

# DESIGN NOTES

## Ultrathin Triple Output $\mu$ Module Regulator for DDR, QDR and QDR-IV SRAM Fits $0.5\text{cm}^2$ Area and Backside of PCB

Design Note 551

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### Introduction

Delivering the highest RTR (random transaction rate) of QDR (quad data rate) SRAMs, QDR-IV provides up to 400Gbps data transfer for high bandwidth networking, high performance computing and intensive data processing applications. A key challenge at these faster data rates is maintaining the integrity of the data transferred between the SRAM and devices such as high speed FPGAs and processors.

A good solution is to place the SRAM—QDR-IV, QDR or DDR, for example—very close to the interfaced devices on the PCB's topside. To conserve PCB area and minimize induced PCB parasitic noise on data bus lines, the DC/DC regulator circuit powering the QDR-IV SRAM data bus drivers should be placed nearby. The challenge is finding space for regulators on a densely populated PCB.

Using a complete DC/DC regulator with onboard inductor and MOSFETs housed in a compact package is one solution. But the scarcity of area on the top of the PCB can render even compact solutions insufficient. If the footprint, height and weight of the DC/DC regulator solution can be reduced enough, it can be placed on the backside of the PCB where space is available.

### VTT, VDDQ, $V_{REF}$ from $12V_{IN}$ in a Tiny Ultrathin Package

The LTM<sup>®</sup>4632 is a complete triple output step-down  $\mu$ Module<sup>®</sup> regulator specifically designed to support all three voltage rails required by the new QDR-IV and older DDR RAMs, housed in a 0.21g miniature ultrathin profile LGA package ( $6.25\text{mm} \times 6.25\text{mm} \times 1.82\text{mm}$ ).

Included in the package are the switching controllers, divide-by-2 circuit, power FETs, inductors and support components. Its tiny footprint and low external component count (as low as one resistor and three capacitors) occupies only  $0.5\text{cm}^2$  (dual-sided) or

$1\text{cm}^2$  (single-sided) while its thin profile enables mounting on the PCB bottom side to free up space on the topside for super-compact board designs.

The LTM4632 operates from an input voltage between 3.3V and 15V, providing precision output rail voltages between 0.6V and 2.5V. Its two switching regulator outputs,  $V_{OUT1}$  and  $V_{OUT2}$ , provide up to 3A for VDDQ and  $\pm 3\text{A}$  for VTT bus termination rails, respectively. Its third output provides a low noise buffered 10mA output for the termination reference (VTRR) tracking voltage. Figure 1 shows the LTM4632 circuit in a typical DDR3 application, illustrating its simple solution and small component count.

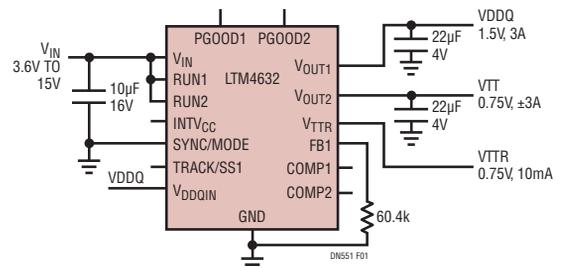


Figure 1. Typical LTM4632 DDR3 Application

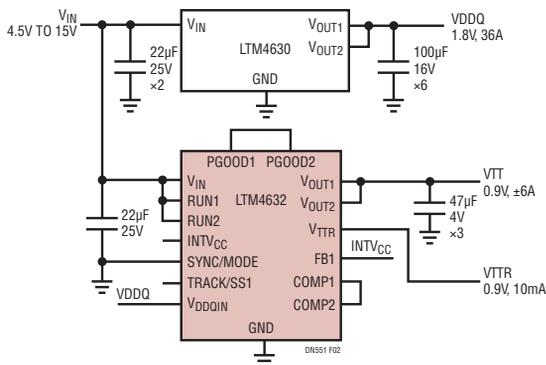
### Powering More SRAM Modules

The LTM4632's design flexibility enables it to support a broad range of application requirements. For example, its VDDQIN input allows the VTT and  $V_{REF}$  rail voltages to be set as either a typical  $1/2 \times V_{DDQ}$  voltage or programmed by an external reference voltage for other values. The LTM4632 can be configured as a two phase single output rail for VTT in applications needing more than a  $\pm 3\text{A}$  termination

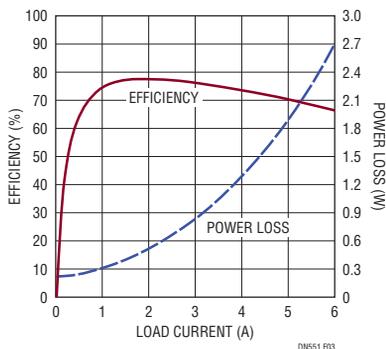
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rail current. These features allow the LTM4632 to support voltage requirements for many different SRAMs and increase load current requirements for larger memory arrays.

Figure 2 illustrates the flexibility of the LTM4632. The two switching regulator outputs of the LTM4632 are connected in a PolyPhase® current sharing configuration to provide up to ±6AVTT for larger memory banks. For more than 6A VDDQ, the LTM4632 can be combined with other µModule regulators, such as the LTM4630, to provide up to 36A for large SRAM arrays. Efficiency and power loss are shown in Figure 3, with thermal performance for the LTM4632 shown in Figure 4.



**Figure 2. LTM4632 Two Phase Single Output ±6A VTT with 36A LTM4630 VDDQ Supply**



**Figure 3. LTM4632 Efficiency and Power Loss. 12V Input. (Figure 2 Design)**

### Tight Regulation with Fast Transient Response

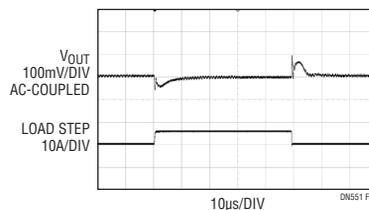
The LTM4632's unique controlled on-time current mode architecture and internal loop compensation allow for a fast transient with good loop stability



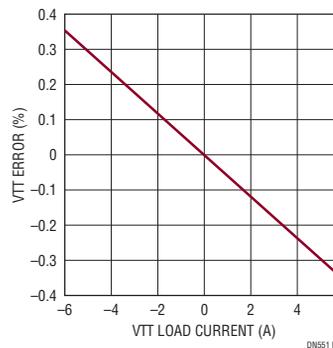
**Figure 4. LTM4632 Thermal Performance. 12V Input, 3A. (Figure 2 Design)**

over a wide range of operating conditions and output capacitance. Voltage regulation for its switching regulator outputs is precise, with guaranteed low ±1.5% maximum total DC output voltage error over line, load and temperature.

Figures 5 and 6 show the fast transient performance and tight load regulation of the LTM4632 VTT rail of the Figure 2 circuit.



**Figure 5. VTT Load Step, -3A to 3A (Figure 2 Design)**



**Figure 6. VTT Load Regulation (Figure 2 Design)**

### Conclusion

The ultrathin LTM4632 provides a complete high performance regulator solution for all three rails required in DDR/QDR RAM applications. Its wide operating range, features and compact solution size make it highly flexible and robust, and capable of fitting into the tightest spaces on the topside and backside of a PCB.

Data Sheet Download

[www.linear.com/LTM4632](http://www.linear.com/LTM4632)

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