

LT5528 WCDMA ACPR, AltCPR and Noise Measurements

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INTRODUCTION

ACPR (adjacent channel power ratio), AltCPR (alternate channel power ratio), and noise are important performance metrics for digital communication systems that use, for example, WCDMA (wideband code division multiple access) modulation. ACPR and AltCPR are both measures of spectral regrowth. The power in the WCDMA carrier is measured using a 5MHz measurement bandwidth; see Figure 1. In the case of ACPR, the total power in a 3.84MHz bandwidth centered at 5MHz (the carrier spacing) away from the center of the outermost carrier is measured and compared to the carrier power. The result is expressed in dBc. For AltCPR, the procedure is the same, except we center the measurement 10MHz away from the center of the outermost carrier.

To measure ACPR and AltCPR, refer to the test setup shown in Figure 2. The DUT (device under test) is the LT5528, which is a high linearity direct I/Q modulator. It accepts WCDMA modulation at the baseband inputs, and generates a WCDMA modulated signal at the RF output. 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 modulator output, and consequently the ACPR measurement. For the generator shown, the automatic level control must be switched off to avoid degrading its broadband noise floor. Also, the operating frequency can drift slightly, so manual frequency correction could be needed.

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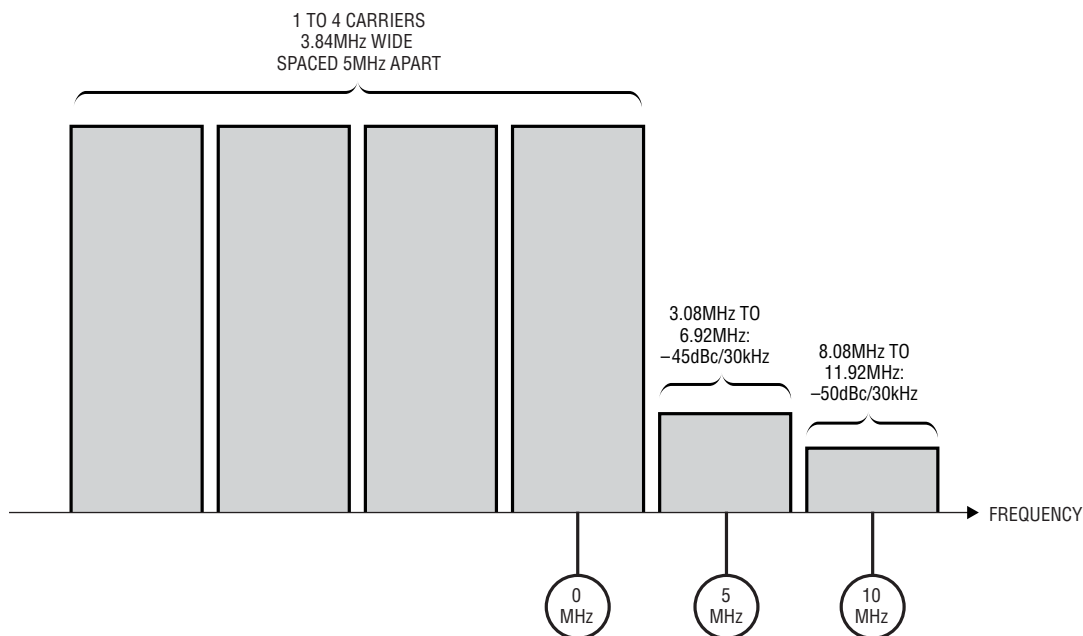


Figure 1. WCDMA ACPR Limits, Per 3GPP TS 25.104, Section 6.6.2.2.1

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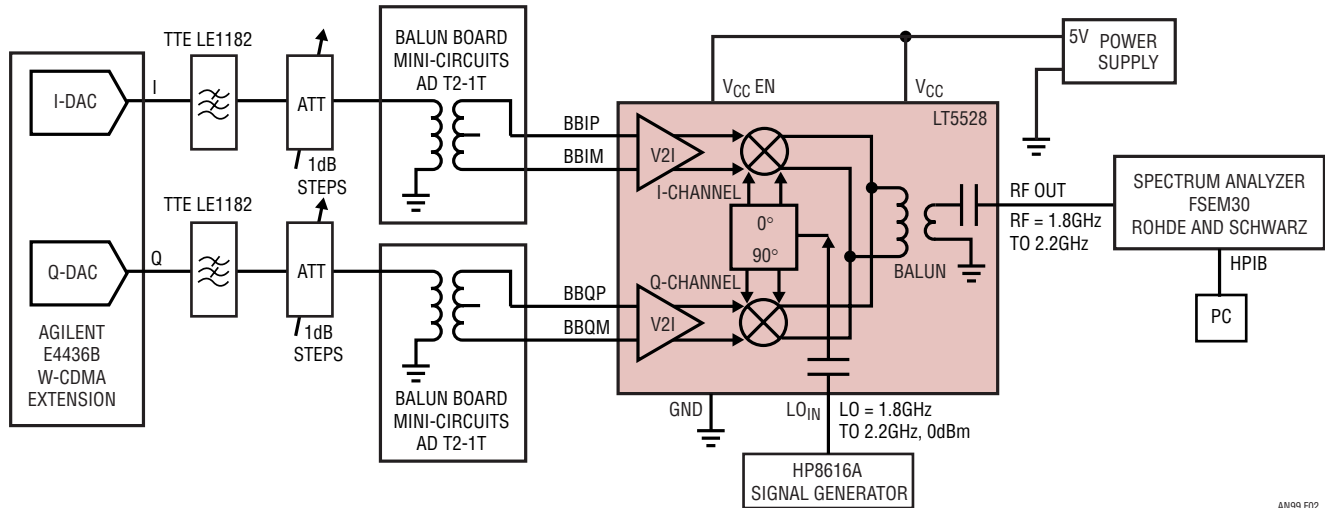


Figure 2. ACPR Measurement Setup

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.

In general, the baseband source will not be ideal. It generates 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 listed below:

- 1-channel ACPR measurement
 - Filter part number LE1182 2.5M-50-720B, from TTE Engineering
 - Rejection at 2.6MHz >20dB
 - Rejection at 3.08MHz >80dB
- 2-channel ACPR measurement
 - Filter part number LE1182 5M-50-720B, from TTE Engineering
 - Rejection at 5.2MHz >20dB
 - Rejection at 8.08MHz >80dB
- 4-channel ACPR measurement
 - Filter part number LE1182 10M-50-720B, from TTE Engineering
 - Rejection at 10.4MHz >20dB
 - Rejection at 13.08MHz >80dB

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.

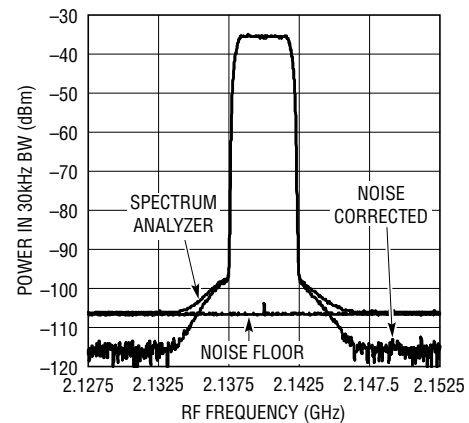


Figure 3. ACPR Spectrum for a Single Carrier WCDMA Signal

To do this, first measure the noise floor of the spectrum analyzer with a 50Ω input termination. The input attenuation of the analyzer should be set to 0dB. This will minimize the input 3rd order intercept point of the measurement system, as well as the noise figure. A 30kHz resolution bandwidth is used because the spectrum analyzer shown has the lowest noise figure (about 24dB) at that resolution bandwidth. This spectrum analyzer includes an RMS display detector mode, which is specifically designed to

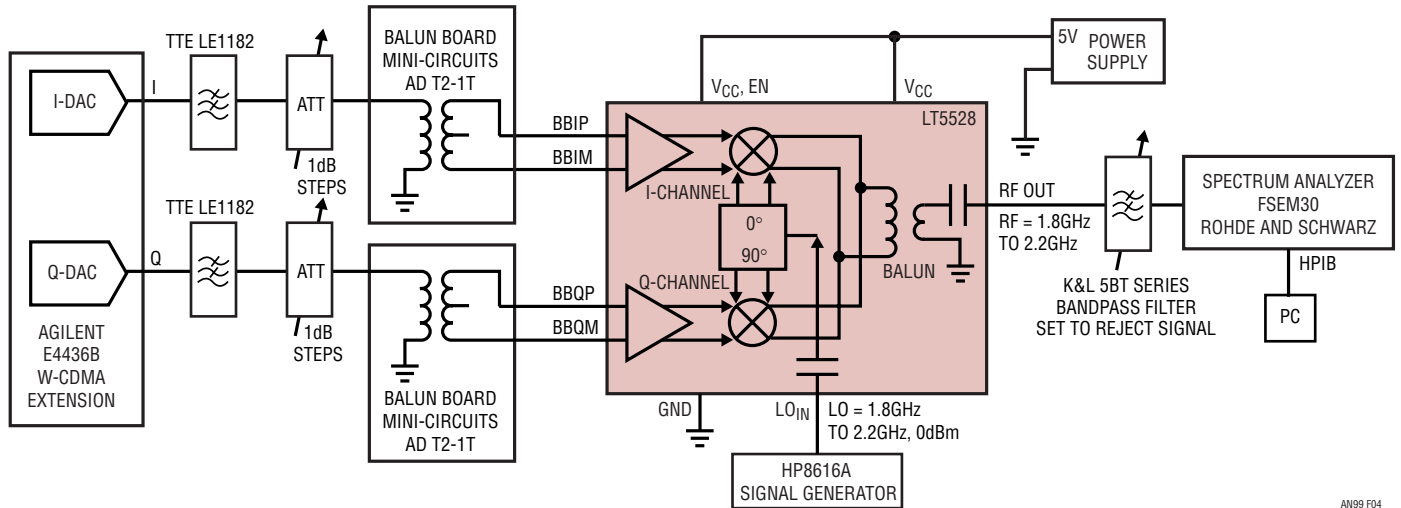


Figure 4. 30MHz Offset Noise Measurement Setup

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, use a video bandwidth of 100kHz. If the ratio of video to resolution bandwidth is too low, the power measurement will be inaccurate. For example, if the ratio is 1:1, the measured power may be 0.35dB lower than the true power. Note that the sweep time must be increased by a factor of 10 or so in order to take advantage of the higher number of samples in this mode. Video averaging helps smooth the result; 100 averages gives good results. The channel power utility of the analyzer is used to find the total power within a 3.84MHz bandwidth.

Next measure the output spectrum of the DUT using the same settings. For ACPR, center the measurement band 5MHz 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. Do the same for the band 5MHz below the center of the lowest carrier. Take the average of the two dBc figures to arrive at the average spectral regrowth.

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

The spectrum analyzer shown also offers an ACPR measurement utility. This utility will not, however, give accurate results for highly linear devices, as it does not

compensate for the measurement system noise floor.

To measure noise at 30MHz offset, the test setup is modified as shown in Figure 4. A tunable bandpass filter is added to the DUT output. This filter should be set to reject the main signal, but not attenuate the noise 30MHz above the outermost channel. Noise measurements that do not use this filter technique will produce degraded results for strong RF signal levels. The reason is that the dynamic range of the spectrum analyzer is not sufficient to accept the power of the main signal while accurately measuring the noise. So the main signal will tend to overload the RF front end of the analyzer. The bandpass filter helps to reduce the amount of signal reaching the analyzer by approximately 20dB, while adding only about 1dB of noise figure to the measurement frequency.

Proceeding with this measurement, measure the noise floor of the spectrum analyzer with a 50Ω input termination. A narrow span of 100kHz can be used, while setting the resolution and video bandwidths to 30kHz. The input attenuation of the analyzer should be set to 0dB. Here again, set the detector mode for RMS. Use the marker noise function and video averaging to obtain a result in dBm/Hz.

Next, connect the test setup as shown in Figure 4. Measure the noise at 30MHz from the center of the signal frequency, using the same settings as above. To find the true noise level, convert the noise power and the noise floor to mW and subtract the spectrum analyzer noise floor from the

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DUT output noise power. Reconvert to dBm/Hz to get the true noise level.

ACPR and AltCPR vary with output signal level. For low RF output 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 is equal to the noise floor of the DUT.

Some sample results of these measurements are shown to illustrate this in Figures 5 and 6. Figure 5 is a plot of ACPR, AltCPR, and noise versus baseband drive level for a 4-carrier WCDMA signal. Figure 6 shows the same results for a single WCDMA carrier.

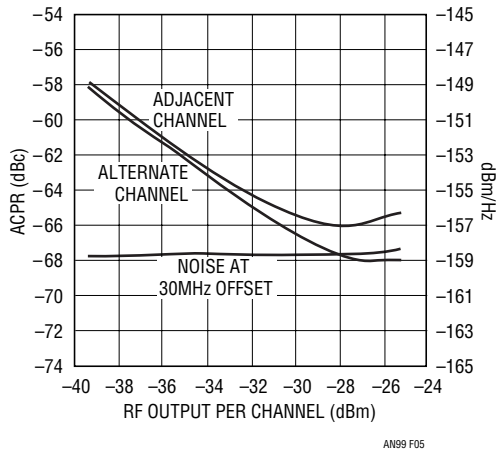


Figure 5. LT5528 4-channel WCDMA Adjacent and Alternate CPR and 30MHz Noise Floor Measurement vs Channel Power

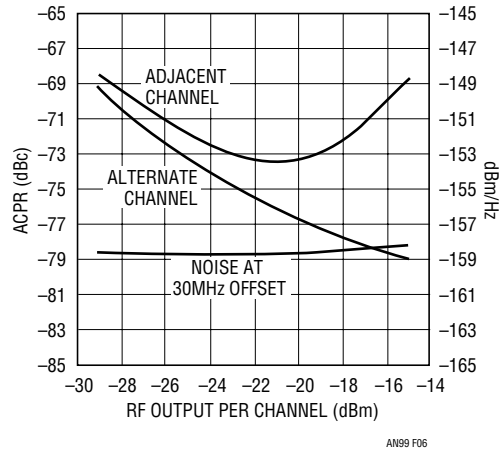


Figure 6. LT5528 1-channel WCDMA Adjacent and Alternate CPR and 30MHz Noise Floor Measurement vs Channel Power