New Miniature WiMAX Linear Amplifier Modules Solve System Challenges

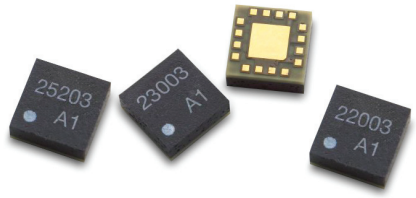
Introduction

Avago has introduced three new linear amplifier modules (LAM) in small 3 x 3 x 1 mm packages: the MGA-22003 (2.3-2.7 GHz, 25 dBm); MGA-23003 (3.3-3.8 GHz, 25 dBm); and MGA-25203 (5.1-5.9 GHz, 23 dBm).

The MGA-22003 and MGA-23003 are optimized for WiMAX systems, and the MGA-25203 is a general purpose amplifier for use when efficient linear power is important. This note focuses on the performance potential of the two WiMAX amplifiers and how system problems can be solved by using them.

WiMAX, Worldwide Interoperability for Microwave Access, is a family of IEEE 802.16 standards designed to address the needs of Wireless Metropolitan Area Networks (WMANs). There are multiple implementations of the standard being developed for fixed and mobile applications.

WIMAX's reach is a significant advantage over Wi-Fi networks. Internet connectivity to local communities and areas can be quickly installed without the infrastructure required by cable or phone technologies. Some forecasts project over 75 million WiMAX subscribers by 2014, with the majority being mobile users. Chipset unit volume may exceed 75 million in the same year.



MGA-22003 and MGA-23003 WiMAX Linear Amplifier Modules

One technical challenge facing designers is how to cover the full band with a dedicated RF Front End solution. After reviewing various deployment scenarios, as well as auctioned frequency bands in certain geographical locations, Avago decided to design a full band solution that provides one set of hardware to cover the WiMAX bands.

The peak-to-average characteristics of a 16QAM OFDMA signal with 10 MHz signal bandwidth over a relatively wide RF band places a special requirement on the TX chain. The requirement to meet a stringent spectrum emission mask in conjunction with system EVM specifications requires special design techniques and sophisticated semiconductor process technologies for the RF power amplifier.

The RF power amplifier must deliver linear power of 23 dBm to the antenna after the post-PA losses. The linearity requirement is met by backing-off the PA at the cost of DC power efficiency. The linearity requirement over a wide frequency band with a high degree of back-off means the RF power amplifier must have a high level of peak power handling capacity. The maximum power from this high 1 dB output power compression point (P1dB) of non-linear power amplification requires a carefully designed output-matching network.

With these constraints in hand the MGA-22003 and MGA-23003 design focused on high gain, full match, low cost, and good efficiency over the WiMAX bands. They meet industry-standard spectral emission mask (SEM) tests. The MGA-22003 meets stringent WiMAX Forum SEM requirements with margin, and the MGA-23003 complies with ETSI SEM requirements. These very small, internally 50 Ω matched amplifiers require only one external capacitor at the supply pin. Standards-compliant performance is achieved in a small space with low supply current. The 50 Ω internal matching reduces development time for both fixed and portable devices. The broad operating frequency range allows designers to use a single power amplifier to cover an entire WiMAX band where previously multiple narrow band parts were necessary to meet performance goals.

WiMAX RF Front end challenges

Equipment designers often experience difficulty locking in the RF front end lineups due to various system architectures and deployment scenarios as well as time-to-market pressure. The lack of historical use model statistics leaves the system architects with RF chain performance assumptions that are iteratively optimized during system integration or network trials. In addition, certain diversity and MIMO expectations in several deployment scenarios require switch + filter combinations with high insertion loss, from 0.5 dB to 4 dB. There are two expectations from these configurations: one is to deliver linear power from 23.5 dBm to 27 dBm from the PA and the second is to maintain the same DC power efficiency across power levels.

The dynamic range requirement of higher than 40 dB can also be handled in the transmit chain by using a gain step. However, once the final RF stage in the transmit chain delivers power levels close to 0 dBm, the PA draws DC current similar to the quiescent current, which is necessary for ultra-linear operation in High Power Mode.

WIMAX OFDMA systems operate using a pulsed signal. The transmit chain is synchronized using a frame structure and the duty cycle of the signal is determined by the application as well as data stream. The MGA-2203 has a bias switch pin (BSW) which eliminates the need for a costly high current switch on the supply line during off-pulse mode. The BSW pin can be controlled by a simple CMOS signal.

How has Avago addressed these challenges?

The choice of semiconductor technology, Avago's proprietary GaAs Enhanced mode pHEMT process, provides a full range of operation from 2.9 V to 5 V with proven reliability. In short, the MGA-22003 and MGA-23003 deliver a linear 25 dBm @3.3 V and over 26 dBm @5 V supply voltage.

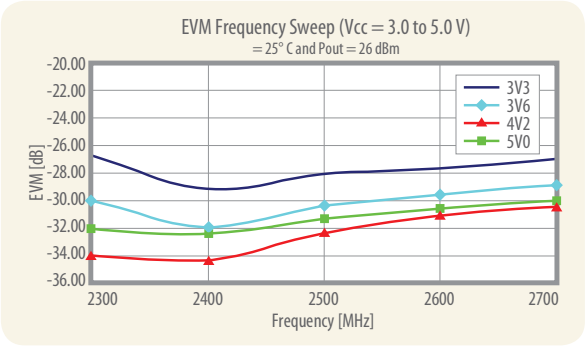


Figure 1. Error Vector Magnitude (EVM) performance at several supply voltages

Both Avago WiMAX LAMs include input and output matching networks and supply/signal pin filtering for ease of use across the full band. Since the LAMs are only 3 x 3 x 1 mm and the number of external components is minimized, the cost of ownership in the final application is kept to a minimum.

Avago has introduced a one-pin external bias control (BCTRL) that is independent of other supply pins. With the BCTRL pin, users can adjust the quiescent current of the three stages for best efficiency and best linearity at various output power levels.

Table1. Bias control settings for high efficiency

VCC = BSPLY = 3.3 V			
Pout	**BCTRL**	**Idd**	**EVM**
25 dBm	1.8 V	418 mA	-27.9 dB
24 dBm	1.7 V	367 mA	-27.6 dB
23 dBm	1.7 V	330 mA	27.0 dB
Idsq	x	94 mA	x

Table 2. Bias control settings for high linearity

VCC = BSPLY = 3.3 V			
Pout	**BCTRL**	**Idd**	**EVM**
25 dBm	2.8 V	501 mA	-32 dB
24 dBm	2.8 V	464 mA	-33 dB
23 dBm	2.8 V	435 mA	-35 dB
Idsq	x	240 mA	x

Avago has introduced two power operating modes: High Power Mode (HPM) and Low Power Mode (LPM). In Low Power Mode, LAM gain is reduced a minimum 10 dB, and the quiescent current is cut to less than 90 mA to make sure that DC power is not wasted. The power mode is selected with the PAMODE pin. No other controls are necessary for quiescent current adjustment. All the adjustments are performed by internal bias circuitry.

In addition, the MGA-22003/MGA-23003's dedicated BSW pin will switch the LAM on/off in nanoseconds. When completely turned off, current is in the microampere range.

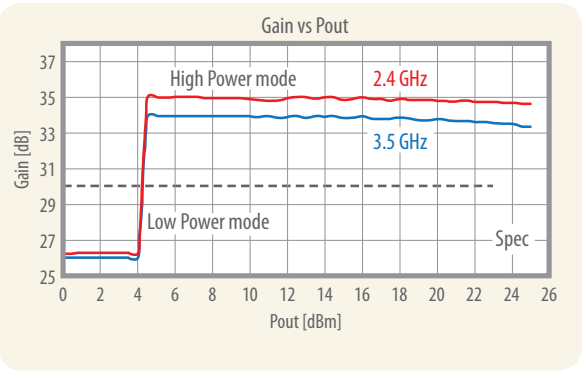


Figure 3. Low power mode current savings

Next steps – Multi-standard Coexistence challenges

As multi-mode portable devices increase in popularity, requirements exist to maintain interoperability when in close proximity to other radios. These coexistence challenges are quickly being addressed by Avago's RF product portfolio. For example, within the transmit path new linear amplifier modules are being developed which utilize aggressive gain-shaping with band-limited noise power characteristics. The next generation of the MGA-22x series covering the 2.5 to 2.7GHz range is scheduled for mid-2010 release and contains an internal filter to suppress out-of-band noise power and attenuate the gain outside the pass-band. Furthermore, the rejection in the PCS and GPS bands from the LAM eases the requirements on the coexistence filter.

Demonstration Boards

Demonstration boards for product evaluation can be requested from Avago's worldwide sales offices.

References and Resources

1. Avago Web and WiMAX frontend design video : www.avagotech.com/wimaxfrontend

2. WiMAX Forum®: www.wimaxforum.org

Contact us for your design needs at: **www.avagoresponsecenter.com/401**