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Radio World
ENGINEERING EXTRA

INSIDE DIGITAL

Photo by Jim Peck

The fall NAB Radio Show will look inside the embedded exporter. Page 3

August 20, 2008

DIGITAL RADIO

Which Digital System Is Right for You?

Broadcasters Must Decide the Best Choice for Their Countries as Digital Radio Is Implemented Globally

by Charles W. Kelly Jr.

Kelly is director of sales for Nautel Ltd.

As digital radio is implemented around the world, broadcasters face a key decision: Which digital radio system is right for my country? The answer to that question is complex and encompasses many technical, regulatory, financial and political issues.

This paper does not aim to solve the question, but to examine one facet: the way existing band plans and allocation tables in the current AM and FM bands lend themselves to various technologies.

By limiting the scope of this paper to digital systems that operate within the existing AM and FM bands we do not discount DAB, DMB, DVB-T, DVB-H and ISDB-TSB, which require additional spectrum to be allocated. In fact, these technologies are not mutually exclusive to systems that operate within the existing AM and FM bands, and should a country implement one of these systems they still will be faced with the question of whether and how to digitize the stations within the AM and FM bands.

There are two systems available for AM digital radio use: Digital Radio Mondiale (DRM) and HD Radio. While there are profound differences between them in bandwidth requirements and flexibility, they both are Orthogonal Frequency Division Multiplex (OFDM) systems, which use a number of sidebands to carry the digital information.

DRM and HD-R

DRM as it exists today is designed primarily as a long-wave/medium-wave/shortwave system and has considerable flexibility in how it may be configured to meet various bandwidth, payload and robustness criteria. The DRM Broadcasters' User Manual, downloadable from *www.drm.org*, is a wealth of information about the various options that DRM makes possible.

Where the channel steps are 9 kHz, such as anywhere outside the Americas, DRM is normally installed with a 9 kHz bandwidth (carrier +/– 4.5 kHz) on a single channel, or 18 kHz bandwidth (carrier +/– 9 kHz), which utilizes one channel plus half of the two adjacents.

There are options for using adjacent channels for an analog AM broadcast, but this isn't in common use, as some tests have indicated that the analog signal must be greater than 16 dB above the DRM field strength at the receiver to avoid interference from the DRM signal into the analog receiver.

There also are proposals to implement a

SEE KELLY, PAGE 6

WHITE PAPER

A New Approach to HD-R Combining

Shively Labs Says Its Technique for Combining HD And FM Offers High Efficiency at High Power Levels

by Bob Surette

The author is director of sales engineering for Shively Labs.

Traditionally, there have been limited techniques available for combining HD Radio with FM, and all typically come with a penalty, whether in terms of efficiency, cost (capital and operating) or potential coverage differences.

With the possibility, or perhaps the probability, of the digital power levels being increased ten-fold from 1 percent to 10 percent of the FM power level, existing approaches to HD/FM combining will either not be practical, or will be too inefficient to contemplate.

Shively presents here a new approach, which offers high efficiency at high power levels, with the only negative being perhaps the additional floor space needed at the transmitter site to accommodate the combining system. The techniques employed have been well proven in digi-

SEE COMBINING, PAGE 10

Analog/Digital High-Powered Low-Loss Combiner

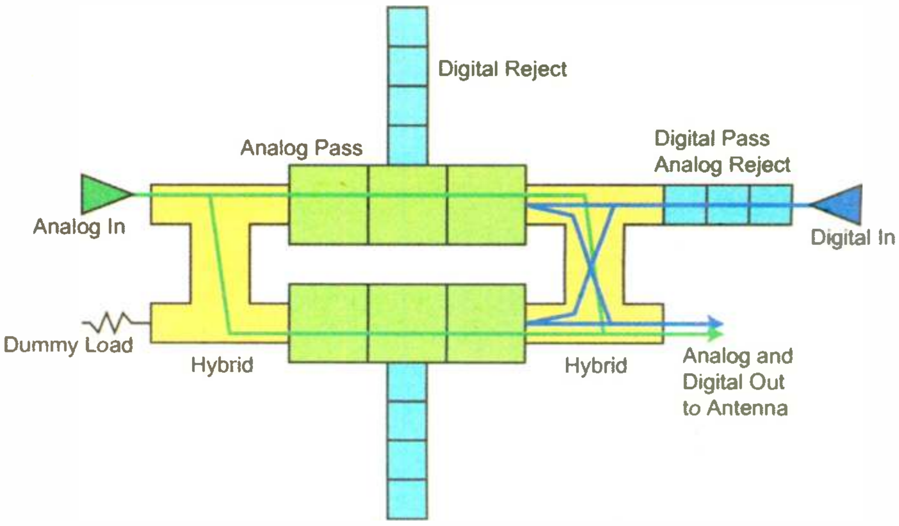
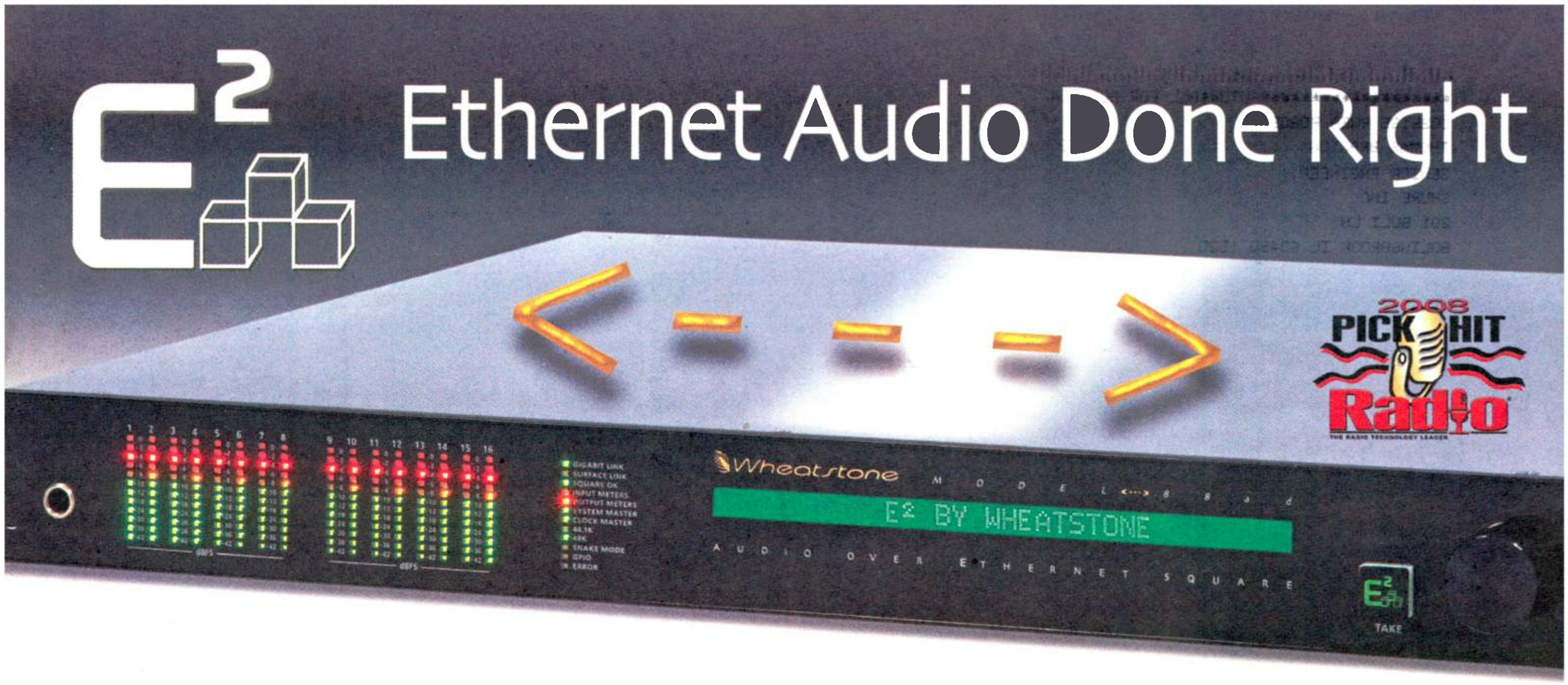


Fig. 1: Shively FM-HD Combiner Outline



MEET THE SQUARE

The Wheatstone E² (E SQUARE) gives you the convenience of Ethernet audio without all the IP hassle. It just *knows*. The built-in Setup Wizard lets you configure an entire system with just your browser and a laptop. Unplug it when you're done and there's no PC between you and system reliability.

SQUAREs are totally scalable: use one as a standalone 8x8 studio or transmitter site router, with browser access from anywhere. Plug two together and have a standalone digital snake. Add a fanfree mix engine and build yourself a studio using analog and digital I/O SQUAREs.

All the power is *in* the SQUARE. Distributed intelligence replicates all configuration data to every unit. Profanity delay and silence detection are done *in* the SQUARE. Even virtual mixing (w/automation protocol) — it's *in* there; all with real front panel meters, 32 character status indicators and SNMP capability.

88D I/O: 8 digital inputs and outputs. You can headphone monitor and meter any of the SQUARE's inputs or outputs in real time. The 32 character display gives you all the information you need about your audio and system configuration. And because you can operate in either 8-channel stereo or 16-channel mono mode, 16 channels of metering are provided.

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88A I/O: 8 analog inputs and outputs. You can bring a new SQUARE up in seconds and of course use the front panel encoder for your X-Y control. Front panel status LEDs give you continuous link, status, and bit rate information as well as confirmation of any GPIO activation.

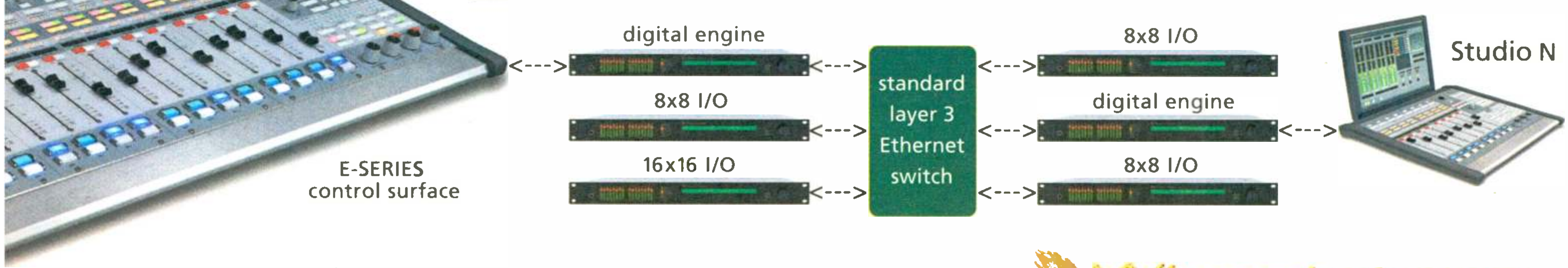
Because the E² system doesn't rely on a third party GUI, tech support is straightforward (and 24/7). Likewise, system operation doesn't require external PCs for continued full functionality. Best of all, 1 Gigabyte protocol eliminates the latency and channel capacity restrictions associated with older technology.

E-SQUARE is Ethernet audio done RIGHT!

88AD I/O: 4 analog plus 4 digital inputs and outputs—perfect for small studios or standalone routing.

88 I/O CONNECTIONS: E² has both DB-25s for punchblock interface and RJ-45s for point-to-point interface. All SQUAREs have 12 individually configurable opto-isolated logic ports that can be either inputs or outputs.

STUDIOS DONE EASY!



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FROM THE TECH EDITOR

by Michael LeClair

Summertime and the Planning Is Busy

Gearing Up for the Presidential Elections and NAB Radio Show as Satellite Merger, HD-R Issues Thrive

Although summer is usually a time to relax a bit and clean up before new projects start in the fall and winter, this year I find myself immersed in preparations for the Democratic and Republican National Conventions.

These quadrennial events are a staple for national news organizations, with four days of speeches and caucuses that culminate in the "acceptance" speech of each party's candidate for president. The conventions kick off the busy fall election season and form the basis for the final campaigns.

Our station plans to go live from Denver for the Democrats and St. Paul, Minn., for the Republicans. We plan to have more than one national show broadcasting from the conventions as well as live reporting during our news programs.

Our remote team clocks in at around 15 people who will be working each event, including yours truly.

This is just a teaser for our October issue. Your intrepid editor will file his observations and comments from the road as the coordinator and engineer for these remotes. In the meantime, I have a few items to note for busy engineers.

Photo by Jim Peck

Embedded exporters made digital radio headlines at the spring NAB Show. The fall NAB Radio Show includes a technical panel on the topic.

RADIO SHOW

Coming up in September is the NAB Radio Show in Austin, Texas, which runs Sept. 17–19. Although I personally prefer the spring NAB Show, this smaller event always has a good selection of technical workshops and other interesting presentations for radio engineers. This year there is a particularly good group of sessions on HD Radio, featuring new topics that were not covered in the spring.

For example, David Maxson of Broadcast Signal Lab will present a workshop on HD Radio measurements. Maxson literally "wrote the book," or at least a book, on HD Radio, and his insights on how to measure digital signals accurately and properly are essential for everyone with an interest in RF.

Also of interest is the panel session on the recently unveiled "embedded exporter" design for HD Radio. This new architecture promises to cost much less than previous exporter designs and bring better reliability to transmission by eliminating the need to use a personal computer in your air chain. The panel will feature representatives from the major manufacturers committed to digital transmitters.

Finally there is a must-see panel on high-power IBOC. This topic was on everyone's lips at the NAB Show in Las Vegas. HD Radio proponents recognize that increasing digital power is the final key to consumer acceptance of this new technology. At the same time there are concerns about potential interference and just how exactly to make it work at all without busting the budget.

> **While satellite radio owners and stockholders must have resented the delays, I have to admit that I felt little sympathy for them.**

The panel includes some of our best and brightest from the broadcast engineering community and is sure to be a treat. This one is on Friday so don't be tempted to leave early and miss it.

BOARDWALK AND PARK PLACE

It has been interesting to watch as the merger of the two satellite radio companies has proceeded very slowly over the course of the last six months. It showed that the FCC as the critical regulatory agency took the time to consider the impacts of awarding a monopoly service to a combined Sirius and XM.

While satellite radio owners and stockholders must have resented the delays, I have to admit that I felt little sympathy for them. Their payoff has arrived with the FCC officially allowing the grandfather of all communications monopolies to come into being at the end of July.

I—and many others—have predicted since the beginning of the satellite radio industry that it was likely to consolidate into one company and that this was the logical end game.

The FCC did impose a number of restrictions on the combined Sirius, such as a three year freeze on subscription prices, a pledge to provide dual capability receivers and reserving a number of channels for non-commercial and minority broadcast entities. However, they chose not to require that all new satellite radio receivers include HD Radio as a standard feature, settling instead for a Notice of Inquiry into the situation.

While I was gratified to see that fines were assessed for the technical violations of both satellite radio companies it remains to be seen whether the $20 million payment was enough to ensure responsible behavior from satellite radio. Promises have been broken before. At this point we can only hope.

SEE TECH EDITOR, PAGE 26

White Papers

White papers are technical articles by manufacturers and other developers of new technology; papers are selected by the editorial staff for their relevance to U.S. radio broadcast engineers. Submit proposals for white papers to radioworld@nbmedia.com, with White Papers in the subject line.

IN THIS ISSUE

by Blažo Guzina

Understanding Microphone Specifications

Typically, microphone users review and compare technical specifications as part of the process of selecting the microphone that best meets their performance requirements.

However, specifications often are written in technical terms that make it difficult for non-professionals to understand their meaning. They also may lead to misunderstandings, as common specifications can be measured or calculated in many different ways.

Hence, when reading microphone specifications, it is important to understand how to evaluate them. The task usually starts with consideration of the influence of the type of transducer on the polar pattern.

BASIC METHODS

A microphone is a transducer that converts acoustic energy into electrical voltage.

The action in a microphone consists of two stages that happen simultaneously: changes in air pressure due to sound waves set a light diaphragm into mechanical motion, and the vibrations of the diaphragm generate an alternating voltage. For the first stage, two basic methods produce mechanical vibration from the action of sound waves.

One method leaves the diaphragm open to sound waves only on one side, with the back effectively enclosed. Microphones constructed to make the most of this method are called "pressure-operated" microphones.

Their directivity pattern is a circle, and a three-dimensional plot would yield a sphere with the microphone in the center. This type of directivity pattern is called "omnidirectional."

The second method is called pressure-gradient (or velocity) operation. Pressure-gradient microphones have the diaphragm open to the air on both sides, so the force acting on the diaphragm depends upon the pressure difference, or gradient, at the front and back sides.

DIRECTIVITY PATTERNS

The voltage output from a pressure-gradient microphone is proportional to sound particle velocity of the incident sound waves, which explains the alternative name, "velocity operation." Their directivity pattern is a figure-of-eight, also called bidirectional.

It is possible to design a broad range of microphone types by combining the pressure and pressure-gradient principles of operation in specific proportions. This approach provides directivity patterns intermediate between the omnidirectional circle and the bidirectional figure-of-eight. The most common patterns in use are cardioid, hypercardioid, supercardioid, wide-cardioid and subcardioid.

The impedance of a microphone, as a source of voltage, is its internal resistance measured in ohms (Ω) for a frequency of 1,000 Hz.

It is essential to know the impedance value of a microphone for proper matching to amplifier, mixer or recorder inputs. As a rule of thumb, the load impedance — input impedance of the amplifier being connected — should be at least three times the microphone impedance in order to achieve voltage matching.

The microphone frequency range states the lower and upper frequency limits of the frequency area in which a microphone is able to reproduce sound within a given tolerance. The frequency range also is known as "bandwidth."

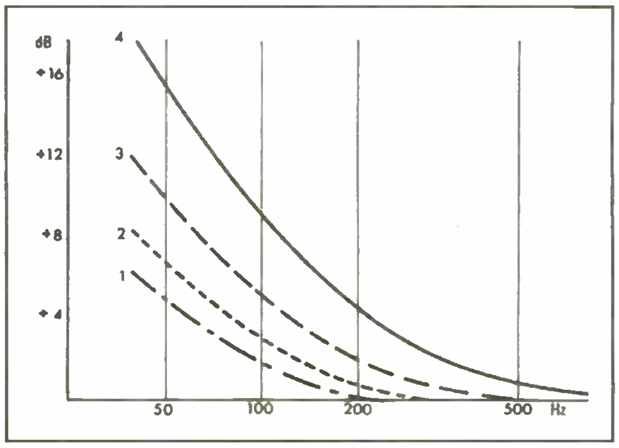


Fig. 1: The Proximity Effect: Bass tip-up of a pressure-gradient microphone to be expected at various close distances — Curve One at 60 cm; Two at 45 cm; Three at 30 cm; Four at 15 cm.

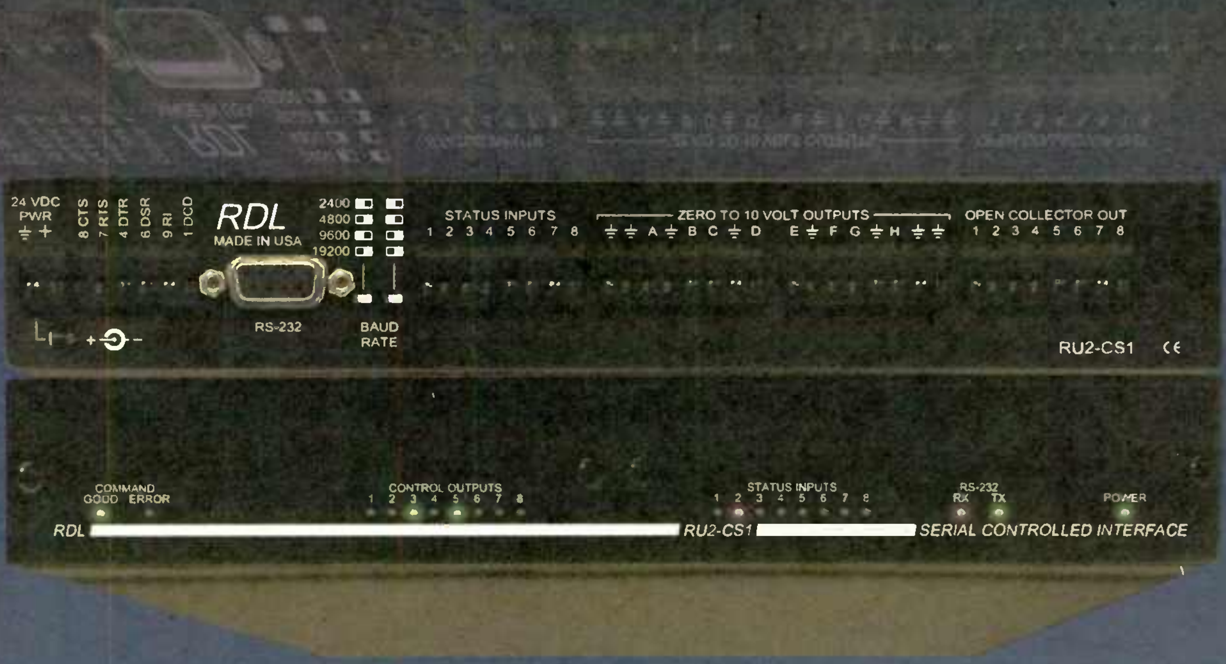
FREQUENCY RESPONSE

The frequency response is a graph of the output voltage of the microphone vs. the frequency. It illustrates the ability of the microphone to convert sound energy into electrical voltage, and whether it is doing so faithfully or introduces coloration.

With the 0 dB reference as the output voltage at 1,000

SEE MIC SPECS, PAGE 14

GET EVERYTHING UNDER CONTROL



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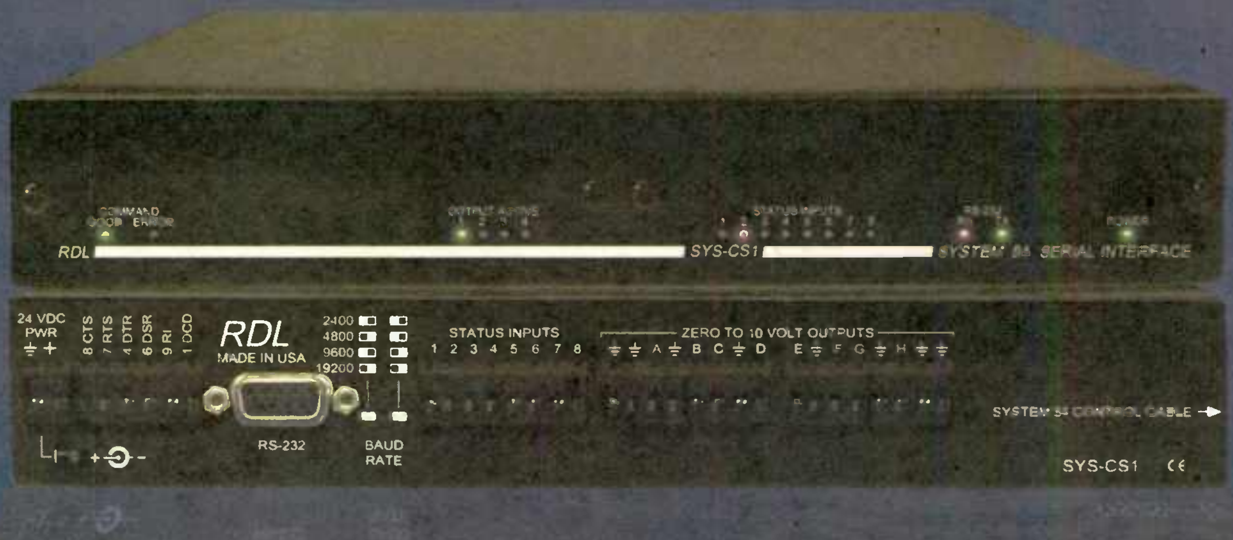
RS-232



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Kelly

CONTINUED FROM PAGE 1

SSB AM signal and use the other half of the channel bandwidth (formerly occupied by the other sideband) for DRM. But this is predicated on synchronous detection of the AM signal, and in general, shortwave receivers are much more likely to feature synchronous detectors than are AM radios.

The other AM in-band digital radio solution is HD Radio, which was developed to meet the unique needs of the U.S. broadcast market and is based on the 10 kHz AM channel spacing found in North and South America. In the United States the AM band is full of stations and there aren't a lot of open frequencies to put a stand-alone digital signal.

On the other hand, adjacent frequencies are not normally allocated within the same area, so HD Radio was designed to keep the AM analog signal essentially unchanged (just band-limited to 5 kHz audio response), and to utilize the spectrum beneath the analog signal, plus on the two adjacent channels for OFDM sidebands to pass the digital component.

HD Radio fits the needs of U.S. broadcasters because it allows full simulcast of the legacy analog signal as well as the new digital signal. Eventually, when digital receivers make up enough of the receiver installed base, the analog signal may be shut down and the HD Radio signal will be reduced in bandwidth to +/– 9.6 kHz.

HD Radio reduces the effect of digital-to-analog on-channel interference because the sidebands above the carrier frequency are out of phase to those below the carrier frequency, and are identical, thus they cancel in the analog receiver. While this is helpful for the on-channel signal, it does not eliminate the interference to adjacent channels.

There is no question that HD Radio can create significant interference to co-channel and adjacent-channel signals and, depending on the IF bandwidth of the receiver, on the second-adjacent signals as well. This has the effect of reducing the secondary coverage areas for a number of AM stations — in some cases, dramatically.

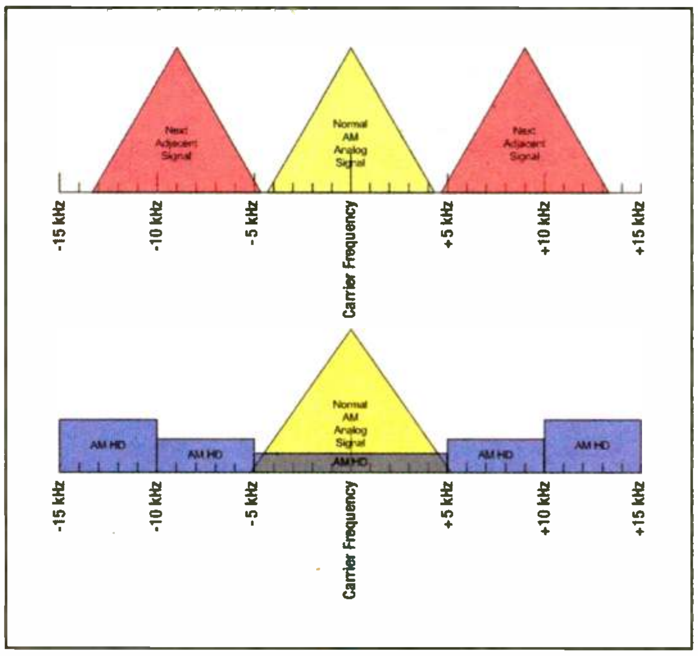


Fig. 1: HD Radio Bandwidth in a 9 kHz Steps Environment

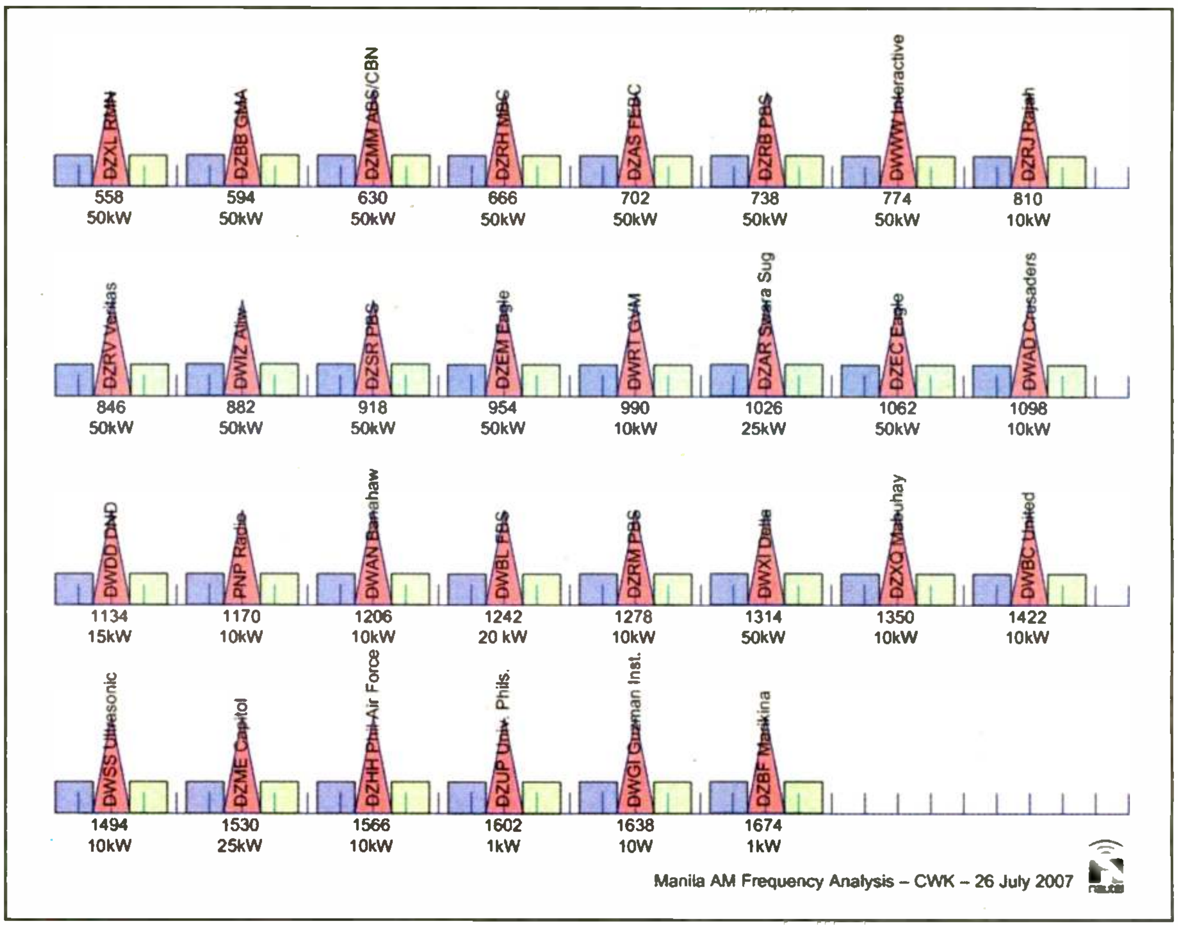


Fig. 2: Manila AM Frequency Analysis

MARKET CONSIDERATIONS INFLUENCE DIGITAL

The choice of the optimal AM system in a particular area can be greatly affected by the radio channel allocation scheme in existence in a particular region. If the channel spacing in a country is 9 kHz, and there are free channels available for allocation, it is a simple matter to implement DRM.

Many European countries fall into this category, as reduced AM listenership has resulted in some AM stations being taken off the air — and these "dark" facilities may easily be re-purposed for DRM.

In some cases, however, HD Radio has been implemented successfully for market reasons. In Surabaya, Indonesia, in 2006, a religious broadcaster bought three adjacent AM channels and installed an HD Radio AM station on the center frequency.

He broadcast the same programming on the analog and digital transmissions, and used the analog channel to promote the purchase of HD Radio receivers, some of which are made in Indonesia. In this way, they provided higher-quality audio programming to their loyal listenership, while having just one transmitter, one antenna and paying a much less expensive license fee from the government than an FM station would have cost.

Fig. 1 shows how a standard HD Radio AM signal fits into a 9 kHz spacing band. Where the AM band is fully utilized, and spare channels are not available to construct new digital-only DRM channels, HD Radio is a possibility. An example is the Philippines, which like all of Asia, has AM channel steps of 9 kHz. Fig. 2 is a graphical analysis that presumes each station is running HD Radio in Manila, the most populous metropolitan area, and with the most crowded spectrum in the country.

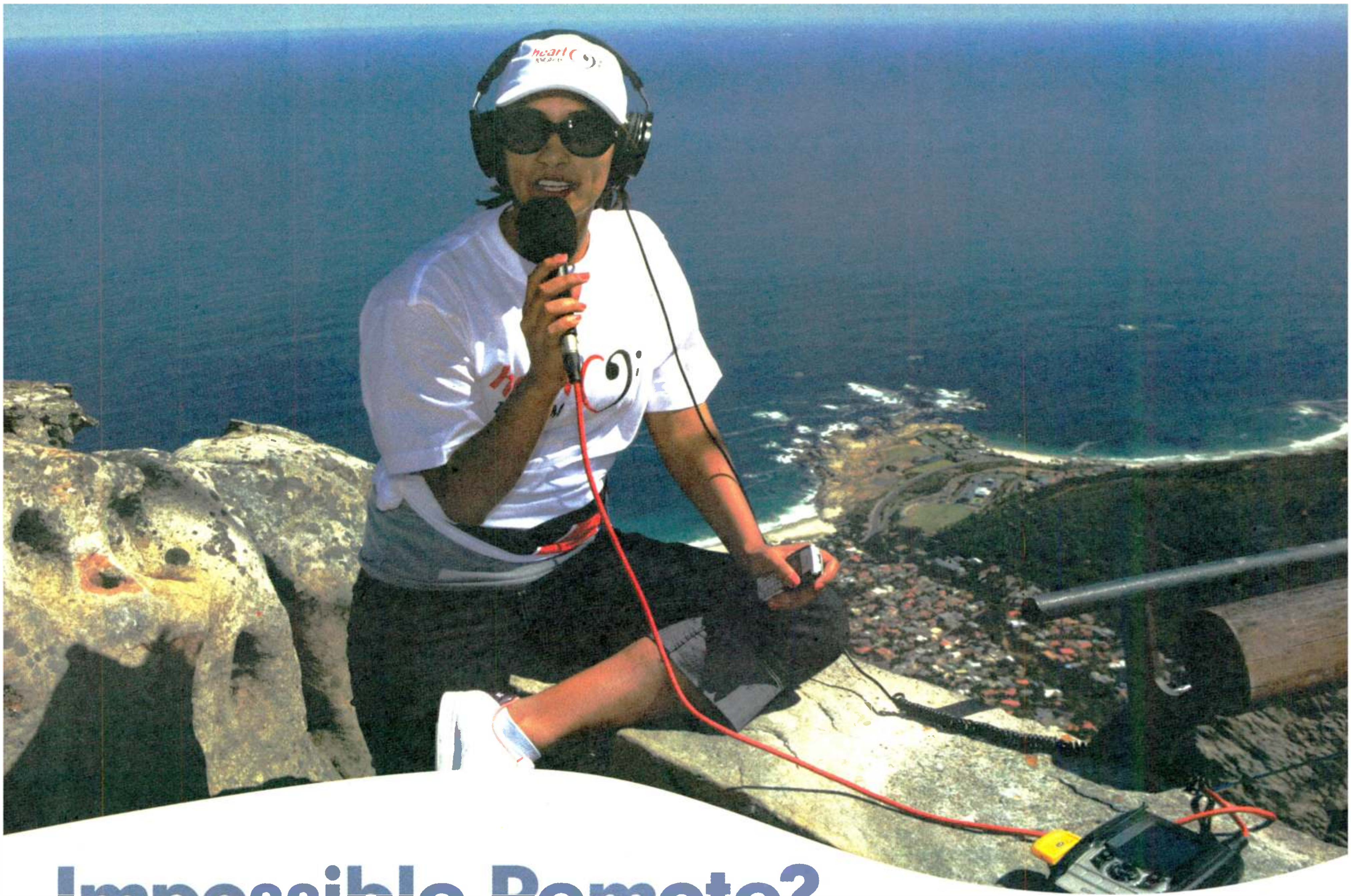
There are options for using adjacent channels for an analog AM broadcast, but this isn't in common use.

As can be seen in Fig. 2, the channel spacing within the Metro Manila area is 36 kHz between stations and a guard band of 6 kHz exists between the AM HD sidebands.

While Fig. 2 is compelling, there is additional analysis needed before any station is approved for use with HD Radio AM. As these are existing stations, co-channel interference to other stations on the same frequency has presumably been known for some time. With the HD sidebands extending to +/– 15 kHz from carrier, however, both of the first-adjacent channels will be impacted, and to a lesser extent, the second-adjacent channels also will be affected.

Fig. 3 is a graphical analysis of the physical locations of first- and second-adjacent

SEE KELLY, PAGE 22



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*Top: **Saskia Falken**, Heart 104.9FM Mid Morning Mix host broadcasting from Table Mountain.*

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Can a radio console be over-engineered?

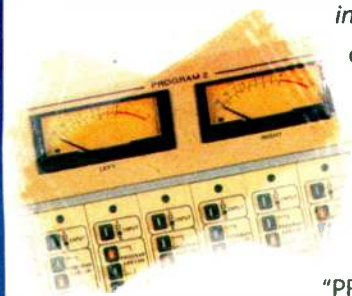
(Only if you think "good enough" really is good enough.)

"OCD" redefined

Building great consoles is more than punching holes in sheet metal and stuffing a few switches in them. Building a great console takes time, brain-power and determination. That's why we've hired brilliant engineers who are certified "OCD": **Obsessive Console Designers,** driven to create the most useful, powerful, hardest-working consoles in the world.

How It began

"20-odd years ago," says Axia President Michael "Catfish" Dosch, "I was designing custom consoles for recording studios. Somebody at **PR&E** – it was still called **Pacific Recorders** then – liked what I was doing and invited me to move there. Work with Jack Williams, the guy who practically *invented* the modern radio console? I jumped at the chance; BMX consoles were ultra-reliable, sounded great, and nearly indestructible!



"PR&E was a dream job. Jack taught me how to design consoles without compromise — how to **over-engineer** them. It's great to see, 15 or 20 years later, that many of the boards I designed are still on the air.

"By the late 1990s, computers and routing switchers were becoming an essential part of the broadcast studio, and I'd been thinking about how useful it would be to combine console, router, and computer network. I shared some of my ideas with Steve Church, who'd introduced digital phone hybrids and ISDN codecs to radio. He thought the same way I did about computers in radio studios, and we decided to work together."

A new kind of console

In 2003, Axia was launched to make digital consoles, but with a twist: Axia consoles would be integrated with the routing switcher, and **networked** to share resources and capabilities throughout the studio complex. This intelligent network of studio devices lets Axia build consoles that are **more powerful** and easier to use than ever.

Our team of engineers blended the best ideas from old-school analog consoles with innovative new technology to produce **bullet-proof boards** that can actually make shows run smoother and sound better.

There's a reason these board-ops are smiling. Axia consoles are in more than 1000 studios worldwide.

And we invented a way to network studios, consoles and audio equipment using Ethernet. It's called **Livewire™**, and it's now an industry standard. Livewire carries hundreds of channels of real-time, uncompressed audio plus synchronized control logic and program-associated data on just one skinny CAT-6 cable.

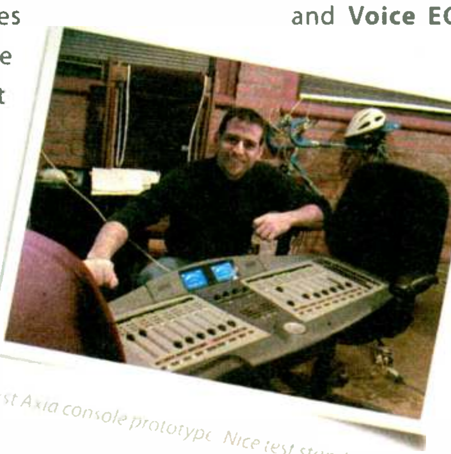
Lots of well-known broadcast software and hardware companies (over two dozen already) now make products that work directly with Livewire. Thanks to this scalable network technology, **integrated router control** is a standard feature of every Element. Any source in any studio can be loaded on any fader with no need for add-on panels.

And Livewire lets you bring computer audio into the air chain without going through multiple A/D/A conversions. Our **IP-Audio Driver** lets you connect computers directly to the network without any intermediate I/O — all that's needed is a CAT-5 cable and your computer's Ethernet port.

Feature packed

Board-ops told us they wanted a console that's **powerful, yet easy to use.** So we designed Element to be user-friendly, yet still have all the power of a full-on production board.

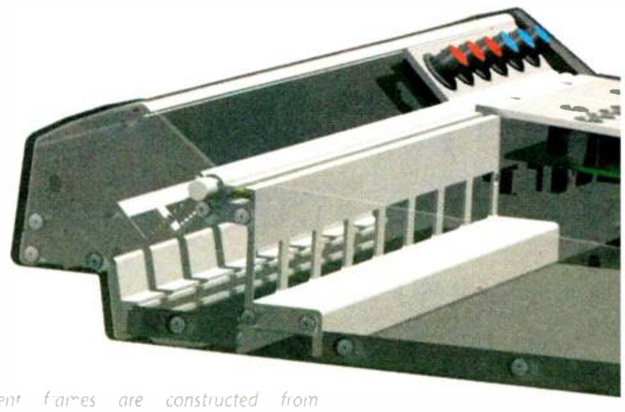
For example, Element Show Profiles can **recall each operator's favorite settings** with the push of a button — audio sources, fader assignments, monitor settings and more. And each jock's Show Profile contains personalized **Mic Processing** and **Voice EQ** settings that load every time they're on the air (so the midday guy will stop badgering you for "just a little more low end"). There's even a "panic button": one key-press returns a Show Profile to its default state instantly. (No more 3 A.M. "Help!" calls.)



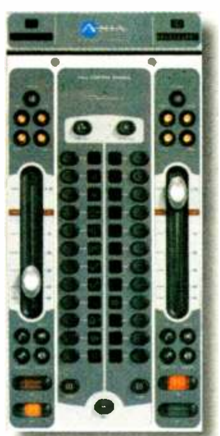
First Axia console prototype. Nice test stand, Catfish.

Did we say "mic processing"? You bet. Every voice channel gets **studio-grade compression, de-essing and expansion** from the processing experts at Omnia, plus three-band parametric EQ to sweeten the deal. There's even built-in **headphone processing** so you don't have to waste money building a separate side-chain just for the studio cans.

Jocks have complained for years that making a mix-minus is too hard — so Element **constructs mix-minuses automatically**. Plus, mix-minus settings are saved for each audio source, so that sources, backfeed and machine logic all load at once. And every fader has a "Talkback" key to **communicate with phone callers**, remote talent or other studios using the console mic.



Element frames are constructed from custom aluminum extrusions for maximum rigidity. Module face plates and console side panels are machined from thick plate aluminum. Even the hand rest is a beefy extrusion. With all this heavy metal, even that ham-handed overnight jock won't be able to dent it.

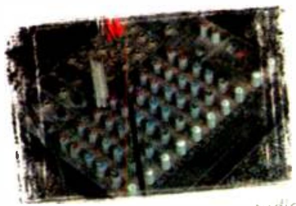


Speaking of phones, board-ops have enough distractions without having to reach for an outboard phone control panel. Element has **hybrid controls with dedicated faders** for Telos talkshow systems; there's even a **dial pad** so jocks can dial, pick up, screen and drop calls without ever diverting their attention from the console.

Nearly every air talent has accidentally changed a fader's audio source while it was on-the-air. To prevent that error, **Element "queues" source changes**: the operator must turn the fader off before the next assigned source "takes".

The radio console, redefined.

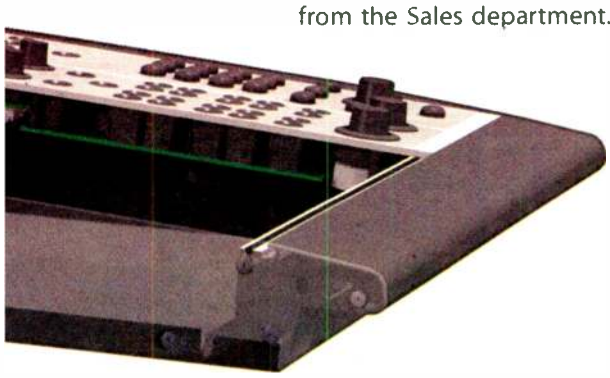
Element was designed to fulfill either a **production or on-air** role, with amazingly powerful features waiting just beneath the intuitive surface. For instance, Element can mix in 5.1 Surround as well as stereo. That's standard; **nothing extra to buy** (except more speakers). There are four stereo Aux Sends and two Aux Returns, so production guys can use their favorite outboard FX boxes. Great for **custom IFB feeds**, too.



Clear the junk out of your studio. Element has 8 submixers built in.

Got a PA mixer tucked away in a studio corner to mix mics for live performers, talk shows and such? Element has **8 Virtual Mixers** — no outboard gear needed. And the Virtual Mixers emulate ACU-1s, allowing tight integration with automation and satellite systems.

You can **administer Element remotely**, from home, the airport — wherever there's network access. A password-protected web server lets you examine the state of the console, see what's on the air and even fix operator mistakes, without ever leaving the comfort of that new Aeron™ desk chair you (ahem) "requisitioned" from the Sales department.



Small VU meters mounted at desk level are hard to read, so we re-invented the traditional meter bridge. Element's **big meters** are presented on an easy-to-read computer monitor along with large analog and digital clocks, event and countdown timers, and tallies that light when mics are open, delay is active, or during phone calls. You can even customize the display by adding your station's logo.

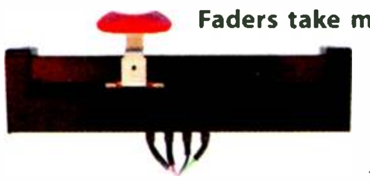
Beneath the surface

There's more to building a great board than just features. **Consoles have to be rugged,** to perform flawlessly 24/7, 365 days-a-year, for years at a time. So when it came time to choose the components that would go into Element, we literally scoured the globe for the absolute best parts — parts that would take the torture that jocks dish out on a daily basis.

First, Element is fabricated from thick, **machined aluminum extrusions** for rigidity and RF immunity. The result: a board that will stand up to nearly anything.

With so many devices in the studio these days, the last thing anyone needs is gear with a noisy cooling fan. That's why Element's **power-supply is fanless**, for perfectly silent in-studio operation.

Element modules are **hot-swappable**, of course, and quickly removable. They connect to the frame via CAT-5, so pulling one is as simple as removing two screws and unplugging an RJ — no motherboard or edge connectors here.



Faders take massive abuse. The ones used in other consoles have a big slot on top that sucks in dirt, crumbs and liquid like the government sucks in taxes. By contrast, our silky-smooth conductive-plastic faders actuate from the side, so **grunge can't get in**. And our rotary controls are high-end optical encoders, rated for more than **five million rotations**. No wipers to clean or wear out — they'll last so long, they'll outlive your mother-in-law (and that's saying something).

Element's **avionics-grade switches** are cut from the same cloth. Our design team was so obsessed with finding the perfect long-life components that they actually built a mechanical "finger" to test switches! Some supposedly "long life" switches failed after just 100,000 activations; when they found the switches used in Element, they shut off the machine after **2 million operations** and declared a winner. (The losers got all-expense-paid vacations to the landfill.)

Individual components are **easy to service**, too. Faders come out after removing just two screws. Switches and rotary volume controls are likewise easy to access. And all lamps are LEDs, so you'll likely never need to replace them.

Engineers have said for years that console finishes don't stand up to day-to-day use. Silk-screened graphics wear off; plastic overlays last longer, but they crack and chip — especially around switches and fader slots, where fingers can easily get cut on the sharp, splintered edges. We decided that we could do better.

Element uses high-impact Lexan overlays with color and printing on the back, where it **can't rub off.** And instead of just sticking the Lexan to the top of the module like some folks do, our overlays are **inlaid on the milled aluminum module faces** to keep the edges from cracking and peeling — expensive to make, but worth it. For extra protection, there are **custom bezels** around faders, switches and buttons to guard those edges, too. Element modules will **look great for years.**

By the way, those on/off keys, fader knobs and bezels are our own design, custom-molded to give **positive tactile feedback**. The switch is flush with the bezel, so it's easy to find by touch. But if something gets dropped on it, the bezel keeps the switch from being accidentally activated.

More than just products

Catfish learned something else important from his time at PR&E: "Even the best products are nothing without **great support.**" So Axia employs an amazing network of people to provide the best support possible: Application Engineers with years of experience mapping out radio studios... the most **knowledgeable, friendly** sales people in the biz... Support Engineers who were formerly broadcast engineers. Plus a genius design team, software authors who dream code... one of the **largest R&D teams** in broadcast.

And now Axia has become radio's **first console company to offer 24/7 support**, 365 days a year. Chances are you'll never need that assistance, but if you do, we'll be ready for you. Our 'round-the-clock help line is +1-216-622-0247.

Proudly Over-Engineered

Are Axia consoles over-engineered? **You bet.** If you're looking for a cheap, disposable console, there are plenty out there — but this ain't it. Not everyone appreciates this kind of attention to detail, but if you're one who seeks out and appreciates excellence wherever you may find it... Axia consoles are built **just for you.**

AXIA
A TELOS COMPANY

www.AxiaAudio.com

Combining

CONTINUED FROM PAGE 1

tal television transmission for 10 years at this point, and even longer than that elsewhere in the world.

BACKGROUND

The approaches to date for HD Radio implementation have focused on either low-level combining and common amplification, or high-level combining using a variety of techniques.

The former offers arguably the best efficiencies, but has been limited largely by the available headroom in the common amplifier stage, which in turn mandates relatively low power levels for both the analog FM and digital signal components.

Whereas a conventional FM amplifier operates relatively efficiently in Class C as a non-linear stage, the addition of digital components mandates a linear amplifier operating in Class A, or more likely Class AB with a substantial reduction in efficiency. The reduced efficiency is bearable at comparatively low FM/HD levels, but for high-powered stations, the size of amplifier and associated costs become prohibitive.

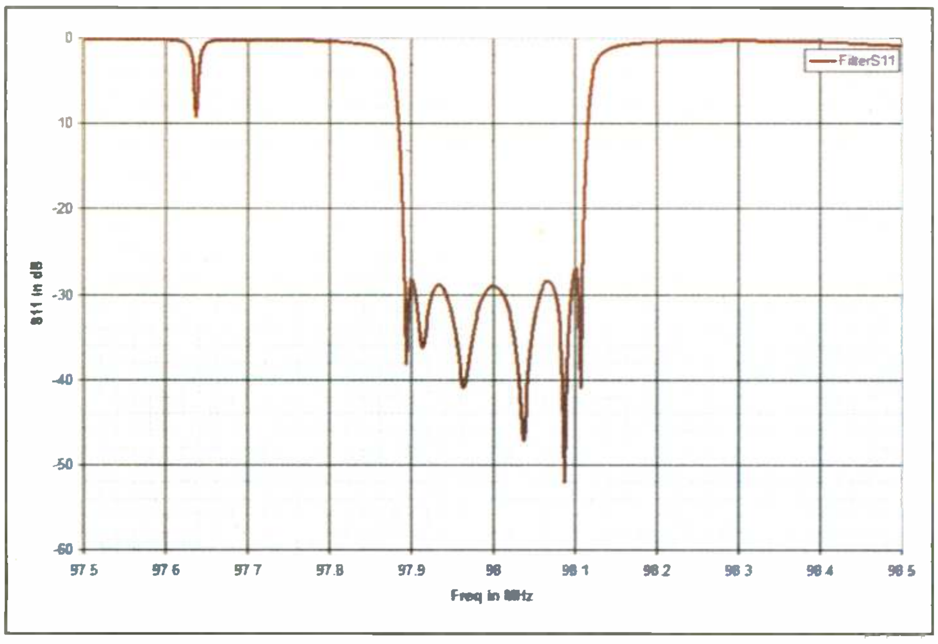


Fig. 2: Analog Input Return Loss

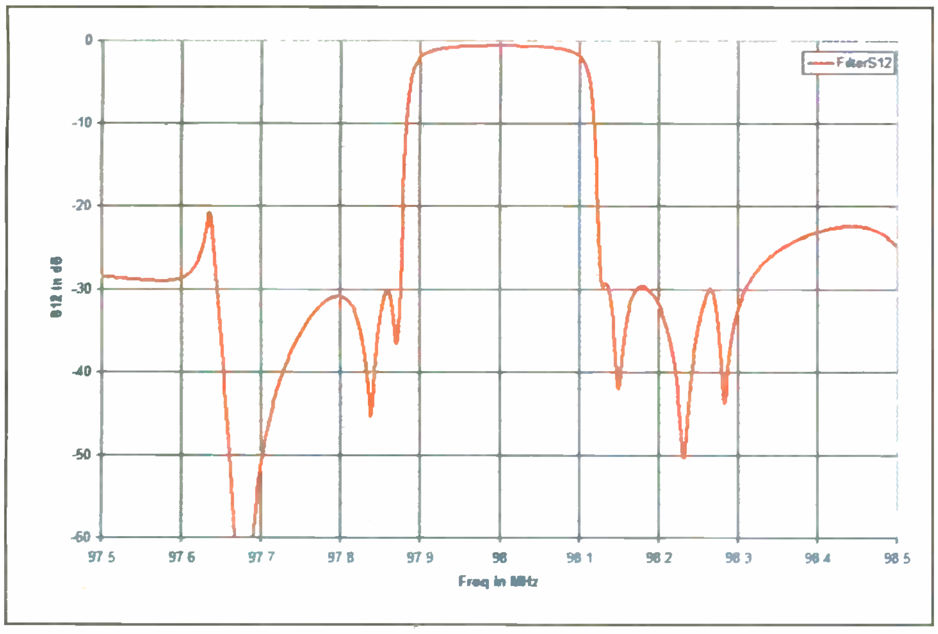


Fig. 3: Analog Input Frequency Response

The high-level approach typically involves one of three techniques:

- HD injection using a conventional hybrid coupler (or "injector") where as much as 90 percent of the digital signal, and up to 10 percent of the analog component is lost to the balance load.

- Dual input antenna systems, often using cross-fed balanced combiner chains. The efficiency concerns associated with "lossy" injectors are largely alleviated, but the isolation between the analog signal and the digital signal is generally a concern, and historically circulators have been added to the system digital inputs to prevent excessively high-analog signals from coupling into the digital transmitters.

- Separate antenna systems. Parameters are fairly tightly governed from a licensing perspective, but achieving comparable analog and digital coverage is difficult. As the number of HD Radio listeners increases, digital coverage will become as important, and potentially more important, as time goes on with the result that mismatched coverage will simply not be an option.

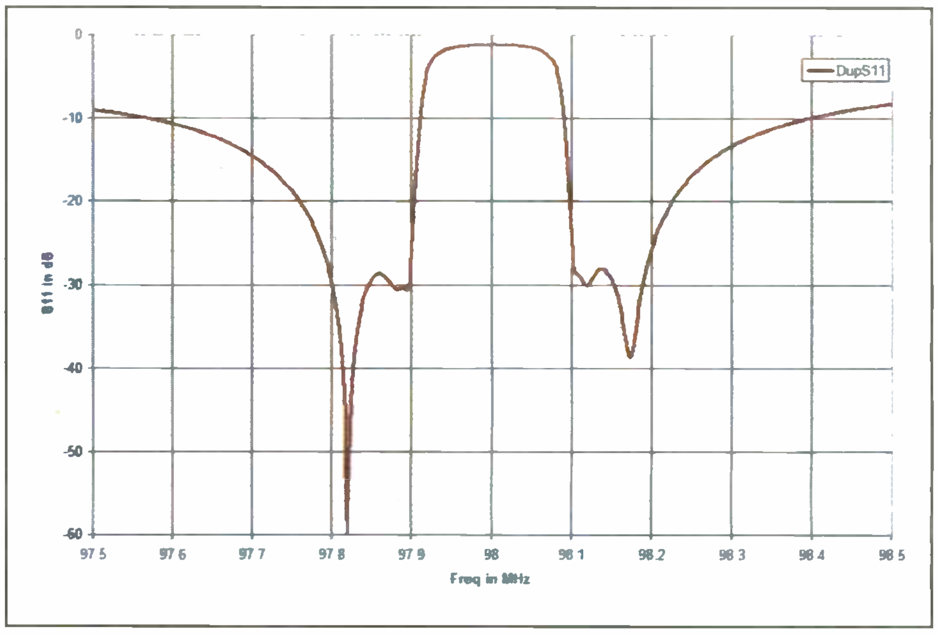


Fig. 4: Digital Input Return Loss

With the possible exception of the "separate antennas" approach, the above techniques are only effective at digital levels around 1 percent of the analog FM power level. When digital power levels are raised to 10 percent of analog FM, it is doubtful whether any of these traditional options will provide the levels of efficiency and performance required by today's broadcaster.

Since early 2008, Shively Labs has been working on an alternate solution, designed for HD Radio at –10 dB, capable of handling the typical transmitter power output levels of a full Class C station, and providing the high efficiencies associated with a well-designed, conventional balanced-combiner module.

Ironically, I first proposed a similar concept at several SBE meetings, some 10 years ago, but limitations in hardware then precluded further development. Significant advances in filter technologies between then and now have made the implementation of this system a reality and, we believe, a necessity.

A NEW APPROACH TO AN OLD CHALLENGE

In the analog TV arena, aural/visual (A/V) combining has been a necessity for decades, and A/V combiners have proven both efficient and realizable even at low VHF. In the past decade, the filtering stakes have been raised with adjacent-channel NTSC/DTV allocations, and in some markets there are now adjacent-channel DTV stations multiplexed into the same antenna system, each filter meeting the strict spectral mask requirement mandated within the FCC rules.

The technology to combine very close spaced channels with sharp-tuned filters is well proven, with the first UHF adjacent TV/DTV systems being implemented in the United Kingdom in 1997 using technology developed in the United States. However, migrating this approach to the FM band, where percentage bandwidths are only 20 percent or less of those available at UHF, is a

SEE COMBINING, PAGE 12

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Combining

CONTINUED FROM PAGE 10

significant challenge. Achieving acceptable levels of efficiency and stability throughout the system is a substantial burden upon the filter designer.

Shively Labs has taken a variation of "conventional" adjacent-channel combining techniques, with some specific additional filtering elements, resulting in a design that currently offers some 60 dB of isolation between analog FM and HD inputs.

Ibiquity has recently recommended a minimum isolation between analog and digital transmitters of 50 dB for 10 percent digital ratios. Clearly, a 10 dB increase in digital power requires a ten-fold increase in amplifier capability when compared to digital at 1 percent. At this level the power becomes significant.

Taking into account the typical peak-to-mean ratios of the HD signal, the amplifier peak power ratings begin to be comparable with those associated with medium-power FM stations. Considerably higher levels of isolation than currently available are required if intermodulation and spectral purity are to be ensured.

The outline of the Shively configuration is shown in Fig. 1. For the purposes of this article, data has been centered on an analog FM carrier at 98 MHz.

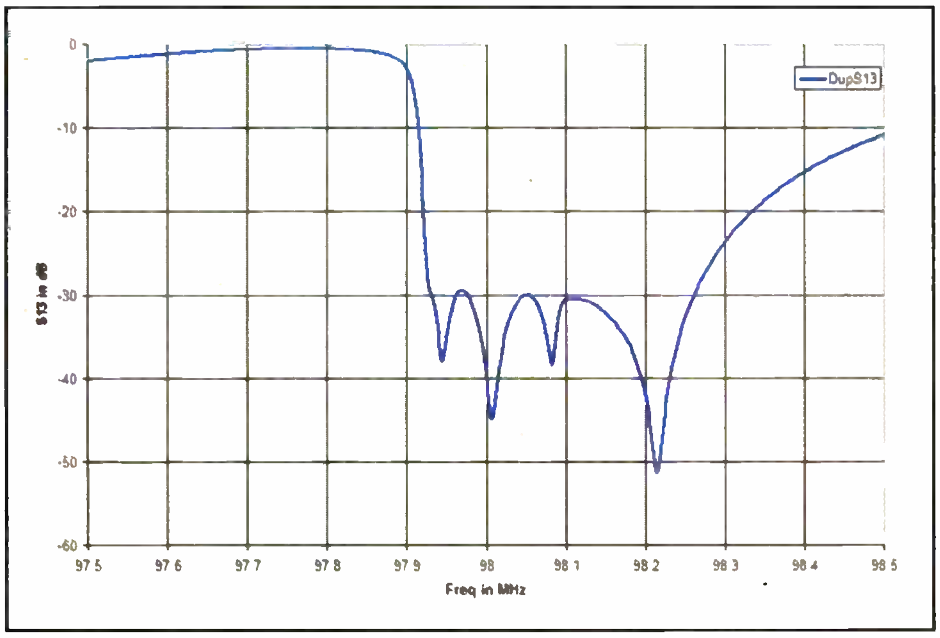


Fig. 5: Lower Digital Sideband Frequency Response

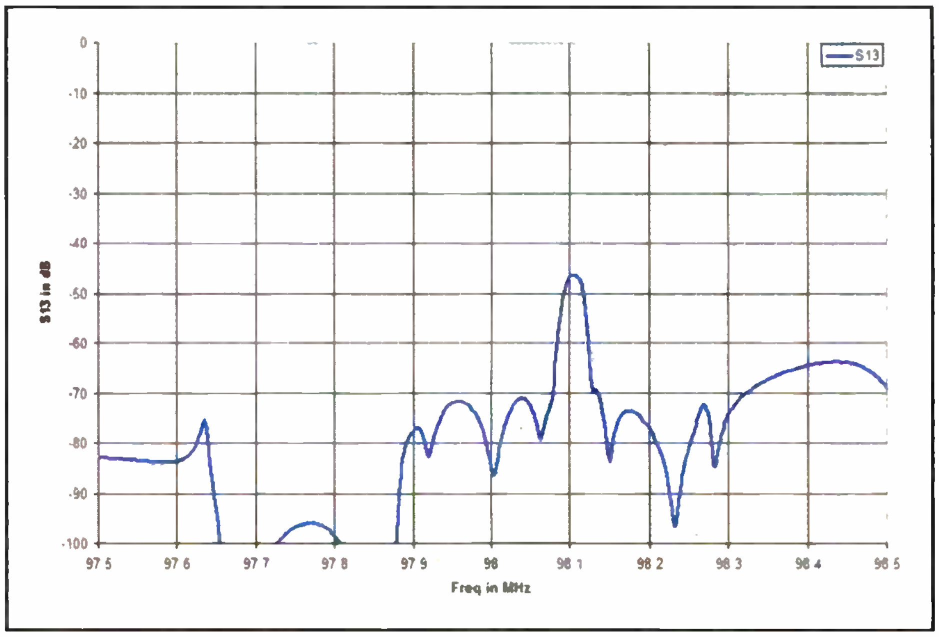


Fig. 7: Analog to Digital Isolation

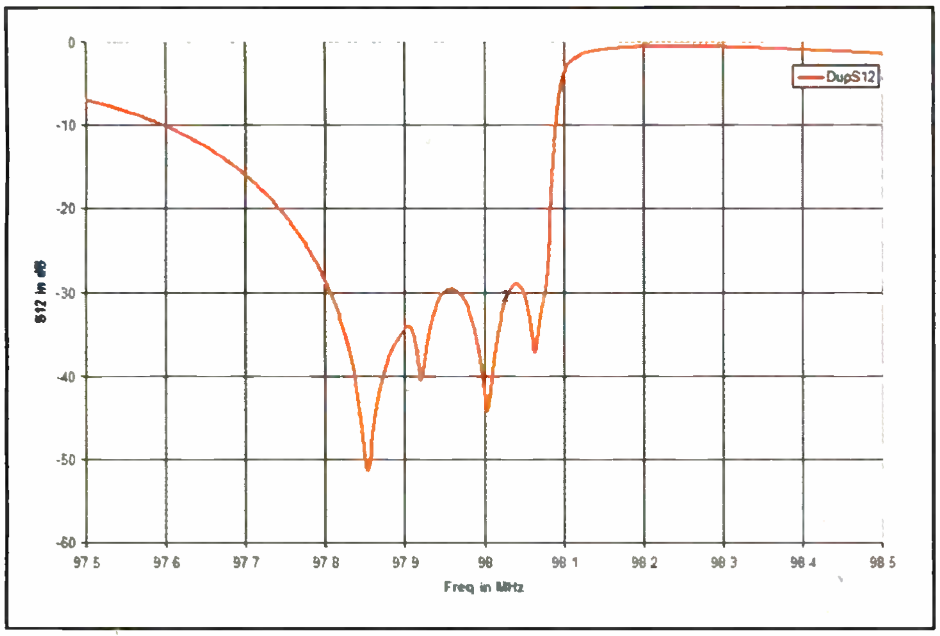


Fig. 6: Upper Digital Sideband Frequency Response

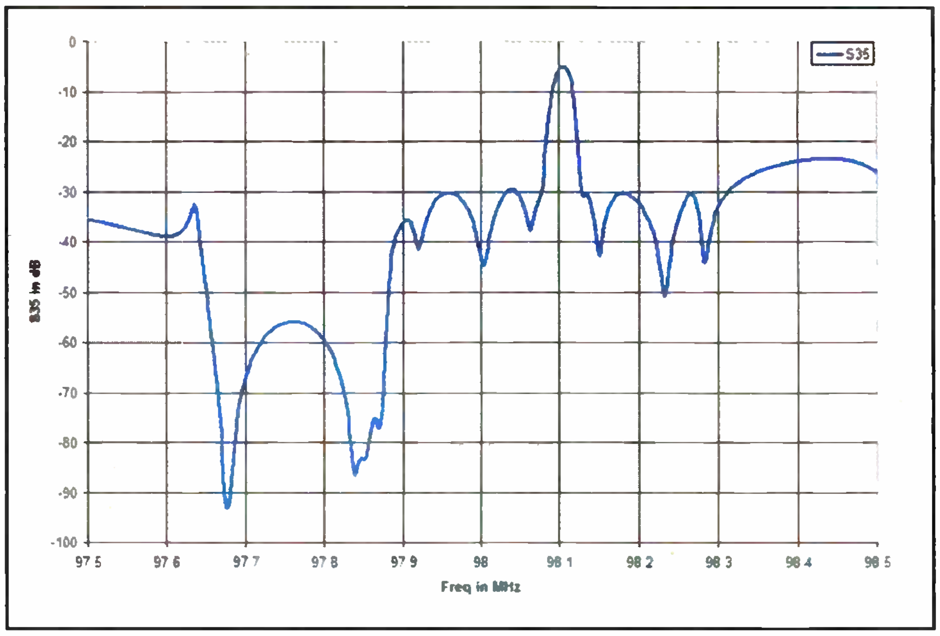


Fig. 8: Digital Input, Isolation to Balance Load

OPERATION

The combiner is designed to provide well-matched inputs to both the analog FM and the digital HD Radio signals while eliminating the inefficiencies of currently available combining options. The basic operating principles are outlined here, and for ease of visualizing signal flow in a more familiar component, comparisons are made to standard "balanced combiner" configurations.

Considering the analog FM signal initially, the input is a conventional, balanced band-pass combiner arrangement with two exceptions: the band-pass filter elements are identical, matched sharp-tuned designs to pass the FM spectral components (–3 dB at +/– 110 kHz) but rolling off sharply to reject both the upper and lower digital sidebands; and additional "reject" elements, tuned to pass analog but reject both digital sidebands, are incorporated into the overall filter assembly.

The result is a unique configuration of filtering elements providing a nominal insertion loss of under 0.5 dB at FM and more than 30 dB of insertion loss at digital (FM +/– 125 kHz). Typical analog system parameters are shown in Figs. 2 and 3, showing analog input insertion loss and return loss respectively.

Beyond this filter, the hybrids are conventional in design, sized to the analog input power and taking into account the peak/mean ratio of the digital input. Typically, the hybrids alone exhibit at least 30 dB of isolation in a "zero-dB" configuration, placed back-to-back.

In conjunction with the digital rejection characteristics the hybrid provides some 60 dB of intrinsic isolation between the "broadband" port, which is the digital input, and the analog input. Analog power is routed diagonally across the unit to emerge at the output port. There is in excess of 30 dB isolation to the digital side of the hybrid due to the inherent balance.

Considering now the digital input, HD Radio components enter the system at what would be the "broadband" port in a conventional balanced-combiner module. The difference in the Shively design is the addition of an extra filter, which is essentially the complement of the analog filters in that it passes both digital sidebands, but rejects the minimal levels of analog signal that get by the high hybrid isolations mentioned above.

As shown in Fig. 7, apart from a slight spurious response at FM + 100 kHz (currently the subject of some tweaking at Shively), the analog to digital isolation is better than 70 dB. The digital signal is "bounced" at the analog pass/digital reject filters and emerges at the output port, together with the analog signal. Digital insertion loss is not specifically shown, but can be inferred from Figs. 5 and 6 and is comparable to the analog insertion loss, currently less than 0.5 dB.

Digital input characteristics are shown in Figs. 4, 5 and 6 where HD input return loss is in excess of –30 dB (1.05:1 VSWR typical.) Fig. 5 and Fig. 6 show the composite response of cascaded digital upper and lower sideband pass filters, which in conjunction with the analog reject filter shown in Fig. 4, provides the extremely high levels of isolation essential to high-power HD Radio operation.

Finally, digital input isolation to balance load is shown in Fig. 8, achieving in excess of 30 dB except for the troublesome spurious response at FM + 110 kHz.

WHAT'S NEXT?

Preliminary analysis and initial development have proven optimistic in terms of the deliverable system performance. Shively is progressing to full prototyping of the entire system outlined here, with a goal of releasing further representative system measurement data by the NAB Radio Show next month. It goes without saying that power handling will be a substantial part of the ongoing test and development program, and Shively's 20 kW test transmitter will see more action than usual over the next few months.

On a more serious note, the group delay response on the filter skirts is not significant by current DTV, or even NTSC standards, but for a typical FM exciter it is substantial to say the least. While the HD Radio exciters incorporate substantial levels of linear pre-correction capability for both delay and amplitude, FM exciters are by no means as flexible. Shively anticipates working closely with transmitter manufacturers to establish the acceptable levels of delay that can be accommodated in an FM exciter and the impact of that delay on the FM signal in general.

In conclusion, Shively believes the system outlined here will become the preferred approach to high-level combining of analog and digital radio signals. Eliminating the inefficiencies of previous approaches will open the door to cost-effective operation of FM and HD Radio facilities including HD at 10 percent of analog power. ■

MINSTRUMENT MATRIX

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

DL1 Digilyzer
Digital Audio Analyzer

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

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

DR2 Digirator
Digital Audio Generator

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

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

AL1 Acoustilyzer
Acoustics, Audio & Intelligibility Analyzer

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

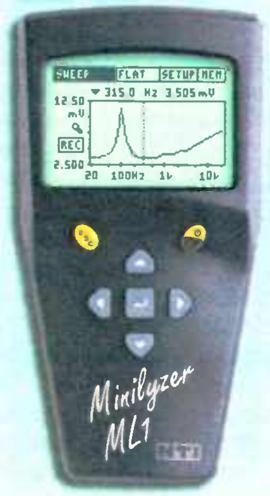
- Real Time Analyzer
- Reverb Time (RT60)
- Delay measurements
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- Automatic Distortion analyzer (THD+N)
- Frequency, RMS Level, Polarity measurements
- Requires optional MiniSPL microphone
- Includes MiniLINK USB interface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

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

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

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

ML1 Minilyzer
Analog Audio Analyzer



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

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


MiniLINK

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

MR2 Minirator
Analog Audio Generator

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

- Intuitive operation via thumbwheel and "short-cut" buttons
- New higher output level (+8 dBu) & low distortion
- Programmable Swept (chirp) and Stepped sweeps
- Sine waves
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- Polarity & Delay test signals
- Illuminated Mute button

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ON THE SHELF

by Cris Alexander

Book Explains NEC Antenna Models

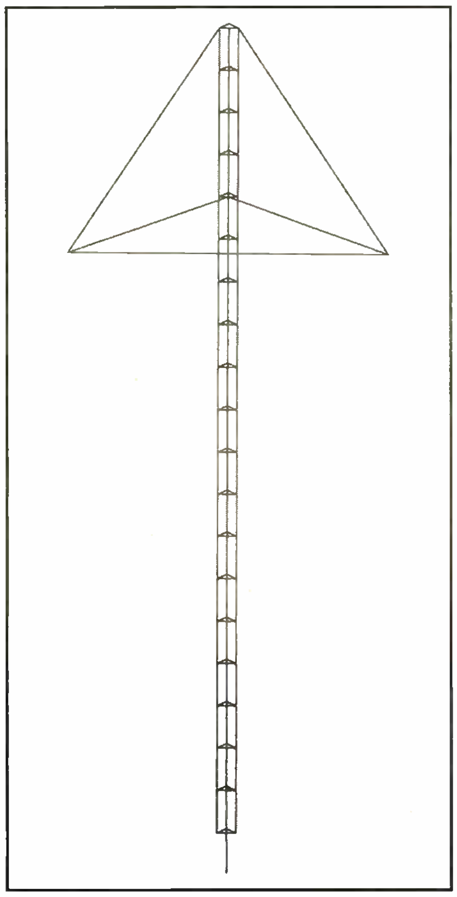
J.L. Smith Provides What Broadcast Engineers Need To Better Understand AM Antenna Modeling Process

For many years, I have been modeling AM antennas and antenna systems. And while I have a good operational understanding of antenna modeling, I always am looking to learn more and do it better. That's what "Basic NEC With Broadcast Applications" by J.L. Smith is all about. After reading the book and working through the exercises, I came away with a much better understanding of the modeling process as well as the features and limitations of the NEC-2 core.

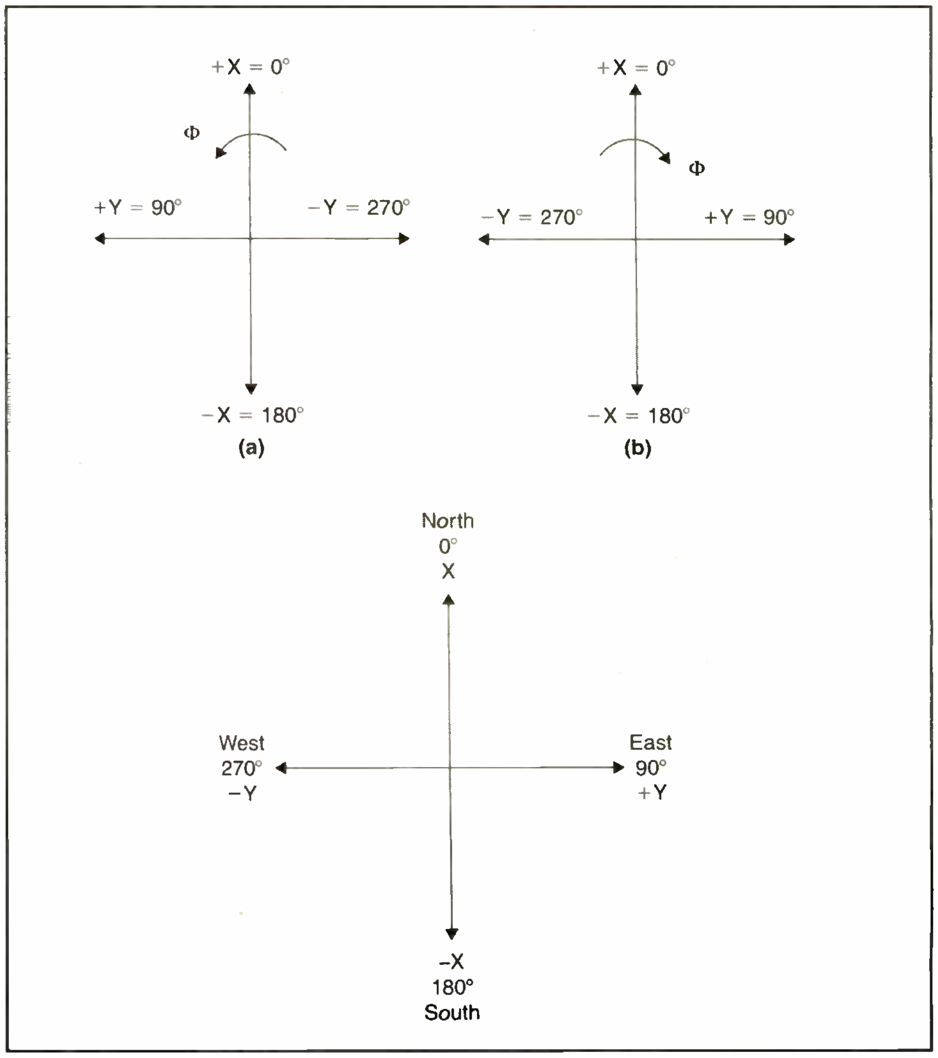
The author is a senior member of the radio engineering community, having spent most of the past 62 years of his career as a professional engineer working in broadcast transmitter/antenna manufacturing and consulting. He has more than 50 technical papers and two published books to his credit.

This book is not light reading; it is a textbook and could easily be used in a classroom setting. Most of the chapters include student exercises that will help the reader gain a better understanding of the material in the chapter. There is no substitute for problem-solving to learn the concepts, and the author certainly recognizes this.

Along with the book, the user is supplied with a CD-ROM containing the NEC-2 executable, and several post-processor utilities needed by the reader as he works through the exercises and for later use on his own. The CD-ROM also contains the NEC-2 listings used in the book if you're not inclined to type them in yourself, and it contains the exercise answers. No fair peeking.



Wire model of a guy-wire top-loaded tower.



Top: (a) X-Y projection of spherical coordinates; (b) X-Y projection with the Y-axis reversed. Bottom: Coordinate system as used for broadcast applications.

THE ANTENNA MODEL

"Basic NEC" begins with a good explanation of what NEC-2 modeling can do for the broadcast engineer charged with tuning up a directional antenna, essentially eliminating much of the trial-and-error process that has long been the means of achieving the proper pattern shape from theoretical parameters.

The reader is then taken through the modeling process, with each step being fully explained. While the appendix contains the full NEC-2 command set, only those commands likely to be needed in modeling MW broadcast antennas are explained in the body of the book.

In my years of modeling, I have always used software that consisted of a "wrapper" around the NEC-2 core, providing command line or graphical user interface in "real-world" units. Basic NEC explains how to communicate directly with the core, giving the reader a whole new level of understanding the modeling process. Basics such as translating the distance/azimuth world that broadcast engineers live in to the X-Y-Z coordinate system of NEC-2 are explained so that making that translation becomes second nature.

Two-port networks are a key element in NEC-2 modeling. Such networks are used for everything from matching and filter networks to representation of the stray series inductance/parallel capacitance of a feed system or the shunt capacitance of a base insulator.

The whole concept of non-radiating networks is thoroughly explained, and the reader is walked through some exercises employing such networks. Non-radiating networks comprise resistance, capacitance and inductance and can be used to "load" a wire, achieve a match or impedance transformation or perform some other function.

Part and parcel of modeling two-port networks is the specification of the complex short-circuit admittance parameters (Y-parameters) that accompany each network. There is a unique equation set for each network configuration, and these are provided to the reader for use on exercises and real-world modeling.

One thing I ran into, however, was something of a "disconnect" between the author's mathematical world and the broadcast engineering world I live in. I made the mistake of using positive and negative reactance values in the equations rather than "j" values (the imaginary part of the complex number).

The correct way to evaluate the equations is to ignore the real component and deal with

SEE NEC, PAGE 18

Mic Specs

CONTINUED FROM PAGE 14

the average human ear to perceive sounds, known as a threshold of hearing.

Maximum SPL is a maximum sound pressure level that a microphone can process without distorting the signal — in other words, without introducing more than a specified amount of total harmonic distortion (THD).

If it is measured at 1,000 Hz, it means that the bass range distortion is not known. It is better to rely on a maximum SPL specified for a broad frequency range, for example from 30 Hz to 20,000 Hz.

SEVERAL STANDARDS

A commonly used level of 0.5 percent or 1 percent THD is the point where it is possible to measure but not hear the distortion. As regards condenser microphones, it is important for the user to know the THD measured for the complete condenser microphone, preamplifier plus capsule.

Some manufacturers do not state maximum SPL for high-quality dynamic microphones, as they are rugged and capable of handling high sound pressures without overloading. They virtually never distort the signal and, even at sound pressures in excess of 130 dB, their distortion is not measurable.

The equivalent noise level also is known as the self-noise of the microphone. An equivalent noise level of 20 dB SPL means the self-noise is as loud as if the microphone were recording a sound of 20 dB above the threshold of hearing.

This is very low, corresponding to the noise level in a quiet recording studio with no air-conditioning noise. The self-noise also dictates the lower limitation in the dynamic range of the microphone. There are several standards in use.

The dB(A) scale, for example, filters out low-frequency noise and weights the SPL according to the sensitivity of the ear. Good results in this scale are usually below 15 dB(A). The CCIR 468-1 scale uses a different weighting, giving good results below 25 dB to 30 dB.

An AKG C 4500 B-BC Broadcast Microphone

HIGH SENSITIVITY

The output level (sensitivity) of a microphone is an expression of the voltage output at a given sound pressure.

The more sensitive microphone will sound louder for the same gain setting. This means there is no need for as much amplification as in the case of a microphone with lower sensitivity.

On the other hand, this also means that there would be a proportionally higher risk of feedback.

In applications with low sound pressure levels, a microphone with high sensitivity is necessary in order to keep the amplification noise low.

According to the IEC 268-4 standard, the sensitivity is measured in millivolts per pascal (mV/Pa) at 1 kHz. In addition, the sensitivity can be stated in dB, relatively to 1 V/Pa, which will give a negative value.

Some microphone manufacturers also state tolerances in sensitivity, usually in the region of +/− 2 dB. For example, 0.7 mV/Pa = −63 dBV; 2.2 mV/Pa = −53 dBV; 6 mV/Pa = −45 dBV; 12.5 mV/Pa = −38 dBV; and 20 mV/Pa = −34 dBV.

The author is a senior engineer at Radio Televizija Srbije in Belgrade, Serbia, and a professor in the Sound Recording Department of the Arts Academy at Univerzitet Braća Karić. ■

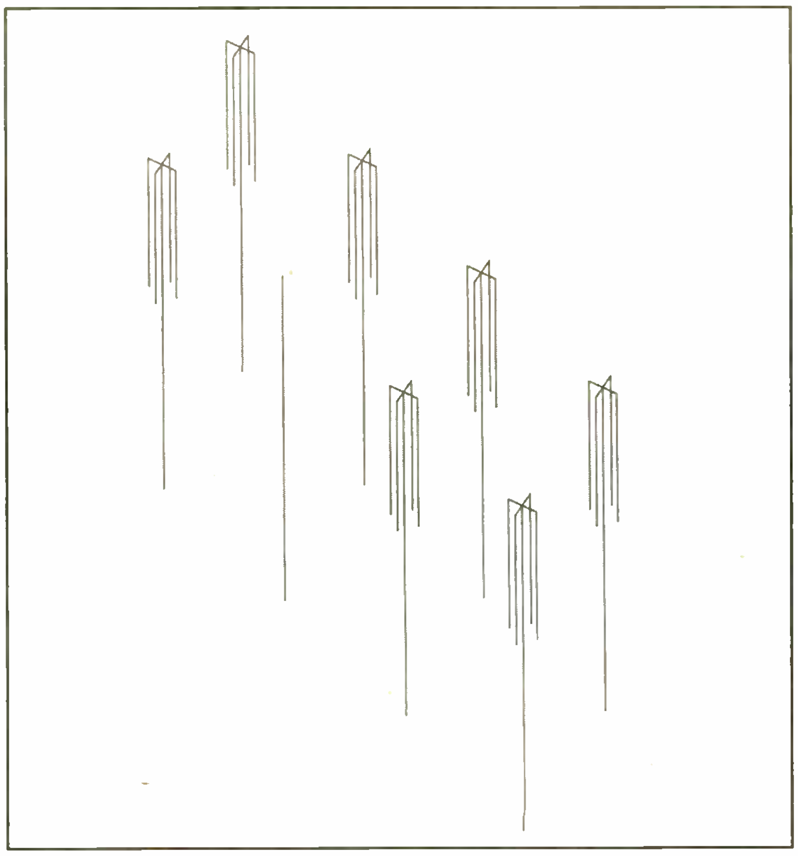
NEC

CONTINUED FROM PAGE 16

just the imaginary part, but treat it with the operator "j." When multiplying complex numbers, one of the terms is always j2, which is equal to –1, so the product will have the opposite sign of what one would calculate using simple values of X. If this sounds confusing and complicated, remember that I said Basic NEC is not light reading.

Current moments in a directional array are explained as the summation of the driven and induced currents in each radiator. The current moment of each tower is the foundation of what is required to get from the ratio/phase world we live in to the source voltage and phase world that NEC works in. The author then shows how to calculate the normalized drive voltages for each tower for a given set of field ratios. Here the author skipped over what would have no doubt been a complex and laborious set of simultaneous equations.

The more mathematically adept should be able to derive these equations from the material provided. For the rest of us the author has provided a piece of matrix inversion software that does it for us. In some ways I was disappointed the author didn't fully develop the equation set, but I think I understand why he did not. The bottom line is he did provide the necessary tools to compute the normalized drive voltages.



NVCOMP.EXE display of eight-tower array detuned with top skirts.

FIELD USEFUL INFORMATION

There is a wealth of useful information in the NEC-2 output listing, including current distribution, driving point impedances and radiation pattern. The author details the many uses for this information, including finding the target antenna monitor indications, detuning unused towers, finding the optimum heights for sample loops and designing matching networks.

Anyone who has done any amount of antenna modeling in conjunction with real-world measurements knows that the model never exactly matches the measured impedances, currents and operating parameters. A number of factors affect this, and quite often the practice is to adjust the model to force it to closely match the measured values.

Smith provides a chapter titled "Model by Measurement" that deals with adjusting the model for this purpose. He provides information on what model parameters affect what, such as the effect that the number of segments and tower diameter has on the modeled impedance.

Top-loading and skirting are dealt with in their own chapter. Smith explains how to create a model of both and the limitations of the NEC-2 core with respect to each.

Another chapter is devoted entirely to bandwidth analysis, an important topic in today's IBOC world. The author shows how to construct a model with matching networks, transmission lines, phase shift networks and common point network to show what the overall system and pattern bandwidths would look like.

To round out the book, Smith included several case studies, real-world directional arrays and towers that were both modeled and measured. These case studies show up the differences between modeled and real-world measured parameters, some of the limitations of the NEC-2 core and some workarounds.

While there is much more to antenna modeling than is included in "Basic NEC With Broadcast Applications," this book provides what broadcast engineers need to understand the modeling process of AM broadcast antennas. This is a very good place to start. In fact, it provides all the information about AM modeling that many engineers will ever need. The reader should come away with a good understanding of the modeling process, the limitations of the NEC-2 core and how he can utilize this powerful tool to speed the array design and tune-up process.

The book is available from Amazon.com or the SBE for $99.95. Society members get a $10 discount at the online SBE Store.

Cris Alexander is director of engineering, Crawford Broadcasting Co., Denver. ■

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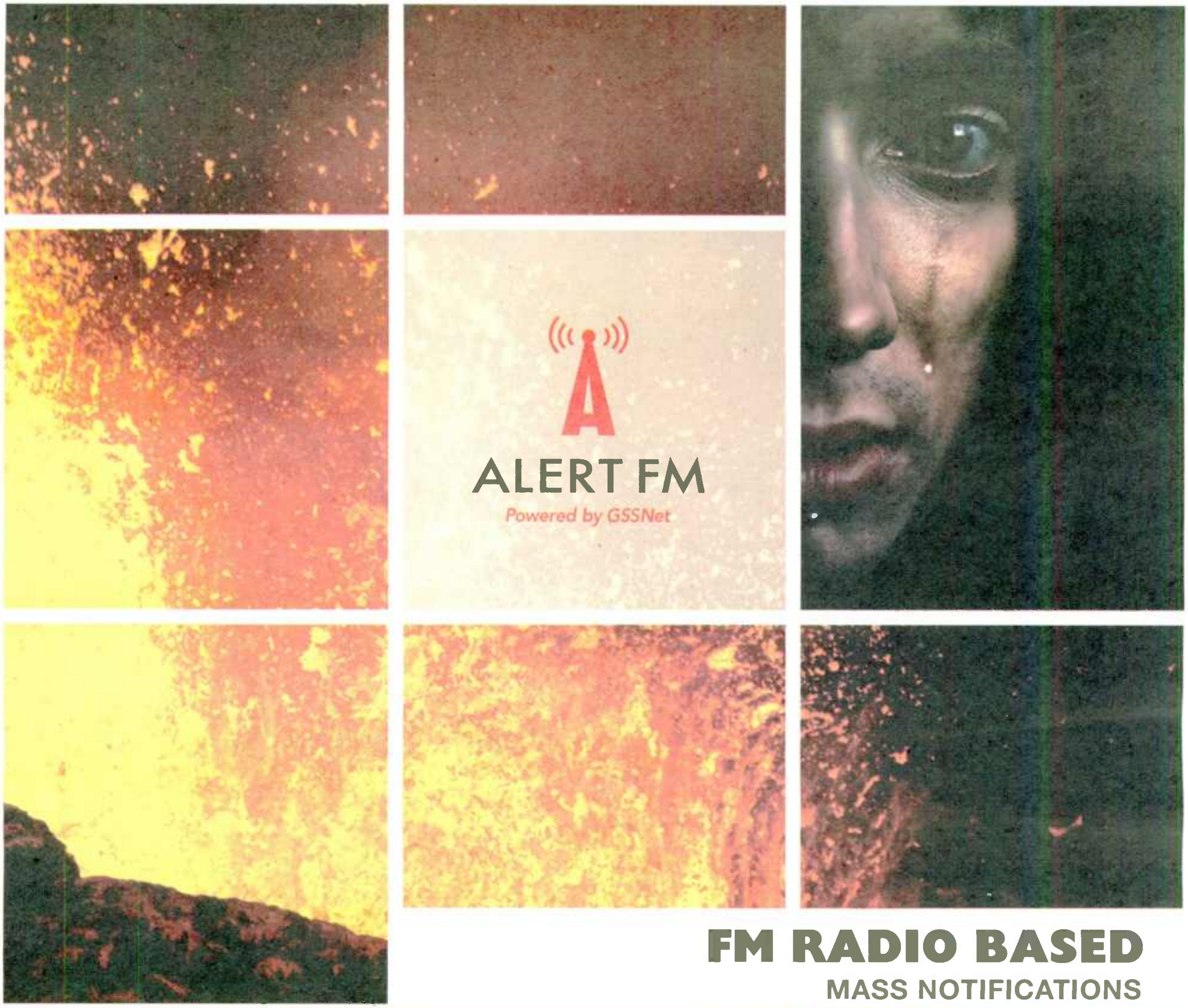

FM RADIO BASED
MASS NOTIFICATIONS

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Kelly

CONTINUED FROM PAGE 6

stations in the Philippines relative to one 50 kW AM station.

As shown in Fig. 3, the nearest station on the first or second adjacent channels to 558 kHz in Manila is DZMQ, a 5 kW station on 576 kHz in Dagupan City, nearly 125 miles away from Manila. Summing the power in each of the AM HD Radio sidebands, which fall within the second-adjacent channel of DZMQ from 571.5 kHz to 573 kHz, totals approximately 375 watts — nearly 200 km distant, and is unlikely to create any interference to either DZXL or the second-adjacent stations.

A more serious problem exists with 1062 kHz; see Fig. 4. We see that there is a first-adjacent station, DZEL 5kW, in Lucena on 1053 kHz. This station, only 124 miles away from Manila, would receive nearly 1,130 watts from the HD Radio sidebands of 1062 kHz.

It is likely that some secondary coverage areas of DZEL would be affected, and conversely, HD Radio coverage of DZEC in the Lucena area could be affected. It is important to understand that the digital sidebands above the carrier and the mirror image ones below the carrier carry the exact same information, thus if interference garbles the ones below the carrier, the receiver can fully demodulate the program audio — with reduced robustness.

Adoption of digital radio in these circumstances is likely to compromise secondary coverage areas, but the tradeoff is that within the primary service areas the broadcaster is able to deliver dramatically improved audio performance, as well as text data.

In summary, both DRM and HD offer broadcasters an opportunity to transition

Fig. 3: Frequency Chart DZXL – RMN – Manila

Fig. 3: Frequency Chart DZEC – Eagle – Manila

and they are dramatically different. HD Radio works a lot like the AM HD Radio system, with OFDM carriers on either side of the analog FM carrier so both the analog and digital signals are on a single FM channel. DRM+/DRM120, currently in development, are digital-only options, with the OFDM carriers occupying 96 or 100 kHz of FM spectrum.

FMeXtra utilizes OFDM carriers added to

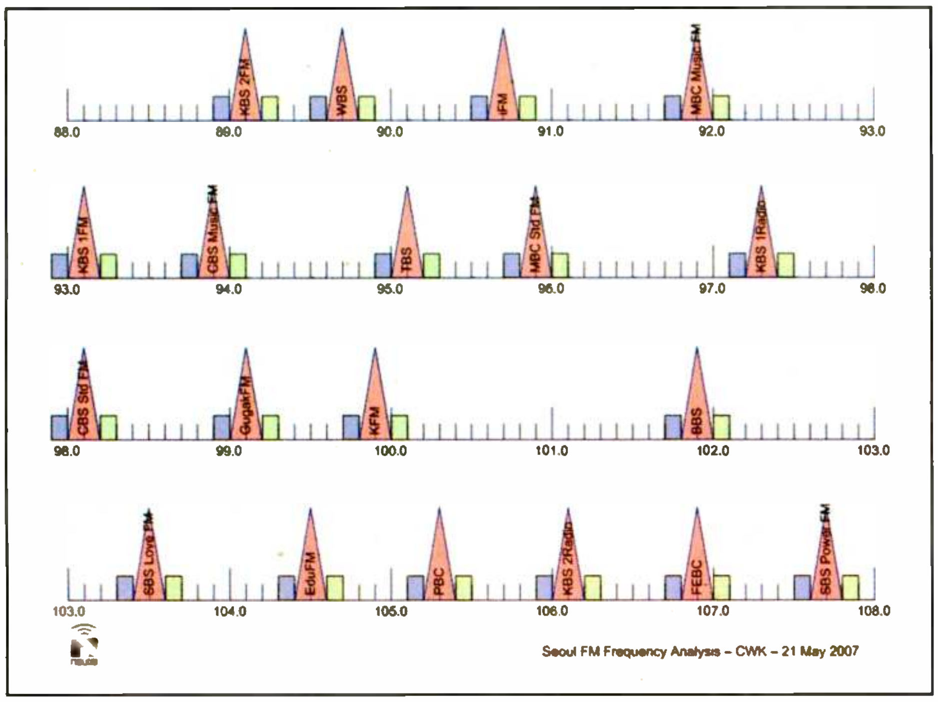


Fig. 5: Seoul FM Frequency Analysis

the AM band to FM-like audio performance, plus adding opportunities for data services. While HD Radio is a hybrid system in which one station carries both the analog AM signal as well as the new digital signal, DRM typically replaces the analog station with a digital only signal.

DRM excels in areas where the AM band has already died, and where the AM band is largely empty, while HD Radio may be the only choice where the AM band is fully utilized and there is no room for digital-only DRM stations.

FM IN-BAND SYSTEMS

There are three digital in-band systems, the composite baseband of a conventional FM analog signal, and thus the bandwidth of the FM signal does not appreciably change. Interestingly, FMeXtra may be operated on an existing FM HD Radio station, increasing the possible total digital payload.

As of this writing, HD Radio is currently on the air in 1,175 stations, FMeXtra is on the air at a reported 100 stations and DRM+ is in testing stage at several stations.

Fig. 5 is a graphical depiction of the FM band in Seoul, Korea, showing that FM HD Radio is compatible with existing Seoul stations. In addition, it can be seen that many DRM+ channels also could be fit into the band, or FMeXtra could be added to the existing FM stations.

The FM spectrum in Taipei, Taiwan, is depicted in Fig. 6. There are four educational FM stations between 88 and 89 MHz that are spaced by only 200 kHz. As can be seen, the HD Radio sidebands are on top of each other, and it is likely that poor coverage would result, with HD Radio reception possible only where one station has significantly higher field strength than the adjacent channels.

Between some of the stations, such as the ones at 89.3 MHz and 87.7 MHz, there is 400 kHz separation. Theoretically, this will work, however the reception of one of the sidebands may be impacted if the immediately adjacent sideband is significantly higher in received strength. This condition is not unlike blanketing interference in analog FM.

Note that in HD Radio FM, the sidebands above the analog carrier and the ones below the carrier are carrying the same information. While there may be interference in one set of sidebands, it may be possible for the receiver to decode the HD signal properly on just the clear set of sidebands, albeit with less robustness.

In some cities, stations on the FM band are spaced too closely for either HD Radio or DRM+. For instance, the metropolitan Istanbul, Turkey, market has FM stations virtually every 200 kHz from 87.5 to 108 MHz. In this situation, it may be that the only workable in-band digital system would be FMeXtra.

To summarize, the selection of a digital radio standard encompasses much more than simply the technical capabilities of the systems. An examination of frequency usage, both within the market, as well as far field, can reveal how a successful transition can be made with minimal interference.

This paper was first presented at the 2008 NAB Show in Las Vegas.

The author is is indebted to Tim Hardy, Nautel Ltd., and Glen English, Pacific Media Technologies. ■

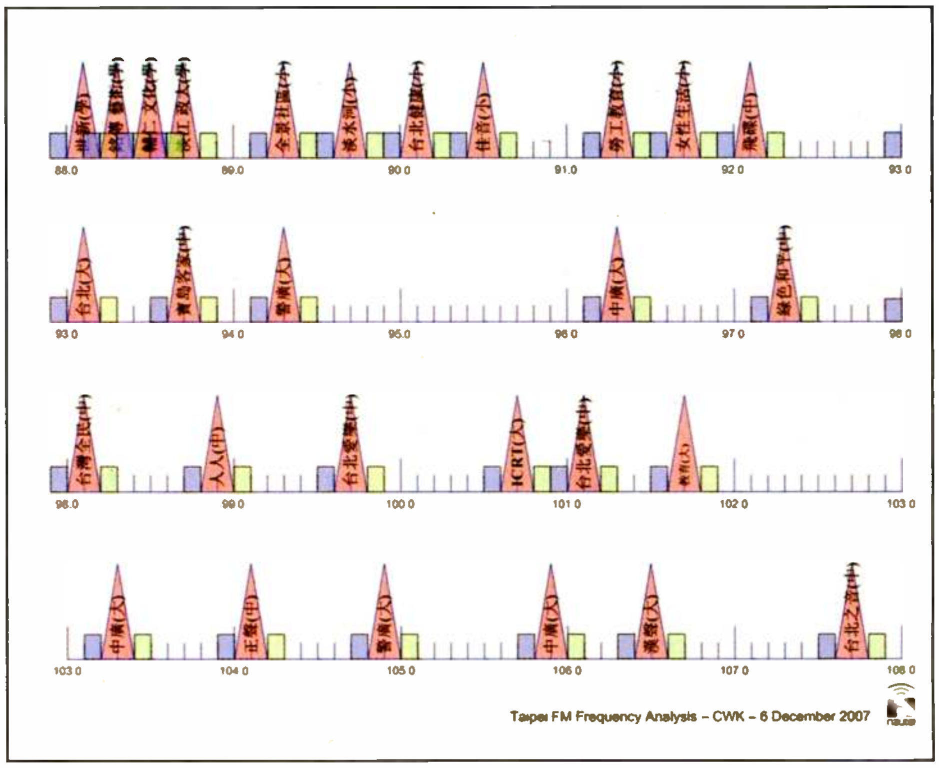


Fig. 6: Taipei FM Frequency Analysis

World Radio History

by Joe Stack

Sensor-Oni (Pronounced Like Rice-A-Roni)

Build an After-Market Indicator Sensor For Remote Monitoring Applications

Some pieces of equipment have no capability to be monitored remotely. There are consumer or semi-pro devices that have been delegated to broadcast use; there is older broadcast equipment that is still in use and working reliably. I've also come across new items that don't offer a tally output that follows front-panel indicators.

It is possible to open the equipment and directly solder to the existing indicator. The downside is that this may take a lot of extra time. It can void a warranty, and the equipment would need to be powered down and removed from service for the modification.

You may need to sense the on/off state of an indicator (LED or otherwise) on a piece of remotely-located equipment and send this information back to the studio or master control location. The need for remote monitoring is even more immediate if the device is a part of a mission-critical application, like part of the air chain.

LIGHT LEVEL

Sensor-Oni is a light-dependent resistor mounted within two concentric grommets and designed to be mounted over a front-panel LED indicator.

The indicator can still be seen through the grommet center hole — some of the indicator output is "seen" by the light sensor through a small hole in the side of the grommet.

This change in light level is sent by a tiny #26 AWG wire pair to the support circuit that amplifies, level-detects and drives a relay.

The relay contacts can be connected to the site remote control system tally/status inputs to alert operators at a distant location and/or sound a local alarm.

Fig. 1 shows the sensor. The sensor unit itself is the round, black item at the center of the bottom of the picture. In this case, the gray wiring is connected to a mini-plug; this mates with a mini-jack on the small black box. That box contains some circuitry and two AAA batteries and a green indicator LED.

I used this setup to do initial testing to check sensitivity and operation of the device. The small plastic black box is slightly longer than an AAA battery and slightly wider than three AAA batteries side by side. In operation, the green LED gets brighter as the intensity of the light inside the sensor increases.

The sensor was affixed to the front panel of various pieces of equipment and different colors of indicators to check the performance.

There was some sensitivity to ambient light changes and, of course, shining something like a flashlight directly into the front of the sensor will cause a false reading.

MINIMALIST

I discovered that, to be useful, Sensor-Oni needed more support electronics added for reliable, predictable operation.

First, some sort of user-settable threshold adjustment was needed (a trimpot) as well as an interface to the outside world (relay contacts).

I used a minimalist approach to the electronics, adding only parts that were necessary for the system to work. This leaves plenty of room to hot-rod the circuitry later, but it gets you up and running with a practical device quickly.

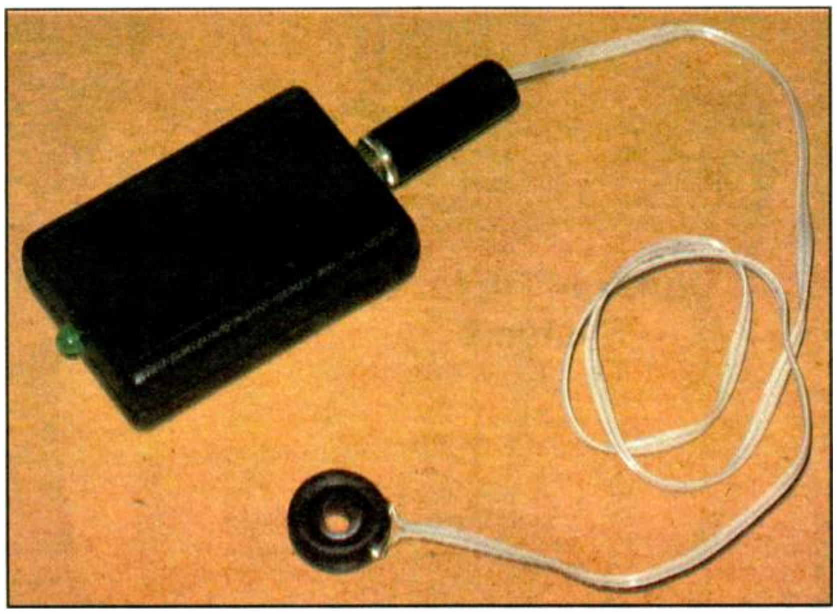


Fig. 1

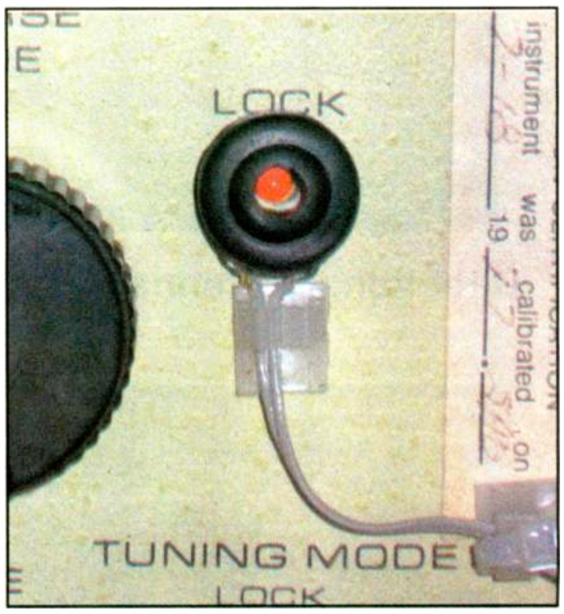


Fig. 2

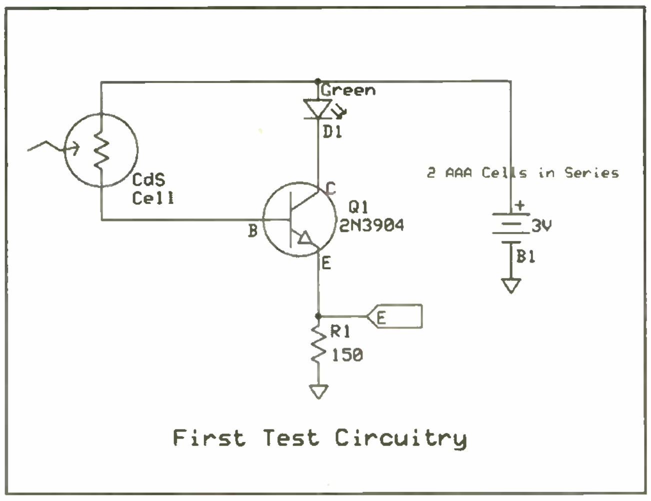


Fig. 3

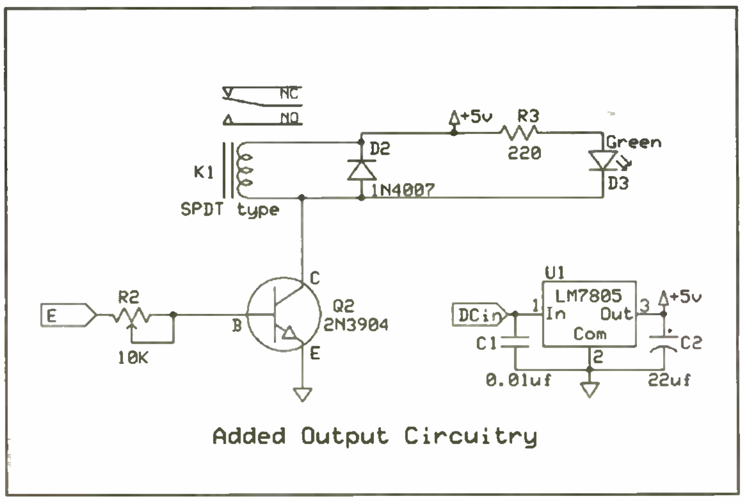


Fig. 4

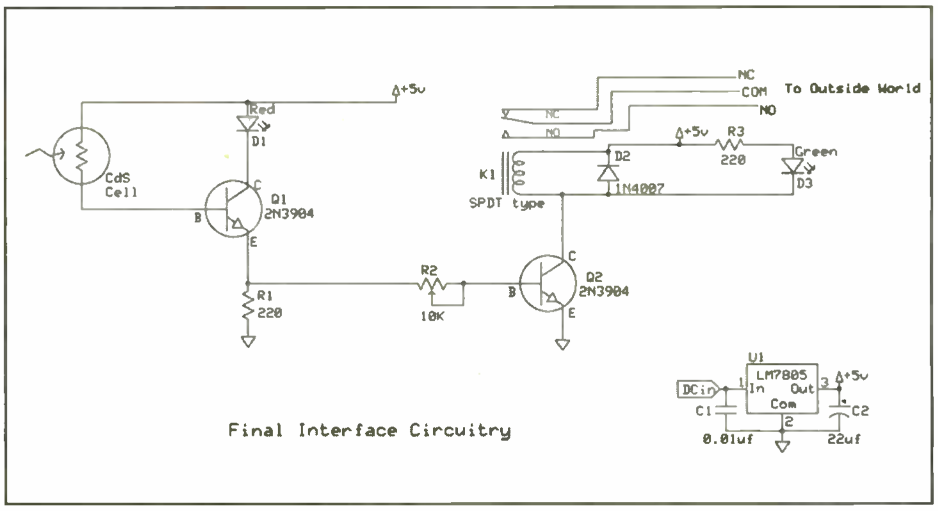


Fig. 5

Fig. 2 shows the sensor on a front panel — double sticky tape is behind the grommet arrangement and small adhesive-backed wire clips are added for support. I know that engineers are creative and can improvise according to the particular situation.

Fig. 3 is the schematic diagram of the sensor and black box as shown in Fig. 1. The transistor is a standard 2N2222 type and the resistor can be carbon film or metal film depending on what is available. The AAA power supply was used for convenience.

The green LED, seen sticking out of the side of the black box housing in Fig. 1, goes from dim to bright depending on the amount of light hitting the inside of the grommet assembly.

The light-dependent resistor device I chose is a cadmium sulfide cell, shown with the designator "CdS" on the schematic. It was in my parts drawer with a bunch of other ones. These can be picked up at a RadioShack, sometimes in a multipack of 10 or 15 together.

Measure the dark and light resistance. For this application, I chose a CdS that was small enough to fit inside the grommet assembly and it had a resistance of approximately 15 kohms when two feet under a desk lamp using a 40 watt bulb. Additional resistors may be needed in the CdS circuit depending on cell resistance.

Fig. 4 is the additional circuitry needed to interface to other equipment in the outside world. The two points labeled "E" connect together to form the complete circuit of Fig. 5.

Note that R1 was changed to 220 ohms after B1 was replaced with a +5V supply. An optoisolator could be used in place of the relay. I chose a relay since I had them on hand.

R2 is the sensitivity adjustment. It is rotated until the relay pulls in when the indicator being sensed lights up. The green LED at D3 shows when the relay is pulled in.

Finally, the normally-closed (NC), normally-open (NO) and common (COM) relay contacts are used to interface to the tally/status equipment at the studio or transmitter site, depending on the application.

Fig. 6 is a photo of the CdS grommet sensor and the circuitry on a protoboard as built — the three colored wires coiled up near the relay are the relay contact outputs.

The 9V battery clip is attached to a 9V batter for testing — no external supply needed!

An on-the-wall transformer with a DC output of 8V to 30V would work as well.

SEE SENSOR-ONI, PAGE 37

by Charles S. "Buc" Fitch

What Do You Do With a Static Drain Coil?

Question posed in the last issue (Exam level: CBRE)

An RF static drain coil is used where and for what purpose in your radio station?

a. An important device in any switching supply. Actually an LC circuit, the static drain coil shunts the high-voltage back spike to ground when the magnetic field stored in the main switching inductor collapses at turn off.

b. The proprietary curlicue spikes normally on top of a tower to drain static buildup.

c. A high-impedance coil usually attached from the antenna input to ground to drain off static charges caused mainly by lightning or wind-driven dust.

d. The small inductive value (normally built in to the tube socket) between the input and screen grids in a VHF power tube to avoid internal arcing.

e. The near-mandatory conductive rug that you should be standing on whenever you work on CMOS circuitry to avoid device destruction.

Society of Broadcast Engineers certification is the emblem of professionalism in broadcast engineering. To help you get in the certification exam frame of mind, Radio World Engineering Extra poses a typical question in each edition. Although similar in style and content to exam questions, these are not from past exams nor will they be on any future exams in this exact form.

The correct answer is c.

The best ideas are the simple ones that solve a larger problem with elemental elegance, and the static drain coil is an excellent example of this maxim.

The problem we have before us is to attenuate in intensity the static charges, either around the tower before a discharge or after high voltage is induced into the system when lightning strikes, and in unique cases where a static charge build-up is developed by wind driven dust or sand. Serious damage can result if the discharge or strike is large enough and finds an errant path to ground through your transmission plant.

The static drain coil is but one element of the system that accomplishes this attenuation. At a minimum, three components are present: the arc gap, the tower grounding and the static drain coil. These components are integrated into the antenna of a typical AM station and its antenna matching system, which is essentially a high-frequency AC network power matching scheme.

The ATU part of that system was discussed previously ("Are You Ready for the SBE Exam?" in the Feb. 20 issue) as the way to match the transmitter to the ether for maximum power transfer. The usual connection for the static drain coil in a series AM antenna is between the ATU output and the antenna input, with the arc gap essentially in parallel with the coil.

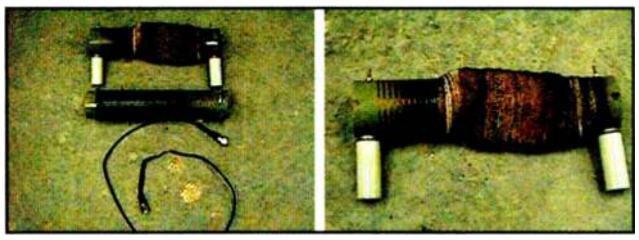
In practice, this static drain device can be either a high-impedance resistor (non-inductive 100k Ω, 200 watt is the industry standard) or a coil with high reactance. The latter is more common. The other end of the coil or resistor is solidly connected to the antenna ground system right at the base of the tower. The static drain functions as a dissipation path to ground, keeping lightning and static charges out of the antenna tuning system.

Inductive reactance increases with frequency (inductive reactance = $2*\pi*f$L, where f is the frequency and L is the inductance). Inductive reactance impedes the flow of AC current and, as you can see from the above formula, the impedance grows larger with frequency. This concept is the key to how the static drain coil works and survives.

In the case of the coil, an inductance is selected such that at your operating frequency its reactance is so high that virtually all of the power from the transmitter flows through the ATU and into the antenna; in effect the static coil appears to be an open circuit at radio frequencies. However, the DC resistance of the coil to ground is just a few ohms.

Static charges are close to DC in frequency and drain down to ground through the low reactance (near DC resistance value) of the coil. To help this process, a series capacitor is usually the last component in the ATU to prevent any DC from flowing backwards from the antenna into the ATU.

As a practical matter, the design of the inductive static drain is usually a 2 or 3 inch diameter coil with more than 100 turns of #20 or so size solid wire. This wire cannot



Fried Static Coils

mechanically support itself so a coil form of some type is used. The RF at the point of connection can be in the neighborhood of 1000 volts (or higher if the base impedance is very high), so the coil winds at the top are more widely spaced to avoid arcing between winds. The spacing is progressively less as the potential diminishes towards ground.

Obviously # 20 wire cannot withstand the large sustained current flow of a lightning strike so the companion device, the arc gap, is used to pass the large current to ground of a direct strike.

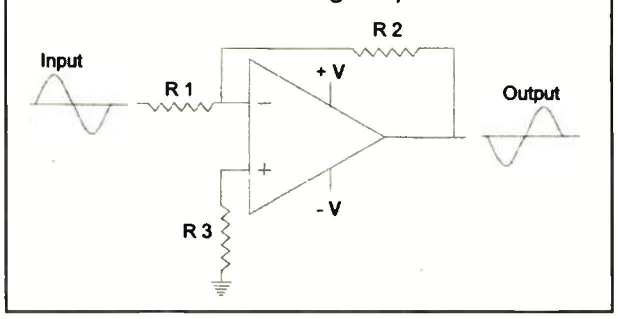
The physics works like this: The arc on the gap occurs when it is forced to do so by the high impedance that the lightning "sees" at the static coil. The very fast-rising wave of the initial component of the lightning strike acts as a high-frequency impulse, creating high impedance to any current flow through the coil. This forces the energy to the arc gap and with the resultant arc most of the energy in the strike is dissipated to ground … we hope.

As the intensity diminishes the frequency drops, lowering the impedance of the coil and theoretically allowing a current flow that the coil can handle. There is little defense for the strikes in the "grand mal" variety and the coil may open (like a fuse) from the excessive energy that dissipates everywhere and anywhere it can (see Figs. 1 and 2). For this reason, most antenna maintenance schedules should include a DC check of the coil to make certain the coil is continuous (has continuity to ground) and still functional.

Although many antenna systems depend on the ground screen to take those lightning strikes to ground, experience indicates that an additional lightning ground grid made up of at least four ground rods driven vertically into the ground around the base of the tower, in something like a 20 ft diameter circle and connected directly to the ATU, minimizes the dissipation distance and overall damage from a significant strike.

For an overview of the care and maintenance of your static drain along with the rest of the components around it, visit John Bisset's 2000 *Workbench* article at *http://radioworld.com/reference-room/workbench/rr-workbench52.shtml*.

Basic Inverting Amplifier



A CBT question for next time: "In the above schematic, what component or components sets the amplifier stage gain?"

a. The gain is set by the chip itself and can be obtained from the IC flysheet.

b. The gain is set by VCC, as the higher the supply voltage the higher the gain.

c. By the value of R3, as this resistor to ground sets the offset bias seen by the op amp, hence the gain.

d. By the value of R2, as this resistor sets up a voltage divider with the very small input resistance of the op amp and thus the feedback level.

e. R1 and R2, as they create a voltage divider setting the feedback level and thus the gain.

Buc Fitch is a frequent contributor to Radio World. Miss one of his SBE Certification Corners? Visit radioworld.com *and click on the Certification Corner tab.* ■

Tech Editor

CONTINUED FROM PAGE 3

HIGH POWER HD-R IN RWEE

We are doing our own bit to further the dialogue on high-power HD with a paper in this issue from Shively Labs' Bob Surette. He proposes an entirely new way to think about high-power digital radio.

Back in April I posed the question, "Is FM ready for high-power HD Radio?" My point was that the existing implementations have flaws when we start to think about increasing the digital power to 10 percent of analog.

For high-power stations like full-power Class B and C FMs, the technologies we are using today do not appear to be cost-effective, with perhaps the exception of separate dual antennas. However, this solution has had notable problems including the generation of self-interference and poor coverage performance.

Surette responded to my question with some new ideas about the use of high-efficiency combiners to put together the digital and analog portions of HD Radio, similar to the method used for decades to combine the video and audio carriers in NTSC television. His paper appears in this issue and offers a new approach to high-power HD.

We selected Surette's paper because it is an important part of the engineering dialogue going on right now about how technically to accomplish the next step in HD Radio. The major manufacturers of radio transmission equipment are working on solutions to high-power HD so they can offer functioning and cost-effective products in the event an increase in digital power is permitted by the FCC. It appears likely that many stations would jump at the opportunity to upgrade.

Regular readers of RWEE know we have discussed all aspects of implementing in-band on-channel digital radio since our first issue. The reason for the close attention is that this is the most significant technical change in transmission methods for radio in the last 40 years.

IBOC remains the most important technical story for radio broadcasting and we will continue to cover the latest technical developments. We welcome submissions of white papers on this topic and other topics of importance to the industry, from any and all companies that want to add to our engineering dialogue.

Also of note in this issue is the paper from Chuck Kelly, director of sales for Nautel. He explores the existing FM allocation schemes in several countries and notes how each country has unique challenges that may affect their decision on a digital radio standard.

Radio World Engineering Extra is here for all of us in the radio engineering community. Please take a moment and send me a note whenever you see something you like or dislike in this paper. Write to *radioworld@nbmedia.com* or to me personally at *mlrwee@verizon.net*. We enjoy your comments and they help us to bring you the best paper possible. ■

by Cris Alexander

Construction Only an Engineer Could Love

When It Comes to New Towers, FCC Clearance Is The Easy Part; It's the NIMBYs Who Stand in the Way

In the early days of radio, there wasn't much in the way of opposition to new radio towers of just about any height. Certainly there were practical restrictions, and broadcast towers often were built outside of town to have enough real estate to encompass the guy wires and ground system. But in those days, building a tower, even a tall one, was a relatively simple matter from a regulatory standpoint.

Even in the early years of my career, the 1970s and 1980s, building a tower or towers wasn't too tough. In many locations, you didn't need permission from any local jurisdictions. If you had that FAA "No Hazard" and an FCC construction permit, you were good to go; call in the backhoe.

I fondly recall building a five-tower directional array just outside of Plano, Texas, in 1989 without talking to a single person at the local level. It was our land and we had the requisite FAA and FCC clearances so we built; no questions asked. Those were the days. Boy, do I miss them.

Site of the E-H Loop Antenna Tests

Nowadays, getting FCC and FAA clearance is a piece of cake compared to getting required local zoning and permits in most places. But even at the federal level there are new challenges.

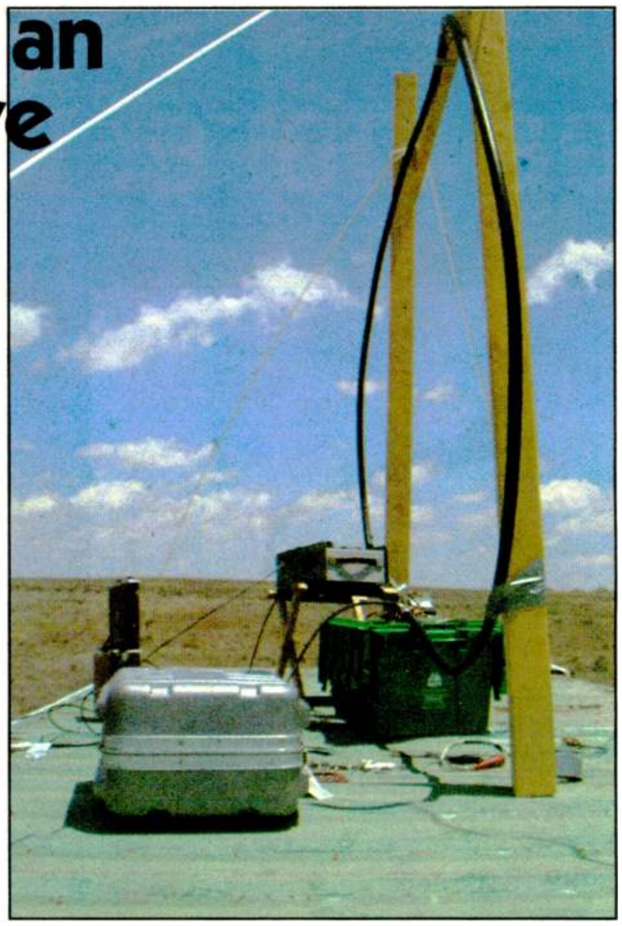
We must jump through a lot of hoops to comply with the National Programmatic Agreement (NPA) to insure we don't inadvertently build on a historically or culturally significant piece of dirt. And the FAA uses an overly conservative model for determining whether a broadcast operation will cause interference to airborne and ground-based stations in the adjacent aviation band. Occasionally we even have to take extraordinary measures to protect migratory birds.

But it's often the locals that give us the most grief. "Not in my backyard!" ("NIMBY") is the response often heard. No one (except perhaps radio engineers) wants an ugly tower anywhere within their view. And besides the aesthetics, there's really no telling what kinds of "radiation" comes off those things, right?

Granted, some locales are more challenging than others. I was driving through the countryside west of Chicago recently and was amazed at the number of towers dotting the landscape. Indeed I have put up a couple of towers in that part of the country in recent years myself without too much difficulty. But try the same thing in, say, Orange County, Calif.!

Just for fun, I recently did a countywide search of the FCC's Antenna Structure Registration database for towers in excess of 200 feet in overall height. I could count the number of hits on one hand.

The same is true where I live in Colorado, at least until you get well out onto the eastern plains where only the deer and the antelope play (and maybe a few prairie dogs). Try to build anywhere close to a settled area and you can just about forget it. We have come to call the local mindset, "BANANA" — Build absolutely nothing anywhere near anything!



Container-top Loop E-H Antenna at Tim Cutforth's Antenna Test Range

Laugh if you will, but it's a fact of life. People don't want towers dotting the landscape, messing up the view and doing who knows what else.

AM HAS IT WORST

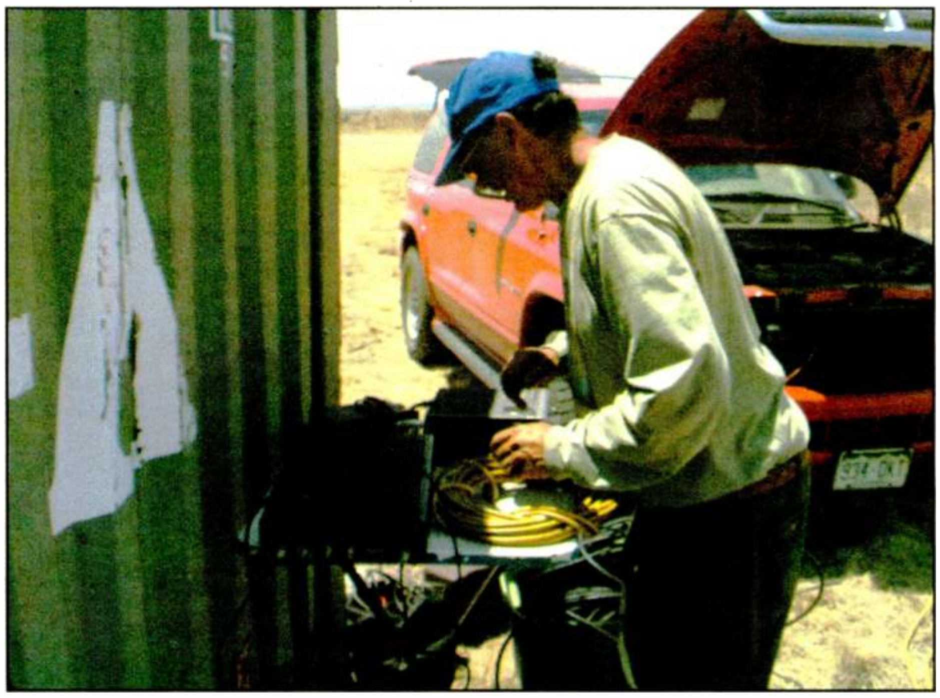
For FM and TV stations in the Intermountain West, mountaintop sites often present themselves as viable if not logistically difficult options. Find a mountaintop with some sort of wheeled access but that is nowhere near anyone's residence and is out of anyone's line of sight and you may well find you'll be able to erect a short tower or other platform to support an antenna. The high elevation often translates to low ERP, so RF radiation isn't that much of a concern, and the clear, line-of-sight path to the community below provides good service.

But AM stations still face the challenges of NIMBY and BANANA. We need sufficient physical height to achieve minimum or better efficiency, we need proximity to the area we wish to serve and we need good ground conductivity. Those factors often work in opposition to one another.

The closer a tower is to a populated area, the more opposition it will generate at the local level and the more likely it is to be subject to local zoning that severely restricts, if not outright prohibits, tower construction. We could move further out, but then we would have difficulty serving the population, especially at night. We could shorten the tower or towers, but that reduces efficiency, and the FCC will not authorize anything shorter than about 54 electrical degrees — more than 200 feet at 700 kHz.

This brings me to the topic of the day: alternative antennas. You've heard it said that if you build a better mousetrap, the world will beat a path to your door. There's truth in that. I would offer a broadcaster's variation: If you can build a very short, low-profile AM antenna that meets minimum efficiency requirements even at the low end of the band, broadcasters will beat a path to your door.

That truth hasn't been lost on radio engineers, and many have spent a good bit of time and effort trying to develop just such a "backyard antenna" for AM, something that is short, has a small footprint and can be located on a rooftop or city lot.



Tim Cutforth, P.E., prepares the transmitter and power amplifier for the test.

Recently, the Valcom Whip was approved by the FCC for AM station use above 1200 kHz. At only 85 feet in height and with a very small visual impact, this antenna may well be the "better mousetrap" for AMs at the top of the dial. But it cannot be used legally below 1200, so for the lower end of the dial the search is still on.

Then there is the Kinstar, which has some height advantage over a full-sized radiator, but at the low end of the band it still requires some height and a good bit of real estate.

THE CROSSED-FIELD EXPERIMENT

One antenna we heard quite a bit about in years past is the "Crossed-Field Antenna" (CFA). This antenna was developed by Dr. Maurice Hately, F.M. Kabbary and B.G. Stewart back in the 1980s. Resembling a big funnel, it operates on the principle of generation of electric (E) and magnetic (H) fields that are in phase and operate as a point source with no nearfield effects. A number of these antennas are reportedly on the air in Egypt, India and China.

SEE TOWERS, PAGE 30

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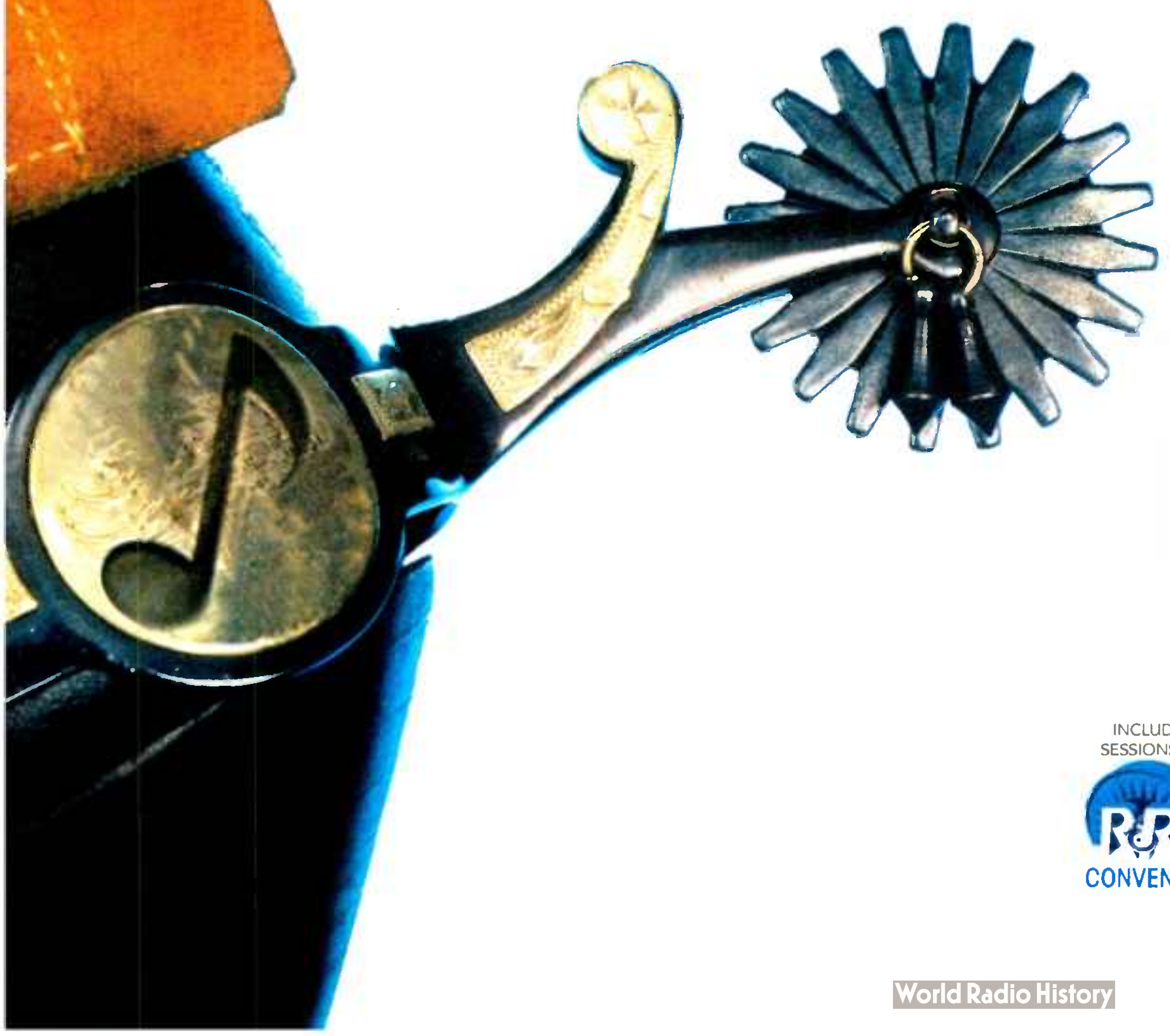

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Radio Seeks to Do More With Less

How Outsourcing, Instant Messaging, Voice-Tracking And Telecommuting Are Changing Our Stations

For many old-timers and battle-scarred vets in this business it wasn't too long ago that there was very little digital anything inside a typical radio station.

Analog consoles with rotary pots fed by carts and tapes ruled the studio. Everything in the air chain from the studio through the STL and transmitter to the antenna was pure analog.

Then came early digital control circuits in remote controls along with monitoring and test gear with digital displays. The CD appeared about the same time personal computers showed up in stations in the early '80s. Since then it's been a title wave of digital gear displacing virtually everything analog.

Programming and sales went through their transition as well. Jocks used 3 x 5 cards to read liner breaks, and secretaries clicked out the logs and paperwork with IBM Selectric typewriters. Sales folks pounded the pavement with their feet, cars and Bell system deskphones as the only means of hooking up with clients.

Now, almost every station employee stares at an LCD screen and processes most of his or her business for the day via a PC keyboard and a wireless device of some kind. The same routine carries on at practically any business of any size almost anywhere you care to mention. Even small isolated towns are no longer immune to doing most everything digital.

I've been guilty of carrying on long conversations with fellow employees only a few offices away, staying glued to the keyboard and never uttering a sound.

Some employees prefer instant messaging over e-mail. My general manager recently enforced a "no e-mail or IM day" for communicating with anyone else inside the building. We had to find our recipients in person and actually talk with them. Unfortunately very little work got done that day.

Bill Gates recently retired from Microsoft. The IT trade press gave him well-deserved accolades for changing the world, and many writers wondered aloud how the commerce of today could possibly function without the advent of the PC.

The evolution of micro-electronics also is a huge part of how technology has totally transformed how we, and practically every business of today's era, get things done.

STREAMLINED INFRASTRUCTURE

Except for the new "digital assets" and Internet presence, radio's basic product hasn't changed much throughout this transformation over the past 30 years. It's still about producing and delivering information, entertainment and companionship. The efficiencies of the digital tools we now use allow fewer people to do more of the work. And we're doing that with a significantly streamlined equipment base and infrastructure.

Today's radio control studio can be little more than a small mixer, a couple of mics, a PC or two for automation and maybe a CD player and a satellite receiver. Of course larger stations will have an expanded version of that with additional sources, players, switchers and processing equipment. Today's reality is that it doesn't take much to be able to tap into and launch a rich offering of programming content to a transmitter.

Except for large multi-station clusters and networks, where extensive Technical Operation Centers with rows of rack gear are still needed, most stations can function just fine without much infrastructure. Gone are the walls and cabinets full of punch blocks and cross connects. Gone are the jackfields and patch cords that were once commonplace. Even the big TOCs have been downsized with various new IP-based options.

My GM recently enforced a 'no e-mail or IM day' for communicating with anyone else inside the building. We had to find our recipients in person and actually talk with them. Little work got done that day.

Audio mixing, switching and routing, all interconnected with Cat-5/6 cabling using IP, are taking over from the traditional mixed analog and digital infrastructures of the recent past. Studio and technical operations can be squeezed into smaller floor spaces and made quite portable. Little equipment needs to be "nailed down" or built-in any longer. I've seen a few new facilities built with modular portable cabinets and tables with all equipment racks on wheels.

It's probably a good thing that radio has found new ways to do more with less. The recession has merely accelerated a long-term trend of downsizing the overall business in terms of the required people, space and equipment needed to run it.

As competing digital media have carved into radio's share of the money pie, more radio station and group owners are reluctant to place long-term bets on "business as usual." They aren't doing 20- or 15-year leases for transmitter and studio facilities anymore. Ten years seems common with a five-year extension option.

Going forward, lease terms for studios will likely shrink to five years or less with options. Why commit to anything longer with such a volatile and uncertain market, especially since it's easier and cheaper to move operations than it had been in the past?

TELECOMMUTING IS THE ANSWER

Not only will lease terms shrink but the amount of floor space typically used by stations also will get chopped down. With more and more employees using remote connectivity to get their work done, managers are realizing it's not necessary to provide exclusive offices and cubes for every employee. Shared work spaces and departmental common areas make more sense.

A lot of other businesses are moving in this direction and have reduced office space and embraced telecommuting as the perfect way to reduce costs and give employees more flexibility. Not having to fight rush hour traffic every day, just by itself relieves lots of staff stress and frustration. But radio has been slow to respond and reluctant to step up. There is still the apprehension that employees won't give a full-time effort unless they're sitting at their desks in the office.

The resistance to telecommuting as a means to enable responsible employees to be more productive is really silly and ends up being counter-productive.

Perhaps the most positive and welcome incentive employers can give their more valued workers is more flexibility in schedule and where they get the real work done. Unless you're blocking all IM connections and heavily filter Internet access at your station, employees generally waste entirely too much time sitting at their desks on PCs anyway.

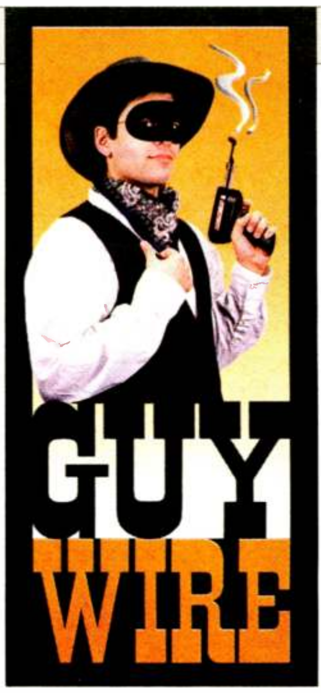
Newer employees may need daily in-office regimentation; but the vets who know that performance is ultimately the only thing that matters would almost universally welcome the telecommuting option. Certainly ground rules have to apply but it's a solution for which the time has come.

Telecommuting is especially appropriate for sales folks. The tools they need to execute their mission successfully are contained in their laptops, on top of their shoulders and in their driveways. An occasional visit to the office for staff meetings, pep talks from the GSM and to pick up new marketing materials can happen by scheduled appointment.

OUTSOURCING AND MORE OUTSOURCING

If you haven't heard the GM mention this term yet, you will soon. Except for the key staff positions responsible for directing the daily grind of producing programming and generating advertising revenue, most of the other support functions are candidates for outsourcing. Not having to pay employee benefit costs saves big money.

The vast majority of small-market stations dispensed with employing full-time engineers years ago. Contractors and part-time engineering support arrangements have had to fill that void. Particularly for RF and transmitter site support, the use of outside contracting is now commonplace, even in major markets. Engineering was perhaps the first traditional radio station job category that was outsourced.



As the skill set needed for broadcast engineering support increasingly required IT expertise, that function also has become another area being outsourced. If the LAN infrastructure and desktop management are properly designed and deployed, IT support becomes primarily a help desk function to keep employees productive. But that is a big if, and is often more the exception than the rule.

Contracting an IT service company for remote and on-site support as needed appears to be gaining preference for many managers. Using a contractor can save money compared to hiring a full-time employee to dispense that service. The key is getting the right contract service that can cover everything needed at the right price. But hiring IT companies not familiar with radio operations to support PC-based audio production and delivery systems can create more problems than it solves.

TRADING AWAY LOCAL SUPPORT

While many will argue that stations without full-time engineering and IT support will never run as reliably or efficiently, managers know that today's broadcast and computing equipment is more reliable than its predecessors. They are simply willing to exchange the additional risk and occasional staff frustration of broken processes or equipment for the operating cost savings.

Managers have to gauge the loss of staff members' productivity when they encounter IT malfunctions and cannot complete tasks until outsourced help comes to the rescue. If they have engaged online remote help desk services, that may be enough in many cases.

Many of the larger groups have deployed internal or contracted help desk services for their stations. As remote access becomes more widely used to maintain IT operations at every level, it's not inconceivable that many groups will choose to scale back local-station IT support personnel and let a single centralized help desk do most everything.

That seems almost sacrilegious to most of us, but know that it's probably coming.

NOW FOR THE CAVEATS

Whether outsourcing technical support can succeed will depend on many factors. It may work okay for many smaller stations and groups, but for larger operations the added insurance of having on-site technical support to resolve problems quickly as they occur will remain the best and cheapest

SEE GUY WIRE, PAGE 34

Guy Wire

CONTINUED FROM PAGE 32

insurance. It only takes one blown big remote, one extended off-air outage or one extensive LAN failure of any kind to trigger big losses in advertising revenue.

With additional HD-R formats being added by many stations, one would think the number of studios and personnel needed to support them should be increasing. With only a few notable exceptions, that does not appear to be happening. The additional HD2 workloads are being dumped on existing employees in most cases. Most HD2 stations are merely automated PCs in a rack.

Those HD2s are the secret stations between stations that offer so many exciting new formats. But they're stuck in the classic Catch-22. Unless we give them proper care and feeding and promotion, they won't stay exciting for long. Care and feeding cost money. Without audiences or ad revenue, the only support they get is the faith and hope of owners and managers committed to HD, and the minimal effort of overworked programming and production staff.

This conundrum will not change until HD2 stations become more commercialized and are able to build significant audiences. Something's gotta give. Getting HD and HD2s off the ground is going to take a lot more work and innovative new thinking. Maybe it's time for an Iraq-style troop surge to turn this around.

We've done a lot of crystal-ball gazing over the years, hoping to see where this business is taking us. Managers under pressure to downsize in this recession are facing tough choices. Layoffs are painful and send negative vibes throughout the entire staff, especially when they come in bunches, as we've seen in recent months.

THE GRIM REAPER

Managers prefer natural attrition as the easier way to reduce staff. They'll shift work loads left behind to those who are willing to hunker down and work longer and harder. But even that solution is beginning to take its toll in many markets.

Radio is struggling more than ever with a dated image and that's also taking a toll. Fewer young folks are attracted to it as a career choice. No wonder it's become increasingly difficult to find qualified people to fill many of the openings in the departments that keep radio's engine running.

This is especially true for engineers. Clear Channel has many CE openings that are going unfilled. Clear Channel engineering management recently held several meetings to brainstorm possible solutions. Outsourcing to contractors and bringing in corporate engineering support for construction and special projects is proving to be the only stop-gap solution.

Most other radio groups have little in the way of corporate engineering support so outsourcing is often their only option. Finding and grooming young talent should be a priority for radio managers. Yet there seems to be few companies devoting any kind of organized effort or plan to do so for most positions. If they can't outsource or double-up, GMs are content to steal somebody from across town, or import their best out-of-market candidate for the asking price.

RADIO SOUL FOOD

Outsourcing may be a solution for some tasks but it steals away a bit of the station's soul.

Voice-tracking from distant voices who masquerade with localized liners has been another form of outsourcing that has stolen radio's soul. It saves money for a while but eventually marginalizes the station's image as no longer live and local or a true member of the community. Listeners aren't stupid. They know who's real and who's Memorex.

The sweeping staff cuts most stations endured over the past six months are probably not over. Expect another round before the end of the year, especially if the recession deepens as the price of oil spirals upward, international tensions boil over and more bank failures hit the economy.

Radio has had a long and profitable ride. Many successful radio companies have churned out tons of cash and enjoyed big profit margins for a long time. But we may be nearing the point where significant reinvestment back into the business, and the people resources that have built and sustained these companies, are sorely needed to keep them healthy and alive.

These uncertain times present great opportunities for the enlightened owners, managers and employees alike, to succeed and prevail. The less-enlightened will fail and fall by the wayside.

We can only hope you are working for and are among the enlightened.

Guy Wire is the pseudonym of a veteran broadcast engineer. ■

MARKETPLACE

MusicamUSA Expands Suprima IP Line

MusicamUSA added a redundancy protocol backup feature to its Suprima IP codec. It says in order to ease the configuration of Suprima IP codecs, a new mechanism of redundancy was developed based on IP.

This redundancy protocol provides the user with a 1 + 1 and N + 1 protection scheme, allowing any Suprima codec to act as a backup unit of 1 or N different Suprima codecs, regardless of whether the main and the backup devices are in the same location or in the same chassis. This protocol can only be used to carry on redundancy for IP connections, not X.21 or ISDN.

Another new Suprima feature is the IP to X.21 Bridge, which converts IP asynchronous data stream to a synchronous data stream without decoding it.

MusicamUSA says one of its customers had an application that required him to access audio from one of his studios to his satellite uplink site. He was using dedicated data lines to send this audio, and he was converting the connection to an MPLS managed IP network.

The problem was that satellite uplink did not support IP, only X.21, and he would have had to decode the audio and then re-encode it with one of his CDQPrima codecs, and send it out X.21 to his uplink. While this solution would work, it wasn't feasible because the re-encoding of the audio would have degraded the audio quality, and added unnecessary delay to the audio path.

The other problem would have been converting the signaling from the originating end (relays/GPIO). Using Suprima's X.21/V.35 interface, an IP asynchronous data stream is converted to a synchronous data stream without decoding it, and then send out the X.21/V.35 port.

Additional highlights include different configuration profiles for different networks; CDQPrima auxiliary data compatibility; and FEC (Forward Error Correction), which compensates for lost packets on the network. The user can select between FEC with 50 percent overhead and 100 percent overhead. FEC is available for IP audio with SIP/SAP protocols.

For more information, contact MusicamUSA at (732) 739-5600 or visit www.musicamusa.com.

READERS' FORUM

Nice Job

Cris, I read with pleasure your latest article ("It's New-School, But Old Principles Still Apply," June 11). In fact I scanned the article and stored it for easy access in the future.

It is rare that we find key calculations in one location; and you addressed the technology extremely well, and in a way that even the average technician may understand. Excellent job.

Benjamin Brinitzer
Regional Vice President Engineering
Southeast and Gulf Coast Region
Clear Channel Radio
Charlotte, N.C.

CORRECTION

Elements of an equation from Cris Alexander's June column were missing in print. The correct equation is:

$$Loss_{dB} = 5\log_{10}\left[\frac{1+D}{1-D}\right]$$

Invisible Waves Analyzers Have White Space Finder

Kaltman Creations introduced a series of PC-based RF spectrum analyzers it says are intended for professional audio and video industries.

Invisible Waves are PC-based RF spectrum analyzers that offer automatic charting of open white space — open RF frequency — for use with wireless microphones, in-ear monitors and remote control.

The first in the series of Kaltman analyzers is the Invisible Waves Model IW1800. The IW1800 covers the frequency span of 100 kHz to 1.8 GHz, making it suitable for VHF and UHF analysis and extending into the lower gigahertz ranges.

Future models will include the Invisible Waves Model IW4000, which will cover 100 kHz to 4 GHz, and the IW7000, covering the frequency span of 100 kHz to 7 GHz. Resolution bandwidth (RBW) in each model is 1 kHz with a typical sensitivity of –120dBm.

"We sat down with a focus group of professional audio engineers and AV integrators, and asked what they needed in a RF spectrum analyzer to help overcome the current and impending wireless 'crunch,'" said Mark Kaltman, president.

"Their first response was the ability to find open space for frequency and channels selection followed by the ability to identify and locate interference. Other items of importance included ease of use, logging and reporting capabilities, portability and, of course, affordability."

The analyzers have an Automatic White Space Finder that identifies open RF space within a user-defined range. The finder graphically depicts the ideal positioning of the transmitters within the given open space. The analyzers also provide sweep analysis, including the ability to split-screen the display into simultaneous broad span sweeps and a zoomed-in view; spectral image printout capability; and extended logging and playback capability.

The analyzers are sold as kits and include a built-in rechargeable battery pack, AC adaptor/charger, multiple antennas and USB-to-PC connection enclosed in a pre-configured, laptop-sized carrying case. The IW1800 analyzer kit retails for $1,495.

For more information, contact Kaltman Creations at (678) 714-2000 or visit www.kaltmancreationsllc.com.

Protect Against Outages With UniStar P

Staco Energy Products debuted the UniStar P series single-phase online Uninterruptible Power Supply, which it says features protection over a wide input voltage range. The true double-conversion UPS is available in 6, 8 and 10 kVA models to protect from outages and irregularities in incoming line voltages from 160 to 280 VA at 45 – 65 Hz.

Up to four UniStar P modules can be installed in parallel for redundancy or additional capacity. With AC to AC efficiency greater than 90 percent and less than 5 percent reflected harmonics, the UniStar P is suitable for broadcast applications, as well as servers and networks, telecommunications equipment, industrial equipment or any sensitive electronic devices.

A constant clean, steady sine wave protects downstream equipment without going to battery mode. Each UniStar P features high overload handling without transfer to the bypass, and protection against short circuit and over-temperature conditions.

The company says the Smart Battery Management System continuously monitors battery status and recharges whenever necessary. Hot-swappable battery packs allow users to change batteries without shutting down the UPS. Matching battery cabinets enhance the aesthetics of the UPS while easing access and maintenance.

The UniStar P's front-panel LCD display includes input and output voltage, input and output frequency, load percentage, battery voltage and inner temperature.

Alarms are provided for line mode, backup mode, ECO mode, bypass supply, battery low, battery bad/disconnect, overload, transferring with interruption and UPS fault, line failure, battery low, transfer to bypass and system fault conditions. Each size offers remote monitoring and diagnostic capabilities through an RS-232 serial port and optional Web, USB, SNMP or Dry Contact Cards.

Standard software is compatible with operating systems such as Windows 98, 2000, ME, NT and XP. Staco says UniStar P is offered in tower and rack-mount models for installation versatility.

Additionally, each UniStar P is warranted for two years and includes a range of planned maintenance and service programs.

For more information, contact Staco Energy Products at (866) 261-1191 or visit www.stacoenergy.com.

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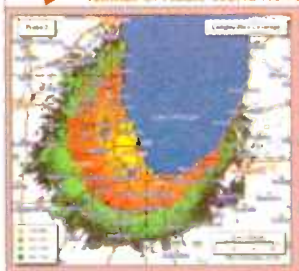

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Sensor-Oni

CONTINUED FROM PAGE 24

MOUNTING

Next, I mounted the protoboard into a small plastic box with the mini-jack sticking through one side (for the CdS grommet sensor) and a small terminal strip on the other side for power input and relay contact outputs.

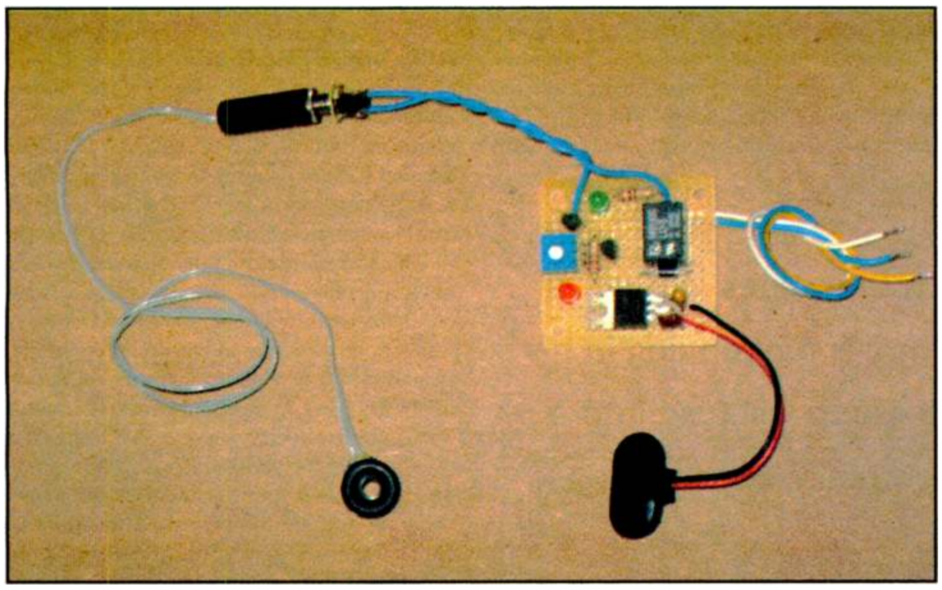

Fig. 6

A small hole is needed to make the sensitivity adjustment and holes for the LEDs to poke out of.

If you perhaps need several of the Sensor-Oni devices in one location, each board could be mounted inside a rack-mounted chassis box with a common power supply and CdS sensor jacks on the front panel for easy access. The barrier strip for the multiple relay contacts could then be placed on the rear panel of the chassis box.

There are lots of potential applications for the Sensor-Oni and many ways it can be mounted; all the circuitry above fits within a 2 inch x 2 inch protoboard. It could be made smaller if an optoisolator is used instead of a relay and if the +5V regulator is placed on the bottom of the board under the remaining component side parts (or omitted, depending on the circumstances).

Here is a little device that can be helpful to you and maybe get you out of a jam or just give you a pleasant feeling knowing that a mission-critical piece of equipment is doing its job.

Contact the author at williamjstack@comcast.net.

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The Last Word

CONTINUED FROM PAGE 38

acoustics, might include the use of a new untested approach. The schedule is such that the studio is functional before it is complete. To save money, older equipment in storage would be the starting point, but with the expectation that the maintenance budget would cover gradual replacement.

For those parts of the design that are very low-risk, the mentor would assign tasks to the freshmen engineers. The control freak would be assigned the task of identifying risk and uncertainty.

This is clearly a made-up example, but I have used this method for decades with great success: assign tasks so they match the values and goals of each individual. To the extent that everyone is now functioning in his or her "comfort zone," the group will fuse into a happy team. The method really does work.

There are several critical properties of a successful decision-maker. First, he or she must be a good listener: creating a deep model of each stakeholder, ignoring the surface explanation and focusing on the hidden biases.

Second, the decision-maker must be an expert in his own biases in order to compensate for skewing the data and driving the conclusion to his own comfort zone. Third, he must understand how to make everyone feel that he gained by the compromise.

On a final note, a decision-maker must recognize the difference between authority and leadership. The former arises when the institution gives power to an individual to force a conclusion on others. The latter is measured only by the number of people who want to follow the leader.

Assign tasks so they match the values and goals of each individual. If everyone is functioning in his or her 'comfort zone,' the group will fuse into a happy team. The method really does work.

I have spent four decades focusing on the art of leadership without ever having had any authority. People without authority also can, with suitable skills, become great leaders. Someone with authority can make decisions using coercion or leadership.

Smart organizations understand that the combination is more effective and rewarding than either by itself.

Barry Blesser is the director of engineering for 25-Seven Systems. ■

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by Barry Blesser

Four Steps to Management Proficiency

In my June 11 article, "What Does It Mean to Manage?" I presented a structure for making decisions. I described four key steps in the process: (1) collecting the relevant data, (2) analyzing the data to determine choices and their implications, (3) sorting the choices based on a value system and (4) executing task assignments and milestones to achieve the best choice.

Using this framework, we can explore the skills needed to become proficient in each of these steps. After some 40 years of being a professional consultant, making decisions for myself and others, I have come to the conclusion that step 3 is actually the most likely to create conflicts and failure. Although one might suspect that it is the easiest step, a careful examination shows that it is, in fact, the biggest obstacle and fraught with conflict.

But before actually discussing how to sort choices, I will digress and begin from a different place: professional diseases.

BIAS AND IDENTITY

Neil Postman, a media theorist and cultural critic, articulated the cliché: To a person with a pencil, everything looks like a text. To a person with a TV camera, everything looks like an image; and to a person with a computer, everything looks like data.

After many decades of being active in a particular profession, the personalities of individuals usually change to match their activities. You become how you live because the way that you live literally changes your brain.

Although sweeping generalizations about people in various professions are mostly unfair and often inaccurate, stereotypes survive because there often is enough truth in these descriptions. Consider the following:

Lawyers believe that there is no real truth, only debatable truth. Engineers believe that outcomes are predictable, because everything obeys the universal laws of cause and effect. Administrators believe in formal procedures without regard to exceptions, surprises and human sensibilities. Executives see people as cogs in a corporate machine that only serves to make profits.

Entertainers believe in people as a source of adulation and wealth. Scientists believe that their models are actually reality. Economists believe that logic and rationality are the basis for all human behavior. Doctors believe that the quality of life is enhanced by the liberal use of drugs and surgery.

Jokes about each of these professions have a grain of truth.

Individuals who have been active in a profession acquire subtle biases in the way that they see the world, and people who are immersed in an organization for decades adapt to the personality of that organization. Adapting to a value-laden environment, whether conscious or not, arises through repeated experiences. The linkage between bias and identity is so strong that to challenge a bias often is perceived as an attack on identity.

Assign tasks so they match the values and goals of each individual. If everyone is functioning in his or her 'comfort zone,' the group will fuse into a happy team. The method really does work.

POLITICS OF CHOICE

Now back to step 3: sorting choices when making a decision.

Regardless of rational debate, people take their biases with them when considering the best outcome for a decision. Working with some 100 clients over the years, and having had complex interactions with an even larger number of professional individuals, I have noticed that people approach sorting choices based on their personal value system and private agendas. Everyone has their own concept for the meaning of life, which forms yet another bias.

Some time ago I noticed that personality types, of which there are many, were a major contributor to value biases. Everyone loves to manipulate their work environment to create a "comfort zone" that matches their personality. Here is my incomplete list of types: leadership, pleasing others, visionary creativity, concrete reality, inventive novelty, reacting rather than asserting, comfortable with flexible responses, recognizing emotional nuances and working in well-defined situations.

There is an equally long list of possible goals: creating social harmony, exercising power over others, achieving individual autonomy, nurturing others, creating community, accumulating wealth, achieving fame, trivializing complex situations, suppressing emotions and psychology, as well as my favorite: starting late in order to get an adrenalin high from the tension of being late.

Now back to where we started with the task of sorting choices. With the variety in biases that arise from professional activities, personality differences and individual value systems, we would not expect any two people to sort a range of choices in the same way. And from this arises the principle of politics, which is the process of sorting conflicts in values and resources.

In spite of the negative baggage associated with professional politicians, the process of conflict resolution is nothing more than politics. Even within a single individual, there is a political process. Humility is essential because there is no right answer in politics.

It is sometimes difficult to see conflicting values systems because public explanations are translated into "legitimate" arguments while hiding the real reason. At this point, we might think that harmonious consensus is hopeless. However, a skillful decision-maker often can find compromises that satisfy conflicting values if he can read below the surface explanation to see the real criterion. People want an outcome that matches their comfort zone.

ALL TOGETHER NOW

To illustrate the process of creating a harmonious decision, I will examine a slightly contrived example of a design for a new studio. Let me also assume that there are many stakeholders who have a personal criterion for the attributes of the design.

The stakeholders might include the following people: a risk-adverse engineer who hates uncertainty, a creative visionary who wants to create a design worthy of an article, an administrator who wants every milestone to be on time, a financial manager who wants the project to match the budget, a nurturing elder statesman who wants the young engineers in the group to make a contribution and a control freak who wants to control every aspect of the process. Some individuals have multiple attributes, flipping among them at unpredictable moments.

If you were charged with the responsibility of managing the project, what would you do? The worst choice is to begin the process with a big meeting with all the stakeholders. Each of them will argue for a design approach that matches their comfort zone, and everyone will become anxious when they sense that someone else's values might be used.

The best first step is to sit with each individual, one on one, to build a model of the individual's values. Then the manager goes away to invent a bunch of compromises, which he shares and discusses with each stakeholder, emphasizing that aspect of a compromise that matches the individual's values.

The manager tweaks and sorts the compromises, and continues to meet with each stakeholder, who comes to recognize that the design incorporates his perspective. Everyone is enfranchised. It is now time to have the big meeting, but the stakeholders have been pre-sold on the compromise.

What might the final design process look like? Part of the design will use conventional approaches, which are low-risk and easy to schedule. Another part, such as the ceiling

SEE THE LAST WORD, PAGE 37

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