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How To Match The DDR Memory Power Solution To The Application

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Double data rate (DDR) memory doubles the data transfer rate by transferring data at both the leading and falling edges of each clock cycle. DDR2 does this four times per clock cycle, while DDR3 and DDR4 do this eight and 16 times, respectively. The advantage with each newer DDR technology introduction is twofold. First, DDR allows faster processing systems such as computers and data servers. Second, the electrical efficiency also improves as the efficacy of data transferring improves, consuming less power per data byte.

Powering DDR memory chips requires the generation of two power rail rails—VDDQ and VTT. Suppliers of power management ICs have developed application-specific voltage regulators to generate these rails. Among the different DDR-specific power solutions, there are several different approaches to generating the power rails. These variations enable tradeoffs in pursuing design goals such as board space requirements, efficiency, and cost. This article explains the various options for powering DDR memory and the advantages offered by each. Specific Texas Instrument devices are cited here as examples. However, similar types of devices are available from other vendors.

VDDQ And VTT

Powering memory with switching dc-dc regulators has become commonplace along with active voltage termination on the data rails. Switching regulators for the main memory power rail, commonly referred to as the VDDQ power supply, are used because of the memory's high-current demand in modern systems with increasing memory requirements. Current supplied by the VDDQ rail can be upwards of many tens of amps.

For DDR memory termination voltage (VTT), special low-dropout regulators (LDOs) are the most common solution, and in many applications these LDOs are adequate. With higher current or where higher efficiency is demanded, switching regulators are gaining popularity. Whether an LDO or a switching regulator is used to generate VTT, in either case the input is the VDDQ rail. The output is regulated at ½ VDDQ voltage referred to as VTT.

What differentiates a DDR termination regulator (also known as a VTT regulator) from a general-purpose LDO is its ability to sink as well as source current. This capability is a necessity for memory termination.

The Integrated Approach

One very appealing approach combines both the switching VDDQ regulator and the VTT LDO. The example in Fig. 1 shows a DDR power application circuit using the TPS51916 buck converter.

Besides combining the VDDQ and VTT regulator in a single package, the VDDQ switching regulator implements a DCAP2 control architecture. DCAP is ideal for memory power applications as its advantages include superior transient response and efficiency, lower overall system cost, no requirement for loop compensation, a reduced requirement for output capacitance, and the ability to work with ceramic output capacitors. The controller's external-MOSFETs approach provides a higher level of scalability to customize for a range of power levels.

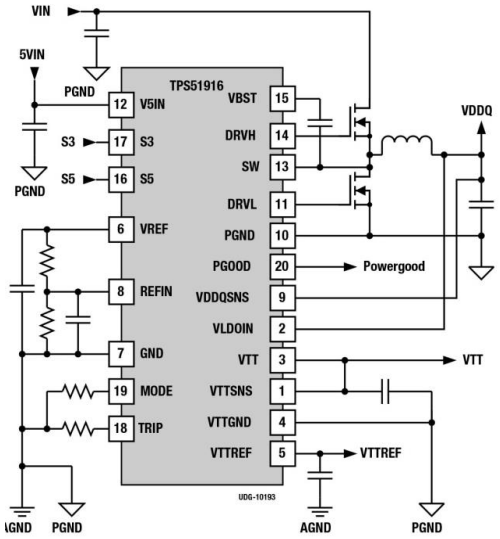

Fig. 1. Integrated DDR power solution with VDDQ and VTT outputs.

A Discrete Power Solution

Fig. 2 shows a common discrete implementation using the TPS53319 14-A integrated FET D-CAP converter and the TPS51200 3-A VTT regulator in a small 3-mm^2 package. The discrete combination offers the highest density with over 90% efficiency and more-flexible layout options.

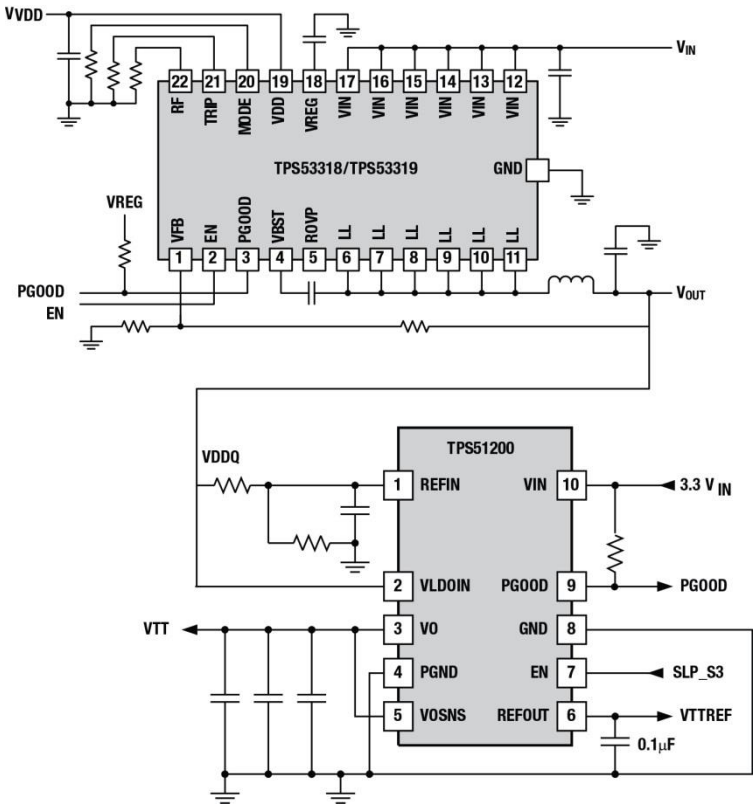

Fig. 2. Discrete DDR power solution for VDDQ and VTT outputs.

Optimizing Efficiency

Fig. 3 shows the TPS53317 6-A integrated FET D-CAP+ switching VTT terminator regulator. The switching regulator is well-suited for applications that require the highest efficiency or in higher-current applications where excessive power dissipation is a concern.

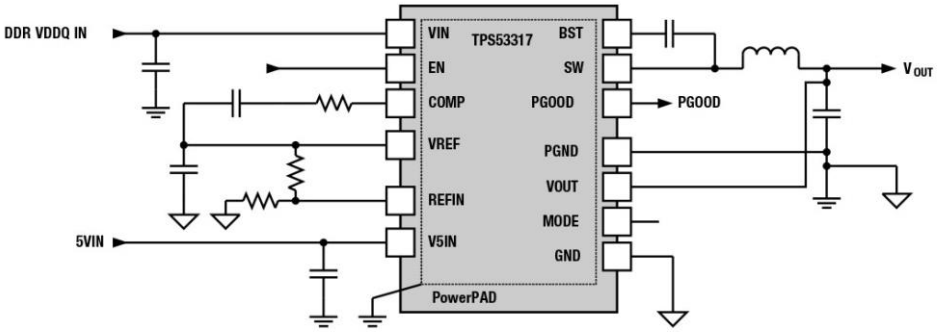

Fig. 3. DDR VTT switching regulator for high efficiency.

Summary

Each approach to generating VDDQ and VTT power rails has unique advantages that address different DDR power selection criteria such as integration, scalability, efficiency, layout flexibility, and total system cost. Which solution is best for your design depends on the criteria most important to the application. Texas Instruments has a broad DDR power portfolio to help you address these variances.

References

1. Datasheets for the devices discussed in this article are available at TPS51916, TPS53319, TPS51200, and TPS53317.

2. For more information about other solution variants described that support different power levels visit www.ti.com/ddr-ca.

About The Author

Jim Aliberti is a product marketing engineer for Computing Power Products at Texas Instruments where he is responsible for marketing products for CPU Core and POL power in a broad range of computing applications. Jim can be reached at ti_jimaliberti@list.ti.com.

For further reading on switching regulators, see the How2Power Design Guide, select the Advanced Search option, go to Search by Design Guide Category and select "DC-DC Converters" in the Power Supply Function category. And for further reading on LDOs, see "Voltage Regulators" in the Power Supply Function category.