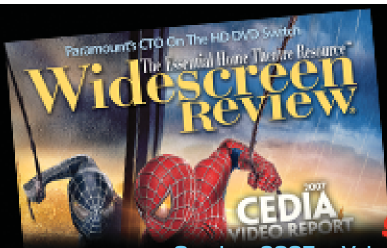

Widescreen Review NEWSLETTER

The Essential Home Theatre Resource™

ISSUE 125 on newsstands soon! SUBSCRIBE TODAY!

October 2007 • Volume 2, Issue 17 • The Official FREE Newsletter Of Widescreen Review Magazine

WELCOME!

I hope you enjoyed Part One of Daniel Sweeney's archived article on power amplification in last month's Newsletter, "Power Envelope—Amplification For MultiSpeaker Arrays." The conclusion to the article is featured in this month's Newsletter.

Did you get your copy of the November "Spidey" issue of *Widescreen Review* yet? I think you'll agree that it's one not to be missed! Besides the "Rogers Report" on Sony's hot new VPL-VW60 1080p Front Projector, the magazine is full of interesting and informative topics, including two different On Screen interviews—one with the Head Monster Noel Lee and the other with Paramount Pictures' Alan Bell.

And lastly, if you haven't been to our Web site lately, now's the time to check it out. In order to provide the most up-to-date home theatre news to you, our readers, we have begun posting news as it occurs throughout the day, every day. So be sure to visit www.Widescreeneview.com as many times a day as you are able for the latest breaking news.

Gary Reber
Editor-In-Chief, *Widescreen Review*

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Issue 125, November 2007 of *Widescreen Review*:

- "2007 CEDIA EXPO Part I: Video" By Danny Richelieu
- "Sony VPL-VW60 1080p Front Projector" By Greg Rogers
- "Sony BDP-S300 Blu-ray Disc Player" By Doug Blackburn
- "Build Your Own Home Theatre PC" By John Kotches
- "Digital Video Essentials HD DVD" By Bill Cushman
- "Monster Cable's Noel Lee" By Gary Reber
- "Paramount Pictures' Alan Bell" By Gary Reber & Danny Richelieu
- Over 35 Blu-ray Disc, HD DVD, and DVD picture and sound quality reviews
- And more...

ATTRACTIONS

I Want To Know

The Studio Scoop

Rumors, Reports, & Ramblings

Stacey Pendry

Walt Disney Studios Home Entertainment

Walt Disney's just-released family flick *The Game Plan* topped the box office charts with $22.7 million in its debut weekend. Beating out the favorite for the biggest box office takings, Universal's R-rated *The Kingdom*, which scored a distant $17.7 million. Chuck Viane, President of Walt Disney Pictures Distribution said, "It always feels terrific when you over-deliver on industry expectations." *The Game Plan* stars Dwayne "The Rock" Johnson as a carefree NFL quarterback who finds he has a daughter from a previous relationship. This is the second biggest opening for Johnson whose 2002 release of Universal's *The Scorpion King* took in $36.1 million in its debut weekend.

Universal

Universal has a few interesting projects in the works. The first being their adaptation of the children's book "Nightmare Academy" by Dean Lorey. David Reynolds, co-writer on such familiar animated films as *A Bugs Life*, *Chicken Little*, and *Finding Nemo*, to name a few, has been named to write the screenplay. The book is the first in a trilogy, which Universal has purchased the rights to for a princely sum in the high six figures.

Working Title, the producers of *State Of Play* (Universal's adaptation of the BBC miniseries), is said to be in negotiations with Hollywood heavy-hitters Rachel McAdams, Helen Mirren, and Robin Wright Penn to star in the project, which already includes an impressive roster with Brad Pitt, Edward Norton, and Jason Bateman committed to the project.

HBO

HBO, whose parent company is AOL Time Warner, took more statuettes than any other network at this year's Emmy® Awards. The final tally gave the network 21 Emmy wins for its projects. *The Sopranos* was given a parting gift of three Emmys for its final season, *Entourage* won two Emmys, *Bury My Heart At Wounded Knee* (see Issue 125, November 2007 for a full DVD review) won a staggering six statues, *Rome* won two awards, and rounding out the multiple award winners was *When The Levee Breaks: Requiem In Four Acts*, which won three awards. The single Emmy Award winners for the network were *Extras*, *Deadwood*, *Addiction*, and finally *Ghosts Of Abu Ghraib.*

Warner Bros.

To commemorate its 25th anniversary, Warner Bros. has restored and remastered Ridley Scott's 1982 classic *Blade Runner* (which will be reviewed in Issue 126, December 2007). The new version, *Blade Runner: The Final Cut* was remastered in 4K resolution (THR 5/23) and 5.1 audio for its re-release. Kurt Galvo, director of feature post-production, said, "Colleges have courses (on *Blade Runner*). It sounds cliché, but the goal was to do it justice and to do it right." The restoration was handled by Technicolor Digital Intermediates, in addition, the visual effects were updated and a few scenes were refilmed.

Warner Bros. Home Video has announced the acquisition of the next three films to be released directly to DVD under their Raw Feed label, which was launched in March 2006. The three projects are tentatively titled as *Otis*, *Supermarket*, and *Rest Stop 2*, the latter of which is a sequel to the first Raw Feed release. Raw Feed features mostly adult horror, sci-fi, and thrillers with budgets up to $5 million.

MGM

In an attempt to boost the profile of *Lions For Lambs*, United Artists' first release under Tom Cruise and Paula Wagner, MGM/UA has enlisted the help of Internet giants Google™ and YouTube™. The film is due to be released November 9, 2007 and will be promoted by a video contest in which participants will submit a 90-second clip discussing the social issue they are most passionate about. The videos will be featured on a dedicated YouTube channel and on a specially designed Google "gadget" that will enable the public to watch and vote for their favorite video clip. The winner of the contest will be chosen on the film's opening day, and will be awarded $250,000 to go to a charity of his or her choice. In addition, some of the videos will be chosen to run as trailers alongside the traditional film previews normally featured. YouTube and Google hope this effort puts them on the radar in Hollywood as a cost-effective, viable way for the studios to promote their projects to the millions who use their Web sites, rather than going with competitors such as Yahoo®.

News In Brief

Peter Morgan has started work on a sequel to *The Queen*, which will focus on Tony Blair's difficult adjustment to the handing over of power from his natural liberal ally Bill Clinton to George W. Bush, who comes from the opposite end of the political spectrum. Morgan is currently researching the project and is due to begin writing it by the end of the year.

It's a good thing billionaire Mark Cuban has kept his day job, as anyone who has watched ABC's *Dancing With The Stars* can tell you. It seems that for all the rhythm he lacks he still has an excellent business head on his shoulders. It was announced that Cuban, along with business partner Todd Wagner, who are at the helm of Magnolia Pictures, has announced a new genre label, Magnet. Magnet's first film, to be released on DVD October 16, 2007, is *Murder Party*, a Jeremy Saulnier comic-based slasher film.

Walt Disney's CEO Robert Iger, addressing a group at Goldman Sachs Communacopia conference in New York, has called the companies that do not embrace the Blu-ray Disc format greedy and shortsighted. He failed to name names but is quoted as saying, "Those studios are largely taking easy money, and it will cost them in the future." He also went on to say, "The Disney brand is the only brand that matters in global entertainment." He noted that Disney is in a position to exploit a project better than any other media company, citing a video game that will become a film, TV show, and theme park attraction. I think someone should remind Mr. Iger of the old adage: "Pride cometh before a fall." The consumer still has the final say in the high-def format war, please try not to dictate. WSR

Coming Soon...
To A Retailer Near You

Danny Richelieu

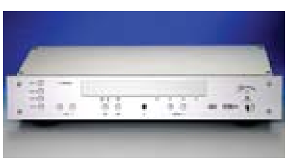
New Video


Westinghouse TX-52F480S

Westinghouse Digital Electronics introduced their new TX-Series of 1080p LCD TVs—the 42-inch **TX-42F430S** ($1,600); the 47-inch **TX-47F430S** ($1,800); and the 52-inch **TX-52F480S** ($3,000). The displays all include an ATSC/NTSC/Clear QAM tuner, four HDMI inputs, two 1080p-compatible component inputs, and a VGA input for connecting computers. The TX-Series includes Westinghouse's Full Color Spectrum and High Contrast Picture processing technologies as well as a dynamic backlight. The displays include colorimetry calibration control, as well as their Autosource™ technology, which automatically turns the TV on and tunes to the correct input when an external source is detected. All three LCD TVs are available now.

Westinghouse *866 287 5555* *www.westinghousedigital.com*

New Electronics


Burmester 057 Top Line Surround Processor

Burmester announced the first of their multichannel home theatre components, including the **057 Top Line Surround Processor** ($20,000). The 057 Top Line Surround Processor includes internal decoding for Dolby® Digital Surround EX, DTS® ES™, as well as DTS neo:6 and Dolby Pro Logic® II processing. The processor includes DC coupling, individually set audio and video inputs, and automatic overload control. The hardware elements and software can be upgraded as needed.

Burmester *877 287 6310* *www.burmester.de*

New Loudspeakers


Cabasse Alcyone

Cabasse has introduced the **Alcyone** satellite loudspeaker to the North American market. The spherical design is made to be very rigid and is free of internal standing waves, and includes the same magnetic mounting device that is available on the Cabasse iO2, making it easy to position. The Alcyone boasts a peak power handling rating of 350 watts, and the loudspeaker, with its 4-inch full-range driver, has an 8 ohm nominal impedance and 91 dB/watt/meter sensitivity. The Alcyone is available in a complete 5.1-channel system with five satellites, a matching **Santorin 17** active subwoofer with 6.5-inch driver and 200-watt built-in amplifier, for $1,060. The system is shipping in October and will be available in black and white finishes. Matching stands are also available for $350 per pair.

Cabasse *360 756 2205* *www.stjohngroup.com*


Sunfire SRS-210R

Sunfire introduced their XT-Series of SubRosa™ in-wall and on-wall subwoofers. The **SRS-210W** in-wall subwoofer combines two 10-inch high-back-emf drivers designed specifically for in-wall use. Using the same low-profile 10-inch woofers, the on-wall **SRS-210R** is only 3.75 inches deep. Both subwoofers are powered by the 2700-watt SRA-2700EQ mono amplifier featuring Sunfire's Tracking Downconverter™ technology, as well as Sunfire's patent pending StillBass anti-shake technology with a patented vibro-tactile I-BEAM™, which reduces mechanical vibrations caused by the movement of the woofers—when the woofers move out, the I-BEAM moves in (and vice versa). The subwoofers will be available in the fourth quarter of 2007, with the SRS-210R selling for $3,500 and the SRS-210W for $3,000.

Sunfire *425 335 4748* *www.sunfire.com*

Other


Fortress Seating Cosmo

Fortress Seating introduced its newest theatre seat, the **Cosmo**. The Cosmo is designed to combine specific structural elements that look like living room furniture but transform into viewing recliners when it's time to watch a movie. The design uses a slimmer back profile and open arm design, which is made of hand-carved solid wood. The seats can be custom stained and, as with all of Fortress's models, the Cosmo is available in any of their configurations.

Fortress Seating *800 873 2828* *www.fortresseating.com*

Honeywell CURxE Light HDMI Cable

Honeywell introduced a new HDMI cable with **CURxE Light** technology, which they developed with Spectrum Electronics, designed to automatically correct corrupted HDCP and EDID data that would otherwise degrade the signals. With inconsistencies of hardware manufacturers' implementation of HDMI, and as the signal travels over long distances, HDCP and EDID data can become corrupted. The CURxE Light technology automatically cleans the bad data to its intended dynamic range. Four LEDs are integrated into the cable's connector to serve as its self-diagnostic monitoring indicators. The cable features full-balanced line transition-minimized differential signaling, 100 percent foil shield, and 90 percent tinned copper braid shield. Lengths range from 0.5 meters to 15 meters.

Honeywell *800 222 0060* *www.honeywellcable.com*

Tributaries HX410

Tributaries introduced the **HX410** and **HX410A** remote-controlled HDMI switchers, capable of switching between four HDMI sources, sending the signals through its single HDMI output. Both models include Signal Enhancement, which engages active equalization to maintain the full integrity of the HDMI transmissions, even over long cable runs. The built-in booster enables it to be mounted along with all of the other equipment and still run up to 30 meters of 1080p signal after the unit. The HX410A adds both optical and coaxial S/PDIF digital audio ports for each input and its output, allowing audio and video signals to be routed independently. Both models are compliant with HDMI v1.3 and HDCP 1.1, and front-panel push buttons provide control over both models. In addition to the wireless remote control, the devices can be controlled over RS-232. The HX410 sells for $300 and the HX410A sells for $400.

Tributaries *800 521 1596* *www.tributariescable.com*

Oculus Series 6 Component Cable

Oculus Designs introduced their **Series 6** line of cables, including composite, component, S-video, digital coaxial, digital optical, HDMI, subwoofer, and loudspeaker cables. Each cable uses 99.99 percent pure oxygen-free copper conductors with double shielding, and the HDMI cable offers three separate shields to ensure more smooth and accurate digital data transfers. Precision-molded or machined 24-karat gold-plated connectors are used, as is low-loss, solid polyethylene dielectric construction. All Series 6 cables come in 1-, 2-, 3-, and 5-meter lengths; with the HDMI also available in 7-, 10-, 12-, and 15-meter lengths.

Oculus Designs *888 252 3904* *www.oculus-designs.com*

Key Digital Systems KD-VPHD3

Key Digital Systems introduced the **KD-VPHD3** ($2,000) video processor, which is designed to act as a universal distribution center for any HDMI or component video source. The HDMI v1.3-compliant device includes Key Digital's Clear Matrix Pro and Super Digital Scaling circuits for deinterlacing and scaling from virtually any standard digital or analog source to the resolution of the video display, including 720p, 1080i, and 1080p. The KD-VPHD3 allows for individual customization of the aspect ratio, brightness, contrast, hue, edge enhancement, and image position for every input source. A VGA input is also included, which can be transcoded to HDMI for delivery to the display.

Key Digital Systems *914 667 9700* *www.keydigital.com*

Universal Remote Control MX-810

Universal Remote Control released the **MX-810** remote controller, which is designed for dedicated, custom control over single-room home theatres or audio/video entertainment systems. The MX-810 remains dedicated to a single room's equipment, complete with a user-changeable label identifying the room. The remote features radio frequency addressability to control components up to 100 feet away or behind cabinets and walls, and it is programmable by any Windows-compatible laptop or desktop computer with a USB port, using URC's ProWizard programming software. The controller includes 32 megabits of flash memory, which can customize controls for up to 24 activities on eight LCD pages for each of 24 different devices, for a total of 384 pages. The $400 controller has a motion sensor that automatically turns on the LCD screen when the remote is picked up and a small integrated speaker that will optionally beep in response to button presses.

Universal Remote Control *800 901 0800* *www.universalremote.com*

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Widescreen Review
The Essential Home Theatre Resource™

Power Envelope
Amplification For MultiSpeaker Arrays

By Daniel Sweeney

When we set out to do a comprehensive article explaing amplifier design as a preface to an expansive review of multichannel ampliferes now on the market, I asked our Contributing Editor Dan Sweeney to take on the challenge. Dan has done a tremendous job explaining what is a rather complex subject. His work provides an excellent reference on the subject of amplification for multi-speaker arrays applied to home theatre entertainment, whether movies or music.—Gary Reber, Editor

Linearity

Most of the output devices in common use today have fairly low inherent linearity. The most linear output device I know of is the giant 845 output tube which produces only about 2 percent THD without feedback when operated in Class A mode. Common transistors produce several times this value of distortion within their rated power range, and MOSFETs tend to have higher inherent distortion levels than bipolars though there are individual MOSFETs that outperform individual bipolars in this regard.

The question naturally arises as to how amplifiers can have rated distortion of 0.01 percent, a not atypical figure for modern designs, when the output devices are so nonlinear. The answer to this question is that the overall amplifier circuit is linearized by any of several techniques described immediately below.

Output Biasing

The first of these output linearization techniques is to set a bias level for optimal linearity within or without the constraints of efficiency, and this is where class A, B, and AB operation comes in, and where, incidentally, many marketing efforts have found their focus.

All active devices have a range between turn on and turn off where they are most linear. If the device is biased with a constant input current so that it conducts current even under no signal conditions, it will be pushed into that linear region and will remain there.

When this bias current is set at a level of few milliamperes, a common figure, the amplifier is said to be operating in the class AB mode, and it will maintain good linearity at low signal levels, but will switch off when the current swing through the device exceeds the bias current, and in so doing will create what is known as notch or crossover distortion. If, on the other hand, the device is biased up to the point where it conducts current at half of its maximum level under no signal conditions, then the device will never turn off when reproducing a signal below clipping, and thus will never be brought into its nonlinear operating region. Such a device will be said to be operating in class A—or God's class as one of my fellow reviewers likes to describe it. (In a push-pull class A design the amplifier will conduct maximum current at all times whether in a quiescent state or at maximum power output.)

No amplifier spe-cifically designed for home theatre use currently operates in the pure class A mode, and certainly none of those surveyed here do. In fact, very few amplifiers of any description operate in the strictest class A, despite claims by manufacturers. A pure class A push pull amplifier is 25 percent efficient at best, thus a 100 watt stereo class A amp must draw minimally 800 watts from the wall at all times and must be provided with massive power supplies, output stages, and heat sinking to cope with the high continuous currents. Unless it is fan cooled, such an amplifier must weigh close to 100 pounds to meet these requirements, and will be inordinately expensive due to the high cost of large power supply components and of adequate heat sinking.

Many manufacturers, trading on the status of class A operation in the high end community, claim class A operation for amplifiers that are biased as little as a quarter of the way up to the true class A point. Others such as Krell and Carver Research make what might be termed quasi-class A designs where the output stages are prevented from shutting off but do not conduct full current at all times. An interesting variant of pure class A, not presently used in any multichannel amps of which I am aware, is current dumping where a small class A amplifier is connected to the load in tandem with a large current amplifier designed to operate in what is more or less a constant voltage condition. Current dumping, also known as quasi-feedforward, is said to offer what is effectively class A linearity combined with near class AB efficiency.

So what does class A, quasi or otherwise, provide that would justify its high cost and relative inefficiency and would truly earn its exalted status in the high end marketplace? Class A unquestionably reduces open loop distortion and makes the circuit less dependent upon negative feedback, which, as I'll explain in a moment is generally a good thing. In fact class A eliminates whole classes of distortion such as notch distortion in all devices and thermal debiasing distortion in bipolar transistors. Furthermore, rigorous double blind testing by Cherry in Australia indicates that the benefits of class A are clearly audible.

In short, if you can afford to pay for a class A amplifier, you'll be buying a real performance feature, and not just a meaningless embellishment. Still, class A operation is no guarantor of sterling perfor-mance in all respects, and the size, cost, and inefficiency of class A designs makes them thoroughly im-practical for most multichannel applications. I don't think we'll be seeing class A to any extent in home theatre.

Push-Pull

The second linearization technique used in output stages is push pull operation where devices of opposite polarity handle opposite halves of the wave cycle and where the resultant antiphase outputs are summed across the load. Provided the two halves of the circuit are perfectly matched, which is almost never the case, this technique will cancel out virtually all even order harmonics, i.e. second, fourth, sixth, and so on. Push pull also permits high efficiency class AB biasing—of which more below—at reasonable efficiency levels.

Push pull operation is used in well over 99 percent of all amplifiers made today, although in the outer reaches of esoterica a few companies have revived single ended triode tube designs where one device handles both halves of the wave cycle. But the ubiquity of the approach should not blind us to its limitations. Because of the characteristics of available devices, push pull is difficult to implement perfectly. Opposite polarity transistors are all mismatched to some extent, and opposite polarity MOSFETs commonly exhibit differences in drive requirements of a magnitude of four. And inasmuch as the devices are mismatched, they can't buck out even order distortions, and in fact they're likely to create such distortions.

Now it is possible to match both halves of a circuit by building compensating asymmetries into the preceding drive circuits, but that adds to the cost and complexity of the amplifier. It's also possible to clean up residual distortion with feedback, and I'll have a good deal to say about such error correction, but that's a topic for the following section.

Before we conclude our discussion of push-pull operation, something should be said about an aspect of amplifier design that is often confused with push-pull operation, but is not really the same thing though it is conceptually related. Here I'm speaking of balanced circuitry, and, more specifically, balanced input circuitry where the circuit terminates at three input terminals, hot positive, hot negative, and ground (in such circuits the ground is often referred to as a floating ground because it is not a reference point for signal voltages but merely a midway point between the positive and negative poles).

Balanced circuits swing voltage in both directions, positive and negative, with the signal swing passing through ground. Positive swing is handled by one half of the circuit and negative by the other, the two halves forming mirror images of one another. Balanced circuits are used for either or two reasons, to provide for greater voltage swing than a single ended circuit using the same type of devices can provide, or, as is more commonly the case, to provide for high immunity from electrical noise. In a single ended circuit noise tends to modulate the ground, and thus the noise itself is subject to amplification, but in a balanced circuit noise is common mode, appearing on both sides of the circuit in an antiphase relationship. Consequently the noise is bucked out when the two halves of the signal are summed. In complex home theatre systems balanced input circuits in power amplifiers are definitely desirable—provided that they are driven by balanced line outputs from the preceding component in the signal chain.

Negative Feedback

Negative feedback is just what the name implies, a return of some portion of the output to the input in an antiphase relationship to the input signal. Like class A operation it reduces efficiency and distortion, but without the liability of high heat. Frequently in audio power amplifiers it is applied around circuits with high open loop gain, and, in such instances, the gain characteristics of the circuit push the signal high above the residual noise and distortion and maximize the ratio of the signal to the spuriae. Subsequently, when the level of both is reduced by the feedback, this favorable ratio will be retained and nonlinearities will be buried. If the trick is managed properly, the distortion can practically be eliminated—at least in regard to steady state signals.

A penalty is paid, however. The feedback itself takes time to pass from the output to the input and so it cannot correct the distortion engendered by a high frequency transients. And if the gain of the circuit is high, which is practically always the case if high values of feedback are used, then the circuit must be compensated at a low frequency and feedback may be practically nonexistent at the highest audible frequencies since the circuit's gain is then approaching unity. What all this means is that the circuit is relatively uncontrolled at the top of its range, and, with all its inherent gain before compensation, is susceptible to hard clipping when passing intense high frequency transients. Once clipped in this manner the amp has little ability to correct for distortion at any frequency, and will produce a range of distortions known as transient intermodulation distortion (TIM).

TIM is the bane of high gain high feedback circuits, particularly those using devices of inherently low bandwidth, and where the requisite gain is gotten by cascading several gain stages and thus lengthening the transit time through the global feedback loop. In early IC designs based on the very slow bipolar transistors of the time, TIM could be pretty serious, and was said to account for the gritty, grainy sound of Japanese receivers commonly employing such ICs.

TIM is often mentioned in the same breath as slew rate, a measure of amplifier performance which indicates how much voltage the amplifier can swing within a given duration while remaining linear (typically that duration is one microsecond). A low slew rate indicates that the amplifier can not pass intense high frequency transients because it can't accomplish the required voltage swing quickly enough. Normally the limiting factor here will be the compensating network used to roll off gain in the high frequencies in order to stabilize the amplifier, and since the corner frequency for the network will be determined both by the value of feedback and the type of device employed, we tend to find the lowest slew rates in high feedback bipolar amps.

TIM and slew rates have always been a matter of controversy within the industry, with most of the *Stereo Review* and former *High Fidelity* writers either denying that the phenomenon of TIM exists or insisting that it was never a problem in any but the very earliest solid state designs. Interestingly, such assertions were usually accompanied by a firm insistence that TIM tests never be utilized in standard product evaluations.

Whatever the truth of that position in the past, TIM is certainly less likely to be a problem in current designs, even chip based designs with their notoriously high gain, high feedback architectures. That's because chips have gotten much better today. Input ICs are available for a dollar or less that have bandwidths into the megahertz and true measured THD in the 0.001 percent range to beyond 20kHz. These new types of ICs do not require the severe low frequency compensation of the older bipolar types because they utilize ultrahigh speed FETs instead, and consequently they don't suffer from appreciable TIM. A manufacturer who elects to cheap out and use penny ICs may still have problems with TIM, but there's no excuse in a component amplifier.

TIM, unfortunately, does not exhaust the list of problems encountered in high feedback designs, however. The feedback loop engenders other side effects as well, some of which are pretty intractable.

Perhaps the worst problem with high gain, high feedback circuits is their clipping behavior. We've already noted their propensity to clip at high frequencies, but in fact clipping at any frequency is apt to be particularly offensive in high feedback designs because, for the most part, they will suddenly change their characteristics at the onset of clipping. All amps lose feedback during clipping since feedback is proportional to gain and since gain levels off at the onset clipping, but because—absent feedback—the gain characteristics of the high gain high feedback amp cause it to clip harder, the loss of feedback is especially serious.

In solid state designs the problem is exacerbated by the inherent characteristics of the devices themselves. Both bipolar transistors and FETs begin to generate high order harmonics at relatively moderate levels of overload (the oft expressed statement that FETs have tube-like distortion characteristics is not strictly true).

Because feedback falls off with increasing frequency, it doesn't correct for high frequency distortion products, particularly the crossover distortion which is the common liability of solid state circuits. Thus, the practical effect of feedback is to eliminate the relatively innocuous low order distortion products and leave most of the irritating high order variety. In a solid state circuit this state of affairs is particularly unfortunate because the balance of distortion harmonics tilts toward the high order to begin with, and feedback exacerbates the unfortunate spectral skewing. Furthermore, the feedback signal itself engenders multiples of the circuit's open loop distortion products as it cycles back through the circuit--for instance, a recycled second harmonic begets a fourth harmonic, while a recycled third begets a ninth. These new distortion products may be fairly low in magnitude, but they are intrinsically more audible because they're not musically related to the signal.

It gets worse.

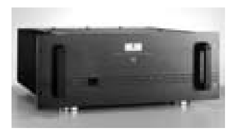
The high feedback amp, being heavily compensated, is also subject to gradual phase shift over most of the audio band under open loop conditions. This phase shift is corrected for the most part by the feedback loop, but what distortion products remain represent output that has escaped the loop, and thus they retain leading phase characteristics that is, they are phase shifted ahead of the feedback linearized audio signal. This phase shift makes them subjectively more audible.

Incidentally this phenomenon of phase incoherent distortion was brought to my attention by Steve Scullions, a free lance design engineer who's worked for Nakamichi and Soundstream, and by Don Werrbach of Aphex Systems. I would add that the current Aphex Aural Exciter exerts its effects by deliberately phase shifting the distortion components it creates.

Obviously severe clipping is accompanied by audible distortion, but sound reproduction is affected in other ways as well when the high feedback amp goes into clipping. Most amplifiers use feedback to bring down the output impedance, and thus when the feedback goes away under clipping conditions the amplifier's damping suffers as does its frequency linearity in the presence of load reactance. In worst case, the amplifier may even oscillate briefly. In other words, the clipping amplifier manifests linear as well as nonlinear distortions.

A final effect of the feedback, which occurs only in solid state circuits, is known as phase modulation and was described by Matti Otala back in the 1970s. Phase modulation (Otala's term) is a condition attendant upon the gross alteration in gain values with both frequency and amplitude that occurs in b-ipolar devices. Because feedback value itself is a function of gain, the characteristics of the circuit are changing on a dynamic basis and specifically the phase of the feedback signal is shifting dynamically. This being the case, feedback compensation can never be set to ensure absolute stability under all signal conditions, and of course neither can constant gain be ensured at high frequencies where feedback is rapidly rolling off. Alterations in gain equal amplitude distortion, while a shift in the corner frequency where gain drops to unity will cause doppler distortion.

The notion of phase modulation is a derived from a mathematical analysis of circuits, and no standard test has ever been developed for its presence, but predictably with complex signals a rich spectrum of harmonics would be generated.



Of course there are those who say, "so what?" when clipping behavior is discussed. Such individuals rea-son that solid state components design-ed with adequate headroom characteristics will not be overloaded in ordinary circumstances anyway, and thus clipping be-havior becomes a moot point.

This position, though frequently expressed in some stereo review magazines, is debatable. Playing highly dynamic program material at realistic levels on low efficiency loudspeakers can require more than 500 watts for the undistorted rendition of peaks. Such output capabilities are far beyond all but a literal handful of solid state amplifiers with sine wave input signals. And with complex music signals the output capabilities of the solid state art appear to be very much lower. The proposition that power amps are not clipped in normal listening just isn't true.

This last point requires some elucidation because it is central to the whole discussion.

In the 1960s, the late Bart Locanthi, a well known audio industry consulting engineer, discovered, while at JBL, that solid state amplifiers of a given nominal continuous power rating would normally produce a small fraction of that power with a pink noise input signal. Tube amplifiers would also produce much less power with pink noise than with sine waves, but curiously a tube amp of the same nominal power rating could usually put out two to three times the pink noise power of its solid state counterpart. I have seen only a few pink noise tests performed on modern solid state amps, so I am some-what hesitant to generalize, but so far the Locanthi dictum has held true in every case I know.

If in fact the observation is generally true, we can draw two conclusions from it. First, the oft stated audiophile position that a tube amp will sound twice as powerful as a solid state amp of the same rating seems to have a basis in fact. Second, the notion that the solid state amp won't be forced into clipping in normal circumstances is untrue. According to Locanthi's finding, solid state amps on pink noise tend to clip at about a tenth of their rated power, and that means a 200 watt amp is really only a 20 watter on an RMS basis with some program material—perhaps with much program material. Remember, pink noise is much closer to most music signals than a 1kHz sine wave, the usual test signal.

Thus we see the solid state amplifier, even the high powered solid state amp, clipping

frequently on transients and putting out lots of high harmonics in the process. And we begin to see a mechanism behind the edgy sound quality we still hear so frequently with transistorized equipment, and so seldom with tubes. It's not just that tube amps have more residual second harmonic distortion at low signal levels that makes so many of us prefer them. It's also that they have much less high order distortion at realistic—not deafeningly loud—listening levels.

And that, I submit, is significant.

Not that I'm suggesting that we all go back to vacuum tube amplification. Tubes will never, in my opinion, play a significant role in multichannel audio systems. What I am saying is that the current solid state art is not perfect, as some in the industry have insisted, and that high nominal power ratings represent one way of getting around the inherent limitations of hard clipping circuits.

Is there any other way to prevent an amplifier from clipping audibly in ordinary use? Jim Croft of Carver Corporation has suggested that sophisticated signal processing may be the answer. For instance, phase shifting peaks so that they do not coincide with low level transients would not only prevent clipping in many instances, but would prevent low level detail from being buried when clipping does occur.

At any rate, poor overload behavior is just one deficiency common to high feedback designs, and recognition of the numerous untoward side effects of negative feedback has led many in high end audio either to reject it or to insist that it be applied at low values. Unfortunately, low feedback designs carry their own sets of problems.

If no feedback is used anywhere in the circuit in a solid state amp, the distortion will reach several percent, and the output impedance will approach that of a tube design. Moreover, the amp will not have constant voltage characteristics and will be unable to cope with load reactance or impedance fluctuations. For these reasons practically all power amplifiers use feedback around at least one stage of the circuit, and many use multiple loops—that is, individual loops around single stages as well as an all encompassing global loop from output to input. Indeed, often designers utilize high values of local feedback in lieu of high feedback overall, and then claim to have low feedback designs! And in a sense they do, but if the feedback of all loops is summed, then the total value of feedback may be and usually is quite high.

How high is high?

Most consumers have the notion that anything above about 12dB is high feedback, but if we look at typical distortion figures of amplifying circuits open and closed loop, then the numbers tell a different story.

As we've seen, intrinsic distortion of most solid state amplifying circuits will exceed 10 percent open loop. To get that distortion down to as low as a tenth of a percent, which is actually pretty marginal by present day standards, will require about 40dB of negative feedback, each 20 decibels representing one order of magnitude in regard to percentage values. To meet and exceed THX specs and hit the 0.01 percent point, yet another 20dB of feedback will be required for a grand total of 60dB. What I'm saying here, is that most amps, high end or otherwise, have a lot more than 12dB feedback.

The Linearity Conundrum

As should be obvious from this discussion the issue of output signal circuit linearity is quite complex and admits of no simple design dicta of the kind beloved of marketing managers. One simply can't say with much validity that MOSFETs are decisively superior to bipolars or vice versa or that eliminating all feedback is the road to perfection.

And yet one can say that the devices themselves do establish a basic floor of performance that appears to limit the performance potential of the design. A bipolar still behaves like a bipolar for good or ill and a MOSFET like a MOSFET. The specs have improved, but the nature of the imperfections has not changed.

In this light fundamental improvement in amplifier linearity appears unlikely unless one of three developments occur. The first would be the invention of some new circuit topology that linearizes the devices beyond what is possible with the current art. The second would be the successful operation of the devices in a radically different mode such as pulse width modulation or pulse density operation. And the third would be the appearance of a new type of active device.

The prospect of a radically new and indisputably superior topology seems unlikely. Just about everything that could be tried has been tried. Nevertheless, every so often one hears rumors of some breakthrough topology or other, and I can't resist mentioning one that came to my attention a few years back and has intrigued me ever since.

Some three or four years ago an English designer named Les Sage began advertising a modular amplifier sans chassis, power transformer, and filter caps, with claimed THD of 0.0001 percent, unmeasurable TIM, 130dB S/N (signal-to-noise), and only 4dB of global feedback. For further information in the form of a literature packet, interested parties were instructed to send a $5 cheque. What the hey, I thought, and sent a money order, a personal letter, and a number of previous publications of mine relating to power amplifier design.

After a wait of several weeks I got a long letter back plus a bundle of Mr. Sage's advertising materials. Though amateurishly written and printed, these were obviously the work of an individual with deep, deep knowledge of analog circuit design, and just enough was revealed to allow me to entertain the possibility that the claims might be correct, though not enough to establish this for a fact. What I got from the deliberately obfuscatory descriptions of Sage's circuit was that it used MOSFET outputs in a bridged configuration, constant current sourcing throughout, proprietary power supply regulation circuitry, and possibly active loads—all this elaborate housekeeping circuitry apparently constituting the magic bullet in the design. Mr. Sage and I corresponded at length subsequently, and he eventually agreed to supply me with modules for a review in *Audio Amateur*, but, for reasons best know to himself, he backed out at the last moment and refused to reply to further letters or faxes. I've always been intrigued as to whether his design performed as advertised, because if it did so, it would represent a genuinely important innovation, though one might still question whether it clipped as gracefully as the better tube designs.

The second development that could elevate amplification to a new level would be the creation of a truly high performance switch mode amplifier. In switch mode the transistors are operated as on/off switches, not as linear devices and the switches produce a series of pulses of varying width or density. These pulses are essentially square waves, and their duty cycle is determined by a triangle wave generator similar to the sync circuit in a television monitor. The pulse train itself forms a high frequency carrier for the audio signal, and is filtered at output like the "staircase" from a D/A converter so as to produce a smooth analog waveform.

Over the years many models of switch mode amps—virtually all PWM types—have been sold to the public, but none has ever won much acceptance. Currently only one consumer model is on the market, the very expensive, very powerful, English Croft. Such switch mode designs are intriguing because they use transistors as switches, a function to which they are supremely well suited, but they have never been shown to surpass conventional designs in measured performance or sound quality. And whether they ever will is open to question.

Finally, we come to the last type of development that could advance amplifier linearity significantly, the introduction of new types of active devices without the various shortcoming we find in existing types. Two candidates are mentioned with some frequency, gallium arsenide FETs (GASFETs) and field emissive devices (FEDs).

GASFETs exhibit good linearity, extraordinary bandwidth, and ultra-low noise and they actually have been used in FM tuners. Unfortunately no one has ever made one that could handle much signal swing, and since companies have been trying for the last twenty years, one has to assume that intrinsic limitations exist.

Field emissive devices, the second contender, are actually vacuum tubes, extremely tiny vacuum tubes using cold cathodes and operating at high currents and low impedances. Currently used only in experimental logic circuits and in video displays, field emissive devices have, for the most part, been highly nonlinear, switchlike devices that behave not all like common audio frequency vacuum tubes. Whether they could in fact be designed to exhibit the linearity and headroom of tubes along with the current capabilities of transistors is open to question. Several audio companies have been interested enough in the technology to approach the half dozen organizations conducting research with FEDs, but don't expect any technology transfer any time soon. If ever.

Current Capability

The second major factor determining the performance of the output stage of a power amplifier is the current capabilities of the devices themselves, and the presence of or lack thereof of protection circuitry to limit current to the output devices.

Current capability refers to the rated maximum value of current a device can conduct. Beyond this value the device performs suboptimally, though the different types of devices perform rather differently in the presence of excessive currents. Bipolar transistors can actually self destruct when asked to pass currents beyond their ratings because their internal resistance drops and they become subject to thermal runaway. MOSFETS, on the other hand, tend to self limit with heat buildup because their resistance goes up and they actually pass progressively less current beyond a certain temperature. Vacuum tubes are a special case, being inherently low current devices, and, for reasons we need not discuss here, tend to hard-limit when faced with increasing current demands.

In regard to the design of output stages, these limitations in current capability common to all active devices are best addressed by using a sufficient number of devices so that the ratings of the individual devices will never be exceeded under any circumstances apart from a dead short across the outputs. But because output devices are fairly expensive components, manufacturers are inclined to skimp there. Therefore, when you're considering an amp, it's a good idea to take a close look at the output stage, calculate the current that will be drawn from the output in worst case—which of course will depend on the speakers you're using—and then add up the ratings of the devices (instantaneous current requirements will usually exceed those dictated by the nominal impedance by an order of magnitude). If the ratings are exceeded under normal circumstances, you'll hear the consequences.

And what exactly will you hear?

MOSFET amps with marginal output stages tend to compress when driven hard into difficult impedances because their current capability is actually decreasing momentarily. This results in squashed dynamics. On the other hand, a bipolar's internal resistance drops as it heats up and it wants to pass more and more current up to the point where it burns. Consequently, many designers of bipolar amps put in current limiting circuits in the power supplies that simply choke off current beyond a certain point. In receivers and power amps with underbuilt output stages such limiters are being constantly invoked during sound reproduction, blunting transients and creating bursts of distortion.

An almost certain sign of problems in this area is an output stage with only two to four devices total or a power IC. In neither case will the amp be up to driving difficult loads, although I must say that power ICs have improved to the point where the best can now be considered marginal rather than totally unacceptable.

Power Supply Capacity

Just as the output stage must have the ability to conduct the current demanded by the load, the power supply must be able to provide it, and adequacy in this regard is, in general, largely a matter of the size of the power supply components.

Power supplies normally consist of a transformer, rectifier diodes, some large capacitors, and, by some definitions, the various regulator circuits that interface the supply with the signal circuitry. (Most amps made today use voltage regulators for the lower stages while remaining unregulated at the output stage.) The transformer and capacitors are the components that largely determine the energy storage capacity of the supply, and it is these components where size becomes issue. They're also the major cost items in the supply, and since cost relates closely to size, manufacturers are especially likely to ecomomize here.

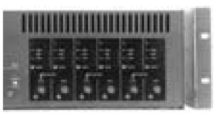
Let's examine this matter of capacity a little more closely.

The collective capacitance of the filter capacitors (measured in microfarads) in the supply determines the supply's ability to store a charge. This in turn determines how much current the amp can put out, provided, of course that the output devices can pass the current. In addition, the total capacitance of the supply has a bearing on the amount of AC ripple riding on the supply rails—in other words the purity of the DC supplied to the signal circuits. And finally, the total capacitance of the supply sets the size requirements for the power transformer used to charge that capacitance—big caps necessitating big transformers.

So in terms of power supplies, bigger really is better. Which is good for the consumer because anyone can determine size just by looking at the caps and transformer and lifting the amp. For example, a 750VA power transformer will exceed 20 pounds, while capacitors rated in the tens of thousands of microfarads will weigh several pounds apiece and will approach the size of a cocoa tin. In most cases you can literally judge the worth of a supply at a glance.

Of course here we're talking about multichannel amps for home theatre, and that inevitably prompts the question of not only how big a supply but how many supplies?

The purist approach is multiple mono where each channel of amplification is provided with a totally separate supply including a separate power transformer. Note that



of all of the amps we will be considering only the Proceed boasts such totally discrete supplies in an all in one chassis. A halfway approach is to provide the separate channels with their own filter caps and rectifiers while forcing them to share transformers. Most of the amps surveyed follow this approach. And finally we have designs where every channel must draw on a single supply consisting of one bank of capacitors and one transformer, of which examples are numerous at the lower price points.

Why is discrete supposedly better? The notion behind building separate supplies for each channel is that with such an arrangement heavy current draw from one channel cannot effect other channels by starving them for current or modulating the signal. But it must be said that this notion is only true up to a point. You see, unless the supplies have individual power cords drawing from dedicated circuits, crosstalk can occur between channels through the housewire. And that's not just hypothetical. Ever noticed what happens when your amp shares a circuit with your refrigerator and the refrigerator's motor starts running? The same thing can happen when a bass transient passes through one channel while dialogue is passing through another.

And in any case concentrating solely on the number of supplies is to ignore other significant issues not only of power supply design, but of the design of the signal circuitry as it relates to interactions of the same with the supply. If, for instance, signal circuitry is designed to exhibit a high degree of power supply rejection—that is, to maintain linearity in the face of supply fluctuations, then the issue of one supply versus several becomes less pressing. Similarly, if the supply itself is tightly regulated for each channel up to and including the output, and the supply itself constitutes a sufficiently large reservoir of electrical energy, then a single supply might perform very well. Moreover, one could argue that if achieving the highest total supply capacity at the lowest price and with the smallest footprint is the ultimate design goal, then unquestionably a single supply is the way to go. While separate supplies certainly constitute a theoretical ideal, a carefully designed amp with one big supply might well surpass a pure multiple mono configuration with poor power supply rejection and/or marginal individual supplies. In our examination of individual amps we shall see how the two approaches fare in practice.

Is there any way around the size requirements for power supplies?

There are indeed a number of ways using unconventional technology to combine high current capability with a small form factor. None of these approaches is entirely without its drawbacks, but they're worth examining nonetheless.

The simplest way of squeezing high current out of a small supply—though it only works on a momentary basis—is to design the supply to have very loose inherent regulation. What this means is that the supply rails, the voltages impressed across the output transistors, are allowed to sag considerably during high signal conditions. In such designs the power supply capacitors, which are selected to have fairly low values, discharge quickly and copiously, and like a depleted car battery, cannot maintain the voltage rails at their normal levels in the face of continuous high current draw. As with a sprinter going into oxygen debt, the amp will put out much more power than its nominal rating would indicate for a brief period—normally a matter of milliseconds—but simply lacks the current capability to sustain high output. Such amps are said to have high dynamic headroom, and the power supply concept they embody is sometimes referred to as the oversized floating supply rail.

The theory informing such designs is that music programming or movie soundtracks generally show a highly variable energy distribution with brief, high intensity peaks and fairly low average levels. While that theory is true as far as it goes, it is nonetheless difficult to design a high headroom amp that is fully equal to the twin current demands imposed by high dynamic recordings on the one hand and difficult speaker loads on the other.

Unless the amp can maintain its augmented output level for at least 300 milliseconds, its apt to be embarrassed by certain types of transients—detonations, kickdrums, electric bass, and so on. And if it has to drive a low impedance continuously at high levels, it will not be able to recharge its supply fast enough to maintain a high output level.

Enthusiastically espoused by midfi reviewers a decade ago, high headroom designs in their most basic form have never enjoyed much high end acceptance. Nevertheless, because they are inexpensive to manufacture, high output amps with small power supplies continue to intrigue manufacturers, and several fairly sophisticated variants have appeared over the years.

The first of these were the class G and Class H designs, also known as stacked power supply types. These actually have auxiliary supplies which sit at high voltages and do not discharge at low signal levels, but at higher levels, trigger circuits open and allow the charges in the auxiliary supplies to flow through the output. These schemes, which are still used in the Proton and NAD amps, are said to allow for more sustained high output than the oversized rail approach.

Related to the stacked supply concept is Carver Corporation's Magnetic Field amplifier design which uses but a single supply, but employs a device called a triac to switch the supply rail voltages dynamically up and down with the signal level to enable the amp to put out high wattages on a demand basis while maintaining the low heat dissipation of a low powered design. While the design can be used with any size power supply, the Carver practice was to make the power supply transformer and capacitors far smaller than would be normal for a given power rating with consequent cost savings at the manufacturing level, and an unparalleled watts per dollar ratio on the retail floor.

The Magnetic Field arrangement (really a misnomer for principle of operation), though much maligned by high end reviewers, really is a clever technique, and will provide for sustained high output from undersized supplies over fairly lengthy time spans —unlike oversized floating rails or class G or H. But it is not, in my opinion fully equal to a brute force supply. Switching the rail voltages produces dynamic distortions, and when the process takes place with a critically small supply meeting demands for continuous high current output, the relatively tiny capacitors are drained, and the little transformers driving them are severely loaded down. Early magnetic field amps could put out impressive amounts of power into constant 8 ohm loads, but collapsed when driving low impedances, and frequently burnt out in demanding professional applications. Such failings led many in the industry to decry the technology as a fraud, a charge no doubt also prompted by jealousy at the company's success in selling the concept. I think it is significant that the company has gone beyond the technique in its flagship Lightstar, of which more in a moment.

The next technique for getting a lot of power output from a small supply is to provide the supply with a DC to AC to DC convertor—making it what is known as a switching power supply. While rare in home products, this design is currently garnering much attention due to its presence in the Carver Lightstar and Sunfire amplifiers. It also appears in the Soundstream THX amplifier, considered in our product review.

Originally developed for mobile radio use and later utilized in the personal computer, switching power supply technology came into consumer audio through the back door as a component in high powered automotive amps. While appearing from time to time in home amps, it never won much acceptance up until now, but the presence of the technology in three new high profile products is provoking heightened discussion of its promise and problems.

A switching power supply is normally small, but has a relatively complex circuit. AC from the wall is first rectified with diodes, filtered, and then chopped up into high frequency AC with a switching circuit. The resulting AC is then rectified and filtered again.

What does all this complication buy you? Because in modern switching supply the rate of refreshment for the main power supply capacitors is several times the highest audio frequency, the caps will be recharged to full capacity several times during the wave cycle of the highest frequency reproduced, permitting the use of very small storage capacitors. Moreover, the AC ripple is easily filtered out so that the resulting DC is much purer than in a brute force supply. And unlike class G and H and even Magnetic Field, a switching supply has no trouble with difficult loads or demands for high continuous power. It really is equivalent to a brute force supply in its ability to provide current on demand.

But the approach is not without its problems. Switching supplies are notoriously dirty, producing radio frequency interference of a magnitude to render utterly insignificant the CD digital switching noise that preoccupies audiophiles. Then too, switching supplies are a good deal more expensive to build than Magnetic Field designs or class G/H supplies—just about on a par with a brute force supply if the switching supply is properly shielded. Again there's no free lunch.

Which brings us to the final development in smart supplies, the nameless circuit employed in the Lightstar and, with some modifications, in the Sunfire, and which surely constitutes one of the most ingenious ever to appear in a mass produced amplifier.

The circuit used in these amplifiers is not absolutely without precedent as regards various details of the design, but in its totality must be regarded as unique.

The switching supply itself utilizes floating rails that track the audio signal, going up and down to meet the power demands imposed on the amplifier and permitting the amp to operate at high efficiency under low signal conditions. In basic concept the design has something in common with the Magnetic Field, but whereas the Field had only three set voltage levels, the new circuit can vary supply rail voltage over an infinite set of values. The pulse width modulation switching mode used in the supply permits the establishment of varying voltage potentials by varying the width of the pulses, so the process of sliding the rails is fairly straightforward.

Incidentally this aspect of the design is not entirely unique in the marketplace. A very similar pulse width modulated floating supply is used in the Blade automotive amp. Furthermore, floating supplies were used in the Technics New Class A circuit and in the Acoustat Trans Nova, though both earlier designs used class B amps to pull the rails up and down.

The initial Lightstar circuit went considerably beyond its predecessors, however, because it also floated the output devices and the output ground up and down (voltage swing at output is between hot negative and hot positive, not hot positive and ground). The output MOSFETs were maintained in a pure class A condition, and never experienced more than 5 volts of voltage swing, and essentially they were current sources following the swing of the supply voltages in either direction. And because they were maintained in a class A constant voltage condition, they were virtually unable to create distortion—no mechanism was present to allow them to do so. What's more, they couldn't heat up in the presence of load reactance from which the amplifier is essentially immune--and indeed back emf was allowed to circulate back into the primary power supply via diodes where it was modulated in the switcher and helped to charge the power supply capacitors.

Due to difficulties in refining the design concept, the actual Lightstar sold today does not incorporate the floating ground class A output nor the provision for channeling back emf. into the supply so as to boost the efficiency of the design. But according to Jim Croft who currently heads design efforts at Carver, the original Lightstar design will be revived (perhaps in a multichannel configuration, as well).

There's no question that the scheme permits the construction of an extremely high powered, high current amplifier of moderate size and weight, but is it sonically transparent? Doubts have been expressed in the reviewing community.

What It All Means

To reiterate, the design of power amplifiers is not a rapidly advancing area of technology, and most current products reflect relatively straight forward engineering and design principals, indeed most tend to resemble one another in basic topology. While such technical maturity and general uniformity of design may detract from the excitement of the category, it serves to provide the consumer with a firm basis for assessing individual products and militates against the survival of truly ill-conceived and poorly executed devices in the marketplace. If amplifier design is largely standardized, and if differences in performance relate largely to the capacities and tolerances of the components, then competent design work should be wide spread—a situation I believe in fact does obtain.

Not that I believe existing designs are close to perfect—they're not. It's just that, given the limitations of the active devices available today and in the foreseeable future, amps aren't going to get much better. ■