Radio World®
ENGINEERING EXTRA

October 19, 2005

A Case Study Of Split-Level Combining

Power Increase and HD Radio Conversion Combined in New System

By Ron Thompson

The author is director of engineering for Pacific Public Radio/KKJZ(FM).

After much anticipation, KKJZ(FM)'s technical staff was given the opportunity to convert our FM transmitter plant to digital. Additionally, a long-sought construction permit for power upgrade had arrived from the FCC. It was also an appropriate time to leverage the project momentum to squeeze in a much-needed backup transmitter for our noncommercial jazz station.

KKJZ is located at California State University Long Beach and transmits to Los Angeles and Orange Counties via its Signal Hill, Calif. antenna site.

Because the digital-conversion portion of the project was partially funded by the Corporation for Public Broadcasting, we compiled an initial and tentative equipment list for grant application purposes. The only available conversion method that met our anticipated signal generation needs was the

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DESIGNER INTERVIEW

So You Want To Build A Tower <u>Where</u>?

Fred Hopengarten Talks About Zoning Regulations and Broadcast Towers

By Steve Callahan

The author is assistant chief engineer of WBUR Group in Boston.

If you have an over-the-air broadcast station, chances are good that you have some connection to a tower, be it an ownership interest or as a tenant on a leased structure. An acceptable tower location is crucial for a successful station, but siting towers is not as easy as it once was. If you have to build a new tower site, or make major changes to an existing site, you'll run the gauntlet of local permitting authorities.

Fred Hopengarten is a telecommunications lawyer who specializes in land use for towers. A graduate of Boston College Law School, he is a member of the Bar in Maine and the District of Columbia. Attorney Hopengarten has been a tower owner and has advised in more than 100 tower cases. He is a frequent speaker on tower issues and has published articles on various aspects of tower zoning. In 2001, The American Radio Relay League published his book "Antenna Zoning." He received his first FCC license in 1956 and is extra class amateur K1VR.

> "With bylaws that forbid the construction of anything that is not specifically enumerated as permitted, regulations kept getting tighter, culminating in the regulation of 'viewsheds,' whatever they may be."

Why do you specialize in tower siting issues in your law practice?

That's easy. I became a shortwave listener at age eight, using a Hallicrafters S-38B to a random length wire about 60 feet long, and received my first ham radio license (WN1NJL, later K1VR) at age 10.

I've always loved radio and antennas. Yet I knew in high school that I wasn't smart enough to be an engineer, so I went to Boston College Law School and Harvard Business School. By doing well there in academics, I was hoping that I could hang around with engineers.

In 1978, at the urging of Fred Collins (W1FC) and Dana Atchley (W1CF), I started Channel One, the first satellite TV dealer in the United States. *[Collins was chief scientist at Microwave Associates, now M/A-Com, a unit of Tyco Electronics; he subsequently left to be a founder of Radio Waves. Atchley was vice chairman at Microwave Associates.]*

After a while, the company drifted into the cable TV industry when a condo association of over 2,000 homes in Connecticut asked us to establish a satellite master-antenna TV system. After 12 years, the company was sold to a substantial minority shareholder, Continental Cablevision, since consolidated into Comcast.

Along the way, though, I obtained permits for 15 headends —VHF/UHF antenna systems, plus satellite TV dishes. After a

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Fred Hopengarten

Radio World
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Vol. 29, No. 26 October 19, 2005

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Next Issue
Radio World: Oct. 26
Engineering Extra: Dec. 14

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Radio World (ISSN: 0274-8541) is published bi-weekly with additional issues in February, April, June, August, October and December by IMAS Publishing (USA), Inc., P.O. Box 1214, Falls Church, VA 22041. Phone: (703) 998-7600, Fax: (703) 998-2966. Periodicals postage rates are paid at Falls Church, VA 22046 and additional mailing offices. POSTMASTER: Send address changes to Radio World, P.O. Box 1214, Falls Church, VA 22041. REPRINTS: For reprints call or write Emmily Wilson, P.O. Box 1214, Falls Church, VA 22041; (703) 998-7500; Fax: (703) 998-2966.

Seek Out Opportunities To Enrich Your Skills

By Michael LeClair

Michael LeClair

I found myself in an unusual situation the other night. Around midnight, I gathered with a colleague and the engineer of another local station at their hilltop transmitter site to try to solve an interference problem that had been devilling them for a long time, perhaps years.

The site was a collocated AM and FM transmitter facility, with two towers separated by about 100 feet. Such sites are common and reflect the history of the technical development of broadcasting in the United States. The original 1,000-watt AM dated from the heyday of the community-licensed stations in the 1950s.

As the transition to FM came along in the 1970s, a new station was licensed and built on the same site, taking advantage of the available land, transmitter building and easier zoning process of locating next to an existing tower.

The transmitter building was a large structure that at one time had also housed studios for the station, and at the entrance the call letters for the original station were fashioned into the tile floor. This once-proud building had deteriorated somewhat and was now just the transmitter site, but the traces of its original grandeur remained.

A COMMON PROBLEM

Unfortunately, it is typical to find in such sites the problem of interference caused by the introduction of the AM signal into the FM carrier. This condition creates a pair of FM-modulated sidebands on either side of the FM carrier frequency, at a distance equal to the AM carrier frequency.

In many cases, such interference is not strictly legal but continues without much complaint, as the sidebands don't happen to land on top of another local FM station. Generally the sidebands are weak enough they will not interfere much beyond a few miles from the transmitter site.

However, in this case the transmitter site was located close to a populated area, and the interference to another station was significant. To a listener it would mostly sound like a burst of multipath noise.

The giveaway that it was actually interference? In certain locations, particularly where the vertical pattern of the antenna had a strong lobe toward the ground, audio from the interfering FM station would come through for brief moments while driving through the area.

To add more complexity to this situation, the various waves of consolidation and trading had resulted in separate ownership for the AM and FM stations. Neither station was eager to accept full responsibility for the interference that was produced.

I have to admit that, as an engineer, I actually enjoy it when faced with these kinds of problems.

Ninety percent of the time my job requires me to work with about 10 percent of my brain. Further, much of what I do on a day-to-day basis is make sure that well-established procedures are followed so that problems do *not* occur. The combination can become repetitive over time.

By working in a different environment, with different conditions and equipment, I am challenged to think creatively about how to solve problems. My approach is to gather as much information and facts as I can and then research possible solutions. It is in this process of asking questions and gathering information that I find myself learning again about the complexities of broadcast engineering, as well as the local broadcast history. This type of work allows me to grow as an engineer in a way that the daily routine does not permit.

Getting back to my interference situation, it was clear that this was a problem that had been looked at before, possibly by more than one engineer. No obvious deficiencies existed in this broadcast plant; in fact, it was one of the better-built medium-market transmitter facilities I have seen, with main and auxiliary equipment for most of the broadcast chain.

The grounding system was in good condition, with large copper straps running to all the equipment and AM ground radials recently replaced. Both the AM and FM transmitters were of recent construction and in good condition. The building was not well-maintained: in particular the interior lighting was limited, so we had to work with drop lights. But there was no smoking or burned chassis to indicate something had failed. Rather, this was a system problem and had to do with design.

AM GETS INTO EVERYTHING

Anyone that works with AM knows that it can be difficult to prevent the powerful electromagnetic fields near an AM tuning network or tower from injecting themselves into all kinds of equipment.

In talking with the local engineer I could see a pattern of clues emerging. The problem appeared to be with the composite cable that ran between their STL receiver and the FM exciter. A special, custom-built double-shielded coaxial cable had been used, run through ferrite rings in an effort to keep the interference down.

Fortunately our radio group has available a recent-model spectrum analyzer to help track down such problems. It took less than an hour to confirm the problem was coming from this connection. Without it the channel was perfectly clear, but as soon as the composite connection was made it would develop the sidebands. The sidebands were down approximately 58 dB below the carrier. This was well above the FCC mask limit of -80 dB at this distance from the FM carrier.

A number of possible solutions occurred to me. First, it would have been possible to filter the FM transmitter to eliminate the sidebands. This would have been a "brute force" solution with a brute force budget.

In talking with the folks at Shively Labs about such filters, a more elegant approach was suggested. Since the problem was in the exciter it was possible to just build a low-power filter that cleans up the exciter output. This was a considerably less expensive approach.

While my thought processes tend toward the theoretical I find that sometimes it pays not to forget the practical. In bringing together a "team" of engineers to look at this problem, we brought a wider range of skills than just one of us alone could provide. I find this to be an effective technique and one that often complements my strengths as an engineer.

In our late-night session we got to playing with the composite cable and found that in a different orientation the sidebands were reduced by about 10 dB. My immediate thought was that we had taken advantage of the principal of orthogonality. In the previous orientation the cable had run across the plane waves generated by the AM tower, intersecting them for long distances. The improved orientation ran the cable in a largely orthogonal path away from the AM tower before cutting across to the STL receiver, greatly reducing the intersecting distances.

If this simple trick could buy us a large improvement, it was possible that by paying attention to the composite installation we could get an even greater improvement. Before going to the filter approach we decided to try to make the composite cable as hardened against interference as we could.

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while, I had become experienced at preparing applications for planning and zoning boards.

The last time I looked, I think I had worked on over 250 tower applications in a whole lot of communities and states. I'm beginning to know what I'm doing.

Please briefly review the history of the legal regulation of tower siting.

Now there's an assignment!

Let's begin with the first zoning regulations in New York City. The year was 1916, and they were created in response to the long shadows cast by the Equitable Building, which still stands at 120 Broadway. Through the 1920s, many states passed enabling acts to permit zoning regulation.

The power of a state, usually through a city or county, to enact a zoning regulation was challenged on constitutional grounds in the case of *Euclid, Ohio v. Ambler Realty Co.*, 272 U.S. 365 (1926), which is usually the first case in law school land-use books. Thereafter, land-use regulations just kept multiplying. As a generalization, you'd be correct to say that it used to be easier to site towers in the past, even through the 1950s.

Eventually though, local land-use restrictions began to prevent effective communications as contemplated by the Congress and the FCC, which led to a series of preemptions — a statement of federal law that overrules local law on the grounds that federal law is the supreme law of the land, unless forbidden by the 10th Amendment to the Constitution.

Fig. 1: Image at left shows simulation of proposed antenna before construction as part of exhibit for zoning board. At right, actual tower construction.

The usual technique for restricting construction of antenna systems was to restrict the height of structures, usually to three-story structures or 36 feet, unless otherwise permitted. After that, with bylaws that forbid the construction of anything that is not specifically enumerated as permitted, regulations kept getting tighter, culminating in the regulation of "viewsheds" — whatever they may be. Does anyone really know what a "viewshed" is?

The tide began to turn in 1985, with the FCC's limited preemption of amateur radio antennas, based on solid work in advance by the ARRL [American Radio Relay League] and Sen. Barry Goldwater, an active ham (K7UGA) and previous Republican presidential candidate.

That test is whether or not the municipality applies the "minimum practicable regulation" to allow for "effective communications." The FCC has declined to specify any minimum height below which the preemption applies, and each situation is extremely fact-specific, communications-specific and location-specific.

As attorney Barry Umansky wrote in Radio World in 2001, "Though petitioned to do so by the National Association of Broadcasters in 1986 and the former Electromagnetic Energy Association in 1994, the commission has declined to adopt a policy of federally preempting state and local broadcast siting regulations that impose duplicative, let alone more restrictive, RF radiation exposure standards."

The Association for Maximum Service Television (MSTV) also petitioned for preemption of siting regulations used to hold up the spread of HDTV, a huge issue for Lookout Mountain, Colo., but this preemption is not being pursued today.

Local regulation of broadcast emissions can be troublesome to broadcasters, as the Lookout Mountain case, still unresolved at this writing, has shown. For a look at the effort required for WIZN(FM) in Burlington, Vt., to overcome a claim that RF emissions were "air pollution," see *www.antennazoning.com/commercial/library.htm.*

The Communications Act of 1996 introduced an absolute preemption of local control over cellular telephone with respect to RF emissions, and modest preemption of local zoning. The test is whether or not the zoning regulations create "significant gaps" in coverage by a carrier.

Less well known is the preemption introduced by §207 the 1996 Act for "Over-the-Air-Reception-Devices," and implemented by 47 CFR §1.4000, better known as the OTARD Rule. It preempts "Common Covenants and Restraints" or

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The first idea was to shorten the length of the composite cable to *exactly* the right length, minimizing the induction of AM signals. To further shield the cable we would install a conduit from the STL rack to the transmitter. Finally, to ensure the best shielding possible we would custom-order a coaxial cable with a solid copper outer conductor (i.e., Andrew Superflex).

It was hoped the combination of these three elements would improve the situation enough that the interference would be reduced while we contemplated the question of who would pick up the tab for the filter on the exciter.

A few weeks later, after doing all the necessary prep work during daylight hours for changing out the composite cable, we found ourselves at the transmitter site at night, and within 15 minutes were rewarded with a complete fix for the interference problem. Careful spectrum analyzer sweeps indicated no trace of the improper sideband modulation.

This was a problem that was solved completely by paying attention to the details of the craft of installation of the cable. The total cost to fix this problem was less than $200 in materials, including a bunch of two-inch EMT conduit from Home Depot.

MAKE THE TIME TO SOLVE THE DIFFICULT PROBLEMS

I am writing about this recent problem-solving session because it strikes me how few engineers have the time or resources to do this any more.

After putting out the daily operational fires at multiple studio sites for a group, the typical chief engineer has little time to investigate difficult problems. Add to this the limited engineering resources in a group where often an individual is in charge of maintaining all aspects of a number of broadcast facilities. I would politely call it a "challenge" for one person to have expertise on such a wide variety of technical systems. It is tough to pull together a team with enough experience to take on complex problems in such an environment. But try to take on tricky problems that are outside the daily routine. The personal benefits are well worth it.

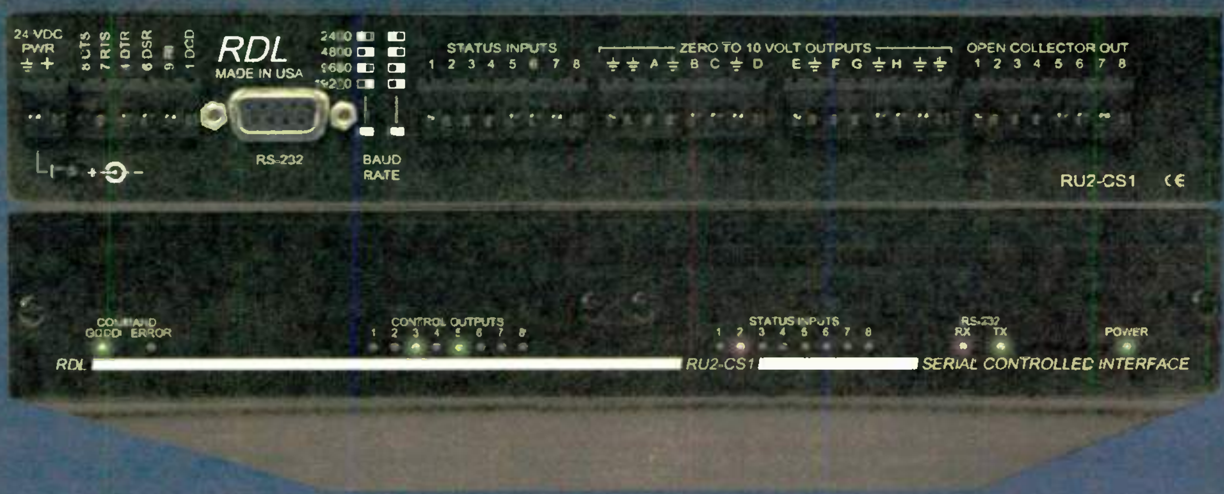
As I pointed out earlier, the learning experience of taking on new and unusual problems can enrich your skills as an engineer. I find that I still remember things I learned many years ago in solving tough problems during a midnight session, much more than I remember the mathematics of my formal engineering education. I look on these problems as opportunities, although I am not so foolish as to wish that I had an unlimited supply of them.

IN THIS ISSUE

In this issue, Barry Blesser's Last Word column concerns this same topic of learning and growing as an engineer. I found it to be wonderfully perceptive and inspiring. We also have a piece from Ron Thompson describing his experiences with the installation of Split-Level Combining for HD Radio. Rolf Taylor of Telos Systems contributes a piece on the latest audio coding technology. To round out the issue we have an interview with Fred Hopengarten about the business of siting new towers and another installment in Guy Wire's discussion of the AM band. Enjoy!

We also invite manufacturers and suppliers to drop us a line if you have a product to be reported in our Marketplace section. Those may be sent to *radioworld@imaspub.com* along with a note that the information is for RW Engineering Extra. ■

GET EVERYTHING UNDER CONTROL



- RS-232 Control of all RDL Switching Modules
  Examples include computer controlled switching of 4x1 and 2x1 audio, video and digital audio signals.
- RS-232 Control of Many OEM Products
- Eight 0 to 10V (or 0 to 5V) Outputs
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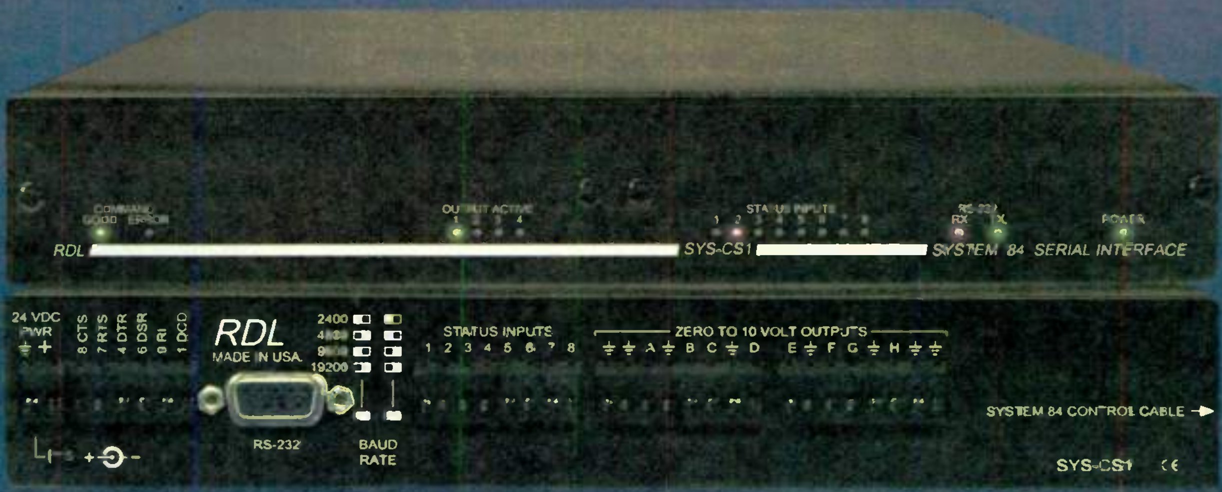
- Status Inputs from Eight Sources
  Examples include sensing contact closures from satellite receivers or from RDL audio or video detection modules
- Rack mountable using RDL RU-RA3HD

RS-232



- RS-232 Control of 8x4 Audio Routing
  Direct interface with RDL System 84 allows switching, mixing & routing 8 mono or stereo sources to 4 outputs.
- Eight 0 to 10V (or 0 to 5V) Outputs
  Examples include computer control of audio levels using RDL VCA modules or computer control of lighting.
- Status Inputs from Eight Sources
  Examples include sensing contact closures from satellite receivers or from RDL audio or video detection modules.
- Rack mountable using RDL RU-RA3HD

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CC&Rs that would prevent the installation of small, one meter in diameter or less, satellite TV dishes or antennas for fixed wireless signals — think wireless Internet — in condos, and zoning that would prevent off-air TV reception satisfactory to the viewer. Since 1999, it has applied to a renter's balcony or patio.

In 2002, the New Hampshire Supreme Court held that the FCC's required minimum-height regulations for AM broadcast stations preempted local zoning. I know of no similar FM or TV ruling. There is work yet to be done.

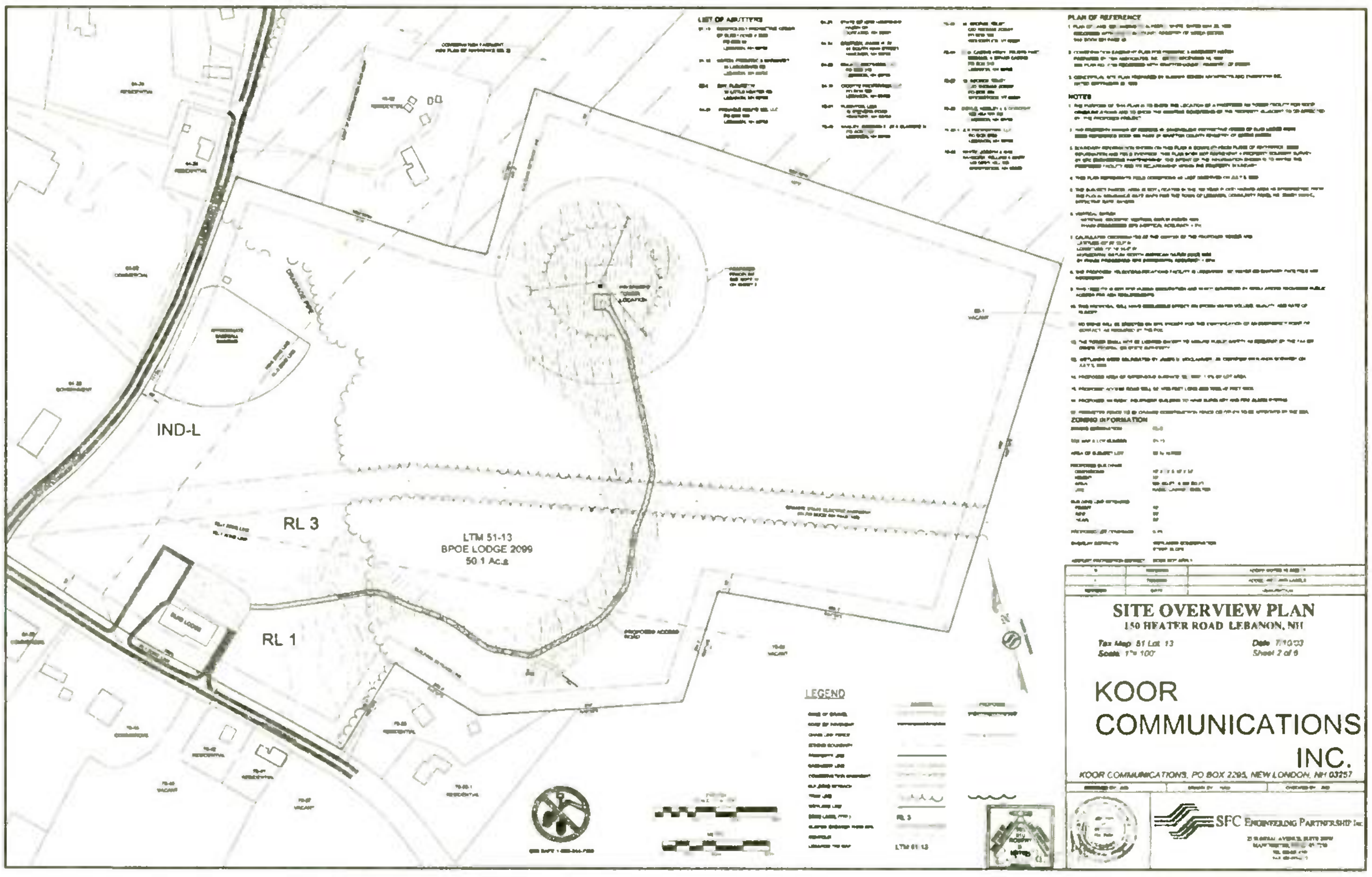


Fig. 2: Typical Detailed Plot Plan for Proposed Tower Site

If I want to build a new tower in a community, what should I do first?

Buy a complete, most-recent copy of the zoning bylaw. Nothing replaces reading the actual regulations.

Then talk to a local zoning lawyer, or an antenna lawyer who does these things nationwide. If you try to do it yourself, you could wind up like the poor owner of the former KROY(AM) 1240 kHz, now operating as Spanish-language KSQR in Sacramento, Calif. The 195-foot tower blew down in a storm in 2001 and the Planning Commission denied permission to rebuild on June 9, 2005.

I was never involved in that case, and I know only what the Sacramento Bee reported, but it sounds like a case where a valuable company asset, the Tahoe Park tower, was lost. It is almost always possible, if the matter is handled well, to rebuild a prior existing use.

Do all local governmental officials dislike new towers?

As President Clinton would say, it depends on what you mean by the word "all."

The professionals seem to want an orderly process, observance of the zoning ordinance and a showing of need. But some planners, planning board members and zoning board members, got into it because they want to control everything. They are not builders; they are controllers. They don't much like development that they didn't instigate. Those are the folks who tend to dislike towers the most.

Can a community legally enact an outright ban against new towers?

The question is pretty broad, but, speaking generally, no.

In fact, that was exactly the case in *Koor v. Lebanon*, where Lebanon, N.H., tried to ban any broadcast tower taller than 42 feet. Fortunately, the Supreme Court of New Hampshire found that the FCC's minimum-height regulations for an AM tower preempted the bylaw, and today you can find the new WUVR(AM) tower, 269 feet tall, visible to the east from U.S. 89.

In the case of AM broadcast stations, there are detailed regulations mandating minimum antenna heights *[see, e.g., 47 C.F.R. §§ 73.189, 73.190 (2001)]* at least in lieu of proof to the FCC that required minimum field strengths can be achieved by an antenna of less than the specified minimum height *[see 47 C.F.R. §§ 73.186, 73.189 (2001)]*. In *Koor v. Lebanon [www.courts.state.nh.us/supreme/opinions/2002/0212/koor152.htm]*, the New Hampshire Supreme Court declared that the FCC minimum height regulations preempt local zoning.

Fig. 3: Fall Zone Sign as Required by Local Ordinance

Some recent zoning bylaws have been drafted with the specific goal of reducing the proliferation of towers. Can local zoning bylaws legally require co-location on an existing tower?

Require? No. But town officials can make life very difficult for a new applicant who rejects the concept out of hand, and won't explore it thoroughly, where the bylaw requires an attempt to co-locate, or perhaps proof of denial, on commercially reasonable terms.

This is exactly what the bylaw of Wolfeboro, N.H. requires, for example. On the other hand, for an AM broadcaster, especially one requiring a multiple tower array to satisfy requirements of non-interference, such bylaws are hardly relevant, as co-location on an existing tower is just not feasible. The TV or FM broadcaster faces a different problem, but the weight and windload of the antenna could play a critical role with respect to the question of co-location feasibility.

Who really controls a tower's height, the FCC or local zoning?

The best answer is going to sound lawyer-like: If the FCC preempts, the FCC controls the tower's height to the extent of the preemption. If the FCC does not preempt, then it's local zoning.

Determining whether preemption applies, and making it stick, is where the legal work comes in. In any event, many installations will require a Certificate of No Hazard from the FAA. And don't overlook the requirements of the National Environmental Policy Act (NEPA) of 1969. This is the wrong area for the novice lawyer or inexperienced engineer to start the learning process.

Is restrictive tower zoning, such as being able to locate only on town-owned land, legal?

A lot of restrictive zoning is legal. But the town must permit commercial antennas somewhere. I doubt an ordinance that allows locations only on town-owned land would survive a competent attack. That type of restriction just doesn't meet the "rational governmental interest" test. This refers to the usual requirement that all land-use regulation must serve a rational governmental interest, and a mere desire to achieve rental income from a broadcaster is probably not good enough.

How has digital conversion of AM, FM and TV affected the tower business?

I just did some work on a digital TV antenna for a CBS affiliate. From my perspective, any time someone needs to put a new antenna in the sky it means new business!

We've read reports that towers injure bird populations ... is that true?

At the moment, the science does not support the proposition that towers are a significant source of bird kills. By contrast, feral cats are far more significant killers of birds.

But I would like tower owners to mount a camera and take a picture of the ground under the tower every morning, keeping the images on tape or DVD. Soon we could develop a significant number of observations, which, if it were 300 towers and daily recording for two years, would result in some serious observational data to replace the hype and speculation of anecdotal tales.

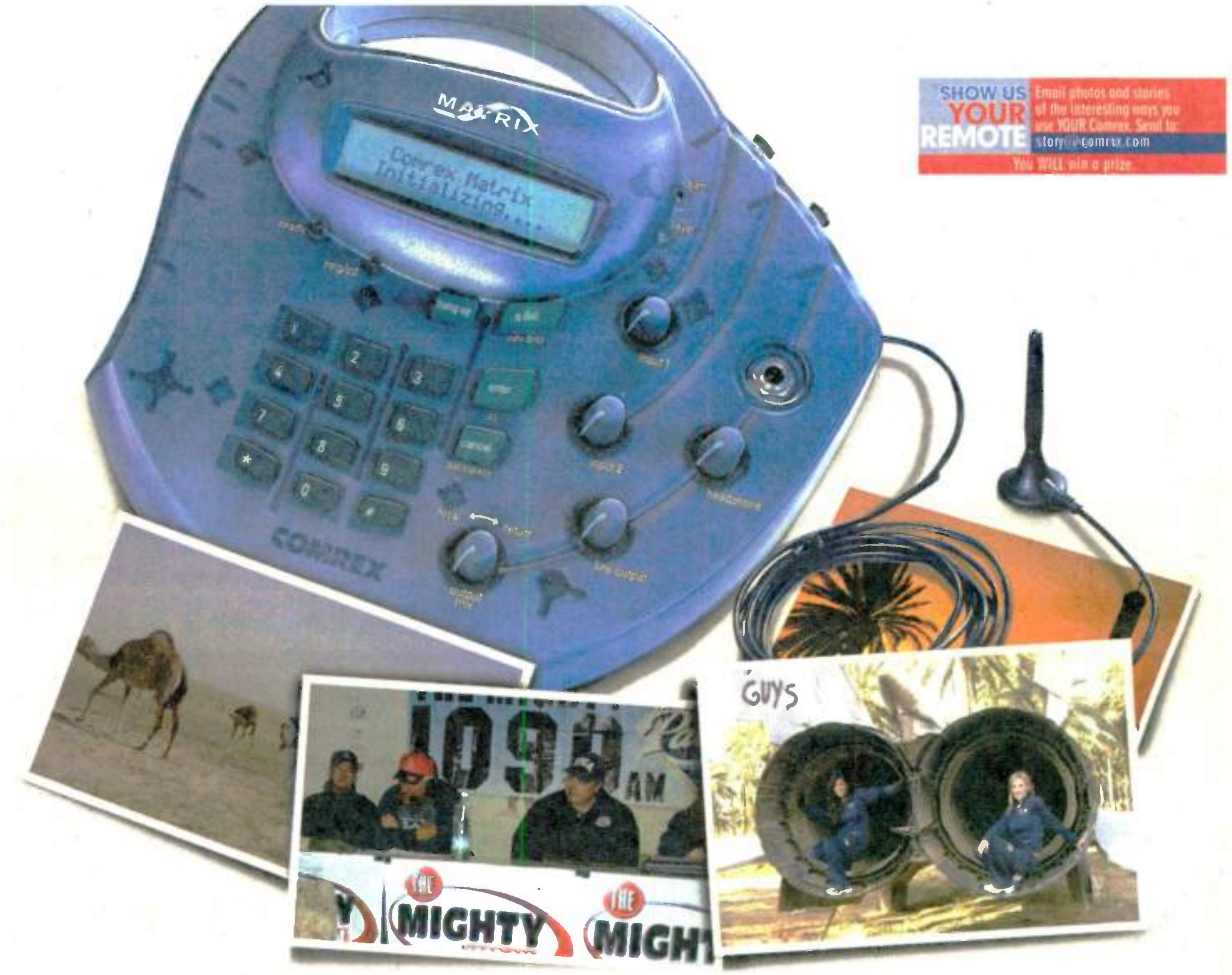
Some of the claims in this area can be pretty wild. See, for example, *Rush Creek Golf Club v. Corcoran, Minn., and Fraasch* (Hennepin County District Court, 1996), where the Golf Club claimed that Fraasch — ham radio call sign K0SF — would ruin the habitat of Trumpeter Swans. The only problem was that the golf club could only produce testimony at trial that the bird had been seen twice in the past 15 years, and there was no known evidence of Trumpeter Swans nesting in the Goose Lake area. Costs and disbursements were awarded to the municipality, which had granted a building permit, and the radio ham, who had constructed a 130-foot tower.

"I doubt an ordinance that allows locations only on town-owned land would survive a competent attack."

What other trends, such as consolidation of tower ownership, FCC auctions and increased land prices, are going to affect tower siting in the future?

I'll take this as a standard question about the future. I see more cellular telephone and PCS installation on "hot towers," more co-location — good news for tower owners; more telephone industry consolidation — bad news for tower owners in areas of overlap; much more detailed application requirements at the municipal level to construct new towers, and more need to bring in a lawyer where once the on-site engineer did the zoning work in a more folksy manner.

The increased need for detailed applications will also require more work by civil engineering as well as surveying firms to provide detailed plans, contours and layouts. The time has already arrived where the cost of the steel is a minor part of the project. ■



KKJZ

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high-level combining (or separate amplification) method of generating the FM plus the HD Radio hybrid signal. Therefore, we built our initial plans around that approach.

Just as we were about to commit to equipment purchases, we became aware of the new split-level combining, or SLC, mode for producing an FM HD signal. The SLC method as introduced by Harris Radio Broadcast Systems seemed far more beneficial to KKJZ's needs. A comparison of high-level combining and SLC follows and supports why SLC indeed was the best solution for KKJZ. A discussion of its installation and implementation within the KKJZ transmitter plant follows the comparison.

Perhaps our experience will provide you with insight on how SLC may benefit your station's HD conversion needs.

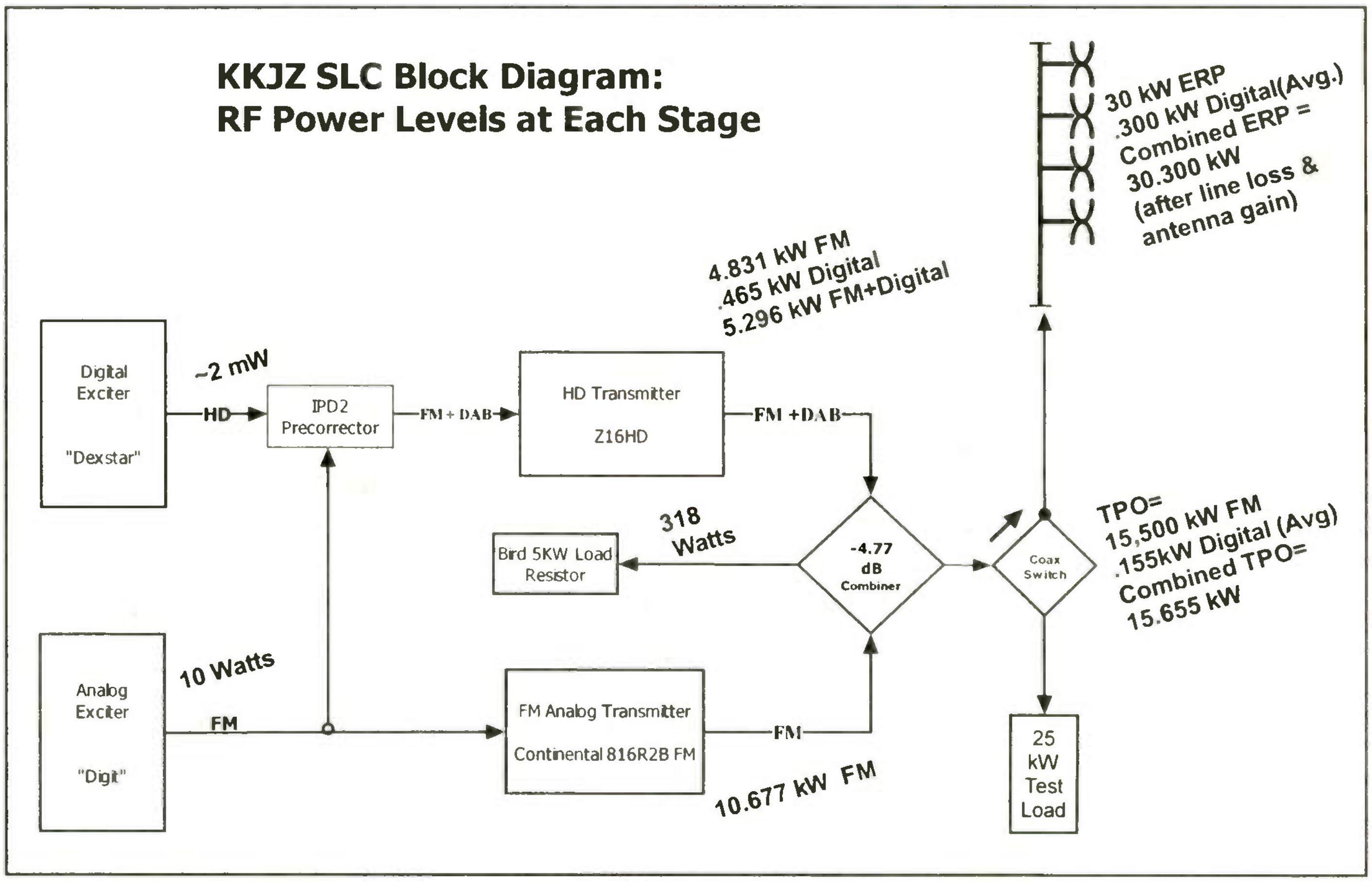

Fig. 1: KKJZ's SLC RF Block Diagram

NEEDS ASSESSMENT

We first needed to understand our new Effective Radiated Power (ERP) and Transmitter Power Output (TPO) requirements since KKJZ was upgrading power in addition to HD conversion. The necessary analog TPO was the first figure to calculate. This number was the necessary variable required to make subsequent HD Radio transmitter sizing and HD generation mode decisions.

The KKJZ construction permit was for a minor change in class that allowed the station to upgrade from a Class B1 to a full Class B station. The existing operation used a Continental 816R2B transmitter running with a 5.2 kW TPO. The licensed ERP was 6.5 kW and nondirectional. The new CP called for a directional antenna with a maximum ERP of 30 kW. Gain on the half-wave-spaced antenna worked out to be 2.055 in the maximum lobe after field-testing. The required TPO for KKJZ's new facility would need to be 11.5 kW after accounting for transmission line losses and antenna gain.

We quickly ruled out the low-level combining (common amplification) method as it is generally best suited for TPOs below 7.5 kW. We also ruled out the space-combining technique (separate or interleaved antennae, one for HD, one for analog) because KKJZ's new construction permit specified a directional FM antenna pattern and the FCC has restricted the use of space combining to nondirectional FM use except under Special Temporary Authority.

We preferred to utilize the existing analog transmitter because it was still in good shape and we felt it would provide more years of service. It was designed to provide up to 21.5 kW of output power and could easily provide 11.5 kW of analog power, plus the additional 10 percent headroom required to overcome combiner losses in HD's high-level combining mode.

New physical space in the existing transmitter shelter was required for an HD transmitter as well as additional footprint for a backup FM transmitter. More space would also be required to accommodate an IBOC combiner and reject load. Expansion of the shelter was not an option, and while the reject load could potentially be placed outside, it was not preferable due to limited outdoor space and the potential delay of requiring changes to the site lease.

The existing closed cooling system was built with extra cooling-capacity headroom that would suffice for operation of the HD and analog transmitter combination. We concluded that heat generated from the combiner reject load was the only factor that might stretch the existing cooling system.

We did not necessarily need a backup transmitter that provided full licensed power. Instead we required a backup that would be able to keep KKJZ on the air during occasional maintenance or worst-case failures.

It was clear that we could make high-level combining work, but were concerned about the required floor space compromises considering our desire for a backup transmitter. We were also unhappy about the additional complexity to our project with the potential need to locate a reject load outdoors. We would also have to spend extra time and money on ventilation and cooling improvements.

SPLIT-LEVEL COMBINING

KKJZ needed to move ahead with its HD conversion in spite of our concerns. We were about to commit to a transmitter order based upon the high-level combining technique when Harris introduced split-level combining as an alternate solution in April 2004.

It helps to think of split-level combining as a variation on the high-level combining technique. (Fig. 1 illustrates the SLC RF signal flow as applied to KKJZ). We quickly realized that SLC would be an excellent choice for KKJZ upon seeing a comparison chart that displayed its improved efficiencies over a basic high-level combining set-up (see Fig. 2).

As with the separate amplification mode, SLC requires (at a minimum) two transmitters, two exciters, a combiner and reject load. Harris provides SLC as an option package available for its ZCD series of HD Radio transmitters and prewired Dexstar exciter racks. The difference is that the ZCD transmitter, which just handles amplification of the digital signal in the high-level combining mode, carries a portion of the FM analog signal in SLC mode. This is provided from a sample of the analog exciter's RF output. The RF signals are then run through a phasing circuit (installed within the ZCD transmitter at the Harris factory). The outputs of the two transmitters are still combined and fed to the existing coax and FM antenna array.

A higher-capacity HD transmitter is required for SLC, but the long-term advantages are manifest and outweigh the additional initial cost. The difference in our case was to upgrade from an originally specified Z8HD transmitter to a Z16HD transmitter. This allowed us to achieve the best overall efficiency, which translated into the least amount of power wasted at the reject load. In turn, this achieved improved energy savings and reduced cooling needs.

Harris helps each station work out the

best transmitter sizing combination with a load calculator spreadsheet (see Fig. 2); the spreadsheet is available for your experimentation on Harris's Web site at *www.broadcast.harris.com/extremedigital*. It provides an efficiency comparison of separate amplification's -10 dB combining method against the SLC -6 dB, -4.7 or -3 dB combining method. One can try various combiner-loss and digital-transmitter model combinations to find the most efficient match for your facility. Of course, the factory application engineers can assist and provide the best recommendations for your facility.

There were several practical reasons for choosing the SLC technique over separate amplification. The TPO requirement for the analog transmitter was reduced, as was the demand on the final output of the existing transmitter. This is an enormous benefit for stations that do not have an additional 10 percent of RF output available to overcome the combiner losses that occur within the separate amplification mode of operation. As previously mentioned, KKJZ's existing transmitter had plenty of power available for a separate amplification mode, but we still benefited with SLC by lightening the demands on the analog transmitter's final output tube. This should translate into longer tube life for KKJZ.

We also eliminated the backup FM transmitter from our shopping list, saving valuable floor space. The SLC mode essentially provides a level of built-in redundancy. The station can stay on the air in both analog and HD if the analog transmitter fails since the solid-state HD transmitter carries a component of the analog RF. Catastrophic failure of the Z16HD transmitter does cause a complete loss of the HD signal. But this is acceptable at this stage of the HD Radio rollout since HD receivers automatically revert to analog.

POWER SAVINGS

Reject load power was also reduced with SLC because of the core advantage provided by SLC of limiting combiner losses. High-level combining uses a -10 dB combiner, which wastes 90 percent of the HD transmitter's power. SLC alternatively allows for use of a -3 dB, -4.7 dB or -6 dB combiner. A -4.7 dB combiner was chosen for KKJZ because it provided the most efficient solution. This was determined through the SLC calculator spreadsheet based upon the required 11.5 kW analog TPO and the capacity of the station's existing analog transmitter.

Consequently, the necessary combiner reject load was physically smaller as it needed to dissipate less heat. KKJZ was able to downgrade from a 10 kW load resistor to a 5 kW model (oil cooled). The reject load could now be installed inside the KKJZ transmitter facility rather than outside.

The existing transmitter-room cooling system provides six tons of refrigeration. With a high-level combined system the transmitter and reject-load combination would have dumped approximately 61,833 BTUs per hour into the room and would have required 5.2 tons of refrigeration. With split-level combining, the system would emit approximately 53,516 BTUs and would require 4.5 tons of refrigeration, leaving 1.5 tons of headroom for external heating of the shelter. The lower cooling requirements will equal energy cost savings in the long run.

Additionally, some AC power-consumption savings could be achieved with SLC. In KKJZ's case, the overall power-consumption needs of the transmitters decreased from 33.8 kW to 31.3 kW. More of the FM signal power is handled by the digital transmitter, which operates more efficiently with SLC than with high-level combining, so a net savings in power consumed is achieved. The AC power consumption column in Fig. 3 illustrates the different load distribution. Also see the "ZHD Transmitter" line in Fig. 2 for the difference in digital transmitter efficiency. With KKJZ, the efficiency of the digital transmitter went from 30.7 percent with high-level combining to 39.1 percent with SLC.

> **"We did not necessarily need a backup transmitter that provided full licensed power."**

INSTALLING SLC

It was clear that split-level combining provided an ideal fit for KKJZ. It conveniently addressed many of the concerns that we had about going with the basic high-level combining technique. We went ahead with SLC equipment orders and turned to preparing the transmitter site.

Most of the facility considerations were not significantly different for HD than for a standard FM transmitter installation. We upgraded our electrical service to support the new transmitter's power-supply requirements by adding a dedicated 200 amp subpanel. Harris has a useful pre-installation manual available at its technical support Web site that proved helpful to us. Additional assistance included downloads of ZCD transmitter and exciter rack physical dimensions and electrical supply requirements.

It was helpful to work out a floor plan in advance of transmitter delivery. We made sure that we placed the new Harris Z16HD transmitter with adequate access

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KKJZ

CONTINUED FROM PAGE 9

clearance at the front and back. The reject load was strategically placed so that air-conditioning inflow air would pass over it. Our existing test dummy load was relocated within the transmitter room.

An in-room transmission line routing plan was also worked out and included strategic placement of the combiner and transmission line routing. We made sure that we avoided routing lines across the transmitter cooling intake and exhaust vents. We also routed the lines and chose ceiling hanger locations that preserved the ability to easily reroute lines in the future.

Any station installing SLC will need to consider the option of installing a combination of coaxial switches or coaxial patch panels that would enable steering of the transmitter RF outputs around the combiner, direct to the antenna or a test load. The ability to bypass the combiner temporarily after failure of either transmitter would allow more RF energy to go straight to the antenna rather than waste a large percentage as heat in to the combiner reject load. Upon failure of one transmitter, more energy will be redirected to the reject load, rather than to the antenna. The reject load must be appropriately sized to handle this additional heat dissipation. Fig. 4 shows how much additional heat goes to the load during shutdown of either of KKJZ's transmitters. Either failure takes the normal 318 watts at the reject load up to nearly 3,500 watts, still comfortable for the 5,000 watt reject load specified for KKJZ.

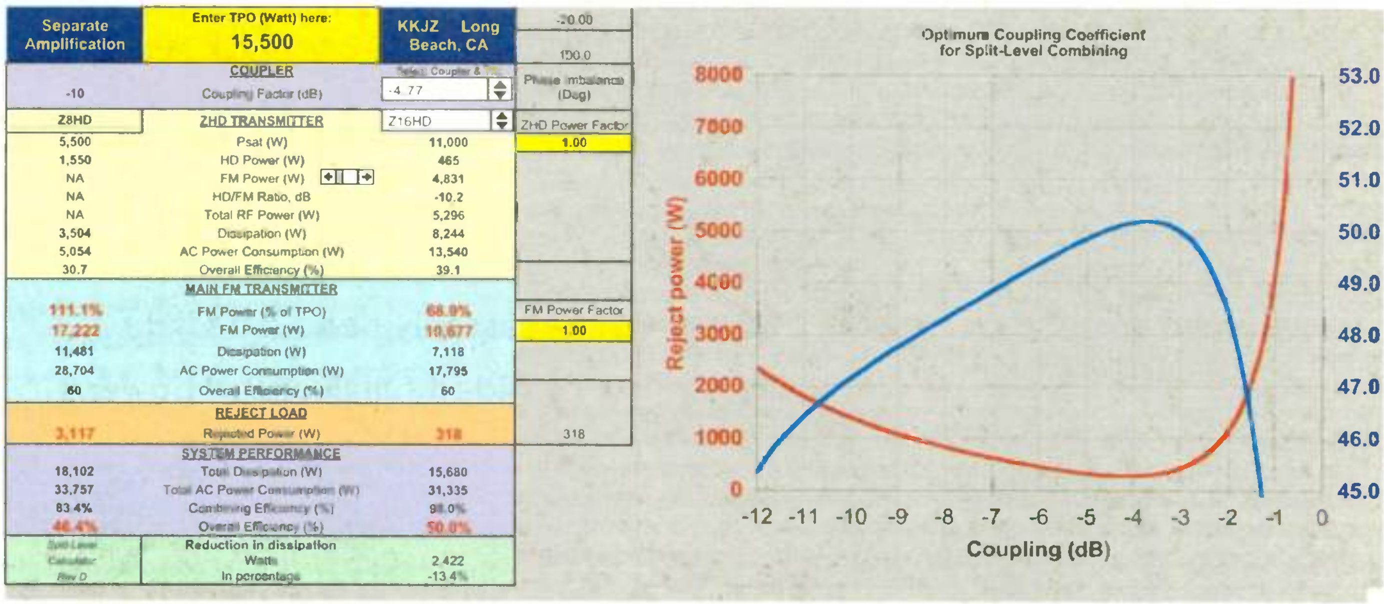

Fig. 2: Harris SLC Calculator. Graphic provided by Harris Corp.

For our installation at KKJZ, in order to meet project deadlines, we chose to go with a simple set-up for initial HD operation without a combiner bypass switching option. We ran the IBOC combiner output directly to our existing coaxial switch's primary input. The existing analog transmitter's output was routed directly to the IBOC analog input port. The combiner's "FM + HD" output was connected to our coaxial switch input port. In this configuration the entire FM + HD signal would normally be routed to the antenna or for test purposes could be routed to the existing 25 kW test load. The combiner's reject load output was connected to the reject load (with a Bird BPM1 wattmeter section inserted in-line for reasons to be explained shortly). Fig. 1 shows how the KKJZ coaxial switch was placed in the SLC circuit just after the IBOC combiner's output.

FAILURE MODE CALCULATIONS PLANNING

For this plan, we calculated the actual output powers achieved during failure (or planned maintenance) of either transmitter for KKJZ. The table in Fig. 4 illustrates the specific output powers achieved and how additional power is dissipated by the reject load during such episodes.

With the digital transmitter shut down, we can still achieve a TPO of 7 kW. This will be an FM-only signal, but allows KKJZ to remain on the air at about half its normal ERP. Shutdown of the analog transmitter drops the TPO at the combiner output to 1.89 kW. The remaining signal will be combined HD plus analog FM at a reduced power. At this time, we are satisfied that these power levels will keep a usable signal available for our listeners during planned or unplanned outages of one transmitter or the other.

Loss of the analog transmitter, of course, changes the ratio of the HD spectrum mask as the amplitude of the RF analog signal would consequently be reduced. This can be resolved with the application of a closure to an externally routed control circuit available on the Dexstar that drops its RF output by 10 dB. The result is an HD-plus-analog spectrum mask that is returned to the Ibiquity-prescribed 20 dB analog-to-HD carrier ratio. This prevents the digital carriers from causing undue interference to the station's temporarily reduced analog signal amplitude.

As in other HD conversions, an RF wattmeter designed for digital operation should be purchased. We used a Bird Electronics BPM-3 in-line wattmeter to read combined HD-plus-FM total power between the IBOC combiner's antenna output port and FM antenna transmission line. With SLC set-ups, a second BPM in-line meter is required for insertion between the IBOC-combiner reject-load output port and the reject load. This additional meter provides a clear indication of how much power is being dissipated by the reject load. A proper phase relationship between the two transmitters will be indicated by the lowest achievable reject-load power reading.

We placed each in-line meter's associated display panel (1 RU each) at the top two rack-unit openings in a convenient location near the top of the exciter rack. SLC opera-

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Heat & Energy Analysis
KKJZ - 11.5 kW Combined TPO
w/6 ton Closed Ventilation System

High Level Combined

Heat Generating Equipment Make/Model	AC Power Consumption	RF output	Heat Dissipation in TX Room		Required Cooling Tons
	x	y	z=x-y	d=(3413)z	t=d/12000
	kW	kW	kW	BTU/hr	
Z8HD Transmitter	5.1	1.6	3.5	11,946	1.0
Analog FM Transmitter	28.7	17.2	11.5	39,250	3.3
10 kW Load Resistor			3.1	10,638	0.9
Totals	**33.8**		**18.1**	**61,833**	**5.2**

SLC

Heat Generating Equipment Make/Model	AC Power Consumption	RF output	Heat Dissipation in TX Room		Required Cooling Tons
	x	y	z=x-y	d=(3413)z	t=d/12000
	kW	kW	kW	BTU/hr	
Z16HD Transmitter	13.5	5.3	8.2	28,137	2.3
Analog FM Transmitter	17.8	10.7	7.1	24,294	2.0
5 kW Load Resistor			0.3	1,085	0.1
Totals	**31.3**		**15.7**	**53,516**	**4.5**

Fig. 3: Heat and Energy Load Study

KKJZ

CONTINUED FROM PAGE 10

equipment be handled by a Harris field service technician. Field service sets the initial phasing of the transmitters for SLC operation and also performs a complete initial

KKJZ SLC TRANSMITTER FAILURE MODE POWER OUTPUTS - W/ KKJZ-FM. NO COMBINER BYPASS SWITCHING INSTALLED
- 4.77 dB Combiner

Condition	Remaining Signal	DAB Output	Analog Output	TPO @ Combiner Output	Reject Load	FM ERP
Nominal Operation	HD + FM	5.3 kW	10.7 kW	15.5 kW	0.318 kW	30 kW
DAB TX OFF	FM ONLY	0	10.7 kW	7.06 kW	3.31 kW	13.7 kW
FM TX OFF	HD + FM *	5.29 kW	0	1.89 kW	3.4 kW	3.7 kW

* HD Exciter RF output should be scaled back 10 dB to maintain proper spectrum mask
Rule of Thumb - 6 dB combiners yield a 1/4 and 3/4 split, -4.77 a 1/3 2/3 split, and - 3 dB is 1/2 and 1/2

Fig. 4: Failure Modes

tion and adjustment are aided by the monitoring of both the combined TPO and reject-load power conditions.

FINAL INSTALLATION AND OPERATION

Because the Harris SLC option is provided as an add-on package by the factory, an extra black box that Harris labels as an "IPD2 Precorrector" is installed within the Z16HD transmitter. It includes a combiner for marrying a sample of the FM analog signal to the HD signal at a low RF level and a phasing circuit to get the signal matched properly. Fig. 5 is a Harris factory diagram that shows how this is situated in the SLC layout.

The best phase match is found when the adjustment minimizes reject-load power as read by the Bird BPM display panel. Harris required that initial on-site setup of the checkout and confirmation of correct HD operation and compliance with the Ibiquity spectrum mask. Field service was also able to assist us with some final installation needs and final cutover to the new operation.

We are now operating the new SLC transmitter combination and are satisfied with the flexibility it provides. The ability to shut down the analog transmitter momentarily for occasional maintenance tasks while remaining on the air has been helpful. We are satisfied that we have chosen an efficient and cost-effective means of HD signal transmission. Thanks to the SLC solution, the KKJZ engineering staff is glad that our transmission facility is not overly crowded with equipment; and we are able to have many more worry-free weekends and evenings knowing that we now have inherent transmitter backup capability.

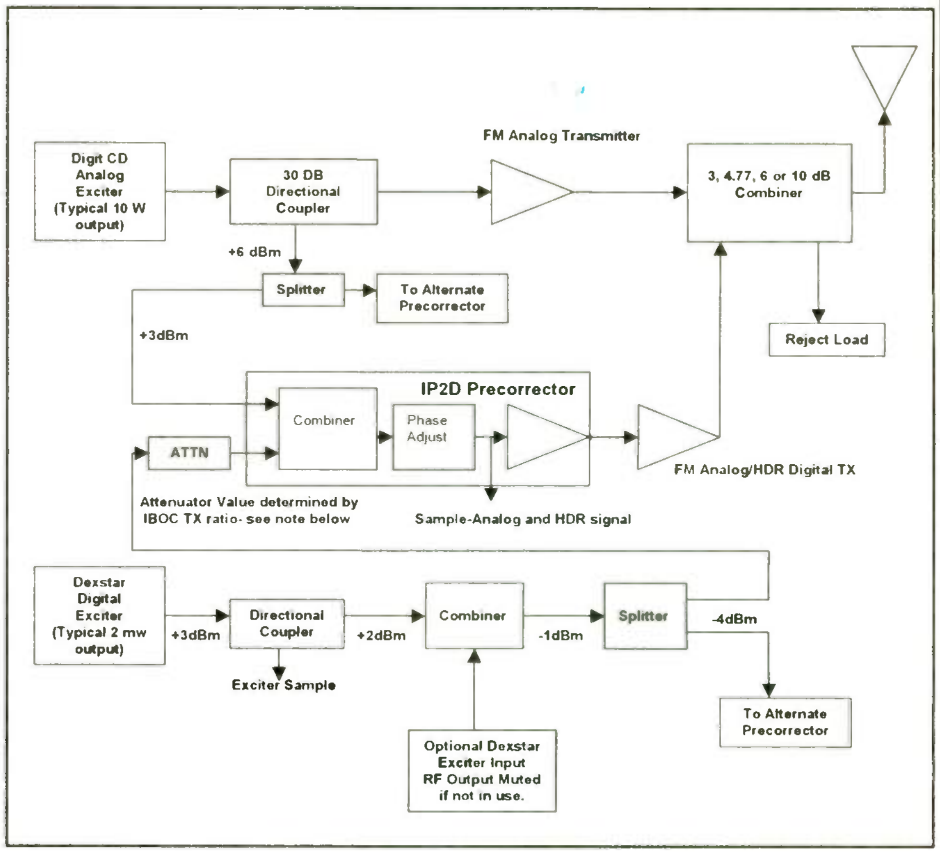


Fig. 5: Harris SLC Block Diagram

We have also been enjoying the characteristics and performance of the HD signal itself. KKJZ does not have a high-altitude antenna site, and the Los Angeles area is prone to many areas of multipath. Informal driving tests by KKJZ staff indicate good results with a useable HD signal in areas that have been intolerable with just an analog signal. The Harris SLC mode of operation is proving to be an efficient solution for operating KKJZ's newly improved analog and HD signals. We would have certainly spent more in equipment, space and operating expense without this solution. KKJZ is satisfied and pleased that as HD receivers become more common, our HD signal will be ready and waiting to be heard by our many dedicated listeners. ■

Case Study

Fixing “Bored Audio” Problems

Solution developed for numerous Logitek customers

THE ISSUES:

- Overnight satellite feed set to the wrong channel
- STL receiver not working correctly
- Other unattended equipment that goes to your air chain not feeding any audio

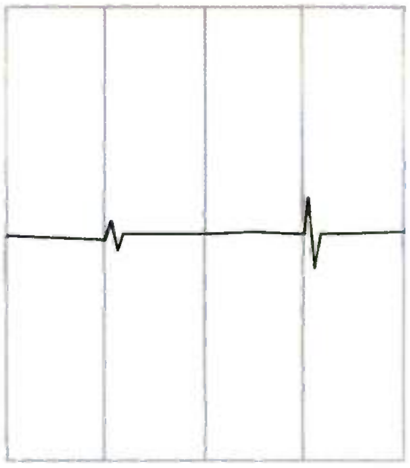
What do you do when you don’t have correct program audio going to your transmission chain, but your silence sensor thinks you’re OK?

For example, you are supposed to broadcast a satellite program overnight, but somehow the receiver has the wrong channel selected. Instead of an audio feed, you get a steady tone.

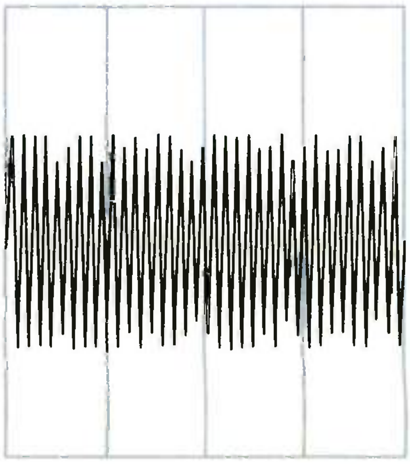
Or, what if your STL receiver is somehow damaged by a storm? It loses the carrier but isn’t squelching the audio, which results in static being fed to the rest of the transmission chain.

We call these problems “Bored Audio”...a nice, steady feed of noise or a constant tone.

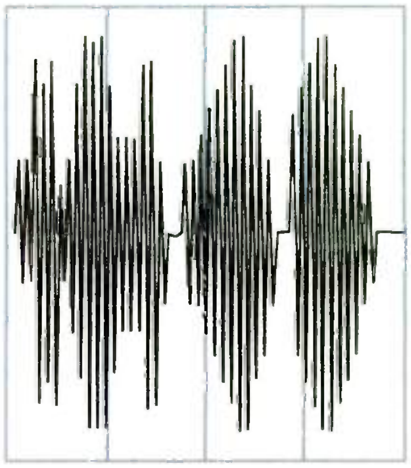
Your silence sensor, which is set for complete drop-outs of audio, doesn’t trigger on Bored Audio.



Silence: *No audio. Your silence sensor can detect this.*



Bored Audio: *White noise, or a steady tone. Your silence sensor is happy, but your listeners (and GM) aren’t.*



Normal Audio: *What you want on-air...Logitek can help restore it in a hurry.*

THE LOGITEK SOLUTION:

Logitek’s SharcAttack DSP card, a useful option for the Audio Engine router, provides both high and low audio alarms. The two can be merged to send out an alert when neither has been activated for a predetermined time period. Since program audio has dynamics which can be easily monitored by the SharcAttack, the Logitek system can tell quickly if you are transmitting Bored Audio and trigger your emergency backup sequence or transmission chain.

With Logitek, you can fix Bored Audio before you lose Bored Listeners (or even better, before the GM calls you in the middle of the night!)

Do you have an interesting application or challenge that was resolved using Logitek equipment? We’d love to hear from you.

For more information on this and other Logitek case studies, visit www.logitekaudio.com

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Logitek

So What's the Big Deal About aacPlus?

SBR Technology and How It Makes aacPlus a Major Advance

By Rolf Taylor

The author is applications engineer for Telos Systems.

In the broadcasting world, aacPlus, otherwise known as AAC plus Spectral Band Replication, or AAC + SBR, has been in the news for a few years now.

Not only is it being used as non-proprietary coding algorithm for transmission over POTS by a major codec manufacturer, but it is also the codec chosen for use by XM Radio for their DARS system, and the new Digital Radio Mondiale (DRM) international standard for short-/medium-wave transmission. The mp3PRO file format, which is MP3 plus SBR, has become popular as an audio-sharing file format, for many of the same reasons, and is now included in many consumer-oriented software programs, such as MusicMatch Jukebox.

To best understand what makes SBR such a major advance in coding efficiency requires that one understand how previous bit-rate reduction techniques work. And to understand how bit-rate reduction works, it helps to recall how audio is digitized.

I. AUDIO CODING BASICS

Digitization

When audio is digitized, the amount of data produced is a function of the sampling rate and the sample word size.

For example, most pro-audio systems use a sampling rate of 48 thousand samples

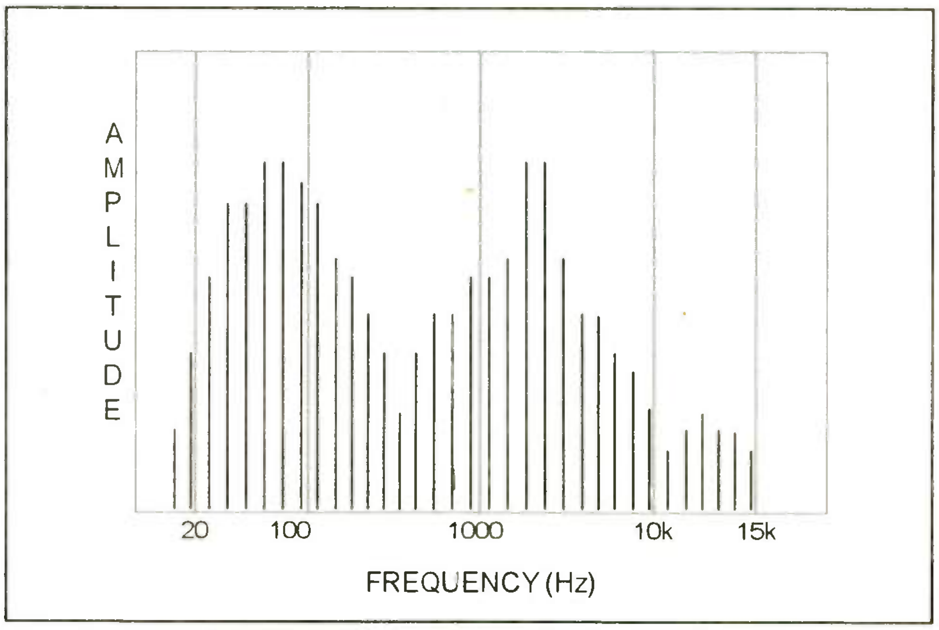

Fig. 1: To transmit the above 15 kHz audio would require a sampling rate of 32 kHz. The raw data rate (mono) would be 32 k samples per second x 16 bits per sample = 512 k bits per second. If the target bit rate were 21.6 k bits per second, this would require a 24:1 compression ratio (512/24). Even the best codec (AAC) would sound bad at such a high ratio.

per second (usually represented as 48 kHz), which means that each second the incoming audio is sampled (or measured) 48 thousand times. To look at this another way, every 21 micro-seconds a sample is taken.

Naturally, doubling the sample rate will double the amount of resulting data. The Nyquist Theorem states that the highest, reproducible audio frequency will be at one-half the sampling rate; thus a 48 kHz system can (in theory) reproduce audio frequencies up to 24 kHz.

The other factor that determines the raw data rate produced by digitization is the precision of measurement of the samples. This is sometimes called "resolution," "bit depth" or "word size." Typical resolutions are 16 or 24 bits per sample. Increased resolution causes a reduced noise floor, at the cost of increased raw data. The 16 bits/sample yields a signal to noise ratio in the 90 dB range, suitable for distribution but not always for production. Hence, 24-bit resolution is common in pro-audio applications.

The amount of data generated by digitizing audio is generally specified in "bits per second" or, since the numbers tend to be rather big, as "kilobits per second" (kbps). This number is the "bit rate." The bit rate can be calculated as follows:

Bit rate = sample rate x resolution x the number of audio channels

For example, the bit rate for Red Book CD audio is 44,100 samples per second x 16 bits per sample x 2 channels = 1,411,200 bits per second. This is generally described by the round number "1.4 megabits per second" (Mbps).

Computers measure memory in 8-bit bytes, so we can determine the actual storage requirements by dividing the bit rate by 8. Thus: 1,411,200 bits per second/8 bits per byte = 176,400 bytes per second.

Bit Rate Reduction Overview

With today's reasonably priced hard drives, it is common to see audio stored on computers in "linear" or "uncompressed" form. However, when audio is to be transported, the cost of the transmission channel can be a significant factor.

In our CD example above, it would require nearly a full T1 data circuit to transport a single stereo stream. Therefore, some form of "data reduction" can be desirable.

The most basic form of bit savings is by carefully evaluating the factors discussed above. While 24-bit resolution is desirable when recording live tracks for later production, it may well be possible to use fewer bits later in the production chain. Reducing the sample rate (and therefore the audio frequency response) can also be a way to reduce the bit rate with only minor decreases in fidelity.

Resolution is rarely reduced below 16 bits. However, it is common to run across audio material with a sampling rate of 44.1 kHz, 32 kHz or even 24 kHz.

For example, a sampling rate of 24 kHz will yield an audio frequency response of better than 10 kHz with a 50 percent savings in bit rate vs. the 48 kHz sampling rate (384 kbps vs. 768 kbps/channel). This still yields a very good user experience and saves on transmission cost.

Even when advanced bit-rate reduction rates are used, the sampling rate and resolution are worth taking into consideration — the more data you begin with, the harder the job will be to get it to a given target bit rate.

AACPLUS, PAGE 18

JUST ENOUGH TEST

Is your bulky bench analyzer more test than you use and more weight than you want?

Sophisticated Minstruments from NTI give you just enough test capability, plus functions not even available on their larger siblings... and these flexible instruments fit in the palm of your hand

ML1 Minilyzer
Analog Audio Analyzer

The ML1 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, but also VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external sweeps of frequency response generated by the MR1 or other external generator.

With the addition of the optional MiniSPL measurement microphone, the ML1 also functions as a Sound Pressure Level Meter and 1/3 octave room and system analyzer. Add the optional MiniLINK USB computer interface and Windows-based software and you may store measurements, including sweeps, on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

- Measure Level, Frequency, Polarity
- THD+N and individual harmonic measurements k2→k5
- VU + PPM meter/monitor
- 1/3 octave spectrum analyzer
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

DL1 Digilyzer
Digital Audio Analyzer

With all the power and digital audio measurement functions of more expensive instruments, the DL1 analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as the embedded audio. In addition, the DL1 functions as a smart monitor and 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 are on an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a sophisticated 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

NEW! AL1 Acoustilyzer
Acoustics & Intelligibility analyzer

The AL1 Acoustilyzer is the newest member of the Minstruments family, featuring extensive acoustical measurement capabilities as well as core 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)
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- THD+N, RMS Level, Polarity

MR1 Minirator
Analog Audio Generator

The MR1 Minirator is the popular behind-the-scenes star of hundreds of live performances, remotes and broadcast feeds. The pocket-sized analog generator includes a comprehensive set of audio test signals, including sweep and polarity signals which work in conjunction with the ML1 Minilyzer.

- Sine and square waves
- Pink & white noise
- Polarity test signal
- Stepped sweep for response plots
- Balanced and unbalanced outputs

MiniSPL
Measurement Microphone

The precision MiniSPL measurement microphone (required for the AL1 Acoustilyzer and optional for the ML1 Minilyzer) is a precision reference mic for acoustics measurements, allowing dBSPL, spectrum and other acoustical measurements to be made directly.

- 1/2" precision measurement microphone
- Self powered with automatic on/off
- Omni-directional reference microphone for acoustical measurements
- Required for the Acoustilyzer; optional for the Minilyzer

MiniLink USB interface
and PC software

Add the MiniLINK USB interface and Windows software to any ML1 or DL1 analyzer to add both display and storage of measurement results to the PC and control from the PC. Individual measurements and sweeps are captured and stored on the instrument and may be uploaded to the PC. When connected to the PC the analyzer is powered via the USB interface to conserve battery power. Another feature of MiniLINK is instant online firmware updates and feature additions from the NTI web site via the USB interface and your internet-connected PC.

- USB interface fits any ML1 or DL1
- Powers analyzer via USB when connected
- Enables data storage in analyzer for later upload to PC
- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard

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"IP-Audio in New York City? Not on my station."

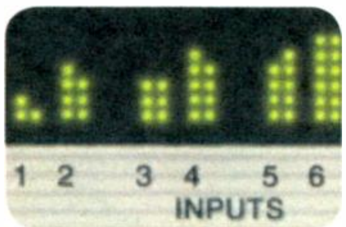
"Buckley Radio decided to move WOR to a new location, leaving behind studios we'd called home for over 50 years.

"My staff and I had spent months carefully planning new facilities, and we were more than halfway through preparations — then, the rug got pulled from under us.

"Quotes to build new studios were astronomical! I had to cut our equipment budget *in half.*

And the huge amount of syndicated, network and local programming WOR produces *demanded* digital audio routing and consoles.

"I'd heard that the Axia IP-Audio system could give us the high-end features we needed. And they said our budget wasn't a problem; Axia costs less because they use standard Ethernet for audio routing instead of expensive proprietary mainframes.



"Using Ethernet for Audio was certainly new and different, and I had some concerns. But moving from cart to PC was a big change, too — and for the better. In our industry, change is natural.

"The more I learned about Axia, the more impressed I became with their routing switcher and consoles, and how well their network topology was designed. I began thinking that this Ethernet stuff might just work!

"So I decided to break new ground and order the Axia consoles and routing setup, nine studios worth. It's been on the air half a year now, and we love it. Our operators keep raving about how easy things are to operate. Even our listeners tell us how good WOR sounds.

"And from the day the Axia surfaces, engines and IP-Audio nodes were hooked up, we've had zero downtime. Zilch. Zip. Nada. Axia works — end of story."

— Thomas R. Ray III, CPBE, Vice President / Corporate Director of Engineering, Buckley Radio

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Conserves AU.

HD Multicast HD Surround conventional stereo — Element handles them all. Upgrade your studios with confidence; you re ready for anything

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Technology can save you money.

Consider: computers, VoIP phone systems and bandwidth cost less and deliver more every year. Wouldn't it be great if broadcast gear did, too? Thanks to Axia, it can.

Axia saves you money by using open Ethernet technology to replace expensive proprietary mainframe routers. Not only is Ethernet less expensive, it's simpler and more reliable — perfect for critical 24/7 operations. The Axia IP-Audio solution eliminates sound cards, DAs, punch blocks and cumbersome cables, so it reduces installation and maintenance costs.

And now, Axia has a cool new modular control surface: Element. Scalable from four to forty faders, you can build the ideal surface for every studio. Element's abundant outputs and flexible architecture can be switched between stereo and surround mixing. Its info-rich user display, built-in router control, and integrated phone and codec support simplify the most complex shows. You'll never outgrow it.

Like all Axia products, Element does more and costs about half what others try to charge for their *"Trust us, this is better than Ethernet, would we lie to you?"* stuff.

Element. Worth its weight in... well, you know.

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CONTINUED FROM PAGE 14

True Lossless Coding — Entropy Reduction

Most types of computer data files have considerable redundancy contained within them, and there are a number of redundancy reduction algorithms available to remove redundancy, and therefore, reduce file size. The classic examples are computer programs such as Stuffit, Winzip and PK-Zip.

For example, most English-language text has significantly more instances of the letter "e" vs. other letters. Graphical material often has large areas with swaths of a background color. Later, the file is restored to its original form by using a complementary process.

Such systems exploit the redundancies present to reduce the file size. For example, a system that allows variable symbol sizes could use a small symbol for the letter "e" and a larger symbol size for the letter "z". Or in the graphical example it may be more efficient to describe the boundaries and the color of certain areas versus describing each identical pixel.

Entropy reduction techniques have the distinct advantage of giving you back the identical source data after decoding. Unfortunately, typical audio material has considerably less redundancy than most graphics or text files. Consequently, entropy reduction techniques offer only a small degree of bit-rate reduction, typically less than 2:1.

It is noteworthy that sine waves are not typical in this regard, and can be efficiently encoded using this technique since only the frequency, magnitude and duration need to be encoded. Entropy reduction techniques, therefore, do offer some value. A number of perceptual coding algorithms also employ them to enhance performance. In fact, the two techniques complement each other well.

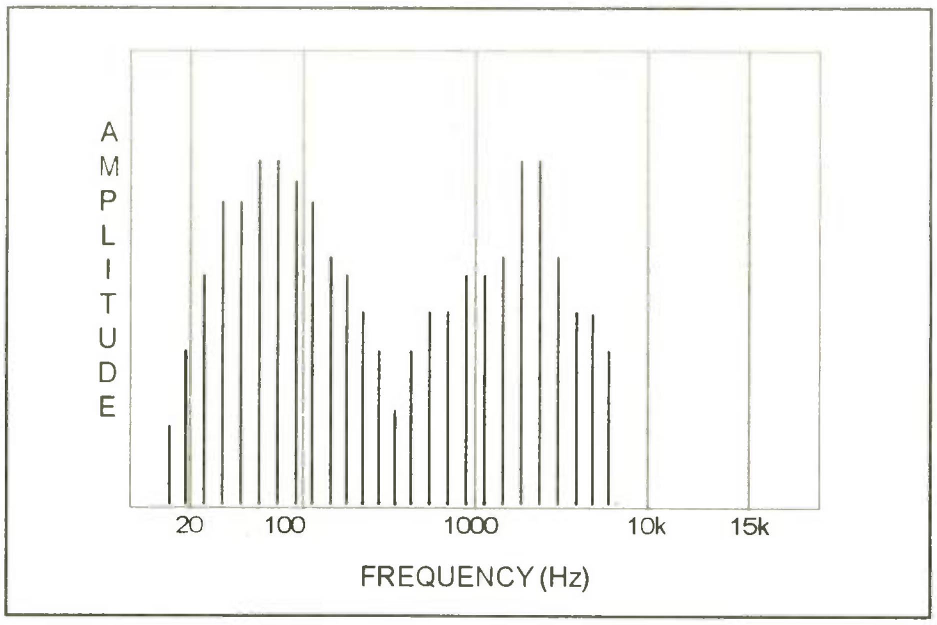

Fig. 2: To transmit the 7 kHz audio shown above only requires a sample rate of 16 kHz. If the target bit rate were 21.6 kbits per second, the compression ratio would be 12:1.

ADPCM Coding

The nature of most audio is that the absolute difference in value between consecutive samples tends to be smaller than the average value of the samples themselves. Adaptive Delta Pulse Code Modulation operates by encoding only the difference (the "Delta") between samples.

To maximize the compression ratio a variable step size is used to encode these sample-to-sample values. A "predictor" algorithm is used to estimate the next value and then determine the step size (e.g. during highly dynamic passages a courser step size is used). Often, a multi-band approach is used. The most common ADPCM algorithms are the international standard G.722 (offering 7 kHz frequency response) and the proprietary apt-X family of algorithms.

ADPCM methods offer a modest 4:1 compression ratio. An advantage is that coding delay is quite low, typically less than 10 msec. High error resilience and good performance with multiple passes of the same algorithm are additional features. Unlike entropy reduction schemes, ADPCM does not offer bit-for-bit transparency through the system.

While these systems do not intentionally discard audio data, they do lose information since they introduce a degree of randomness to the sample values. The output of such a system is not identical to what goes in, but is numerically close. Because information is lost, it is considered "lossy," as opposed to the entropy reduction systems, which are described as "lossless."

The result of the ADPCM process is analogous to a reduction in resolution, but the change is nonconstant sample-to-sample. A visual analogy would be blurring, with some parts of an image blurred more than others. Indeed, when pushed too hard, ADPCM's artifacts are typically described as a "fuzzy" quality to the sound.

The biggest drawback of ADPCM systems is the fact that the typical 4:1 compression ratio limits their usefulness. For example, 384 kbps is required for a stereo 20 kHz feed.

Perceptual Coding

Perceptual coding presented a breakthrough in the quest to achieve high fidelity at ever-lower bit rates.

Experimental psychologists have known for years that there are many cases where the human perceptual system ignores auditory information presented to it. Scientists call this group of phenomenon "masking."

There is considerable debate as to whether this is due to basic "flaws" in the system, or due to an evolutionary value of screening out certain "unimportant" information to make the brain's job easier at processing the rest.

In any case, this aspect of our perceptual system allows a "loophole" that can be exploited by those seeking to design bit-rate reduction techniques. The perceptual coder must, in real time, determine what audio information will be inaudible to the listener and remove it from the encoded bit stream. Therefore, a core component of a perceptual coder is its "model" of the human perceptual system.

Perceptual codecs are "lossy" and multiple passes of these types of systems remove additional data on each pass. For this reason users should be aware, and should evaluate the final audio of such cascaded chains for audible artifacts.

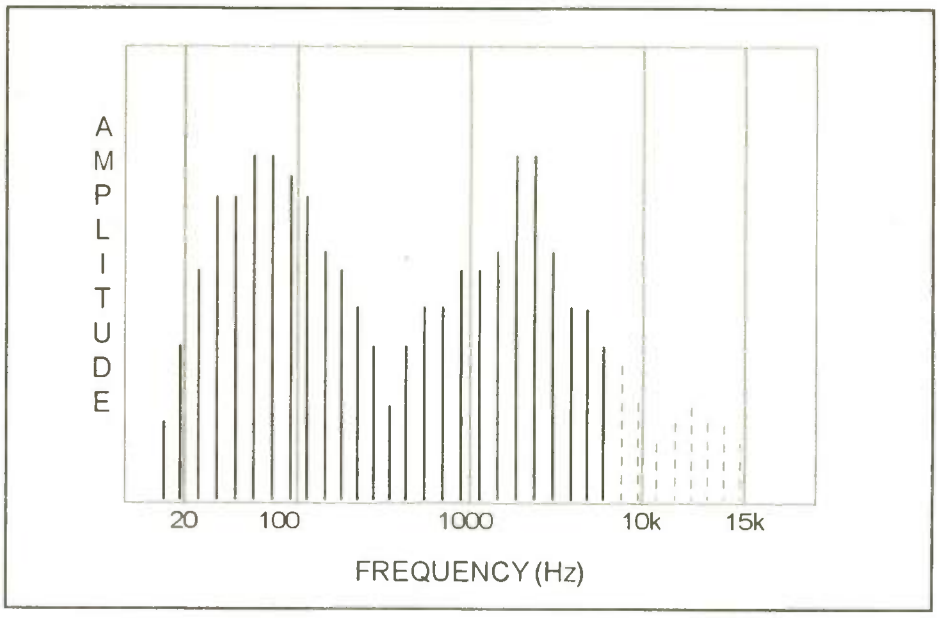

Fig. 3: The Combined Output of the Perceptual Coder and the SBR Process. All material above 7 kHz is generated via Spectral Band Replication.

In addition, various techniques to exploit the redundancy in typical stereo material can achieve improved fidelity of stereo source material at a given compression ratio. (See the references for more on the subject of perceptual coding.)

Remarkably, the sophisticated algorithms designed to do this can easily achieve very high fidelity at compression ratios of 10:1, leaving only 10 percent of the original audio information intact. Without this technology, cost-effective audio transmission over ISDN, digital radio and audio streaming over the Internet would be impossible.

The latest perceptual coders, such as MPEG Advanced Audio Coding (AAC), also known as "MP4," can achieve at 128 kbps (stereo) quality rated as "indistinguishable"

AACPLUS, PAGE 20

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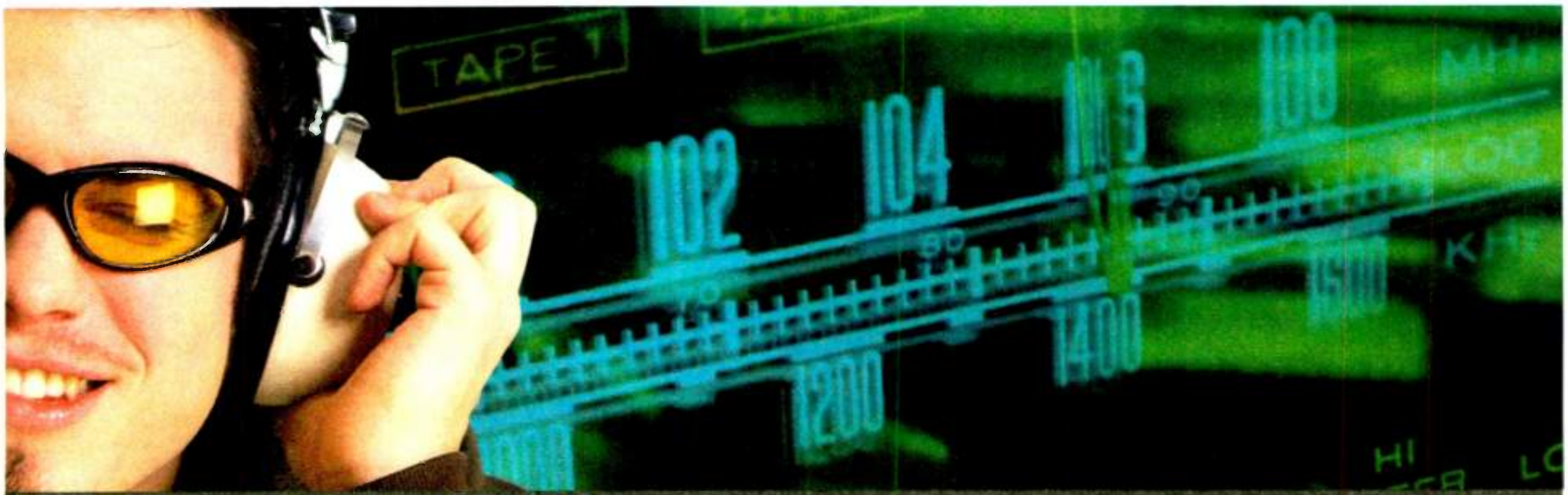

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CONTINUED FROM PAGE 18

using the International Telecommunications Union (ITU) standard testing procedures. Moreover, "near-CD" quality can be achieved at compression ratios as high as 16:1!

II. SPECTRAL BAND REPLICATION

Spectral Band Replication, or "SBR," is the most recent tool available in the bit-rate reduction arena. This technique, developed by Coding Technologies, works together with a perceptual coder to improve performance by 30 percent. Therefore, SBR technology will always be seen in the context of another coding scheme. For example, "mp3PRO" is MPEG Layer 3 with the SBR enhancement added, and "aacPlus" is Coding Technologies' trademark for its implementation of MPEG AAC (MP4) with SBR added.

As discussed above, a reduction by half in the sampling rate will reduce the compression ratio by half as well. For example, changing from a 48 kHz sample rate to a 24 kHz sample rate will generate half the amount of raw data, thereby achieving a given target bit rate with half the compression ratio. The problem with this approach, of course, is that you'll have a frequency response of 12 kHz at best due to the Nyquist limit. See Figs. 1 and 2.

Next let's look at the bit savings incurred if we only need to transmit the audio spectrum below 7 kHz.

To transmit 10 kHz audio only requires a sample rate of 16 kHz. The raw data rate (mono) would be 16 k samples per second x 16 bits per sample = 256 kbps. With a target bit rate of 21.6 kbps, the compression ratio would be 12:1 (256/21.6). At this reduced compression ratio, even Layer 3 could yield good results and AAC will yield excellent performance.

SBR restores the missing high-frequency material using its replication process, and therefore full 15 KHz bandwidth can be achieved in our examples. The final audio spectrum is a combination of the output of the perceptual coder and the SBR process as shown in Fig. 3.

Of course the actual compression ratio of the AAC + SBR combination is over 20:1, a high ratio unobtainable by any other means.

This process is akin to the old "high-frequency enhancers" made by Aphex and BBE, and like them generates harmonics of mid-frequency material. However, the addition of sophisticated digital algorithms, and a small amount of guidance data allows for remarkably accurate reconstruction of both harmonic and "noise-like" high-frequency materials.

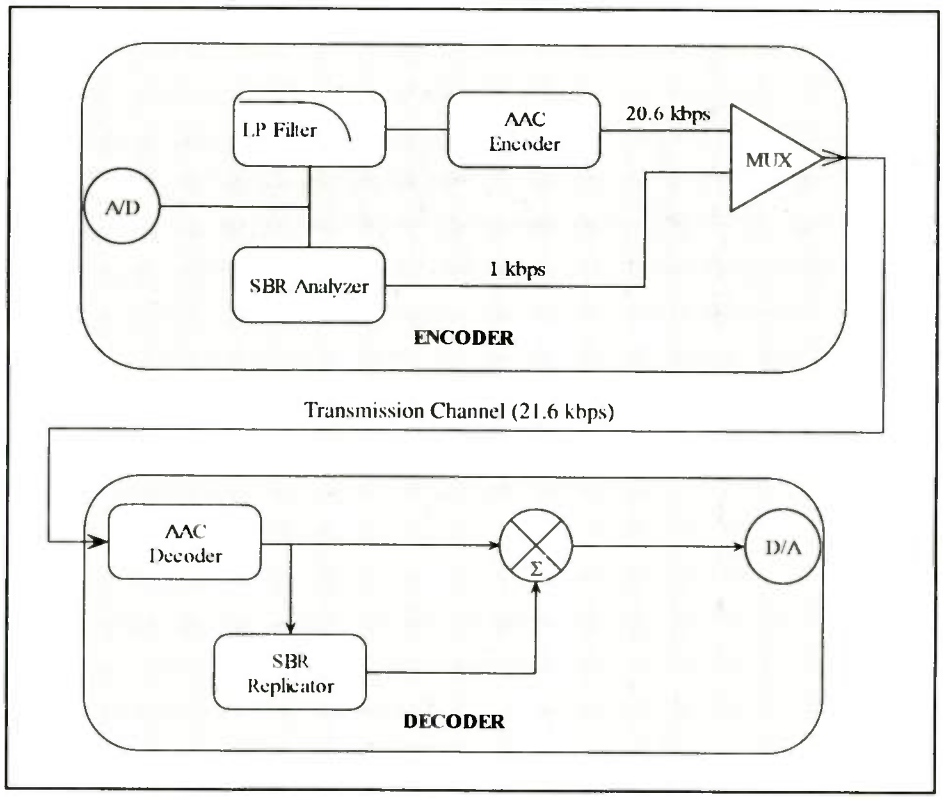

Fig. 4: The aacPlus System. Note that while a discrete multiplexer (MUX) is shown as part of the encoder, the usual practice is to embed the guidance data into the ancillary data stream of the AAC encoder to achieve backwards compatibility.

The guidance data is generated by the SBR analyzer in the encoder, and is the result of analysis of level vs. frequency snapshots (e.g. spectrograms) of the audio material across time. The most important information is a "spectral envelope" representation. This records the presence or absence of energy at various cells of a level vs. frequency grid. The size and distribution of the cells is dynamically adjusted, so that more precision is available in the areas with the most sonic energy — this is similar to how the variable step size works in the ADPCM technique, or variable symbol sizes in entropy reduction systems. This permits the SBR replicator to generate sinusoids that adjust the harmonically generated material.

The other major area analyzed is the degree of "tonality" vs. "noisiness." Repetitive energy in the spectrogram implies "tonality," whereas random energy implies "noisiness." This "tonal-to-noise ratio" permits the decoder to increase the tonal component (inverse filtering), or add noise, to better replicate the original material.

One decided advantage of Spectral Band Replication is that it easily offers backwards compatibility with the core coder, albeit with reduced audio bandwidth. This is accomplished by embedding the guidance data into the ancillary data mechanism of the host encoder bit stream, thereby maintaining the standard data-framing format. Non-SBR decoders simply ignore this ancillary data, and decode the lower-frequency portion of the audio encoded by the core codec.

aacPlus (AAC + SBR)

The combination of MPEG AAC (sometimes referred to as "MP4") and SBR is referred to by the trademark aacPlus. The MPEG-4 standard refers to this combination as "High Efficiency AAC" (HE AAC). aacPlus is used in the Telos Xport POTS terminal and by XM Satellite Radio, and has been chosen by the DRM Consortium for terrestrial broadcasting at 30 MHz and below.

In tests performed by the DRM consortium, aacPlus at 24 kbps out-performed AAC at 32 kbps. Similar results were found by tests performed by the European Broadcast Union.

Let's use a 15 kHz POTS codec operating at 21.6 kbps as an example to demonstrate how this works.

The AAC encoder is operated at a 16 kHz sample rate, configured for operation at a bandwidth of 7 kHz. The AAC is therefore operating at a compression ratio of 12:1, well within its normal operating abilities, yielding high-quality 7 kHz audio at the decoder. The SBR analyzer also generates a small amount of guidance data, typically about 1 kbps.

At the decoder the AAC decoder works in the usual fashion. SBR then takes the decoded 7 kHz audio, plus the guidance data, and "replicates" the audio from 7 to 15 kHz. The process is shown in Fig. 4.

CONCLUSIONS

Spectral Band Replication can improve the coding efficiency of virtually any coding algorithm, reducing required bit rates by 30 percent. Its ability to produce clean high-frequency material is particularly complementary to perceptual encoders, which tend to have high-frequency artifacts present when operated at higher compression ratios. The development of this technology promises to drive a new level of applications based on its significantly improved coding efficiency.

REFERENCES

"CT-aacPlus — A state-of-the-art audio coding scheme." M Dietz & S. Melzer, Coding Technologies; EBU Technical Review, July 2002:
www.ebu.ch/trev_291-dietz.pdf

"A closer look into MPEG-4 High Efficiency AAC," M. Wolters, K. Kjörling, D. Homm & H Purnhagen; Audio Engineering Society, Paper presented at the 115th Convention, October 2003, New York:
www.telos-systems.com/techtalk/hosted/HE-AAC.pdf

"On Beer and Audio Coding: Why Something Called AAC Is Cooler Than a Pilsner, And How It Got to Be That Way," Steve Church, Telos Systems:
www.telos-systems.com/techtalk/aacpaper_2/default.htm

"Audio & Multimedia MPEG-2 AAC." Fraunhofer Institute:
www.iis.fraunhofer.de/amm/techinf/aac/

"Facts About MPEG Compression," Telos Systems:
www.telossystems.com/techtalk/mpeg/default.htm

"Facts About MPEG AAC," Telos Systems:
www.telossystems.com/?/techtalk/aac/default.htm

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VAD-2

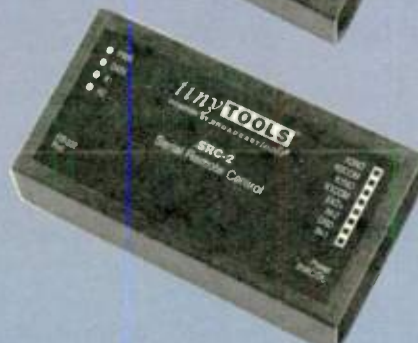
The tiny TOOLS VAD-2 is a user programmable two-input multi-number voice/pager auto dialer with integrated stereo silence sensor, designed for dial out paging and/or voice message notification. The VAD-2 is equipped with two dry contact inputs and stereo silence sensor, which, when tripped, will sequentially dial a pager and/or up to four different phone numbers and play back a user recorded message corresponding to the tripped input. The VAD-2 also provides two SPST one amp relays for the control of external equipment.

WRC-4

The tiny TOOLS WRC-4 is a fresh approach to remote site monitoring and control, or providing an inexpensive solution to Internet enabling your present remote control system. The WRC-4 combined with web access and your favorite web browser brings you the following features; A powerful built-in web-server with non-volatile memory; 10/100base-T Ethernet port; four each channels of 10-bit analog inputs with a large monitoring range; optically-isolated status (contact closures or external voltages) inputs; normally open dry contact relays; open collector outputs; front panel status indicators, a single front panel temperature sensor and 4-email alarm notification addresses. The WRC-4 is also SNMP enabled. The WRC-4 has carefully been RFI proofed, while including the accessories other manufacturers consider optional. The WRC-4 is supplied with removable screw terminals and loaded with a generic web page that may be easily edited by the end user.

Time Sync Plus

The tiny TOOLS Time Sync Plus provides four separate GPS time referenced outputs. The first is a SPST relay, which pulses at 12:00, 22:00, 42:00, 54:30 each hour and is user programmable in each of four locations for any minute and second each hour. The second output is an active high driver with a 100 ms pulse each second, while the third output is a 4800-baud, RS-232 serial port providing a time zone adjustable hours, minute and seconds time code. The forth output provides an active high driver in the ESE TC-90 serial time code format. Indicator LED's are provided to display power/valid GPS data, programming mode and time sync relay operation. A Garmin 12 Channel GPS receiver with embedded antenna is suppled.



SRC-2/SRC-2x

The tiny TOOLS SRC-2 interfaces two optically isolated inputs and two SPST relays to a RS-232 or USB port, while the SRC-2x does this via a 10/100baseT Ethernet port. Both the SRC-2 and SRC-2x can notify a user's PC software program that any of two optically isolated inputs have been opened or closed and allows your software to control two SPST, 1-amp relays. The SRC-2x is also able to send an email when either of the two inputs change state. The user may also add up to 48 ASCII strings per input and 16 user defined strings per relay. Communication with the SRC-2(x) is accomplished via short "burst" type ASCII commands from the user's PC. Also, two units may be operated in a standalone mode (master/slave mode) to form a "Relay extension cord," with two channels of control in each direction. The SRC-2 communicates using RS-232 at baud rates up to 9600 and the SRC-2x via 10/100baseT Ethernet. The SRC-2(x) is powered by a surge protected internal power supply. Either unit may be rack mounted on the optional RA-1 mounting shelf.

ESS-1

The ESS-1 provides a cost-effective, small profile solution for standard serial-to-Ethernet connectivity. Designed with the broadcaster in mind, the ESS-1 is equipped with extensive RFI protection. It is ideal for applications requiring data support for both RS-232 and RS-422 communications. The ESS-1 allows any device with a serial port, Ethernet connectivity and is ideal as a serial bridge/tunneling or applications where a COM port, TCP Socket, UDP Socket, or UDP Multicast functionality is needed. The small profile of the ESS-1 makes installation hassle-free.

AVR-8

The AVR-8 is a voice remote control system that automatically reports changes detected on any of its eight status inputs to a remote telephone and/or pager. After speaking a greeting message that may identify the source of the call, the AVR-8 then speaks a unique message for each status input. The user may customize each factory-recorded message. After reporting, the AVR-8 is ready to receive commands through your telephone keypad. Functions include telling the AVR-8 to report on the input state of any of the eight status inputs, commanding the AVR-8 to pulse any one of its four SPDT relays for 750 ms and/or turning any one of the relays on or off. When a relay command is given, the AVR-8 speaks the relay 'name' followed by the 'on' or 'off' message.

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AM IBOC Tries to Get Past the Noise

Will Interference Problems Derail AM's Digital Upgrade?

Guy Wire, Radio World's masked engineer, is the pseudonym of a well-known radio veteran. Opinions are his own.

As we contemplate what's going to happen to the venerable AM broadcast band during the transition into hybrid IBOC operations, a myriad of unanswered questions remain.

We've seen FM IBOC adoption and implementation accelerate nicely, in spite of the delayed rollout of receivers.

Multicasting with SPS has suddenly ignited a new level of excitement throughout the industry. FM IBOC now has a real "killer app" to counter the increasing competition from satellite, iPods and wireless streaming devices.

Sadly, AM has no such weapon in its digital arsenal.

GREAT PROMISE, GREAT PROBLEMS

While AM IBOC still holds great promise for its ability to deliver dramatic improvement over its analog host with 15 kHz stereo reception, it only appears to be able to do that reliably inside the protected primary and NIF coverage contours. Even then there are problems with analog degradation on various models of existing receivers.

A number of stations are finding it difficult to suppress the "bacon-frying" noise produced in all analog receivers because of nonlinear performing transmission chains, including the null regions of many directional antennas. The necessity of having to rebuild antenna systems will place an expensive burden on numerous stations, many of which are the least able to afford it.

Using IBOC at night undoubtedly will unleash an ugly Pandora's Box of trouble for many stations. The Canadian government has formally objected to U.S. stations operating IBOC at night, fearing significant interference to Canadian stations operating on adjacent channels. Neither the NAB nor the FCC had yet to comment on this objection at this writing.

We've suggested that for AM IBOC to have a better chance at succeeding, especially at night, the band needs to be thinned out.

Our proposal could offer an equitable way of reducing the number of AM stations by half and would certainly help reduce overall congestion and interference issues significantly. But even if they were to be adopted, the problem of adjacent-channel interference at night for many surviving stations would remain real.

Most AM station owners understand the risks of investing in the Ibiquity standard and are postponing plans to add IBOC until more of the lingering questions receive answers.

According to one resource as of this writing, there are 77 stations on the air with daytime AM IBOC. At least five Class A 50 kW blowtorches and a few other stations have turned it off, mostly because of interference caused to their own analog listeners or to their adjacent-channel neighbors.

Curiously, only 26 of the 77 stations feature music formats that would benefit the most by using IBOC digital while the rest are all news, talk or sports. The research for this is available online at: *http://topazdesigns.com/iboc/station-list.html*. The information contained in this list appears to be valid and is, of course, constantly changing for a variety of reasons.

ROOM FOR IMPROVEMENT

I've been a fan and supporter of the evolution of digital radio and the extraordinary effort of all of those who have helped develop the standard that now awaits adoption at the FCC, all the way from Project Acorn through the contributions of USADR, DRE, Lucent and Ibiquity.

I was an early supporter of IBOC for both AM and FM, but after carefully reflecting on how the AM rollout has faltered I am now convinced the proposed standard for AM during the hybrid transition period is not the best it could be. I am joined by many other engineers who see the possibility of a colossal train wreck coming, when and if AM IBOC is opened up for full-time operations by all stations.

Ibiquity has held firm to its original modulation design scheme for AM IBOC and has pushed it through on the back of the FM system. Receiver and chip-set manufacturers have largely committed to it as the only solution available to propel U.S. terrestrial broadcasting into the future.

But there has always been one fundamental problem with AM IBOC. The digital sidebands produce high levels of analog noise interference on both first-adjacent channels, resulting in degraded and even destroyed reception of the secondary coverage contours of many stations. Several studies indicate that 5 to 10 percent of all stations may experience this interference inside their protected primary contours.

Ibiquity has suggested that the laws of physics prevent any real resolution to this problem, and AM stations will essentially have to forget about their secondary and skywave service areas and accept the notion they are not important. Only the primary contour matters and will continue to be protected.

That's been a hard pill for many AM owners and operators to swallow as they hunker down for the hybrid period with no definite end point for transition to a complete digital system.

Listeners who lose the ability to hear a desired and dependable radio service they've enjoyed for a long time could care less where a protected contour ends or begins. It will simply eliminate one of their favored choices and further diminish the size of AM radio's already dwindling audience.

Why would we want to accept such a self-inflicted wound when it could be ameliorated by using better technology?

DRM TO THE RESCUE?

Other technology options that could make the digital transition easier are available.

Some involve smarter processing and filtering using DSP at the receiver end. On the transmission side, Digital Radio Mondiale offers some compelling options. DRM and the Ibiquity OFDM modulation structures are similar in many ways. Even though it does not showcase or promote its hybrid option that includes the existing analog component, DRM offers the advantages of a more flexible and scalable digital architecture.

The design is an existing world standard for digital transmission under 30

GUY WIRE, PAGE 23

MHz. It is open and nonproprietary. Many parameters are dynamically adjustable on the fly including guard intervals and error correction. Channel bandwidths are adaptable as propagation conditions change, which offers a huge benefit for skywave listening. Most important, the DRM single sideband option could mean dramatically reduced interference for many first-adjacent stations at night.

Take the most notable and often used example of three Class A stations: WLW 700 in Cincinnati, WOR 710 in NYC and WGN 720 in Chicago. All three are 50 kW powerhouses that enjoy extensive secondary contour as well as skywave coverage and audience. Large areas of that will be lost in both analog and digital reception when all three light up IBOC at night.

But with DRM SSB, WLW could switch to LSB at night, while both WOR and WGN switch to USB, thereby reducing significant amounts of destructive interference. This case involves protecting useful service in secondary contours.

There are other examples too numerous to mention where the appropriate use of DRM SSB could reduce nighttime interference to protected NIF primary contours for many key stations and their adjacent-channel neighbors. Obviously the entire inventory of AM stations would need to be studied carefully to reveal how well the DRM option could provide significant reclamation of lost coverage, but my hunch is that it may be impressive.

Assigning appropriate DRM sidebands to every station that chose to operate digital at night would be challenging but could be done on an equitable basis. The FCC would employ the established precedent of longevity on the channel as used in determining nighttime skywave protection limits.

PROTECTING THE FRANCHISE

Unfortunately Ibiquity seems to have ignored DRM, mostly because of internal politics and its insistence that the business model and the standard they have constructed remain unchanged. It would appear that it's just too unappealing to integrate other people's software into a closed and proprietary structure that is poised to become a long-term for-profit monopoly.

But such a bold move could very well produce a better system, even though it may delay finalizing standards and chip-set designs in the short term.

Ibiquity may be facing potential litigation at the hands of Microsoft and others for keeping its HDC codec under wraps and out of the proposed FCC IBOC digital standard. Clearly the interests of everyone except Ibiquity would be better served if codec specifications could be part of the standard and left open to enable others to contribute future improvements.

That discussion is best reserved for another time. As FM IBOC deployment continues to gather momentum, Ibiquity insists on playing hardball in the face of rising opposition to several key parts of its blueprint for the future of terrestrial radio. It's the sheer arrogance of Ibiquity that disappoints so many of us in the industry.

BACK TO THE FUTURE

If the commission chooses to adopt the Ibiquity IBOC standard for unlimited AM day and night operations as proposed, here is a worst-case scenario that might unfold: A messy outbreak of interference complaints will be filed by adjacent-channel stations that lose existing analog coverage as increasing numbers of stations deploy IBOC full-time. Many of the complaints will be dismissed on the basis that the interference occurs in unprotected coverage areas, which is understandable and expected.

In cases where the interference complaints are legitimate, the offending stations will be forced to reduce IBOC power. In many cases, they may have to reduce it to a level where it's not justified to operate it at all without leaving its listeners a poor impression of the new technology and the station's inability to use it effectively. Would such stations be content to operate IBOC only during the day, outside of critical hours and nights?

The overall result of this chaos could leave AM IBOC an under-achieving digital standard that only a minority of stations could use to full advantage. We could see the filing of lawsuits by stations that invested in the technology but were forced to stop using it.

To resolve such disputes with an easy way out, the commission might allow such stations to negotiate "buyoffs" for these complaints to be able to keep using IBOC full time. The station that received the interference may decide that a cash settlement is more valuable than the "lost coverage." The precedent of buying off your interference has already been, at least partially, established.

Many of the 5 to10 percent of stations that receive IBOC interference inside their

GUY WIRE, PAGE 24

"I am joined by many other engineers who see the possibility of a colossal train wreck coming."

CONTINUED FROM PAGE 23

protected contours may lose enough of their critical hours and nighttime coverage rendering operations during those times unprofitable and essentially useless.

Many of the rimshot stations that rely heavily on secondary coverage to serve their intended target audiences will probably be shut down by IBOC interference with no remedy whatsoever. Some may just throw up the white flag and be content to be daytimers or go out of business entirely. Others could get angry enough to pursue litigation.

END-GAME STRATEGIES

The ensuing malaise would cripple AM further until such time that a significant number of stations simply go away and turn in their licenses. That may provide enough relief for at least some of the survivors to be able to use IBOC at night.

This might just be the FCC's secret solution to curing congestion on the AM band. Eventually the commission would likely set a date for mandatory conversion by all remaining stations to full digital operations, leaving analog behind forever and marking a merciful end to the misery of the hybrid period.

Ibiquity would have you believe that such a worst-case scenario will never happen and that the hybrid conversion period will proceed with only a limited number of valid interference complaints. The affected stations will be able to negotiate mutually acceptable resolution with few complications or the need for many interfering stations to abandon IBOC operations completely at night.

With DRM SSB, WLW could switch to LSB at night, while both WOR and WGN switch to USB, thereby reducing significant amounts of destructive interference.

History will probably record the actual course of events occurring somewhere between these two extremes.

It's probably too late to hope or expect that Ibiquity might embrace the idea of changing its AM IBOC design to make it better. Or it may be too early, depending on your point of view. The introduction and eventual widespread use of smart radios that can receive software changes and upgrades seamlessly over the air will make future improvements so much easier.

It is entirely probable that this will happen during the hybrid period, making it more palatable for Ibiquity to consider and actually implement system modifications like DRM. Only time will reveal how the hybrid transition will fare.

RW welcomes other points of view. Comment on this or any story in Radio World Engineering Extra by writing to radioworld@imaspub.com. ■

Products & Services SHOWCASE

Reader's Forum

GUY WIRE AND THE GREAT AM DEBATE

IBOC is going to go the way of AM stereo anyway, so why let us go through the debacle that AM stereo was, even though it was a much better idea?

Clear Channel is just converting in increments; it will convert all their stations to IBOC when a receiver under 500 bucks becomes available (if one ever does).

It is a complete waste of time.


Guy Wire

The Great AM Debate

Guy Defends His Proposals to Thin the Population of a 'Herd Full of Cripples'

STATION NUMBERS ARE UNCHANGED

GUY WIRE

Why not use some of the band that is soon to be vacated right above the AM band for IBOC? The receivers are going to have to be new anyway. AM radio can sound great in wideband.

I have an IBOC station about 40 miles from me, WBZ 1030. It completely obliterates anything on either side during the day; and I have a very good selective receiver. I can't imagine what the AM band will be like if IBOC is ever switched on at night; 90 percent of the stations will have to vacate the airwaves.

> **My 1 kW regional signal on 910 is much more powerful than my small community … needs for good local coverage. I would gladly turn in my AM kilowatt license for a 100-watt FM mounted on my existing towers.**
>
> **— Larry Langford**

IBOC is not the answer; anything that forces all AM stations to reduce their bandwidth to 5 kHz is inherently flawed. Any system that causes interference 10 kHz and more on each side of the station itself is flawed and will not work. Ninety percent of AM is talk anyway, who the hell wants to hear windbag Limbaugh in digital?

Give us some wideband receivers with a selectivity switch, which would sound better than any digital IBOC radio ever could, and the stations would not have to change anything.

Bob Young
Millbury, Mass.

Another approach to Guy Wire's desire to clean up the AM band, a highly commendable ideal:

Let each of the big radio operators bid at auction for the right to begin accumulating all the AM stations on the same frequency. When this right is acquired, the operators can start trading, accumulating and purchasing signals on the same channel, for instance, all the stations on 1180. When the operators have stations on the same frequency, they create a nationwide audio service, with mostly the same audio on all stations, especially at night. Interference is no longer objectionable, because it's the same audio slightly out of phase. Night skywave fills gaps in local coverage.

After a period of time, perhaps four years, the big chains could implement their own engineering modifications, and raise their power/direction to whatever levels they want, with the prevsio that a) they don't interfere with other countries, and b) they don't generate an excessive amount of co-channel interference, unless they own that channel, too. The four-year provision gives incentive to small operators to sell out.

This would generate a lot of new ideas about how to use AM in creative and useful ways. It would give the chains something new to promote, and provide a boost for their stock prices. The consumers are the big winners. They would hear the same service — e.g., sports, business news — on the same frequency wherever they traveled in the U.S., also a big draw and simplification for radio advertisers.

All the locals on 1240 could have a great nationwide "localized" service, the sports powerhouses could take over 850, and so forth.

Let them interfere with themselves!

Michael Lowery
Director of Engineering
Electronic Site Services Inc.
Colorado Springs, Colo.

> **All the locals on 1240 could have a great nationwide 'localized' service, the sports powerhouses could take over 850, and so forth. Let them interfere with themselves!**
>
> **— Michael Lowery**

I enjoyed Guys Wire's rant on the problems of AM and IBOC. What a great idea: give AM stations that are eating up AC power and getting very few listeners a crack at incentives to just turn the things off. In the case of my station, WGTO(AM), Cassopolis, Mich., I am running a kilowatt day and 35 watts night. No matter what I do, as many other AM owners have found, you cannot fight FM with music.

My 1 kW regional signal on 910 is much more powerful than my small community of 2,000 people needs for good local coverage. I would gladly turn in my AM kilowatt license for a 100-watt FM mounted on my existing towers. The idea of a point system based on listeners and interference is really great.

I can only pray that Guy Wire's writings spark some real debate.

Larry Langford
Owner, WGTO(AM)
Cassopolis, Mich.

You can't put 10 pounds of stuff in a five-pound bag without some of it spilling out! The digital carriers out 10 kHz, right dab on your first adjacent is no good; worse than that IT IS BAD!

As I look over descriptions of the transmitter plant for IBOC I see a machine that will be demanding and delicate of adjustment, and a system that when put right will not stay right.

One of your columnists recently said that the digital signal was far better than the analog signal he was receiving. But was the analog signal he was looking at a full, unsmashed signal or the squeezed thing that was left over after all the capacity was used for IBOC? An AM signal can sound very good if you do not overburden it.

Lee S. Parr
WAMV(AM)
Amherst, Va.

BY THE NUMBERS

I enjoy each and every issue of Radio World. I especially enjoy the Engineering Extras.

Would it be possible to sequentially number them? I'm never quite sure whether I am missing an issue.

Unless I'm missing something, the only way I can tell is to look for a continuation of an article. Every now and then, an issue of Radio World fails to show up, but I know to look for two per month. I'm not certain if the engineering extras come out on a regular schedule or not.

If these were Engineering Extra #1, Engineering Extra #2, etc., I would know if something is missing. Believe it or not, I save these for future reference. I have most every issue of Radio World going back 20 years or so.

Gary Peterson
Corporate Engineer
Triad Broadcasting Co. LLC
Rapid City, S.D.

U.S. Editor in Chief Paul McLane replies: Radio World Engineering Extra comes out six times a year and is numbered in sequence with the other issues of Radio World.

To help readers keep track, though, we print the next cover date for RWEE on the masthead on page 3. You'll also find that information in each issue of your "classic" RW, at the bottom of the inside back page. ■

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RDL Has Serial-Controlled Interface

Radio Design Labs' new RU2-CS1 serial-controlled interface is now available for all RDL modules and other OEM equipment, and controls eight open-collector outputs. It provides eight separate 0-to-10 VDC outputs to control external VCAs. Eight status inputs for sensing external switch or transistor closures are also provided.

Connecting to a computer through an RS-232 serial link, the RU2-CS1 includes individual and global instruction for the inputs and outputs, and programmable ramp rates for VCA control.

The steel chassis is constructed with detachable euro block connections on the rear panel, while the front-panel LEDs depict audio outputs, active status inputs, transmit and receive data, errors and power. With the use of two bays in an optional RDL RU-RA3 rack adapter, rack mounting is possible.

For more information contact Radio Design Labs in Prescott, Ariz. at (800) 281-2683 or visit the company's Web site at www.rdlnet.com.

DR 100 Recorder Is Size of a Cellphone

AEQ said it has enjoyed strong interest in its DR-100 recording-editing system since first showing it this spring at the NAB convention.

The recorder, which received a Radio World "Cool Stuff" Award, uses cellphone-type batteries. The design allows the user to operate it with one hand and view the information on its screen. Recording is via internal or external mic, and the unit comes packaged with an external mic, headphones and carrying case. Editing can be done using the DR-100 audio editor or on a computer.

A built-in receiver allows recording of FM stations. Audio files can be transferred via external modem or through USB port.

The unit retails for $699.

For information contact AEQ in Florida at (866) 817-9745 or www.aeqbroadcast.com.

Dielectric Touts Isolation Of HD Plus Antenna

Dielectric Communications is promoting its new HD Plus FM Antenna, shown, which the company says achieves a level of analog and digital signal isolation necessary for IBOC broadcasts "without the isolator required by the majority of separate antenna systems recently approved by the FCC for high-definition radio operation."

The HD Plus antenna can be integrated with existing analog antennas, allowing a station to continue analog FM broadcasting while adding a digital broadcast of the same signal at the same frequency.

Other recent news from the company includes 7C, 7P and 7S Series antennas designed for the 700 MHz spectrum. The product line includes slotted coaxial antennas as well as panels, and all can be polarized horizontally, vertically or circularly.

Also featured are the HDR Dibrid combiner for IBOC radio broadcasts that combine analog and dual sideband digital signals; and the Low-Power FM Constant Impedance Filter, designed as a low-power offering for multi-frequency master antenna applications. The company says this modular system uses band-pass technology and is field-tunable and compact.

For information contact Dielectric in Maine at (800) 341-9678 or www.dielectric.com.

We'd Love to Hear from You!

Radio World Engineering Extra welcomes your comments, suggestions and point of view. Tell us how we're doing so far!

Send letters via e-mail to *mlrwee@verizon.net* with "Letter to the Editor" in the subject field; fax to (703) 998-9300; or mail to RW Engineering Extra, P.O. Box 1214, Falls Church, VA 22041.

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Next Issue of Radio World: October 26, 2005
Radio World Engineering Extra: December 14, 2005—

For address changes, send current and new address to Radio World a month in advance at P.O. Box 1214, Falls Church, VA 22041. Unsolicited manuscripts are welcomed for review; send to the attention of the appropriate editor.

The Paradoxes of Learning

By Barry Blesser

If we are to survive rapid changes in society and technology, we must be students. As Plato so aptly said, "the learning and knowledge that we have, is, at the most, but little compared with that of which we are ignorant."

You can measure each day by what you have learned or achieved. Under the pressure of technical obsolescence and global competition, however, most of us choose the latter, not the former. There is an imbalance.

For most of us, learning rarely exists outside of a formal setting. Should one take courses at a local university, read dozens of books and journals on weekends, or experiment with new technology in precious spare time? Is the effort worth it? Knowledge and curiosity are useless if they have no personal or professional relevance to improving the quality of our lives.

The acquisition of knowledge, then, provokes two related questions: What is worth learning? How does one learn?

The answers are interdependent because one can be less selective about what to learn if the process is extremely efficient. At the other extreme, classical learning methods are notoriously inefficient because they implicitly aim towards accuracy, completeness and expertise.

For example, the typical textbook on accounting or software is written to be the student's first step toward becoming an accountant or computer programmer. In contrast, most of us need only a feeling for a subject, with exposure to its questions, assumptions, methods, dilemmas and philosophy. The details are irrelevant unless one plans eventually to become such an expert.

Yet authors and teachers, for their own egotistical reasons, mostly design their teaching styles to make students just like themselves. And classical methods try to create an aura of detached objectivity by removing the personal components, even though we learn best from personal experiences.

Parenthetically, I should mention that in the Middle Ages, students of wealthy families were in charge of the relationship with their teachers. Students hired them, selected topics and specified where and when they would meet. In contrast, today's schools place the teacher in charge of all aspects of the relationship, including the evaluation of success. There are few, if any, checks and balances.

Modern universities are like a feudal institution where the choice of subject matter and the requirement for graduation are supervised by the same group who may only be interested in raising the *perceived* value of their services and certificates. Students are too passive.

EXPERTS ARE EVERYWHERE

The most efficient learning method is the most obvious but least used.

We all meet experts in various fields, but do not take advantage of such encounters because we do not know how to do so. Moreover, we also ignore the fact that people like to talk about what they know, what they have achieved and how clever they are. They are potential teachers, but only if one places oneself in the role of a student.

Try inducing an expert to talk in a focused discussion. Do not ignore what you can learn from janitors, plumbers, firemen, executives or even your children, each of whom is a master at something.

Ask a lawyer about how he learned to practice law, and how legal assumptions are different from those of ordinary life. For example, lawyers have three definitions of truth, none of which corresponds to facts as viewed by an engineer.

Similarly, accountants are far more than number crunchers; computer programmers are also psychologists. Ask an engineer to talk about his experience with bugs, defects, design risk and contradictory requirements. Ask your supervisor to describe his most difficult dilemma. Collect a list of nonfiction books that others found useful.

You will learn a lot with little effort, perhaps only the cost of a cup of coffee.

Having used this method for years, and having acquired an intuitive feel for dozens of arcane fields and subjects, I know that the method works. And it is very, very efficient, at least when measured by the ratio of expended effort to acquired knowledge.

Actually, it is not that I am smart, but rather I have used everyone I know, at one time or another, as a teacher. At the age of 62, I have therefore accumulated a vast collection of knowledge from hundreds of experts.

There is a fundamental error in the old wisdom "learn from your own mistakes." It should be stated "learn from the successes and mistakes of others."

But there is a psychological cost to this approach. Being a student can be experienced as humiliating and self-devaluing. In our status-oriented society, teachers are perceived as parents, supervisors and leaders, while students are thought of as children, interns and followers.

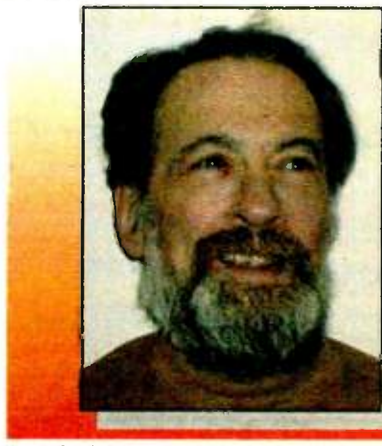
For some personalities, this psychological cost is too high and it is better to fake knowledge than to admit that one has something to learn. I once knew a professor at MIT who decided to learn software in the early 1960s, but unfortunately he had already created the image of being knowledgeable in that subject. Hidden from everyone, he tried to learn from obsolete books rather than from the many experts around him. He elected a very inefficient and expensive method just to preserve a useless illusion: the façade of intelligence. Remember, humility produces efficient learning, while arrogance produces mental paralysis.

ASK QUESTIONS

Consider a personal example. Even though I have designed several digital audio editors, if I were to have a cup of coffee with a broadcast production engineer I would ask him several open-ended questions, as if I knew nothing about the subject:

What kinds of tasks do you do? What makes your job hard or easy? How did you learn to become skilled? How do you recognize competence? What were some of your biggest successes and failures? How did your profession evolve as it did?

The discussion will not make me a production engineer; but it will give me a good feel for the activity of sound editing. If I had this kind of conversation with many sound editors, I would quickly notice consistent patterns. In the end, I would have acquired the surface wisdom from dozens of man-years of sound editing.



Keep in mind that the goal is not to practice sound editing, but to acquire a feel for the activity. However, if I suddenly needed to become an expert, I would know whom to talk to and how to gain additional skills.

Veteran broadcast journalist Peter Jennings said of his life that he never had a day where he did not learn something new. Jennings reached the pinnacle of his profession, yet was a high-school dropout. I have noticed that the best educated frequently are those without any formal degrees or professional certificates. Educational insecurity motivates them to become an information vacuum cleaner, forever sucking in particles of knowledge from the nooks and crannies of life.

This contrasts with the humorous poster at MIT that read, "With this advanced degree you are judged to know everything that you will ever need in life."

In closing, what have you learned today, or this month or even this year? If the answer is difficult, then you have an imbalance in your life, both personally and professionally, and it is time to reexamine your lifestyle.

We have now answered our opening question: Broadcast engineers must take advantage of those whom they meet: equipment vendors, consultant specialists, technical writers, acoustical engineers, network technologists, senior executives and so on. End users and designers should routinely share a cup of coffee. If nothing else, when faced with a new problem, you will be sufficiently knowledgeable to have an informative dialog, asking the right questions and understanding the answers. ■

Dr. Barry Blesser is director of engineering for 25-Seven Systems, a former associate professor at MIT and past president of the AES.

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