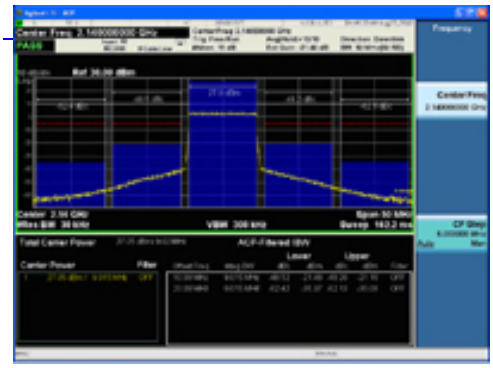
How Femtocells Are Playing a Critical Role in the Transition to 4G

By Joe Cozzarelli, ANADIGICS

As mobile carriers and network operators transition to 4G service, they are faced with several challenges, including the massive amount of smartphones available in the market, the volume of data traffic per phone that is rising exponentially, and all the steps required to deploy and upgrade their network infrastructures. From both an economic and quality-of-service perspective, small-cell solutions hold the key to providing an effective path forward as 4G rollouts begin to take hold in the coming year.



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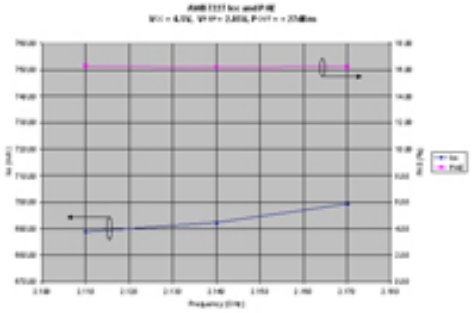
Today’s networks are based on the traditional infrastructure model, which consists of deploying macrocells to blanket a geographic area and relies on microcells to fill the gaps that the macrocells simply couldn’t cover. Despite the technology, calls are frequently routed to their destinations through either terrestrial T1 lines or microwave backhaul, which are typically leased by the network operator. If caller demand exceeds the capacity in a specific area, the operator must add more cells to handle the traffic. Not only has this traditional approach become stressed, it also has been rendered less attractive due the cost. The proliferation of feature-rich smartphones, such as Samsung’s Epic 4G and Apple's iPhone has pushed the model to the limit.

With social networking, proximity services and a number of other applications, smartphones and connected devices are creating a world in which many people are virtually always linked to the network. Mobile carriers must look to create a new operating environment in which many smartphone customers will have a session that is almost always open. Small-cell equipment, such as femtocells, can solve these challenges as they augment the macrocell model by adding hundreds of thousands of small local cell sites within homes, shops or businesses that connect these mobile users.

Industry organization Femto Forum has reported that the femtocell market will expand to approximately 49 million access points by 2014, with 114 million users worldwide accessing mobile networks via femtocells. The performance of the femtocell's RF power amplifier (PA) module is of utmost importance in the design of these small base stations since the PA will consume a good portion of the overall power and is responsible to boost the signal linearly.



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In order to harness success in this growing market, the femtocell design must balance features, functionality and pricing. With these characteristics in place, the most important PA requirements for femtocells include exceptional RF and DC performance, multi-mode support, multi-standard support and reliability. The essential attribute in selecting a PA that influences all of these characteristics is the semiconductor process used to manufacture the PA itself.

The GaAs Advantage

Gallium arsenide (GaAs) is the process of choice for PAs destined for use in the vast majority of mobile handset and low- to mid-power infrastructure applications. It is likely to remain so as 3G and 4G networks are deployed because of its superior performance characteristics. The most recent development is a GaAs-based bipolar transistor called InGaP HBT (indium-gallium-phosphide heterojunction bipolar transistor).

The ANADIGICS InGaP-Plus™ process combines bipolar and FET devices on the same GaAs die, which means that features which usually reside off chip can be integrated into conveniently sized surface mount parts. Switches, step attenuators, power detectors, and voltage regulators are commonly found in ANADIGICS power amplifiers.

RF Performance and Beyond

ANADIGICS is currently designing a family of balanced and single ended power amplifier modules for use in femtocells, picocells and in-home customer premises equipment (CPE). Each module is specifically designed to provide optimal performance in one or more of the several popular frequency bands used by wireless carriers. While specific features vary from module to module based on the

application, the design approach for each is similar. The availability of a family of devices offers significant advantages to design teams that must provide femtocell products that implement different standards and operate over different frequency bands.

When designing PA modules, one should take into account linearity, adequate RF power for good coverage, and the capability of handling high capacity waveforms with high Peak to Average Ratios (PAR). ANADIGICS PA modules deliver high power, outstanding linearity, and good thermal performance for high reliability. These products draw on the company's extensive experience in developing PA solutions for mobile handsets and broadband infrastructure products as a basis for meeting the requirements of femtocell use.

To meet the goal of creating modules that combine extremely linear performance with a full complement of functional integration, ANADIGICS relies on the native efficiency and broadband capabilities of GaAs devices, and uses state-of-the-art RF circuit simulation and thermal analysis tools during the circuit design and layout process. Taking advantage of the capabilities of their patented InGaP-Plus technology, our design team has created both single ended and balanced PA modules with common features in each of the popular wireless bands. Earlier this year, the AWB7123 and AWB7127 singled ended parts were released with average powers of +24.5dBm. Later this year, the balanced versions of these parts will be released. The AWB7223 (1.9GHz) and AWB7227 (2.1GHz), are 4.5 volt PA modules designed to deliver up to +27dBm of linear output power with a high peak to average ratio waveform such as WCDMA or LTE. These power levels are more than adequate to cover a home or small office space.

Looking to the Future

As the capability of the mobile infrastructure continues to evolve, the associated air interface technology puts different burdens on the power amplifier module. We kept the future in mind when we designed the AWB series of power amplifiers. By designing very linear yet power efficient modules, AWB power amplifiers can handle very high Peak to Average Ratio (PAR) waveforms such as WCDMA. They are also capable of handling the transition from WCDMA to LTE. Designers in turn will be able to design femtocells that can adapt to standards and support migration and growth strategies. Figure 1 shows the AWB7227 performance with an LTE waveform. The same part works equally as well with a CDMA2K or WCDMA waveform.

Maximizing the mean-time-to-failure (MTTF) of the power amplifier is also critical in the design of any infrastructure application, especially femtocells. Over the years, InGaP RF PAs have become the devices of choice for applications in the femtocell power range, since they combine high reliability with extremely high efficiency (see Figure 2). The ANADIGICS AWB7227 PA design offers excellent power added efficiency (PAE) operation. By reducing overall power consumption, the AWB7227 reflects the rising trend of green technology initiatives by reducing overall power consumption and enabling such femtocell features as battery back-up.

With a careful choice of materials and the application of sound design principles, we are producing high performance power amplifier modules that enable the design and development of exceptional femtocell solutions. As the small cell market for both service providers and consumers grow, ANADIGICS AWB series of power amplifiers look to provide ubiquitous coverage and high quality-of-service for 3G and 4G wireless networks.

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