

POWER SUPPLY DESIGN

WORKSHOP SERIES CONTINUES IN 2002

Workshop attendees experienced an intense four days of theory, practice, design, and analysis at Ridley Engineering's Power Supply Design Workshop in October. The first in a series, the Workshop is the only fully-equipped laboratory learning environment outside a university setting available today.

The Workshop was a sell-out event, filling the lab to capacity. Despite the loom of despair over threats of National terrorism and recession, the engineers present felt very strongly about continuing education and the opportunities for technological progress that it offers in the long run.

A general consensus from the attendees suggested that many US companies are far from thoughts of recession, and recognize the need to push new designs ready for the general economic recovery in the US.

Attendees came from a variety of industries, with diverse backgrounds in power. Represented at the course were:

IBM
Motorola
Samsung
Daktronics
Caterpillar
Semtech
Seimens
Nordson
CUI Stack
Lockheed Martin
General Dynamics
QSC Audio
Harris Semiconductor
Phillips Consumer Electronics
Raytheon Missile Systems
Broadcast Electronics

They learned advanced magnetics design, circuit waveforms, snubbers, two-stage filter design, voltage-mode and current-mode control design and compensation, lab instrumentation, frequency response measurements, and much more.

In the morning theory, Dr. Ridley covered basic and advanced design and analysis of power converters. And in the afternoon, the theory was applied to circuits in a state-of-the-art laboratory environment.

"Ray is an excellent teacher. The course resolved differences between the practical and theoretical. And the measurement techniques in the labs will be of great value."

**- Jerry Westberg
Broadcast Electronics - Quincy, IL**

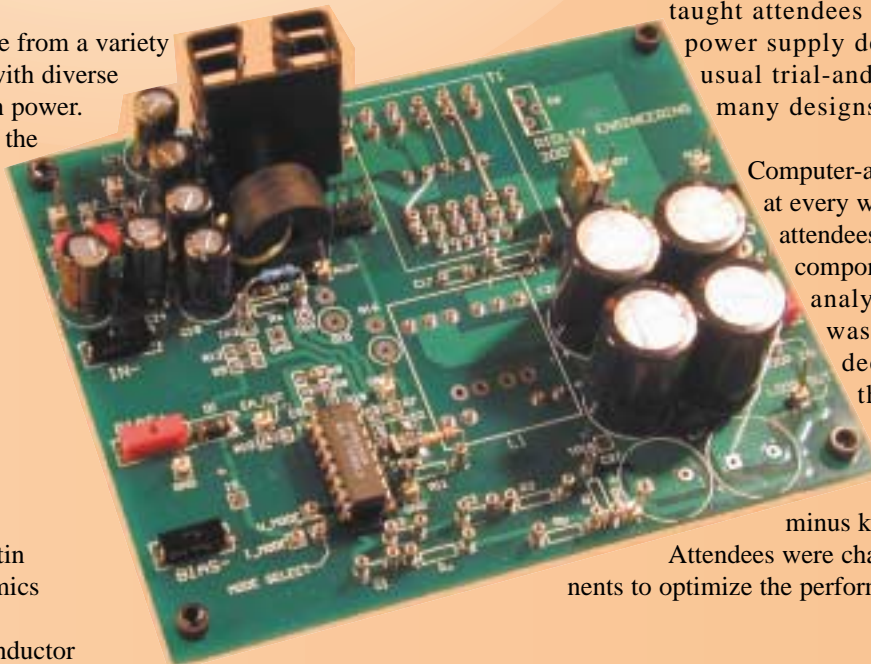
Every workstation was equipped with an advanced oscilloscope from either Tektronix or LeCroy, programmable power sources and loads from American Reliance, and a Frequency Response Analyzer from AP Instruments. This equipment, combined with computer analysis and design tools, taught attendees how to rapidly accelerate the power supply design process, eliminating the usual trial-and-error, and guesswork of many designs.

Computer-aided design tools were provided at every workstation, allowing course attendees to rapidly design power supply components. A careful balance of analysis and practical experience was maintained to show attendees where each is essential in the design process.

Real-world test circuits and components were provided minus key power and control elements. Attendees were challenged to design these components to optimize the performance of the converters.

"An excellent four-day power supply design course! The hands-on approach every afternoon takes the theory into practice and provides extremely useful insight into real design issues. I can envision Power 4-5-6 software quickly resolving a number of design issues that I experience every day at work."

**- Richard Gosla
Raytheon Missile Systems - Tucson, AZ**



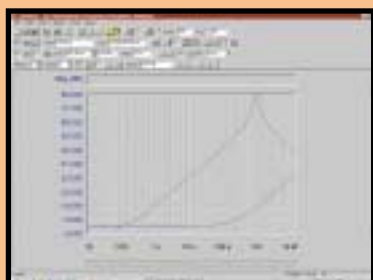


One board provided for a dual-output flyback converter at 30 W, and the other for a forward converter operating at 60 W. Both converters were designed for a 36-60 V input.

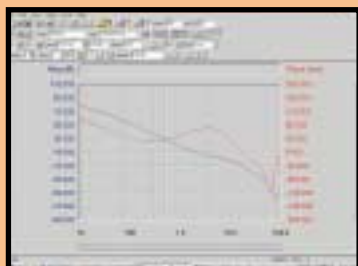
Magnetics design and construction is new to many power supply designers, as they rely on their magnetics vendors to do this for them. In this course, attendees learned how to rapidly accelerate the development process by designing and winding their own magnetics. Within the first four hours of lab on Monday, attendees completed their own fully-operational magnetics and placed them in their test circuits.

Based on preference, courses attendees designed either low-voltage systems, or full triple-insulated transformers, and compared the performance of each. The latest magnetics materials and wires were provided to show how this is accomplished in practical industry design.

Before testing the magnetics in the power circuits, frequency response analysis was done to measure critical transformer parameters such as magnetizing and leakage inductance, resonant frequency, and winding capacitance.



Magnetics Impedance Measurements using the AP Instruments Frequency Response Analyzer



Loop Gain Measurements with the AP Instruments Frequency Response Analyzer



Loop Gain Predictions with POWER 4-5-6

The Workshop has an excellent balance of theory and lab work. The pace was excellent, and the course materials were well done. Power 4-5-6 software is very comprehensive.

**- Justin Graves
Harris Corporation -
Mason, OH**

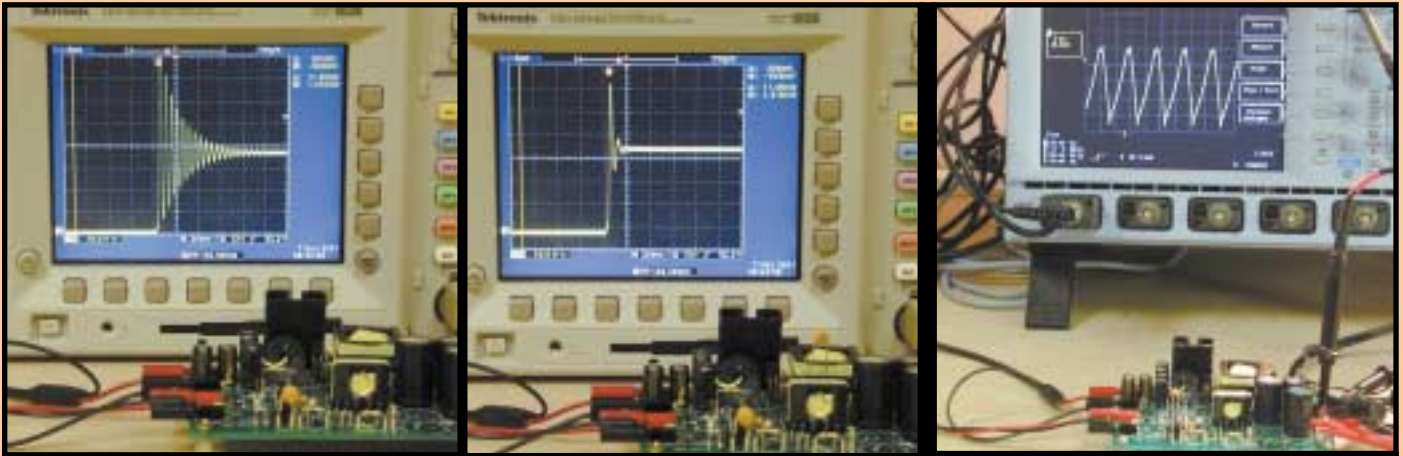
Attendees learned how to specify magnetics properly to their vendors, assuring quality parts with complete test data. The transformers and inductors were then plugged into the power supply development boards ready for full-power testing.

A variety of different designs and winding techniques showed attendees the tradeoffs of size, isolation requirements, and circuit performance.

The effect of the parasitics from the magnetics is readily apparent in ringing waveforms appearing on the power semiconductors.

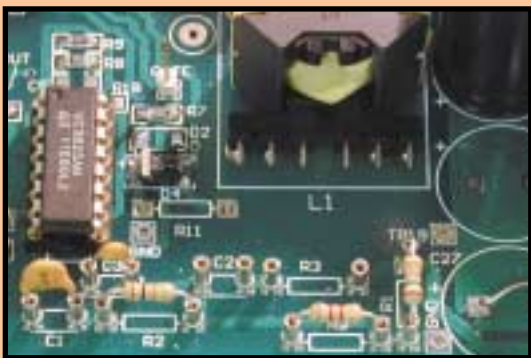
Before proceeding to full power operation of any power supply design, these ringing waveforms must be properly characterized and suppressed to protect the semiconductor devices, and minimize radiated and conducted EMI.





Attendees learned how to quickly attenuate parasitic ringing with the first pass design of snubbers. The trade-offs between EMI generation, voltage overshoot, and snubber complexity and dissipation were explored in this part of the lab.

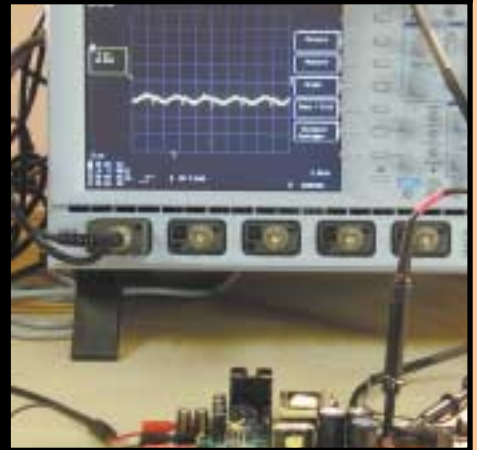
As with many real-world designs, magnetics often exhibit higher loss than anticipated from simple DC analysis of the windings. Attendees learned how to apply proximity loss analysis to their designs to identify the origin of the additional dissipation.



Once the converter was working properly, attendees learned how to close the control loop with the proper compensator components. System performance was verified with loop gain measurements, and compared to predictions from the design software.



Loop stability margin was correlated with step load responses measured in the lab. While the step load shows the condition to be locally stable, it does not provide design insight to improve the loop compensation.



Multi-stage filters are a powerful way to reduce converter EMI and output ripple. When applied properly, a small component can attenuate noise by an order of magnitude or more. But great care must be taken to ensure that the filter does not affect converter stability.

Attendees learned how to design multi-stage filters, and incorporate them in the control loop. This optimized regulation and transient performance without degrading the converter stability.

Attendees at the course received lecture notes, laboratory exercise manual, Power 4-5-6 software and manual, and a power supply control book.



A special thanks to the sponsors of the 2001 Design Workshop:

Tektronix - Digital Oscilloscopes

LeCroy - Digital Oscilloscopes

American Reliance - Power Supplies and Load Banks

VIP Wire - Triple-insulated Wire

TDK - Multilayer Ceramic Capacitor Kits

To Register for February 25 - 28, 2002, call 770-642-1918 or visit the Ridley Engineering website: www.ridleyengineering.com