Design Article Archive

Abstracts of articles published in the January through December 2011 issues

January 2011:

Synergy: SEPIC-Cuk Combo Illustrates Benefits of Creative Thinking

by Anthony Esposito, Avatar Engineering, Scottsdale, Ariz.

Abstract: Synergy is the combining of two or more things to create something new. In this article, the author presents an example of how the term can be applied to power supply design. In the design described here, the author combines two converter topologies, Cuk and SEPIC, to create a tracking dual supply with performance benefits and greater simplicity than other more-conventional approaches. In this case, the benefits include low-noise operation (which eases filtering requirements), integration of magnetics, and use of a single MOSFET power switch. This article is not a scholarly review, but rather an encouragement to think creatively and move beyond "cut and paste" circuits from vendor-supplied application notes.

Notes: 6 pages, 4 figures. Read the full story...

Automotive LED Driver Keeps Backlights Running Under Cold Cranking

by L.K. Wong and T.K. Man, National Semiconductor, Hong Kong

Abstract: Under typical operation, the output of a 12-V vehicle battery varies from 9 V to 16 V. However, this range does not consider the cold-cranking condition during which the battery voltage can fall as low as 2.8 V. Although this condition does not last long, automotive equipment like LCD panels and safety electronics are still required to maintain normal operation during this period. If the LCD panels are to remain operational during cold cranking, then the LEDs used to backlight them, and therefore the LED driver (a boost converter) used to power the LEDs must operate down to 2.8 V. This article discusses design considerations such as dual power supply paths, inductor and MOSFET selection, and thermal management, which must be addressed to maintain operation of the boost converter during cold cranking. With that as background, the article presents an LED driver circuit that meets the cold-cranking requirements.

Notes: 6 pages, 6 figures, 1 table. Read the full story...

The Over-Power Phenomenon in DCM/CCM-Operated Flyback Converters (Part 4): The Leakage Inductor Contribution

by Christophe Basso, ON Semiconductor, Toulouse, France

Abstract: In previous parts of this article series, it's been shown that the output power runaway in a flyback converter operated at high line can be attributed to two variables: the propagation delay only for DCM-operated converters and a combination of the propagation delay plus the mode transition from continuous to discontinuous in CCM-operated power supplies. During the derivation of the power transfer equations, various values for the total converter efficiency were estimated based on experience with real application circuits. But rather than guessing the efficiency, here in the fourth and final part of this article series, the author calculates the theoretical maximum transmitted power by explaining the role of the transformer leakage inductance at the switch opening.

Notes: 10 pages, 6 figures. Read the full story...

February 2011:

Utilizing Full Saturation and Power Loss To Maximize Power Transfer In Magnetic Components

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: To optimize magnetic component design, electrical (winding) and magnetic (core) power losses should be made equal to maximize power transfer from input winding to output winding. Utilization of the core is maximized when the winding window area is full of wire and the core is driven to near saturation while dissipating the desired maximum power loss. To achieve these optima, a multiplicity of design parameters must be just right including input and output voltages, number of turns, current ripple factor, field-referred inductance, and core power-loss density. This article will describe how to determine these parameters in a power conversion application, so that maximum power transfer can be achieved for a given core material at the smallest possible core size. At the same time, this discussion will help designers understand how to optimize their choice of core material for a given application.

Notes: 4 pages. Read the full story...

Primary-Side Current Monitoring Won't Stop Overcurrents In DCM-Operated Flybacks

by John Bottrill and Lisa Dinwoodie, Power Management, Texas Instruments, Dallas, Texas

Abstract: Many designers assume that the use of the primary-side pulse-by-pulse current monitoring and control in a flyback power converter is sufficient to limit the secondary-side current to slightly more than the maximum load requirement. A review of this technique demonstrates that this is not the case and that the current out of a flyback converter can easily result in higher than expected currents, if using this method. In turn, this can result in damage to the components in the power converter. To explain why this is the case and why improved fault protection is needed, the authors review operation of the flyback converter and discuss the factors that leave the flyback converter vulnerable to an overcurrent event when operating in discontinuous mode.

Notes: 6 pages, 4 figures. Read the full story...

March 2011:

Paralleling Electrolytic and Ceramic Capacitors Perks Up POL Transient Response

by Timothy Hegarty, National Semiconductor, Tucson, Ariz.

Abstract: The supply voltages required by ASICs, FPGAs, and microprocessors are decreasing on an absolute basis, while the associated tolerance bands are decreasing on a percentage basis. This trend is compounded by increasing supply current amplitudes and growing slew rate demands. For designers, it has become imperative to understand the effects of load-current transient requirements in the context of static and dynamic voltage regulation constraints. This article offers perspective on the step-load transient behavior of point-of-load (POL) dc-dc regulators and the dependence of their transient response on output filter capacitance. The author explores the rationale of paralleling capacitors of dissimilar chemistries yet complementary performance. Load transient waveforms are reported using time-domain simulation, allowing examination of the key indices of load transient performance—peak deviation and settling time.

Notes: 11 pages, 11 figures, 2 tables. Read the full story...

Match Circuit And Field Resistances For Optimal Magnetics Design

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: In this article, the author explains how the design of transformers and coupled inductors (transductors) can be optimized for maximum power transfer and optimum core utilization by matching the resistance of the circuit to that of the magnetic field of the core. Equations are derived for optimizing core selection and turns ratio to achieve these objectives and then a design example is presented to illustrate the application of these equations.

Notes: 6 pages. Read the full story...

Adjustable Clamp Circuit Enables Use of Lower-Voltage MOSFET In High-Voltage Flybacks

by Ed Wenzel, STMicroelectronics, Schaumburg, Ill.

Abstract: Flyback converters often require use of an expensive high-voltage MOSFET to accommodate operation from a high input voltage such as 240 Vac. The voltage seen at the MOSFET drain is equal to the dc voltage from the rectified ac line plus the flyback voltage, the clamped leakage inductance voltage, and some design margin. A circuit presented in this article can be used to dramatically reduce the required MOSFET drain-to-source voltage (V_{DS}) rating. By lowering the necessary V_{DS} rating, this circuit permits use of a discrete MOSFET with better switching performance, lower $R_{DS(ON)}$ and lower cost. Alternatively, the circuit can enable the use of a controller IC containing an integrated MOSFET.

Notes: 4 pages, 4 figures, 2 tables. Read the full story...

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April 2011:

Single-Stage Flyback LED Driver Meets Class C Limits On Harmonic Currents

by Yuequan Hu, Laszlo Huber, and Milan M. Jovanović, Delta Products, Delta Power Electronics Laboratory, Research Triangle Park, NC

Abstract: This article presents a single-stage LED driver with a variable PFC boost inductor for the universal input voltage (90 to 270 Vrms). The proposed circuit overcomes the limitations of the conventional single-stage PFC flybacks. For example, it avoids the need for post regulators, which are required by PFC flyback circuits without an energy-storage capacitor on the primary side. And when compared with PFC flybacks with the energy-storage cap, the proposed design does a better job of reducing line-current harmonics, enabling the LED driver to meet the Class C limits imposed by IEC 61000-3-2 and JIS C 61000-3-2 while still keeping bulk-capacitor voltage levels within a practical range. In this article, the authors review the prior art, explain how their new design overcomes previous limitations, and then verify its operation by presenting experimental results for a 24-V, 91-W prototype circuit.

Notes: 8 pages, 8 figures. Read the full story...

The Magic Carpet Ride: Class D Audio Circuit Design And Some Live Testing Results

by Paul L. Schimel PE, International Rectifier, El Segundo, Calif.

Abstract: As a field applications engineer for IR, the author has demonstrated the IRAUDAMP7S class D audio amplifier solution to some very high-end customers in some of the finest listening environments. The testing always ended with customers expressing their disbelief that a switching amplifier can compare favorably against known-good linear solutions. But to walk that amplifier into his home theater and plug into his meticulously handcrafted loudspeaker creations required much more than a favorable review. The author needed to overcome his own skepticism about Class D audio. To do so, he had to build the amplifier solution up proper, test it on the bench and address any concerns. In this article, Paul Schimel explains the reasons for his skepticism, then takes the reader step by step through his process of designing, building, bench testing, and live testing the IR class D audio solution. The results, he says, were nothing short of impressive.

Notes: 11 pages, 10 figures. Read the full story...

An Accurate Method For Measuring Capacitor ESL

by Steve Sandler, Picotest, Phoenix, Ariz.

Abstract: The equivalent series inductance (ESL) of chip capacitors is becoming an increasingly important parameter as bandwidths and switching frequencies rise in many high-performance systems. The stability and high-frequency dynamic performance of these systems is dependent, in part, on capacitor ESL. Manufacturers of ceramic and tantalum capacitors have been working hard to reduce the ESL of their components. However, system designers cannot simply rely on the capacitor vendors' published data for ESL, which is limited at best. It's important that designers be able to make their own ESL measurements. Yet, with values typically in the range of 1 nH to 5 nH, measuring the ESL of chip capacitors is not a trivial task. This article presents an ESL measurement method using a network analyzer in combination with an impedance adapter to measure the device impedance over frequency. This approach specifically addresses the issue of test-fixture parasitics, accurately measuring both the capacitance and inductance of the device under test.

Notes: 5 pages, 7 figures. Read the full story...

May 2011:

Eliminate The Guesswork When Selecting Primary Switch V_{DD} Capacitors

by Ed Wenzel, STMicroelectronics, Schaumburg, Ill.

Abstract: A primary switch, used for off-line applications, often contains a controller and a high-voltage MOSFET. The engineering documents of primary switch families state that the capacitor at V_{DD} must be sized according to the time needed to start-up. Some provide a formula for the capacitor at the V_{DD} pin to ensure start-up and some do not have a formula. The formula given in some primary switch specifications contains an undefined start-up time, t_{ss}, which depends on many parameters. In this article, we derive an equation to determine a capacitor value at V_{DD} using known circuit component values and parameters from one primary switch specification. The derivation begins with a calculation of the time it takes to charge up the output capacitors, t_{ss}. We then use this parameter together with the required V_{DD} switching current (I_{DD1}) and V_{DDhyst} to determine the value for the V_{DD} capacitor.

Notes: 5 pages, 1 figure. Read the full story...

Simple Stepdown Regulator Generates Multiple Voltage Rails With Good Efficiency And Regulation

by Vijay Choudhary, National Semiconductor, Phoenix, Ariz.

Abstract: Various methods may be used to generate the multiple voltage rails required in systems. One approach uses coupled inductors with a synchronous buck regulator to generate auxiliary outputs. This approach is simple and can provide both isolated and nonisolated outputs. However, the efficiency degrades at lower values of secondary output voltage because of diode rectification. In addition, the flyback action of the diode causes poor regulation at no load. In this article, another approach employing coupled inductors is presented. This converter is based on a constant-on-time (COT) buck regulator with low-side gate drive. This design uses synchronous rectification for both rails resulting in better efficiency and regulation. And since the COT topology does not require compensation, less design effort is needed to generate multiple voltage rails. This technique can be extended to generate any number of additional voltage rails.

Notes: 7 pages, 11 figures Read the full story...

Energy Meter Design Operates Accurately Over Wide Current Range

by Felix Yao, Kelly Ding, and Paul Pu, Integrated Device Technology, San Jose, Calif.

Abstract: The current specification is an important parameter for energy meters as it signifies a meter's ability to accurately measure the power consumed by a user's electrical load. Both utilities and energy meter manufacturers would like to develop a single current specification that would meet the electricity demands of all users. This is a challenge that R&D teams have been working for years to solve. To that end, IDT has developed a metering IC that enables the design of a single-phase energy meter with a current specification of 1 A (100 A). This design maintains a measurement accuracy of better than 0.2% from 20 mA to 100 A. With its wide current-measurement range and high accuracy, this energy meter design can merge existing requirements for multiple current specifications and therefore multiple meter designs. In this article, the authors describe the design of a 1 A (100 A) wide-span energy meter including the key points of hardware design, calibration procedures and metering features, and test data verifying meter performance.

Notes: 5 pages, 2 figures, 2 tables. Read the full story...

MOSFET Package Technology Enhances Performance Of Motor Drives

by Shishir Rai, International Rectifier, El Segundo, Calif.

Abstract: Many motor-drive applications continue to use power MOSFETs in traditional wire-bonded packaging. One reason for doing so has been the low-frequency operation of motor drives—typically 20 kHz or less. At these frequencies, the effect of the parasitic inductance introduced by the package leads and wire bonds may not be significant. However, they still add resistance to the package and are typically enclosed with mold compound, which is a poor conductor of heat. Today, newer packaging technologies enable lower power losses and better heat transfer, permitting higher power density. In this article, an experimental evaluation of DirectFETs in an inverter power stage is presented to demonstrate how this packaging technology can improve the system efficiency and increase power density for high-current motor drives.

Notes: 7 pages, 7 figures, 1 table. Read the full story...

June 2011:

Solar Microconverter Implements Novel MPPT Algorithm

by Richard K. Hester and Dave Freeman, Energy Laboratory, Texas Instruments, Dallas, Texas

Abstract: Photovoltaic (PV) solar systems usually are deployed as arrays of series-connected PV modules. Optimal energy harvesting from such an array cannot be achieved if its modules are mismatched by design, manufacturing or aging variances, temperature, soiling or shading. Adding module power conversion electronics enables each module to operate at its maximum power point (MPP) independent of the current that loads the array. This article describes operation of a prototype dc-dc converter with emphasis on the proposed maximum power point tracking (MPPT) scheme, a variation on the perturb & observe method, which can track the true MPP even when the module is partially-shaded. The prototype demonstrates efficiency above 96 percent at 215 W over a load range of 3 A to 7 A.

Notes: 10 pages, 11 figures. Read the full story...

Tapped Inductors Enable Simple, Compact Buck-Boost Converters With Single Noninverting Or Dual, Complementary Outputs

by Hector F. Arroyo, National Semiconductor, San Diego, Calif.

Abstract: Many applications require nonisolated, positive-output dc-dc converters where the output voltage falls within the input voltage range. This type of buck-boost converter finds use in industrial, automotive and low- and medium-voltage battery systems, among others. Today, these systems must not only be efficient, they must also be as compact and power dense as possible. Traditional approaches such as SEPIC, four-switch buck boost or transformer-based topologies including flyback, forward and push-pull can provide a converter solution but also bring some compromises in the form of increased size, complexity or losses. This article introduces and analyzes a different approach based on a tap-to-ground tapped-inductor buck-boost architecture. Converters based on this architecture are compact, uncomplicated and flexible enough to be used in single-output applications as well as those demanding dual complementary rails.

Notes: 8 pages, 8 figures. Read the full story...

Add A Black Box To Your Big (Or Small) Box

by Dewight Warren, Maxim Integrated Products, Sunnyvale, Calif.

Abstract: An airplane's black box, more properly known as an "event data recorder," collects numerous data points about the operating conditions of the aircraft like altitude, speed, flap and rudder positions. It also records what the pilots were doing and saying right before an accident. This running log of what transpired just before a crash can be critical in determining the root cause of the incident. Adding a black box to equipment other than aircraft can prove extremely valuable. Called a complex system manager in electronic equipment, black-box functionality provides fault logging in networking, industrial control, medical, and communications applications. The principal benefit of fault logging is quite straightforward: faster, more definitive failure analysis. This article explains how to implement such a function, and outlines the benefits that can be realized from nonvolatile fault logging.

Notes: 5 pages, 5 figures. Read the full story...

July 2011:

How To Implement A 5-W Wireless Power System

by Upal Sengupta and Bill Johns, Texas Instruments, Dallas, Texas

Abstract: Wireless power for handheld products is now a practical solution. While new chipsets provide the core functionality for the solution, there are a number of additional factors related to external component selection, physical design, and thermal analysis that need to be understood as part of the system-level implementation. This article provides a brief introduction to the Wireless Power Consortium's Qi industry standard for wireless power transfer, and focuses on issues relevant to the hardware design of a 5-W capable wireless power transfer system.

Notes: 7 pages, 9 figures. Read the full story...

Why Use Aluminum Wire?

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: Aluminum wire is produced by major wire companies yet it is not commonly found in the transformers and inductors (transductors) of switching power converters. Aluminum wire has an advantage over copper wire at high frequencies because its conductivity is lower than copper, causing its skin depth to be greater at the same frequency. Its conductive area is greater and thus its resistance for the same length and cross-sectional area of wire is lower. In this article, the author explores the issue of when it is advantageous to use aluminum wire in the design of transductors.

Notes: 6 pages, 3 figures. Read the full story...

Quad-Comparator Circuit Provides Power-Down Sequencing At Low Cost

by Josh Mandelcorn, Texas Instruments, Dallas, Texas

Abstract: Many applications with multiple supply rails now require both power-up and power-down sequencing. If only power-up sequencing were needed, this could be implemented at no added cost simply by tying the power good signal of one voltage regulator to the enable pin of the next regulator. However, such an approach does not allow for a controlled power down. This article describes a simple solution using a low-cost voltage reference and a low-cost multi-output comparator to sequence multiple power-converter outputs. This approach can be used so long as power-down sequencing is in the reverse order of power up.

Notes: 4 pages, 3 figures. Read the full story...

August 2011:

Designing Power Converters For 100°C+ Environments: Why Use 225°C-Rated Power Components?

by Pierre Delatte, CISSOID, Mont Saint Guibert, Belgium

Abstract: In applications that have to operate in ambient temperatures around or above 100°C, thermal management quickly becomes a major design constraint that must be taken into account from the beginning of product development. This is particularly true for power converter designs. When starting such designs, the cooling system—if any—and the proper selection of the components are two key considerations. While more and more active components claim to operate in the range of 125°C to 175°C, possibly 210°C, the question of long-term reliability must be studied carefully when selecting components. This article discusses the improved life expectancy and other benefits of using power ICs guaranteed for 225°C operation in high-temperature applications.

Notes: 4 pages, 1 figure, 3 tables. Read the full story...

Component Aging Is Primary Hurdle In Design Of High-Temperature Power Converters

by Steve Sandler, AEi Systems, Los Angeles, Calif.

Abstract: Extreme environments such as oil drilling, deep sea exploration, and space applications present daunting power supply design challenges. Power converters used in these applications, especially in “down-hole” drilling, may be subject to temperatures in excess of 200°C, while also facing extreme pressure. Relatively few electronic components are rated for such high-temperature operation, and even when they are, their useful operating life may be only a matter of hours. In most cases, the culprit is aging, which is accelerated by temperature. This article explores the impact of temperature on the aging of resistors and capacitors with an eye toward assessing the useful life of these components at high temperatures (200°C and beyond) using the Arrhenius equation. It also discusses component options for achieving longer component life in severe operating environments.

Notes: 6 pages, 1 figure. Read the full story...

Aspiring Power Electronics Engineers Must Master Four Aspects Of Converter Design

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: Power converters are not trivial to design. They involve analog and digital circuits; discrete-time, sampled feedback loops; parasitic elements in components that significantly affect circuit behavior; and control models of the nonlinear element (the PWM switch) that have taken decades to refine. In all, power electronics is one of the most demanding areas of electronics. This article presents a brief overview of power converter design, describing four essential aspects of this activity—circuit waveforms, magnetics, parasitic resonance, and control—and highlighting some of the complexities of converter design. This article will also point out some of the skills engineers need to overcome converter design challenges.

Notes: 4 pages. Read the full story...

September 2011:

How2 Get From AC To Below 1 V With eGaN FETs

by Johan Strydom, Efficient Power Conversion, El Segundo, Calif.

Abstract: A common challenge in power management for the computing industry is how to most efficiently convert ac line voltage to the approximately 1.2 V dc consumed by high-performance digital processors and peripherals. Today, the most common approach is to first convert the ac line voltage directly to a 12-V dc power distribution bus in one isolated power supply, and subsequently convert 12 V dc down to about 1.2 V dc in a second, nonisolated stage. Multiplying the efficiencies of these two stages and adding the distribution losses typically results in a total system conversion efficiency of approximately 81%. This value degrades further when the IC supply voltage drops below 1 V. This article examines options for improving this efficiency using the latest generation of enhancement-mode gallium nitride (eGaN) FETs.

Notes: 5 pages, 6 figures. Read the full story...

Current-Loop Control In Switching Converters
Part 1: Historical Overview

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: Peak or valley current control of switching converters is well established in engineering practice. Yet the irony of current-loop control is that, after decades, its theory is still undergoing refinement. This is the result, in part, of the complexity of the seemingly simple current-loop controller circuit. Its typical circuit diagram has few parts, yet the current-feedback loop is nonlinear and switched, having discrete-time behavior. This series of articles reviews current-loop control history, clarifies established concepts, presents some problems with the existing theories or models of the current-control loop, and then offers what might be the first truly unified model of current control.

Notes: 4 pages, 1 figure. Read the full story...

Circuit Implements Low-Cost Ballast Control With High Power Factor

by Tom Ribarich, International Rectifier, El Segundo, Calif.

Abstract: Fluorescent lamps continue to offer a high efficacy, long lifetime and low cost. T5 fluorescent lamps typically have high working voltages and are driven by an electronic ballast that is used to preheat the lamp filaments, ignite the lamp, and provide a high-frequency ac lamp running current. Adding power factor correction (PFC) to the electronic ballast is a requirement at higher power levels and enables the ballast to work like a “resistive” load on the ac mains. This article describes a novel circuit used to control an entire electronic ballast that includes active PFC as well as complete fluorescent lamp control. This article introduces the designer to the main circuit blocks of an electronic ballast, presents the new circuit control methods, and provides the complete electronic ballast circuit schematic for driving two 54-W T5 lamps. Experimental results are also shown.

Notes: 5 pages, 6 figures, 1 table. Read the full story...

October 2011:

Current-Loop Control In Switching Converters
Part 2: A Waveform-Based Model

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: In part 2 of this article series on current-loop control, we continue to lay the groundwork for the development of a waveform-based model by deriving time-domain expressions for inductor current that describe the closed-loop converter behavior without introduction of slope compensation into the PWM block. We then derive the equations relating inductor current slopes to converter parameters under steady-state operation. These slope equations allow us to analyze the effect of small changes that occur from cycle to cycle and are of interest in incremental (small-signal) and linear analysis.

Notes: 5 pages, 2 figures. Read the full story...

Use Exponential Equations And A Simple Program To Solve Power Supply Problems

by John Dunn, Ambertec, Merrick, New York

Abstract: Many physical processes in which some parameter changes value from one number to another will undergo transitions between those numbers which may be described by exponential equations. Temperature excursions in most electronic equipment often proceed that way. The coefficients of those equations can yield valuable insight into the underlying physical processes and can sometimes predict if a product will work properly or whether it will catastrophically fail. Unfortunately, the software for doing that analysis can be a bit costly. But you can avoid that cost for some purposes with a little mathematics for which you can write your own code in a language of your choosing. In this article, the author presents a power supply case history in which a thermal runaway problem was diagnosed, a failure analysis was performed and a remedy was achieved— all using this analysis method.

Notes: 6 pages, 6 figures. Read the full story...

A Holistic Approach To Reducing Backlight Power Consumption

by Greg Lubarsky, Texas Instruments, Santa Clara, Calif.

Abstract: Long battery life is a key metric in the portable electronics market. The LED backlight driver for LCD displays accounts for 25% to 40% of the total active system power. In the past, the tools a designer had to minimize backlight display power consumption were limited to decreasing the LED driver current and increasing the converter efficiency. Today, power savings of up to 50% are possible by utilizing LED drivers with an optimized converter, ambient light sensors, and content adjusted backlight control (CABC) methods. These techniques can enhance driver efficiency without severely degrading the visual quality of the information found on the display

Notes: 4 pages, 4 figures. Read the full story...

November 2011:

*Core Geometry Coefficient For Resonant Inductors**

by Hiroo Sekiya, Chiba University, Chiba, Japan and Marian K. Kazimierzuk, Wright State University, Dayton, Ohio

Abstract: A resonant inductor is required to have a small size, a low power loss, and good heat dissipation. In particular, it is difficult to design an optimal inductor for high-frequency and high-power applications. The design methods for resonant inductors presented until now are based on the trial-and-error approach. There is no criterion to pick the candidates for the core for resonant inductors from different core-product companies. But as the authors explain, the core geometry coefficient (Kg) is one of the useful criteria to select the core. By using the Kg method, it is possible to select the core satisfying the acceptable wire loss, the electromagnetic conditions, and a core area restriction. This paper presents expressions of the core geometry coefficient for the resonant inductor design. Additionally, a design example of a resonant inductor for a class-E power amplifier is given.

**This paper was originally presented at the 2010 Electrical Manufacturing & Coil Winding Expo, held October 18-20, 2010 in Dallas, Texas.*

Notes: 13 pages, 2 figures, 1 table. Read the full story...

Current-Loop Control in Switching Converters Part 3: Waveform-Based Model Dynamics

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: In this article, development of a refined model of current-mode control continues with the derivation of the dynamic equations for transfer functions of blocks in the current loop. Here in part 3, we transform the discrete-time equations from part 2 to the z-domain and pass quickly through it to the sampled s-domain. Conversion of the waveform equations to the z-domain is straightforward and lets us derive a closed-loop transfer function of the peak-current controller. Dynamics equations are derived for both the valley-current samples and for the average inductor current for each switching cycle. By deriving the transfer functions for the average current, a new refined model begins to emerge that shows a somewhat different response than the familiar valley-current model.

Notes: 7 pages, 1 table. Read the full story...

Self-Starting Can Be Hard To Do–Understanding Power-on-Reset Requirements In Regulators And Bandgaps

by Bill Laumeister, Maxim Integrated Products, Sunnyvale, Calif.

Abstract: Many integrated circuits require special handling at power-up. Analog and digital circuits may need to be placed in predictable conditions at start-up. To do that, we use circuits that are commonly called power-on-reset (POR) circuits. POR makes sure that there is an orderly and predictable sequence of events during power-up. In this article, the author discusses start-up problems afflicting voltage regulators, voltage references, and bandgap references; the techniques for addressing these problems; and the functions performed by POR circuits.

Notes: 5 pages, 5 figures. Read the full story...

Use Intelligent High-Side Power Switch To Satisfy Safety Requirements In Process Control And Industrial Automation

by Giuseppe Di Stefano and Michelangelo Marchese, STMicroelectronics, Catania, Italy

Abstract: To satisfy safety integrity level (SIL) criteria in process control applications, a high-side switch must have certain protection features associated with it. In this article, an integrated solution is presented in the form of a smart high-side switch that is intended to serve as a versatile building block in SIL systems up to level 3. This intelligent power switch, STMicroelectronics' L6370Q, is well suited to process control in very hazardous and risky areas like petrochemical or pharmaceutical installations. Operation of the L6370Q's protection features is explained here and key features of the L6370Q's evaluation board are described. This evaluation board was used to test the device's compliance with various EMC requirements. The results of those tests are presented in this article.

Notes: 7 pages, 7 figures, 3 tables. Read the full story...

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December 2011:

*Power Electronic Circuitry In LED Modules: An Overview**

by Agasthya Ayachit, Veda Prakash Galigekere, and Marian K. Kazimierczuk, Wright State University, Dayton, Ohio

Abstract: This article presents a detailed overview of the power electronic circuitry that constitutes an LED driver. To begin, electrical characteristics of LEDs are discussed briefly, and the demands and criteria for designing efficient drivers are mentioned. When these drivers are connected to the ac supply line, active power factor correctors become highly essential, and usually, they are accommodated in the ac-dc stages of the power converters. These stages are described in brief and their merits and demerits are explained. To maintain high efficiency and optimum brightness of LED lamps, dimming control and bypass diodes become essential. These topics are briefly discussed as well.
**This paper was originally presented at the 2010 Electrical Manufacturing & Coil Winding Expo, held October 18-20, 2010 in Dallas, Texas.*

Notes: 7 pages, 7 figures. Read the full story...

Current-Loop Control in Switching Converters Part 4: Clarifications Of Existing Models

by Dennis Feucht, Innovatia Laboratories, Cayo, Belize

Abstract: The progression of models, from the low-frequency averaged model through Ridley's sampled-loop model and on to Tan and Middlebrook's effort to unify them in the unified model will continue in part 5 of this article series in the refinement of the unified model, the refined model. But here in our part 4 discussion of current-mode control, we digress in our derivation of a unified model by taking a closer look at the existing models. The goal here is to obtain a better understanding of the various current-loop models by uncovering the similarities among these models as well as some of their underlying assumptions. These concepts set the stage for explaining the refined model of current-mode control that will be presented in part 5.

Notes: 5 pages. Read the full story...