

# DESIGN NOTES

## Step-Down $\mu$ Module Regulator Produces 15A Output from Inputs Down to 1.5V—No Bias Supply Required

1.5V to 5.5V Input, 0.8V to 5V Output from a 15mm  $\times$  15mm  $\times$  4.32mm LGA Package

Design Note 488

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### 15A High Efficiency Output from a Low Input Voltage

The LTM<sup>®</sup>4611 is a switch mode, step-down DC/DC  $\mu$ Module<sup>®</sup> regulator in a compact 15mm  $\times$  15mm  $\times$  4.32mm LGA surface mount package. The switching controller, MOSFETs, inductor and supporting components are housed in the package. With a built-in differential remote sense amplifier, the LTM4611 can tightly regulate its output voltage from 0.8V to within 300mV of  $V_{IN}$  and deliver 15A output efficiently from 1.5V to 5.5V input.

Only a handful of components are needed to create a complete point-of-load (POL) solution with the LTM4611 (see Figure 1). The  $C_{SS}$  capacitor provides smooth start-up on the output and limits the input surge current during power-up.  $C_{FF}$  and  $C_P$  set the loop-compensation for fast transient response and good stability. The output voltage, 1.5V, is set by a single resistor,  $R_{SET}$ .

Efficiency is exceptional, even down to the lowest input voltages, as shown in Figure 2.

### Input and Output Ripple

Output capacitors should have low ESR to meet output voltage ripple and transient requirements. A mixture of low ESR polymer and/or ceramic capacitors is sufficient for producing low output ripple with minimal noise and spiking. Output capacitors are chosen to optimize transient load response and loop stability to meet the application load-step requirements by using the Excel-based LTpowerCAD<sup>™</sup> design tool. (Table 5 of the LTM4611 data sheet provides guidance for applications with 7.5A

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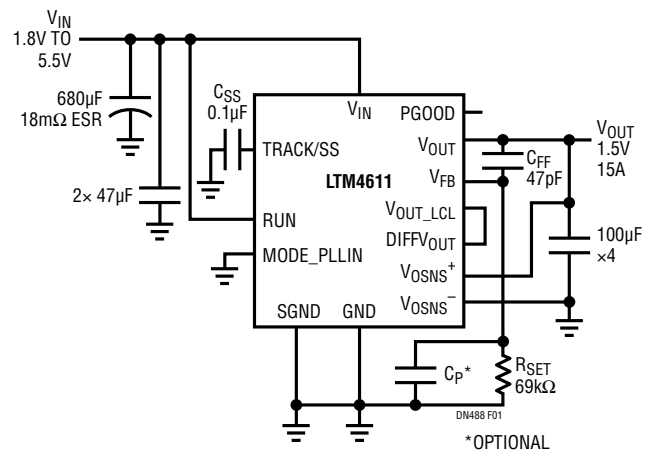


Figure 1. 1.8V<sub>IN</sub> to 5.5V<sub>IN</sub> to 1.5V<sub>OUT</sub> with 15A Output Load Current

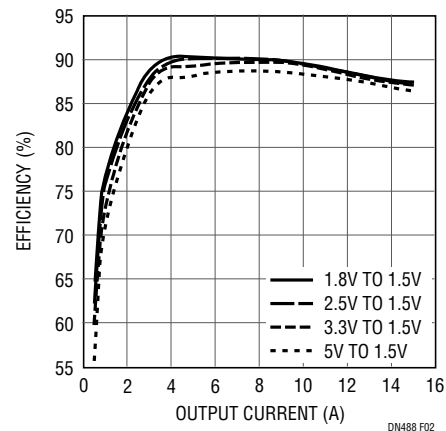


Figure 2. Efficiency of Figure 1 Circuit



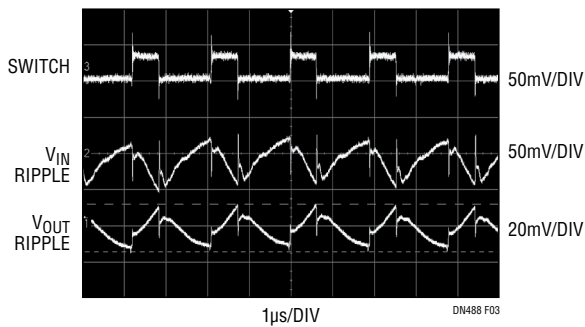
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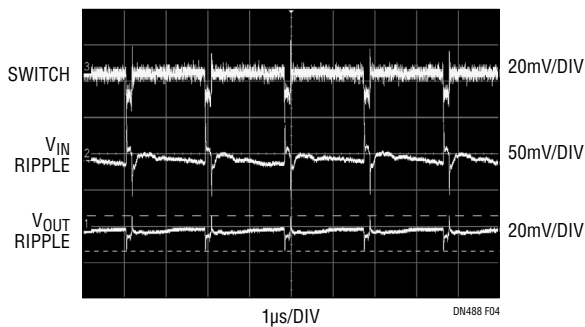
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**Figure 3. 5V<sub>IN</sub> to 1.5V<sub>OUT</sub> at 15A Output Load**



**Figure 4. 1.8V<sub>IN</sub> to 1.5V<sub>OUT</sub> at 15A Output Load**



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load-steps and 1µs transition times.) For this design example, four 100µF ceramic capacitors are used. Figures 3 and 4 show input and output ripple at 15A load with 20MHz bandwidth-limit. View the associated videos to see the test methodology, as well as ripple waveforms without bandwidth limiting.

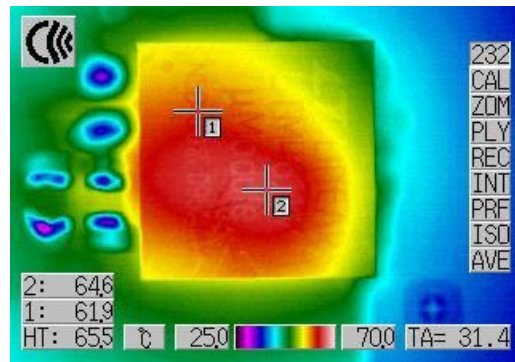
For this design, the choice of input capacitors is critical due to the low input voltage range. Long input traces can cause voltage drops, which could nuisance-trip the µModule regulator’s undervoltage lockout (UVLO) detection circuitry. Input ripple, typically a non-issue with higher input voltages, may fall a significant percentage below nominal—close to UVLO—at lower input voltages. In this case, input voltage ripple should be addressed since input filter oscillations can occur due to poor damping under heavy load current. This design uses a large 680µF POSCAP and two 47µF ceramic capacitors to compensate for meter-long input cables used during bench testing.

### Thermally Enhanced Packaging

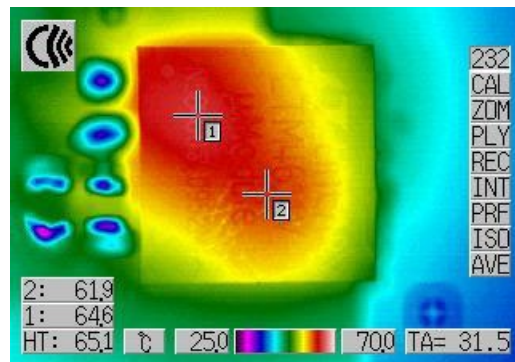
The device’s LGA packaging allows heat sinking from both the top and bottom, facilitating the use of a metal chassis or a BGA heat sink. This form factor promotes excellent thermal

dissipation with or without air flow. Figure 5 shows the top view thermal imaging of the LTM4611 at a power loss of 3.5W with no air flow, when converting 5V to 1.5V.

Internal self-heating of the LTM4611 remains quite low even at a low 1.8V input voltage due to its micropower bias generator that enables strong gate drive for its power MOSFETs. Figure 6 shows a power loss of 3.2W with hot spots slightly changed from their positions with a 5V input—the nominal surface temperature is 60°C. Watch the associated videos to see the test set-up and watch 200 LFM of air flow cool the unit by 10°C.



**Figure 5. 5V<sub>IN</sub> to 1.5V<sub>OUT</sub> at 15A Output Load. 3.5W Power Loss with 0LFM and 65°C Surface Temperature Hot Spot**



**Figure 6. 1.8V<sub>IN</sub> to 1.5V<sub>OUT</sub> at 15A Output Load. 3.2W Power Loss with 0LFM and 65°C Surface Temperature Hot Spot**



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### Conclusion

The LTM4611 is a step-down µModule regulator that easily fits into POL applications needing high output current from low voltage inputs—from 1.5V to 5.5V. Efficiency and thermal performance remain high across the entire input voltage range, simplifying electrical, mechanical and system design in data storage, RAID, ATCA, and many other applications.

**Data Sheet Download**

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