SOT-23 SMBus Fan Speed Controller Extends Battery Life and Reduces Noise

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Introduction

Battery run times for notebook computers and other portable devices can be improved and acoustic noise reduced by using Linear Technology’s LTC1695 to optimize the operation of these products’ internal cooling fans. The LTC1695 comes in a SOT-23 package and provides all the functions necessary for a system controller or microcontroller to regulate the speed of a typical 5V/≤1watt fan via a 2-wire SMBus interface. By varying the fan speed according to the system’s instantaneous cooling requirements, the power consumption of the cooling fan is reduced and battery run times are improved. Acoustic noise is practically eliminated by operating the fan below maximum speed when the thermal environment permits. Designers also have the option of controlling the temperature in portable devices by using feedback from a temperature sensor to control the fan speed.

Figure 1 shows a typical application. Fan speed is easily programmed by sending a 6-bit digital code to the LTC1695 via the SMBus. This code is converted into an analog reference voltage that is used to regulate the output voltage of the LTC1695’s internal linear regulator. The system controller can enable an optional boost feature that eliminates fan start-up problems by outputting 5V to the fan for 250ms before lowering the output voltage to its programmed value. Another important feature is that the system controller can read overcurrent and overtemperature fault conditions from information stored in the LTC1695. The part’s SMBus Address is hard-wired internally as 1110 100 (MSB to LSB, A6 to A0) and the data code bits D0 to D6 are latched at the falling edge of the SMBus Data Acknowledge signal (D6 is a Boost-Start Enable bit and D5 to D0 translate to a linearly proportional output voltage, 00–3F hex = 0V–5V). The

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Table 1 compares the input and output ripple current for single-phase and 2-phase configurations. A 2-phase converter reduces the input ripple current by 50% and the output ripple current by 75% compared to a single-phase design. The reduction in the cost and size of the input and output capacitors is significant.

Figure 3 shows the measured load transient waveform. The load current changes between 2A and 42A with a slew rate of about 30A/µs. Output capacitor type and size requirements are dominated by the total ESR of the output capacitor network. Six low cost aluminum electrolytic caps (Rubycon, 1500µF/6.3V) are needed on the output to meet this requirement. The maximum output voltage variations during the load transients are less than 200mVp-p. Active voltage positioning was employed in this design to keep the number of output capacitors at six (refer to Linear Technology Design Solutions 10 for more details on active voltage positioning). R4 and R6 provide the output voltage positioning with no loss of efficiency. If OSCON caps are used, four 1200µF/2.5V (2R51200M) capacitors will be sufficient.

Conclusion
The LTC1709 based, low voltage, high current power supply described above achieves high efficiency and small size simultaneously. The savings in the input and output capacitors, inductors and heat sinks help minimize the cost of the overall power supply. This LTC1709 circuit, with a few modifications, is also suitable for VRM9.0 applications. Refer to Linear Technology Application Note 77 for more information on the PolyPhase technique.