Book Review
Reviewed by Dennis L Feucht
Wideband Amplifiers, by Peter Staric and Erik Margan, Springer Verlag, ISBN 0-387-28340-4, hardcover, 640 pp, $159.00 (€135)

On rare occasion, a book is published that the analog designer wants to have within arm's reach near one's desk. This 640 page hardbound book which comes with a matching CD is one of them.

The authors live in Slovenia, but hardly far from the analog state-of-the-art. The two are from the Jozef Stefan Institute in Ljubljana. I remember passing Peter occasionally while walking around the Tektronix campus in Beaverton, OR when he worked there and Erik has long been in contact with some of the leading oscilloscope vertical amplifier designers from Tek. The book has that European penchant for being theoretically complete and in-depth, in this case on the subject-matter of how to design fast dc amplifiers. Much of what was once proprietary company information at Tek is now explained in detail in the book. Yet, 25 or more years later, these concepts are not widespread in the electronics industry. That fact was also a motivation for why I wrote my book, Analog Circuit Design (ACKTS), which put into book form three large engineering looseleaf notebooks from my T&M instrument design work. It is now being offered as a four-volume set on CD or via e-mail attachment. http://www.innovatia.com Wideband Amplifiers is a good complement to it because it presents in more complete form what ACKTS covers in some of the High-Performance Amplifiers volume.

What is in Wideband Amplifiers (WA)? In some ways it is reminiscent of the Amplifier Frequency and Transient Response (AFTR) course of Tektronix, started by amplifier designer Carl Battjes. This course, replete with hand-sketched notes from the actual designer's notebooks, taught basic concepts known within Tek that were used to design vertical scope amplifiers. WA starts out, as did AFTR, with the Laplace transform, but offers more extensive coverage, including contour integrals in the complex domain. Then the book moves into inductive peaking circuits, covering two- through four-pole bandwidth extensions. This includes the T-coil, which Carl Battjes introduced as the peaking element in Tek scopes, while Bob Ross contributed significantly to the mathematical analysis. T-coils double the bandwidth in comparison with the simple series peaking circuit. (The MFED bandwidth extension of the T-coil is 2.72 times that of the uncompensated stage. The MFA extension is 2.83 times).

In WA, T-coil theory is developed at length, including the various schemes found in Tek scopes and amplifier ICs. The book is not all mathematics, however, and T-coil construction, in various media (discrete coils, circuit boards, hybrids, ICs), is also presented and illustrated.

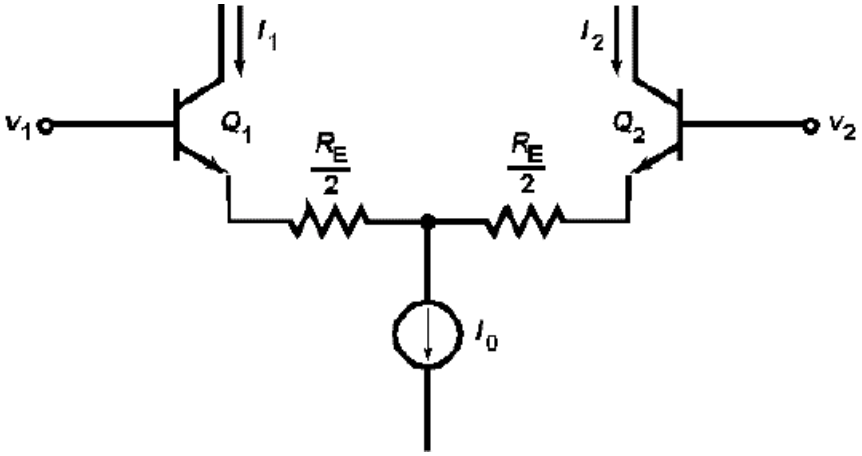
After that, WA moves into one of the most important (and neglected) concepts in electronics, impedance gyration above the bandwidth of active devices. I cover this more thoroughly in ACKTS than does WA, but the basic theory is worked out. (This topic was covered in my recent TechNote series at analogZONE on "Why Circuits Oscillate Spuriously.") Because base resistance appears inductive at the emitter in the high-frequency region (between bandwidth and the gain-bandwidth frequencies), wideband amplifiers (and other analog circuits) must take these effects into account and compensate them for the desired response. WA goes on to explain the details of how to do this for various basic amplifier stages, including the cascode.

Identical amplifier stages, when cascaded, do not have the same response characteristics as a single stage, and overall amplifier design must take this into account. ACKTS is light on this subject but not WA. The order of stages with various pole placements results in the desired response, which is usually between maximally-flat amplitude (MFA) and maximally-flat envelope delay (MFED) in scopes -- a compromise between maximum scope bandwidth and accurate step response.

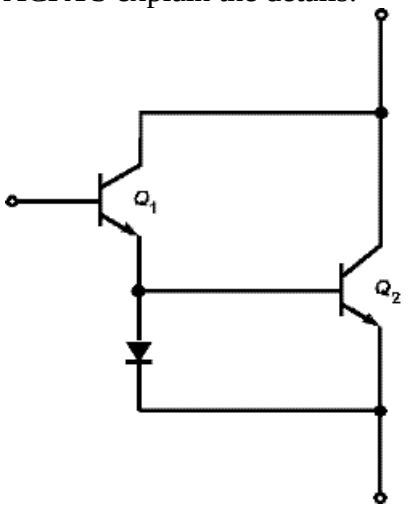
Part 5 of WA continues with interstage sequencing in a detailed example, followed by front-end circuits: attenuators and their coupling to JFET source followers. Various details, such as capacitive "hook" due to permittivity variation in circuit-board material, overdrive recovery, and input protection -- considerations in actual circuit design -- are included. Multipath amplifiers are introduced. (There are additional topologies in ACKTS.) Then the topic of op amps appears, both voltage and current feedback. Nifty circuits are presented here and there. Feedback theory is assumed and covered adequately. I cover it more thoroughly in ACKTS, another complementary aspect of the two books.

One multipath amplifier scheme that WA covers in more detail than ACKTS is feedforward amplifiers. Feedforward is another neglected concept that the authors do well to emphasize. They give interesting historical background throughout the book of the topics they cover. Feedforward was invented before feedback, but when feedback took off, feedforward became neglected -- like semiconductors were when vacuum tubes took over. For the design engineer looking for a novel direction in which to push forth, consider what the authors present on feedforward. The audio people were the first to rediscover it, but its benefits have yet to be exploited in other areas of electronics.

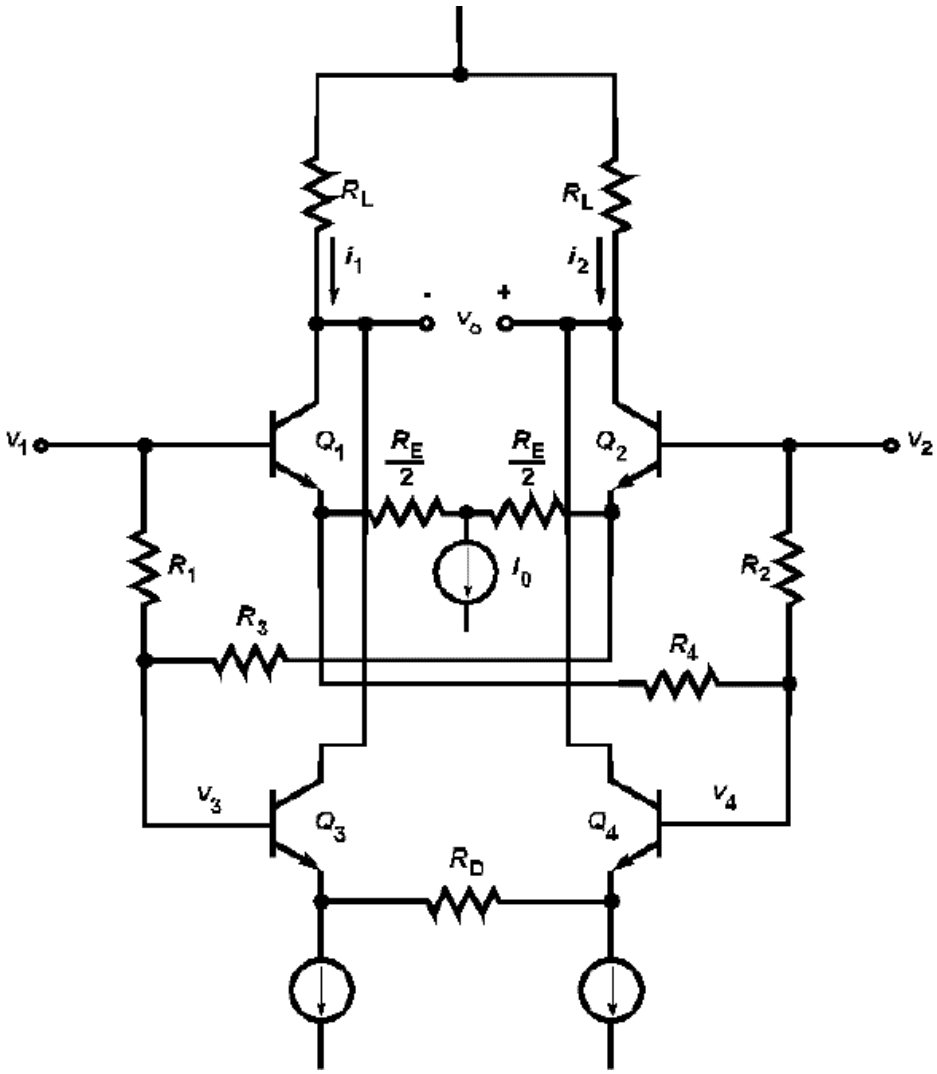
The book then gets into a topic that I enjoyed writing about in ACKTS: some of the newer amplifier topologies that emerged in the 1980s that are very exacting. Feedforward provides the background as a general concept. This topic is approached (as it is also in ACKTS) by starting with the emitter-coupled BJT diff-amp, shown below, and considering how to linearize its $\tanh(v_{in}/V_T)$ transfer function. By adding emitter resistance, R_E, it can be linearized, but at the expense of gain.



The next step is to introduce various circuit enhancements such as another Battjes' invention, the Darlington f_T -doubler circuit, shown below. By the addition of the diode to a Darlington configuration, the bandwidth is essentially doubled. Both WA and ACKTS explain the details.



This is followed by diff-amp error-correction in the cascomp stage, shown below, invented by another creative Tek engineer, Pat Quinn. Various cascomp feedforward schemes are covered in WA. Q_3, Q_4 are a feedforward diff-amp, used to amplify and feed forward an error-correction current that sums with the main diff-amp (Q_1, Q_2) output current.



Moving on, section 5.4.6 of WA discusses the Tektronix M377 IC, used in Tek's 11000-series plug-in scopes. It constitutes an advance in analog design by using a microprocessor to improve upon some of the negative aspects of analog: calibration adjustments. Instead, the IC is designed to allow a μC to do most of the calibration. It also continues a developing trend toward "cold-switching": electronic switching and variation of front-panel user controls through a μC.

Chapter 6 presents computer algorithms used in design of wideband amplifiers, given in a descriptive form that looks like the language. Chapter 7 continues into computation of convolution and filtering. The index of the book is adequate, though somewhat sparse. But no matter. On the inside back cover is a CD with book contents that can be searched using computer methods. The CD certainly adds value to the book, helping to justify the high price of books nowadays.

WA is a reasonably complete book on wideband amplifiers. More coverage might have been given to thermal distortion, and shunt-feedback amplifiers are notably missing. Good coverage is given to a three-BJT feedback amplifier consisting of a BJT diff-amp and an emitter-follower, used in the Tek M377. Every book reflects the interests and experience of the authors and this one is no different. Their mastery of the subject

will make this book the prospective book of reference for wideband amplification. If you are an analog amplifier designer, WA is required reading and is easily worth the price. Kudos to Staric and Margan for a book well written.