*Solutions for*

# Amplifier Test

## Ensuring Quick, Accurate ACPR Measurements of LTE Power Amplifiers

Application Note

### Overview

The 3GPP Long Term Evolution (LTE) initiative is intended to provide a framework for the evolution of 3G toward a high-data-rate, low-latency and packet-optimized radio-access technology. Its aim is to achieve a peak downlink cell data rate of greater than 100 Mbps and an increase in capacity of three to five times compared with HSDPA (in the same bandwidth), with latency as low as 20 ms. While LTE has the potential to enhance 3G networks and enable significant new service opportunities in mobile TV and video, achieving success in consumer-enabled devices will not be easy. Among other things, it will require the engineer to pay close attention to the power amplifier (PA); a component which plays a key role in the LTE transmitter's RF front-end. The PA contributes significantly to handset power consumption and as an active device, exhibits nonlinear behavior which can be problematic. LTE's evolved Node B (eNB) power amplifier faces a similar problem and is compounded by the fact that it can be multi-carrier or even mixed-carrier. Optimal LTE system performance demands that the PA be both highly efficient and linear. Accurately testing the PA during design and optimization provides one means of achieving this goal.

### Problem

Testing the PA is a difficult task—one that is complicated by the complexity of the LTE system, the nature of its signal (e.g., wideband, relatively noise-like and subject to stringent performance requirements), and the technology's continuing evolution. Designers and test engineers working with LTE systems must therefore confront not only a slew of new measurements, but also confusion as to how to even make the required measurements. One such measurement is adjacent channel power ratio (ACPR or ACLR), a measure of the linearity in a system, and it is a necessary and critical performance test for PAs since LTE systems can drive them into nonlinear regions.

Today, ACPR measurements are generally made using standard measurement tools that engineers already have at their disposal (e.g., spectrum analyzers and software). Unfortunately, these tools fail to provide an optimal means of quickly and accurately measuring a power amplifier's ACPR, nor do they offer a means of simplifying test setup or actual test—all of which is critical to ensuring the commercial success of LTE-based devices.

## Solution

Quickly and accurately measuring ACPR in LTE PAs demands access to a flexible, general-purpose signal generator and signal analyzer—both of which must be capable of dealing with the changing requirements and complexity of the LTE standard. The signal generator provides the standard-based LTE signals required for component test. The signal analyzer enables the engineer to access a wide range of standards-based power measurements like ACPR, and a wide array of demodulation measurements for troubleshooting and detecting subtle characteristics of the DUT including EVM performance. Besides ACPR, other possible measurements include LO phase noise, shoulder attenuation, spectrum emission mask, constellation, MER/EVM, I/Q distortion, frequency error, and BER.

Using a general-purpose signal generator and signal analyzer is key to quickly and accurately measuring ACPR, but there are other requirements that these instruments must meet as well. They must be cost-effective, fast, scalable, and support the evolving LTE standard. And, since ACPR measurements require an input test signal with low distortion that will not mask the amplifier's true performance, the measurement solutions must also feature low distortion characteristics over a wide range of output power levels—even at high power levels. This eliminates the need for external power amplifiers to drive the DUT (depending on the input signal level requirements).

The Agilent MXG RF vector signal generator and MXA signal analyzer are powerful tools for quickly and accurately testing the LTE PA. The MXG RF vector signal generator features fast switching speed (≤ 1.2 ms in SCPI mode), industry-best ACPR (better than -70 dBc)—even at high power levels or over a wide range of output power levels, high power, small form factor, and simplified self maintenance (Figures 1 and 2).

With a choice of frequency ranges and performance attributes, as well as support for all 3GPP defined test models and the latest published version of the LTE standard, the MXG can be easily scaled to meet the PA measurement needs of the designer or test engineer. Because it is extremely intuitive to use, users can modify key signal parameters "on the fly" locally or remotely.


FIGURE 1: *The Agilent MXG RF vector signal generator supports the March 2009 version of the LTE standard.*

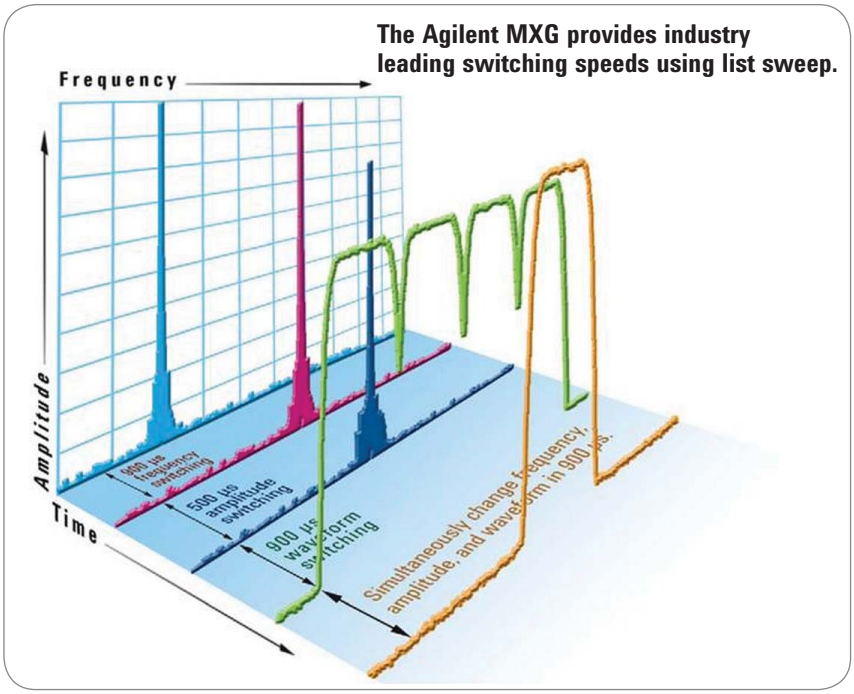



FIGURE 2: *MXG switching speeds include frequency, amplitude and waveform. All of these attributes can be switched simultaneously in list mode.*

The MXG's wide, flat bandwidth and low distortion characteristics deliver the high dynamic-range test signals required to make accurate amplifier ACPR measurements for all waveforms, at any power level, including those with high crest factors. It supports multicarrier signals with optional W-CDMA carriers, an important feature given that many early LTE system deployments may involve both W-CDMA and LTE configurations. When utilized with Agilent's Signal Studio software, the MXG provides application-specific signal generation.

Signal Studio for 3GPP LTE is a PC-based software application that creates uplink and downlink standards-based LTE waveforms for use with the MXG signal generator. The industry validated waveforms are performance optimized for testing a wide range of component attributes including: EVM, ACLR, CCDF, and others. Access to predefined set-ups and the ability to modify signal parameters allow the engineer to create custom reference signals to meet their changing needs.

Agilent's midrange MXA signal analyzer offers the accuracy and performance needed to design and manufacture LTE-based communications systems (Figure 3). It delivers fast speed (<39 ms mode/measurement switch and <14 ms ACLR with fast method) and scalability, the industry's widest range of application-specific measurement solutions (more than 20), and support for more than 50 modulation types. It provides support for multiple frequency ranges (20 Hz to 3.6, 8.4, 13.6, and 26.5 GHz), an internal fully calibrated pre-amplifier option up to 26.5 GHz, optional analysis bandwidths of 25 MHz, and an optional 1-dB electronic attenuator to 3.6 GHz. It also features an all digital IF, +15 dBm TOI, -151 dBm/Hz DANL (-154 dBm/Hz typical), 0.3 dB absolute amplitude accuracy and 73 dB W-CDMA ACLR dynamic range (78 dB typ. with noise correction). A new ACPR measurement method now available in MXA—filtered IBW—allows for increased dynamic range through the use of a sharp cutoff bandpass filter.

Using the N9080A LTE measurement application, running on the MXA, engineers can perform in-depth, standard-compliant modulation analysis for all bandwidths and modulation formats of LTE signals for both UL and DL measurements. The engineer can view the LTE signal by resource block, sub-carrier, slot, or symbol—and can also view the composite signal or select a specific region for analysis. A hardkey/softkey manual user interface and SCPI remote user interface enables automated design validation and/or prototype production.

With the MXA's PowerSuite, engineers have access to a standard, complete set of powerful one-button measurements for characterizing signal quality (e.g., ACPR, channel power, occupied bandwidth, spectrum emissions mask, CCDF, burst power, and spurious emission) (Figure 4). Running the 89601A Vector Signal Analysis (VSA) software application in the MXA enables advanced signal modulation analysis and troubleshooting of 30 additional modulation types.

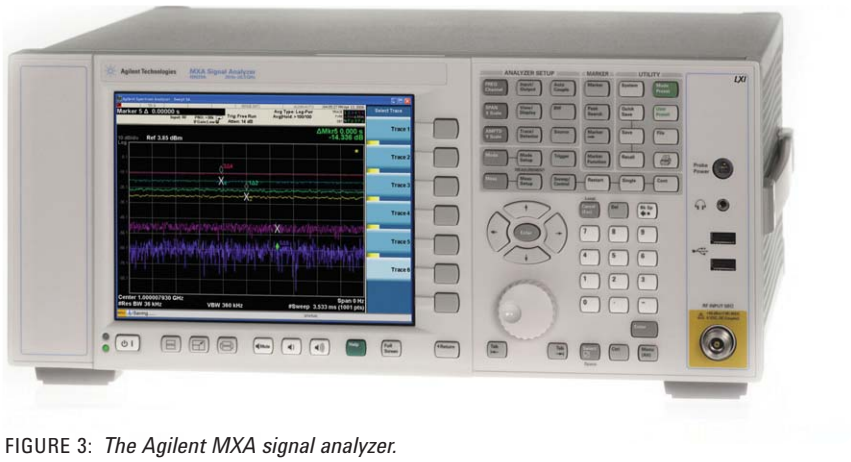


FIGURE 3: *The Agilent MXA signal analyzer.*


FIGURE 4: *Typical adjacent channel power ratio performance with an MXG connected directly to an MXA.*

## Summary of Results

Despite the benefits offered by LTE systems, the technology's complexity creates significant measurement challenges, especially with regard to testing the power amplifier. Optimal system performance demands that the LTE PA be both efficient and linear and therefore it must be accurately tested. Solutions like the Agilent MXG RF vector signal generator and MXA signal analyzer can greatly simplify this task. The flexible performance, scalability and fast measurement speed offered by these solutions ensures that today's design and test engineers have the tools they need to create optimal LTE systems.

POWERED *The Power to Get to Market Faster*

## The Power of X

The MXG signal generator and MXA signal analyzer are key products in Agilent's comprehensive Power of X suite of test products. These products grant engineers the power to gain greater design insight, speed manufacturing processes, solve tough measurement problems, and get to market ahead of the competition.

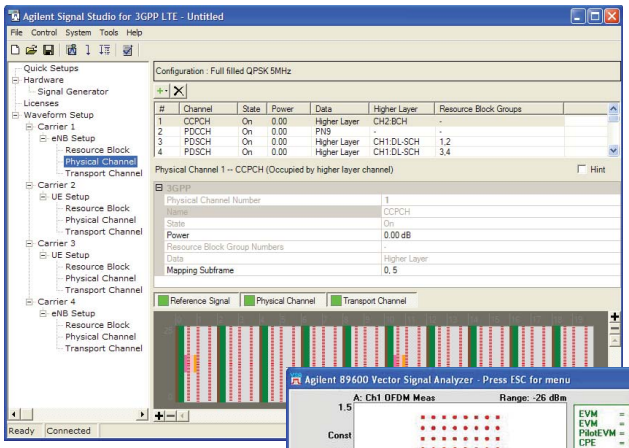
Offering the best combination of speed and scalability, and created and supported by renowned worldwide measurement experts, Agilent's X products are helping engineers bring innovative, higher-performing products to emerging markets around the globe. To learn more about Agilent's suite of X products please visit: **www.agilent.com/find/powerofx.**

## Related Applications

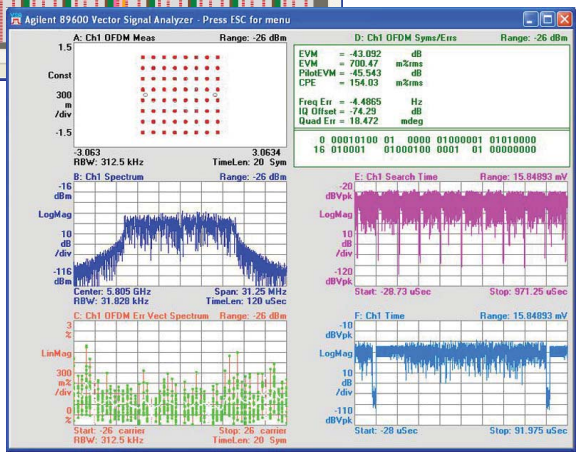
- Transmitter test
- Receiver test
- Baseband verification
- Pre-conformance testing

## Related Agilent Products

- N5106A PXB MIMO Receiver Tester
- 89601A VSA Software
- N9080A LTE Measurement Application
- N9030A MXA Signal Analyzer
- N7624B Signal Studio for 3GPP LTE
- N7625B Signal Studio for 3GPP LTE TDD
- MXA PowerSuite




Signal Studio for 3GPP LTE




89601A VSA Software

### Remove all doubt

For more information on repair and calibration services, go to:

**www.agilent.com/find/removealldoubt**

### Agilent Email Updates

**www.agilent.com/find/emailupdates**
Get the latest information on the products and applications you select.

### Agilent Direct

**www.agilent.com/find/agilentdirect**
Quickly choose and use your test equipment solutions with confidence.

**www.agilent.com**
**www.agilent.com/find/powerofx**

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

**www.agilent.com/find/contactus**

### Americas

| | |
|---|---|
| Canada | (877) 894-4414 |
| Latin America | 305 269 7500 |
| United States | (800) 829-4444 |

### Asia Pacific

| | |
|---|---|
| Australia | 1 800 629 485 |
| China | 800 810 0189 |
| Hong Kong | 800 938 693 |
| India | 1 800 112 929 |
| Japan | 0120 (421) 345 |
| Korea | 080 769 0800 |
| Malaysia | 1 800 888 848 |
| Singapore | 1 800 375 8100 |
| Taiwan | 0800 047 866 |
| Thailand | 1 800 226 008 |

### Europe & Middle East

| | |
|---|---|
| Austria | 01 36027 71571 |
| Belgium | 32 (0) 2 404 93 40 |
| Denmark | 45 70 13 15 15 |
| Finland | 358 (0) 10 855 2100 |
| France | 0825 010 700* |
| | *0.125 €/minute |
| Germany | 07031 464 6333 |
| Ireland | 1890 924 204 |
| Israel | 972-3-9288-504/544 |
| Italy | 39 02 92 60 8484 |
| Netherlands | 31 (0) 20 547 2111 |
| Spain | 34 (91) 631 3300 |
| Sweden | 0200-88 22 55 |
| Switzerland | 0800 80 53 53 |
| United Kingdom | 44 (0) 118 9276201 |

Other European Countries:
www.agilent.com/find/contactus

Revised: March 24, 2009


Printed in USA, June 24, 2009
5990-4128EN

Agilent Technologies