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High performance microwave/millimeter wave GaAs components enable faster, higher capacity in 3G/4G backhaul networks

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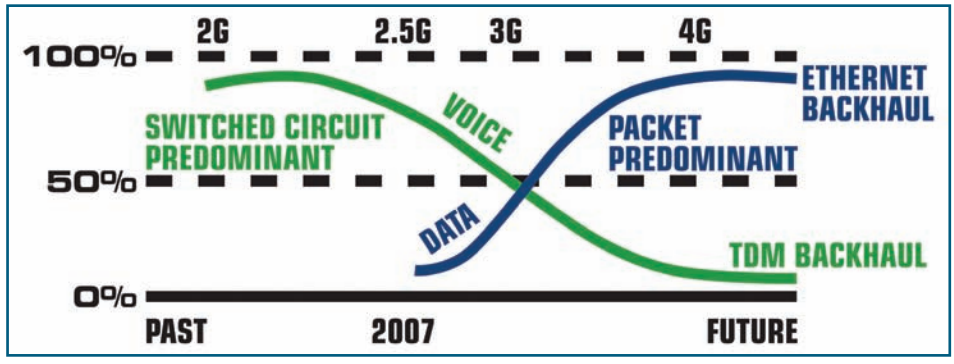
Increasing data traffic is creating a backhaul network bottleneck

The last several years have seen a marked increase in the number of broadband users and the introduction of many new handheld mobile internet devices (MIDs). With data and video-centric applications now exceeding voice (see Figure 1), the demand placed on the transmission networks has never been greater. According to a recent report from market specialist ABI Research, the total number of mobile communications subscribers will reach 4.3B in 2009 and nearly 5.4B by 2013. As a result, data as a percent of all mobile traffic is increasing rapidly. Maintaining this growth trend will depend largely on mobile users having a positive broadband experience. To ensure QoS for all, the backhaul networks that aggregate and transport data must keep pace with user demand.

The proliferation of Smartphones and other MIDs is driving the increase in data traffic and some operators have already begun to experience network issues. Recently, Yankee Group Research reported that 50 percent of mobile network failures can be attributed to insufficient backhaul networks. It is now widely observed that the bandwidth bottleneck in mobile networks has shifted from the Radio Access Network (RAN) to the backhaul network. Making the transition from voice to data requires a significant increase in capacity and data rate capability for backhaul networks. As data traffic volumes continue to grow, mobile users have expectations for robust broadband connections and continuously increasing downlink speeds. Additionally, usage patterns are shifting from mostly asymmetrical traffic (download-centric), toward a more symmetrical pattern as peer-to-peer data and two-way video applications increase.

Figure 1: Voice to Data centric application transition (Source IWPC 2008).



High-performance GaAs can ease backhaul bottlenecks

Increased broadband demand will require network operators to work aggressively to upgrade their backhaul networks. The current dependence on leased line, multiple T1 capacity for backhaul is an expensive and inefficient solution that is also insufficient to keep up with rising capacity demands. Most providers will opt to move toward 40 Gb/s fiber and high capacity microwave radio as the wireline and wireless technologies of choice for upgrading their backhaul networks. Both technologies have distinct advantages over leased line. Cost, geography, time-to-market and available frequency spectrum all play an important role in carrier choices. However, both fiber and radio solutions will require next generation, high-frequency, high-performance RF components with improved bandwidth, linearity and power consumption — devices with characteristics commonly found in gallium arsenide (GaAs) transistors, amplifiers and related components. Ideally, these high-frequency components will also be available in low-cost surface mount packages that employ the same assembly methods typically used for low- frequency electronic products.

Fibre backhaul — Considered the optimum backhaul solution for speed and capacity, fiber networks have increased cell site backhaul share to 25 percent worldwide according to Yankee Group research published in WiMAX Trends. According to International Data Corporation (IDC), much of the installed fiber capacity has already been consumed by current demand; IDC estimates that data traffic may triple by 2012. High speed networks with greater bandwidth will allow operators to more cost-effectively meet growing worldwide demands. The transition from 10G to 40G/100G fiber networks is well underway, driving the need for high-performance, wideband GaAs component solutions. These GaAs products, combined with efficient modulation schemes like Differential Quadrature Phase-Shift Keying (DQPSK), provide network operators and consumers a means to achieve higher capacity on existing fiber networks.

Spectrally efficient 40G DQPSK modulation requires a narrower optical

spectrum, has excellent tolerance to chromatic dispersion, and can be deployed utilizing current 10 Gb/s line cards in standard 50 GHz channel spacing, providing a big benefit for network operators. Additionally, with DQPSK modulation, 40 Gb/s transponders require system electronics to operate at half the bit rate. Wideband, high-performance GaAs MMIC modulator drivers with >22 GHz bandwidth are required for optimum performance in today's DQPSK systems.

As an example, TriQuint's new TGA4943-SL modulator driver module is the first to combine multiple amplifiers and filters within a surface mount package, providing designers easier assembly for 40 Gb/s optical networks. The integrated SMT module provides high output drive capability, superior edge rates and excellent signal-to-noise ratio and consumes only 2.1 W — about 50 percent of other existing 40G solutions. This provides significant savings for network operators. The new module was created specifically to meet the performance requirements of the DQPSK modulation standard. Figure 2 illustrates the compact 14.4- x 7- x 2-mm SMT modulator driver module. Figure 3 illustrates a DQPSK eye pattern measured at 22 Gb/s, 0.48 Vpp input, Vout = 8 Vpp.

Figure 2: TGA4943-SL SMT module.

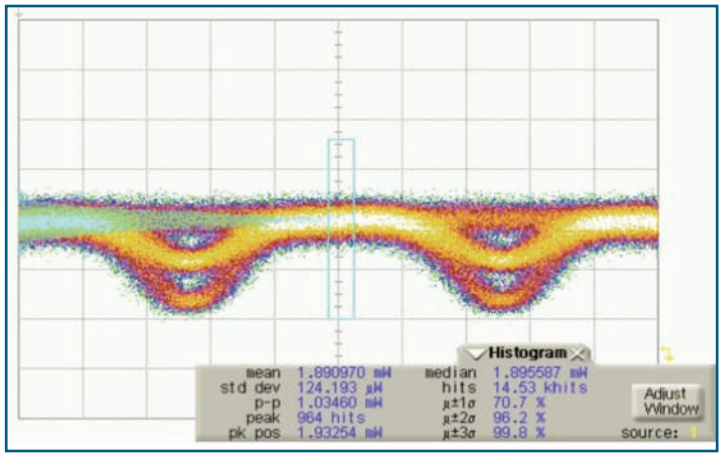


Figure 3: TGA4943-SL module DQPSK eye pattern measured at 22 Gb/s, 0.48 Vpp input, Vout = 8 Vpp.

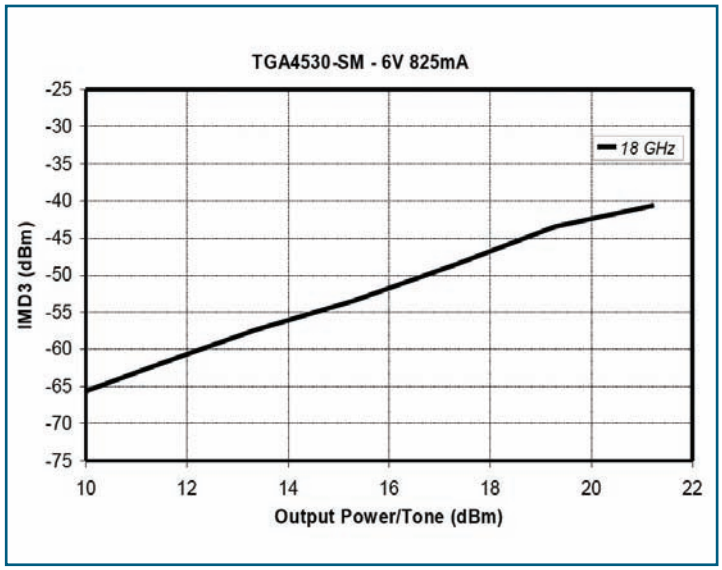
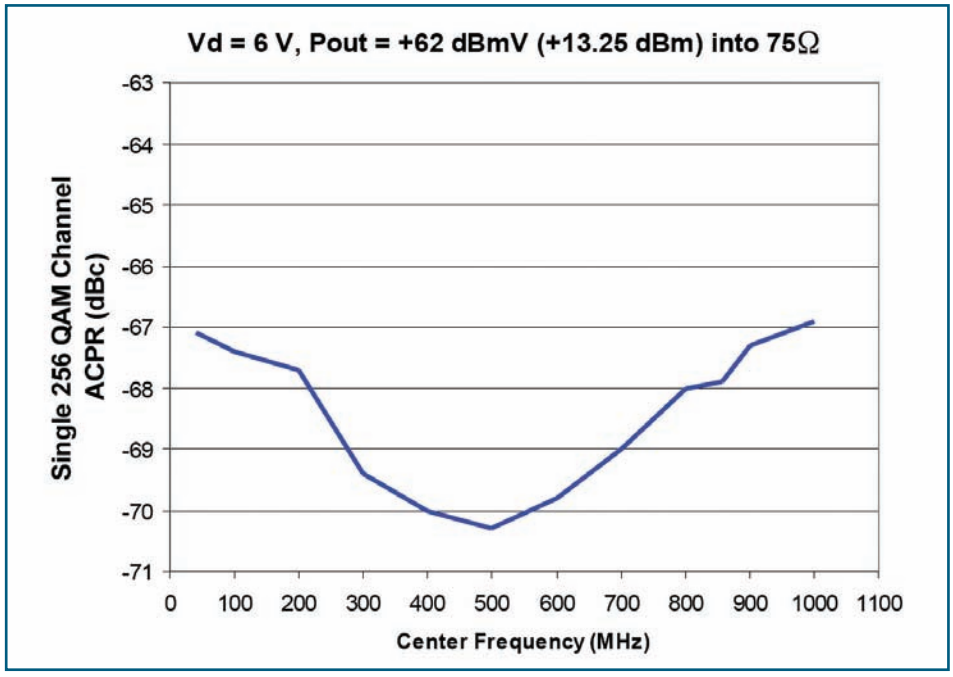


Figure 4: TGA4530-SM IMD3 performance plot.

Wireless backhaul — Microwave radio offers a cost-effective and rapid time-to-market alternative for high-capacity backhaul. Fiber is ubiquitous in the US but less prevalent elsewhere, making microwave radio solutions very attractive in such areas. According to EJL Wireless Research, approximately 80 percent of radio installations around the world have been lower capacity PDH links utilizing QPSK – 16QAM modulation to deliver data rates up to 64 Mb/s, operating in licensed frequency bands between 6-40 GHz. With the ever-increasing need for speed and capacity, a larger share of radios now deliver data rates in excess of 155 Mb/s by utilizing increasingly complex modulation schemes (up to 256QAM) to improve spectral efficiency in a limited channel bandwidth. There is also increasing activity in the licensed 71-86 GHz frequency range (E-band) where gigabit data rates are possible over a limited range.

High capacity radio systems require higher performance RF front-end components, especially in the final transmit power amplifier stage. New amplifier designs for high-capacity millimeter wave radios require excellent linearity, low power dissipation and low-cost surface mount packaging that can be assembled utilizing standard SMT equipment and techniques. An example of a linear PA used for 18 GHz radio applications is the TriQuint TGA4530-SM. The TGA4530 provides 29 dBm saturated output power at the 1 dB compression point and 41 dBm OTOI at 6 V, 825 mA bias point. The typical gain is 22 dB and the part is supplied in a 4x4 QFN surface mount package. Figure 4 illustrates the third-order intermodulation distortion curve versus single tone output

Figure 5: TGA2807-SM ACPR performance plot.



power level at 18 GHz and is typical of the performance level that radio customers require for linear PAs in high capacity radios.

Cable — Recent cable network upgrades and expansion to support increasing consumer demand for services such as high-speed internet, video on demand (VOD) and HDTV help to reduce the backhaul bottleneck, especially in suburban areas where fiber nodes have pushed deep into the network. The DOCSIS® 3.0 standard places higher performance requirements for linearity in the form of adjacent channel power ratio (ACPR) and wider bandwidth (50 MHz to 1 GHz) to support new digital TV requirements. Reduction in dissipated power is also an important requirement placed on rack and card-mounted components where thermal management can be challenging.

Tailored for the performance requirements of DOCSIS® 3.0, TriQuint recently introduced the TGA2807-SM for CATV headend applications. The new TGA2807-SM has improved ACPR, ~2 dB better than previous generations, as well as significantly reduced power consumption. The TGA2807-SM offers high output power, excellent linearity and comes in a standard 5- x 5-mm QFN package for efficient thermal operation. The device can replace two similar amplifiers in conventional designs, reducing overall system costs and external matching circuitry. ACPR is a critical performance parameter in CATV systems and a key 'care-about' for CATV components. Figure 5 illustrates the TGA2807-SM ACPR performance, which is consistent with DOCSIS® 3.0 requirements.

Summary

As consumer demand for Smartphones and other MIDs increases, the transition from voice to data-centric applications is occurring rapidly. This is driving the bandwidth bottleneck from the radio access network to the backhaul network. In spite of the current economic downturn, it is anticipated that operators will return to a level of CAPEX spending required for the upgrade of current backhaul networks. To preserve QoS for both voice and data users, tomorrow's networks will need to deliver higher data rates and improved spectral efficiency by utilizing 40 Gb/s fiber, higher-capacity microwave radios and upgraded HFC cable networks. Each of these transmission systems will require a new generation of high-performance microwave/millimeter wave components. Manufacturers serving these markets are utilizing the latest GaAs process technologies, design tools and innovative high-frequency packaging and testing methods to deliver wide bandwidth, cost-effective and linear power solutions that also offer more efficient power utilization.