Meeting ADSL System Design Goals With Advanced Analog and Power Management Designs

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Kurt Eckles
Business Manager, Infrastructure Products
Broadband Communications Group

Richard Nowakowski
Product Marketing Engineer
Power Management Products Group

James Zell
Product Marketing Engineer
High Performance Linear Group

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While digital technology provides ADSL's processing foundation, it is the complementary analog and mixed-signal technology that will make it possible for carriers to cost-effectively deploy ADSL upwards to 90 percent of their installed base. In many ways, the analog and mixed-signal technology in an ADSL design is the springboard for achieving overall system goals because these components comprise the lion's share of the board area. Well conceived analog and mixed-signal designs enable dramatically lower power ADSL infrastructure systems allowing more highly integrated devices with fewer components, thereby lowering the system's overall cost per port. Cost per port is the carrier's single most important consideration when seeking to lower their cost model, subsequently boosting profit margins.

The Importance of Low Power

Initially, ADSL system designers were primarily concerned with achieving high performance across long loop lengths (18,000 feet or greater) from the Central Office (CO) to a remote terminal or customer premise modem. As ADSL's popularity grew, it quickly became apparent that limited space, power and cooling abilities in the CO would require more highly integrated and power efficient designs. For example, the first ADSL boards serviced only four channels, while today's boards contain up to 72 channels, proving power and space to be even more critical considerations.

To achieve the goal of reaching 90 plus percent ADSL coverage, OEMs are now focusing on equipment for intermediate and short-loop length connections, especially as carriers move to extend local loops for primarily new neighborhoods. These additional nodes make it possible to connect more customers with full-rate 8 Mbps or higher service, particularly users with loop lengths too long to be serviced with CO connections. Carriers connect customers using intermediate loop length infrastructure, such as Digital Loop Carriers (DLC), for distances typically up to 12,000 feet. Other customers, residing in multi-dwelling unit (MDU) environments, may be connected through optical networking units (ONU), with short loop lengths of up to 6,000 feet. Because of these physical environments, the DSL systems serving them require even more dramatic space constraints, requiring ever more power-efficient, high-density designs.

ADSL infrastructure systems that incorporate intelligent, efficient and highly integrated ADSL analog and power management designs will resolve these space and power issues, ensuring the proliferation of ADSL. Utilizing these designs, OEMs can build cost-efficient, high-density products that make it possible for local

exchange carriers (LEC) and service providers to cost-effectively reach more customers.

Accordingly, it is important for manufacturers, and ultimately carriers, to choose an ADSL solutions provider with the systems knowledge, the process technology and the integration expertise to help implement the most effective ADSL power management and analog solution. Leveraging five generations of field-deployed ADSL solutions, Texas Instruments (TI) provides the industry's most advanced analog and power management solutions.

TI high-performance analog solutions for ADSL systems include a full range of line drivers and receivers, integrated line drivers/receivers, high-performance, low-power codecs and power management products. They are designed in very close coordination with TI's DSP-based DSL transceivers to provide maximum integration and low-power performance. Additionally, designers can choose stand-alone components of TI's ADSL analog and power management portfolio. Whether standalone or complete solutions, these products support all worldwide ADSL standards and are designed to provide low-power performance.

Line Drivers/Receivers

Line drivers and receivers, which provide the real-world interface for ADSL signals coming off of or going on to the line, present the single most important design challenge for reducing system power consumption, and thus increasing board density. The earliest CO designs featured line drivers that consumed around 2.5 watts of power when driving full-rate Discrete Multi-Tone (DMT) ADSL signals. Today, integrated line drivers/receivers are still the primary source of power dissipation in the overall system budget. However, through design improvements and advancements in design topologies, highly integrated line drivers/receivers like TI's THS7102 and THS7103 use 1.1 watts per channel to perform the same function.

This dramatic increase in performance is achieved through a combination of improved design topologies and device integration. TI has progressively pushed its line driver products along an amplifier technology curve, beginning with Class A/B line drivers, then Class G and now, full active termination drivers such as the THS7102 and THS7103. Active termination, or synthesized impedance, line driver technology virtually eliminates the power-hungry matching resistors that were previously required to terminate the line. In addition, eliminating the matching resistors reduces the output voltage requirements of the line driver, enabling the THS7102 and THS7103 to operate off a single +15-V power supply for full-rate downstream ADSL DMT, versus two to four from other vendor designs.

Integration plays another key role in optimizing analog system performance. In addition to a low-power differential receiver and low-power active termination

differential line driver, the THS7102 and THS7103 integrate transmit filters, receive filters and integrated transmit/receiver gain resistors that were previously implemented discretely.

While line driver/receiver technology remains an important area for design optimization, advances in topology, integration and system knowledge make it possible to reduce system power and size. These advancements greatly impact the OEM and carrier's goal of lowering power per port and increasing the number of channels per board, per rack and per system. Today these advancements are hastening the true mass deployment of ADSL.

Power Management Solutions

Optimization of power management functions is crucial for maximizing the potential of ADSL designs as well. Heat dissipation, board space and system protection are primary concerns of any ADSL system. By utilizing advanced power management techniques, designers can significantly increase system performance.

TI's Active Power Management technology is an example of how intelligent power management solutions can greatly reduce power per port, leading to lower heat dissipation and enabling higher solution density. TI's power optimization (TPS54900) allows an ADSL system to intelligently regulate the supply voltage the line driver requires to drive the signal. During line testing, the transceiver calculates the loop length and then requests an optimized voltage required to drive the line.

As a comparison, a fixed-voltage implementation at a reduced loop length may operate at 15 V, whereas the TI TPS54900's with Active Power Management technology may determine that the loop length only requires 8.5 V on the line driver. With a reduction of 6.5 V per channel, as much as a 50 percent reduction in power is realized on many loops. This is significant, especially on the newer shorter loop build outs where at least 50 percent of the potential subscribers reside.

TI's line of ADSL power management solutions offers system designers maximum flexibility in balancing design ease and ultimate system performance. Designers can choose from a line of integrated circuit solutions that allow maximum freedom in building the most highly optimized systems. Products include isolated switching controllers, supervisory circuits, low dropout regulators (LDO), hot swap controllers, DC/DC switching controllers, and DC/DC converters with integrated MOSFETs. Designers can also utilize easy-to-implement, reliable, and fully integrated plug-in power solutions that reduce time-to-market and ease design.

TI supports its power management products with extensive design resources and system expertise, giving designers the ability to improve their system's performance. They also utilize innovative packaging technology to conserve board space. Integrated circuits featuring PowerPAD™ packaging provide an exposed thermal pad for increased thermal performance to eliminate bulky heatsinks. Moreover, TI's Plug-in Power solutions in Excalibur™ packaging offer the versatility of surface- or vertical-mount single in-line packages (SIP), which increases design flexibility.

Codecs

Although the analog-to-digital and digital-to-analog conversion in ADSL systems does not consume nearly the power of the line driver, ADSL codecs still represent an opportunity for board-saving integration and power savings. As part of an overall intelligent analog design, it is an important way to further power budgets and decrease board-space requirements.

TI's new TLV320AD18 is one example. The eight-channel codec can operate with a 1.5-V supply, and each channel of the codec can be powered down individually to reduce power consumption and heat dissipation. In addition to power savings through integration, the device eliminates the need for 36 additional discrete components typically required in CO designs, saving on average one square inch of board space per eight channels.

Design Support

In addition to leading-edge chip technology, adequate design support can play a vital role in building the most advanced analog ADSL designs. TI approaches ADSL design from a system-level perspective, utilizing years of real-world experience gained through five generations of complete DSL solutions. As a result, TI can offer designers the right level of support for their project. Hardware support includes evaluation modules and full reference designs for developers who want to take TI designs from conception to delivery, as well as analog- and power-management-specific resources such as reference designs, applications notes, user's guides and datasheets.

Conclusion

In the final analysis, the success of any ADSL system largely depends on the cost per port it delivers to the carrier. Power, which determines how densely a system can be integrated, and integration, which helps determine how many ports are available in a given system, are key factors that prescribe how inexpensively a carrier can connect a single port with a single end user. Intelligent analog and power management system design can make the difference in reaching the OEM's design goals and the carrier's business goals.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265