Technical Article

Seven New Power Seminar Papers

Robert Taylor

I had the privilege of being able to both contribute and present material at the latest Texas Instruments Power Supply Design Seminar, one of a series of seminars that have been going on since the early 1980s. During the seminar, we present seven technical topics covering a variety of power supply design-related subjects.

The topics covered at the seminar were:

- "Choosing the Right Fixed Frequency Buck Regulator Control Strategy." *Brian Cheng, Eric Lee, Brian Lynch and Robert Taylor*
- "Choosing the Right Variable Frequency Buck Regulator Control Strategy." *Brian Cheng, Eric Lee, Brian Lynch, & Robert Taylor*
- "Examining Wireless Power Transfer." *John Rice*
- "Under the Hood of a Multiphase Synchronous Rectified Boost Converter." *David Baba*
- "Control Challenges for Low Power AC/DC Converters." *Brian King, Rich Valley*
- "GaN FET-Based CCM Totem-Pole Bridgeless PFC." *Zhong Ye, Alvaro Agular, Yitzhak Bolurian and Brian Daugherty*
- "LLC Converter Small Signal Modeling." *Brent McDonald*

During the presentations two presenters usually split the material, so to review these seven seminar topics we will also do the same. I will cover the first four topics here and my colleague Brian King will cover the last three in a second follow-up post.

The first two topics cover strategies for controlling a buck regulator. There are many different ways to split up the control methods, but we chose to use fixed frequency and variable frequency. Fixed frequency can be split further into subcategories of voltage-mode control, current-mode control and emulated current-mode control. Figure 1 shows a block diagram of a fixed-frequency control loop.

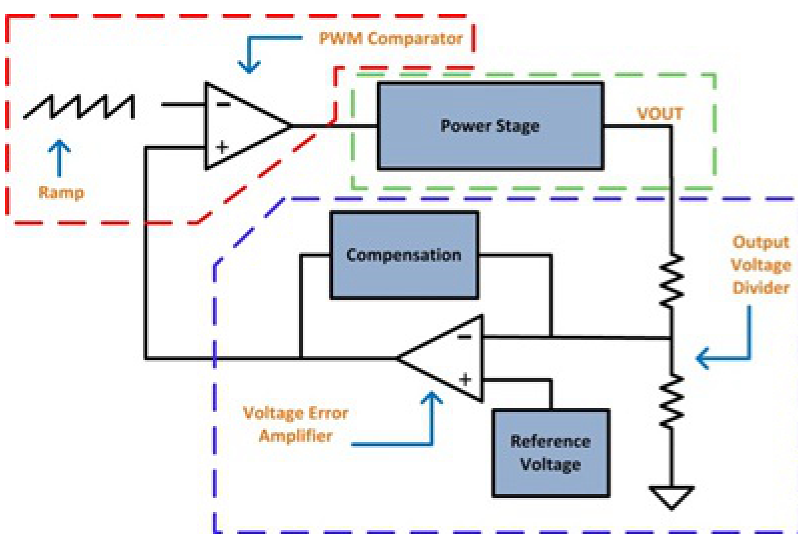

Figure 1. Block Diagram for Fixed-frequency Control

The difference between the three methods is what is used for the ramp input. The ramp input gets compared to an error-amplifier voltage to determine the power supply's duty cycle. In voltage-mode control, a ramp voltage is generated inside the control integrated circuit. In current-mode control, the ramp is directly proportional to the current in the inductor. In emulated current-mode control, the current ramp is reconstructed by using the previous current measurement and a ramp-generation circuit. In this case the ramp is also proportional to the inductor current but free from some of the noise issues present in current-mode control.

The variable topic also covers a wide range of methods, including DCAP™, DCAP+™ and DCAP2™ integrated circuits; DCAP3™ control mode; constant on time; and adaptive on time. The discussion starts with the very basic concept of hysteretic control and moves through improvements in the control scheme to help designers. Also covered is the concept of multiphase power supplies. Higher-current power supplies can take advantage of multiple phases to reduce component stresses. Design examples for each of the control methods help reinforce the ideas.

The third topic examines wireless power transfer, using electromagnetic theory to provide a basic understanding of the concept and then apply it to a design example. Figure 2 shows the basic setup for a wireless power-transfer design for typical electronic systems.

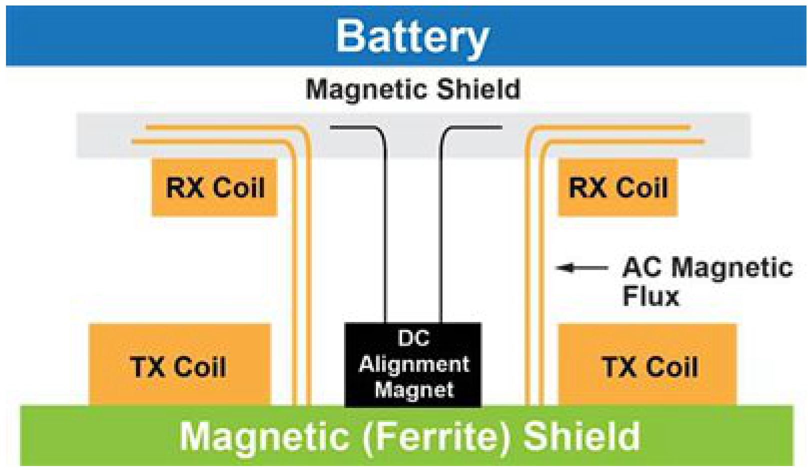

Figure 2. Cross-section for a Wireless Power-transfer System

In this case, transmission of power relies on magnetic resonance and coupling between a primary coil and secondary coil. The topic also covers a number of issues with wireless power transfer, including electromagnetic interference, foreign-object detection, coil alignment, efficiency and coil construction/design. The author discusses a practical 5W WPC Qi-compliant design example in-depth.

The “Under the Hood” series has been a theme throughout the TI Power Supply Design Seminars. This type of topic is deep-dives into a certain power topology and applies the topology to specific design examples. In this case, we examined a multiphase synchronous-rectified boost converter. The multiphase boost is used for power levels in which a single phase will face too much power dissipation. Other advantages of the multiphase boost include ripple-current cancellation, lower ripple, better thermal performance, improved transient response and higher efficiency.

It was truly an honor to work on this prestigious seminar series and travel around the U.S. and Asia to give the presentations. Now available on TI.com, I hope this material will find its way to thousands of more engineers. Please be sure to check out Brian King’s post on the last three seminar topics.

Additional Resources:

- Explore more power supply topics
- Watch Power Tips videos to help with your design challenge

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265