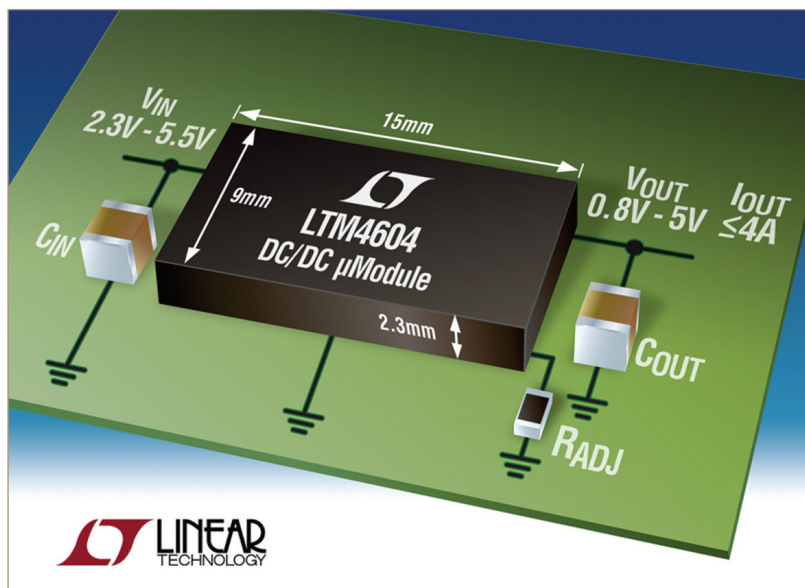


# Low Profile POL Solution

Last year, Linear Technology introduced a family of DC/DC point-of-load (POL) regulator systems referred to as  $\mu$ Modules. These switchmode DC/DC solutions are housed in tiny and compact surface-mount packages. The LTM4604 is the latest DC/DC  $\mu$ Module which also introduces a new family. Whereas the first family of six DC/DC  $\mu$ Modules targets higher voltage and higher power applications, this new family is specifically designed for lower voltage, slightly lower power applications. Moreover, the new family is housed in a 40% smaller package. **Afshin Adabae, Linear Technology Corp., Milpitas, California, USA**

**Figure 1:** The LTM4604 is an ultra-thin and complete switchmode DC/DC regulator system encapsulated in a 9mm x 15mm x 2.3mm package



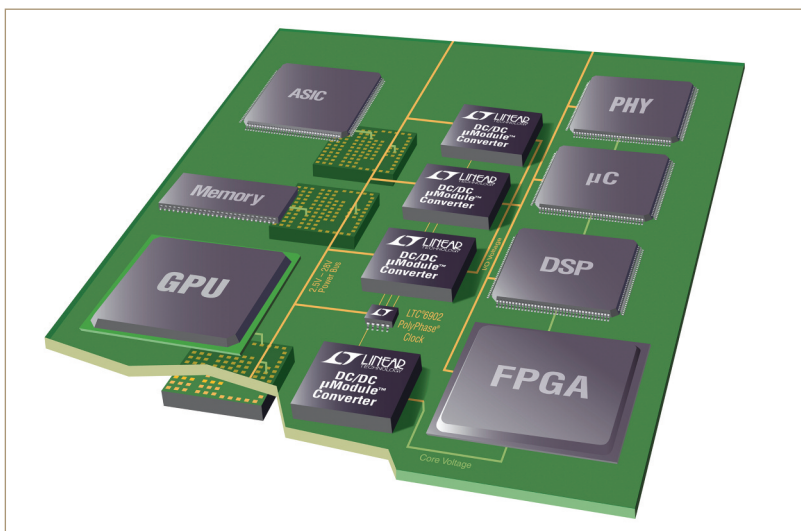
The LTM4604 is a complete 4A DC/DC regulator system including an inductor, DC/DC regulator, power MOSFETs, input and output bypass capacitors, as well as the compensation circuitry. All these components are included in a 2.3mm profile (height) encapsulated plastic LGA package that occupies 9mm x 15mm and weighs 0.86g (see Figure 1). The

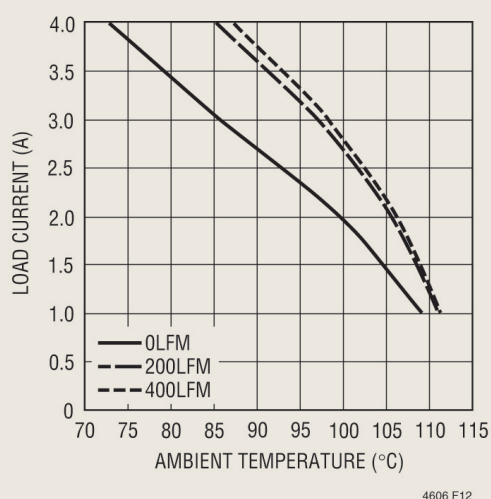
package is specifically designed to provide a compact point-of-load DC/DC solution for applications requiring ultra-thin packaging, such as RAID systems and single-board computers using PCI or PCI Express. Because of the LTM4604's lower voltage and lower power operation, this device is housed in a smaller and thinner LGA package which

occupies 40% less board area and is 18% thinner than the first family which provides higher power and higher voltage (LTM4600, LTM4601 and LTM4603).

The package has only 2.3mm thickness, which is especially beneficial in applications where the top of board is densely populated and leaves little room for a power supply. The thin package does not add significant overall thickness to the board and takes only 9mm x 15mm. According to PCI Local Bus Mechanical Specifications (revision 2.1, Chapter 5, Section 5.2) 'the maximum component height on the back side of the card is not to exceed 0.105 inches (2.67mm)'. With the LTM4604's 2.3mm height and addition of 0.2mm of solder, the total height is well below the PCI Cards' specification. The thin packaging and light weight of the LTM4604 allows it to be mounted on the back side of the card without violating the specifications (Figure 2). Back side mounting takes advantage of the room available otherwise unusable with bulky and heavy DC/DC regulators. In addition, the short profile of the LTM4604's package allows air to flow easily and evenly between multiple cards in a box.

**Figure 2:** A  $\mu$ Module regulator can be mounted on the back side of a system board

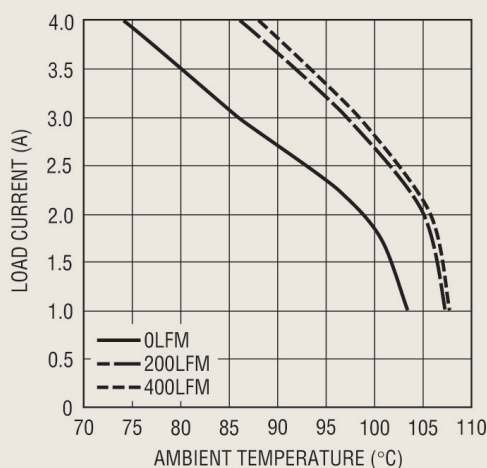




**Figure 3: Load current with different airflow at 3.3V input to 2.5V output (no heatsink)**

assembled power supplies operate at a maximum of 6 to 16V input. The few that operate above this voltage occupy more board area (40% more), have much higher profile (up to 2 times) and are lower power (2 to 5W). The LTM4600 and the family are all encapsulated solutions and are offered in two versions rated for different maximum input supply; for example, LTM4601EV (20V) and LTM4601HVEV (28V).

The package has only 2.3mm thickness which is especially beneficial in the applications where the top of board is densely populated and leaves little room for a power supply. The DC/DC  $\mu$ Module family can be soldered onto the back side of the board. The thin package does not add significant overall thickness to the board and takes only 9mm x 15mm.



**Figure 4: Load current with different airflow at 5V input to 2.5V output (no heatsink)**

### Thermal performance

Just because a DC/DC regulator claims high efficiency does not mean it is capable of dissipating the wasted power especially if its size has been reduced. To deliver the same power in a more compact DC/DC design, the POL system must feature lower thermal impedance. Otherwise, the output power of the POL solution has to be derated even at a relatively normal ambient temperatures and voltage conversion conditions. For example, if the LTM4604's package were to suffer from poor thermal impedance, it has to be derated to a 1.5A device in 70 to 90°C ambient temperature range even with airflow. To guarantee highest output delivery with minimal power derating even at extreme ambient temperatures and DC/DC conversion conditions, the LTM4604's package is designed to dissipate heat from top and bottom. Figures 3 and 4 show examples of measured thermal impedances for a 2.5V output voltage design.

### Electrical performance

The LTM4604 regulator operates from an input voltage range of 2.375 to 5V (6V maximum) and regulates an output voltage from 0.8 to 5V. This  $\mu$ Module regulator is a very compact solution for 5 and 3.3V main-power systems that need 2.xV, 1.xV and sub-1V point-of-load DC/DC conversion. It easily achieves 95 to 90% efficiency from 5V input and 3.3V output with load currents from 500mA to 4A. Only one external resistor is necessary to set the output voltage and a few bulk capacitors.

With current mode architecture, the LTM4604 is quick in protecting the load and itself against short circuit conditions. Other protection circuitries monitor over- and under-voltage, as well as over-temperature conditions. Because most digital systems monitor the output voltage regulation before powering-up completely, the device flags the system when the output voltage is in or out of regulation. Also, for a controlled power-up and

elimination of sequencing issues in complex multi-voltage boards, the LTM4604 is equipped with both soft-start and tracking functions.

Multiple LTM4604s can easily be paralleled to share the output current if more than 4A load current is needed. The current mode architecture and precise current sharing allows each device to equally share the increased load current eliminating overheating of any one of the devices. This feature allows the heat to dissipate uniformly among multiple regulators, eliminating overheating or hot spots. Also, to minimise EMI (electromagnetic interference), the internal inductor is shielded. Moreover, the internal layout and traces have been designed to reduce or eliminate any interference that maybe introduced from the fast switching currents.

This new family of  $\mu$ Module converters is unique for its low input voltage operation and smaller. The majority of pre-

### Conclusion

Linear Technology Corporation decided to introduce a new family of low voltage  $\mu$ Module products because many systems have decided to incorporate 3.3V as the main voltage bus. The rest of point-of-load voltages are derived from this voltage (2.5, 1.8V, 1.5, 1.0 and 0.9V). The LTM4604's compact package occupies 9mm x 15mm and has 2.3mm height. Its encapsulated design protects the components from the moisture or physical damage. A great deal of attention has been paid to its layout to minimise EMI and maximise heat dissipation. The device is so thin and light that can be easily mounted on the back side of a PCB creating room on the top for the digital components such as FPGAs, memory and ASICs.