality product, the test line limit is set to the measured performance plus the measurement uncertainty. Thus every unit must pass this level of performance before it is shipped to you.

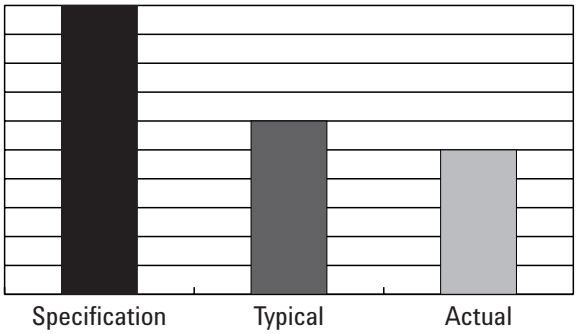
Many times, Agilent will also publish typical performance numbers along with the warranted performance. Typical performance is not warranted, but represents the expected performance at room temperature. The typical number is usually the same as the test line limit. Remember that the test line limit is an upper bound. Thus all units must meet the published typical numbers and many will exceed it.

The end result

Not everyone in the industry goes to these lengths to ensure the performance of their products. In many cases, what Agilent would call a typical specification is quoted by others to be a warranted specification. This difference in specification philosophy leads to confusion and invalid comparisons. However, with the 8960, you can be sure that the unit you purchase meets the published performance over the specified temperature range. Usually you will find that the actual performance is much better than the warranted specification and will meet or exceed the typical specification.

The following measurement discussion is based on an Agilent E5515C wireless communications test set with the E1960A GSM test application. The concepts discussed here apply to an E5515C with different technology test applications installed, however the specific measurements and values will differ.

Relationship of specification, typical, and actual



Receiver measurements

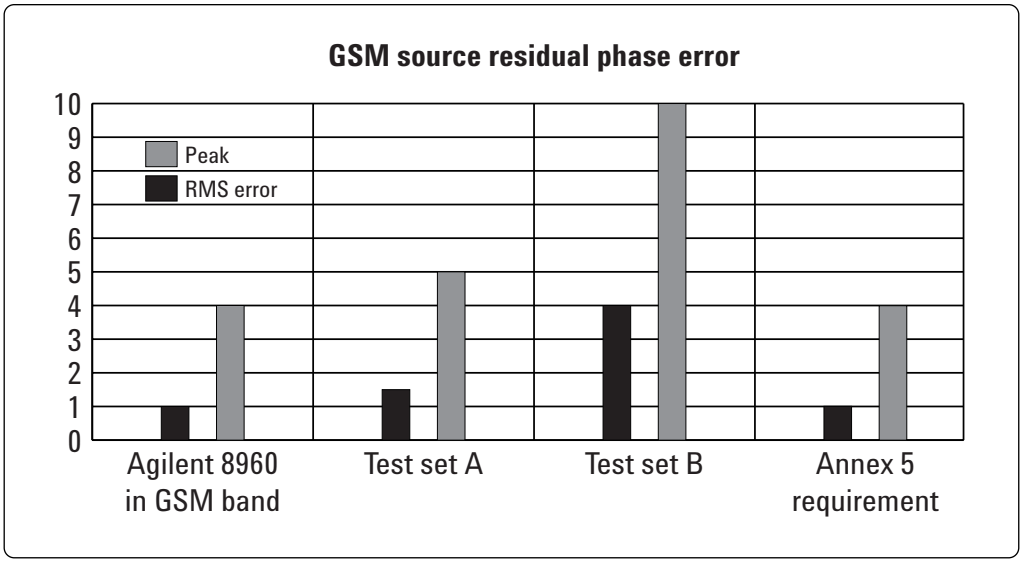
Level accuracy and repeatability

The most important parameters for receiver measurements are absolute source level accuracy and level repeatability. The 8960 excels at these parameters because it uses a fully electronic attenuator. Due to the nature of digital systems, the BER of a GSM phone will remain low until the system can no longer demodulate the signal. At this point, the BER ratio rapidly rises causing the so called "sharp knee effect." In order to accurately characterize the performance of a GSM phone, the test signal's level must be known to a very accurate degree. Level inaccuracy directly erodes test margin and can result in false positives as well as false failures. Repeatability also has a negative effect since system level calibrations that include cabling and fixtures cannot be performed to any tighter tolerance than the repeatability of the source.

The Agilent 8960 provides ±1.0 dB source level accuracy from –110 dBm to –13 dBm in the GSM, EGSM, DCS-1800, and PCS-1900 frequency bands. Typical level accuracy is better than ±0.5 dB. Even more importantly, the 8960 has a source level repeatability (returning to the same frequency and level) of better than ±0.1 dB. Repeatability is a key parameter for level accuracy since most test systems include external fixtures to connect the mobile to the test set. These external fixtures must be calibrated for path loss to assure that the correct level is reaching the mobile under test. With its typical level repeatability of <±0.1 dB, systems using the 8960 will hold their system level calibration to <±0.1 dB accuracy if the repeatability errors of the cables and fixtures are negligible.

Modulation performance

In addition to providing excellent level accuracy and repeatability, the 8960's source provides a high quality 0.3 GMSK modulated signal. With rms phase error performance of less than ±1 degree and peak phase error performance of less than ±4 degrees, the 8960 ensures that its signal quality does not adversely affect receiver measurement results. This level of performance also meets the Annex 5 of GSM recommendation ETSI 3GPP 51.010 (formerly ETSI 11.10) modulation quality requirements for test equipment. You can trust that the receiver measurements from the 8960 reflect the true performance of your GSM phones.



TX carrier power measurements

One of the most often performed measurements on GSM phones is the carrier power measurement. It is critical for optimum performance that a GSM phone be properly calibrated at all of its TX operating levels. This means many power measurements must be performed.

Accuracy and repeatability

Accurate carrier power measurements are the key to reducing total calibration time. High measurement speed provides little benefit unless the results are accurate. High-accuracy carrier power measurements reduce your error budget and raise quality without the need for complicated system calibration. The 8960 provides an industry leading measurement accuracy of ±0.27 dB with typical performance as good as ±0.08 dB.

Another important consideration is the repeatability of the measurements. Typical first or second generation GSM test sets require multiple measurements to provide consistent results. Multiple measurements drastically reduce the throughput of your test stations. With typical power measurement repeatability of ±0.05 dB, the 8960 eliminates the need for multiple measurements to reduce test equipment repeatability errors. You may still need to perform multiple readings to average the performance of your phone. In such cases, the 8960 allows you to perform multiple readings due to its outstanding measurement speed without worrying about the repeatability of the test set.

Effects of standing wave ratio (SWR)

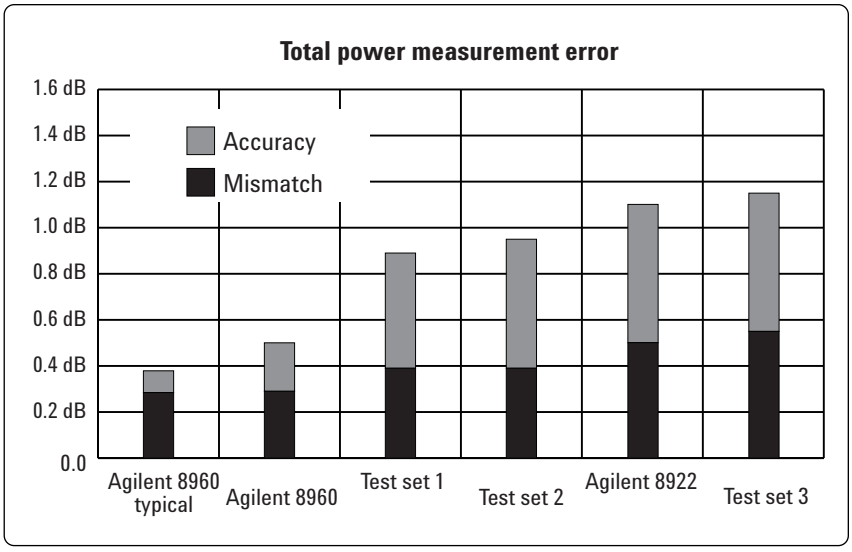
While having excellent instrumentation accuracy is important when making carrier power measurements, another factor that affects the total uncertainty is the error caused by mismatch. The 8960 has a typical SWR of <1.14:1 over the 810-960 MHz frequency bands and <1.20:1 over the 1.7-1.99 GHz frequency bands. This level of performance greatly minimizes the mismatch uncertainty of your test budget. If, for example, the input to a phone has an SWR of 3.0 (typical of most GSM phones), then the 8960 will have a mismatch error of +0.385 dB/ –0.40 dB. Excellent SWR performance coupled with the 8960's industry leading measurement accuracy provides you with the best available power measurement performance.

Further reduction in mismatch error is achievable by padding the connection between the test set and the phone. For example, by placing a 3dB external attenuator with an SWR of 1.1 between the 8960 and the phone, the mismatch uncertainty is reduced to ±0.21dB. With the SWR reduced to this level, the 8960's allows a wider production line test limit which will translate to improved yields without compromising quality. The extra loss is possible since the 8960 specifies power measurements down to –20dBm.

Effect of measurement speed

During phone power calibration, power levels are measured to verify ETSI compliance. If all power levels are measured using a traditional approach, power measurements would take 5-10 seconds per GSM band. The 8960 can make multi-burst power measurements faster than the GSM frame rate.

The 8960 can measure all the power levels in a given GSM band in less than 100 milliseconds if the phone can change power levels at the GSM frame rate. If these transmit power levels were measured using traditional measurement techniques and instruments, it would take five to ten seconds to complete.

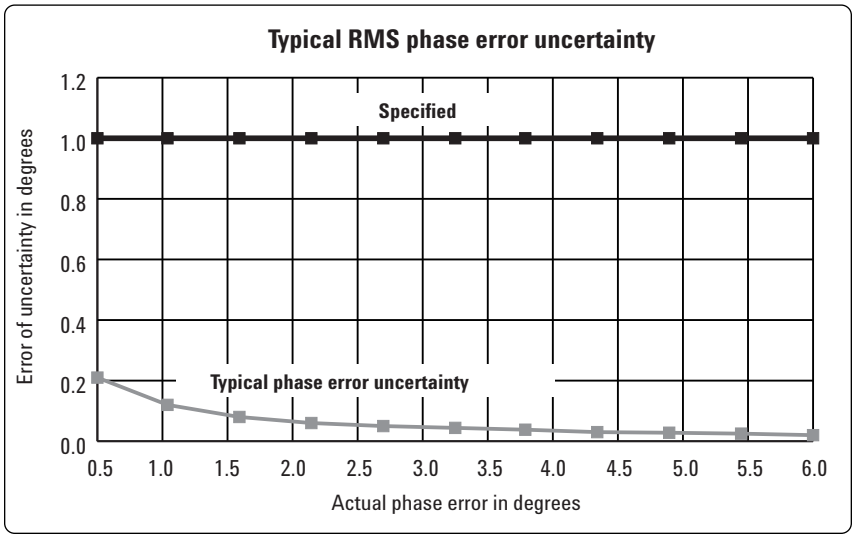


TX phase error measurements

Global phase error is an important transmitter measurement for the GSM system since it quantifies the overall transmitter performance of the phone. While providing incredible measurement speed (<40 msec for 1 burst), the 8960 gives you excellent phase error measurement performance. With a specified rms measurement error of <±1 degree and <±4 degrees peak, the Agilent 8960 improves your yield by reducing measurement uncertainty. The typical measured rms phase error uncertainty is less than 0.15 degrees for measured phase error values over 1.0 degree rms.

TX frequency error measurements

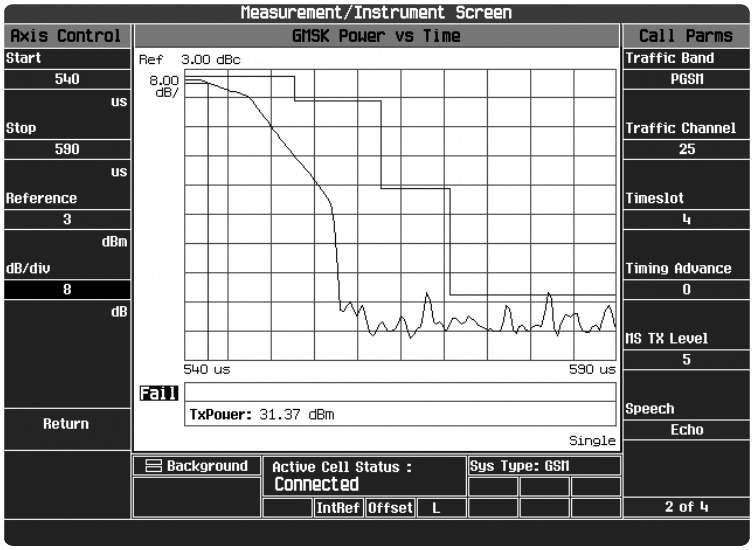
Another important component of the global phase error measurement is frequency error. Since GSM modulation precludes using traditional frequency counters, the global phase error measurement is the main method of measuring the frequency accuracy of GSM mobiles. The 8960 offers excellent frequency accuracy measurement with specified performance of ±12 Hz for normal bursts and ±18 Hz for RACH bursts. Of course, the accuracy of the timebase adds to these values. To minimize the frequency error measurement uncertainty, the 8960 includes as standard equipment an internal 10 MHz OCXO reference that has ±0.1 ppm per year aging. Within 15 minutes of turn-on, the 8960's timebase will be within ±0.01 ppm of the final value. The typical performance of the 8960's OCXO reference yields ±17 Hz timebase accuracy at 900 MHz.



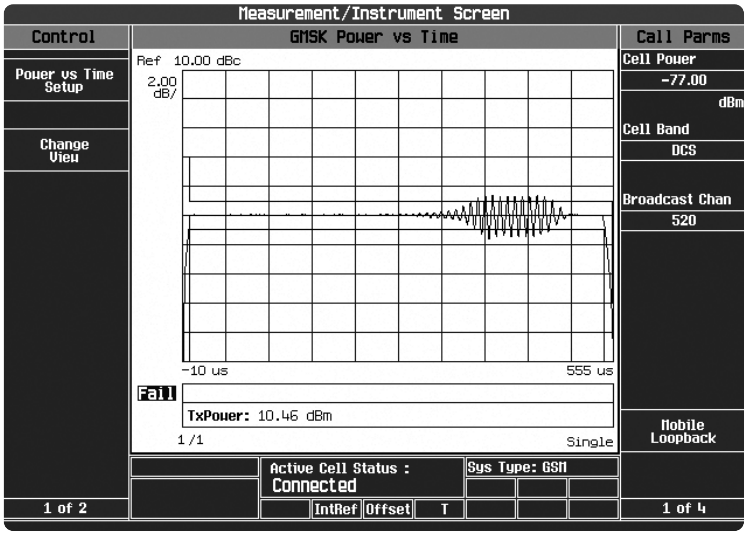
TX power versus time measurements

Since the GSM system is based on TDMA technology, an important transmitter parameter is the timing and accuracy of the transmitted bursts. Commonly referred to as the power versus time test, this measurement checks to see if a mobile confines its power to the prescribed power versus time template. With midamble synchronization, the 8960 aligns to each burst to within ±0.1 bits. This ensures that the power versus time limits will be correctly applied so that the reported measurements will reflect the actual performance of your phone. The 8960 not only gives you near perfect template alignment, but also has good relative measurement accuracy. Since the power versus time template is a measure of the relative amplitude as the phone turns on and off, the relative level accuracy of the test set has a direct effect on the error budget for this test. The 8960 has ±0.5 dB relative accuracy for the top –7/+1 dB of the burst (on portion) and ±1 dB relative accuracy down to –20 dB.

Another significant benefit of the 8960 is that it processes 2220 samples for each burst during the PVT measurement to ensure that all the power variations on the burst are captured.



This figure shows a power vs time graph of a phone that does not meet ETSI specifications. The 8960 identifies the correct failure because of the excellent resolution achieved with the 2220 measurement points per GSM burst. Note the “Fail” indication shown at the lower left portion of the GMSK Power vs Time display.



This figure shows a power vs time graph of a phone that does not meet ETSI specifications. The 8960’s excellent resolution of 2220 measurement points per GSM burst captures the ripple during the burst failure as seen here. Note the displayed “Fail” indication shown at the lower left portion of the GMSK Power vs Time display.

TX output RF spectrum measurement

To ensure that the GSM system provides optimum performance, the ETSI test recommendations specify that the out-of-channel emissions of a phone meet rigorous limits. The output RF spectrum due to modulation and switching must be kept to low levels to prevent interference to adjacent channels. The 8960 makes these measurements using the ETSI specified 5 pole synchronously tuned filter with a 30 kHz resolution bandwidth.

First and second generation GSM test sets provided these measurements but did so without specifying their measurement uncertainty. The 8960 provides warranted performance for output RF spectrum due to modulation so that your test yields can be increased. For carrier offsets out to ±1800 kHz, the 8960 has a measurement uncertainty of ±1.5 dB. Typical measurement accuracy at an offset of ±400 kHz is an excellent ±0.7 dB. This level of performance is maintained even though the 8960 provides a ten times increase in measurement speed for this measurement over previously available test sets.

Conclusions

The 8960 provides not only revolutionary ease of use, parallel measurement processing, and measurement speed, but also provides state of the art accuracy and repeatability. The result is high measurement throughput that maintains or improves the integrity of your measurement processes. Phones that meet your specifications are passed, while those that require rework are quickly identified. Improvements in test set accuracy and repeatability will help reduce the number of no-trouble-found phones. The 8960 fully delivers on the potential of high measurement throughput to reduce your test costs while improving the quality of your products.

For more information about the Agilent 8960 Series 10 E5515A Wireless Communications Test Set visit our web site at:
www.agilent.com/find/8960support

Agilent Technologies' Test and Measurement Support, Services, and Assistance

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."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

By internet, phone, or fax, get assistance with all your test & measurement needs

Online assistance:

www.agilent.com/find/assist

Phone or Fax
United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 282 6495

China:
(tel) 800 810 0189
(fax) 1 0800 650 0121

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (82 2) 2004 5004
(fax) (82 2) 2004 5115

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Taiwan:
(tel) 080 004 7866
(fax) (886 2) 2545 6723

Other Asia Pacific Countries:
(tel) (65) 375 8100
(fax) (65) 836 0252
Email: tm_asia@agilent.com

Product specifications and descriptions in this document subject to change without notice.

Printed in USA November 5, 2001
5968-2324E

Agilent Technologies