Reduce Power Consumption of DSL Modems with the LT1969 Line Driver

by Tim Regan

Introduction

The LT1969 is an ADSL line driver ideally suited for CPE modem designs, with the added feature of programmable operating current. With a minimum output current capability of ±200mA and a wide 700MHz gain-bandwidth product, the LT1969 is suitable for placing any standard ADSL signal with up to 13dBm of RMS power onto a 100Ω phone line. The part is housed in a very small MS-10 package; the two additional package pins are employed to program the operating current of the driver stage.

One of the biggest headaches in the implementation of DSL modems is the total power consumption of the system. Although the DSP and analog front end (AFE) ASICs use much of the power, a significant amount is also dissipated by the line-driver stage. The driver stage must have large enough power supply rails to prevent clipping of the peaks of the DMT signal in ADSL or the PAM signals of HDSL2. These peaks can be four to six times the normally transmitted RMS signal. The quiescent biasing current of the amplifiers times the increased power supply voltage level sets the minimum power consumption of the driver stage, even when no signal is being transmitted.

This issue becomes a major concern in central office DSL designs where multiport cards are required. It is less of a problem on the CPE end of the connection where the power dissipation of just a single modem or port can be tolerated. However, as the deployment of DSL into the office environment expands, multiport CPE boxes face the same cumulative power consumption issue. Any techniques that reduce power consumption and power dissipation are most welcome by the power supply and thermal management engineers producing multiport DSL line cards.

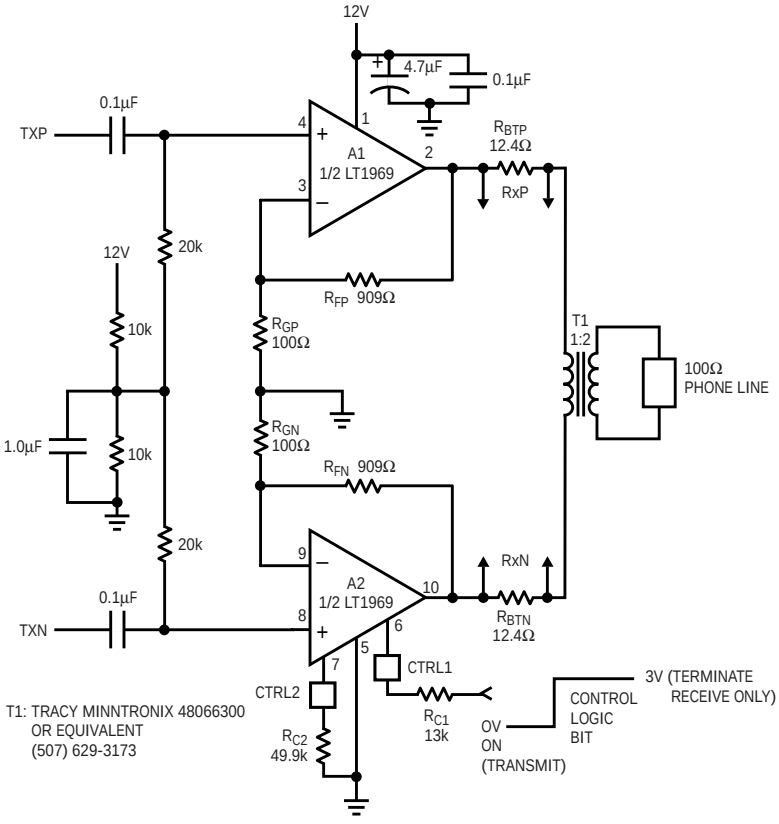

Figure 1. CPE ADSL line driver with operating current control

Adjust Transmit Driver Quiescent Current and Receiver Line-Terminate Bias Current

Two control pins (pins 6 and 7) are available on the LT1969 to set the operating current of the driver (Figure 1). Both of these pins are biased internally to approximately 1VDC above the V^- supply rail (pin 5). Resistors connected between these two pins and V^- set the driver stage operating current. The intended operation of the LT1969 is to fix the minimum operating current with one of the resistors in order to maintain low driver output impedance when not transmitting signals. This maintains termination of the transformer back-termination resistors so that signals received from the telephone line can still be developed across these resistors and detected by the receiver circuitry. Fixed resistor R_{C2}, connected from CTRL2 to V^-, sets the minimum operating current. The total supply current of the driver amplifiers is approximately 150 times the total current flowing out of the two control pins. An R_{C2} value of 49.9k sets 20µA of control current resulting in a minimum total driver supply current of 3mA (1.5mA per amplifier). Figure 2 illustrates the output impedance of each driver amplifier vs the programmed supply current. At 1.5mA per amplifier of supply current, the output impedance is less than 1Ω, which allows received signals

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to be developed across the 12.4Ω back-termination resistors. This is the line-terminate mode of operation, in which the line drivers consume only 36mW of power from a single 12V power supply.

During "Show Time," when the modem is communicating with the central office, the line driver needs more biasing current to provide sufficient bandwidth, slew rate and output current for distortion-free placement of the transmitted signal on to the phone line. This is where the second controlling pin is used. Referring again to Figure 1, the CTRL1 input pin is connected to a second resistor, R_{C1}, which is driven by a 0V to 3V logic input signal. This logic signal sets the driver into transmit mode or terminate mode. When taken high (greater than 1.2V more positive than V^- of the driver), no current flows out of the CTRL1 pin, leaving the supply current to be set only by the CTRL2 pin. When taken low, to a potential equal to V^- of the driver (which, in this case, is ground), resistor R_{C1} (13k) effectively parallels R_{C2} (49.9k), producing a total control resistance of 10.3k. This increases the total current flowing out of the control pins, thereby increasing the driver supply current for signal transmission duty. A total supply current of 12mA is normally sufficient for distortion-free transmissions of ADSL upstream data.

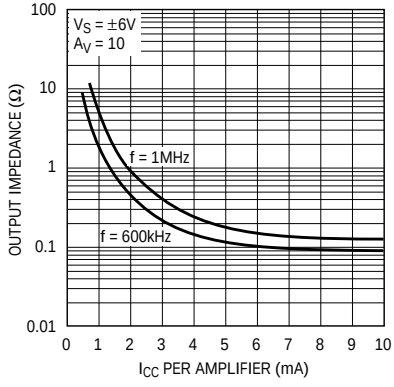

Figure 2. The LT1969 output impedance remains low at reduced operating current.

Conclusion

At this operating level, the quiescent power consumption of the line driver is 144mW when not transmitting. Using the LT1969 and adding simple logic control of the operating current provides 75% power savings in an idle channel. This can really add up in multiport designs. Additionally, the tiny footprint, MS-10 package used for the LT1969 occupies only 50% of the board area of a standard 8-pin surface mount device (S8 package), another benefit for compact multiport designs.

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