

Beware: Worst-Case Specifications Can Be a Reality

by Steve Hobrecht

Introduction

The design of portable electronic devices always involves trade-offs among cost, weight, size, speed, run-time, features and reliability. It is necessary to design the power supply for worst-case conditions because the software, which may or may not have been written yet, may, in some situations, exercise the hardware to its fullest potential. If typical operating conditions are used to define the power supply design requirements, hardware reliability may depend upon the particular software being used, either in normal operation or when the software is "acting up."

In the case of a typical notebook computer, the nominal 120mA I/O current can rise to 2.5A for an indeterminate amount of time. The software being executed is the determining factor. If a linear regulator is

used that is only capable of a lower continuous current due to power dissipation or maximum current limit, a system crash or a hardware failure may result when higher current is required. Hidden costs for warranty repair may result from running seemingly innocuous code, posing a long-term risk for the manufacturer. A high efficiency, dual, current mode controller can be substituted for the single controller plus linear regulator normally used in this application, to provide a small, reliable, efficient solution. This will prevent the inevitable thermal problems associated with the use of a linear regulator.

The application presented here provides a VID-controlled, 0.9V–2.0V, 15A CPU supply, 1.5V/2.5A I/O supply and 2.5V $\pm 5\%$ /150mA clock supply. The power supply compo-

nents chosen meet the maximum current specifications over the operating temperature and input voltage range.

The LTC1708-PG is the newest member of Linear Technology's third generation of PolyPhase DC/DC controllers. This controller is similar to the LTC1628 controller (see "A Third Generation Dual, Opposing-Phase Switching Regulator Controller," *Linear Technology* IX:2 [June, 1999], pp. 16–20) but with the addition of 5-bit VID output voltage control and a power-good indicator.

Application Benefits

The LTC1708-PG includes a dual, synchronous, current mode controller, VID output voltage programming and a power-good function in a 28-pin SSOP package, providing a compact

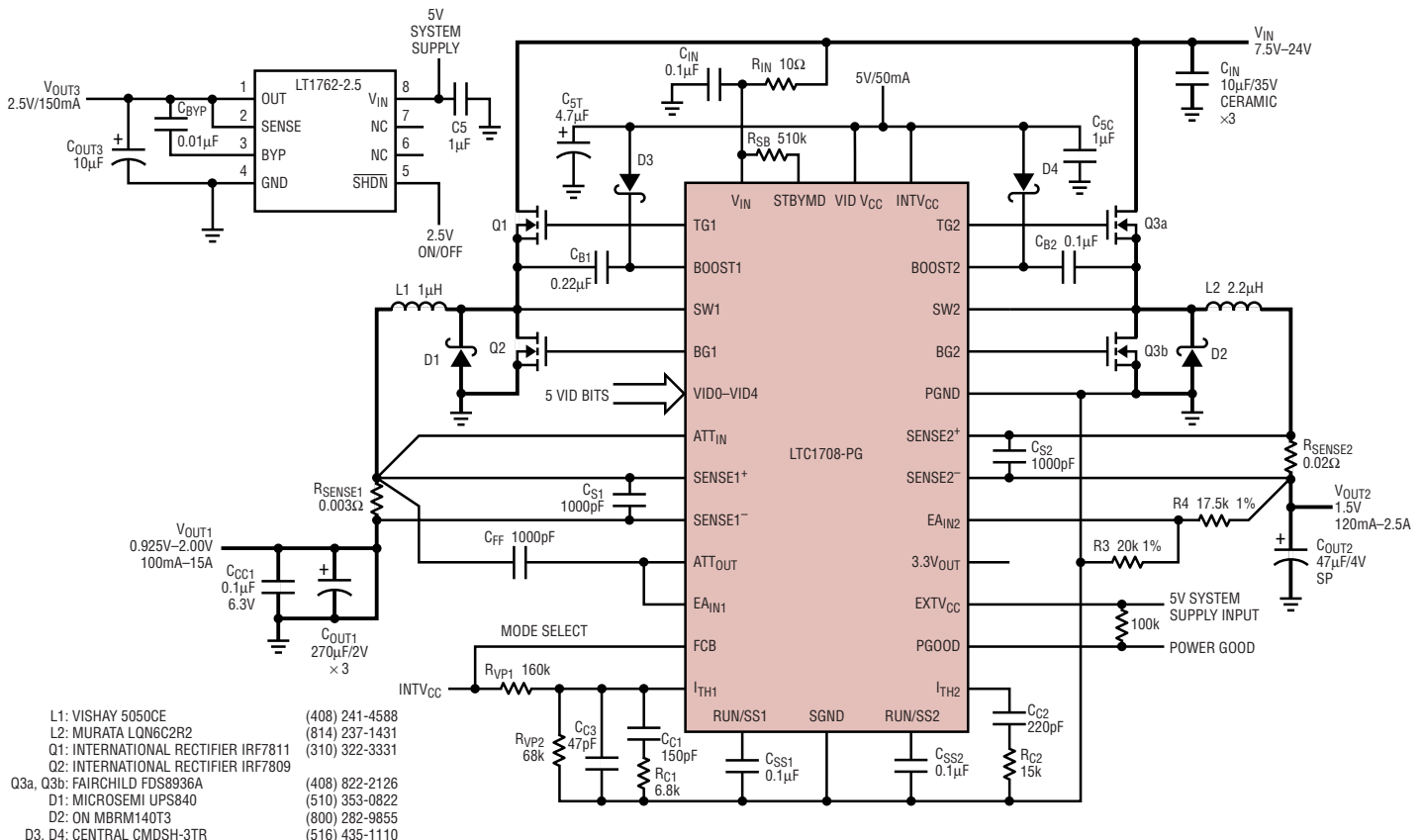


Figure 1. LTC1708 microprocessor core, I/O and clock supply: 0.9V–2V/15A, 1.5V/120mA–2.5A and 2.5V/150mA with active voltage positioning

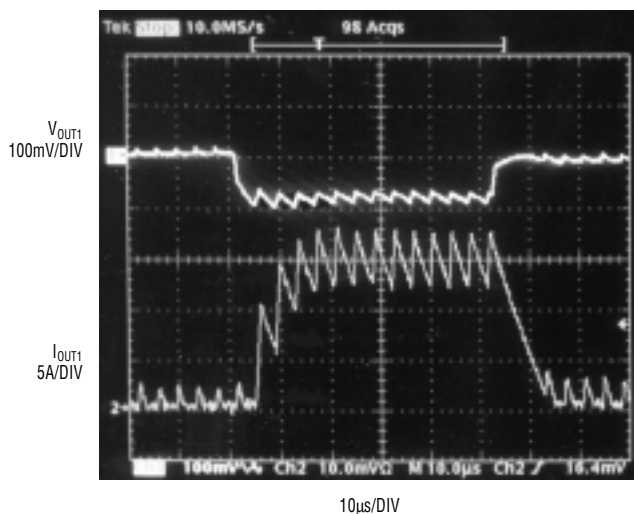


Figure 2. Output voltage response to a 100mA-15A load step

CPU power supply solution. Internal timing control interleaves the turn-on timing of the top MOSFETs for the two controllers, reducing the input RMS current and hence the input capacitance requirement. OPTI-LOOP compensation and low current Burst Mode operation reduce the output capacitance requirement.

The 1%, 0.8V reference voltage provides output voltage accuracy along with compatibility for future, lower voltage microprocessor and ASIC requirements. Load regulation is typically 0.1% and is compatible with active voltage positioning techniques (see "Active Voltage Positioning Saves Output Capacitors in Portable Computer Applications" on page 23 in this issue). The device incorporates an overvoltage "soft-latch" that protects the load if power supply problems develop but does not interfere or latch off when extreme transient conditions end. Internal foldback current limiting eliminates the need to overdesign the power components to protect against short circuits; an overcurrent shutdown can be enabled if desired. These protection features combine to make a very robust solution for long term reliability. The operating modes provide a choice of Burst Mode operation, constant-frequency operation and PWM modes (in order of decreasing efficiency) to satisfy almost any application. The constant frequency mode offers a low

noise solution that has high efficiency due to discontinuous operation, offering a solution for applications requiring bursts of high current at an audible rate. This technique reduces or eliminates the audible noise emanating from the gapped inductor that is typically used. The fast response time of the internal controller circuits allows the controller to maintain its operating frequency even with very high input-to-output voltage ratios. A 5V and a 3.3V linear regulator are provided to power ancillary functions.

2-Phase Operation

The LTC1708 dual, high efficiency DC/DC controller brings the considerable benefits of 2-phase operation to portable applications. Notebook computers, PDAs, handheld terminals and automotive electronics will all benefit from the lower input filtering requirement, reduced electromagnetic interference (EMI) and increased efficiency associated with 2-phase operation.

Application Circuit

Figure 1 shows a VID-controlled 0.9V to 2.0V, 15A CPU supply, a 1.5V/2.5A I/O supply and 2.5V $\pm 5\%$ /150mA clock supply. The controller's V_{IN} and $EXTV_{CC}$ pins should be connected to a supply of at least 4.5V, as specified by the MOSFET manufacturer, but the topside switching MOSFET drains can be connected

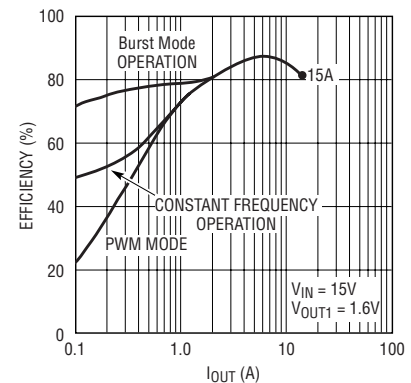


Figure 3. Efficiency vs output current of Figure 1's circuit for three operating modes

independently to a 3.3V, 5V or 10V-15V battery supply, or even a 24V wall adapter if desired. The schematic illustrates components selected for a 7.5V to 24V input.

Transient Performance

The oscilloscope photo (Figure 2) shows the switching power supply's high current output voltage response to a load current step of 100mA to 15A in the constant frequency mode. Figure 3 illustrates the overall efficiency for the three different operating modes: Burst Mode operation, constant-frequency operation and forced continuous (PWM) mode for 100mA to 15A.

Conclusion

A practical solution has been presented that exceeds the mobile CPU core, I/O and CLK specifications. The circuit performs reliably under the most adverse stimulus. The high overall efficiency minimizes cooling requirements as well.

The LTC1708 is just one member of Linear Technology's third generation family of constant frequency, N-channel high efficiency controllers. With PolyPhase timing control, VID programming, overvoltage and overcurrent protection features, OPTI-LOOP compensation and strong MOSFET drivers, the LTC1708 is a very safe choice for CPU core and I/O power applications. 