10A High Performance Point-of-Load DC/DC µModule Regulator
4.5V to 28V Input, 0.6V to 5V Output in a 15mm × 15mm × 2.8mm Package

Design Note 385
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Introduction
Advancements in board assembly, PCB layout and digital IC integration have produced a new generation of densely populated, high performance systems. The board-mounted point-of-load (POL) DC/DC power supplies in these systems are subject to the same demanding size, high power and performance requirements as other subsystems. The rigorous new POL demands are difficult to meet with traditional controller or regulator ICs, or power modules.

For such demanding applications, an ideal POL power supply must meet high performance specifications while simplifying board assembly—mounting similar to other surface mount ICs on the board without requiring special tooling. Such POL DC/DC regulators must also demonstrate exceptional thermal performance with innovative packaging technology. Power density increases without the danger of overheating and shortened device life. The LTM\textsuperscript{®}4600 µModule\textsuperscript{®} regulator does all of these things.

10A DC/DC µModule Regulator in IC Form Factor
The LTM4600 µModule regulator is a complete power supply point-of-load DC/DC regulator with a low profile IC form-factor. The controller, onboard inductor, MOSFETs and compensation circuitry are all housed in a 15mm × 15mm × 2.8mm LGA surface mount package which weighs only 1.73g (Figure 1). These size parameters allow the LTM4600 to be mounted on the back side of a system board, taking advantage of the otherwise unused space. The µModule regulator switches at a nominal 800kHz in a synchronous topology to offer very high efficiency in a small form factor and low profile.

The µModule regulator is offered in two versions. The LTM4600EV operates from an input supply range of 4.5V to 20V; the LTM4600HVEV operates from 4.5V to 28V. Both offer adjustable output voltages from 0.6V to 5V and output currents of 14A peak and 10A continuous. Fault protection features include overvoltage protection and overcurrent protection.

Quick and Easy Design
Figure 2 shows a typical LTM4600EV design for a 2.5V output and Figure 3 shows the efficiency of the circuit. Although bulk capacitors on the input and output suffice in most applications, this design uses two low ESR 10µF 25V ceramic capacitors to reduce input RMS ripple. The output voltage is set with an external resistor from the \textit{V}_{\text{OSET}} pin to ground. The output capacitors are selected for low ESR to maintain an initial voltage droop of the output voltage to approximately $\Delta V_{\text{OUT}} = I_{\text{LOADSTEP}} \times R_{\text{ESR}}$ in a transient step.

Figure 1. The LTM4600 Offers Unprecedented Power Density in a Small Package
Thermally Enhanced Packaging

The µModule regulator package has extremely low thermal resistance of 6°C/W and 15°C/W junction-to-case and junction-to-ambient, respectively. It allows heat-sinking from both the top and bottom of the device. Figure 4 shows the top view thermal imaging of the LTM4600 at full throttle with no airflow and heat sink. Refer to Application Note 103 for detailed thermal analysis and measurements.

Fast Transient Response

A unique feature of the LTM4600 is its no-clock-latency valley current mode architecture. This feature allows very fast loop response to rapid load transients with minimum output capacitance. Typically, the output voltage turns around in 4 to 6 microseconds and fully recovers in 20 to 25 microseconds. Figure 5 shows the transient deviation of only 55mV on a 2.5V output with a 5A load step. The 6µs of turnaround is achieved with only a 470µF POS cap and the three 22µF ceramics.

Paralleling the µModule Regulator for 20A Output

Two LTM4600 µModule regulators can be used in parallel to double the output current. The current mode architecture and precision current limiting allow two modules to equally share the output current, thus maximizing efficiency and equally distributing the heat.