Dual Output µModule DC/DC Regulator Produces High Efficiency 4A Outputs from a 4.5V to 26.5V Input

by Alan Chern

Dual System-in-a-Package Regulator

Systems and PC boards that use FPGAs and ASICs are often very densely populated with components and ICs. This dense real estate (especially the supporting circuitry for FPGAs, such as DC/DC regulators) puts a burden on system designers who aim to simplify layout, improve performance and reduce component count. A new family of DC/DC µModule regulator systems with multiple outputs is designed to dramatically reduce the number of components and their associated costs. These regulators are designed to eliminate layout errors and to offer a ready-made complete solution. Only a few external components are needed since the switching controllers, power MOSFETs, inductors, compensation and other support components are all integrated within the compact surface mount 15mm × 15mm × 2.82mm LGA package. Such easy layout saves board space and design time by implementing high density point-of-load regulators.

The LTM4619 switching DC/DC µModule converter regulates two 4A outputs from a single wide 4.5V to 26.5V input voltage range. Each output can be set between 0.8V and 5V with a single resistor. In fact, only a few components are needed to build a complete circuit (see Figure 2).

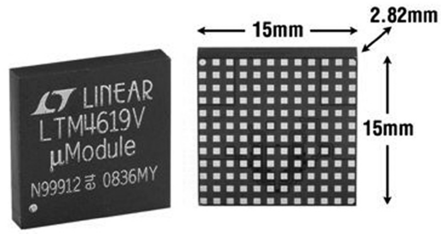

Figure 1. The LTM4619 LGA package is only 15mm × 15mm × 2.82mm, yet it houses dual DC/DC switching circuitry, inductors, MOSFETs and support components.

Figure 2 shows the LTM4619 µModule regulator in an application with 3.3V and 1.2V outputs. The output voltages can be adjusted with a value change in RSET1 and RSET2. Thus, the final design requires nothing more than a few resistors and capacitors. Flexibility is achieved by pairing outputs, allowing the regulator to form different combinations such as single input/dual independent outputs or single input/parallel single output for higher maximum current output.

The efficiency of the system design for Figure 2 is shown in Figure 3 and power loss is shown in Figure 4, both at various input voltages. Efficiency at light load operation can be improved with selective pulse-skipping mode or Burst Mode® operation by tying the mode pin high or leaving it floating.

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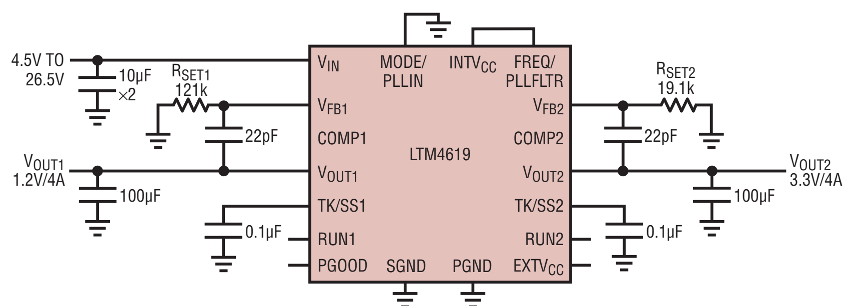

Figure 2. µModule regulator converts a 4.5V to 26.5V input to dual 3.3V and 1.2V outputs, each with 4A maximum output current.

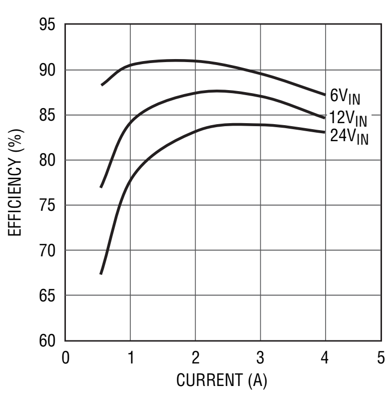

Figure 3. Efficiency of the circuit in Figure 2 at different input voltage ranges for 3.3V and 1.2V outputs

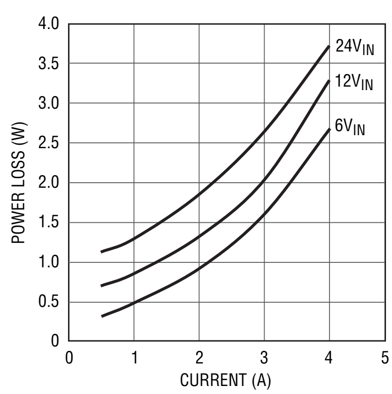

Figure 4. Power loss of the circuit in Figure 2 at different input voltages for 3.3V and 1.2V outputs

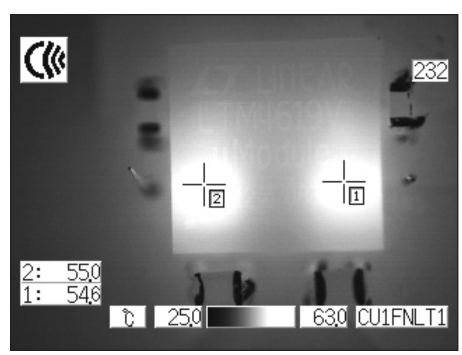

Figure 5. Exceptional thermal performance of a paralleled output LTM4619 µModule regulator ($12V_{IN}$ with two channels paralleled to $1.5V_{OUT}$ at 8A load)

Battery Charger

The LTC3577/LTC3577-1 battery charger can provide a charge current up to 1.5A via V_{BUS} or wall adapter when available. The charger also has an automatic recharge and a trickle charge function. The battery charge/no-charge status, plus the NTC status can be read via the I^2C bus. Since Li-Ion/Polymer batteries quickly lose capacity when both hot and fully charged, the LTC3577/LTC3577-1 reduces the battery voltage when the battery heats up, extending battery life and improving safety.

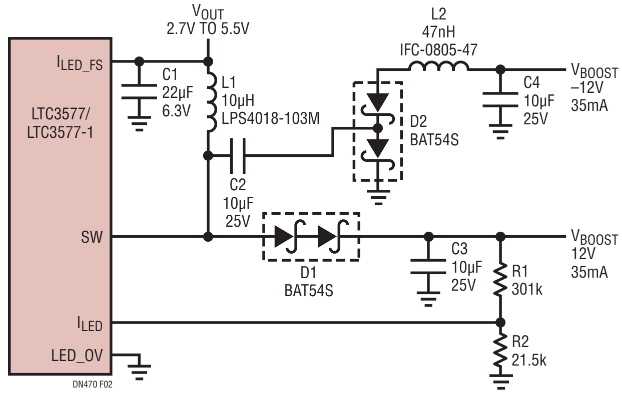

Figure 2. Dual polarity boost converter

Three Bucks, Two LDOs and a Boost/LED Driver

The LTC3577/LTC3577-1 contains five resistor-adjustable step-down regulators: two bucks, which can provide up to 500mA each, a third buck, which can provide up to 800mA, and two LDO regulators, which provide up to 150mA each and are enabled via the I^2C interface. Individual LDO supply inputs allow the regulators to be connected to low voltage buck regulator outputs to improve efficiency. All regulators are capable of low voltage operation, adjustable down to 0.8V.

The three buck regulators are sequenced at power up (V_{OUT1}, V_{OUT2} then V_{OUT3}) via the pushbutton controller or via a static input pin. Each buck can be individually selected to run in Burst Mode operation to optimize efficiency or pulse-skipping mode for lower output ripple at light loads. A patented switching slew rate control feature, set via the I^2C interface, allows the reduction of EMI noise in exchange for efficiency.

The LTC3577/LTC3577-1 LED boost driver can be used to drive up to 10 series white LEDs at up to 25mA or be configured as a constant voltage boost converter. As a LED driver, the current is controlled by a 6-bit, 60dB logarithmic DAC, which can be further reduced via internal PWM control. The LED current smoothly ramps up and down at one of four different rates. Overvoltage protection prevents the internal power transistor from damage if an open circuit fault occurs. Alternatively, the LED boost driver can be configured as a fixed voltage boost, providing up to 0.75W at 36V.

Many circuits require a dual polarity voltage to bias op amps or other analog devices. A simple charge pump circuit, as shown in Figure 2, can be added to the boost converter switch node to provide a dual polarity supply. Two forward diodes are used to account for the two diode voltage drops in the inverting charge pump circuit and provide the best cross-regulation. For circuits where cross-regulation is not important, or with relatively light negative loads, using a single forward diode for the boost circuit provides the best efficiency.

Conclusion

The high level of integration of the LTC3577/LTC3577-1 reduces the number of components, required board real estate and overall cost of power systems for portable electronics. It greatly simplifies power path design with built-in solutions to a number of complex power flow logic and control problems.

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Multiphase Operation

For a 4-phase, 4-rail output voltage system, use two LTM4619s and drive their MODE_PLLIN pins with a LTC6908-2 oscillator, such that the two µModule devices are synchronized 90° out of phase. Reference Figure 21 in the LTM4619 data sheet. Synchronization also lowers voltage ripple, reducing the need for high voltage capacitors whose bulk size consumes board space. The design delivers four different output voltage rails (5V, 3.3V, 2.5V and 1.8V) all with 4A maximum load.

Thermal Performance

Exceptional thermal performance is shown in Figure 5 where the unit is operating in parallel output mode; single 12VIN to a single 1.5VOUT at 8A. Both outputs tied together create a combined output current of 8A with both channels running at full load (4A each). Heat dissipation is even and minimal, yielding good thermal results. If additional cooling is needed, add a heat sink on top of the part or use a metal chassis to draw heat away.

Conclusion

The LTM4619 dual output µModule regulator makes it easy to convert a wide input voltage range (4.5V to 26.5V) to two or more 4A output voltage rails (0.8V to 5V) with high efficiency and good thermal dissipation. Simplicity and performance are achieved through dual output voltage regulation from a single package, making the LTM4619 an easy choice for system designs needing multiple voltage rails.