RF Power Amplifier Efficiency Improves with Varied Vcc, from DC-DC Supply

Power amplifiers are usually optimized for ACPR and efficiency at full output power. However, most of the time cellular handsets operate at medium/low power range, where the power amplifier's efficiency drops dramatically.

With a variable power supply from a switching regulator such as the MAX8506, the power amplifier efficiency can be improved more than two-fold at +16dBm output. At +10dBm, efficiency is increased from 2.8% to 8.3%.

Introduction

The MAX2291 chip-scale-packaged, linear, RF, power amplifier was designed for use in N-CDMA handsets using the PCS band. It also performs well in the 1920-1980MHz WCDMA band by changing the input and output matching circuits. It includes a high-power path for full power transmission and a low-power path for medium- and low-power transmission with higher efficiency.

In cellular handset applications, the average transmission power is +12 to +16dBm. Therefore, the power amplifier efficiency at these "medium" output power levels is critical for longer battery talk time. The MAX2291 provides 37% of added power efficiency (PAE) at +27dBm output from the high-power path and 12% at +16dBm output by using low-power path. An undesired side-effect is that the signal phase shifts over 80 degrees when changing between the two paths. This causes concerns in base-band processing and correction.

Varying the MAX2291 supply voltage (while using only the high-power path) is another good way to enhance efficiency at medium and low output power. The MAX8506 switching regulator can be used to supply the required voltage. From bench test results, the MAX2291 can achieve 18.9% PAE at +16dBm with -38dBC ACPR, and without any phase shift. PA gain decreases with lower Vcc as expected.

Circuit Description

The MAX8506 is a 600mA switching regulator to supply variable Vcc to the MAX2291 PA based on the desired output power. There are two control pins for the MAX8506: BP and REF_IN. BP is used to bypass the regulator to reduce voltage drop at full output power, and REF_IN controls the output voltage. The MAX8506 output is taken as the main Vcc source for the MAX2291 PA

as shown in Figure 1.

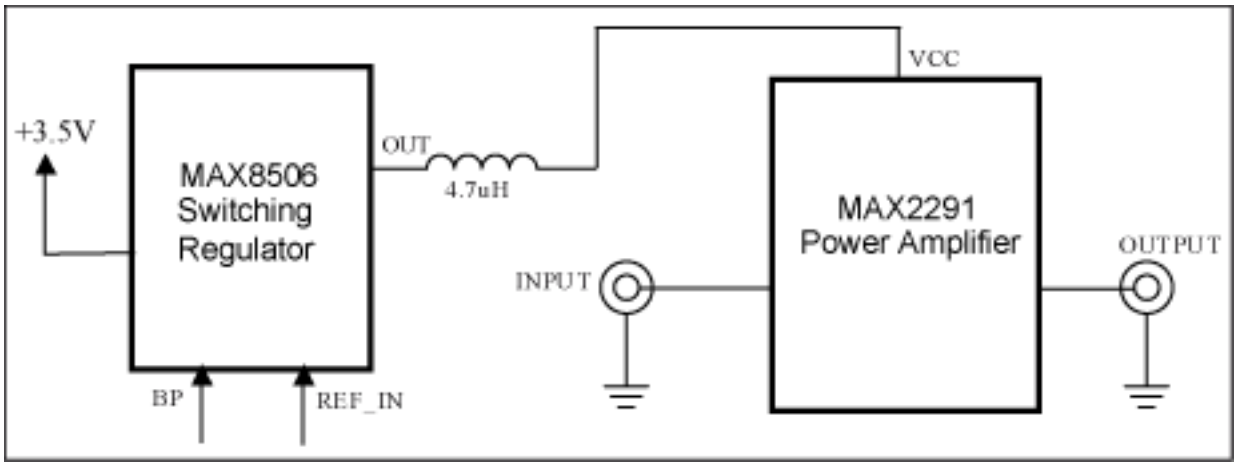

Figure 1. MAX2291 PA with Variable Vcc from MAX8506 switching regulator

A WCDMA application board was used for the tests. At certain required PA output powers, both PA Vcc and RF input power were adjusted to achieve the target output power with desired ACPR: -38dBc in this case. Then the current consumption was recorded for the efficiency calculation.

Equipment used:

- Agilent E4433B signal generator
- Agilent E4406A
- Power supply, RF coupler, 20dB pad
- RF power meter

On the E4433B, select 3GPP modulation, up link, DPCCH + 1 DPDCH The Agilent E4406A was for ACPR measurement.

The measured data is plotted in Figure 2. Power added efficiency (PAE) of MAX2291 at +27dBm is 34.6% in both cases, since MAX8506 is in bypass mode (input directly connected to output, not switching). At +24dBm, the PAE with fixed 3.5V is 25.7%, but increases to 30.5% while using switching regulator. At only +16dBm, the advantage is much more pronounced: the PAE increases from 8.3% to 18.9%, while maintaining -38dBc ACPR. At +10dBm, PAE increases from 2.8% to 8.3%.

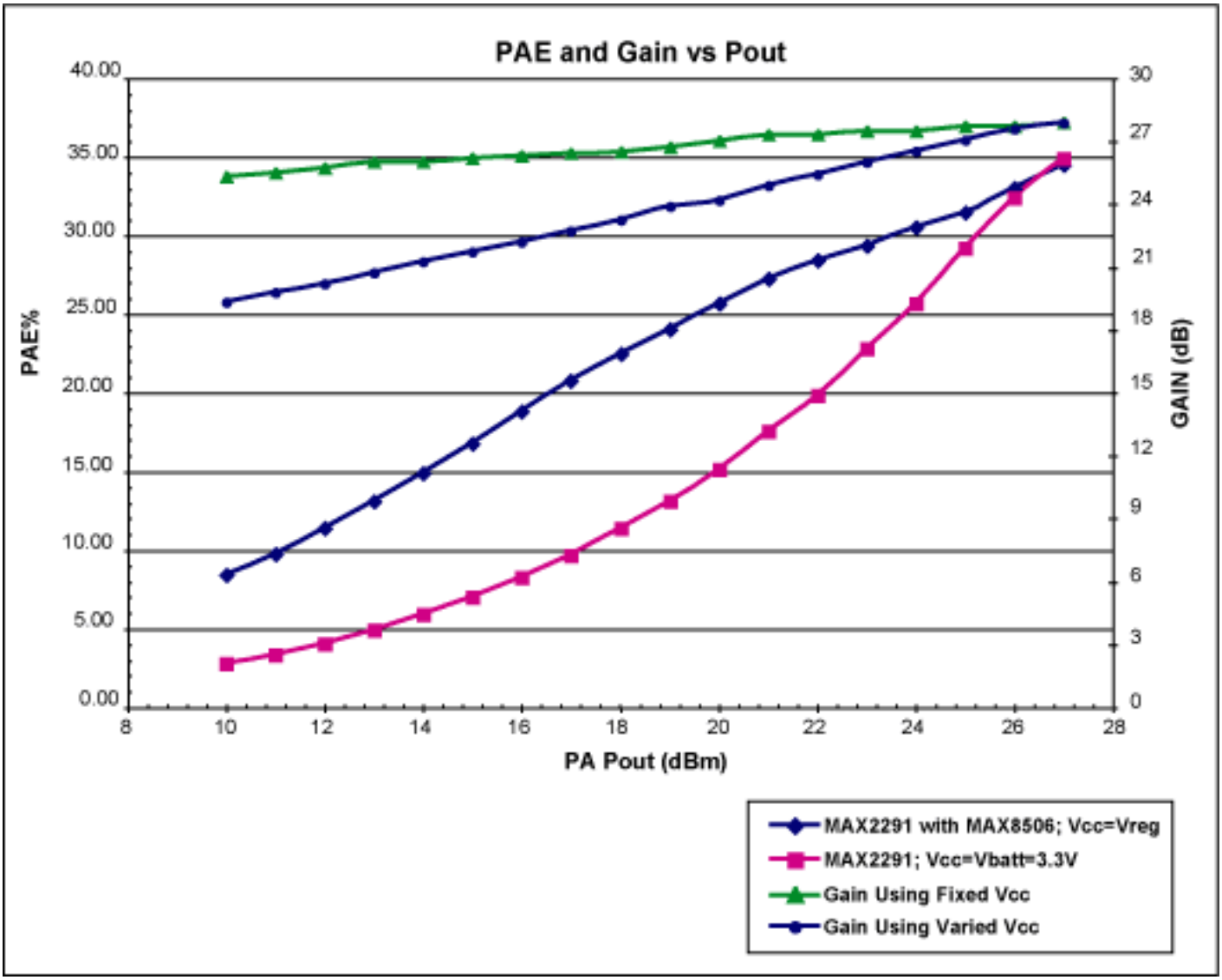

Figure 2. Measured PAE and Gain over Output Power

More Information

MAX8506: QuickView -- Full (PDF) Data Sheet -- Free Samples