ENGINEERING EXTRA

TALK TO ME
Is your network connection working?
Ping it to find out. Page 8

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NewBay Media

The Making of a Transmitter Line

Anderson Describes Harris Flexiva in the Context of Solid-State FM's Evolution

BY TIMOTHY B. ANDERSON

The author is the radio transmission product development manager for Harris Broadcast Division in Mason, Ohio, and an SBE Certified Professional Broadcast Engineer.

WHITEPAPER

Recent advances in RF power transistor technology and performance have contributed to significant improvements in individual device power density, efficiency, linearity and reliability. These ovements have resulted in lower hase and operating costs, improved performance and robustness on par tube-based RF power amplifiers. e devices can be applied to broad- transmitter designs for terrestrial ission of traditional radio and tele- , including analog and all world- igital transmission standards.

benefits of higher-power amplifier efficiency include AC power consumption savings, reduction in physical size, reduction in cooling requirements and reduction of carbon footprint in support of global green initiatives.

Harris has been developing transmitter products that apply this latest device technology to new platforms, offering significant size reduction and improved performance compared to previous designs.

TUBE VS. SOLID STATE

Solid-state power amplification has many advantages over tube technology. Built-in amplifier redundancy, soft failure modes and lower maintenance requirements are the hallmarks of solid-state transmitters. Broadband input/output tuning makes N+1 configurations possible, where a single transmitter can provide backup on multiple frequencies without the need for retuning. Aside from the obvious safety advantage, lower power supply voltage requirements for solid-state reduce the size of the power supplies and RF systems and simplify maintenance.

Traditionally, FM broadcast transmit-

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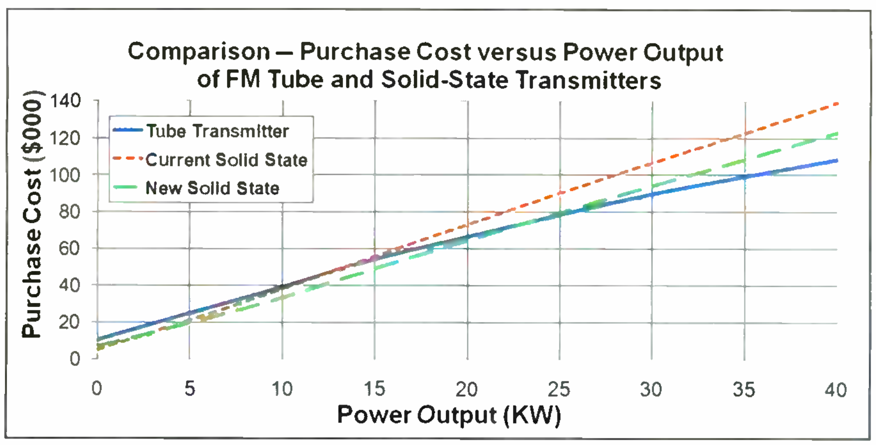

Fig. 1: Cost vs. Power for Tube and Solid-State Transmitters

We Like Our Precast Transmitter Shelter

BY CRIS ALEXANDER

Back in the 1960s and 1970s, we heard a lot about "space age" products. A lot of this was advertising hype, but some was the real deal. The race to space, to put a man on the moon, to send unmanned vessels to other parts of our solar system and beyond, and to get a viable orbital transport up and running resulted in a lot of new technologies.

A DAY IN THE LIFE

These found their way into our daily lives in everything from car wax to the integrated circuits that spawned the "digital age." We have all benefited from these advances.

We don't hear about it as much, but another business more recently has driven a significant number of technology advancements. The wireless industry, still growing almost exponentially in some regions, has spun off any number of advancements that we in the broadcast world enjoy.

One of these "wireless age" components is the rapidly deployable precast

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Steve Lampen's Message to Engineers

Get Ready for More Changes to Traditional Broadcast Infrastructure

BY MICHAEL LECLAIR

Steve Lampen is familiar to most of us engineers as the face of Belden Inc. Hardly a major industry show or conference goes by without his presence and up-to-date engineering information about the wire and cable products we all use.

His full title at Belden is multimedia technology manager and product line manager for entertainment products. As part of the first half of that lengthy title, Lampen meets with broadcast engineers all over the world. The second half involves coming up with new technology products. Lampen, who also is a contributor to Radio World, was named SBE Educator of the Year recently.

As someone who spends much of his time talking to broadcast engineers, Lampen is qualified to talk about technology trends that affect the radio broadcast industry. We connected via e-mail recently to talk about the industry and where things could be heading.

Steve Lampen

What is your impression about the state of the radio industry right now?

I think radio is going through some major changes. First, there was the "Internet broadcaster" who has siphoned off a significant percentage of their non-mobile audience. The only reason that the Internet has not claimed a larger share is that there is no way to count, or even estimate, listenership. I have read that there are 55,000 Internet broadcasters, although I have no idea how they would qualify, much less count, these entities. Besides, it only takes a $99 CD player and a simple adaptor and you're an "Internet broadcaster."

The second concern is HD-AM, which still seems to be wandering around in limbo for many broadcasters. HD-FM is doing much better, although I would love to know what the long-term goal and long-range plans are for this format.

The third, and most serious, challenge will be "cloud" broadcasting, which nobody has mentioned (that I have seen). When you can download anything, anytime, in any order and pay a few cents, or nothing? I simply can't see how existing radio broadcast can compete. What can they offer that you can't find cheaper, at better quality, and with greater choices?

Apple is experimenting with a cloud service to help consumers access their media content more easily. When this includes constant bit-stream data (i.e., radio or television) the whole thing will grind to a halt, starved by lack of wireless bandwidth. Consumers like convenience, but they also dislike a progress bar.

> **Take a networking class** ... even better, learn how to program a managed Ethernet switch.
>
> – Steve Lampen

With this will come targeted advertising, the Holy Grail of market penetration. You're sitting in your local coffee house when your iPad says, "Hey! You like Mexican food" — which they have learned from their capture of your search data — "there's a new Mexican place right around the corner. And they feature the chorizo burritos you love!" And how much is that worth to an advertiser?

Do you see regional differences in how well broadcasters are doing?

Sorry, I am not tuned in to this kind of data. My big-picture view says broadcasters are acting the same as most other businesses. Those that were wise with their money at the start of the recession are now reaping the rewards. Those that ignored the warnings are still suffering and some have changed hands or, even worse, just closed their doors.

Wire and cable are essential infrastructure to new buildouts of studios and consolidations. Do you see a pick-up in that business?

On the TV side, where they spent a wad in the digital upgrade, things are slowly coming back to normal. On the radio side, that has even more market pressure, but wasn't pushed as hard into new technology, these stations recovered faster, but I think that masks the fact that there are some big winners and some big losers.

One of the losers is the small-market independent station, which I think has lost ground in the recession that may not be recoverable. Many of these have been gobbled up by the giant station groups, losing their local character and ushering in a very restricted range of common formats that the Internet would be glad to mimic.

It has been more than a decade since the move to convert audio signals from analog to AES serial digital. Is AES serial digital itself now falling prey to the march toward multi-purpose standardized wiring systems based on Cat-5/6 and the RJ-45?

I am constantly amazed by our sales figures of analog audio cable. Most of the audio, even in networks and station groups, is still analog. Quality is

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THIS ISSUE

DECEMBER 7, 2011

PRECAST SHELTERS

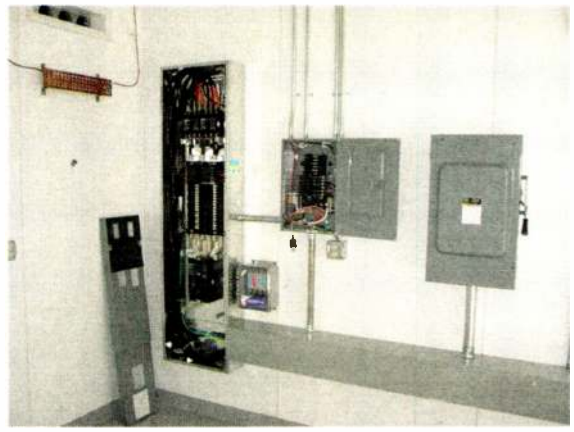
(continued from page 1)

equipment shelter.

For most of my career, transmitter buildings were constructed on-site from traditional building materials — wood and masonry of one type or another. My personal favorite was joisted masonry construction: concrete block walls topped with closely-spaced roof joists covered with a wood or metal roof deck. This provided for a sturdy, secure, well-insulated and durable shelter for transmitter equipment.

Ten or so years ago, in the early 2000s, the building environment changed. That was about the time that the cellular network buildout began to level off. Companies that had for many years stayed very busy providing the wireless networks with prefabricated equipment shelters began finding themselves with time and materials on their hands. They began looking for new markets, and broadcast was one of the industries that they targeted.

It was about that time when I found myself in need of several transmitter buildings around our company. I initially started down the old path of building joisted masonry structures. When I priced those against some of the proposals I had received from precast equipment shelter manufacturers, I quickly concluded that I could get a much better shelter more quickly and for a lot less money than anything I could do using standard building techniques on site.



The electrical system comes pre-configured to the customer's specifications, in this case a three-phase disconnect for a 30 kW FM transmitter.

Cable ladders, 'halo' ground, telco board and high/low temp alarm thermostats are available options.

Precast shelters are shipped on 'low boy' flatbed trailers and unloaded with a crane.

THE ICE CHALLENGE

One of the challenges that we have long faced with our transmitter buildings, particularly in FM applications, is ice fall protection. Transmitter buildings typically are placed close to the tower base to minimize line losses, and it is that placement that puts those buildings right in the fall zone for large chunks of ice that fall off the tower. Joisted wood and metal roofs are not very good at deflecting such missiles. At best, they often end up with holes in the roofing membrane and have resultant leaks. Sometimes, ice bombs do a lot more damage than that.

With their concrete lids, precast shelters really shine in the area of ice fall immunity. In my first application, the new shelter would sit at the base of a 1,380-foot tower in Alabama, a place where we do get some ice storms from time to time. I knew that a conventionally-constructed building would have to be protected with a galvanized steel ice shield, which would really run up the costs and make re-roofing a royal pain down the road. That, more than any other factor, is what convinced me to try a precast shelter that first time. Since then, I have not even considered going back to conventional construction.

BUILT TO SPEC

Precast equipment shelters typically are ordered with all the electrical, HVAC, security, cable ladders and other facilities built right in. The customer specifies all this and the factory builds it all. The idea, which again came from the wireless industry, is rapid deployment — with all these items taken care of at the factory, the site can be up and operating within hours of the shelter's arrival.

I have found this to be a huge convenience and time-saver. Our people don't have to deal with or coordinate the schedules of all the subcontractors. The electrician is not getting in the way of the mechanical contractor and vice versa. In fact, you only need a general contractor to construct a mounting pad (you can set most precast shelters on a bed of gravel if you wish) and an electrician to tie in the power from the utility. Once those two are done, the building is all yours to begin installing equipment.

Fine-tuning the placement on the foundation slab.

The electrical specifications include what circuits are needed for what. For example, you might specify two 150-amp three-phase circuits for the main and aux transmitters. These would be provided in the panel and conduit would be installed to a junction box on the ceiling above the specified locations of the power entries for the two transmitters. A drop of Liquid Tight conduit, complete with connector, would be provided for the final connection to the equipment. Ditto for the electrical circuits for the equipment racks and other equipment.

A generator transfer switch (manual or automatic) can be specified, or provision for a vendor-supplied switch can be ordered. A generator receptacle also can be specified for connecting a portable (trailer-mounted or rental) generator if a permanent pad-mounted generator will not be provided.

Another great option available with most precast shelters is a "halo" ground system. This consists of an AWG #2 wire that runs around the perimeter of the inside of the shelter about six inches below the ceiling (like a halo, thus the name) with drops to the various pieces of equipment, cable ladder, transmission lines and grounding blocks. Wireless operators have figured out how to protect their stuff from lightning damage, and the "halo" ring is a big part of that.

Broadcasters have not been quick to employ cable ladders at their transmitter sites, but again, this "wireless age" innovation is making inroads. Precast equipment shelter manufacturers routinely provide overhead cable ladders to the customer's specifications, and this is another huge time-saver. Control, audio, AES, monitoring and other cabling can be installed quickly and neatly, and routed between transmitters and equipment racks, between equipment racks and telco board and between microwave racks and "waveguide ports" (industry-speak for transmission line egress ports). I, too, was slow to come around to this way of thinking, but now I'm a believer.

There are many HVAC options available. Typically,

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PRECAST SHELTERS

(continued from page 4)

two self-contained units are provided on the end of the shelter in a lead-lag configuration, where one unit runs for a week and then the other unit takes the load for a week. If either unit fails, the other takes over and an alarm contact is closed. Mechanical thermostats often are provided for settable high- and low-temperature alarm contacts. You can specify anything special that you may want, such as exhaust ports for transmitter cooling air, make-up air intakes and emergency ventilation systems.

One important consideration is the width of the door. Single doors are available for up to about 48-inch widths and beyond that a double-door must be specified. Some manufacturers also offer doors with more resistance to bullet penetration, usually specified as a particular caliber fired from a certain distance. That is certainly something to think about in a lot of installations where vandals might find a steel door to a transmitter building an irresistible target.

UP TO CODE

Precast manufacturers have engineers on staff who are licensed in virtually all states; they can provide sealed drawings acceptable in just about any jurisdiction. This makes the permitting process straightforward. My experience has been that plan checkers at local building departments are well-acquainted with precast shelters and in fact prefer them to on-site construction.

Precast shelters are delivered on flatbed trucks. It's up to the customer to ensure a clear path for the truck to the installation site and provide a crane and operator for unloading and placement. I have used the general contractor for the crane work in every case to handle the site details, and I have found that local crane operators tend to be fairly well-acquainted with precast buildings. All the ones I have used have been capable and well-versed in their unloading and placement.

I have now installed five precast equipment shelters and am now planning for a sixth, the latest an oversized 12-by-30-foot building for a 50 kW AM that will be shipped in two pieces and joined on site.

As far as I'm concerned, this particular product of the "wireless age" is an excellent fit for broadcast transmitter site applications. I intend to use precast shelters for all my future projects.

W.C. "Cris" Alexander is director of engineering at Crawford Broadcasting and a past recipient of SBE's Broadcast Engineer of the Year award.

LAMPEN

(continued from page 3)

excellent. It's easy to install. And the price can't be beat. But whole villages in India went from nothing to cell phones. I think a lot of radio broadcasters will be doing the same thing. And the change will be to "AVB."

AVB is a new Ethernet standard, P802.1BA AVB, for "audio-video bridging." This is not new devices aimed at audio and video, but a complete rewrite of the Ethernet standard that will include bells and whistles such as low latency and aligned bitstreams (among many features) aimed at expanding the Ethernet market. The Cobranets, Axias, Ethersounds and other proprietary Ethernet systems will now have to contend with a common interoperability standard. This signals a new day for the infrastructure of broadcast facilities.

If you were asking me how would broadcast engineers prepare for this, I would say, "Take a networking class" or even better, "Learn how to program a managed Ethernet switch." And if you don't know what that means, and don't want to learn, I truly hope your 401(k) is in order.

Tell me a bit more about your role at Belden.

My role as multimedia technology manager is to travel around the world and talk to broadcast engineers. Lest you think the USA has been singled out, the digital revolution is happening everywhere. And the funny thing is broadcast engineers in Santiago, Chile or Helsinki, Finland all think they're missing the boat and need to catch up … when many of them are ahead of the pack. As product line manager, my job is to think up our new products.

As you can tell, one of my key challenges is to link together our networking division with our audio-video division, which is going to happen with or without us. Belden now owns two manufacturers of Ethernet switches (Hirschmann in Germany and Garretcom in the United States), and I am sure they are wondering why this broadcast guy (me) is bugging them on a regular basis. But now you understand! Along the way, there will be many products with features of both traditional audio and video and with traditional Ethernet, and slowly these product lines will merge.

Comment on this or any story in RW Engineering Extra. Email rwee@nbmedia.com.

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Use Ping to Troubleshoot Your Network

This Easy Command Can Tell You Just About All You Need to Know

BY STEPHEN M. POOLE

In previous articles we've built some useful servers. But this time let's take a look at one of the most powerful network troubleshooting tools ever written: the mighty "ping" command.

You may have used this program and wonder why I'd devote an entire article to it, but if you *don't* know how to ping, you *definitely* need to keep reading.

Ping was developed by a fellow named Mike Muuss back in 1983 for the express purpose of troubleshooting fundamental IP network issues. The name is borrowed from sonar systems: You "ping" a host and then wait for a reply, much as a submarine might ping an object in the water, then wait for the echo.

Ping uses the Internet Control Message Protocol or ICMP, which operates at a relatively low level. You can imagine that it's underneath any server software running on the PC.

This has implications: If someone yells, "Our Web server is down," I'll try "ping www.crawfordbroadcasting.com." If I can ping it, that tells me that the server machine itself is powered on and that the network connection is OK. I need to check the Apache Web server for a problem. But if I can't ping it, I'll call Denver and ask my colleague Amanda Alexander to go make sure no one turned it off or unplugged the network cable by accident.

Ping is useful because it tests everything in your network settings. It checks the physical connection as well. The sequence of a typical ping goes something like this:

- If you use a domain name, a Domain Name Server is used to determine the IP address.
- If you use an IP address (or once the IP address has been fetched from a Domain Name Server), the netmask is used to determine if it's on your local network.
- If the address is local, Address Resolution Protocol is used to find the physical address of the local target.
- If the address is external, ARP is used to find the physical address of your gateway (this is typically the "default gateway" in your network settings).
- Now that the target has been located, an ICMP ECHO_REQUEST is sent to it.
- The target responds with an ICMP ECHO reply. The ping command calculates the time needed for the round trip and displays it.

Therefore, for a ping to work, all of your network settings must be correct, and your network connection must be good. This makes it a complete, one-stop test of the network in one go.

CAVEAT: CHECK YOUR FIREWALLS

Some firewalls block pings, which actually violates published standards. RFC1122 states that support for ICMP ECHO_REQUEST and ICMP ECHO — which are what a ping uses — is "mandatory." In spite of this, some public servers block pings to avoid denial-of-service attacks. Some hackers will send a flood of ping requests at the target to bog it down. Other security experts recommend that ping replies be disabled because of the way that some crackers search for computers to exploit: They'll ping an entire block of network addresses and then take a look at the responses for desirable targets.

However, on your own internal network, I strongly recommend that every machine should respond to ping requests. Most network-capable appliances, from printers to Web-capable remote controls, do *not* block ping echoes; they're ready to respond out of the box. But Windows, in particular, *will* block ICMP by default. You need to either enable it in the firewall, or enable file and printer sharing. Do a Web search on your specific OS; for example, go to Google and try "opensuse linux ping firewall" or something like that.

The bottom line is to ensure that everything on your internal, local network(s) can respond to a ping.

NO TROUBLE TO USE

Ping is easy. Simply open a command prompt and type in "ping," followed by the IP address or domain name that you're trying to reach. The various ping programs included with various operating systems behave a bit differently. For example, Windows automatically stops after four ping attempts, while on Linux, by default, the ping will keep repeating until you press CTRL-C to stop it.

Fig. 1 shows a typical response; I've pinged an HP printer on our network.

The positive result tells me that the printer has a working connection on our local network, that my connection is configured properly (at least for the local network) and that the target printer is powered up and is running.

If I see this, and yet I still can't print, I'll check my PC's printer settings, and then go ensure that the printer hasn't experienced an error.

Fig. 1 also shows the response times in milliseconds; this is for the complete round trip from your PC to the target and then back. The first response usually takes the longest, because the target has to be located. Once it has been found, subsequent pings are a bit faster. We'll return to that in a moment; now let's ping a remote site (see Fig. 2).

```
stephen linux edxs:~  ping 192.168.50.106
PING 192 168.50.106 (192.168.50.106) 56(84) bytes of data.
64 bytes from 192.168.50.106  icmp_seq-1 ttl-64 time-4.56 ms
64 bytes from 192 168.50 106  icmp seq=2 ttl-64 time-3 20 ms
64 bytes from 192.168.50 106  icmp seq-3 ttl-64 time-3 23 ms
 C
    192 168 50 106 ping statistics
3 packets transmitted  3 received  0% packet loss. time 2003ms
rtt min avg max mdev = 3 209 3 669 4.563 0.635 ms
```

Fig. 1: Ping Test of a Printer on the Local Network

```
stephen.linux edxs:   ping google.com
PING google com (74 125.65 106) 56(84) bytes of data
64 bytes from gx in f106.1e100 net (74.125.65.106)  icmp seq-1 ttl-42 time 38 1 ms
64 bytes from gx in f106 1e100 net (74.125 65.106)  icmp seq-2 ttl-42 time 37 8 ms
64 bytes from gx-in-f106 1e100 net (74 125 65 106).  icmp seq-3 ttl-42 time 56 0 ms
 C
    google.com ping statistics
3 packets transmitted. 3 received  0% packet loss. time 2003ms
rtt min avg max mdev - 37 862 44.043 56.088 8 519 ms
```

Fig. 2: Ping Test of a Remote Address (google.com)

We'll try Google, because it does reply to pings (they have so many servers distributed around the globe that I guess they figure, "Good luck trying to swamp us!"). This adds another useful test: "google.com" must be translated to an IP address, which means that our ping command is going to use our DNS settings. Because it's a remote IP address, it'll use a gateway. This tells me that my laptop's DNS and default gateway are correct.

This one-two procedure (ping someone on the local network, then ping Google) is a standard test that we use daily. It's much faster than pulling up a Web browser to see if we can get onto the Internet, then waiting for a timeout if there's a problem. As a general rule, if a ping doesn't respond within one second, unless you're trying a host on the other side of the planet, just press "CTRL-C" to stop the test. You've got a problem that needs to be fixed.

RESPONSE TIMES AND LATENCY

The response times are interesting, too, and here's a super tip: When transporting audio-over-IP, if you have access to more than one Internet service or microwave link, move your connection around and do some pings to see which is the fastest. Audio-over-IP needs low latency; you want virtually no delay between send and receive. Note that if you test encrypted links you'll also confirm what you've probably suspected: Encrypted links can be significantly slower, because you have the overhead of encryption and decryption.

Ping isn't the best tool for checking network quality; a hardware analyzer or the analysis software built into many microwave links nowadays is better. But you can still see gross errors and dropouts on a remote connection. You'd see wildly varying response times — the first might be 50 ms, the next is 400 ms, and so on — or even missed replies entirely.

On a microwave data link, this is commonly caused by interference. Here's the bottom line: if you get even one ping reply, the remote host is connected and powered up. It's trying to respond. If you have wildly different ping response times and/or dropped pings, you've got a problem with network quality.

MORE INTERPRETATION

Again, imagine the flow of the signal as you troubleshoot. You're sending out an ICMP ECHO_REQUEST and the remote host should return the corresponding ECHO reply within one second if everything is OK. There are three possible unsuccessful outcomes.

If you get "Timed Out" — i.e., the ping never completes at all — this means just what it says. Ping sent the echo request but timed out waiting for a reply. If you are certain that the remote target is powered up and is working, you should troubleshoot on your end.

If the ping returns "Network Unreachable," first check your physical network connection. Next, if you're trying to reach the local network, check your netmask and IP address. If you can't ping the Internet, check your default gateway.

(continued on page 10)

TRANSMITTER

(continued from page 1)

ters with solid-state power amplifiers up to approximately 10 kW provided equal or better overall AC to RF efficiency when compared to tube-based power amplifiers. That said, single-tube transmitters at power levels above 10 kW offered a significantly lower purchase price and lower long-term operating costs. This is the challenge to be met by solid-state high-power FM transmitter design and the impetus for the introduction of the Harris Flexiva.

The incremental cost increase of solid-state transmitters is linear with power increases and is at a premium at power levels above about 15 kW with the current solid-state technology as compared to tube-based transmitters. There is a 1:1 ratio for power vs. cost in a solid-state transmitter design. Doubling the power output requires doubling the size or number of power supplies, PA output modules and RF combiner ports used, thus doubling the manufacturing and acquisition costs. The cost of tube transmitters flattens at higher powers because the size of the tube and output cavity only increases fractionally.

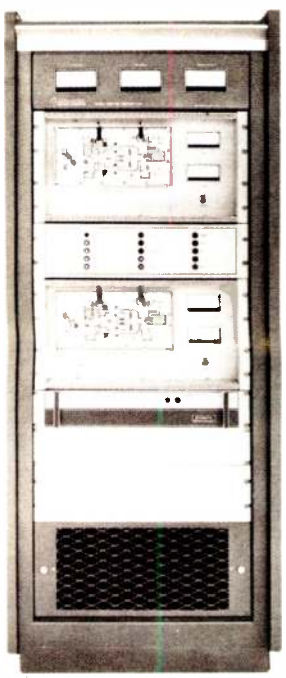

Fig. 2: Sparta 600B, 250W Solid-State FM Transmitter

The most practical method of reducing the cost of solid-state high-power FM transmitters is to increase the power density of the power supplies and RF amplifiers. By reducing the cost per watt of the devices themselves, it is possible to gain a significant advantage by tilting the solid-state cost line slope downward. As shown in Fig. 1 (on page 1), by leveraging the lower cost of higher power density devices, it is possible to raise the solid-state "premium" power level to well over 20 kW, on parity with tube-based transmitter costs.

EVOLUTION OF SOLID-STATE FM

The first solid-state FM transmitter was introduced in 1974 by Sparta Electronics (Fig. 2). Their Model 600B was a 250-watt all solid-state transmitter using two combined 150-watt amplifiers. The amplifiers each used two parallel driven 12-volt bipolar transistors.

With 12 volts and 36 amperes of collector current, the 600B could deliver 250 watts at 58 percent PA efficiency and around 38 percent AC-RF efficiency, when properly tuned. The 600B including exciter sold for $6,500 (USD) in 1974 or about $28,500 in today's dollars, or about $100/watt.

These early solid-state FM transmitters used 12-volt bipolar junction transistors (BJTs), such as the Communications Transistor Corp. (CTC) BM70-12, configured as a common-emitter amplifier. The input signal drives the base and the collector delivers the output while the emitter is grounded. Two or more devices were often driven in parallel to lower the output impedance and provide higher output current.

BJTs have significant shortcomings as VHF FM RF amplifiers. Because of the very low input and output impedances of the devices, the matching networks were quite high-Q (highly resonant) resulting in a very narrow bandwidth, making them difficult to match and decouple. They have relatively low gain and low efficiency.

BJTs also have a positive temperature coefficient and are prone to thermal runaway. As the device temperature increases, it will draw more current, in turn causing its temperature to rise further; hence even more current is drawn, resulting in a further temperature increase and thermal runaway until the device fails. These characteristics make bipolar transistors too fragile for high-power RF amplifier applications.

MODERN RF POWER AMPLIFIERS

The vertically diffused metal oxide semiconductor field effect transistor, or VMOSFET, was a game-changer when it was introduced in the late 1980s. In MOSFETs, a small control voltage on the oxide-insulated gate electrode can induce a conducting channel between the two other contacts called source and drain. It has become by far, the most common RF transistor, supplanting the BJTs that once held that title.

MOSFETs have superior characteristics when compared to BJTs on the following points:

- Thermal stability
- Frequency stability
- Improved linearity
- Higher gain
- Increased ruggedness
- Lower noise
- Lower feedback capacitance
- Simpler bias circuitry
- More easily matched input impedance
- Better IMD performance
- Lower thermal resistance

MOSFET devices are ideally suited for RF amplification of digital modulation waveforms requiring high peak power capability, wide frequency range, high linearity and good ruggedness. They can be used in Class AB mode by reducing the output power until the desired linearity is achieved, where a comparable bipolar transistor could only attain the same linearity in Class A mode, requiring high current consumption and very low efficiency.

The vertically diffused MOSFET transistor is named (allegedly) for the V-shaped groove architecture shown in Fig. 3. The increased gate surface area provides higher current handling and blocking voltage capability, better reliability and improved stability even in the presence of severe mismatch.

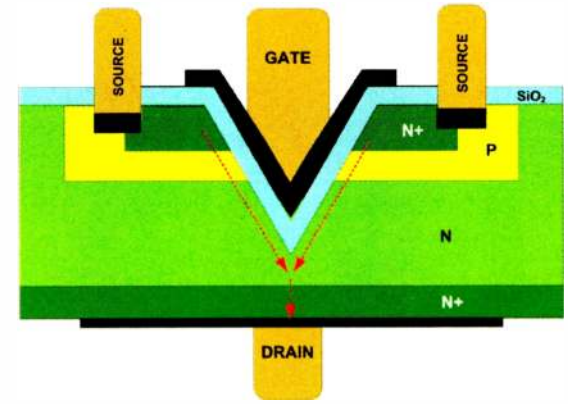

Fig. 3: VMOSFET Structure

The power, stability, reliability and efficiency of high-frequency MOSFET RF power transistors make them especially well suited for many RF power amplifier applications. The devices can be easily driven in a push-pull configuration, suppressing even-order harmonics, which reduces the need for second and even order harmonic filtering. VMOSFET power devices such as the Freescale MRF-151, NXP BLF-177 and ST Micro 2932 have been used for high-power FM RF amplifier applications since the early 1990s, and are currently used in Harris' Platinum Z and ZX lines of high-power FM transmitters and other broadcast FM transmitters (see Fig. 4).

(continued on page 14)

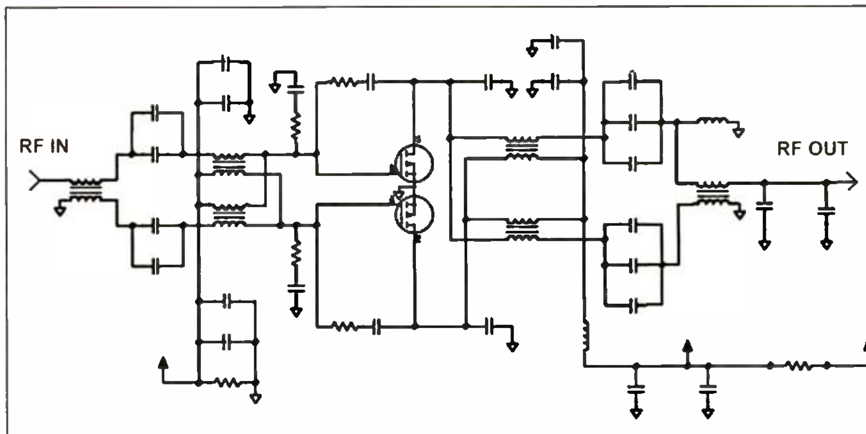

Fig. 4: Schematic of a Modern MOSFET PA Amplifier

PING

(continued from page 1)

If you see "Unknown Host" or something like that, check your DNS settings. Your PC is unable to translate names like "google.com" into the appropriate IP address for the ping.

On that last one, it's useful to keep handy a couple of known IP addresses on the Internet that you can ping. For example, I know that our Web server in Denver is at 173.8.230.33; if I can ping that IP address, but "ping www.crawfordbroadcasting.com" doesn't work, I've got a DNS problem. If you can't ping either, either your Internet connection is down or your gateway is set incorrectly.

Remember, the results in Figs. 1 and 2 will vary from one OS to the next. Learn how your version of ping responds to different problems. Do a ping with your network cable unplugged and note the result; then do a ping with the target unplugged. Learn to recognize what the various replies mean and you can troubleshoot network issues much more quickly and easily.

If you want more information, do a Web search on "ping," or read the Wikipedia article. There are more advanced versions of ping available on the Internet, too, some which will allow you to scan an entire network and do other fancy tricks. But the default ping program included with Windows, Mac OS and Linux is still plenty good enough. Learn to use it!

Stephen M. Poole, CBRE-AMD, CBNT, is chief engineer of Crawford Broadcasting in Birmingham, Ala. Find past Radio IT Management columns at radioworld.com *under the Business tab.*

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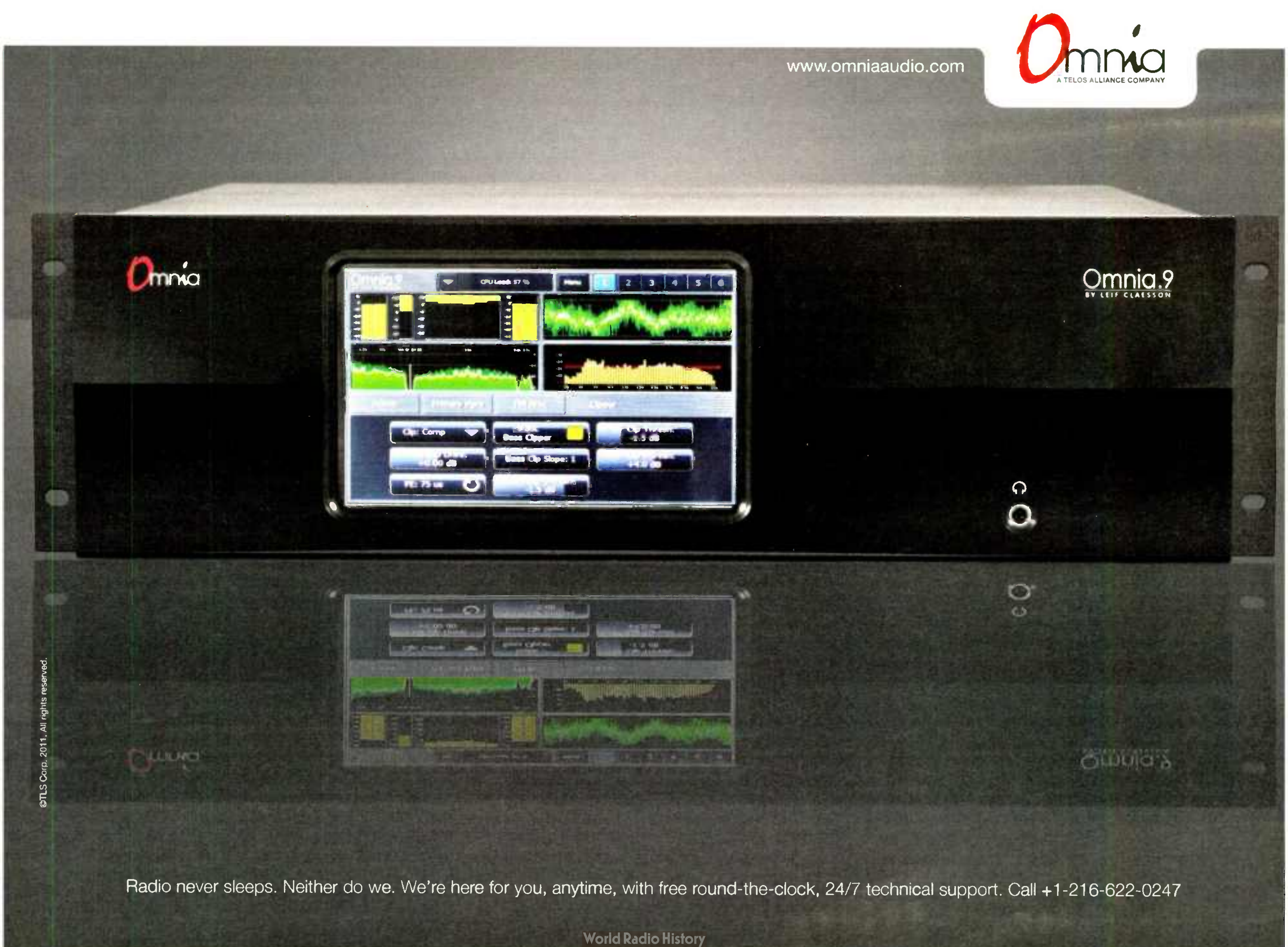


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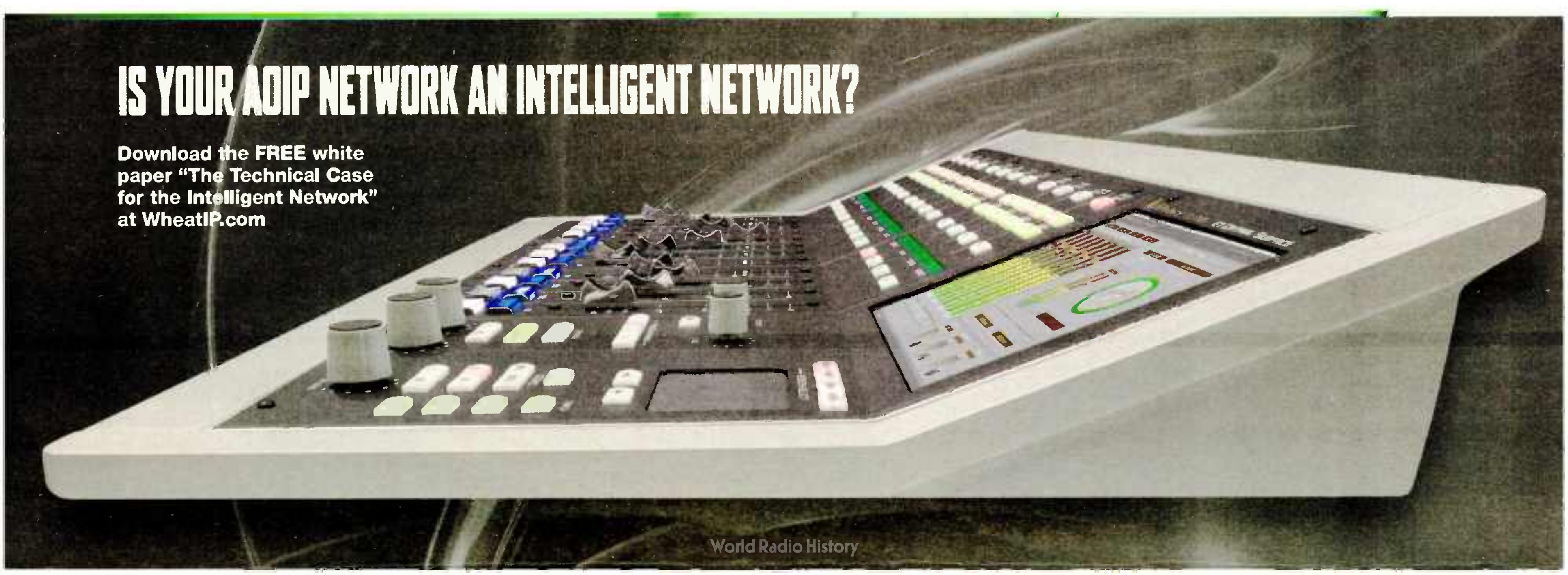
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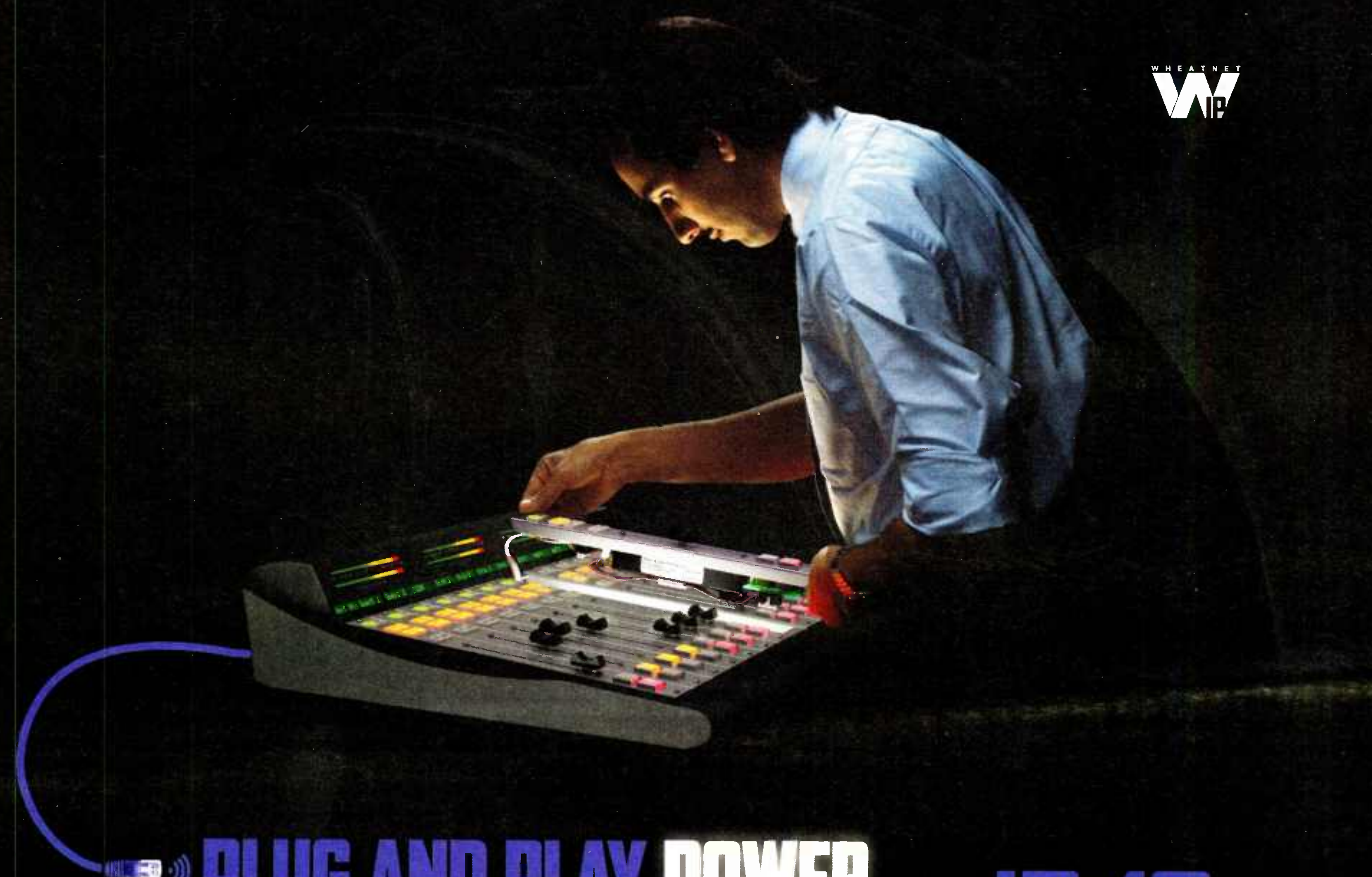


TRANSMITTER

(continued from page 10)

THE LDMOSFET

The laterally diffused power MOSFET (LDMOS) is an asymmetric MOSFET designed for lower on-resistance, higher blocking voltage and current handling capability than its VMOS counterpart. Combined with a short channel length and high breakdown voltage, these characteristics make them attractive for high-power RF amplifiers in many applications.

Harris has a great deal of experience with these devices. LDMOS devices are used in Harris' Maxiva UHF and VHF television transmitters, as well as the Platinum series L-band television transmitters. LDMOS power amplifiers also are used extensively in communication base stations, cellular systems, and wireless communications and radar systems.

Recent developments in LDMOS device technology have resulted in major improvements in power density and maximum power output. VHF Band II optimized LDMOSFETs use a 50-volt structure, offering a dramatic increase in power per device, linearity and efficiency.

The gain of each device is approximately 21 dB, a substantial increase over the VMOS devices that typically offer 14 to 15 dB gain per device. This increased gain, made possible by the LDMOS's lower source inductance, allows a reduction of the driver stage's power of by up to half, thereby contributing to higher overall system efficiency.

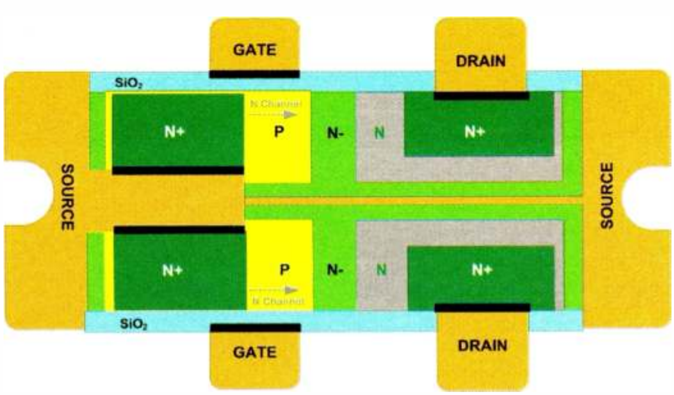


Fig. 5: LDMOSFET Structure

Another important feature of the new 50-volt LDMOS devices is the ruggedized qualities with which they have been designed. Harris worked with the device manufacturers to optimize the structure and geometry to avoid destructive conditions during impedance mismatch. This ruggedization allows them to tolerate extreme VSWR reflections of up to 65:1, pulsed at full rated power, at all phase angles (see Fig. 5).

POWER REQUIREMENTS AND DENSITY

A wide range of power levels is required to fulfill the varying needs and applications of FM broadcasters around the globe. Some analog FM stations have transmitter output powers of 40 kW or higher.

With the advent of digital radio formats around the world, solutions are needed to supply higher power at increased linearity. To reduce distortion and intermodulation products, digital FM amplifiers must operate more linearly by running them closer to saturation in Class AB mode. This reduces the available power and efficiency when compared to an analog amplifier of the same size.

Typically, with the linearization and the additional headroom required for the high peak-average ratios of OFDM modulation, transmitters need nearly twice the peak power of that required for analog. The new LDMOS devices have a peak envelope power rating of 1.25 kW running at an average power of 850 W. When used along with the latest signal processing techniques for crest factor reduction, they provide sufficient headroom to allow minimal back-off even with the relatively high peak-to-average modulation of digital radio.

Amplifier power density is the key to reducing both the size of the transmitter and the cost of manufacturing and purchase; 50-volt LDMOS makes it possible for fewer devices and more simplified RF combining than before. Contemporary solid-state FM transmitter designs can achieve about 10 kW analog power per 19-inch rack cabinet, or put another way, about 625 watts per cubic foot. By taking advantage of the higher per-package power levels of these new devices to develop new transmitters with nearly double that power density, we can achieve 20 kW in the same 19-inch rack, or around 1,250 watts per cubic foot.

The desire for higher power densities, lower cost per watt and increased operating efficiency has driven the development of solid-state amplifier technology. For many years, tube-based amplifiers have reigned supreme in these categories. For the most frequently used power range of 1 kW to about 20 kW average digital power, these new solid-state devices fulfill the requirement readily, providing important benefits — safety, simplicity and stability — over tube-type designs with comparable efficiency and cost.

DEVICE SELECTION

Initially, several LDMOS devices were evaluated as possible candidates for the new high-power FM module. With similar specifications, several devices met or exceeded our requirements in power density, gain and efficiency. These devices have been used successfully in industrial, scientific and medical (ISM) markets where there are potentially destructive impedance mismatch conditions encountered in applications, such as CO^2 lasers, plasma generators and magnetic resonance imaging (MRI) scanners.

The LDMOS device ultimately selected passed all of our stress tests for reliability and incorporation into Harris' next-generation FM module.

The LDMOS device shown in Fig. 6 is a dual "Gemini" device package rated at 1.25 kW of peak envelope power. This is nearly four times the power of the VMOS devices used in previous-generation transmitters as well as many current-generation transmitters using 250-watt "single" VMOS power devices.

AMPLIFIER PALLET DESIGN

A new RF pallet has been developed by Harris RF design engineers around the new LDMOSFET device to conservatively deliver 825 watts of analog power using a single Gemini device operating in a push-pull configuration.

The devices are biased into Class C operation when running FM analog and Class AB operation when operating in digital modes. The load lines are optimized for maximum efficiency at the top of their power curve at 50 volts. Automatic drain voltage control is utilized to maximize efficiency as output power is decreased. Onboard control and monitor circuits provide VSWR, over-current and temperature protection for the devices.

DISSIPATION AND COOLING

Like tube-based amplifiers, all solid-state power devices have a finite lifespan. Eventually, junction heating and metal migration within the structure will cause any device to fail. Typically, the mean time between these modes of failure is measured in millions of hours when operated within the voltage, current and junction temperature design specifications. High operating temperature is the silent killer of solid-state RF power devices. Over time, operation even slightly above the maximum design junction temperature will shorten the devices service life dramatically. Other parasitic problems may be onset by high junction temperatures causing catastrophic failures.

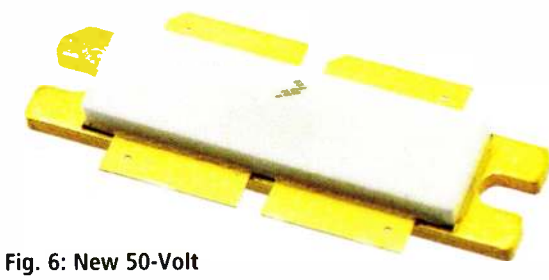


Fig. 6: New 50-Volt LDMOS Gemini Flat-Tab Package

By virtue of their lower on-resistance, LDMOS devices inherently are more efficient than their VMOS counterparts, reducing the overall power dissipation into the heat sink. In addition, the source structure is bonded directly to the package flange in the LDMOS device eliminating the inefficient (and toxic) Beryllium Oxide (BeO) insulating layer found in VMOS devices. This significantly lowers the thermal resistance between the junctions and the flange, making the device easier to cool. That said, keeping the maximum junction operating temperature below the recommended 180 degrees C, under the worst operating conditions, still is challenging when working with 1,000-watt devices. Designing for the worst dissipation conditions, we must not only consider maximum ambient temperature, but maximum VSWR at which the device may be operated at full power.

Under the worst phase angle of reflected power, LDMOS device power dissipation in excess of 400 watts may be expected. This translates into more than a 60 degrees C temperature rise within the device. With 55 degrees C ambient temperature, the temperature drop across the heat sink cannot exceed 60 degrees C, imposing the need for very careful design of the air cooling system. Computer-aided modeling was used extensively to optimize the heat sink and cooling system design. The system uses five, rear-door-mounted, 6-inch axial fans. Fan speed is temperature-controlled, operating at 550 CFM, producing only 62 dB of fan noise during normal conditions and increasing to 1,100 CFM and 65 dB under extreme conditions for quiet, efficient operation.

NEW ARCHITECTURE FOR HIGH POWER

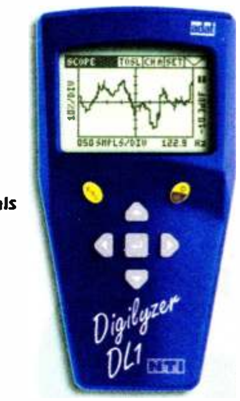
A modular approach was taken in the overall design of a transmitter system that accommodates the new LDMOS amplifier. A 16 RU, 10 kW power unit is the primary building block of the system. The 10 kW block consists of a chassis frame containing dual redundant IPAs, seven hot-swappable power supply modules, seven hot-swappable, dual power amplifier modules and a compact, high-efficiency, 14-way, constant-impedance, Wilkinson-Gysel coaxial combiner,

(continued on page 16)

MINSTRUMENT MATRIX

Sophisticated Minstruments from NTI give you comprehensive test capability... and these flexible audio instruments fit in the palm of your hand

DL1 Digilyzer
Digital Audio Analyzer



A handheld digital audio analyzer with the measurement power & functions of more expensive instruments, the DL1 Digilyzer analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as embedded digital audio. In addition, the DL1 functions as a smart monitor and digital level meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you connect to an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a comprehensive event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp
- Audio scope mode

DR2 Digirator
Digital Audio Generator

The DR2 Digirator not only generates digital audio in stereo & surround, it is a channel transparency and delay tester as well, all condensed into a handheld package. Delivering performance & functionality challenging any digital audio generator made today, it produces all common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bit. The Digirator features a multi-format sync-input allowing the instrument to be synchronized to video and audio signals. In addition to standard two-channel digital audio, the DR2 can source a comprehensive set of surround signals.

- AES3, SPDIF, TOSLink, ADAT outputs
- 24 bit 2 channel digital audio up to 192 kHz SR
- Sine wave with stepped & continuous sweeps; White & Pink Noise; Polarity & Delay test signals
- Dolby D, D+, E, Pro-Logic II, DTS and DTS-HR surround signals
- Channel Transparency measurement
- I/O Delay Measurement
- Sync to AES3, DARS, word clock & video black burst
- User-generated test signal files

AL1 Acoustilyzer
Acoustics, Audio & Intelligibility Analyzer

The AL1 Acoustilyzer features extensive acoustical measurement capabilities as well as analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

- Real Time Analyzer
- Reverb Time (RT60)
- Delay measurements
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- Automatic Distortion analyzer (THD+N)
- Frequency, RMS Level, Polarity measurements
- Requires optional MiniSPL microphone
- Includes MiniLINK USB interface & Windows PC software for storing tests and PC transfer

MR-PRO Minirator
High performance Analog Audio Generator + Impedance/Phantom/Cable measurements

The MR-PRO Minirator is the senior partner to the MR2 below, with added features and higher performance. Both generators feature an ergonomic instrument package & operation, balanced and unbalanced outputs, and a full range of signals.

- High (+18 dBu) output level & <-96 dB residual THD
- Sine waves & programmable swept (chirp) and stepped sweeps
- Pink & white noise
- Polarity & delay test signals
- User-generated custom test signals & generator setups
- Impedance measurement of the connected device
- Phantom power voltage measurement
- Cable tester and signal balance measurement
- Protective shock jacket

ML1 Minilyzer
Analog Audio Analyzer

The ML1 Minilyzer is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand. The comprehensive feature set includes standard measurements of level, frequency and THD+N, plus VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external response sweeps generated by a Minirator or other external generator.

Add the optional MiniLINK USB computer interface and Windows-based software and you may store all tests on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.


MiniLINK

- Measure Level, Frequency, Polarity
- Automatic THD+N and individual harmonic distortion measurements k2 – k5
- VU + PPM meter/monitor
- 1/3 octave analyzer
- Requires optional MiniSPL microphone for SPL & acoustic RTA measurements
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

MR2 Minirator
Analog Audio Generator

The MR2 pocket-sized analog audio generator is the successor to the legendary MR1 Minirator. It is the behind-the-scenes star of thousands of live performances, recordings and remote feeds.

- Intuitive operation via thumbwheel and "short-cut" buttons
- New higher output level (+8 dBu) & low distortion
- Programmable Swept (chirp) and Stepped sweeps
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- Pink & White noise
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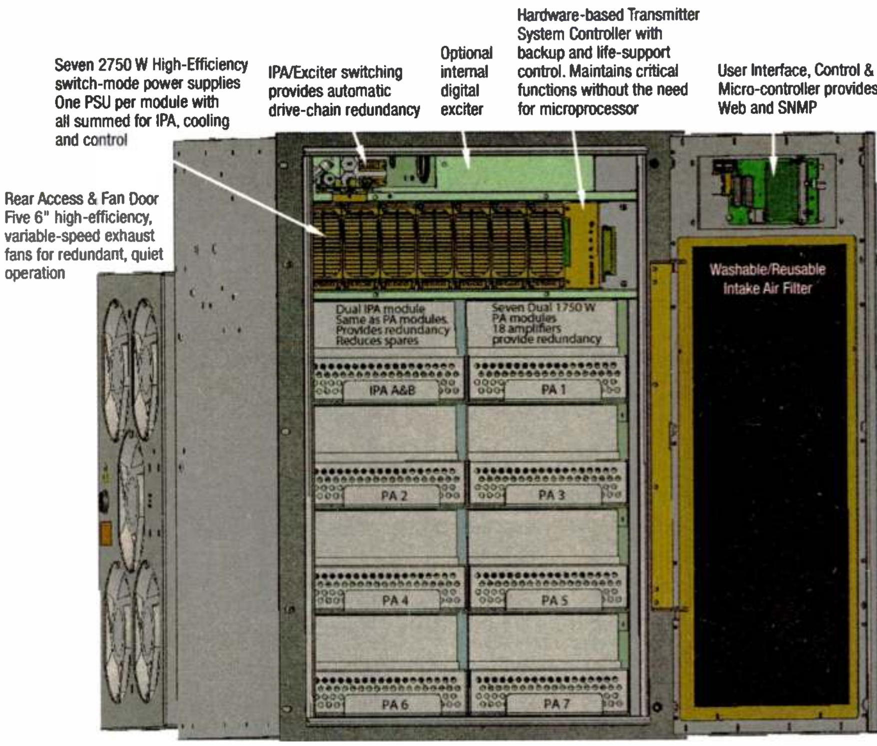

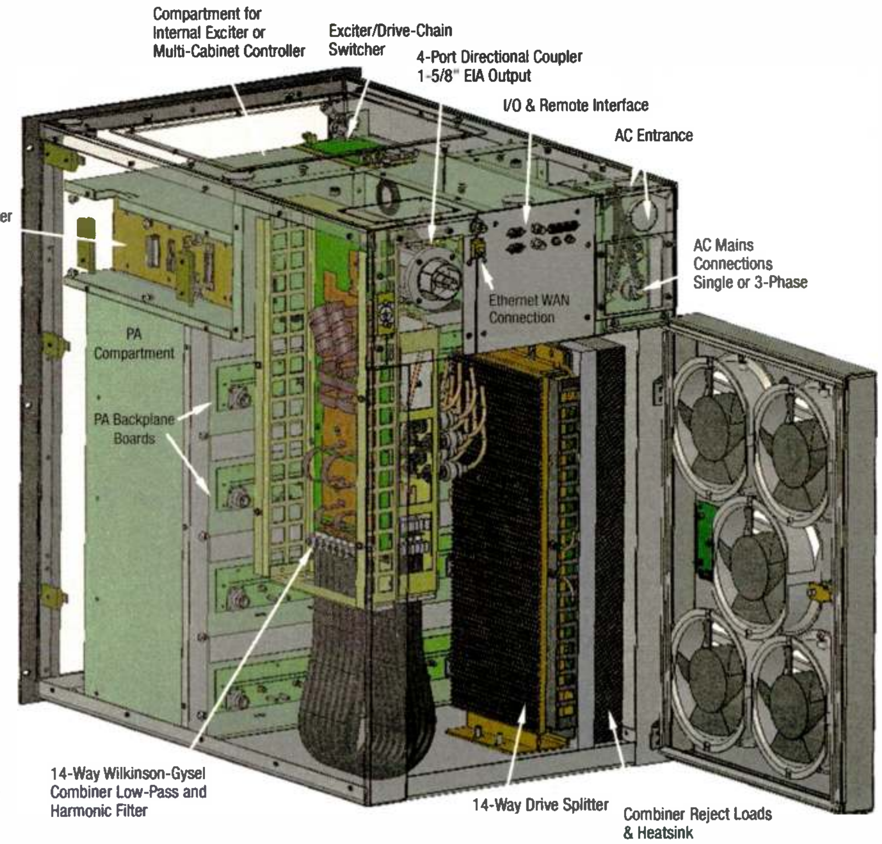

Fig. 8: Architecture of the Flexiva 10 kW FM Transmitter

TRANSMITTER

(continued from page 14)

low-pass filter and directional coupler unit (see Figs. 7 and 8). Transmitter control user interface and optional modulator are in the upper compartment bay. To satisfy the cooling requirements, air is drawn in from the front and exhausted to the rear.

The transmitter architecture uses two identical RF pallets per 7 × 10 × 4.6-inch hot pluggable, PA module, resulting in a very compact and power-dense module design. The PA module shown in Fig. 9 is rated at 1,725 watts analog power and over 2,400 watts of peak envelope power.

As the PA module power has doubled, so too have the power supply module requirements. To improve the power supply density, a new high-efficiency switch-mode power supply was implemented. Each PA module is powered by an independent 2,750 watt power supply. Voltage to each module is automatically optimized for best PA efficiency for a given power output. The supplies are universal input, power-factor corrected and will operate from 190–264 volts, 50 or 60 Hz AC and may be wired as single or three-phase as needed. In the case of three-phase, the loss of one or two phases will still permit the transmitter to operate at reduced power.

Fig: 7: The Flexiva FAX10, 11,000 Watts in a 16 RU System

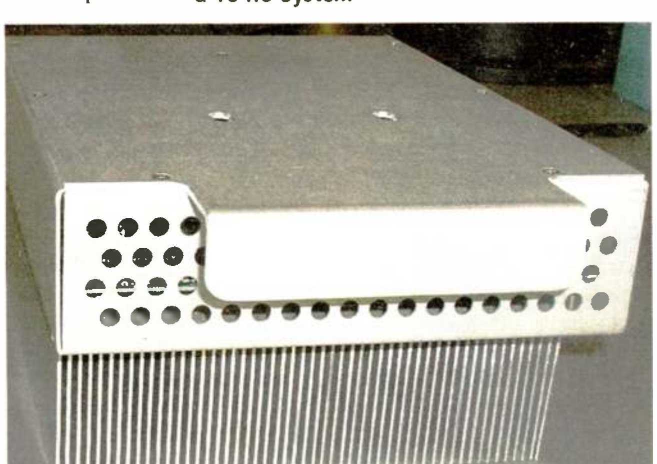

Fig. 9: 1,725-watt PA Module

PA control functions including mute, fault monitoring and protection logic are located on each PA module. Current, forward power, VSWR and temperature are monitored on the module and reported to the hardware-based system controller. A hardware-logic based system controller manages all basic functions such as metering, On/Off, Raise/Lower, Automatic Power Control and main/alternate exciter and drive chain switching to provide basic life support without reliance on a microprocessor. Data and command control from the hardware-based system controller are passed to an advanced microprocessor based controller, which runs the front-panel user interface as well as Web server and SNMP interfaces. An optional direct-to-carrier, digital modulator is integrated into the transmitter cabinet or redundant external exciters with automatic fail-over switching may be used.

Multiple power blocks with modular "in-rack" hybrid combiners and an integrated control system allows for power levels of 20, 30 and 40 kW. The system is designed to provide integrated transmitters up to 22 kW per 19" × 44 RU rack scalable to 80 kW and beyond.

The first 10 and 20 kW Flexiva transmitters began shipping to customers in September. Several low-power versions of the Flexiva, with similar architecture and features, from 50 watts to 5 kW, are planned for release early next year.

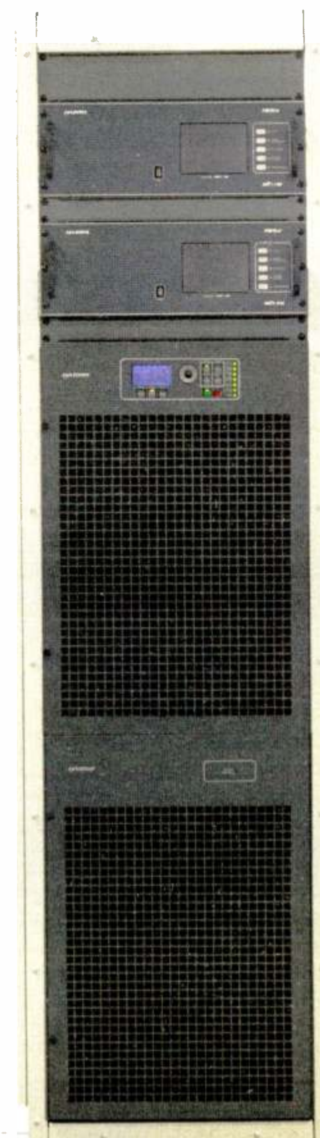

Fig. 10: The Flexiva FAX20FLX, 22,000 Watts With Dual Flexstar Exciters in a Single Rack

What Determines How Far Your Signal Goes?

In AM, Look to the Ground Below Your Feet

Strong in Your Field
(Exam level: CBRE)

In the Oct. 12 issue of RWEE, we asked:

What factor(s) most affect the predicted or measured far-field signal strength of a nondirectional AM station?

a. Transmitter power
b. Antenna power input, antenna height
c. Antenna power input, antenna height, radial count
d. Antenna power input, antenna height, radial count, top loading
e. All other factors being equal, ground conductivity

BY CHARLES S. FITCH

Before we get to discussion of our question from last issue, might I mention that the time between columns has been one of introspection for me. I realized that I am fast approaching becoming a septuagenarian, which in the scheme of seniority is one down from an octogenarian.

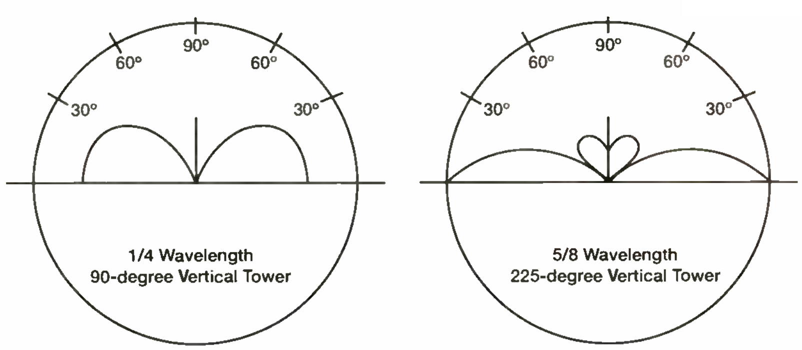

Fig. 1: Taller towers tend to focus radiofrequency signals toward the horizon, an advantage in broadcast AM. As towers are increased in length beyond a full wavelength, their efficiency decreases, making the range of ideal tower heights roughly between 1/4 and 5/8 wavelengths.

Among other consequences is that you tend to clear your desk rather than postpone things because you might not be getting back to them. You spend more time with your 2-1/2-year-old grandsons, the only ones who truly understand you. Reflections on the past become more numerous simply because there is more past than future, and in life's rear view mirror, everything is far clearer.

There is a Chinese adage normally attributed to Buddha: "Not having a goal is more to be feared than not reaching one." This is so true, especially as regards growth in our profession. To whip out another pertinent point: Somewhere in the first week of medical school, all the students are told that if you're not growing, you're dying.

Might I urge you to set a personal goal to grow. Resolve to become certified or to advance at least another grade or add a specialty certification. Advancement in certification is good for you and our profession — and proof that you're not retired in place.

IT'S THE GROUND WAVE THAT MATTERS

Back to the question. The correct answer is e.

Signal strength falls off according to the inverse square law in far fields; that is, it decreases in a ratio to (is divided by) the square of the distance from the antenna. For standard AM, this behavior is consistent in places like outside the earth's atmosphere, where you might encounter an atom of something every few hundred miles and the radio energy is unaffected by stars, planets and other celestial bodies and magnetic fields.

Here on earth, calculating AM radio field strength in the *near* field includes factors such as antenna power input. This is the power level from the transmitter after you subtract transmission line losses.

Tower height/antenna length (of which top loading is a component) is another important factor as it affects the efficiency of the antenna. Antennas of ideal height concentrate electromagnetic radio waves toward the horizon and thus provide a stronger signal on the surface of the earth without wasting energy straight up into the sky. Ground radial count and their length again is another efficiency factor.

However, once that signal is launched, the signal has to pass over and then return through the land or sea. In radio parlance, this ground propagation is affected by a factor called conductivity. The value of conductivity sets the signal loss over distance as measured in wavelengths. Put simply, electrical conductivity is the measure of the amount of electrical current a material can carry. AM is unique in broadcasting in that we depend mostly on this signal propagated through the ground.

Dapper Buc, braving the elements for his art, demonstrates the use of a Potomac FIM41 field-strength meter.

The graphic representation of the field radiation pattern of a typical 1/4-wave antenna indicates that most of the signal is released along the horizontal (see Fig. 1). The graph for the 5/8-wavelength antenna demonstrates an additional small lobe above the horizon. The horizontal component is the ground wave and highly affected by conductivity. Getting these currents in and out of the ground is the primary reason for all those ground radials and the choice of ideal soil and location. As Dr. Frederick Terman tells us, "The earth is like a leaky capacitor."

The above ground lobe is the skywave, and is radiated towards the atmosphere, where ionospheric reflection (incident angle of reflection, layer hardness and other factors) have the most influence on the signal's carriage. After sunset, when the ionospheric reflection is greatest, skywaves are receivable at very long distances, although they are subject to random fades and noise. Most AM stations measure their coverage area based on their ground wave.

Electrical conductivity is denoted by the symbol σ and is measured under the metric SI convention in siemens per meter. The term gets its name from the German inventor and industrialist Ernst Werner von Siemens, and whether singular or plural is always written in the plural. In the world of radio, millisiemens (mS) is a more apt unit as it provides whole numbers for a greater range of the values we work with on a daily basis.

CONDUCTIVITY – ESTIMATES VS. REALITY

Classically, the FCC and the radio engineering community have looked to the M3 chart for a generalized description of the conductivity of the continental United States (see *http://tinyurl.com/fitch12*).

While the M3 conductivity values are useful for estimating the value of conductivity on a rough basis, in many areas, especially rocky or mountainous terrain, they are not detailed enough for good accuracy.

An important factor in calculating AM field strengths for FCC purposes is that localized actual readings of field strengths can be substituted for the generalized conductivity conditions shown on M3. The ordinary circumstance where this is beneficial to the radio station is where lower than anticipated conductivity would allow a new facility to be shoehorned into a desirable market, or a substantial increase in power can be achieved for an existing facility.

In these cases your local measurements have to be accurate, sufficient in number and properly taken to support your supposition that the facility you are proposing will actually perform as you postulate rather than those conductivities shown on M3.

The actual measurement of AM field intensities — such that they can be submitted and also repeated by others — is a skill I covered in a past article; see *http://tinyurl.com/fitch11*.

Sometimes you have to suffer for your art. The dashing gentleman in the picture is me. In the tundra it is freezing

(continued on page 21)

READER'SFORUM

MORE ON IP REMOTES

Michael, I enjoyed your RWEE piece on IP remotes (RWEE, Oct. 12).

We have for a few years now been doing IP remotes using Telos Zephyr/IP ("Z/IP") units. Initially we limited those to venues that could provide a hard-wired IP connection, but as time went on we began running into more and more firewall issues. Venue operators were either reluctant to create a firewall exception for us or, more likely, they didn't want to pay their IT consultant a couple of hundred dollars to come in and do it.

That led us to 3G connections through Sprint, Verizon and other carriers. We bought and activated the plug-in (USB) 3G radios from the carriers and were off to the races. We could do great-sounding remotes from anywhere on a moment's notice. We operated in this mode for a year before the trouble started.

Our current problems mirror what you described toward the end of your article. Our remote engineers go out to do the "line check" (a holdover term from the ISDN days) and find that we have a good signal and are able to connect to the studio unit and pass clean audio in both directions with no problem. But when the concert or other event starts, 10,000 people start texting, MMSing photos and videos and all that and the connectivity goes to zero. We moved to 4G when it became available in our Chicago market last year, and it worked well for a few months before we started having the same problems.

So … we're back to ISDN (or hard-wired IP) at the big-dollar remotes. So far there have been no issues getting ISDN lines installed. We miss the convenience and zero lead time of IP remotes, but ISDN works every time for the whole remote. We still use IP (4G mostly) at the small remotes, those at small businesses and the like.

W.C. "Cris" Alexander, CPBE, AMD, DRB
Crawford Broadcasting Co.
Denver

The writer is a regular contributor to Radio World.

WHY NOT SKYPE?

One more technology to try for remotes over the public Internet: Skype.

I set it up recently for a client doing a daily talk show from a remote location on a budget. Low delay times, two-way audio and text messaging are all reasons to consider this solution. The music, phone calls and spots are still being played back at the main studio. If you use USB audio interfaces to mate the pro audio gear and the two computers running Skype you can have a pretty good-sounding, voice-only remote for a local AM station.

John Kosian
Holliston, Mass.

GOOD RESULTS IN KEENE

Hi Michael, while I agree that audio over IP is still in its infancy regarding reliability, which varies greatly, it can work very well.

At WKNE(FM) in Keene, N.H., we routinely do remotes that are well beyond the range of our Martis due to terrain limitations. In the past we've used phone line codecs such as BlueBoxes with good success but limited audio quality. We have been using two sets of Comrex Access units, and once Internet access is established on the remote broadcast end we've had 100 percent success keeping two-way audio operating for hours at a time.

Though we have licenses for Comrex's reflector server service, which permits connections behind firewalls on both ends, we've never required it, as our studio ends are static public IPs.

We use a combination of wired and Wi-Fi wireless on the remote end, depending upon what's available. We have not used cellular data services, as coverage and data rates are inadequate in the Keene area. The Access units being two-way meant we could also feed relatively non-delayed audio to the PA system at the remote.

Note that actual on-air audio suffers from the eight-second HD Radio delay. So having a fairly low-latency IFB return feed from the studio is a requirement for these remotes.

Once a site has been scoped out and the client's IT folks have provided us with temporary passwords to their networks, setting up the remote is easy enough for our non-technical programming folks. WKNE's PD is computer-savvy and can usually do the advance work without my assistance.

My sports-talk AM station covers all local sports events, mostly high-school baseball and football, with older, less-sophisticated audio-over-IP technology that has proven reliable for entire broadcasts, namely Barix 100 boxes and DSL modems in the press boxes at the ballfields.

On the studio end we use two networks, cable modem for the bulk of our data including office, WAN and Internet connectivity, but download speed is around 6–7 Megabits per second. Our backup emergency DSL line is only good for around 1.6 Mbps. We have automatic fallback to line two through our Cisco firewall/router.

When we lost the TA adapter in our classic Telos Zephyr (used to bring the weatherman live to three of our stations during morning drive from his offices on Long Island), we resorted to laptop computers and Skype, which for the most part worked until the replacement card arrived from Telos.

Ira A. Wilner
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THE ART OF WRITING

The distinguished Barry Blesser promotes a cogent and effective theme in his carefully-crafted article "Why You Should Practice the Art of Writing" (Oct. 12).

As an addendum to Blesser's persuasive narrative, we recommend that Radio World readers also consult "The Elements of Style" by William Strunk Jr., with revisions, an introduction and a chapter on writing by E.B. White.

In "the little book," Prof. Strunk's own description of his work, there is a line that fits well within the proposition for better writing by Mr. Blesser: "Make definite assertions. Avoid tame, colorless, hesitating, non-committal language."

We must add that the editors, reporters and writers of Radio World and Radio World Engineering Extra certainly appear to be disciples of, and adherents to, both the "Art of Writing" espoused by Mr. Blesser and "The Elements of Style" by Prof. Strunk.

Keith Trantow
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ADVERTISER INDEX

SIGNAL

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cold, the wind is blowing 120 mph and we are above the Arctic Circle. (OK, the truth? It was chilly that day near New London, and we were more than a mile from a good restaurant.)

Conductivity can range from 5,000 mS for salt water as an extraordinary high (little loss) to a miserable low of near 0.5 mS, such as you have on the moraine field called Long Island. The national average for conductivity is about a 4.

This efficient ground wave carriage over sea water can create havoc for coastal stations such as the now-defunct 1510 in New London, Conn., and the 1510 in Boston when it was located closer to Boston Bay. The area of interference in between was quite notable at times.

Charles "Buc" Fitch, P.E., CPBE, AMD, is a frequent contributor to Radio World. Missed some SBE Certification Corners or want to review them for your next exam? See the "Certification" tab under Columns at radioworld.com.

Function Like Bessel

Question for next time

(Exam level: CPBE)

What is a Bessel function and what is a typical application?

a. A numerical description of propagation through a solid body, most often used in coax design.
b. A thermal transfer derivative, most often used to enumerate fluid cooling such as around the new solid-state components in liquid-cooled transmitters.
c. A solution to a particular type of equation, used in broadcasting mainly as a determinant of FM modulation levels.
d. The delta change in free air temperature, most often used in broadcasting to enumerate non-linear coax expansion and the potential for shearing.
e. The delta change in wire temperature as a function of uneven harmonic currents, most often used in broadcasting to enumerate the capacity of neutral power conductors.

SPEAKERS

(continued from page 22)

mixing until your mix sounds good on all of the available speakers, not just some of them." So I've tried going through an exhaustive auditioning process, including listening to my production work (both mixing and mastering) on multiple speaker systems in the studio, on a boom box in the kitchen, a home theatre system in the living room (complete with Dolby Pro Logic) and several car systems (where I audition while parked, driving around fast, driving around slow, top up, top down, etc.).

I've also asked some other mix and mastering engineers what they do.

Little by little, especially after the quality of my monitors improved because of a Bang & Olufsen project I've been involved with, I've been able to set this obsessive range of testing aside. I've done this both because it can be exhausting (and expensive for the client!) and because as I got more and more grooved into my monitors, I found I had fewer and fewer surprises when I checked my work on other systems. I came to "know," beforehand, what, for instance, the system in car #2, at speed, with the top down, was going to sound like.

WHAT DOES IT ALL MEAN?

My advice to you is this: Do your critical listening and production work on the best speakers you can obtain. Then check your work on speakers of various appropriate topologies (i.e. boomboxes, TVs and bookshelf speakers) of the best quality you can obtain. That should enable you to get a reasonably clear idea of "what it will sound like" for those topologies, in an idealized sort of way, with as few extra errors as possible. Your speakers may not sound as crummy as your end users' speakers do, but you'll be able to guess more accurately at the general range of crumminess that they are encountering.

Some years ago, I took part in a loudspeaker evaluation project that directly addressed these issues. You can read about that adventure on my website *www.moultonlabs.com*. It's actually fairly interesting, if you're curious about these things.

Dave Moulton is an audio engineer and producer, author, composer, educator and acoustician. He operates Moulton Laboratories/Digital Media Services in Groton, Mass. This article was first published in TV Technology magazine.

The Myth of Mixing on Crummy Speakers

Does Critical Listening Require Low-Fidelity Monitors?

BY DAVE MOULTON

An essential habit in audio recording is Critical Listening, the professional practice of listening in a systematic and careful way to audio in production in order to make it sound better for others, including producers and end users.

In this column I want to discuss an interesting myth that has rattled around the industry for years (I've certainly contributed to the rattling): "The Myth of Crummy Speakers."

That myth is based on the assumption that our end users all or mostly listen on crummy speakers. Therefore, we reason, we need to do our production work on crummy speakers as well, so that (a) we can hear all the crumminess that our end-users are subjected to, and (b) we can try to "make our audio sound good" on our crummy speakers in the hope that it will then also sound good on their crummy speakers as well.

There is even a brand of speakers that has been widely used as a reference for "crummy speakers": the Auratone (and a successor, the Avantone). These are small cubes with a single 5-inch driver and a retail price of approximately $100/speaker. I have a pair standing by in my studio (that I haven't actually used since 2003!).

For years, audio professionals have used Avantone Mixcubes to determine audio quality on small speakers.

A LACK OF EXCELLENCE

The first thing to note, when we start to consider this, is that not all crumminess sounds the same. In fact, crumminess is inherently diverse, so that the crummier things are, the more different ways those crumminesses manifest themselves. Crumminess is, in fact, a massive random accumulation of errors in design, manufacture and usage.

Such crumminess is usually a function of some or all of the following: inappropriate design goals, inadequate design specifications and standards, inadequate budgets, and indifference to outcomes.

What this all means is that crummy speakers are *much less* likely to sound alike than excellent speakers, and we can rest assured that whatever crumminess we choose to use will probably sound different, perhaps much different, than most of our end-users' crummy speakers.

The problem this presents to us is that we cannot count on our crumminess resembling the range of crumminesses that our listeners must endure.

Thought about this way, it is actually fairly obvious.

THE IMPORTANCE OF SPEAKER TOPOLOGY

There is more to this, however. Loudspeakers are complex and imperfect devices that utilize a small family of topologies based on the number of drivers included in the design.

At the same time, the number of drivers determines something fundamental about the bandwidth (or frequency spectrum) of the loudspeaker, which in turn determines much about "how it sounds."

So a single-driver speaker, such as the Auratone, can only have a quite limited bandwidth. The 5-inch driver of the Auratone is too small to generate long wavelengths (low frequencies) and too large to generate very short wavelengths (high frequencies). As a result, it has easily observed audible limitations.

And here's where that myth has some validity. The Auratone will, in many respects, resemble *all* similar single-driver loudspeakers of approximately the same size (say, from 4 inch to 7 inch). Such speakers show up in very cheap cars and trucks, as well as many cheaper boom-boxes, table radios, cheap TVs and the like.

By the same token, a two-way speaker, with a tweeter and a woofer mounted in a small box (a so-called "bookshelf" speaker, typically), will have much in common with most of its topographical siblings. The tweeter will usually be designed to cover the top three octaves (say, 2.5 kHz to 20 kHz, sort of), and will be crossed over to a woofer designed to cover perhaps 4 octaves (which is really a stretch) from, say, 125 Hz to 2 kHz.

> **My advice to you:** Do your critical listening and production work on the best speakers you can obtain.

There will often be an audible dip in response between the woofer and the tweeter, and the lower bass will also be comparatively weak. Such behavior will be characteristic of most such small two-way "bookshelf" speakers.

WHAT I'VE FOUND

Over the years that I've struggled with this, I've tried a lot of things. My neighbor, mentor and ultra-engineer, Tom Bates, makes the case that "you can't quit

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CLEANUP

YOUR ON-AIR SOUND & IN THE RATINGS

AirAura's **31-Band Limiter** Delivers FAR More Clean Sound Detail than ANY Other Limiter on the Market. Here's Why This Is Important...

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