Photo courtesy of Bob Newberry and Clear Channel Birmingham

Radio World
ENGINEERING EXTRA

February 20, 2008

WHITE PAPER

Radio Sunshine HD Tests Successful

The First European HD Radio Test Licensee Says Results Show Improved Coverage Compared to Analog

by M.A. Ruoss

With respect to digital radio, Europe is known as a 100 percent DAB Eureka-147 area, and the image of in-band, on-channel digital in Europe is very poor. Unproven arguments against IBOC are disseminated, like "technically not feasible in Europe because of many differences in the FM system," and there is confusion of FM with AM HD Radio questions.

Based on large DAB investments and a European digital FM system (DRM+) on its way to finalization, it is understandable no one is really interested in a "foreign" FM digital alternative.

However, not even one European country has a commercially profitable DAB operation yet (with the eventual exception of the United Kingdom, where there is the chance to become profitable some years from now; CGap, the biggest U.K. operator predicts "digital break even" for 2010).

Moreover, some thousands of local and regional (single-program) broadcasters are no longer so sure that a multiplex technology is the proper solution for them; perhaps more feasible and economically viable systems with a slow evolution path to digital should be found.

That's why the Swiss Federal Office of Communications (OFCOM) and the Association of Private Broadcasters (VSP) started to support our initiative to do some HD Radio field trials, and to follow any other kind of FM digital system that could be an alternative.

The Swiss OFCOM granted the first European HD Radio test license at the end of 2005 for two years to Ruoss AG/Radio Sunshine. This license was extended until the end of 2008, and a total of three different frequencies are now allowed to be tested simultaneously.

Since field testing began, and especially after the successful HD Radio days in Lucerne in October 2006, HD Radio has begun to gather a lot of positive interest in Europe. The "false statements" about HD Radio have started to fade away, piece by piece.

A good example of such false statements was that European FM deviation will have to be reduced below 50 kHz peak deviation, and the audio multiplex power to –6 dBr, to make it work. This argument has now completely disappeared.

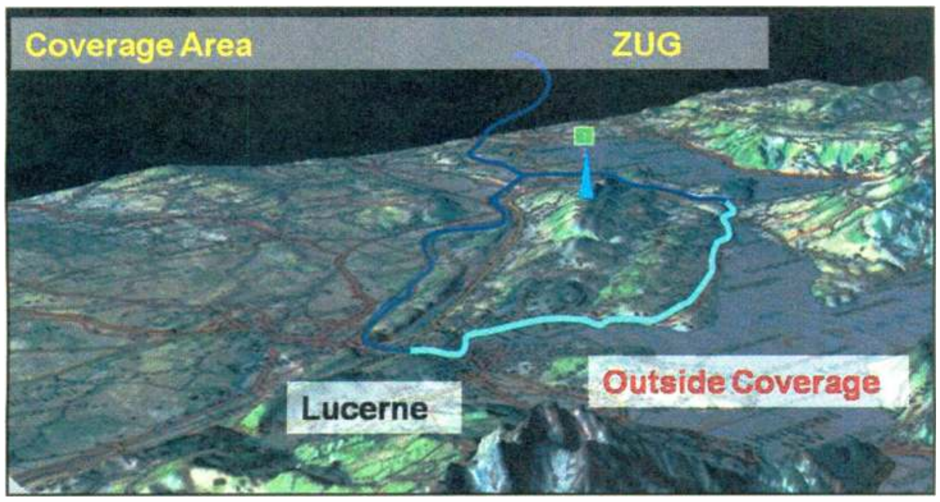

Fig. 1: Simplified map of critical field test area

FIELD AND LAB TEST SETUP

For IBOC field testing, the main transmitter of Radio Sunshine (88 MHz, located at around 400 meter height above average terrain, with mountains approximately 7, 13 and 25 miles behind the coverage area) is used in a high-level combined standard hybrid mode with 3,500 watts analog and 35 watts digital power. The main coverage area is the town of Zug and vicinity; Radio Sunshine has a total of 16 transmitters to cover Central Switzerland (see Fig. 1).

The content transmitted in 24/7 multicast mode is:

- Radio Sunshine analog FM
- Radio Sunshine digital (HD1) 48 kbps
- Radio Energy Zurich digital (HD2) 32 kbps
- Service digital (HD3) 15 kbps, voice, traffic, weather, sport, events
- PAD HD-display 1 kbps

A second transmitting setup together with other FM test equipment is used for lab simulations and testing. For the first part of the trial, a number of JVC, Sanyo and Kenwood car receivers are used together with some tabletop radios from Polk and Boston Acoustics. ADA receivers are used for audio quality reference.

Twelve FM receivers were used for lab testing: three Walkman radio/cellphone-type, three car radios, four portable and two compact HiFi.

DEVIATION AND MPX POWER ISSUES

The FM system in the United States uses 75 µsec pre-emphasis, a maximum deviation of 75 kHz and multiplex power above 0 dBr.

Europe uses 50 µsec pre-emphasis, a 75 kHz maximum deviation and maximum MPX power levels ranging from 0 dBr to "some dBr" depending on country and "best practice." Some European countries only allow a maximum of 0 dBr MPX audio power while other countries like Switzerland allow +3 dBr, and some countries use even higher MPX levels. See Fig. 2 for typical peak deviation and MPX power for all HD Radio lab and field testing *[Ed. Note: For European radio broadcasters, the International Telecommunications Union established a modulation density specification that uses the integrated value of the power in the audio modulation of the FM signal to define "peak" modulation levels. This reference of 0 dBr is equal to a 19 kHz average deviation over a 60 second integration interval, which is typically much lower than modulation used by an FM station in the United States.]*

All our testing so far shows clearly that "the European values" of peak-deviation,

SEE SUNSHINE, PAGE 14

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FROM THE TECH EDITOR

by Michael LeClair

The Empirical vs. Analytical

Former Approach to Problem-Solving Is Less 'Daunting' for Engineers Trained in the Latter

I recently spent some time troubleshooting a type of problem that seems to crop up often in our increasingly IT-intensive world.

The initial problem reports were of random failures and file corruptions while transferring files to a file server that shares audio production work between desktops and studios. The file-sharing system had seemingly worked well for months before this time.

Over the course of a couple of weeks and after having an engineer look into the problem, the reports worsened. Not only were we unable to find the source of the problem but it was happening more frequently.

One particular user who reported this first was having the most trouble and complained of not being able to move files at all without errors. Over the next few days other users began to report problems with their production work as if their machines were slowly being "infected" with the problem.

Our engineer determined it was probably due to a third-party authentication software client that controls access for users to move files onto the file server and copy them back off. He contacted their technical support and we were sent an "updated" version of the client that worked no better (and possibly worse) than the original.

The only proposed solution on the table was to dismantle this previously working system and go back to "sneaker net" file sharing, or completely unmanaged storage on various disks with no backup. I didn't like either of these two options.

> Just try doing things until you figure it out.

I decided to get my fingers involved because these systems are essential to our daily operations. I didn't know much about the specifics of the software involved but I noted that the situation had deteriorated from a working system to the point where production work was coming to a standstill. That suggested to me there could be some operational issues involved and not just broken equipment.

Sure enough, within a few hours we had the whole thing figured out.

THE POWER OF THE GUI

Since the beginning of the use of computers in broadcasting, we have seen a dramatic improvement in usability that has powered the wide-scale deployment of computers in broadcasting.

Moving from command-line systems, which required a user to memorize a relatively large set of individual instructions, we have reached a stage where the individual user is required to know little about the internal workings of a computer and its software.

The graphical user interface is the heart of this revolution in usability. Computers are easier to control with selectable menu choices and icons instead of having to look up commands in a reference manual. The GUI allows a user to do sophisticated work without having to memorize every function.

Along with this shift to the GUI has come a change from analytical to empirical problem-solving. I was trained as an engineer to use an analytical approach, similar to how a doctor will come up with a diagnosis on a patient based on a set of key symptoms. By analyzing the behavior of a system, and knowing every aspect of how it works in great detail, an engineer can come up with a rapid diagnosis of a failed system and home right in on where to fix it.

However, with software it has become a daunting analytical task to figure out what symptoms to look for unless a specialist exists for each application.

No user can readily remember all the possible commands on every piece of computer software they need because there are just too many different applications out there. There is no longer one set of symptoms that can be observed to create a diagnosis of a failed system.

Often the empirical approach to problem-solving will work faster and better. Just try doing things until you figure it out.

For users this means simply looking at every menu option until you find one that does what you need to do. It saves having to remember all the specific commands.

If I know a software program, say Excel, can make graphs, I don't need to memorize how to do it, as I can simply find the correct menu options and create a graph whenever I need one. Not having to memorize each feature allows people to operate many different software programs successfully, whereas in the past it may have been all a person could handle to master one program in its entirety.

With more people using more software programs it means that IT specialists now support a vast number of computers but rarely have the time to learn even a fraction of all the applications that are used in a broadcast facility. Unless they need to use these programs regularly themselves, they do not become experts.

When something goes wrong with a particular piece of software, it can take using it for an extended period of time to learn how it works and what it should do normally. This makes support of software-based systems challenging. It takes extra creativity and sometimes trial-and-error methods to get to the heart of a problem.

> With more people using more software programs, it means IT specialists now support a vast number of computers but rarely have the time to learn a fraction of the applications used in a broadcast facility.

TIME OUT

One negative aspect of the graphical user interface is that it can hide a lot of computer activity from the user.

With a simple click, many simultaneous actions will occur but without any activity seen by the user. This can be a bad thing if something doesn't work because many software programs report back no errors or a misleading error that can create additional confusion.

In the problem we encountered with our audio file server it was just such a breakdown in error-reporting that caused our operation to slow to a crawl. In fact, there really wasn't much of a problem at all but the GUI made things appear broken and confused users to the point where they could no longer get their work done.

It turned out that when the authentication client was run, the software would spend a certain amount of time negotiating with the file server to determine what files were available and where they were stored.

SEE EMPIRICAL, PAGE 6

IN THIS ISSUE

by Charles S. "Buc" Fitch

Are You Ready for the SBE Exam?

A New Series of Questions to Help You Prepare for Your Next Certification

CPBE Sample Question

In a negative 90 degree 'T' network ATU for a 90 degree AM series tower, the adjustment of what component would have the greatest effect on the input reactance?

a. The variable component (normally a tapped coil) in the shunt arm.
b. The variable component (normally a tapped coil) in the output arm.
c. The variable component (normally a tapped coil) in the input arm.
d. The value of the fixed output capacitor.
e. None of the above as intrinsically the input is always a resistance.

Before reading this article, read and consider the question shown in the box at right.

SBE certification is the emblem of professionalism in broadcast engineering. To help you get in the examination frame of mind, Radio World Engineering Extra, in cooperation of the SBE, will pose a typical question in each edition. Although similar in style and content to actual exam questions, our examples are not from past exams nor will they be on any future exams in this exact form; they are intended to help you prepare.

ANSWER AND DISCUSSION

The correct answer to the question posed in the box is c, the variable component (normally a tapped coil) in the input arm.

The negative 90 degree "T" network ATU (antenna tuning unit) is ubiquitous in non-directional stations and a handful of "T" networks of varying phase shifts are in almost all DAs.

Why are they so prevalent? The math works out to be simple for making calculations at –90 degrees, the component count is low, the inductance in the arms create a low-pass filter for harmonic reduction and the circulating currents and voltage peaks are not extreme. The 90 degree T network also is easy to adjust.

The greatest power transfer (lowest loss) is achieved when the impedance of the generator (the transmitter/line) matches the impedance of the load (the antenna in this case). That's what any ATU accomplishes; it optimizes the impedance conversion match between the line and the antenna.

The "T" network is viewed and analyzed as a simple four-terminal network (see Fig. 1).

A typical antenna resistance encountered in a real-world 90 degree tower is about 60 ohms + 70j (the positive sign indicates an inductive reactance component).

So in our specific case, R1 is 50 ohms + 0j, which is the characteristic impedance of the coax line and essentially the output of our transmitter. R2 is 60 ohms + 70j, which is the characteristic impedance of our antenna.

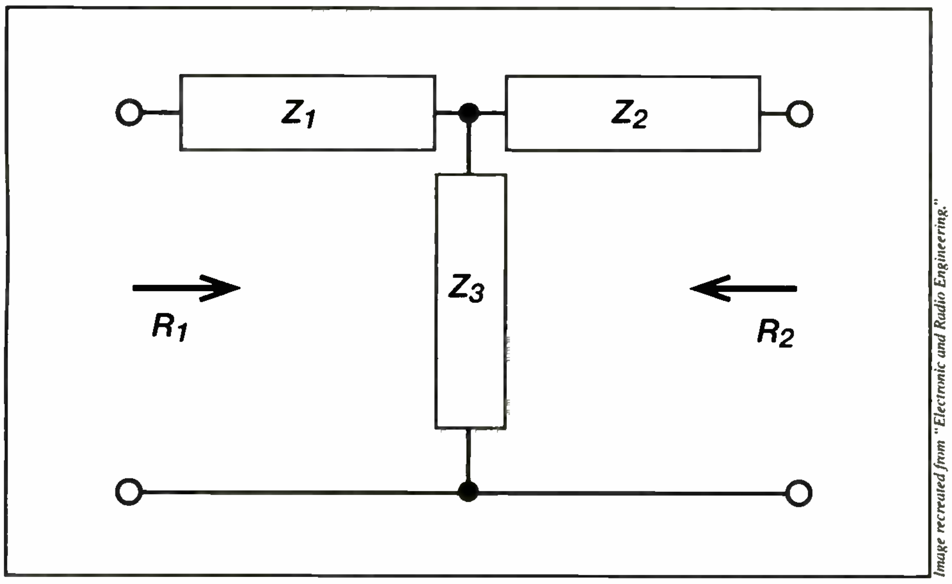

Image recreated from "Electronic and Radio Engineering."

Fig. 1: The 'T' network is viewed and analyzed as a simple four-terminal network.

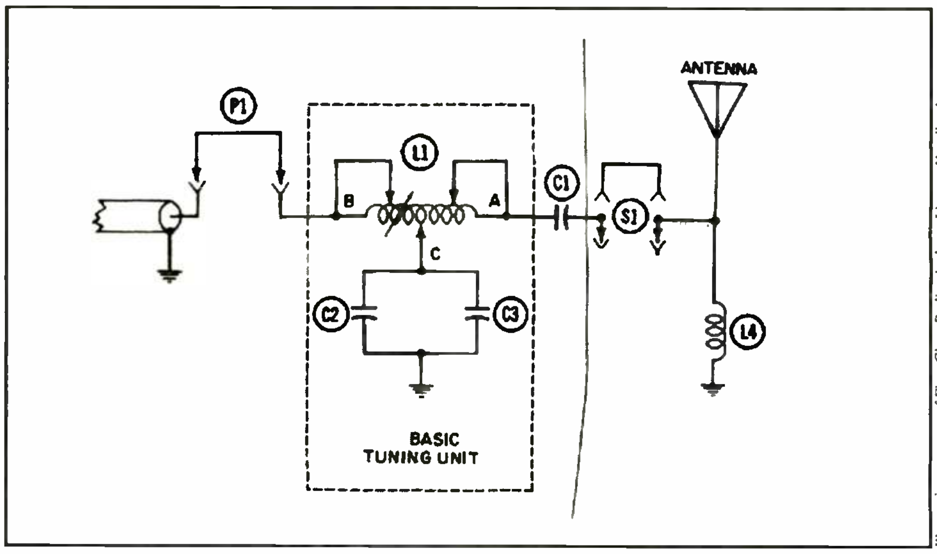

Illustration courtesy of First-Class Radiotelephone License Handbook

Fig. 2: Twin caps in the shunt arm were used by the ATU vendor to split the current flow, and allow the use of cheaper small current capable capacitors as a cost function.

Change in leg reactance (– other legs at 54.8j)	Z1 leg value = input reactance	Z2 leg value = input reactance	Z3 leg value = input reactance
+5	59.8 = +5	59.8 = –4.14	–59.8 = –0.07
+3	57.8 = +1	57.8 = –2.5	–57.8 = –0.22
+1	55.8 = +1	55.8 = –0.83	–55.8 = –0.14
0	54.8 = 0	54.8 = 0	–54.8 = 0
–1	53.8 = –1	53.8 = 0.83	–53.8 = 0.2
–3	51.8 = –3	51.8 = 2.5	–51.8 = 0.77
–5	49.8 = –5	49.8 = 4.14	–49.8 = 1.58

Fig. 3: A tabulation of the input reactance using our antenna load resistance of 60 + 0j ohms (reactance canceled out).

The formulas for calculating the values of the three legs are:

$$Z_1 = -j\frac{R_1\cos\beta - \sqrt{R_1R_2}}{\sin\beta}$$

$$Z_2 = -j\frac{R_2\cos\beta - \sqrt{R_1R_2}}{\sin\beta}$$

$$Z_3 = -j\frac{\sqrt{R_1R_2}}{\sin\beta}$$

We have two configuration choices: capacitors in the series arms and an inductor in the shunt arm; or inductors in the series arms and a capacitor in the shunt arm (the industry standard).

As mentioned, this latter configuration has the bonus of being a low-pass filter attenuating any harmonics that might be in the original signal input.

Most likely then our ATU, as a practical matter, would look something like Fig. 2.

Twin caps in the shunt arm were used in this case by the ATU vendor to split the current flow, and so allow the use of cheaper small current capable capacitors as a cost function. Most often the large negative reactance value of the shunt capacitor will be adjusted exactly to the desired network value by a small series coil providing positive reactance.

We mentioned simplicity, and addressing the antenna reactance first really simplifies matters. That reactance is nulled out by a contrary negative reactance supplied above by a capacitor labeled C1. The bonus here is that this capacitor eliminates the DC path that lightning likes to take into your transmission plant.

What we have left to address then is the resistive components of the input and the antenna. The –90 degree angle cancels most of the trigonometry associated with this network. If we substitute into the above formulas just the trigonometric values of angle μ(beta) at –90 degrees (sin = –1 and cos = zero) and the resistive elements, we are left with the reactance arms of the network being determined by taking the square root of the product of the line resistance times the load resistance: $Z1 = Z2 = -Z3 = \sqrt{R1 * R2}$ (resistance only)

In this case the resultant would be 54.772j ohms (pure reactance) and to make it easy on ourselves, we'll round that to 54.8js.

Now that we've addressed the reactance in the antenna, let's restructure the basic leg calculations to solve for the input impedance. We'll use some incremental reactance values substituting each in turn for the value of the three network legs. This will identify which one has the greatest effect on the input reactance when adjusted.

Fig. 3 is a tabulation of the input reactance using our antenna load resistance of 60 + 0j ohms (reactance canceled out).

Evident from the above numbers, changing the value of Z1 (the input leg) causes the greatest change in input reactance.

Changing the value of any of these legs also alters the phase shift somewhat through the network as well but we'll leave that discussion for another SBE Certification Corner.

Broadcast engineering is a practice art and this question could be answered simply from experience. The values of the networks are usually set in advance before applying power by either using an RF bridge or rough calculation.

Here's your question to mull for the next issue: "How are transmitter final stage efficiency factors determined?

Charles S. Fitch, P.E., CPBE, AMD is a frequent contributor to Radio World.

REFERENCES

"Electronic and Radio Engineering" — Terman 4th edition, pages 112–115

"Radio Engineering Handbook" — Terman 1943, pages 210–215 ■

Empirical

CONTINUED FROM PAGE 3

If this negotiation was not completed by the time a user completed the login, the authentication would not succeed.

The next attempt to copy a file would cause it to be corrupted because the user did not have the proper rights to write to the file server. Unfortunately the authentication client would appear to have worked fine even if it failed.

had been largely ignored as an infrequent problem that "just happened" once in a while and not a serious issue.

What changed was that one user suddenly was doing more production work than ever to support a new show, and he was forced to move from one studio to another to work around other existing shows. He was regularly rebooting the machines because he thought this would make them work better, but it made the problem worse.

And as he moved from room to room he would tell other users of his difficulties and they would proceed to try and prevent the

By analyzing the behavior of a system, and knowing every aspect of how it works in great detail, an engineer can come up with a rapid diagnosis of a failed system and home right in on where to fix it.

Most of our staff is aware that rebooting a computer usually will clear a problem. So their response to any sort of file corruption was to reboot the computer and restart the software. But the same problem would happen again if there wasn't enough time for the negotiation before login. It was a vicious cycle.

Undoubtedly this timeout period had caused occasional problems since the authentication had been installed. But this

problem by rebooting before they started their own work. This is how the problem seemed to infect previously working machines until everyone was stuck.

The simple solution was to tell the staff simply to wait for a certain amount of time after booting the computer and the problem went away. Although we don't know the precise way in which it works, this empirical solution allows everyone to get back to work.

While as an engineer I find this kind of workaround non-intuitive, it is sometimes the best way to solve a difficult problem where analysis can't easily come up with an answer.

NEW FEATURE

In this issue we debut a new column on SBE certification, conceived and authored by Charles "Buc" Fitch.

We will pose a question that is similar to the kinds of questions encountered in the SBE certification exams and offer multiple choice answers. A detailed explanation is provided for the correct answer. Go ahead and try out our questions and see how you fare.

I would encourage any and all broadcast engineers out there to pursue certification with the SBE as essential proof that you know your field and are committed to your career. If you're on the fence about taking the exams, here is a chance to get a feel for what to expect. And if you are an experienced pro, you can test your knowledge with us and see how you stand.

SECURITY CAM

There is a remarkable photo in Cris Alexander's "Day in the Life" column this issue. It shows an armed intruder breaking into a transmitter site in pursuit of copper to steal for scrap. The security camera at the site caught this image. These days responding to a transmitter problem may be more dangerous than many of us realize.

Do you have any photos of similar break-ins? Share your pictures with us and we'll print the best for everyone's edification. You can contact us at *rwee@nbmedia.com.* ■

MARKETPLACE

Staco Adds Troubleshooting Tips, Product Info to Site

Staco Energy Products revamped its Web site, giving viewers several ways to search for solutions to common power problems such as power outages, overheated transformers, flickering lights, power factor penalties, voltage fluctuations, high utility bills, and nuisance tripping breakers.

Staco offers information on its voltage regulators, UPS, power factor correction equipment, harmonic mitigation equipment, variable transformers, test sets and more. In addition to searching by problem encountered, viewers may also browse by product category, brand name and industries served.

The site, also available in Spanish, offers product manuals, application notes, engineering drawings, product specifications and software downloads. A "service" drop-down list details the service offerings available to ensure proper use and functionality of Staco equipment.

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

Shark, shown interviewing BERT MCCRACKEN, lead singer for THE USED, says: "When Comrex told me that their internal code name for ACCESS was "THE NEXT BIG THING" I got it right away. This IS BIG – I was live, on the air, in places I could NEVER have gone with regular old technology. THANKS COMREX!"

ACCESS

Impossible Remote? Nah, You've Got ACCESS.

Meet Another Real-World Super Hero...

Live coverage of *Next Big Thing 7*, Tampa's 15-band, two-stage, 20,000 screaming fan concert, seemed daunting. But it couldn't have gone smoother for *Shark*, Cox Radio's 97X Program Director and afternoon host. When covering an event like this, *Shark* would normally be battling for a frequency with all the wireless mics, and getting back stage to interview all 15 bands with a live wired mic was just impossible. ACCESS pulled it off without a hitch. *Shark* went live with the push of a button and not a care in the world. Covering even the gnarliest live event is a natural for ACCESS.

ACCESS delivers mono or stereo over DSL, Cable, Wi-Fi, 3G cellular, satellite, POTS (yep, ACCESS is a full featured POTS codec and works seamlessly with Matrix, Vector and Bluebox)—plus some services you may not have even heard of. Given the challenges of the public Internet, it's no small boast to say that ACCESS will perform in real time over most available IP connections.

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by Art Reis

Flywheel Keeps Tx on the Air When Utility Can't

Energy Storage Via 7,700 RPM Flywheel Inside a Vacuum Chamber; Is This UPS an Electrical Blessing?

So you're at the mercy of a power company that doesn't seem to have any mercy? Are you getting electrical "dropouts" on your three-phase feed which last only a second but take your big rig down to zero voltage on the filaments, which means 30 seconds of down time each time?

We did, and we ended that problem once and for all. Here's how.

Crawford Broadcasting Co. is the licensee of station WPWX(FM), in Hammond, Ind., which serves the Chicago market. Because of the city of license and some very old short-spacing issues, WPWX transmits not from one of the tall buildings downtown, but rather with a full 50 kW from a 500 foot tower located just past the south edge of Chicago, in the town of Burnham, Ill.

The site is literally "on the other side of the tracks," in an abandoned industrial park we fondly call Camp Desolation. I've been chief engineer at WPWX for 10 years, and during that time we've changed formats, transmitters and transmitter buildings, but we never anticipated we'd have to completely revamp our electrical service. But that was exactly what we had to do.

INDUSTRIAL DECAY

In 2004, the reliability of our electric feed had deteriorated to the point where we were experiencing on-air outages several times per day.

These outages were not long enough to bring our emergency power generator on, and only involved one phase at a time, but it would be enough to take the transmitter down and cause us a lot of grief. Installation of an AC line monitor at the main disconnect confirmed our suspicions.

I remember our corporate director of engineering, Cris Alexander, coming to Chicago to visit the operation, spending an evening with Station General Manager Taft Harris and me at the transmitter site, and witnessing our otherwise reliable main transmitter dump twice, as if on cue, while we were standing in front of it.

Mr. Harris asked what was going on, and when we told him, he came on board immediately in support of doing whatever we could to deal with the situation.

The transmitter site at Burnham is fed by only one electrical power source, a three-phase Commonwealth Edison line which goes back to the 1920s or maybe earlier.

Fig. 1: Electricians install the 125 kW Onan generator, right, next to the new UPS building, left. A great deal of planning, including the services of an architect, was involved in putting together this project.

Back in its heyday, it counted among its customers numerous factories in our industrial park, all of which are gone now. That doesn't count many other large-scale users further up the line, all the way to a substation located about six miles away on Chicago's far southeast side. Now these factories and businesses are no more than past-tense pieces of the Rust Belt in Midwestern America.

To make a long story short, we are just about the last major customer left on that line, and of course we're located at the very end of it. If there is a power failure anywhere on that line, the outage will last not just minutes, or hours, but days. We've operated on generator power for as much as eight straight days, and the great Com Ed cares not a whit.

When a major storm goes through the Chicago area, taking out power for tens of thousands, ours is the very last line to be re-activated. The reason is simple: the lack of customers tends to make the line unprofitable to operate. And, hey, we have a generator. What are we complaining about?

Worse, a half mile section of the line wends its way through an old forest preserve marsh, which is inhospitable for man or a large electric company truck. That section of line hasn't been maintained in more than 20 years, and that was the source of many of the electrical outages that have plagued our operations in the past.

And, at least at the outset, no one at Edison was listening. My engineering assistant Mack Friday and I had to drive the length of that line to see for ourselves where the dead fuses were, and tell them ourselves.

BATTERIES NOT INCLUDED

We began to take matters into our own hands. We had already put a new, emergency generator into our capital expense budget for 2004. The existing generator, an Onan 70 kW unit, was deemed to be under-powered for the additional load presented by our recently installed HD-R transmitter, so a 100 kW Onan was budgeted to replace it.

However, we were now going to have to go one step further. Enter a new product into the mix: the UPS 150, a large-scale UPS without batteries, manufactured by Active Power in Austin, Texas, and marketed by Caterpillar. Cris Alexander had seen it at NAB in Las Vegas.

This is an amazing device. The energy storage is accomplished with the use of a large three-ton flywheel, operating at 7,700 RPM, inside a vacuum chamber.

That's a lot of energy. So much energy is stored in that whirling disk that when the power fails, the disk, acting as a generator, can continue to supply power to our transmitter site load for up to 40 seconds, more than enough time for the emergency generator to take over. That's with the UPS operating at 65 percent of its rated load.

There was only one joker in the deck — these UPSs operate only at 480 volts AC. At 240 volts, the doubled current requirement makes operation of such a UPS impractical.

Since this project was turning into a major operation, the next step was to assemble "the team" to deal with it: our local electricians, Commonwealth Edison, Active Power, Caterpillar, Cummins Onan, our local crane rental service and even our fence contractor.

To this mix we decided to add one more member: our station architect. This turned out to be a great move, as it gave us project managers one less thing to worry about, namely hassles about the physical layout of the system.

OVERLOADED POLE

The first step in the plan was to lay out the project electrically (see Fig. 1).

In concept, this is not rocket science. The incoming Edison 12.5 kV feed is fed to a transformer to down-step the incoming AC to the required 480 volts. This is fed into the transfer switch's normally closed side

SEE UPS, PAGE 10

Connect with Zephyr/IP: The World's Most Advanced IP Codec

The new Zephyr/IP brings an effective package of sophisticated technology to the world of IP audio codecs. Optimized for operation over the public Internet and mobile phone data services, the Z/IP delivers when others can't.

NEW "AAC-ELD" (ADVANCED AUDIO CODING-ENHANCED LOW DELAY) CODEC: Z/IP introduces a new codec technology invented by the experts at Fraunhofer Institute, the people who brought us MP3 and AAC. Optimized for interactive IP applications, AAC-ELD combines features from MPEG AAC-LD and the Spectral Band Replication technology used in AAC-Plus. It's the most powerful audio coding tech on Earth, offering outstanding bitrate efficiency, low delay, and support for packet loss concealment.

NEW TELOS ACT (AGILE CONNECTION TECHNOLOGY): Z/IP brings automatic on-the-fly bitrate adjustment to IP codecs - a first. The Z/IP constantly monitors the network and sets its bitrate to the optimum value. A dynamic adaptive receive buffer also responds automatically to network conditions, minimizing the effects of the varying bandwidth and jitter that occur on real-world networks.

EFFECTIVE PACKET LOSS CONCEALMENT: The Internet usually has packet loss on audio streams, often ranging up to a few percent. The new AAC-ELD codec combined with ACT can conceal this loss, making for smooth audio even with rough network conditions.

TELOS-HOSTED Z/IP SERVER WITH DIRECTORY SERVICES: Enables you to look up, view the status and connect to other Zephyr/IP users worldwide, even through the toughest firewalls.

A STATE OF THE ART USER INTERFACE: And so you don't feel like you are on a blind date, we give you all of the status information you need on a sharp-looking color LCD which shows live network statistics and trace-route maps in an easy-on-the-eyes graphical interface.

Telos
AUDIO | NETWORKS

Telos-Systems.com

UPS

CONTINUED FROM PAGE 8

first. The 480 volt generator (which, by the way, cost about 5 percent less than its 240 volt counterpart) is fed to the other side of the switch. The UPS gets the output, which then feeds the 480 VAC to 208 VAC step-down transformer to the main disconnect.

The trick is to locate all the objects near to the building in such a way as to keep the jumble of conflicting conduit to a minimum. We almost made that goal. See Fig. 2 to see how we did.

The architect visited the site and we went over the proposed move. We had to have a layout for the three or four new pieces of equipment that would be added. A couple of our existing power-handling devices were going out of service. Our old 70 kW Onan generator would be moved to another transmitter site, along with its 500 gallon LP gas tank. Our faithful old Square D 85 kVA 240 volt delta-to-208 volt wye transformer with Faraday shield also was retired.

The new items were the UPS, the generator, transfer switch to match and another new transformer, a 480 delta to 208 wye transformer, capable of at least 100 kVA. In addition, our electricians got into the act and, in keeping with requirements of the electric code, gave input to our architect about what meters and disconnects were going to be needed, and where on which concrete pad they were to be placed.

We also decided on two more things: the original Edison feed, back when the site was new, was an open delta with pole pigs mounted some 20 feet up. The delta had been closed in the years since, which meant that the wind load and weight on that pole were massive. One windy day, when a couple of our staffers were out visiting the site, we witnessed the pole swaying back and forth about a half foot at the top, in a 30 mile per hour wind.

We decided then and there to get rid of the pole pig arrangement, opting instead for a pad-mounted primary feed step-down transformer, which dictated that the main 12.5 kV primary incoming line was going to have to be diverted outside of our existing fence line, extended to the other side of the compound and run its entire length underground to the new primary transformer pad.

In fact, all of our wiring was going to be underground this time. None of it would show as it had in the past.

PROJECT COORDINATION

The biggest part in this project, as in all other projects with this many team members, was to coordinate who was supposed to come in and do what, when.

That was my job, and it was a major challenge. I had coordinated the construction and installation of a new transmitter building at the site the year previous, but this was the first time I had done a project with so many outside vendors working at once. Needless to say, I learned in short order exactly what made slowdowns happen.

Anybody on the team who did not arrive when they were supposed to caused us to have to wait in order to keep the project moving along. We were well aware that the tasks had to be completed in a certain order, and so the work schedule became our marching orders. Those orders, however, were not always followed.

At one time or other, every vendor got involved in the slowdown. I won't name names but you all know who you were.

We also had to make sure all pieces of

Fig. 2: This was the area of greatest concentration of wiring. Pictorial documentation of such a project is vital to prevent future accidents due to digging at the site.

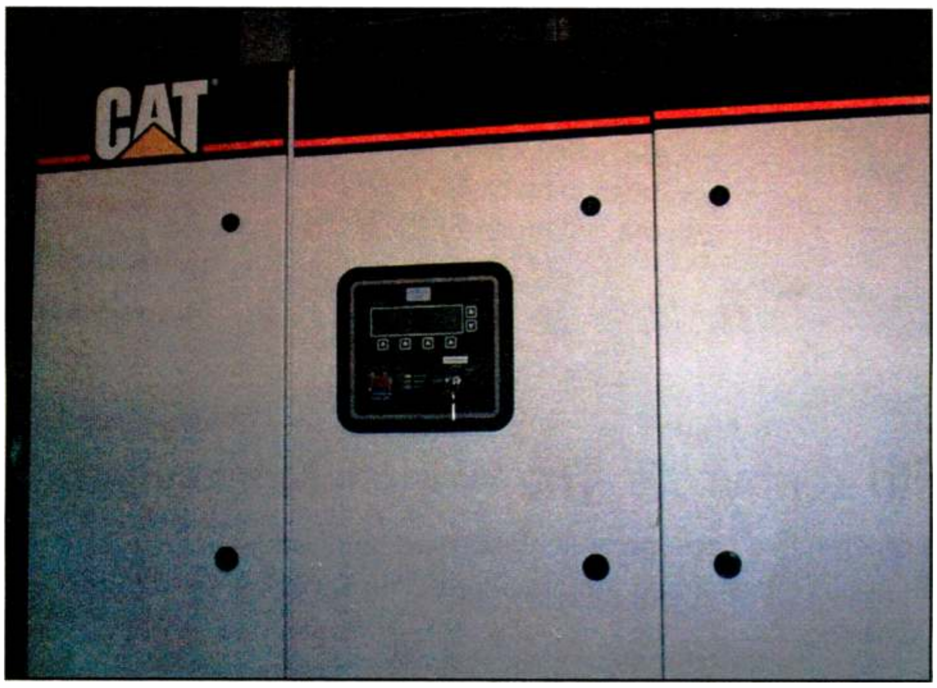

Fig. 3: This is the UPS at the WPWX site, a Caterpillar UPS 150. It is the smallest such UPS in the series and was the first of its type to use a flywheel for energy storage.

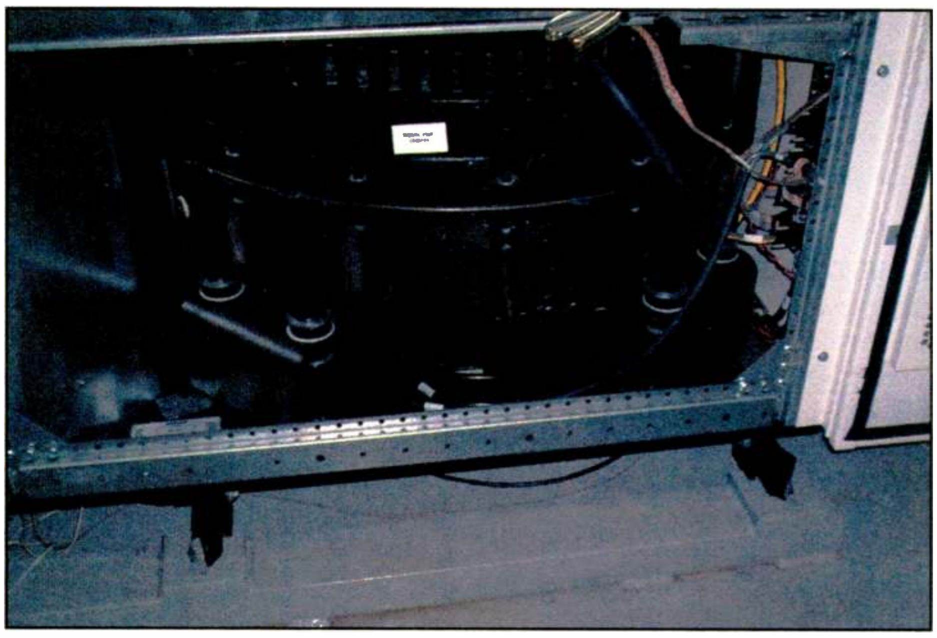

Fig. 4: Here's the case for the energy storage flywheel in the UPS. Weight of just this part is three tons. The UPS comes in its own building.

equipment were documented accurately so we would know without question where electrical cable conduits had to go, as they all had to be set within the concrete pads. We actually came close to perfection on that point. Only with the UPS itself did we have to do any last minute reworking.

That's because the folks who packaged the UPS changed their building plans without telling us. Cute. Only some fast action by our electricians, costing us several hours of overtime and some more PVC pipe, saved that piece of the project.

One thing I cannot stress too heavily is to keep records of what was done and what is where. While the electrical schematic of the system is the basis of the entire project, part of the architect's job is to decide which piece of equipment is to go where, and that includes the location of the generator transfer switch, inside the transmitter building. Try to make the layout come as close as possible to what the schematic says, though that's a lot easier said than done.

Design of the layout doesn't just mean relative locations of the equipment, but also the distance between pieces of equipment.

That brings up an important point: Except under unusual circumstances involving space, there is no sin in separating things out a little way. There is a lot of electrical wiring in a project such as this, the wiring is really huge and all of it is going into underground conduits. While spreading out the equipment pads might mean a little more cost in terms of wire, PVC pipe and labor cost, the result is more acceptable in terms of underground congestion.

Take a look at the photo in Fig. 2. As you can see, there's a little more to a project like this than meets the eye, and in our case, we almost "blew it" where pipe congestion was concerned.

One of the things we had to consider in the project was that the addition of all this hardware, plus the new transmitter building we had installed the year before, had practically blocked access to the tower for folks who needed to work on it. Understand that our entire transmitter building compound has always been fenced in, which made this issue a big deal.

It was the architect who noticed this first, and he designed into the plans an extension of the fenced-in area to more than double its original size, strictly for the addition of an access path, including a gate wide enough to allow a truck through it. Once the space had been enlarged, we ordered gravel for the entire fenced-in area. That eliminated any threat of mud vs. truck access.

YOU CAN'T GET THERE FROM HERE

Our project took about five weeks to rough in, from excavation to form creation, through PVC pipe installation and pad pouring and then the cable and wire pulls. Control cable and other low-voltage lines had their own conduits running from pad to building, as code requires. The generator and transfer switch arrived relatively early, and the transfer switch was actually installed first.

The big delay was the UPS itself. One of the issues was that, as an oversized load, the travel for these things is dictated by the state Department of Transportation. The UPS was packaged at a shop near Peoria, Ill. Our transmitter site is in Illinois, but it can only be accessed from Indiana. This meant that both states dictated the route the load had to take, and each state had their points of exit and entry at a different road, several miles apart.

I ended up solving the problem by meeting the truck at a mutually agreed-upon point in Illinois, figuring out a compromise route (which favored the border crossing indicated by Illinois), then taking the shortest route to meet up with the route that Indiana had dictated, and praying that we didn't meet any Indiana state troopers while we were on the way. That actually worked, and we were at the site before any cops could find us.

The UPS, in its housing, and the generator were installed on their pads on the same day. An adequately sized crane was rented to lift both into place. The Com Ed crews came out at around the same time and installed their pad-mounted replacement transformer for the pole pigs, using their own crane, and

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UPS

CONTINUED FROM PAGE 10

they installed the 480-to-208 transformer we had purchased at the same time.

Note that we'd had the option to buy our own such transformer, or use one Edison would supply. We elected to own it. Edison also installed the primary line underground, but we had to supply the trencher. Don't forget to add that to your list.

We also had our new 1,000 gallon LP gas tank piped to our old generator temporarily, and a new gas line run underground over to the new generator.

I cannot stress too highly the importance of having a reputable contractor handle this part of the project. Insist that the gas line be wrapped to prevent corrosion while it's down there, especially in an environment with a high water table, which is the case at our site.

Also make sure that a flexible coupling is in place between the tank output and the black pipe going underground. At least in our area, that also is code. Our contractor also added a support for the line above ground to aid in the line's stability.

That gas line to the old generator became important for us because for a period of about three days the old generator was the only source of electrical power the transmitter site was to have, while system switch-over was in progress.

Fortunately, with the digital transmitter taken off the air, and after switching to our smaller backup transmitter and antenna system, the old generator passed its test with flying colors, and was in turn rewarded with a complete checkup and oil change afterward. It is now happy in its new assignment, supplying 20 kVA of single phase power at a transmitter site way out in the country.

Fig. 5: The building that houses the actual UPS is built around it at a separate facility, then shipped intact to the site by oversize truck.

After the new 12.5 kV underground line was trenched in, the power from the overhead feeders was cut, the part of the old line going to the pole-mounted pig transformers was cut and a hole was dug in the ground at the splice point where the new cable was to meet the old in order to allow the splicing crew a place to do their work of meticulously splicing the high voltage-cables together.

At the same time, over at the new primary transformer, another crew was preparing the cable.

Installation involved no lugs and lug nuts. For safety, the inner conductors of the coaxial-style cables are plugged directly into sockets on large insulators. The outer sheath forms the neutral side of the line, and those go to ground connections on the transformers. These cables are actually easier to install than are the 480 volt secondary wires, which are much more thick and bulky.

Meanwhile, the electricians were busy wiring the 480 volt cables and control system to the generator, and wiring in both the UPS and step-down transformer. This took a couple of days to complete, so large were the cables. Com Ed also installed the new electric meter into the system.

In three days, we were ready. Caterpillar sent out its technician, Edison threw the switch and the UPS was online. After a check of phase rotation, the UPS was calibrated and then put into operation.

The generator technicians came out and got the generator commissioned. Its phase rotation was OK. Then, late that night, the station was taken down for the first time, the old generator was shut down and the wiring to the transmitter building was switched from the old transfer switch to the feed from the new step-down transformer. The new generator got the honors to be the first of the new system to feed the building, and once the phase rotation was checked again, we went back on the air.

An hour later, the Edison feed was switched in, and the new system was completely online. The site was down for all of about two hours.

ONLINE

There was still work to be done, such as filling in the excavations, removal of the old pole pigs and pole and the re-installation of the fence around the compound, but that was really secondary. For all practical purposes, the project was a wrap, and a success.

With this system in place, we're pretty much immune from whatever Com Ed can throw at us.

If a power outage hits, the UPS switches

SEE UPS, PAGE 14

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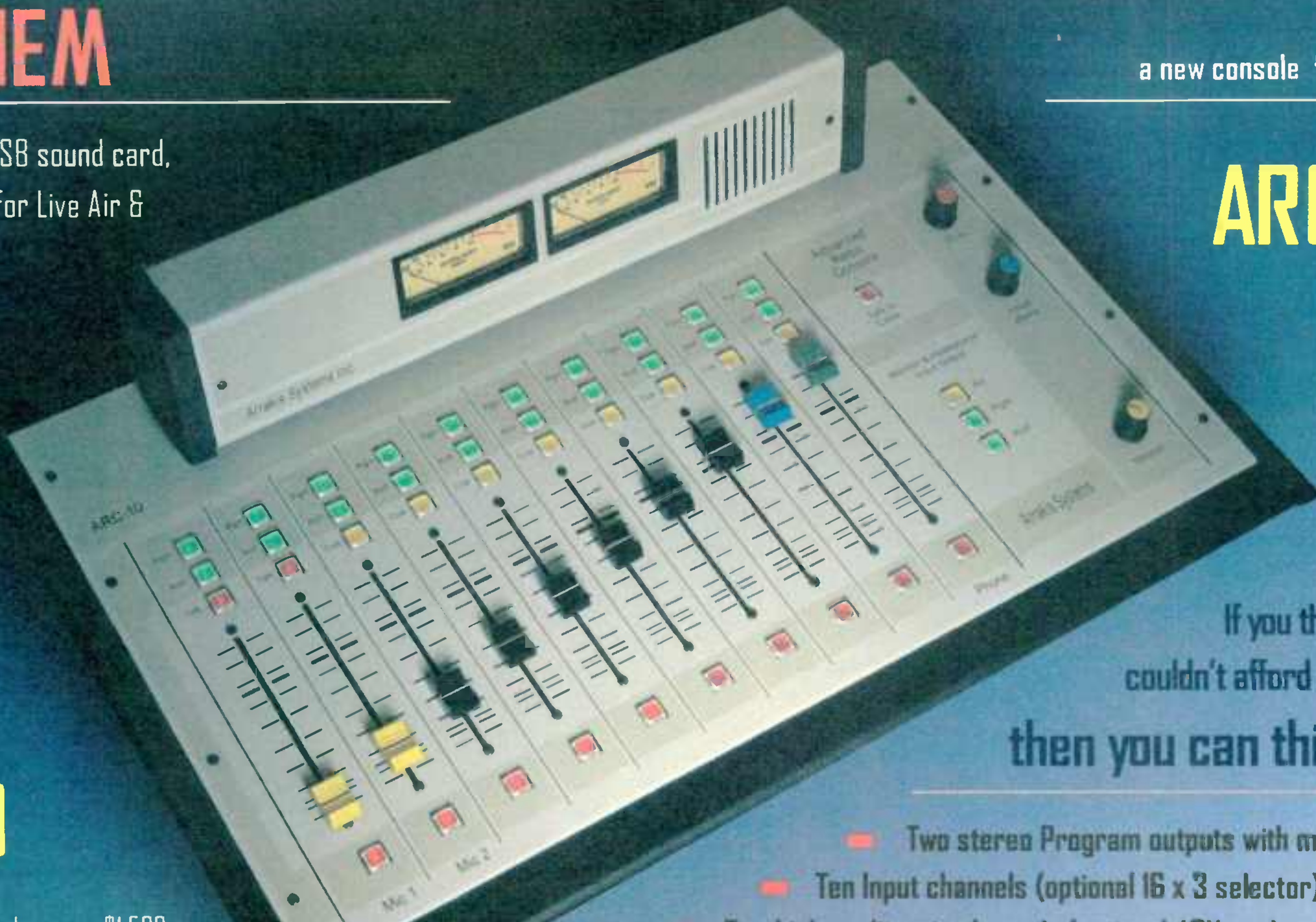

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Sunshine

CONTINUED FROM PAGE 1

pre-emphasis and MPX power levels (up to 6 dBr) do not give any relevant limitations for the use of the HD Radio system.

HOST COMPATIBILITY

Is the European receiver universe different from that of the United States? Not really, but in most countries in Europe, portable and indoor listening of FM radio is much more important than in the U.S.

Actual figures from Switzerland show that approximately 2/3 of all radio listening is indoor/portable. This means that portable receivers have to be tested as well as car receivers. Home stereos are a bit less important nowadays because they are mostly connected to cable systems and no longer to an antenna.

Earlier receiver studies from Nozema (Netherlands, 1998) and the Swiss OFCOM in 2002 indicated that a greater part of the portable receivers are not even able to meet the minimum signal-to-noise ratio requirement and the minimum RF-Selection criteria as recommended by the ITU-R BS.412-9, BS.415-2 and ITU-R BS.641 rules. Fig. 3 shows the S/N performance (with and without HD signal) of a sample of typical European FM receivers.

The S/N influence of the two digital HD Radio sidebands on Europe's FM receiver universe at the time of operational introduction of HD Radio should be very minimal, and the commonly used planning criteria on minimum S/N performance can be met. No influence on RDS-AF function was detected so far.

EXTENDED HYBRID AND MULTICAST

Simple lab measurements and comparisons with extended hybrid operation did not show any relevant differences to the measurements made in the United States.

However, to get best possible S/N protection for some of the existing high-performance FM receivers, I would actually recommend delaying full extended hybrid operation until after initial operational introduction in European radio markets to minimize any potential interference to existing receivers. Looking from a marketing perspective, of course, multicast is a must, right from beginning.

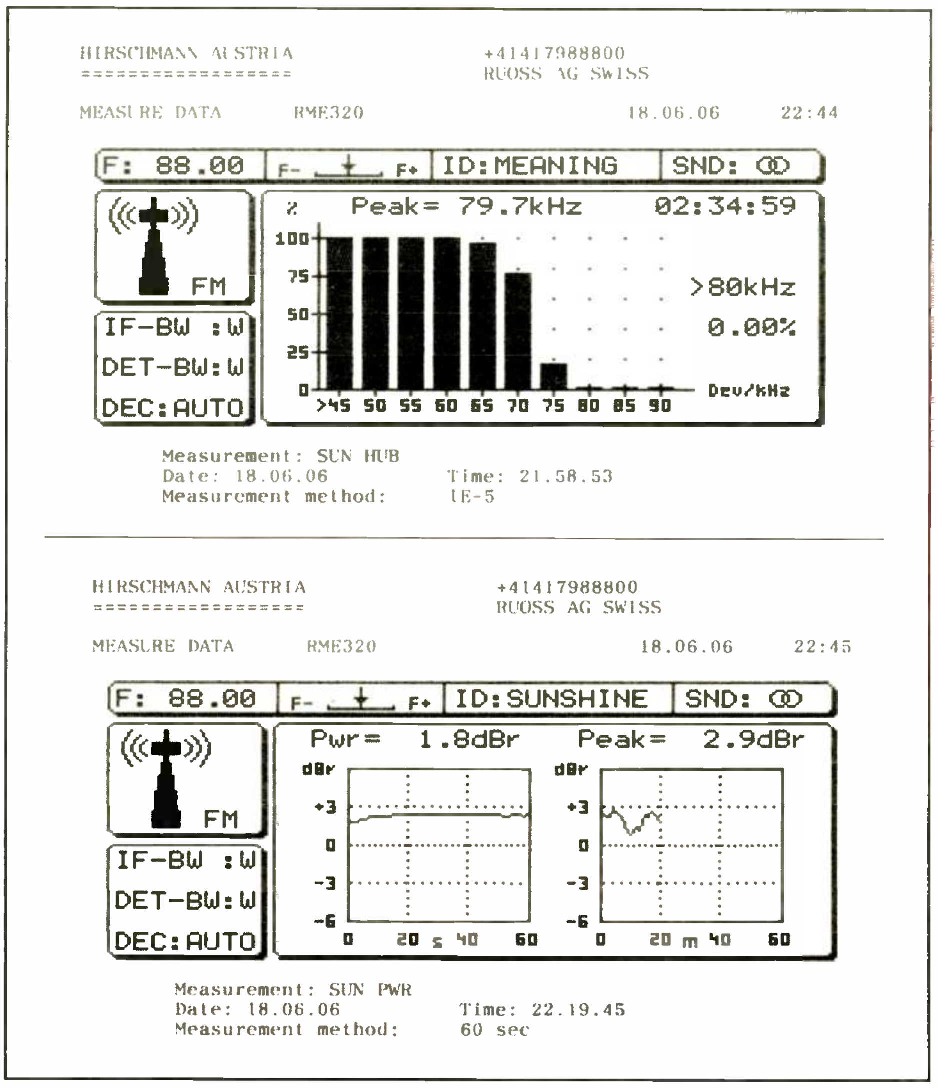

Fig. 2: Measurement of typical peak deviation and audio multiplex power used at the Radio Sunshine transmitter network. The recorded values are at the 'edge' of what is allowed in Switzerland.

	CAR I	CAR II	Home Stereo I	Home Stereo II	New Walk-Radio FM/DAB	New Cellphone	Old Mini-Portable	Old Walkradio Portable
FM-Only	56	56	69	68	54	53	47	47
HD-ON	56	55	67	62	52	51	46	46

Fig. 3: SNR (in dBA) of typical European FM receivers

I. FIELD TEST RESULT
Digital Coverage in the FM Coverage Area

Within the FM coverage area the digital coverage for all digital content is perfect and 100 percent stable with car receivers. For examples see Fig. 5.

It also can be seen that coverage extension happens in areas where FM analog is unusable (black/blue and green in Fig. 4) because of strong multipath reception, as long as there is sufficient field strength and off-spectrum protection.

Fig. 4 shows the FM analog quality (ITU, five-grade scale) of almost the complete reception area of the 88 MHz transmitter. Almost all of the green/blue and black parts will have digital reception with some blending to analog. The coverage area for the multicast content is smaller than for the host program because there is no blending feature. These results are not yet validated for complete indoor reception in all of the areas where car reception is good.

RDS-AF Functionality/ Host Compatibility

In the first nine months of operation with the HD Radio signal during our testing, not one complaint was received from a listener (more than 50,000 FM receivers on 88 MHz) about S/N reduction from HD Radio sidebands.

Nor were there any complaints about RDS Alternate Frequency function, which is very important in the test area (more than four different frequencies are needed for FM analog coverage around Lucerne/Zug). This is a clear indication that HD Radio can be introduced on existing FM transmitters

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UPS

CONTINUED FROM PAGE 12

mode to temporary generator instantly. If the outage is of more than five seconds duration, the generator comes up. There is no momentary outage while the transfer switch does the "switch-over two-step." In fact, the transmitters never notice a change at all. The UPS shields them from that.

We do notice a mild power glitch when the air conditioners in either the UPS building or the transmitter building go on or off, but let's be fair about this: the HVAC units are on the transmitter side of the UPS. I can live with that.

There are some things a buyer must know when purchasing a UPS of this type. We found this out recently, when a few problems regarding our UPS came to light.

In brief, we had trouble when a major transmitter overload blew the circuit breaker that provided the line power coming out of the UPS, without blowing the breakers or fuses between the UPS output and the transmitter, or the input breaker to the UPS.

This was the technical equivalent of blowing the building breaker but leaving the UPS running. However, without any power being supplied to the air conditioning units in the UPS building, the heat build-up in the UPS came to the point where we nearly lost the UPS as well.

In the ensuing investigation, we learned that the input and output breakers in the UPS building were neither known about, nor accepted by, Active Power. They had been installed, unilaterally, by the manufacturer of the building in which the UPS was housed, without anyone else's knowledge or consent. And the breakers installed were microprocessor-controlled; very inappropriate for this application.

As a result, I've learned a few lessons that should prove useful to anyone wishing to obtain and install this type of UPS.

✓ First, be sure to specify in the UPS order that there be no breaker installed ahead of the UPS, and if there is going to be an output breaker, which may not be needed either, specify something simple and less expensive. A Square-D KAL series, or equivalent, is one appropriate example. Don't let the manufacturer of the facility shelter install any kind of breaker without your consent. There should be no microprocessor-controlled breakers ordered or installed. We have found that the factory will likely not have adjusted such breakers for optimum performance, and you may not be given any instructions on how to do the job yourself.

✓ Second, if at all possible, get the air conditioners set up so that they get fed directly out of the UPS, before the output breaker. Heck, just have the entire UPS building breaker box fed from the UPS direct through a step-down transformer, if at all possible. Yes, this is costly. But it may save your UPS life if the output breaker fails and the UPS continues to run.

✓ Third, make certain the UPS is adjusted at startup such that it presents a low load to your generator when it is in charge mode. This will increase the time it will take for the UPS to get back up to full speed, but it also will save your generator from itself being overloaded when your emergency power system has to be up and powering your transmitter at the same time.

The UPS is quite nifty in that we can train it to run equally well on either primary or emergency generator power. It is a simple matter of programming the auxiliary power settings on the UPS to match the characteristics of the generator. And, in case of trouble, a simple old-fashioned phone modem, located within the UPS housing and attached to our transmitter site POTS line, allows Active Power's customer service department to "look in" on our UPS and make any corrections they deem to be necessary. The ability to remotely monitor the UPS saves expensive service calls and the look-in is free.

How effective is this UPS? The system has now been in place for two years and nine months, as this is being written, and during a routine change of the flywheel bearings (required at approximately every 30 months of operation) we learned that our unit has absorbed in that time almost 600 short-term electrical outages from Edison, outages which would otherwise have put the station off the air. Avoiding those outages is vital in a market as competitive as Chicago.

Actually, the weak link in the system has been the generator. It went down during a Com Ed outage one night, due to loss of oil through a broken fitting. That is the only time the UPS actually ran down in the nearly three years we've had this system in place. We did get the generator going again, but had to have it repaired later, after the Com Ed Power came back up. That took a while, as the electric mains were down for five days. Apparently, Com Ed's problems with our line are not entirely over.

Still, our site was only off the air for a little over an hour. The transmission system works a lot better with that UPS in place and we highly recommend that any station that uses anywhere from 100 kW and up, and which "cannot go off the air," put a product such as the Caterpillar UPS 150 into its site.

Art Reis is chief engineer, Crawford Broadcasting Co., Chicago. ■

~~500~~ 700 studios already?

Time flies when you're having fun!

Hard to believe, but we passed the ~~500~~ 700 studio mark recently. We're told that it's a major milestone, but we prefer to call it a good start.

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Sunshine

CONTINUED FROM PAGE 14

in a European frequency planning environment.

Indoor Portable Reception

At this moment, few indoor reception tests have been done. Extensive indoor testing with 40 or more portable receivers distributed to listeners in the fringe area of the 88 MHz transmitter will take place in the second part of the trial. We already know that outdoor field strength in the fringe areas gives us around 15–20 dB "headroom" for digital reception.

Based on the commonly used factor of 14 dB for FM building penetration, we are confident the indoor results will be promising, with the exception that we cannot yet quantify the influence of today's typical indoor noise environment on digital reception in the FM band. To achieve deep indoor reception, approximately 60 dBuV/meter at 2 meters (commonly used in Switzerland for actual FM planning) will be necessary.

HD Robustness at High Speeds

Because 88 MHz is relatively "well protected" (in respect to ITU 412-9 recommendation), additional "artificial" interferers on both sides of 88 MHz were needed to simulate digital reception robustness in fast moving vehicles.

Compared to actual lab results some degradation could be recognized, but at maximum allowed ITU-412 interfering levels the digital reception still is robust. More quantifiable work will be done on this issue in Part II of the trial.

II. LAB TESTING RESULTS

For lab testing the ITU 412-9 and ITU-R BS.641 Recommendation for FM Planning and Measurement is taken as the basic reference. Because FM HD Radio hybrid operation is a mixture between an analog and a digital system, and because the two HD sidebands are redundant, some of the recommended procedures are not useful anymore.

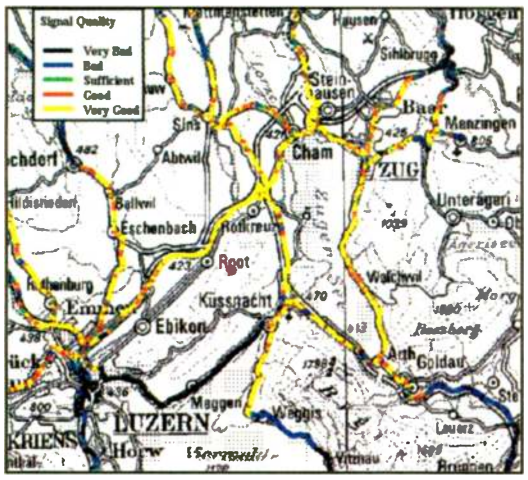

Fig. 4: Measured coverage quality of the analog FM signal of Radio Sunshine's main transmitter at 88 MHz. The different colors represent the five-grade CCIR scale for audio quality.

Also today's station audio processing produces somewhat other spectral densities than at the time the recommendations were made. For judging the HD Radio system we must have a different set of protection ratios for the following interfering situations: D to A (Digital to Analog), an HD station interferes with an analog-only FM station; A to D, an analog-only station interferes with an HD station; and D to D, interference between digital hybrid stations.

For A to D and D to D, one also will need different protection ratios for stationary/portable and reception in fast-moving vehicles. To get realistic numbers, both sidebands have to be interfered at the same time. Some subjective evaluation of the difference between an FM signal interfering with an analog FM signal and an OFDM HD signal interfering with an analog FM signal at the typical HD signal differences has to take place.

Fig. 6 shows the typical RF spectrum for hybrid and extended hybrid operation.

Critical Spectrum Issues?

For the D to A measurements, the same receivers as for the host compatibility tests were used. For A to D and D to D measurements, HD Radios from Sanyo, JVC and Kenwood were used. Co-channel and 400 kHz interfering situations are not critical at ITU limits and the same as in the United States, so no special additional attention is necessary for these situations.

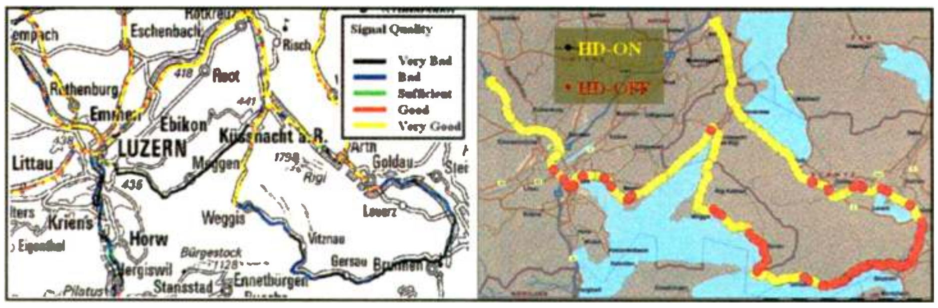

Fig. 5: Digital coverage at the fringe and outside of FM analog coverage area. In strong multipath areas (like the sections with the black color on analog graph) there is much better digital than analog coverage.

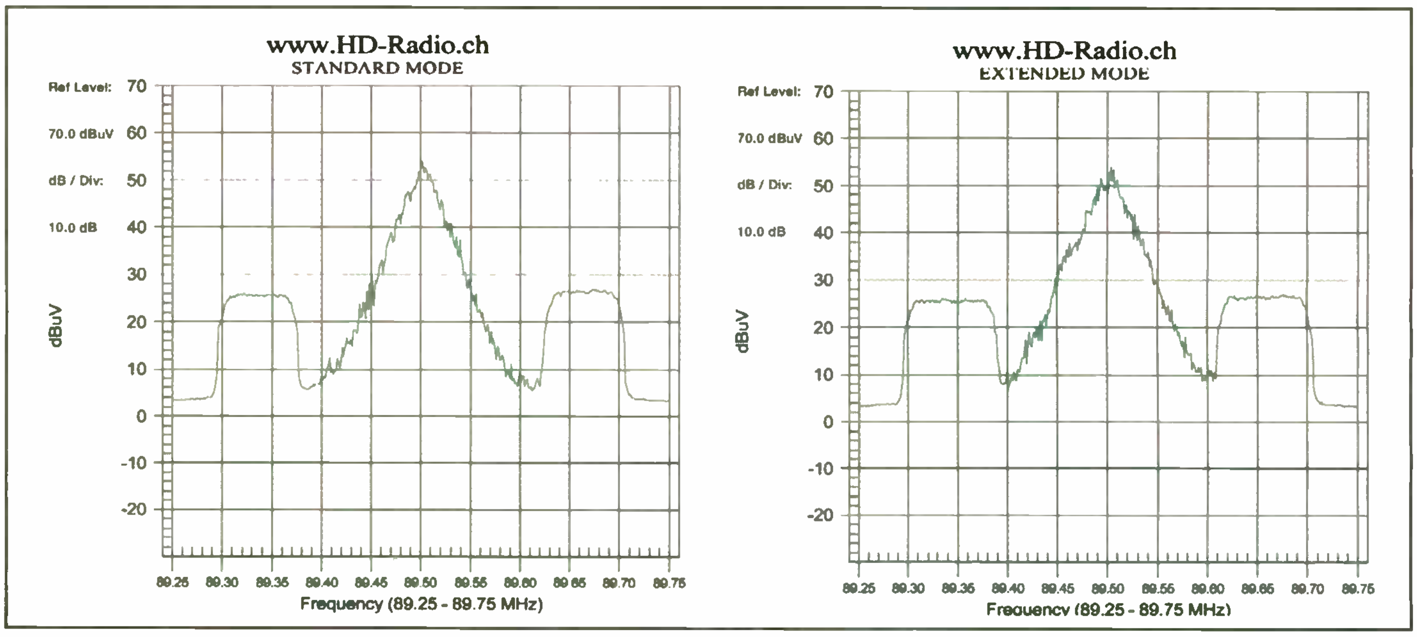

Fig. 6: RF spectrum measurements for hybrid and extended hybrid operation during the HD Radio field trial in Switzerland.

Fig. 7 shows European 100 kHz Interferer at ITU 412-9 limit. This allocation condition is not critical for D to A, A to D and D to D interference. The analog interference is always stronger than the interference from the digital sidebands. Depending on the FM receiver, more than 10 dB of headroom was measured on the ITU limit.

Fig. 8 shows the 300 kHz interference situation at ITU 412-9 limit. This constellation is not critical for D to A, A to D and D to D interference. The headroom to ITU 412-9 limits is only "some dBs" depending on the receiver, and symmetrical interferers, both strong at same time, can be critical in fast-moving vehicles.

Fig. 9 shows the worst possible condition for Europe with both HD sidebands interfered with at ITU limits. This is the most critical situation in the field (same as in the U.S.) and is fortunately not standard practice in most European countries. It is uncommon to find stations with strong interferers at both +200 kHz and –200 kHz adjacent channels.

D to A Interference

When the listener does not use an HD Radio, the maximum stereo S/N can be reduced well below the recommended value. In practice, almost all of today's car receivers will blend to mono (producing approxi-

SEE SUNSHINE, PAGE 18

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- 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

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Sunshine

CONTINUED FROM PAGE 16

mately 20 dB better S/N) during this kind of strong interference, and the average listener will not notice.

Home stereos with individual aerials, which these days exist only in rare cases, will have degraded noise performance, and "old" receivers with poor RF selectivity (and missing low-pass filter after demodulator) will have analog interference before they notice the additional noise from the OFDM signal. Therefore it is recommended that special attention be paid in 200 kHz interferer situations, especially when both sidebands are affected, to protect the existing FM receivers.

A to D and D to D interference at ITU limits will produce stable HD Radio reception for the wanted signal.

New FM HD Radio Planning Rules?

If the ITU 412-9 recommendations are respected as was "common practice" for earlier FM planning in Europe, and if estimated future average FM receiver performance is used, no new rules are necessary to implement HD Radio in Europe.

The following provisions may apply:

- Avoid symmetrical, (and same time/same location) 200 kHz interferers in the coverage area.
- Provide some headroom at 200 kHz frequency difference; average 7 dB would be great.
- Use 60 dBuV/meter at edge of coverage area.
- Correct earlier non-conforming 200 kHz interferers in the coverage area.

In Europe, the same interferers (+/- 200 kHz) are the HD Radio system limit for the existing analog FM receiver universe as in the United States!

Fig. 10 shows typical lab test configurations as they were used for preliminary protection ratio measurements.

Receiver Sensitivity

Coming as no big surprise, all tested car HD Radio receivers had very good sensitivity and very good FM analog performance as well. HD Radio uses the same proven FM radio RF front end as current radio receivers. The car receivers we measured so far worked in digital mode a bit below 30 dBuV at the receiver antenna input. The first generation tabletop radios are a few dB less sensitive.

How selective are today's FM receivers? Unfortunately not all receivers in the existing FM radio universe have the same performance when it comes to selectivity. As Fig. 11 shows, there are dramatically big differences between receivers.

As an example at 200 kHz frequency separation, a relevant part of the receiver universe (BAKOM Study 2003) is more than 20 dB worse than the ITU recommendation (portable/mobile), but another group of receivers — especially car receivers — is up to 50 dB better than the ITU-R is looking for.

The good news is that with the exception of 100 kHz interferers the actual FM receiver chips built in cheap portable receivers and cell phones are much better as

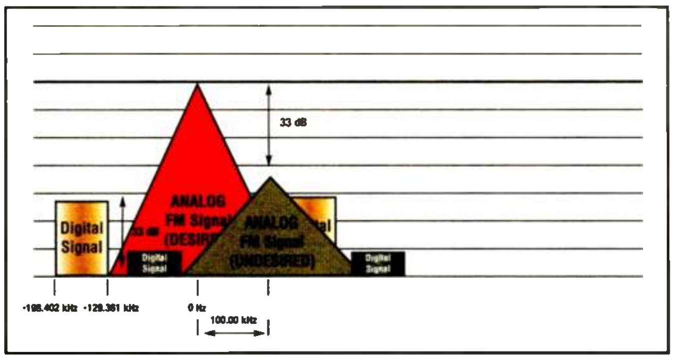

Fig. 7: European 100 kHz interferer at ITU 412-9 limit

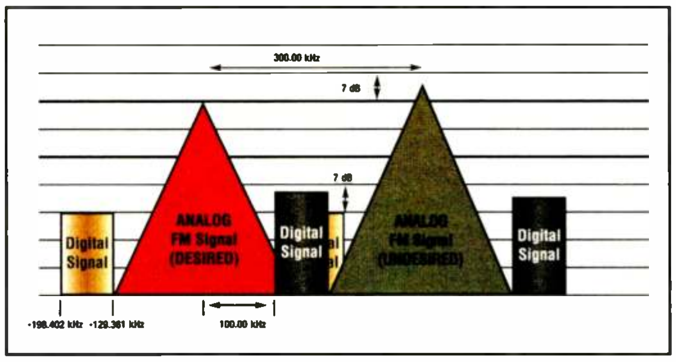

Fig. 8: European 300 kHz interference situation at ITU 412-9 limit

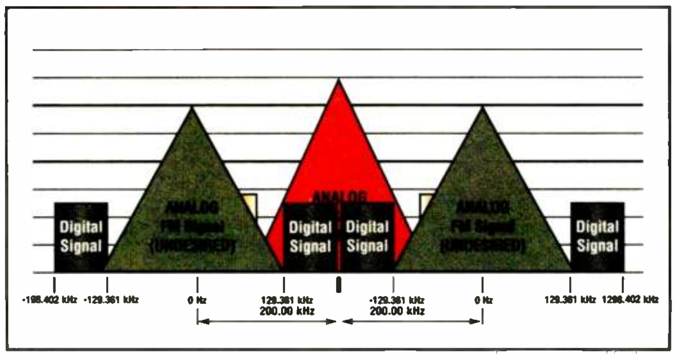

Fig. 9: Worst-case spectrum allocation condition for Europe, both sidebands interfered with an HD Signal at ITU 412-9 limits (same as in U.S.)

some years ago, and are reaching ITU 412-9 minimum performance.

HD Radio as ETSI Standard?

The initial steps have already been taken to make HD Radio a European Technical Standard Institute standard. An important part of this process will be the inclusion of the European RDS standard with the AF-Functionality (Alternate Frequencies), because in contrast to the United States, an average private broadcaster has a high number of translators and not just one main transmitter.

Other FM HD Radio Trials in Europe

HD Radio's growing popularity in Europe has led to some "HD Radio tourism" to our location in central Switzerland for a test drive and a laboratory demonstration of all critical protection ratio issues.

Almost all unbiased visitors, who previously had only heard of and read about HD Radio in the United States, become real fans of the digital FM idea after demonstrations in the lab and field.

Some of the leading OEMs for the German automotive industry and some German car manufacturers have started to use central Switzerland as the test bed for their HD Radio equipment.

Examples of car manufacturers include BMW, Daimler, Harmann Becker, Visteon and more. Even after the announcement by the World DAB Organization about the arrival of the far more efficient new DAB+ (with AAC+ audio codec, which is similar to the HDC used by HD Radio and with better error correction) the interest from regulating bodies and private broadcasters in Europe in HD Radio is still growing strongly.

In France, Towercast and NRJ-Group, with backing from SIRTI, have been doing intense testing since April 2006 in the Paris area with two HD transmitters on the air, in a critical European frequency assignment. Poland and Ukraine also are running some HD Radio tests.

Since Dec. 3, 2007 the first German HD Radio field trial has been on air with the Radio Regenbogen high-power transmitter in Heidelberg. The practical subjective results after the first weeks of operation are promising, even though it was predicted that the spectrum jam around Heidelberg will never allow a successful practical operation of HD Radio.

Other new plans for HD Radio trials and interest in HD Radio in Europe that we know of include Austria (Krone-Hit-Vienna and others); Italy (RVR with some broadcasters in north Italy, Aeranti Corallo-Radio Association); Romania; Czech Republic; and Bosnia.

Next Steps

Even with the positive results so far, more detailed investigations in the lab and in the field are necessary before regulatory agencies can start issuing operational licenses for HD Radio.

Following are the major steps in our trial project:

- Comparison between FM and HD Radio indoor coverage
- Support for OFCOM lab measurement of HD Radio protection ratios for all major allocation conditions and receiver segments
- Determine the consequences (if any) on FM planning for FM HD Radio implementation in Switzerland (and Europe), and a comparison with U.S. and ITU 412-9 recommendations
- Translators and single frequency network boosters for HD Radio in the field (and RDS-AF functionality test)
- Implementation and operation costs in comparison to FM operation and other digital platforms
- Implementation comparison with other digital FM systems like DRM +
- Support of timely creation of operational HD Radio operational licensing guidelines
- More general awareness in Europe for FM HD Radio, including at the receiver manufacturer level for multi-platform receivers

The Key Advantages of FM HD Radio

HD Radio can become the optimum path to the digital radio age for European single-program broadcasters.

The advantages are obvious. The broadcaster can con-

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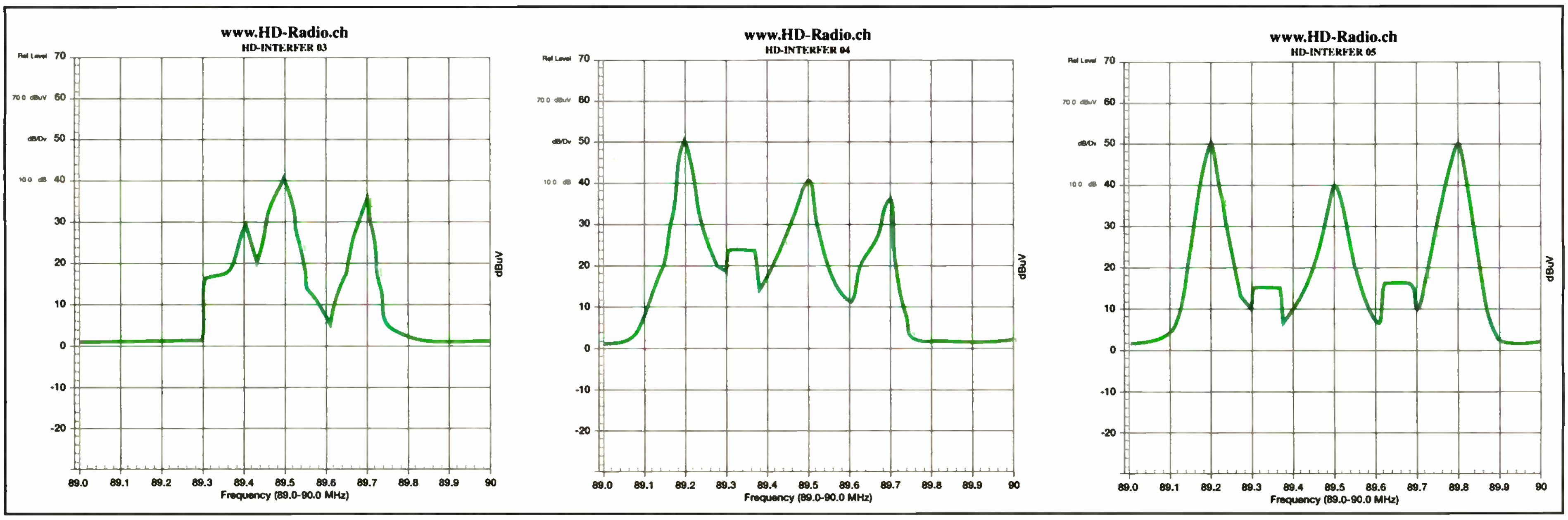

Fig. 10: Typical lab test configurations with 'European 100 and 300 kHz interferers' as they were used for preliminary protection ratio measurements

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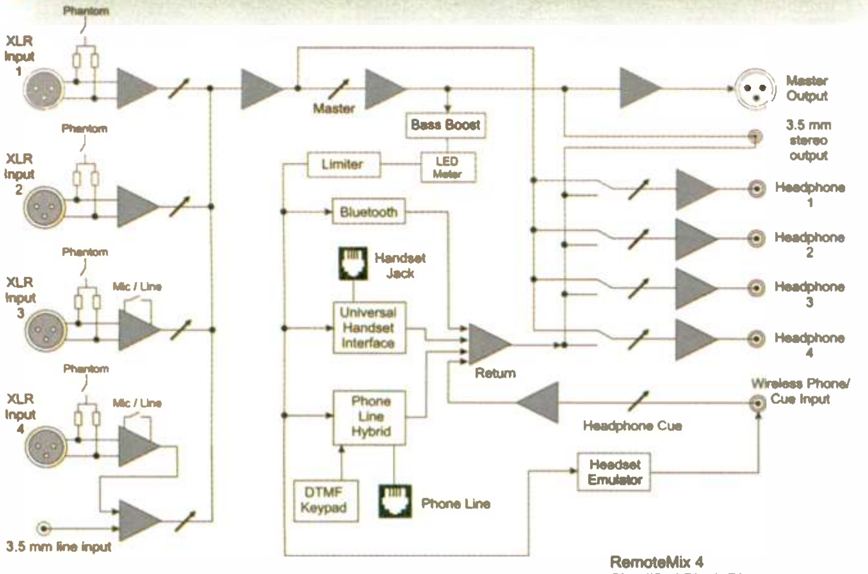

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Testing Audio Quality in Live Radio Broadcast

FFT and Multi-tone Tests Make Analyzing the Audio Quality of Live Radio Broadcast Content Simpler

The author is applications engineer for Prism Sound.

The radio broadcast signal chain is a long and complex path involving electro-acoustic transducers, mixers, storage media, interface channels, signal processing and more.

Each process within this path can induce distortions upon the original audio signal, even when working correctly. These distortions can become intolerable when devices fail or are incorrectly configured or interfaced, and should therefore be analyzed at the installation stage and also during ongoing use.

Although the main motivation for ensuring acceptable audio performance is to ensure that the audience experience is not compromised, audio specifications often form part of contractual obligations between network regulators and providers, thus reaffirming the need to continually analyze broadcast quality. Analyzing live radio performance can be a difficult problem for engineers, despite what might appear to be a fairly simple brief:

"Determine whether the audio quality of a radio broadcast is within agreed acceptable limits."

Answering this brief, in the context of today's audio analysis tools, will form the focus of this discussion.

In order to highlight the difficulties of this problem, we need to discuss the details of the individual tasks involved in more detail.

REQUIRED TASKS

The first task is to define the objective parameters that determine perceived audio quality. Once these parameters are defined, we then need to establish "acceptable" performance limits for each parameter. We must discuss how these parameters might be measured at various receiver locations during a live broadcast, and how these multiple measurements could be analyzed and logged.

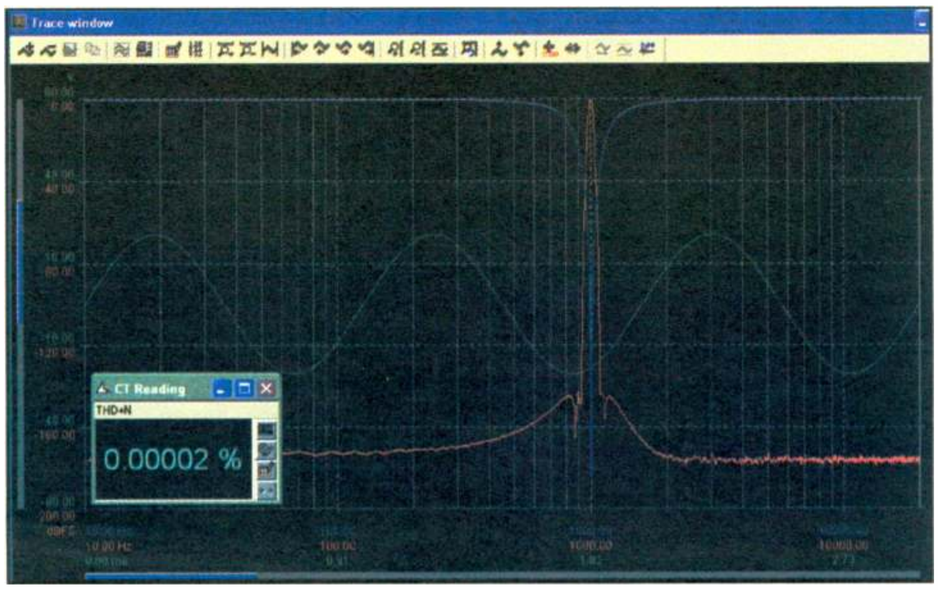

Fig. 1: THD+N of a 1 kHz sine wave (green trace) measured using an analog 1/3 octave band-reject filter (blue trace). FFT of sine wave also shown (red trace).

1. Define Objective Parameters

Subjective evaluation of audio quality is a somewhat contentious issue, and we have yet to fully characterize the relationship between objective measurable data and subjective listener experience. However, there are a number of parameters that are understood to correlate closely with perceived audio quality, as follows:

- Bandwidth
- Amplitude linearity
- Noise
- Harmonic distortion
- Intermodulation distortion
- Crosstalk

Most modern audio analyzers can measure these parameters as standard, and audio engineers should be familiar with the techniques for measuring them.

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Sunshine

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tinue to use almost all of his existing transmitter and translator sites and equipment. Compared to the total operating cost of an FM distribution network, only minor reinvestment for the startup of the digital operation is needed.

As our actual experience so far shows, not all translators have to be modified to digital. Radio Sunshine has a total of 16 sites. For a minimum of 80 percent HD Radio coverage approximately 10 sites will be needed to be modified to HD Radio technology. In contrast to the United States where one licensee has only one transmitter per program stream, a typical European private broadcaster has an average of more than five translators per program stream. This further use of the existing broadcast infrastructure gives the broadcaster the unique chance for a controlled slow evolution to digital at low cost.

To be able to use the same FM channels for the programming and other content is an extremely valuable marketing advantage for the broadcaster.

As additional advantages the broadcaster will get better quality of service within his coverage area and good indoor reception. Portable and indoor reception is important in Europe because it counts for more than 2/3 of total radio listening hours.

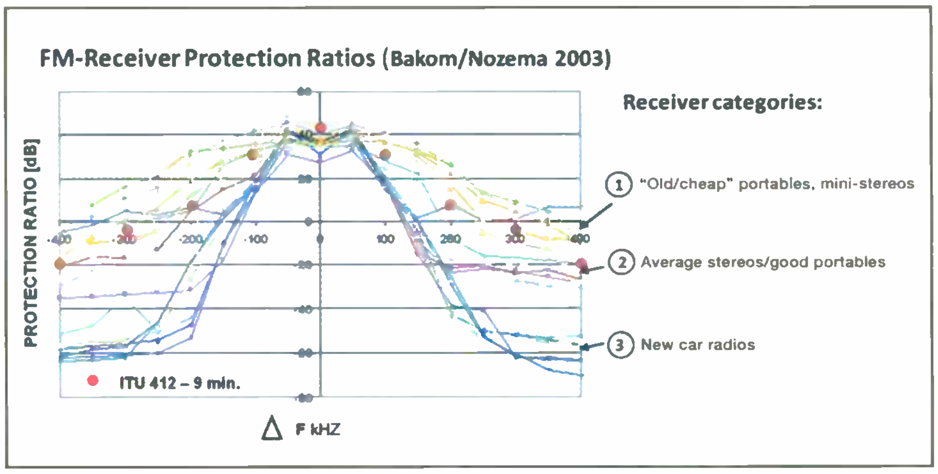

Fig. 11: Three groups of receiver performance, according to ITU 412-9 specifications are shown. Group 1 is almost worse than the minimum specification. Group 2 is a bit better than the ITU Reference and Group 3 is much better than the ITU 412-9 minimum performance. The difference at first adjacent can easily be greater than 1:1000 (60 dB!).

For the success of HD Radio in Europe it is critical that broadcasters and the industry begin to show interest in this technology and its development. This is the reason we founded the European HD Radio Alliance, or EHDRA.

More information about the HD Radio Field Trial in Switzerland can be found at *www.hd-radio.ch*. For more information about EHDRA, visit *www.ehdra.org*.

M.A. Ruoss is founder and owner of Ruoss AG, Electronic Media Consultants and chairman of Radio Sunshine, both in Switzerland. ■

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Test

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Standards documents including AES17, IEC61606 and IEC60268 (collectively catering for digital, analog and mixed-signal equipment) have been produced to enable engineers to characterize audio equipment to recommended standardized procedures.

A copy of the AES17 standard can be downloaded from *www.aes.org*, and a single-page summary can be found at *www.prismsound.com/AES17*.

There are limitations to these tests, however. These tests focus on the short-term, steady-state response, but this does not guarantee that equipment will perform reliably over the long term.

Radio engineers must ensure that systems are free from intermittent "glitches," "drop-outs" or drift caused by poor interconnections, inadvertent asynchronicity or faulty equipment. These defects can be difficult to identify using these short-term tests.

Some modern audio analyzers have sufficient flexibility to provide reliability checking, and these tests should be included as part of the signal chain commissioning process. Whilst beyond the scope of this article, more information on reliability testing can be found at *www.prismsound.com/broadcast*.

Further insight into today's audio analyzers and their capabilities may be found by Web search of phrases such as "digital audio analyzer."

2. Define Limits for Objective Parameters

Despite the difficulties in defining the limits of perceptually "transparent" audio, most of the parameters identified above will have limits imposed by the broadcast signal chain. In some cases, limits are imposed by the broadcast channel itself.

For example, the modulation bandwidth of FM radio is 30 Hz–15 kHz, thus providing us with a suitable test limit for bandwidth analysis.

In other cases, equipment used within the signal chain will be the limiting factor of performance: dynamic compression will generate harmonic distortion; noise from microphone preamps may limit system dynamic range; and lossy compression codecs will exhibit complex noise and distortion characteristics. All of these issues, and more, need to be characterized in order to ascertain the limits of performance of the broadcast system as a whole.

Once the audio signal path is characterized, typical test specifications/limits for an FM stereo radio transmission might look something like the following:

Bandwidth (–3 dB):	30 Hz – 15 kHz
Amplitude linearity (40 Hz–13 kHz):	+/-1 dB
Total distortion (@ +18 dBm*):	<1 %
Signal-to-Noise Ratio (@ +10 dBm*):	>50 dB (unweighted)
Crosstalk (@ +10 dBm*):	>55 dB

**Dependent on relationship between source amplitude and modulation depth*

3. Measure Parameters During Live Broadcast

Typical radio program material cannot easily be analyzed in terms of the parameters defined above. Hence test tones are normally used for analysis.

Test tones are fairly objectionable to listen to, so their use in live broadcast is generally restricted, and typical test "windows" may be as short as a few seconds and limited to perhaps once daily.

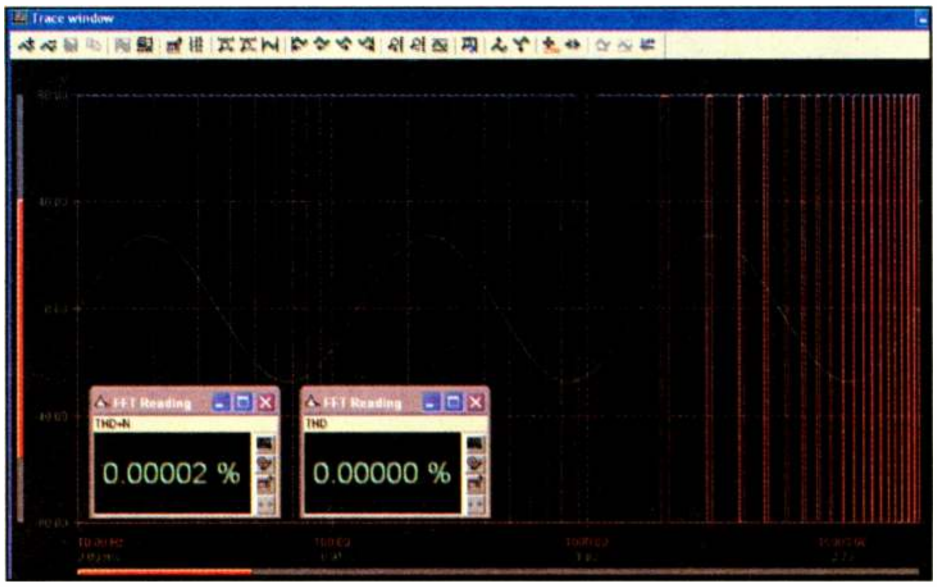

Fig. 2: THD+N (blue filter trace) and THD (red filter trace) of same 1 kHz sine wave measured using digital frequency domain filtering.

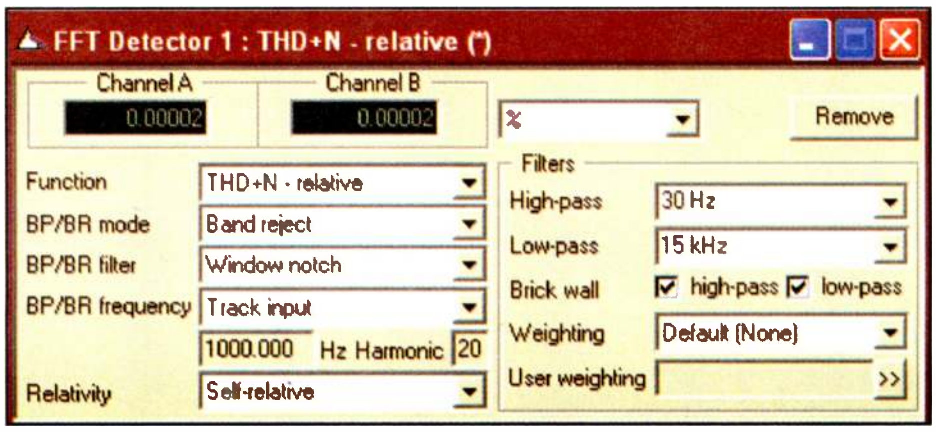

Fig. 3: dScope FFT Detector configured to measure THD+N over 30 Hz–15 kHz bandwidth, with brick-wall high-pass, low-pass and band-reject filters.

The test window duration can prove to be a tough engineering challenge. It can take several minutes or more to fully characterize an audio device using the techniques laid out in AES17, for example, but this is simply not practical during a live broadcast, so an alternative approach to these traditional testing methods is required. These alternative techniques will be discussed in more detail later.

4. Analyze and Log the Data

Broadcast networks can cover vast territory, and ideally the entire network needs to be analyzed on an ongoing basis.

This implies large amounts of test data, and therefore that the analysis task requires automation. Ideally an audio analysis system for radio transmission should be capable of automation of all necessary tasks, including test tone detection, data capture, data analysis and compilation and distribution of test reports.

These tasks are non-trivial, and will require a good deal of automation flexibility, not only in terms of the audio analysis, but also in terms of communicating results to the outside world. Fortunately, off-the-shelf audio analyzers are now capable of performing the tasks required to solve our initial brief.

RECENT DEVELOPMENTS IN AUDIO ANALYSIS

1. Digital Audio Analyzers and FFT Analysis

In recent years, there has been an increasing trend towards digital analyzers in audio test. These devices generally employ high-quality analog-to-digital converters (ADCs), enabling analysis of both digital and analog signals. Once digitized, signals can be analyzed either in the time domain, as with conventional analog analyzers, or in the frequency domain.

A buffer of time domain samples can be translated into a spectral representation by applying the Fast Fourier Transform algorithm (FFT). The resolution of this frequency-domain representation depends on the length of the time domain sample buffer; a "4k" (4,096 samples) buffer will result in 4,096 frequency bins, distributed linearly from DC to the digital sample rate (FS). A trade-off exists between frequency resolution and analysis time, as a larger time domain buffer will take longer to fill and process.

One advantage of processing signals in the digital domain is that analysis filters are not subject to the same hardware constraints (and costs) associated with analog systems, giving us more flexibility and power.

Take distortion, for example. Using an analog analyzer, we can measure the distortion of a system by applying a sinusoidal signal to our equipment under test (EUT) input, and applying an appropriate band-reject notch filter to the EUT output. We can then measure the output from the filter (see Fig. 1) giving us the sum of the harmonic distortion components and noise (THD+N).

In the digital domain, we could simply opt to make an equivalent distortion measurement using a digital realization of this analog notch filter. However, FFT analysis offers us additional flexibility. Once a signal has been translated into discrete frequency domain components, we can be highly selective as to which of these signal components to include or exclude from our analysis, and thus true brick-wall topologies are made possible, with no irregularities in amplitude or phase response.

We could therefore choose to employ a brick-wall filter to measure THD+N with greater precision than with our analog analysis, or we could use a series of band-pass notch filters positioned at the harmonic frequencies of the generator signal to analyze just the total harmonic distortion (see Fig. 2).

In this latter case, we now have the power to resolve the noise and distortion independently, a feature not generally possible with analog hardware due to the prohibitive hardware costs.

2. Multi-tone Testing

A further benefit of digital analyzers is the potential to generate and analyze waveforms of arbitrary complexity.

Whilst analog oscillators, filters and voltmeters are discrete hardware components, with inherent cost-related topological limitations, DSP provides the potential for a signal generator or analyzer to be as complex as the software designer chooses, at no extra cost other than that involved in developing the appropriate code. Generator and analyzer functionality can even include options to be entirely user-defined if sufficient flexibility is designed into the system.

• *Multi-tone Frequency Response*

This increased generation and analysis potential can enable more advanced measurement techniques than conventional methods.

The AES17 procedure for measuring frequency response, for example, is to sweep the frequency of a sinusoidal generator through a series of steps, and to monitor the output amplitude of the equipment under test (EUT).

This can be a time-consuming process, especially for high-resolution measurements. The analyzer must allow for settling/convergence and any EUT latency at each sweep step before logging a result. A 200 point swept-sine measurement might take a significant fraction of a minute to execute in a system with zero latency.

Compare this with a more advanced signal generator, which could be configured to excite every possible bin frequency of an FFT analyzer simultaneously. A frequency response can be derived by plotting the amplitude at each FFT bin, and therefore a "4k" (4,096-point) FFT analysis, with

SEE TEST, PAGE 24

It can take several minutes or more to fully characterize an audio device using the techniques laid out in AES17; this is simply not practical during a live broadcast. An alternative approach is required.

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Test

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2,048 data points in the sub-Nyquist band, will give more than 10 times the resolution of a 200 point sinusoidal sweep, and can execute in a fraction of a second.

• *Multi-tone Noise and Distortion*

We can develop this powerful technique further if instead of exciting all FFT bin frequencies with our signal generator we chose to excite a smaller number of frequencies. We can then analyze not only the bins occupied by signal frequencies (to analyze the frequency response), but we also can simultaneously analyze the bins unoccupied by signal frequencies (to analyze the noise and distortion response).

We can strategically place the multi-tone signal components at even-numbered FFT bin frequencies, and this in turn guarantees that any harmonic distortion components (integer multiples of the signal frequencies) and intermodulation distortion components (sum and difference products of the multi-tone components/harmonics) also will end up in even-numbered bins. The odd-numbered FFT bins will therefore contain only noise, and we then have the ability to independently measure the distortion and noise components.

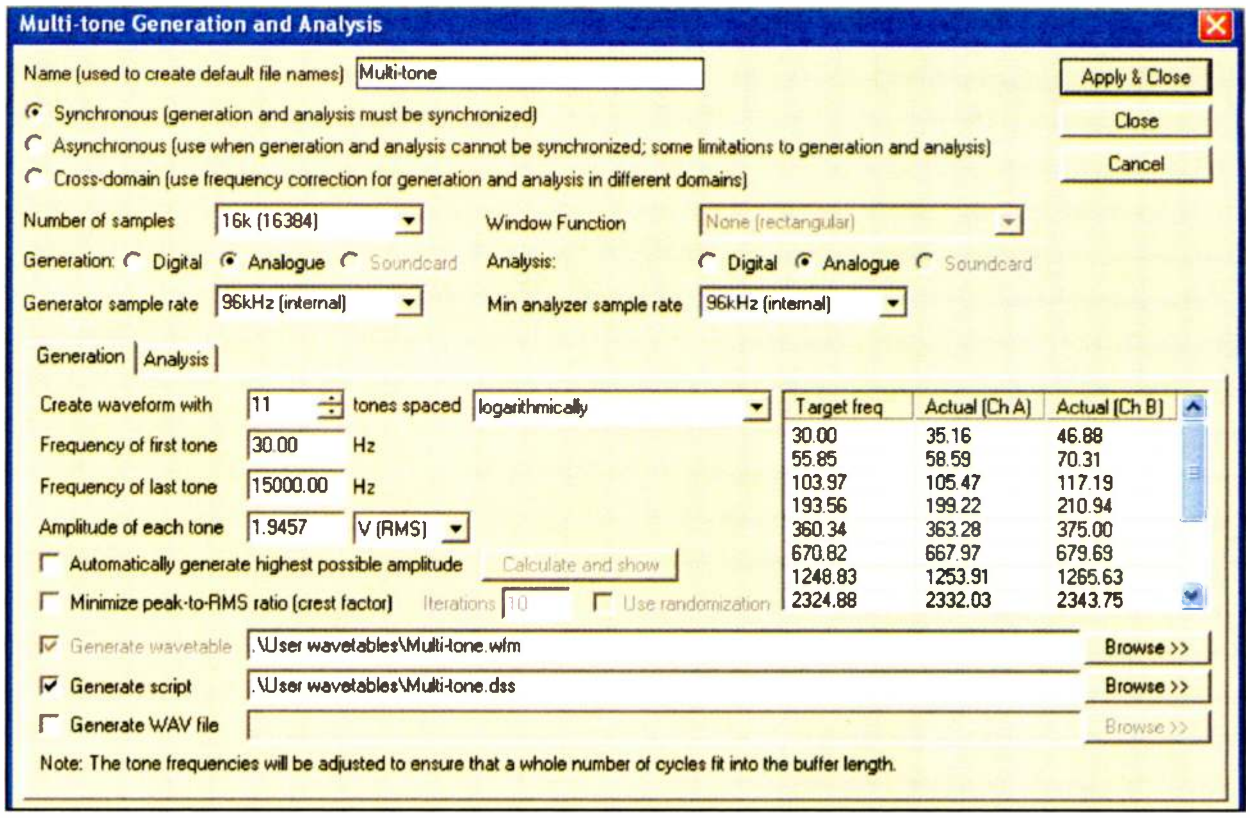

Fig. 4: dScope Multi-tone Generator Configuration Window

• *Multi-tone Crosstalk*

We can even choose to offset the tone frequencies between the two channels of a stereo system, and if we analyze the channel A signal frequencies on channel B (and vice-versa), we can measure the crosstalk response.

All of the above measurements can be achieved in a single capture of an FFT buffer, and our EUT can potentially be fully characterized in less than a second. This represents a huge time-saver over the conventional AES17 characterization process, and illustrates the enormous power of multi-tone measurement techniques.

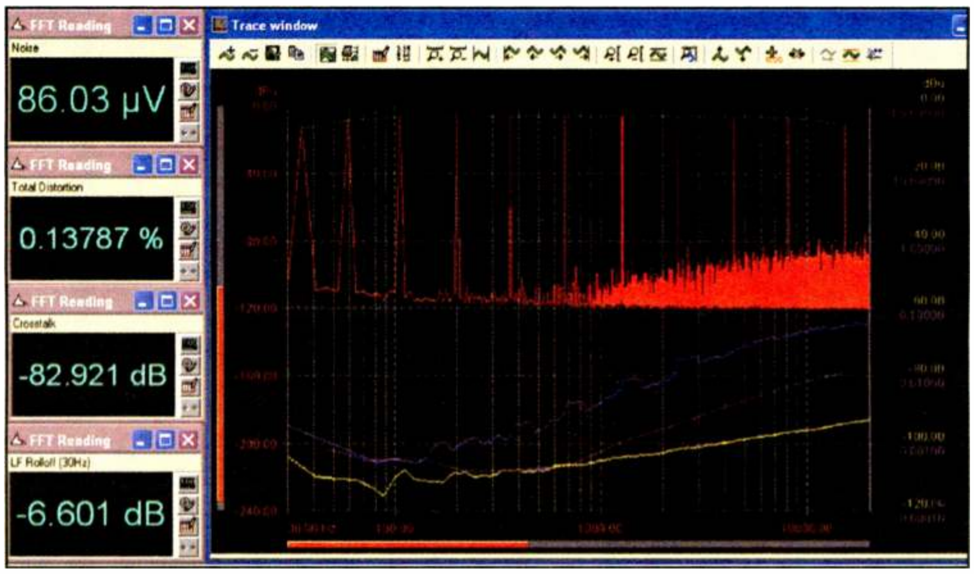

Fig. 5: dScope multi-tone analysis of EUT using signal configured in Fig. 4. Single channel shown for clarity. FFT–red trace; frequency response–green trace; distortion response–blue trace; noise response–yellow trace; crosstalk response–purple trace.

• *Interpreting Multi-tone Measurements*

It should be noted that whileAES17 measurements generally are made at single frequencies, multi-tone measurements are integrated over the entire spectrum.

In the case of distortion, for example, an AES17 THD+N result would be the sum of all harmonic components of a single tone (plus noise). In the multi-tone case, however, we have a number of simultaneous signal frequencies, resulting in many more harmonic and intermodulation components in the EUT output. The two measurements therefore will give different results.

Engineers may want to "translate" the multi-tone results into a more familiar context, and the solution is simply to characterize a known "golden reference" unit using the familiar AES17 methods, and then to re-characterize this same unit using multi-tone techniques. We can then test a device of the same type to establish a pass/fail result relative to the reference multi-tone result.

• *Multi-tone Conclusion*

The rapid and comprehensive nature of multi-tone tests make them ideally suited to analyzing live radio broadcasts. The analysis techniques described above apply equally well to the output of an FM demodulator or DAB decoder in the field as they do to any other EUT on an engineer's test bench, thus comprehensive evaluation of radio broadcast quality is possible in a very short time window.

dSCOPE SERIES III AUDIO ANALYZER

The dScope Series III analyzer, available from Prism Sound, is an audio test and measurement system suited to the demands of radio engineering.

The system comprises a Windows software application and an external audio-processing interface. The dScope Series III architecture makes the most of the processing and multitasking capabilities of the Windows platform, allowing the system to measure many parameters simultaneously.

dScope provides the user with a stereo "Continuous Time Detector," which can be configured to measure parameters such as amplitude, crosstalk, noise and distortion in the same manner as a conventional analog analyzer. This analysis can be configured for single frequency measurements, or can be built into sweeps vs. time, amplitude, frequency, etc., and thus enables AES17 characterization, either manually or via in-built AES17 test scripts.

dScope also provides the user with up to 40 stereo "FFT detectors," which exploit the power of the host PC's processor, enabling up to 40 different parameters (x 2 channels) to be measured simultaneously from a single buffer capture. In addition to the standard measurement functions, dScope's FFT detectors also can be customized using Visual Basic script commands, enabling user-defined filter functions and analysis algorithms. Fig. 3 shows dScope's FFT detector configuration window configured to make a standard THD measurement over the FM radio bandwidth of 30 Hz–15 kHz, using brick-wall analysis filters.

MULTI-TONE ANALYSIS

dScope features advanced multi-tone configuration tools, allowing the user to configure a customized multi-tone signal, and an appropriate series of FFT detectors, in an intuitive configuration wizard. Fig. 4 shows dScope's multi-tone generator configuration panel, and Fig. 5 shows the dScope's analysis of this signal.

The analysis has been configured to include signal amplitude, noise amplitude, distortion and crosstalk, in addition to plotting these results with respect to frequency. All of the information visible in Fig. 5 has been captured from a single buffer of audio data, in this case a buffer size of 16k points (around 0.3 seconds of audio at 48 kHz sample rate).

AUTOMATION

dScope also incorporates VBScript programming tools, enabling automation and expansion of the system. For example, in the automated radio broadcast monitoring scenario, there is a requirement to discriminate between program material and multi-tone test sequences, in order to trigger analysis at the appropriate time.

This can be accomplished within dScope by configuring a series of additional FFT detectors with band-reject filters centered on individual multi-tone component frequencies, and testing for the condition that all of these FFT detectors output a signal level above a defined threshold. If all FFT detector outputs meet this condition, then the multi-tone signal has been detected, and analysis can be triggered.

Once this trigger condition has been met, the time domain sample buffer can be filled, and this completes the data acquisition stage. Signal processing and analysis can then commence, and once complete, the entire set of data can be compared to predefined pass/fail test limits. dScope's VBScript commands enable the system to interface with other Windows processes, so these test results could be automatically written to a spreadsheet, attached to an e-mail and sent to a central location, or streamed directly to a remote database, using the host PC's TCP/IP connection.

An illustration of using dScope script commands to send test results via e-mail is available at *www.prismsound.com/email*. This automated analysis and communication functionality enables the system to analyze and log our test tone bursts on an ongoing basis, entirely free from user input.

More detailed information on the dScope analyzer is available from *www.prismsound.com*. In particular, an illustration of how the multi-tone test techniques discussed in this article have been applied to solve the problem of live FM broadcast analysis is available at *www.prismsound.com/FM*.

CONCLUSION

We have discussed the requirements for, and the difficulties of, analyzing the audio quality of live radio broadcast content. Particular attention has been paid to the parameters we need to analyze, and to the difficulties of measuring these parameters using conventional test techniques within a limited time window. A fast and comprehensive digital test technique involving multi-tone signal generation and analysis has been introduced, and shown to be ideally suited to the restrictions that radio broadcast imposes.

Prism Sound's dScope Series III analyzer is one possible instrument to facilitate this type of measurement, and has been shown to be a system which supports comprehensive automation, and is therefore ideally suited to the task of maintaining sound quality on broadcast networks and radio stations. ■

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by Cris Alexander

Prevention of 'Cu Theft' Is Critical For Broadcasters

Our Sites are Attractive, Vulnerable Targets for Copper Thieves, As Prices Rise for the 'Hot Commodity'

Back in the early 1980s, I was site manager at a multi-user tower site in Cedar Hill, Texas, the big antenna farm serving the Dallas-Fort Worth market. The tower was 1,549 feet tall, had two elevators and three wide platforms.

Despite a 12-foot high fence topped with razor wire, it was a popular target for BASE jumpers (BASE is an acronym for Building, Antenna, Span or Earth, platforms used for daredevil parachutists).

I remember watching "PM Magazine" on a local TV station one evening and seeing a feature on BASE jumpers. As I watched, I was horrified to realize that it was our tower they were jumping from!

We eventually placed a retired sheriff's deputy at the site full-time and caught one of the jumpers. We never had another problem with them under my tenure.

While I'm sure that BASE jumpers still scale broadcast towers, today our site security issue is copper theft, which has been much in the news over the past year or so. It's something we in the broadcast engineering trade have dealt with for many years, but it has gotten some real mainstream media attention as of late.

With copper prices way up, this erstwhile low-value metal is now a hot commodity, especially on the scrap metals market. Anyone who has priced copper strap, screen or soft-drawn wire lately has no doubt had a case of sticker shock.

Copper thieves are targeting construction sites, new housing developments and even electrical substations. There have been some rather gruesome photos of a copper thief who was electrocuted while stealing copper wire out of a transformer vault making the rounds on the Internet lately.

I have seen news reports in the local media of thieves hitting vacant buildings, taking the copper water pipe, Freon lines and electrical wire for scrap.

Broadcast station transmitter sites are a particularly attractive and vulnerable target.

TO CATCH A THIEF

A few months ago, we began dealing with a different kind of copper theft in our St. Louis market.

Copper thieves began stealing the 100-pair trunk cable that fed one of our transmitter sites (and many other customers in the area). This cable was suspended overhead on utility poles beside a paved but lightly-trafficked road.

The thieves evidently tossed a strong rope up and over the cable, tied it to a vehicle and drove until the cable pulled free of its supports on several poles. They then cut the cable, pulled off as much as they could roll up and carry and hauled it off. That killed our telco-based services to the site, including T1, POTS and ISDN.

The phone company (AT&T in this case) came out and spliced in another cable but laid the temporary section on the ground beside the poles. Can you guess what happened?

Time after time the thieves returned, stealing the temporary cable. Sometimes the splice didn't last a day.

Eventually, AT&T buried the spliced-in segment and we haven't been hit again since, but we know it's just a matter of time.

In Birmingham, Ala., we share a mountaintop FM site with Clear Channel. We both have our own towers; they are located side by side on Red Mountain and share a common access road/driveway. We had experienced periodic copper theft from that site for some time, but back in November, things changed.

Photo courtesy of Bob Newberry and Clear Channel Birmingham

This armed, masked copper thief eventually was caught by police. This particular story had a happy ending, but it could have been much different.

Guy wire anchor steel should be periodically checked below grade for corrosion.

Clear Channel was getting hit hard, and in an effort to catch the thief, it installed a high-resolution security camera system at the site along with a perimeter motion-sensor alarm.

On one evening in late November, Bob Newberry, Clear Channel's market CE, and his assistant had just left the site after replacing copper stolen in a prior incident. While en route back to the studio, Bob was notified of a perimeter motion-sensor alarm. Believing that it was a false alarm (after all, they had just left the site), they went on to the studio.

Once there, they logged in and looked at the security camera system. What they saw gave them pause.

A masked intruder came out of the woods, took aim with a pistol and fired several shots at the security light, eventually hitting it.

He then scaled the fence, transited the ice bridge to the roof and cut the cable to the camera covering the tower base area. He then took the just-replaced copper items, including a strap that Bob had coated with gooey roofing tar to make it undesirable to copper thieves.

Over the next couple of weeks, the thief and his female accomplice returned again and again, always masked, always at the same time of day, secure in the knowledge that they would have plenty of time to make their escape if the police appeared at the access road entry gate (it's a long access road, and the thief posted his accomplice in the woods beside the road as a lookout).

Our site got hit, too, but we didn't have a lot of exposed copper, so our losses were minor. But with main, aux and STL transmission lines exposed just above ground level beneath the ice bridge, the potential for disaster was huge.

Our Red Mountain tower is also home to the City of Birmingham's public safety radio system. This includes police, fire, ambulance and the county sheriff. I got on the horn to the mayor's office and described the issue to the mayor's assistant, telling her that if the city's transmission lines were to be cut and stolen, the police and other agencies would be without communications. I also sent her some of the security camera photos, including one of the thief firing his gun at the security light (the muzzle flash was visible in the photo).

All of that got her attention. Soon, the mayor and police chief were involved and things started to happen.

The police set a trap and baited it with a marked copper bus bar. The trap was sprung and the thief and his female accomplice were arrested. A search warrant was run on their house and numerous items of evidence were found there. The pair had other outstanding criminal warrants as well, so they are now guests of the city and hopefully soon to be long-term guests of the state.

This particular story had a happy ending, but it could have been much different.

What if Bob, his assistant or one of our engineers had arrived at the site when the armed copper thief was engaged in his evil work? Would he have shot more than the light if someone surprised him? Who's to say?

The fact that copper thieves are coming armed certainly changes the landscape, and it changes the way we have to approach our site security.

EXTREME SOLUTIONS

There are two sides to the crime prevention coin: deterrence and detection.

Deterrence comes in the form of fences, lights, visible cameras and warning signs. Detection involves alarm systems, motion sensors, sirens and (not necessarily visible) cameras.

The problem with broadcast tower sites is that they are usually remotely located. A determined, well-equipped thief will come to the site with everything he needs to defeat the deterrence measures in place quickly, and he uses the remote location to his advantage, secure in the knowledge that police response time will be relatively long.

This is exactly what happened in the Birmingham case. The deterrence measures were defeated with a pair of bolt cutters. The detection measures were not a factor because of the long response time; in one security camera picture, a Birmingham police car is shown arriving at the site a full half-hour after the thief and his accomplice left. Had the mayor himself not taken a personal interest in this case and forced it from a file drawer to the chief's desk, the thefts would still be going on today.

So what are we to do in all the places where the mayor and police chief aren't involved? How do we protect our copper? What's to stop a copper thief from coming with a Sawzall and hacking out 50 feet of our main, aux and STL transmission lines, putting us off the air for days or longer?

There are no easy answers. We're going to have to get creative.

One of our chief engineers suggested that we tie a 160 decibel outdoor siren into the perimeter alarm system, hang it some distance up the tower and armor it and its connecting cable. That's a good idea, and it may be effective. Not many people would want to work in an area of eardrum-rupturing sound pressure for very long.

SEE THEFT, PAGE 28

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Theft

CONTINUED FROM PAGE 26

We could also install some powerful strobe lights that would disrupt vision. Video surveillance is a must (we are equipping most if not all our sites with multi-camera, high-resolution, visible/infrared video systems), as are fiber-optic based perimeter alarm systems.

These measures are sure to irritate nearby neighbors, and will all this put a stop to the theft? I doubt it. It will help, but the determined and experienced copper thief will still make off with the goods.

With that certain knowledge, we also are preparing for the eventuality that our transmission lines will be cut. We're stockpiling some transmission line segments, connectors and hardware we can use to get back on the air quickly if the worst happens. And yes, those items will be stored off-site.

Somehow, dealing with this frustrating issue makes me long for the days when my biggest site security issue was crazy parachutists jumping off the tower. At least they didn't usually damage anything.

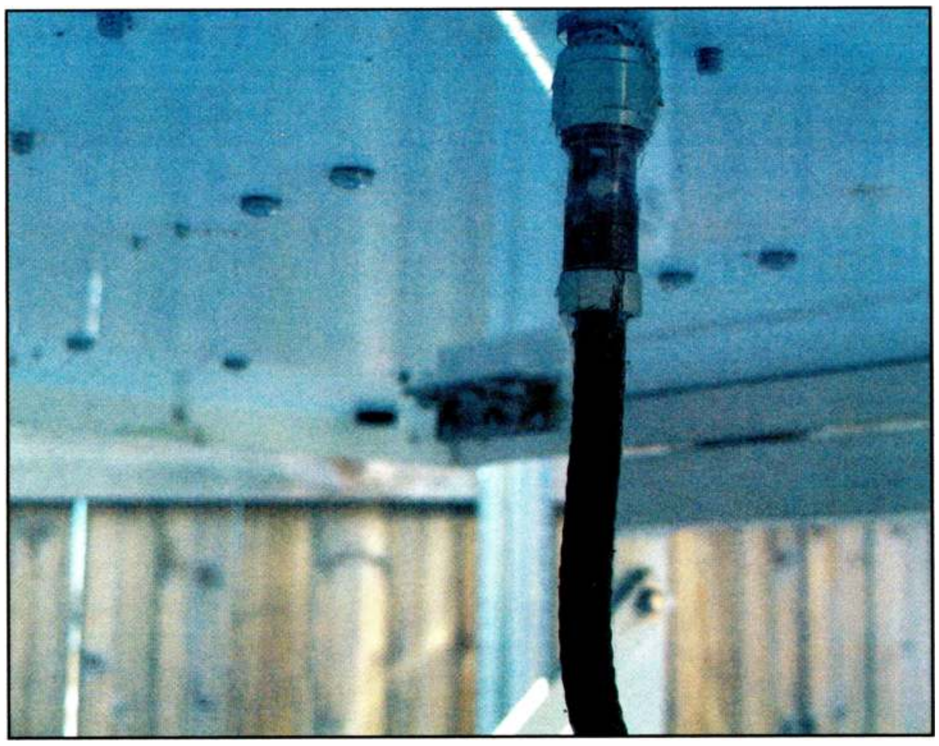
DIG IT UP

While we're on the subject of towers, when is the last time you looked at the anchor steel below the surface?

I'm not just talking about looking at it down a few feet, but all the way to the concrete. My guess is that most engineers have never had their anchor steel checked.

That was certainly the case back in early December in Joliet, Ill. Non-comm station WJCH(FM) lost the top 200 feet of its 460 foot tower in an ice storm.

What failed? You guessed it — the steel in one of the guy anchors, way down deep, just above the concrete "dead-man." Acidic soil had eroded the steel down to the size of a No. 2 pencil. When the tower got loaded with ice and hit with a little wind, something had to give and it was the anchor steel.



A suspect in the case of the mysterious shifting parameters.

If you have low-pH soil at your tower site, I think it wise to take a look at your anchor steel every few years.

Another thing that can contribute to erosion of anchor steel is nearby items with cathodic protection.

At one of our Chicago tower sites, a refinery pipeline runs along an easement that passes within a few feet of one of the anchors. This pipeline employs cathodic protection to prevent corrosion. The very cathodic action that protects the pipeline will leach material off nearby metallic objects in the soil, and because on a non-insulated tower all the anchors are to some degree electrically connected together, this has the potential to erode the steel in all the anchors.

How do you protect against this cathodic action? The simplest way is to electrically bond the nearest anchor to the cathodically-protected item. A second choice would be to employ a separate cathodic protection system for the tower and its anchors.

What did we do? We took option "C" and encased the anchor steel in concrete all the way to the surface.

Anchor steel is mostly out of sight, so it tends to be out of mind. If there is any doubt (and maybe even if there isn't), dig it up and take a peek.

DRIFTING PARAMETERS

One evening back in December, I was chatting on a local 440 MHz ham repeater that is frequented by broadcast engineers. The chief engineer for a local AM station was on there, talking with us about an interesting but frustrating problem he was having with his four-tower inline array.

The phase of one of the towers was shifting by a couple of degrees periodically. The phase shift was occurring without apparent rhyme or reason, and was seemingly unrelated to temperature, precipitation or other environmental factors.

The problem had evidently been there for some time, as the former CE of that station chimed in with the news that he, too, had dealt with it without locating the source.

As we hashed over the potential causes, I was reminded of a similar problem I faced 12 years ago. We had just completed construction of a four-tower 50 kW array near Denver International Airport. The parameters for the night pattern would shift periodically. As we were in the middle of the pattern tune-up, I chased the shifting parameters with phasor controls. As I did, the field strength at the tune points was all over the map.

Then I made an interesting discovery. Another engineer was installing STL equipment in the rack, a QEI CAT-Link. When he plugged the CAT-Link in to the Wiremold strip in the rack, Tower 4's parameters shifted.

I yelled at him to unplug the unit, and the parameters shifted back. We pulled the CAT-Link out of the rack and plugged it into another outlet. This time it had no effect on the antenna parameters. We put the unit back in the rack and plugged it into another outlet with an extension cord. Some outlets would produce the shift, some would not.

I tried plugging the antenna monitor into different outlets. No parameter shift. This was nuts! Keep in mind that the parameter shift was just affecting one tower.

What do you think the problem was? If you figured it out with the information so far provided, you're a genius (or a good guesser).

Next, I took the plug-in RF ammeter out to the tower. While watching the meter, I had someone plug the CAT-Link in and out, confirming the parameter shift on the antenna monitor. The antenna current did not change. Aha! A clue.

Then on a whim, I disconnected the green electrical safety ground wire in the ATU. This wire was brought all the way back to the electrical panel, some 1,400 feet away in the transmitter building. With the wire disconnected, the antenna monitor showed a huge shift in that tower's parameters.

My next step was to connect the TDR (time-domain reflectometer) to the sample line and see if there was some sort of issue there. It showed 1,400 feet of good line terminated in an open circuit, just as it should be (I had disconnected the sample line at the ATU). Curiouser and curiouser.

Finally, out of altitude, airspeed and ideas, I used an ohmmeter and at the ATU checked for continuity between the outside of the sample line connector and the green safety ground wire. Open.

Open? That didn't make any sense. The sample line was grounded to the antenna monitor in the rack in the transmitter room, which was electrically connected to the panel through the conduit. The green safety wire was connected to the ground bus in the panel, which was electrically connected to the panel. And the TDR showed a good sample line all the way out.

FIGURED IT OUT YET?

Not knowing what else to do, I cut the heat shrink and weatherproofing away from the connector on the 3/8 inch Heliax sample line, intending to take the connector off and see if somehow the collet had lost its electrical bond to the line's outer conductor.

But I didn't have to go that far. As soon as I peeled the heat shrink away, I could see white foam dielectric.

When someone installed the connector, that someone used the tubing cutter to score the jacket — not a bad thing to do, unless the cutter was set too deep. In this case, it scored but did not quite cut through the copper outer conductor. As workers at the tower base moved the line around while raking the rock covering the ground screen into place, the outer conductor broke on that score line. That resulted in an open circuit in the ground connection on the sample line at the ATU.

Somehow, the sample was getting its ground reference through the AC safety ground connection to the ATU! As the CAT-Link was plugged in and unplugged, somehow there must have been some imbalance that produced a small current on the rack safety ground, very likely an RF current. That affected the sample for Tower 4.

I still haven't heard whether the problem with the local AM station's parameter shift has been solved. Because none of the other tower parameters are affected, the problem is most certainly a sample problem and not a real operating parameter shift.

Something tells me that to find it, the CE and his crew will have to look beyond the usual. You just never know.

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

MARKETPLACE

Pentadyne Systems Eliminate Dead Air, Lost Listeners

Storms, wind, fires and an aging utility grid compromise incoming power to broadcast facilities. UPSs with lead acid batteries have been the general solution to power protection.

VRLA batteries and a quarter the weight, the flywheel system serves as a quiet, low-maintenance, space-saving alternative to service-intensive batteries for UPS systems.

However, Pentadyne Power Corp. says broadcast engineers have had to contend with difficulties of batteries including high maintenance, health and safety issues, space requirements, frequent replacement costs and expensive cooling needs.

Pentadyne says its flywheel energy storage technology has been proven as a cost-cutting reliability enhancement and that its flywheel reduces UPS costs dramatically while improving system reliability compared to battery-based systems.

Pentadyne states that its flywheels use 90 percent less power than other flywheel systems. With half the footprint of

Its kinetic battery is a DC flywheel power system compatible with the UPS systems of most major manufacturers. It is an electro-mechanical device that stores kinetic energy in a rotating mass with the capability to convert it back into electrical energy when backup power is needed to support critical loads.

The company says its flywheel system can handle the high inrush current from crowbar effects, which can kill lead-acid batteries quickly.

For more information, contact Pentadyne at (818) 350-0370 or visit www.pentadyne.com/site/your-business/broadcast.html.

IF THEY COME, SOMEONE WILL BUILD IT

Guy, I wanted to respond to your comments you made after my initial brief summary on Internet radio (*RW Online*, Nov. 26, 2007).

I completely agree with you on almost all points, but you really need to gain some hands-on experience with some of the tools available; you might be quite surprised.

For example, you are absolutely correct that the average person doesn't want to fumble with complicated installations, hookups of various equipment, navigating complicated menus or pressing tons of buttons just to perform a simple task; also the average Joe doesn't care about how this stuff works, so long as it does.

Right now, these custom "infotainment" systems are primarily in the hands of a small niche market, consisting of mainly techheads and software gurus.

However, these individuals have put their heads together to come up with solutions to some of the problems you pointed out.

Yes, currently, it is fairly complicated to *initially* build/setup an infotainment system to pick up streaming audio and have all the other bells and whistles that off-the-shelf systems, or vehicle OEM systems, do. However, once the initial setup is done, tuning in to your favorite stations can take as few as a couple finger presses on the touchscreen.

Supply and Demand

Also, with PC motherboards that provide options for PCMCIA cards, you can have a custom system complete with aircard integrated into the system, set up to connect to the Internet when powered on and never have a need to hook up your cellphone at all, or any other complicated equipment.

Although because of cost and convenience, I am sure most people will opt for the Bluetooth cellphone connection to the infotainment system. But the point is, the system *can* be made so that it is easy, and convenient to access whatever content you desire.

I also agree with your comments regarding the lack of bandwidth of 3G cellphone service to instantly support the demands of streaming audio should everyone decide to tune in simultaneously. However, demand dictates the supply. And like any other service in the past, not everyone jumps on the bandwagon simultaneously.

Back in the mid-1990s most people were content with dialup. However, as the demand for faster connections increased, the ISPs obliged and started offering broadband services. And like all new technology, initially the cost was high (as the aircard subscriptions are currently), but as the demand is met, the costs do come down.

Maybe 3G is the wave of the future, maybe it's not. But the main point here is, if there is a demand for a service, and a profit can be made providing that service, someone *will* provide the supply, whether it is 3G or a faster form of it, or WiMax, which I am not really familiar with. I think the technology is here. The only question is, what does the average Joe really want?

If the demand is there it's only a matter of time before two companies (let's say, Pioneer and Verizon Wireless) figure this out and get together and offer a complete turnkey system complete with Internet radio. With the current crop of "car stereos" that do darn near everything but make breakfast, it wouldn't be too difficult to incorporate a 3G transceiver circuit in the system, and offer a subscription, much in the same way that GM/Ford offers you a subscription to XM/Sirius when you purchase a new car.

I don't really follow your comments on the wireless carriers configuring their services for "forward and store" rather than real-time streaming audio.

In a "forward and store" scenario, the goal is to get the data from point A as quickly as possible to point B. The benefit of course is if there is a delay or some packets have to be resent, as the content isn't real-time, there will be no pauses or skips when the content is finally played back. But you are still transferring massive amounts of data; you're transferring as much data as you possibly can and as quickly as you can from one point to another.

> I guess to sum up this long novel, no one knows what the future holds, but we do have the technology now to start rolling out mobile Internet radio in the car.
>
> — Alan Smith

With streaming audio, you "trickle" data from point A to point B. With today's higher quality high compression codecs, *very* good quality audio can be had with as little as 48 kbps. If I am not mistaken, this bit rate is on par with HD Radio bit rates, so the end product quality should be very similar.

Although streaming audio does have the disadvantage that momentary loss of network connectivity or packet loss can cause interruption in playback, with the right buffer settings in your player, you can configure your software to minimize those effects for all but the longest network outages.

Streaming Transfer

In both "store and forward" and real-time streaming, you're transferring a large amount of data from point A to point B. The difference, however, is that in store and forward you're transferring a large amount of data in a short time using the maximum bandwidth available; in a streaming scenario, you're transferring a large amount of data, but you're only using the minimum bandwidth required for the encoded bitrate, and evenly distributing it over a long period of time.

Finally, I wanted to address your comment of hoping when these systems do arrive they "don't use Windows."

You didn't really elaborate on that comment, so I don't know what you were inferring, but — and let me make myself perfectly clear here — Microsoft is *not* one of my favorite companies, and I am rapidly becoming a proponent of the open source model of software. But I have to give credit where credit is due. Windows 2000 and XP have been some of the best, most stable Windows platforms.

As far as the OS goes in an "infotainment" system, you can use whatever you like. I do believe Windows is probably the most popular platform, but there are Linux distributions in development right now that are being designed specifically for infotainment systems.

When it comes to actual use of the system, the OS is irrelevant. In both cases, the systems run a piece of software called a "front end" that is the main navigation point for all features of the system. The actual OS itself is hidden away, and is not accessible (unless you make it so) by the end user. Gone are the desktop, task bar, start menu, etc.

I guess to sum up this long novel, no one knows what the future holds, but we do have the technology now to *start* rolling out mobile Internet radio in the car. As you said, there isn't enough bandwidth to sustain a massive influx of customers, but as the demands increase so will the supply if there is a dollar to be made from it. It all comes down to what the average consumer really wants.

As the saying goes, "If you build it, they will come," but I think in this case it's more along the lines of "If they come, they will build it."

Alan Smith
Memphis

Guy Wire replies:

There is no question that a lot of momentum is building to supply and enable Internet access and streaming audio services into the dashboards of new cars in the near future. The recent tests by TheRadio.com in South Carolina with the Ford Sync are impressive. They herald an exciting future for wireless Internet radio and as you say, if they come (and enough are willing to pay for it), they will build it.

Such capability, however, will be offered as an option with a price tag and monthly fee for the service provider just like satellite radio. Early adopters and techies will undoubtedly jump right in.

But just as we have seen with satellite radio, the rollout enthusiasm and growth rates will level off. What percentage of the mass audience will buy in and stay with it is unknown. Certainly a successful business model should be forged that will sustain dashboard Internet services better than satellite radio has been able to achieve.

Free and ubiquitous radio service in the car has been almost a birthright for more than three generations now. About 45 percent of streaming audio consumption is now provided by the Web streams of existing radio services, and that figure is growing.

If traditional terrestrial radio stays focused on providing valuable and compelling local service on both their legacy AM/FM channels and via their Web streams, we will likely be the major supplier of Internet radio content used in the car.

Whether cellphone companies with 3G and 4G connectivity or the deployment of a national WiMax system will be the infrastructure used by mobile streaming audio services to reach the masses in the future is unknown. There are still a lot of technical challenges to be resolved before such a service will be able to prove itself as a reliable and widely available mass delivery system comparable to over the air radio.

I'm still convinced we're not going to know for sure for quite a while. Just as satellite provides another option for mobile consumers, so will Internet radio; but it will come at a price. Don't count free AM and FM radio down and out anytime soon.

Visit radioworld.com *to read more Guy Wire including letters to Guy's mail bag.* ■

WHO'S BUYING WHAT

PSI Settles In on War Eagle Mountain

CSN International is using Propagation Systems equipment for a new facility on War Eagle Mountain in Idaho, KAWS(FM).

Calvary Chapel of Twin Falls is home to two radio networks, CSN International and the Effect; the former broadcasts Bible teaching and praise/worship music; the latter plays Christian rock music.

Calvary Chapel has constructed a new station approximately 40 miles south of Boise on War Eagle Mountain.

"The 8,000 foot site sees its share of rugged winter weather," said Kelly Carlson, director of engineering for CSN International. Carlson said extreme cold and high winds, coupled with snow and ice, are the norm six months of the year so the durability of the antenna was important. "The site is only accessible via helicopter or snow cat" during those times.

CSN chose a four-bay, vertically polarized array using the PSIFLV-4A.

CSN chose a four-bay, vertically polarized array using the PSIFLV-4A. The antenna was to be mounted to a Rohn SSV tower that varied in width and taper. PSI designed and supplied the mounting hardware with the antenna.

For more information, including pricing, contact Propagation Systems Inc. at (814) 472-5540 or visit www.psibroadcast.com.

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by Dave Moulton

Loudness Management Tough, But You Can Do It

Measuring a Subjective Attribute Like Loudness Is Difficult; SPL Measurement Helps Solve the Problem

I'd like to look a little more deeply into the principles of audio monitoring. This complex topic is multifaceted and confusing, but one of the primary and most important elements, audio level, appears to be itself quite simple. It has to do with the level, related to loudness, of an acoustic audio signal. What could be simpler, or more basic?

ON THE LEVEL

Sound Pressure Level is the actual physical magnitude of pressure variation in the air within our audible range of frequencies. It is usually expressed in decibels, referenced to 2/10,000th of one millionth of atmospheric pressure, which is approximately the "threshold" of human hearing.

The perceived subjective impression of any given sound pressure level would be its loudness. Humans hear the range of levels from zero decibels sound pressure level — extremely soft — to 120 decibels sound pressure level — uncomfortably loud — without significant pain or risk of injury (a discussion of that will require at least an entire article, maybe a dozen).

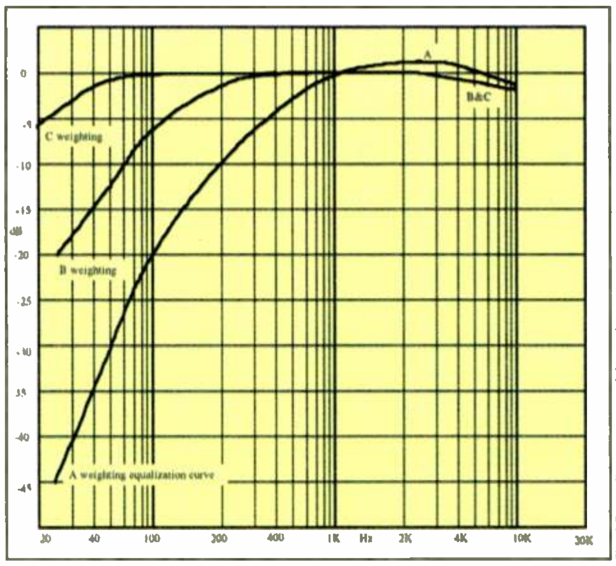
HOW TO MEASURE SPL

Measuring loudness, a subjective attribute, is really hard, in fact almost impossible. So, instead, we try to measure a physical quantity, sound pressure, which we use to stand in for loudness. We do this with a calibrated microphone attached to a level meter; we call the whole contraption an "SPL Meter."

Sounds simple, right? Well, there are some devils in them details.

You can buy a cheap SPL meter from RadioShack. I would recommend one, if you don't have something like it or better already.

Such meters measure the sound pressure at a point in space (where the microphone capsule is) over a given period of time. Cheap meters can't measure low levels or very, very loud levels. The RadioShack meter will measure, if memory serves, between 50 and 130 dB SPL, subject to some other limits. A really good meter (expensive, of course), will measure from about 15 to 160 dB SPL, with much more flexibility.



Total Recording, courtesy of the author.

Fig. 1: Approximate A, B and C weighting curves.

AVERAGED OVER TIME

The most important constraint to such measurements has to do with the time period over which we measure SPL. Sound pressure varies widely and rapidly. If we measure over a very short period, say 1/1000th of a second, the meter reading will always be a blur. Further, that blur may not correlate well at all with our subjective impression of loudness.

So, we use several different time-averaging schemes, including Fast (the average over 3/10ths of a second), Slow (the average over a second) and Leq (the power average over the period of measurement — this is only available on more expensive "integrating" meters).

The Fast setting correlates moderately well with how humans perceive loudness. The Slow setting allows us to easily see what the ongoing average SPL is, because the meter movement appears to be damped by molasses. The Leq level is a single number that stabilizes as the measurement period grows longer. It is used for noise pollution measurements.

'WEIGHTING' CURVES

Meanwhile, we use some "weighting" curves to fiddle with the parts of the spectrum we're measuring. The usual curves are known as A, B and C weighting curves, and they represent equalization curves that are applied to the microphone's output prior to measuring the level. The history and reasoning behind these curves is complex and not always reassuring. Suffice it to generalize that A-weighting throws out the bottom four octaves, B-weighting throws out the bottom two octaves and C-weighting doesn't do much at all (we usually call it "broadband").

See Fig. 1. A-weighting is suitable for low-level measurements (less than 60 dB, perhaps), and is used for most noise pollution measurements. It also is appropriate for measurements of speech level. It is often abused badly when making high-level measurements. It discounts low frequencies that can be troubling, dangerous and perhaps toxic at high levels, and yields readings 6–15 dB lower than broadband SPL. Confusing A-weighted and C-weighted levels is equivalent to failing to distinguish between Fahrenheit and Centigrade when measuring temperature.

For most of our work, C-weighting and Fast detection times are most appropriate. However, it is worth asking what level is appropriate for listening during production work? I suggest, after a lot of study, that 0 VU (and/or –14 dB FS) average or RMS (not peak, not Fast) level of a pink noise signal should yield 85 dBC Slow at the listening position for each loudspeaker by itself.

This bedrock chunk of level management is probably the single most important part of audio monitoring. Until we get control of it, we simply can't do reliable and consistent work, in my experience.

THE TAO OF LEVEL

Loudness, both absolute and relative, has very specific emotional meanings and attributes.

Interestingly, these are anchored physically by our expectations for the level of speech (about 65–70 dB SPL with Fast detection, either A or C weighting), which is how and why Dolby came up with their elegant Dialnorm protocol.

If we change the level, we change the emotional intensity

SEE SPL, PAGE 35

Guy's 2008 Predictions (And Surprises)

Our Visionary Cowboy Test-Drives a Sync-Equipped Ford and Makes Bold Prognostications

Your masked correspondent with smoking solder gun in hand begins his 10th year of observations and Radio World commentary in this, the first issue of RW Engineering Extra for 2008.

Making room for a new calendar as I did in January prompts a look back on how our industry grappled with the past year's challenges and what's likely to occur moving into the new year.

Practically all of our predictions for 2007 a year ago became reality, but there were also a few new developments that will help sharpen the focus of how radio will fit into the crowded and ever-changing multimedia landscape.

Let's do a quick recap, then take a close look at one new product that just might bring significant change.

FULL-TIME HD BECOMES LAW

FCC adoption of HD Radio standards and deployment of full-time AM HD captured lots of attention in early fall of last year. FM HD and HD2 channels grew at a snappy pace, but the AM HD rollout seems to have stagnated and remains mired in controversy. The anticipated wave of filed interference complaints did not materialize, with the WYSL(AM) vs. WBZ(AM) story as the one notable exception. There will likely be similar challenges from other unlucky stations, especially rim-shooters that have been shoe-horned in to serve a larger nearby market or its suburbs.

I do not see this lingering interference controversy changing the AM HD rollout or its potential to effect significant improvement in the AM service any time soon.

What will likely happen is the larger interfering stations will negotiate and buy off the complaints if they are convinced AM HD will help them long-term. The new rules do allow bilateral negotiations to resolve complaints. But look for AM HD to have little impact on how most AM station owners decide to keep their stations viable.

I do not expect Ibiquity, the NAB or the FCC to change course or offer any real help to those stations that have lost important coverage. In the long run, most surviving stations will choose to bypass the AM HD hybrid mode before the benefits of all-digital can be fully realized and appreciated. I hope I'm wrong about those predictions.

ROLLOUT ROLLS INTO UNCERTAINTY

FM HD will continue to grow with more "secret channel" offerings. Because most operational HD station owners are members of the HD Alliance, the supplemental HD2 and HD3 channels will mostly be non-commercial for another year, ostensibly to gain quicker acceptance without ad clutter.

I am betting that before any big car company will be willing to offer HD radios as standard equipment, major licensing fee concessions will have to be extracted from Ibiquity.

But the rubber will not meet the road on whether the added channels will be of any real value until more HD Radios find their way into the hands of consumers. Until they appear as standard OEM equipment in most new cars and not as added-cost options, mass acceptance of HD may not be a winner and the new channel offerings will not be a factor.

I am betting that before any big car company will be willing to offer HD Radios as standard equipment in all models, major licensing fee concessions will have to be extracted from Ibiquity. That could happen in 2008 as Ibiquity and its broadcast partners become more concerned about the slow acceptance and long-term viability of HD. That should force Ibiquity to quietly renegotiate their fees and royalty structure.

The other "ace card" Ibiquity may consider playing in 2008 to rescue the rollout is requesting the long-rumored 10 dB digital power increase. That will most certainly improve digital reception and reliability, but at the expense of added noise in existing analog receivers.

However, this trade-off will stoke the fires of controversy all over again and likely take several years to unwind before some form of compromise is achieved.

The year 2007 did bring a number of new HD Radio models that perform better than early offerings. RF sensitivity and the need for external antennas for inside reception is still an issue. Boston Acoustics abruptly discontinued the Recepter with no indication that an improved replacement version would be offered.

The overdue battery-powered portable HD models are still being perfected and need to become a marketplace product this year. Ditto for models that store content and replay on demand, i.e. Radio TiVo. Hopefully the Sony, and other new entries into the HD receiver space with Apple's i-Tagging innovation, will help jump start HD Radio sales.

AND THE WINNERS ARE ...

As predicted, the FCC did move forward last year with a proposed rule-making to expand the LPFM service.

Despite the sticking points of opening up third-adjacent channels for LPFMs and requiring existing FMs to protect licensed LPFMs for any future changes, this proposal appears to have "fast track" backing and should be adopted in 2008.

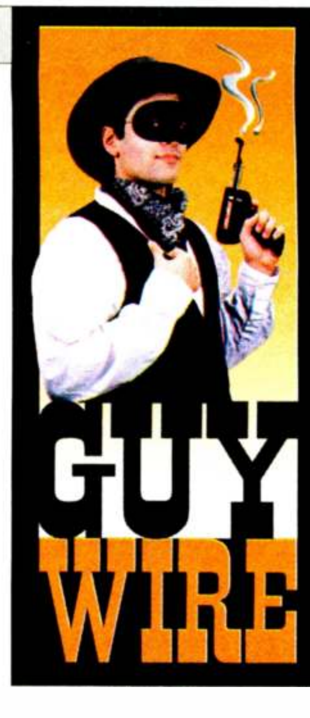
Another long-overdue FCC proposal launched last year that offers some AM improvement will allow AM stations the right to license FM translators. Some see this as a token offset for the coverage damage done by AM HD. For smaller markets and especially daytimers, this will be welcome relief. In some cases, it may even allow the AM license to be retired and the translator converted to a minimum power Class A FM.

A 2007 prediction we nailed spot-on is the proposed revamping of EAS. Adding a new 700 MHz communications band for interconnected emergency agencies as well as adopting the use of CAP, the Common Alerting Protocol, promises to bring us a much-improved system. All the players finally got together and hammered out a very good proposal, but it needs additional industry input and support.

MEL MAKES HIS MOVE

Everyone saw the possible merger of satellite operators looming. Almost on cue, Mel Karmazin launched his effort last spring to merge XM with Sirius to give both a better chance of long-term survival.

As I write, decisions from the Justice Department and the FCC have still not been announced. Despite the original intent and force of existing SDARS rules, plus all the antitrust and government-sanctioned monopoly counter arguments, Mel is likely to win this one. But there will be restrictions to appease the opponents.



Ibiquity is taking its shot, wanting mandatory inclusion of HD in all new satellite radios. Satellite not only faces a huge debt problem but also the challenge of even more competition from burgeoning mobile multimedia and wireless internet streaming technologies.

Satellite radio faces more pressure from wireless Internet than terrestrial radio because of the added burden of having to charge subscriber fees. It also has less leverage making real money with paid advertising since its cume totals are so tiny compared to national radio networks and large group-owned operators.

As wireless and mobile Internet use ramps up, both services will have to focus more heavily on streaming and Web site-delivered products. Both will add more video content attracting the younger demos to ensure a place in the Web-dominated multimedia future. Indeed, Karmazin appears to be planning on transitioning Sirius to video-only content if his merger plans are approved.

The new Arbitron PPM world coupled with the precise metrics of Internet connectivity will give advertisers most all the feedback they've wanted about who is listening and when. As my old sparring partner Skip Pizzi says, these new tools will "replace the magnifying glass with an electron microscope" for media consumption measurement.

All services will have to adjust, but I'm predicting radio with its long legacy of staying nimble in the face of change and new threats, will do just fine. Over time, broadcasters will have to readjust ad rates as more listeners are delivered via the Internet while those using traditional AM/FM reception will no doubt slowly decrease.

WIRELESS IP RADIO HERE AND NOW

One important prediction we made last year that is now gaining traction is the emergence of wireless IP radio.

There is no demand for wired IP radios, but the ability to listen to wireless Internet audio streaming via cellphones both in and out of the car is pushing this development. Guy Wire reader Alan Smith and I recently engaged in some give and take in our online Mailbag on how relatively easy it now is to listen to Internet radio via a cellphone or a laptop PC in the car.

Radio engineers and geeks are easily impressed with how well G3 cellphones and wireless Internet-equipped laptops are making this possible in well-served urban

SEE PREDICTIONS, PAGE 37

SPL

CONTINUED FROM PAGE 34

and character of the work. Authenticity depends on a Gestalt sort of authenticity that is largely intuitive while related to speech, but it needs to be carefully tended and oriented. And if our levels are neither stable nor controlled, we cannot effectively generate or maintain that authenticity.

There is a psychophysical basis for this. Our hearing organism is not at all linear or consistent. Among other things, the frequency response of our hearing varies with SPL. A change of 10 dB introduces significant, even large, frequency response changes in our hearing.

If we do not have tight control of the sound pressure levels at which we are listening during production, we have no reasonable control of the frequency response of our system. Change in level equals change in frequency response. Period. End of story. No exceptions.

FUN AND PROFIT TIME

Levels management is tough; very tough. But you can do it. First, establish a pink noise test signal with a known average level set at a viable production level (I recommend 0 VU/–14 dB FS RMS). Then, I suggest you calibrate each speaker in the control room so that its level, playing back said pink noise, is 85 dBC Slow at your listening position.

Once you've established that, document the master monitor level control setting, and as a general practice, never change it except with dim or mute switches. Got it? Ahhh! Now we can begin.

Thanks for listening.

Dave Moulton writes for Radio World's sister publication TV Technology. Complain to him about anything at his Web site, www.moultonlabs.com. ■

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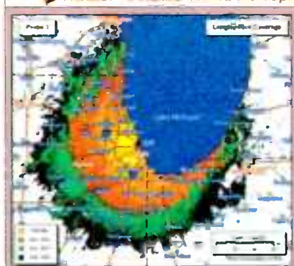

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Predictions

CONTINUED FROM PAGE 35

areas. Consumers, of course, need this capability to be made available in a much easier and low-effort format.

Microsoft and Ford saw this coming several years ago: the need to fully merge all multimedia services into cars. They teamed up to produce Sync, a cool new product unveiled at the 2007 CES. Sync is now available as an option in most 2008 Ford, Lincoln and Mercury model cars.

I test drove a Sync-equipped Ford Focus over the Christmas holidays and it felt like the future.

SYNC UP WITH THE FUTURE

Sync as an option is really more about integrating iPods, MP3 players and cellphones into the built-in audio and control centers of automobiles using speech recognition and hands-free ergonomics. Bring any version of cellphone or player you have and simply connect via USB port and Bluetooth.

The universal combo AM/FM/CD unit driving a multiple-speaker sound system in cars is now yesteryear's product. Responding to consumer demands to be able to easily use their music players and cellphones with the car's integrated sound now seems a no-brainer, just like the innovative placing of drink holders in cars 30 years ago.

Many regard Sync as a paradigm-changing product that does not bode well for radio. The salesman devoted most of my demo time hyping the voice-activated cellphone and one-button responder features ... and showing me how the built-in computer copied and served up any of my iPod songs on a simple voice command. All audio plays through the impressive pseudo-surround sound speaker system.

He did point out at the end of the demo that I could stream any Internet audio from my Verizon cellphone through the system. When I asked about trying out the built-in AM/FM radio, he seemed dismissively smug, pointing out there was nothing new there and that all cars had those.

This demo unit did not have HD capability, but the sales manager assured me it will be available soon as an additional cost option. That seemed like a pyrrhic victory for HD at best.

How the Internet gets into cars is still a work in progress. Various cellphone companies are accelerating their efforts to be that primary delivery method. Buying unlimited Internet access for an existing cellphone account for about $60 a month is certainly the easiest way to tap into mobile connectivity in most markets.

Last year, I had predicted that community WiFi and WiMax projects designed to cover large areas with tax-subsidized Internet would become an option, but they don't seem to be getting anywhere. To date, there is little talk about the FCC creating a national band for WiMax services.

In Philadelphia, where Earthlink was contracted to deploy a city-wide WiFi system, the technical performance of the network had problems and there was discussion of not completing the build-out due to the lack of interest and escalating costs. Some of the new wireless Internet services actually prohibit streaming for now.

I expect to see WiMax begin to roll out in earnest after the February 2009 analog TV shutdown but it will probably take longer before we see this at a level where mobile products for cars are in the pipeline.

VALUABLE FEATURES OR GIMMICKS?

As a $395 option, Sync appears to be a winner. With such a glitzy and futuristic play toy now available to the mass market, few are going to pay any attention to the capabilities of the integrated radio, which is a mere tag-along. But then I got to thinking how average users would respond to Sync and which features they would use often and regard as valuable for their $395 investment.

Moving the cellphone out of a driver's hand and away from his head into the integrated control of Sync is certainly desirable. Many state laws are now requiring hands-free cellphone use in the car anyway. Transferring a few thousand iPod tunes into Sync for instant replay via a big sound system while driving is also an attractive feature.

As I thought about these new features a bit more, it strikes me that most consumers who heavily use their cellphone in the car already have hands-free adaptors or will be compelled to get them soon. Most who prefer non-stop music of their choice while driving have already been using their CD players or iPods via headphones or Bluetooth for quite a awhile. Plus, we are now seeing reports of "iPod burnout" that should slow down the rush for many to make iPods their primary music playback device in cars.

Those who want local news, traffic reports, talk radio shows, local personalities and the like will continue to use the radio. Free and local radio service has been an American birthright for almost four generations. If they live where local radio is too limited or unreliable and are willing to pay for a satellite subscription, they will use that.

Will the speech recognition feature and one-button steering wheel commands in Sync have staying power as the preferred way to use the cellphone? Or will they strike many users as merely gimmicks? Perhaps others will find they may not work reliably? And will bringing the Internet into the car become a must-have feature for cars of the future? The two most important bidirectional communications resources used while driving a car are already covered by GPS navigation displays and the ubiquitous cellphone.

Providing Internet audio streaming in the car can certainly supplement radio listening but beyond that, using the Internet productively demands focus and attention. Drivers need to reserve every bit of that for the number one job of driving.

There seems little doubt, however, that the Internet will join integrated video screens for watching movies as useful options for backseat passengers in larger cars and SUVs.

TEST-DRIVING THE FUTURE

Sync was recently tested as an Internet radio streaming appliance in a Ford Explorer by TheRadio.com in South Carolina. Reed Bunzel is an old radio hand who formed and renamed that company from American Media Services-Internet to sell and promote Internet radio streaming. From all accounts, the field testing was successful. He is convinced this technology will eventually be the primary delivery platform for radio.

But it's very early in the game to know how well cellphone wireless Internet will be able to handle many thousands of simultaneous connections that hope to support reliable audio streaming in moving cars throughout populated areas.

It's likely going to take many years and may require G4 technology before this platform can rival the affordability, reliability and coverage capability of broadcast radio. And we have no clear idea if enough of the mass market will prefer Internet streaming to terrestrial and satellite-delivered radio in cars, and are willing to pay extra for it.

The bottom line for options like Internet, satellite radio, GPS displays, integrated cell phones, surround sound systems and other multimedia devices in cars including Sync is that they all come with an acquisition cost. Many require separate ongoing monthly subscription fees. Their providers need to make such options affordable and easy to use for a large number of consumers who want them. If they don't pass those tests, they don't succeed.

We'll be watching the Sync introduction closely. It just might be the future.

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

Imagination

CONTINUED FROM PAGE 38

audio because less imagination is required when multiple senses are stimulated. The programming on those technologies spoon-feeds us with a sensory "conclusion." We are not asked to supply imagery, because everything is already complete. We are passive receivers, not active participants.

Imagination engages; imagination is an active process; imagination is compelling. Sound leverages, challenges and expands our unique human ability to imagine.

Well-trained sound engineers believe that they understand sound; successful radio program directors believe that they understand listening. After 40 years in the audio, acoustics and broadcast industry, I too thought I was well educated on the essence of my craft. But I had only scratched the surface.

Sound and listening are far more than the physical details of sound waves. We think of sound as the means for understanding language and enjoying music, but more importantly, sound connects us to dynamic events and provides us with social cohesion. As a species, we evolved an auditory system that is deeply wired to a large number of brain substrates.

Sound can soothe or agitate; sound communicates emotional nuances. Sound is automatic, always entering our consciousness even as we sleep because we have no earlids.

Sound provides a sense of place and space; sound flows around obstacles without respecting private property; sound contains information about temporal sequences; and sound can transport the listener to imaginary worlds.

Sound anchors us in the present, and contributes to our emotional and psychological stability. A half-century ago in England, Dr. Roth reported that undiagnosed hearing loss was the primary cause of mental illness in the elderly, and more recently, Dr. Zimbardo at Stanford University demonstrated that simulated deafness in normal individuals produced symptoms of paranoia.

Indeed, when we "scratch the surface" we find that sound is far more than audio engineering and wave physics. Sound sustains life.

Dr. Barry Blesser is director of engineering for 24-7 Systems. Geoff Steadman is the company's president. ■

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by Barry Blesser with Geoff Steadman

Imagination: The Real Art of Radio

The Golden Age of Radio in the 1940s and 1950s was a magical period worthy of nostalgia for those who are old enough to remember it. I am. It was a special period for many reasons, most of which were historical accidents that cannot be duplicated in the media environment of the 21st century.

Why then should we take another look at this forgotten time? History, while considered boring by many of us who suffered through mundane high school courses, also is a wonderful teacher of fundamental principles that are universal, and just as applicable today as they were a half-century ago.

Radio of this period attracted some of the most creative artists and personalities because it was novel, innovative and without competition. But more importantly, the mood was that of playful creativity without a massive commercial bureaucracy. Rules and formulas had yet to be invented.

Everything was new and there were no imprisoning traditions that required blind obedience. People were creative because they were inventing and having fun doing so.

Recreating playful creativity is still possible, albeit on a smaller scale. Some people actually still make a successful career and significant money by being creative — taking a modest risk by deviating from the rigid main stream.

So much for my soap box; now on to substance.

CUE THE MOUNTAIN

This article began at 3 a.m. when I suddenly awoke with the vivid recollection of a radio spot I last heard 40 years ago. That spot made a permanent impression because it contained the essence of radio: the power of imagination.

For those of you who have not heard Stan Freberg's 1-minute spot promoting the power of radio, you can listen to it on my Web site at *www.blesser.net/downloads/RadioSpot.mp3*. In this spot, Freberg describes an imaginary event:

"Alright, watch this. Okay, people, now when I give you the cue, I want the 700-foot mountain of whipped cream to roll into Lake Michigan, which has been drained and filled with hot chocolate. Then the Royal Canadian Air Force will fly overhead, towing a 10-ton maraschino cherry, which will be dropped into the whipped cream, to the cheering of 25,000 extras. All right, cue the mountain."

This little radio theater continues with sound effects and the cheers of extras. You can hear the cherry dropping into the whipped cream. Even with the relatively primitive sound effects of the period, the images are compelling and funny.

Sound effects created a vivid soundscape, including spatial acoustics. The listener is projected into Freberg's imaginary world of Lake Michigan as a giant bowl of hot chocolate; he concludes with the essence of this media: "Radio stretches the imagination."

Stan Freberg is perhaps the most famous and still living representative of that period. Michael Landry and Richard Stone chronicled his creative life in the article, "Theatrics of the Mind: Stan Freberg and the Art of Radio," which appeared in Journal of Radio Studies, May 2006.

During his long life, Freberg has been a satirist, comedian, musician, lyrist, writer, radio and television performer, author and advertising man. In 1995, he was elected to the Radio Hall of Fame.

There were many other creative talents of the era who understood the power of imagination. As a kid, I can remember being glued to the living room radio listening to Humphrey Bogart and Lauren Bacall in the syndicated radio drama "Bold Venture"; Milton Cross transported me into the live performances at the Metropolitan Opera; and the sounds of the Lone Ranger still rattle around in my head.

There is a long list of famous radio programs and personalities, fortunately preserved on reissued CDs. Albert Einstein said it clearly: "I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world."

SWEPT AWAY

Except for the passionate fans of the Golden Age of Radio, the average 21st century listener is unlikely to get swept away by any of these historic programs.

However, in analyzing the period we see several key elements: (1) listeners were transported into a truly virtual world of people and events; and (2) listeners were drawn to the enthusiastic and playful creativity of those who were making these imaginary worlds.

From our perspective, these are the two elements that could rejuvenate radio instead of following mass culture towards the lowest common denominator.

While we know there are some exceptions, the radio announcers of commercial radio are "talking heads" with floating voices in a spaceless recording studio. When received, those voices are projected from dashboards into boring spaces of the listeners' automobile, which is probably stuck in a frustrating sea of traffic. Where is the imagery? There is none.

Sound anchors us in the present, and contributes to our emotional and psychological stability.

Doctors listen to the narrative story of their patients. We used mini-stories in this article. Teachers use anecdotes to educate their students. Stories can be about real events or imaginary worlds of virtual realities.

Radio was the first electronic media of virtual worlds based on sound. It follows the ancient traditions of orators, poets and storytellers. Yet now that multimedia technologies have advanced the art of virtual world, radio has abandoned its groundbreaking innovations of the early 20th century.

What an odd paradox. Multimedia technologies are actually more limited than pure

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Networked / Independent

This D-75N Console is BOTH

OUR DIGITAL D-75N is a full-featured standalone mixing console that can also be seamlessly integrated into the AUDIOARTS DISTRIBUTED NETWORK along with other D-75N consoles. Designed specifically for the broadcast industry, the D-75N is intended for on-air and production applications that demand a lot of function and performance. It's got all the features you need: four stereo program busses, dual caller Superphone module, line selector modules, control room and studio modules, plus additional accessory positions.

The D-75N gives you the benefits of both standalone and networked architectures—the console has both independent faders for "local sources" and six networked faders capable of accessing designated sources and mixes throughout your system. Single CAT-5 cables connect all studios to your central rackroom, eliminating the need for costly multi-pair wiring between rooms and making installation and expansion fast and easy.

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