EDN Access--11.21.96 Signals & Nois

EDN Staff - November 21, 1996

Departments*November 21, 1996*

Signals & Noise

A Royer by any other name...

I have enjoyed Jim Williams' articles for many years, but I have some objections to his series of articles on cold-cathode fluorescent-lamp (CCFL) circuits. The latest article is "Measurements on CCFL-driver circuits pose tricky problems" (EDN, May 9, 1996, pg 175). My first complaint is that he calls his sine-wave oscillator a "Royer circuit," which it is not. Royer oscillators produce square waves and depend on saturation of the transformer to initiate each switching transition. See the following references:

- Royer, GH, "A switching transistor DC-to-AC converter having an output frequency proportional to the DC input voltage," AIEE Transactions on Communication and Electronics, Volume 74, July 1955, pg 322 to 326.
- Severns, R, and G Bloom, Modern DC-to-DC Switchmode Power Converter Circuits, Van Nostrand Reinhold, New York, 1985, pg 89.

The sine-wave oscillators in Williams' CCFL circuits use feedback from the tank voltage to switch the transistors, and they do not saturate the transformer core. This type of sine-wave oscillator is more properly called a "current-fed push-pull parallel-resonant inverter." See the following references:

- Tompkins, FN, "The parallel inverter," Transactions AIEE, September 1932.
- Baxandall, PJ, '"Transistor sine-wave LC oscillators," IEEE Proceedings Part B, Supplement 16, May 1959, pg 748 to 758.
- Gulko, Michael, and Sam Ben-Yaakov, "Current-sourcing push-pull parallel-resonance inverter (CS-PPRI): theory and application as a discharge lamp driver," IEEE Transactions on Industrial Electronics, June 1994, pg 285 to 291.

My second complaint is that Williams has obtained a patent that covers the ballast circuits described in his articles, but the articles have not mentioned this (see US Patent 5,408,162, April 18, 1995). It is my understanding, however, that ballast manufacturers have been using this circuit for many years. Also, one might consider the following patents:

- Tanaka, S, US Patent 4,905,136, Feb 27, 1990. This patent describes a push-pull parallel-resonant converter powered by a buck-converter current source.

- Jones, D, US Patent 4,344,122, Aug 10, 1982. This patent describes a Royer inverter powered by a buck-converter current source.

I also have a disagreement with a statement in his latest article. He asserts that for 1% uncertainty in measuring the energy in the ballast output, the meter measuring the current must be accurate to 10 MHz. He then explains in detail how to make rms measurements with such a wide bandwidth. The techniques he presents are useful and interesting, but he is way off in the bandwidth requirement. A 1-MHz bandwidth should be adequate. Assuming a resistive load, the energy in a current waveform is proportional to the sum of the squared values of the current components. Looking at Figure 1, pg 175, after the fifth harmonic (about 360 kHz), the harmonics are more than 40 dB below the fundamental. The energy content of one of these high-order harmonics is therefore less than 0.01% of the fundamental. As a sanity check, it can be assumed that lamp currents should have far lower harmonic levels than a square wave, and 99% of the energy content of a square wave is in the first 41 harmonics (about 3 MHz).

Despite these complaints, I must say that I always find Williams' articles useful and interesting.

Bryce Hesterman
Bryce-Hesterman@worldnet.att.com

Author Jim Williams responds:

This is not the first time Bryce Hesterman has communicated his concerns to me; apparently, my previous response was inadequate. I hope this forum will provide me with a second chance.

All previous Linear Technology Corp (LTC)-originated publications and submitted manuscripts refer to a "resonant Royer" or "current-driven Royer class converter." The adjective modifiers were carefully chosen and intended to convey that the discussed configuration was an extension of the basic Royer converter. I regard a self-toggling, magnetically switched push-pull converter as an extension of Royer's original circuit. This judgment is clearly subjective, and, for this reason, I was careful to include the adjectives to indicate modification of the original circuit. In at least two LTC publications I go further, stating: "Royer's circuit is not an LC resonant type. The transformer is the sole energy storage element and the output is a square wave." I had hoped this kind of verbiage would avoid the (in my opinion) semantic argument Hesterman advances.

It is true that LTC has obtained patent positions, and various LTC publications make prominent mention of this fact. My understanding of the patent positions is that the claims are specific to use in CCFL application and primarily read on issues relating to derivation of feedback information. Neither I nor the US Patent Office believes the previous patents Hesterman cites anticipate our work.

Finally, we seek a 1% total error for all measurements of current and voltage. In practice, I think, we often fall a little short of this, but we make every effort to provide our customers with the best data we can (and they do check us out!). As such, we seek measurement integrity beyond 1% for both current and voltage to, I hope, achieve the all-inclusive 1% error band. Additionally, the waveforms harmonic content varies significantly as the transformer, its related capacitors, and the lamp (including its nonresistive parasitics) vary. I have seen combinations that yield several percent of every content beyond 5 MHz. These practical realities mandate the specified 10-MHz, 1%-error bandwidth if measurements are to be trusted.

I hope this response clears up any issues or ambiguities.

Jim Williams
Linear Technology

Corrections and updates

The article, "Low-voltage power sources keep pace with plummeting logic and µP voltages," (EDN, Sept 26, 1996, pg 51) failed to mention several recent offerings from Unitrode Integrated Circuits (Merrimack, NH). The UC3941 single-cell alkaline boost converter, for example, provides 3.3V, 5V, or an adjustable voltage at 500-mW output power, with an input voltage ranging from 1 to VOUT +0.5V. The UC3910 is a 4-bit DAC and voltage-monitor circuit for Pentium Pro and other µP power supplies. The UCC3880 combines a 4-bit DAC and PWM controller for powering Pentium Pros and other µPs. Finally, the UCC3830 integrates a 5-bit DAC and a current-mode PWM controller for powering current and anticipated Pentium Pro µPs. EDN regrets the omission. For information, call (603) 429-8610.

Too much of a good thing

I agree with Richard A Quinnell's sentiments regarding online documentation (EDN, Sept 26, 1996, pg 11). Many help files are not helpful at all, and, apparently, so much pain is required to produce them that they are hardly ever up-to-date or correct. I have also never found a way to get the highlight colors readable at the same time that I have the rest of Windows set up to reduce eyestrain. (I have found a very nice setup that makes window backgrounds the same color as pool-table felt and everything else either green or gray, but I cannot find the switch for help-file highlighted text.) I recently gained access to a Unix (well, OK, a Solaris) system and found the online docs even worse than those in Windows.

Since the release of the most recent, and mostly bug-free, Adobe Acrobat reader, I have come to prefer PDF files for online documentation, downloaded via modem, and especially when supplied on a CD-ROM full of data sheets.

Michael T Halloran
Coulter Corp
Miami, FL

Design Idea correction

I was pleased to see my Design Idea, #1927, "Transistor and FVCs make linear anemometer," appear in EDN (Sept 26, 1996, pg 72) and very pleased to see that the circuit it elaborates upon won the March 14, 1996, "Best of issue."

The schematic for DI #1927 picked up a couple of fairly serious errors in the publication process. I would like to save readers from unnecessary frustration by publishing these corrections:

1. S2 pin 1 is erroneously hooked to ground; it should be a no-connect.
2. The resistor from IC1B pin 3 to 5V should read 1.5M, not 1.5 µF.

3. The current draw of the circuit from the 5V supply is &=200 mA, not 200 µA as drawn. It would be nice if the measurement could be made with that little power, but no such luck.

Steve Woodward
Chapel Hill, NC