

# DESIGN NOTES

## WCDMA ACPR and AltCPR Measurements – Design Note 375

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### Introduction

ACPR (adjacent channel power ratio) and AltCPR (alternate channel power ratio) are important measures of spectral regrowth for digital communication systems that use, for example, WCDMA (wideband code division multiple access) modulation. Both ACPR and AltCPR quantify the ratio of regrowth in a nearby channel to the power in the transmitted channel.

To measure ACPR and AltCPR, refer to the test setup shown in Figure 2. The DUT (device under test) is the

LT<sup>®</sup>5528, which is a high linearity direct I/Q modulator. It accepts complex modulation signals at its baseband inputs and generates a modulated RF signal at the RF output. An accurate measurement of the spectral regrowth of a highly linear device such as the LT5528 is difficult because its dynamic range may rival that of the measurement equipment. Because of this, it is important to account for the noise of the measurement system; i.e., the spectrum analyzer. Refer to Figure 3.

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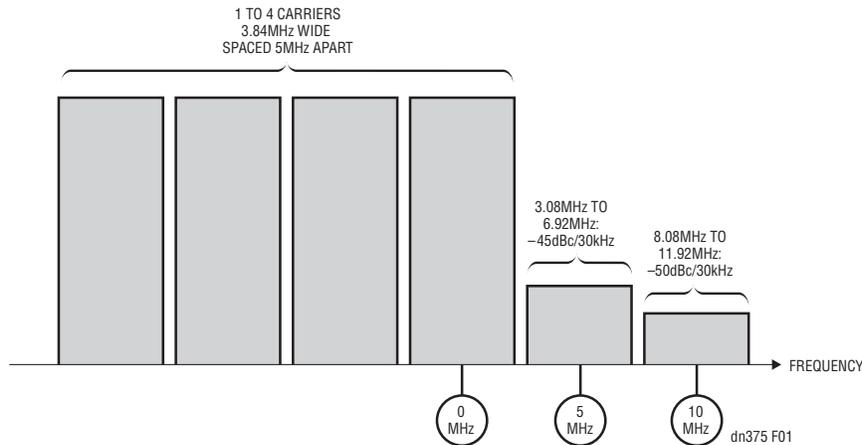


Figure 1. WCDMA ACPR Limits, Per 3GPP TS 25.104, Section 6.6.2.2.1

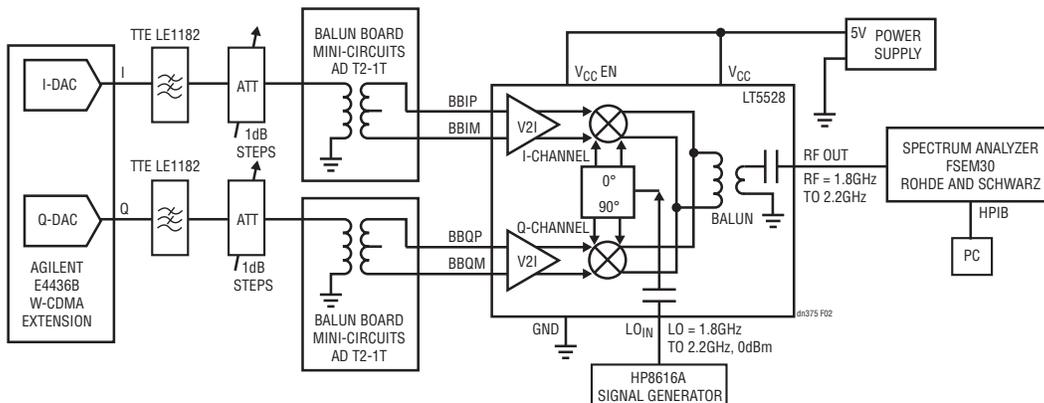
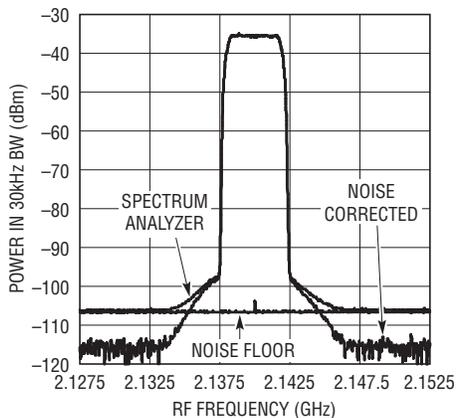


Figure 2. ACPR Measurement Setup



**Figure 3. ACPR Spectrum for a Single Carrier WCDMA Signal**

Some spectrum analyzers offer an ACPR measurement utility. This utility will not, however, give accurate results for highly linear devices, as it does not compensate for the system noise floor.

The spectrum analyzer must have a wide dynamic range. That means a high input 3rd order intercept point, and a low noise floor. The analyzer shown in Figure 2 meets both of these requirements.

Note that a free running RF generator provides the LO signal. This type of generator is used because of its superior noise performance. This is critical, as a noisy LO signal may corrupt the ACPR measurement. Its output operating frequency can drift slightly, so manual frequency correction is required.

Also, the baseband source can generate spectral regrowth and noise which may swamp the performance of the DUT. The lowpass filters shown at the baseband generator outputs reduce these impairments to a tolerable level. Filters suggested for this purpose are made by TTE Engineering and offer >20dB rejection at 10.4MHz and >80dB rejection at 13.08MHz.

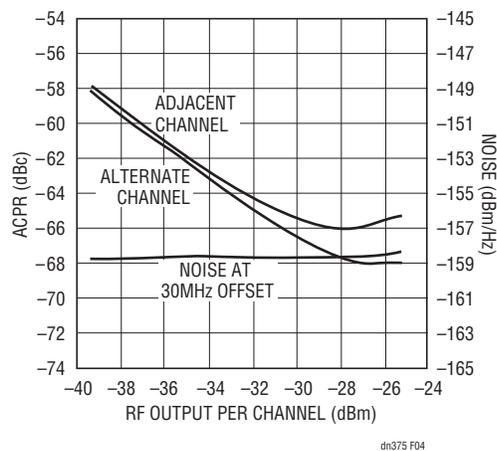
To start, measure the noise floor of the spectrum analyzer with a 50Ω input termination. The input attenuation of the analyzer is set to minimize the noise figure of the measurement system. A 30kHz resolution bandwidth is used because the spectrum analyzer shown has the lowest noise figure (about 24dB) at that resolution bandwidth. The spectrum analyzer shown includes an RMS display detector mode, which is specifically designed to

measure noise-like signals. For spectrum analyzers that do not offer this mode, it is important to set the video bandwidth to at least 3 times the resolution bandwidth; in this case 100kHz. If the ratio of video to resolution bandwidth is too low, the power measurement will be inaccurate. Video averaging helps smooth the result; 100 averages gives good results. Once the settings are correct, use the channel power utility of the analyzer to find the total noise power within a 3.84MHz bandwidth.

Next measure the output spectrum of the DUT using the same settings. For ACPR/AltCPR, center the measurement band 5MHz/10MHz above the center of the highest carrier. To find the true spectral regrowth power, convert the measured spectral power levels to mW and subtract the spectrum analyzer noise floor from the measured DUT power. Reconvert to dBm to get the true spectral regrowth.

The ACPR/AltCPR is equal to the difference in dB between the signal power per carrier and the spectral regrowth.

ACPR and AltCPR vary with output signal level. Figure 4 shows the ACPR and AltCPR versus RF output level for a 4-carrier WCDMA signal centered at 2.14GHz. For low RF power levels, these are limited by the output noise floor of the DUT. At high RF output power levels, they are determined by the linearity of the DUT. The maximum ACPR/AltCPR are observed between these extremes, where the spectral regrowth equals the noise floor of the DUT.



**Figure 4. LT5528 4-Channel WCDMA Adjacent and Alternate CPR Measurement vs Channel Power**

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