Radio Guide

Radio Technology for Engineers and Managers

May 2006

Moving Ahead with Digital

Inside Radio Guide

With the large number of transmitters installed in the past year or so, real world experience is accumulating and efforts are underway to solve many of the problems that have been uncovered. Phil Alexander offers some insight into a key aspect of the implantation of IBOC on AM that is troubling many consultants.

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Cover Photo: Nactel's CEO Peter Conlon, and Continental Electronics' General Manager John Udovich make a joint announcement (see page 20).

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PO Box 20975, Sedona, AZ 86341
Phone: 928-284-3700 Fax: 866-728-5764

Ray Topp *(Publisher)*
Email: radio@rconnect.com

Barry Mishkind *(Editor)*
Email: editor@radio-guide.com

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Radio Waves

by Barry Mishkind – Editor

Feeding the Buzz

The buzz on the floor at NAB was clear this year – it was about all things digital.

The major transmitter manufacturers reported strong sales all year long and with the introduction of higher-powered tube transmitters for IBOC, installations have been rolling along.

And why not? Last year, the owners and managers were "shown the light" about multicasting. With promises of increased ad inventory dancing before their eyes, they have happily "green lighted" many installations.

Naturally, many folks came to see the technology this year – to learn about the process of getting the increased audio bandwidth to the transmitters and onto the air, and the new monitoring gear to "see" the signal and diagnose whether it is healthy or not. Monday and Tuesday were busy floor days, with many of the manufacturers reporting strong interest and sales.

The crucial question, of course, is whether the buzz will sustain through this year. A lot depends, not only on the arrival of more receivers, but upon listener acceptance of the air product (content), making receiver sales the key to the tenor for the Fall Show and into next year.

On the other hand, what does it mean that the NAB is moving many TV booths onto the "Radio Floor" next year, pushing radio, in general, to the west end of the hall?

Finally, to all of you who stopped by our booth at the show or stopped us in the aisles and said so many nice things about the magazine, we say want to say "Thank you!" And to you manufacturers who have supported us over the years, another "Thank you!" It is your support and suggestions that make ***Radio Guide*** much more than a slogan – we appreciate being important to you. – RG –

Overcoming the Hidden Menace in AM IBOC Directional Systems

By Phil Alexander, CRSE, AMD

Clearly, the focus of the 2006 NAB Convention was on the implementation of digital transmissions. With the large number of transmitters installed in the past year or so, real world experience is accumulating and efforts are underway to solve many of the problems that have been uncovered. Phil Alexander offers some insight into a key aspect of the implantation of IBOC on AM that is troubling many consultants.

There is a real problem and almost no one seems to be talking about it.

Whether you call it "phase bandwidth," or "phase/frequency stability," or "pattern bandwidth," it has been around since the days when AM broadcast engineers began building directional arrays. It was the subject of a short paper at the 2005 NAB Radio Engineering conference, but this year – amid all the hyperbole over IBOC (also called HD radio) – not a single paper presented to the engineering sessions directly addressed this problem as its primary topic.

A LARGER ISSUE

Until IBOC, "pattern bandwidth" (to use the preferred term) could, in the worst cases, make an AM station sound bad in a few limited directions, usually not too far from the transmitter.

Now, with the deployment of IBOC in a substantial number of directional arrays, the effects of what we call "pattern bandwidth" can, in certain situations, wipe out most of the protection given to first adjacent stations by the NRSC "Mask."

What is this monster that IBOC has unleashed? It is simply basic physics and geometry at work; it is "merely" the inherent change of a directional antenna's pattern at "sideband" frequencies.

DIRECTIONAL DESIGN

In the beginning we calculated combinations of the classical two-tower patterns published by the late Carl E. Smith in 1946 for development of more complex arrays.

Later, standard pattern equations were developed and systematically reduced to the FCC standard pattern equation in the 1960's. *This was the design origin of the majority of the directional antenna arrays in service today*; AM radio was the big hit of the '60's and '70's.

In the Computer Age, the National Electromagnetic Code (NEC) – a computer program built around the Method of Moments approach for solving the performance of antenna systems of all kinds and its adaptation to small, powerful computers – was introduced. This gave us a sophisticated tool for fully calculating complete performances of a directional array at all the frequencies it might transmit.

THE LEGACY PATTERN PROBLEM

Unfortunately, the tool arrived after most of the original work was completed.

When we built most of the directional antenna arrays now standing, making reasonable assumptions of "off-design" performance was the best we could do because full determination of array performance at "off-design" frequencies, or sideband frequencies, was a daunting task. The only practical benefit of improved pattern bandwidth was somewhat better sounding high frequency audio performance in the "nulls" (or minima) near a directional array.

Therefore, solving performance for a typical AM directional station for carrier frequency was enough because the higher sideband frequencies were mainly short-duration intermittent bursts as the audio hit high frequencies at high modulation levels. If a pattern satisfied the FCC by preventing prohibited contour overlaps at carrier frequency – that was enough. The prohibited contour overlaps and the normal character of audio prevented noticeable interference.

Thus, although increasing pattern bandwidth was a way to make stations sound better near the nulls, there was no FCC requirement for making the radiated patterns conform to similar shapes across the entire bandwidth occupied by their modulation.

LOOKING AT THE SIDEBANDS

Figure 1 shows a typical directional pattern and superimposes the pattern performance at ±10 kHz from assigned carrier frequency.

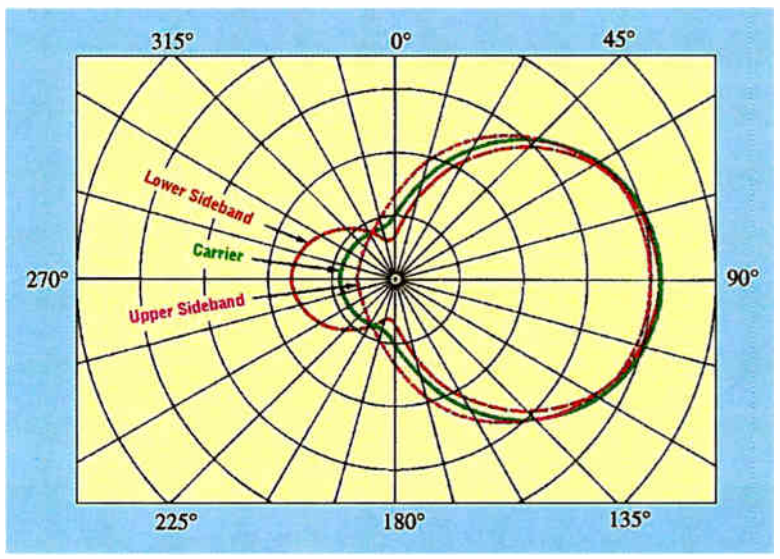

Figure 1: The Effect of Pattern Bandwidth

With intermittent peaks, the energy transmitted off-carrier was not a major issue until the modulation wars of the 1980s. As more stations used pre-emphasis and heavy processing, the sidebands of some stations, especially directional stations, got somewhat "dirty."

The NRSC standards were adopted, in part, in an attempt to reduce the "chatter" between stations. Voluntary restraint gave way to the NRSC-2 filter and annual bandwidth measurements the FCC had stations install in the early 1990s. Some improvement was noted.

THE MASK

NRSC-2 specifications were published in July 1998 and the result was the NRSC "Mask" or emission limit specified in Section 73.44(b).

The mask set a -25 dBc limit for emissions more than 10.2 kHz above and below carrier frequency. This limit became a key factor in the IBOC proposal made in the FCC's digital radio proceedings by iBiquity's predecessor, USA Digital Radio.

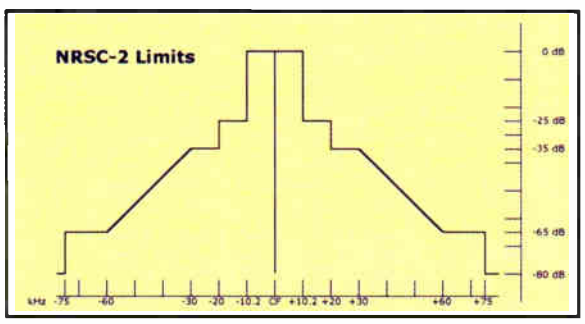

Figure 2: The NRSC-2 Mask Standard

As we will see, the method of measurement is a critical factor. Section 73.44(d) says (in part):

"Measurements made of the emissions of an operating station are to be made at ground level approximately 1 kilometer from the center of the antenna system. When a directional antenna is used, the carrier frequency reference field strength to be used in order of preference shall be:

(1) The measured non-directional field strength.

(2) The RMS field strength determined from the measured directional radiation pattern.

(3) The calculated expected field strength that would be radiated by a non-directional antenna at the station authorized power.

This language effectively rules out measurements made in directional pattern minima (nulls) and, as a practical matter, it means most mask measurements must be made at an accessible location in the primary lobe of a directional pattern to comply with the FCC Rule.

PACKING MORE ONTO THE BAND

Roll the clock forward to 1999 and the present IBOC Rule Making (Docket 99-325), which began to pull together the various pieces that would become the First Report and Order.

That year, USA Digital Radio purchased Lucent Technology's Digital Radio division and the merger formed iBiquity Corporation. Thus, the former USADR proposal to the FCC calling for the addition of primary digital subcarriers in the region between 10 and 15 kHz above and below a station's carrier frequency at levels below the NRSC-2 mask became the only remaining proposal before the Commission.

However, unlike analog AM radio where demodulation of intermittent high frequency audio bursts causes brief *low level* sound bursts from a receiver tuned to an adjacent channel, the IBOC digital sub-carriers are *continuous* and the net result of their demodulation by an AM detector is a steady buzzing sound as the individual sub-carriers change state.

Essentially, the adjacent IBOC emitter produces co-channel interference to the analog signal of its neighbor that is far more audible and bothersome than the simple intermittent low level audio bursts that were the only adjacent interference known when NRSC-2 and the NRSC mask Rules were written.

IS THE MASK STILL USEFUL?

There is considerable debate between promoters and detractors of the IBOC system, but it is essentially the position of the NRSC that the protection of the mask and the minimal contour overlap permitted for first adjacent stations will prevent significant interference between first adjacent stations.

For the sake of argument, we will overlook the ongoing debate and accept this idea as fact. Nevertheless, the whole point of any discussion of "pattern bandwidth" is that directional stations *do not* have the same directional characteristics at all frequencies in all directions.

As we will see, the laws of physics make achieving good pattern bandwidth very difficult and, in some cases, virtually impossible.

WHERE THE PROBLEM BEGINS

Figure 1 shows the effect of pattern bandwidth, but it does not show the reasons for this response to different frequencies.

Pattern bandwidth issues arise from the fact that an antenna array has fixed physical constants such as distance between towers, transmission line lengths, tuning networks, etc.

(Continued on Page 6)

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Overcoming the Hidden Menace in AM IBOC Directional Systems

Continued from Page 4

The directional characteristics of an antenna array depend mainly on the distance between towers and the phase difference in the signals fed to those towers. Yet, as frequency changes, the wavelength of the signal changes and the *electrical* distance between towers changes, as does the *electrical* length of transmission lines and the phase delay of tuning networks.

For example, if a station operating on 1000 kHz has two towers spaced 180 electrical degrees apart on a north-south line and both towers are fed equal signals of the same phase, we know that a figure-eight pattern will develop with two equal east-west lobes having theoretically true nulls in the north-south direction.

THEORY VS REAL WORLD

We know practical considerations will prevent the formation of perfect nulls (i.e., no signal emitted on the north-south line) because towers are not point sources and slight re-radiation from the local environment from power lines etc. will upset the prefect symmetry needed for an absolute null.

Additionally, some null filling is desirable to avoid total signal loss on a very narrow azimuth between the two lobes of the pattern. A simple way of accomplishing null fill is making the fields radiated by the towers slightly unequal. For example, if the reference tower which we will call "Tower #1" has a field of 1.0, the other ("Tower #2") might have a field equal to 0.90 or 0.95 of the field radiated from Tower #1.

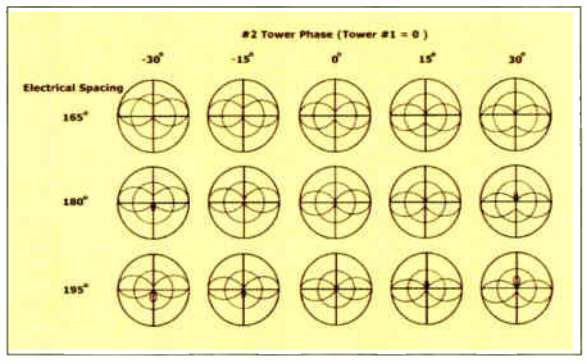

Figure 3: Pattern effects from phase and electrical distance.

In this case, cancellation is incomplete, although the pattern minima would be very deep, especially for the 0.95 field ratio case. We also know that, as the phase between the towers is shifted from 0° differential toward 180°, the pattern tends to become – at 180° phase differential – a "figure 8" in-line with the towers and with equal radiation in both directions.

THE BEST FOR THE TIME

To keep things simple we will take a look at this wide-spaced two tower array and assume the transmitter building is located very near the #1 reference tower because this style of construction was rather common after World War II when many directional stations were built.

If these two towers are each 500 feet tall, or just over one-half wavelength at 1000 kHz, their base self-impedances will be high and mutual coupling between them will be minor. The distance and phase relationship also minimize mutual coupling, and driving impedances will be in an ideal range for good RF bandwidth, or low VSWR across a wide range.

In some ways, this is a best-case condition and might be considered an excellent, easily managed directional array by all twentieth-century standards.

THIS IS THE BEST CASE

Having only a single transmission line means considering the phase change of only one length of line, thus this system is near the best we can expect for one not specifically engineered for pattern bandwidth. It represents a best case scenario, not a worst case.

If we find potential problems in a "good" system like this one, we can expect pattern bandwidth problems in *many* older directional arrays as we begin converting them to handle IBOC emissions. In fact, the deeper the minima of the pattern and the lower the driving impedances of its radiators, the more likely an array will be a problematic conversion candidate.

Looking inside this simple, *best case*, two-tower system, we can begin seeing the effects of varying frequency and why obtaining similar directional performance across the entire bandwidth is not an easy task. As we look closer, remember that our mythical station must faithfully transmit frequencies across a range beginning at 985 kHz through 1015 kHz. **Figure 1** shows that the pattern nulls are the potential problem area.

To learn more and begin understanding the problem we confront, we should take a closer look at the geography of the array. I promise the math will not hurt too much.

ARRAY GEOMETRY AND PHYSICS

According to the FCC's AMwave calculator, the wavelength of 1000 kHz in free space is 299.8 meters,

(Continued on Page 8)

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Overcoming the Hidden Menace in AM IBOC Directional Systems

Continued From Page 6

or 983.6 feet, so the towers will be located 491 feet, 9.5 inches apart.

We must also consider the physical layout of the transmitting plant. In this case, as would be true of many older directional arrays, the transmitter building is located next to Tower #1 (the tower receiving the higher power), for the minimum loss in the transmission system.

In this case, the station is an older 1 kilowatt station, like many built in the 1950's and has RG-17/U solid dielectric coaxial cable feeding the Tower #2 while Tower #1 is fed directly from the phasor power divider.

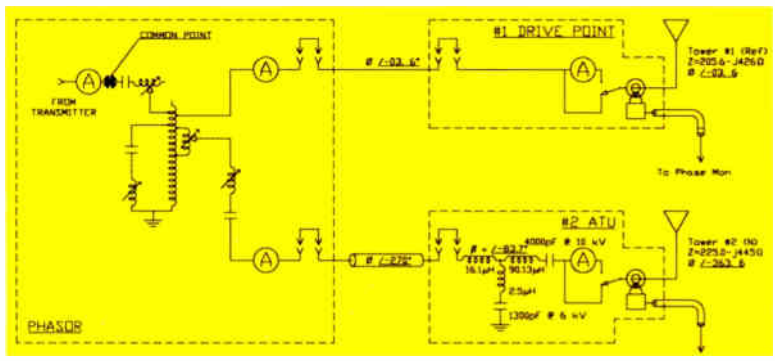

Figure 4: A simplified transmission system.

LOOKING A BIT DEEPER

This construction technique means a minimum phase delay in transmission line to Tower #2 of slightly over 270°.

Thus, the Tower #2 coupling unit (ATU) has a nominal 85° delay "Tee" network design set to 83.7° and the phasor incorporates a series LC phase trimmer capable of about ± 15° phase correction. A low Q "tank" coil with fixed tap for Tower #1 and a "jeep" coil power divider for Tower #2 completes the picture.

Although the towers appear to be "in phase," Tower #2's input actually is delayed by 360° with respect to Tower #1. This is the case at carrier, but what happens at the frequencies of interest above and below the carrier where the IBOC sub-carriers reside?

Table 1 shows how the changes in electrical distance at other frequencies affect the impedances and phase differential, and the direction of the effects on the pattern of the array as a result.

distortion and "spectral regrowth" can easily cause significant emissions at second adjacent frequencies, shown above as 980 kHz and 1020 kHz.

While the mask of the proposed IBOC standard (NRSC-5) strictly limits emissions in this spectrum, array adjustment without "spectral regrowth" monitoring equipment may generate a mask compliance problem at the second adjacent frequency when the intention is simply bringing a monitor point into compliance with the licensed limit.

WHAT TO LOOK FOR

Look back at **Figure 3** to get an idea of the way these changes affect the pattern.

If an adjacent station is located in one of the nulls of our simple pattern, depending on frequency, either the null fills in and the entire pattern shifts toward the filled-in side or a minor lobe forms in the null at a right angle to the major lobe. Either way, the contour of an adjacent station in one of the nulls will receive more radiation than indicated by the basic pattern.

In a very simple pattern, the interfering signal may not be too objectionable, perhaps only two or three dB more than a non-directional station would radiate. However, if the main purpose of a pattern null is protection of an adjacent station, it is easy to see how poor pattern bandwidth can make a mockery of the "protection" intent of the NRSC mask for an adjacent station.

The first clue that a problem may be present is an FCC requirement for an expanded scale of the horizontal pattern plot to meet Section 73.150(b)(2):

Table 1

Frequency	980 kHz	985 kHz	990 kHz	1000 kHz	1010 kHz	1015 kHz	1020 kHz
Wavelength	1003.6 ft	998.5 ft	993.5 ft	983.6 ft	973.8 ft	969.0 ft	964.3 ft
Tower #1 Feedline	10 ft	10 ft	10 ft	10 ft	10 ft	10 ft	10 ft
Tower #1 Feedline Delay	-3.6°	-3.6°	-3.6°	-3.7°	-3.7°	-3.7°	-3.7°
Tower #2 Coax	510.0 ft	510.0 ft	510.0 ft	510.0 ft	510.0 ft	510.0 ft	510.0 ft
Tower #2 Coax Delay	-274.4°	-275.8°	-277.2°	-280.0°	-282.8°	-284.2°	-285.6°
Tower #1 Base Resistance(Ohms)	267.9	252.0	237.7	205.6	177.6	168.8	158.3
Tower #1 Base Reactance (j)	-453	-448	-436	-426	-413	-407	-393
Tower #2 Base Resistance (Ohms)	290.0	270.0	251.1	225.0	200.9	187.5	175.1
Tower #2 Base Reactance (j)	-479	-473	-468	-445	-421	-417	-408
Tower #2 ATU Delay	-75.9°	-76.6°	-77.6°	-83.7°	-88.4°	-85.7°	-81.1°
Phasing Differential	-346.7°	-348.8°	-351.2°	-360.0°	-367.5°	-366.1°	-363.0°
Twr #2 Elect. Dist.° @ 491.79 ft.	176.4°	177.3°	178.2°	180.0°	181.8°	182.7°	183.6°
Pattern Shift from Design Point	+9.7°	+8.5°	+7.0°	0.0°	-5.7°	-3.4°	+0.6°

Although the calculation of phase delay at off-design frequencies is complex, the results in the table are a very close first-approximation and an excellent representation of results expected in the real world.

FILLING IN THE BANDWIDTH

Since both higher and lower frequencies are broadcast simultaneously the tendency of this array will be one of filling the nulls on both sides of the pattern, and also developing lobes in the nulls on both sides of the pattern, with the result of null filling with a "bubble" directly on the null axis.

Normal IBOC sub-carriers are emitted in the red columns. System nonlinearities, causing intermodulation

"... *Values of field strength on any pattern less than ten percent of the maximum field strength plotted on that pattern shall be shown on an enlarged scale ...*"

In this situation, it will take only very little excess radiation from IBOC sub-carriers to compromise the intended protection the NRSC mask gives an adjacent station as a deep null fills from the pattern bandwidth effects at the operating frequency of the adjacent station.

MORE INFORMATION NEEDED

The scarcity of published information about pattern bandwidth effects in hybrid IBOC systems itself is cause for some concern. More published information is needed.

As more directional arrays – especially those installed in the '50's, '60's and '70's become IBOC emitters – we will begin seeing the effects of theory turned into practice. The large number of nighttime arrays with very deep minima will compound the problem if these are placed into IBOC service as expected when the FCC follows the recommendations of the NRSC Digital Radio Committee (and endorsed by the NAB) to permit digital operation 24/7.

The figures below show a reality check from the field.

ONE REPORT FROM THE FIELD

This is a real station on the air with IBOC. The mask measurement differences between the main lobe and one of the minima are obvious. Like the hypothetical station above, this one has a simple two tower pattern, but the minima are shallow.

What do you suppose a six or twelve-tower array with carefully crafted minima for adjacent stations will look like if this is typical of a very *simple* array?

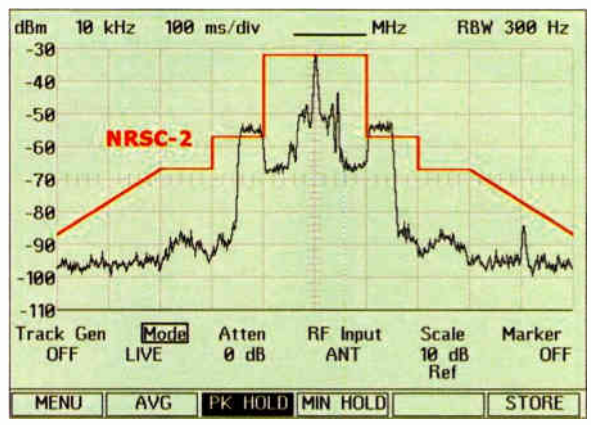

Figure 5: Radiation in the main lobe.

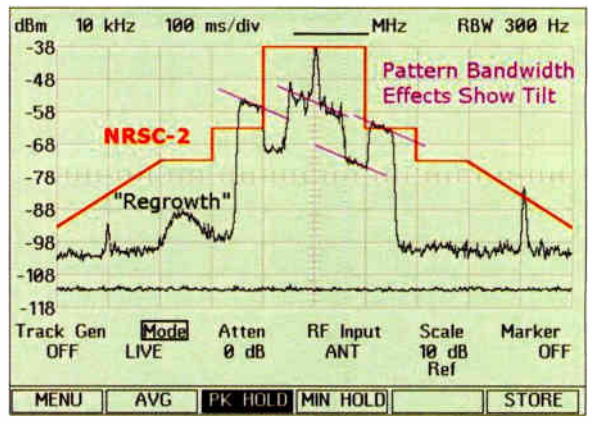

Figure 6: Radiation in a minima of the same pattern.

In the long run, the industry needs to be able to implement IBOC on directional AM stations without creating interference that is simply unacceptable by any standard.

It is clear that those of us who must make the transition to IBOC work need new tools for assessing existing directional array designs and better design tools for improving those arrays.

It is a daunting task, but if we acknowledge the problems now and develop those new tools, it appears we have a very good opportunity to convert many directional arrays to IBOC without destroying adjacent analog signals.

A contract engineer specializing in RF transmission and AM directional stations, Phil Alexander is President and Technical Director of Broadcast Engineering Services and Technology based in Indianapolis, IN. He can be contacted at dynotherm@earthlink.net

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by Jeff Welton, Nautel, Ltd.

Digital Radio Crash Course

Part 6 – FM Installations and Recap

Jeff Welton wraps up the Digital Radio Crash Course by sharing some of his experience with HD Radio™ installations for FM and offers a short list of key questions to ask before the gear shows up at your transmitter site.

The past few years have been very interesting for me, as I have had the opportunity to travel extensively and install FM-HD systems in a variety of facilities, from large to small.

All this activity has, as you can well imagine, given me a wide range of experience in seeing what can happen during these installations. By sharing some of the pits and pratfalls I have encountered, perhaps I will be able to provide you with some information that will allow you to avoid falling into some of those same traps.

LET ME COUNT THE WAYS

FM digital installations involve much of the same basic preparation in the same sequence as for AM facilities. Both involve receiving a bunch of boxes full of gear – some familiar, some that you have never seen before.

For example, you will definitely have an HD generator and associated parts; there may well be more items, perhaps some pieces to upgrade your transmitter. And do not forget the instructions on what to do with it all.

As soon as you get these packages, open them and check the contents. Check them against the packing slip by all means, but also check them against any other paperwork you may have: invoices, quotations, emails from the manufacturer – whatever resources you have regarding the project.

Trust me – there is nothing worse than getting the station shut down and the transmitter disassembled, then discovering that the instructions on how to configure one of the new boards that has to go into it are missing.

Tech support will probably be able to walk you through it over the phone, but it is a lot less stressful to discover any anomalies before the parts all get hauled up the mountain – and well before the transmitter is shut down and in pieces.

BENCH CHECK-OUT

If you have a couple of days between the arrival of the equipment and actually performing the upgrade, remove the HD generator and any related items from the packing and follow the start-up procedures in the generator's technical manual to be sure it appears to function properly.

If you can apply audio to it, do so at this time. I find that the majority of problems that occur between our door and yours will be in this area. After all, this is basically a computer we are shipping and it is not unknown for boards or connectors to vibrate loose during shipping.

One thing to note – equipment that has been configured for installation at the transmitter site may have shipped from the factory set to operate from a 220 Volt power source. Confirm this before applying AC to the unit, if it is not covered in the technical manual.

You do not need to perform a full configuration and test nor do you even need a transmitter – we are only interested in the basics. When you apply power, do the lights come on? Does it settle down and appear to be working without any unexpected alarms?

STRESS REMOVER

These are things that can easily be checked in the comfort of your office well in advance of installation time. You may find some alarms depending on exactly what you are testing, but a quick call to the factory can sort that type of thing out during business hours (as opposed to three o'clock in the morning!).

For example, if you apply audio, do your audio monitors indicate that it is passing through the system properly?

On the other hand, if you receive a separate exciter for the digital signal, it is important to remember that it may require feedback from the digital transmitter – bench testing may not be an option in this case – and you may wish to check with your manufacturer as to whether or not bench testing this unit is possible or even recommended.

INSTALLATION TIPS

Once you know you have all the right pieces and are reasonably sure they seemed to have survived shipping, it is time to move them on out to the transmitter site.

At this point, we need to figure out where to start the installation. A significant difference between AM systems and those for FM is that – for FM – it might be required to install a whole new transmitter for the digital signal (in the case of high level or space combined systems) or you may simply be adding a new exciter and the HD generator to the existing transmitter (for low level combined systems).

In either case, it is not possible to check one piece at a time, beyond the bench testing that was previously done. The entire system will need to be installed and powered up simultaneously, per the instructions provided by your manufacturer.

DO NOT FORGET THE CAT5

At this point, install and connect the HD generator and equipment in their final resting places. There are one or two things you may want to consider as you do this.

First, you will be running Cat5 cables from the HD generator to the transmitter exciter, maybe from the exciter to the transmitter, and possibly from a site Ethernet connection to the generator. Nautel provides a couple of ten-foot cables for the transmitter connections with every shipment, but other manufacturers might not – or you may need more.

You can save a lot of grief by having a length of cable on hand, as well as some RJ45 connectors and a crimp tool. Install the connectors using the T-568B standard, noting that in some cases you may need to configure the cable as a crossover; this should be identified in your technical manual. (For Nautel transmitters this should only be necessary when using a computer to connect directly to the NE-IBOC HD Generator.)

FM IS EASY

For FM stations, there are very limited adjustments needed as you install digital transmission gear, depending on the equipment make and the combining method. We will not dwell on the combining systems here, as this will have been decided upon long before the gear shows up.

For high level combined systems, you will need to confirm the power levels of the digital transmitter versus the analog. To do this, either sample the output of the combined system through a directional coupler and sample element rated for HD or use an FM antenna to the spectrum analyzer.

The primary digital sidebands should be more than 40 dB below the unmodulated analog carrier (the exact specification is -41.4 dBc). If necessary, assuming the analog transmitter power output (TPO) is at the licensed level, adjust the digital transmitter's output to achieve this level.

Adjustments to minimize spectral regrowth should not normally be an issue for FM stations. Transmitters operating with Nautel equipment will benefit from the adaptive pre-correction, which samples transmitter output and dynamically adjusts phase and magnitude to minimize regrowth. Other manufacturers may offer a form of adaptive correction or will pre-correct via factory selected algorithms.

Only in extreme cases should any adjustment be required, in which case a call to your manufacturer is in order.

MEASURING THE SYSTEM

To measure the spectrum, connect the signal sample or antenna to the spectrum analyzer. Once it has powered up and settled, set the center frequency to the analog carrier frequency, with resolution bandwidth set to 1 MHz, trace detection set to sample mode and span set to 1 or 2 MHz.

Then adjust the reference attenuation or reference level offset as necessary to place the fairly flat line that will result at the 0 dB level on the display.

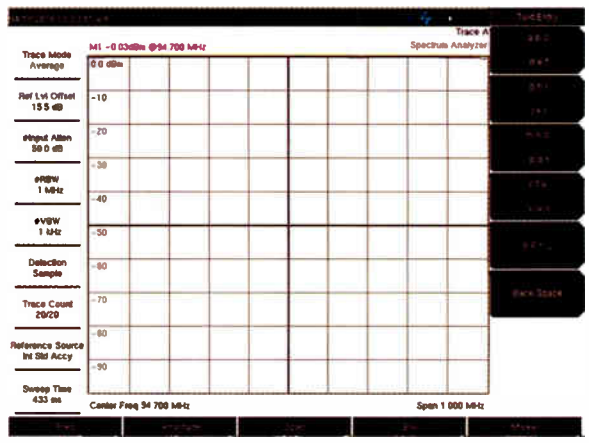


Figure 1: Initial Spectrum Analyzer Setup

Next, set the resolution bandwidth to 1 kHz and turn the averaging on so that you are averaging 30 samples.

A SAMPLE FM SPECTRUM PLOT

At this point, you should be looking at a waveform fairly similar to **Figure 2** (note that the analog carrier may not reach the 0 dBc point, depending on the display resolution of the analyzer, but I have set the 0 dBc line up as the 0 reference here). Depending on the analyzer model, there may be other variables to be set, such as number of displayed points and method of averaging.

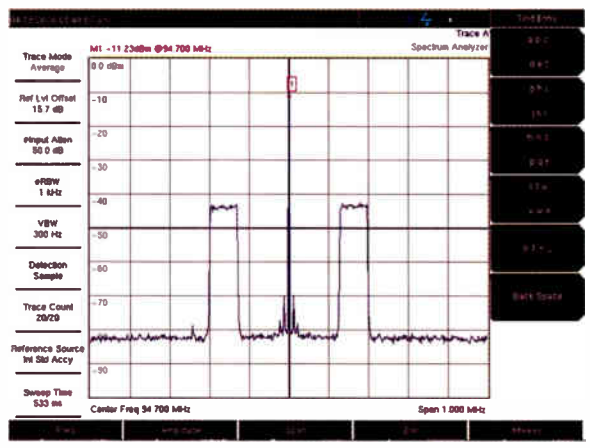


Figure 2: The FM Digital Waveform

At this point, the key thing you want to confirm is that the digital sidebands are at least 40 dB down from the unmodulated analog carrier and that any spectral regrowth is within the mask. The mask is based on the following table:

(Continued on Page 12)

Digital Guide

by Jeff Welton

Continued from Page 10

Frequency Offset Relative to Carrier	Level, dB/kHz
200-215 kHz offset	[-61.4 - (|frequency in kHz|-200 kHz) x 0.867] dB
215-540 kHz offset	74.4 dB
200-215 kHz offset	[74.4 - (|frequency in kHz| 540 kHz) x 0.093] dB
>600 kHz offset	-80 dB

FM Mask Specifications

There are also many resources on-line to provide additional information. One of them, focused on the Rules, is on the FCC site itself, at: http://www.fcc.gov/mb/audio/digital/

Other sources of information may be obtained through the various consulting firms and manufacturer websites; by all means check with your transmission equipment manufacturer – they should be able to steer you toward their favorites.

And that really sums up most of what you will encounter with FM-HD installations. If you have any questions, no matter what transmitters you are using, feel free to contact me. If I do not know the answer, I can usually point you towards the right person to get the information you need.

A QUICK CHECKLIST

To summarize our Digital Radio Crash Course, here are the primary steps for an HD installation, including several "points to ponder" during the process.

PLANNING:

For AM stations:

- Is the antenna bandwidth sufficient for the digital signal or will significant rework be required?
- Is there enough flexibility in the system to rotate the phase in order to present the proper load to the output of the transmitter power stage?
- Can my existing transmitter be upgraded?
- Is processing available for both paths – analog and HD?
- Is analog delivered to the site in AES format or will an A/D converter be required?

For FM stations:

- How will the HD be combined with the analog?
- Is there space on the tower to accommodate digital antennas for space combining?
- Will the tower support the additional weight of digital antennas and cabling?
- What power will I need from a digital transmitter for high level or space combining? (this needs to take into account combiner efficiency and cable loss, among other things)
- Will my existing transmitter handle the additional power required?

PURCHASING:

- Will brand A's HD generator work with my new or existing brand B transmitter?
- Are there feedback loops that would give me better performance with a single brand of gear?
- Do I have sufficient rack space to accommodate the new equipment and are the racks deep enough? (It really does not look good, nor is it advisable, to mount long gear in short racks.)

INSTALLATION:

- Are all the various pieces of gear and peripheral parts accounted for, including setup instructions?
- Do I have enough cabling on hand for routing audio and digital signals?
- How much off-air time will I need to get everything installed and set up?
- Have I coordinated any antenna/tower changes or retuning so that they are completed before I am ready to turn on the new equipment?
- Are any new racks properly grounded and wired for AC power?

Given the wide variety of installations, I am sure there will be a few points you may see that I might have missed. However, these listed points cover most of the major issues I have run across at various installations, some of which have ended up requiring time-consuming workarounds.

On the other hand, some of the points in the list can end up causing installation delays of days or weeks as things that were not considered become obvious.

Properly planned and executed, an HD installation can be done with a minimum of off-air time and frustration. I hope this series helps you to complete your installation in that manner.

Nautel Senior Customer Support Technician Jeff Welton has assisted in a variety of digital transmission installations. He is happy to offer assistance by phone or email (jwelton@nautel.com) to help you solve your RF problems.

Safety Guide

by Richard R. Strickland

RF Personal Monitors Facts and Fallacies

RF personal monitors are important tools for ensuring RF safety. In order to maximize their value in this regard, users must understand how they operate and what are their limitations.

RF personal monitors are a pretty common sight at many broadcast facilities. They can be valuable tools for controlling the amount of RF energy to which a person might be exposed.

Like any tool, it is important to start by selecting the correct monitor to do the job and then make sure you are using it correctly.

MONITORS PROMOTE SAFETY

In addition to standard RF personal monitors, there are several low-tech detectors being touted as low-cost alternatives to the standard monitors. People often ask why a monitor has to cost $1,500 and why a $10 detector will not do the job just as well.

The purpose of an RF personal monitor is to indicate when the wearer is exposed to RF fields that may exceed the FCC's Maximum Permissible Exposure (MPE) limits for Occupational/Controlled (occupational) exposure.

Personnel who use monitors should be trained RF workers. They must satisfy the FCC criteria for being fully aware workers who are able to exercise control over their exposure. Otherwise, they should not be exposed to RF fields that exceed the FCC MPE limits for General Population/Uncontrolled exposure.

NOT COMPLICATED

Monitors are not really complicated from the user's point of view. The user does not have to know how to design one in order to use one successfully.

However, it *is* important to have a basic level of understanding of how they work in order to recognize what is happening in potentially hazardous environments. I often find that people who wear monitors do not understand what the monitor is telling them. That is why I now ship out a training CD that I developed with each monitor order.

What are the important things to consider when selecting and using an RF personal monitor? Can RF personal monitors be used with RF protective garments? How do different monitors compare to each other? These are important questions and anyone who uses or is considering the use of RF personal monitors should know the answers to these questions.

PERSONAL RF MONITORS

Narda Safety Test Solutions, a division of Narda Microwave, supplies more than 95 percent of all RF personal monitors sold worldwide. Narda offers two different monitor designs – the Nardalert XT and the RadMan.

Two of the most common personal RF monitors.

At least a dozen models of each family are offered, but of the approximately 25 models, only seven are designed for use when one is attempting to comply with the FCC Regulations.

There is a basic model, a data-logging model, and what is referred to as an ELF-immune model for each family. The seventh option is a high-power Nardalert XT that is designed to be worn outside of an RF protective garment. It is set to alarm at much higher field strengths so that the individual wearing the suit is warned when the strength of the RF field might be too high even with the RF suit on.

The remaining models are designed for use by those individuals and organizations complying with standards and regulations other than the FCC's.

MODEL CHOICES

The basic monitors are fine for most applications. However, as we all know, most engineers like their toys, and reviewing logged data can be useful, so the data-logging models are also fine.

The ELF-immune models are designed for use when in very close proximity to very high voltage power lines. They are essentially the same as the data-logging models except that the outer case is coated with a conductive film that functions much like a high-pass filter.

However, in order to kill the monitor's response to high 60-Hertz fields, the sensitivity of the monitor is degraded well into the HF band. Since these models are more expensive and do not work at AM frequencies, they are not appropriate for broadcasters.

SPECIFICATIONS

The Nardalert XT accurately operates from 100 kHz to 100 GHz. The RadMan is rated up to 40 GHz, but in reality is only functional from about 40 MHz to 4 GHz. Its diode-based dipole sensor does not work on the body at lower frequencies and it has extreme variations in sensitivity at higher frequencies.

While this frequency range seems adequate for most applications in communications other than AM radio, the RadMan is far less accurate and offers far fewer features than the Nardalert XT. Furthermore, even in the band in which it functions reasonably well, it generally overestimates the field level by a factor of two to one or more (3 to 4 dB).

Since equivalent models in each family sell for exactly the same price, it is easy to see why the Nardalert XT outsells the RadMan by about three to one in the United States.

COMPARISONS

In contrast to the RadMan's simple diode-based dipole detection scheme, the Nardalert XT uses diode-based dipoles primarily for the VHF/UHF frequency bands. It uses a displacement-energy sensor design that works very well on the body down to 10 kHz.

Higher frequencies are detected using strings of thermocouples that function as a combination of dipole and detector. These handle any waveform, including extremely sharp pulses that a diode detector would peak detect and greatly overestimate, at frequencies up to 100 GHz and higher. At frequencies above about 26 GHz they function as traveling wave detectors.

Both the Nardalert XT and the RadMan have a "shaped" frequency response in which the sensitivity of the sensor is a function of frequency.

DESIGN CONSIDERATIONS

The design technique is similar to that of a filter. The goal is to have the frequency response mirror one of the standards, such as the FCC Regulations, as closely as possible.

For example, the FCC's MPE limit for Occupational/Controlled exposure at VHF frequencies (30-300 MHz) is 1 mW/cm², while the MPE limit below 3 MHz is 100 mW/cm². Take any simple site with one AM and one FM antenna and you can see the advantage of having a shaped sensor that responds in terms of percentage of the MPE, or "percent of standard."

If you are exposed to a 20 mW/cm² field, with 19.9 mW/cm² coming from the AM and 0.1 mW/cm² from the FM, you are only at about 30 percent of the MPE limit (19.9/100 + 0.1/1). Of course, if half the field were coming from each antenna, then you would be at 1,010 percent of the MPE limit (10/100 + 10/1).

The wireless industry faces the same type of problem when PCS systems are collocated with VHF two-way radios. In this case, the difference in exposure limits is only five to one but the issues are the same.

The shaped response automatically weights each signal and determines the total exposure in terms of percent of standard. Users do not even need to know the operating frequency of the systems that they are working near. Monitors are typically set to alarm at 50 percent of the MPE occupational limit to allow for measurement uncertainty.

MONITORS VS PROBES

While monitors employ the same sensor technology as the probes used in survey instruments, there is one important difference.

Probes use three sensors arranged in a mutually orthogonal design so that they are omnidirectional. You cannot do that with a monitor, as the human body functions as both an RF absorber and an RF reflector. So monitors use two sensors and detect fields in roughly the forward hemisphere but do not pick up energy from behind the wearer.

Although the monitors do not detect what is behind you, they are generally very effective providing you do not stay motionless. The danger in RF fields is heating, so as long as you move occasionally, the monitor should pick up any fields before you have a significant time-averaged exposure.

What about the very simple, very low-cost detectors? They generally are made up of a tiny printed dipole and a diode tied to some form of indicator. They will pick up RF energy under some conditions, but are highly directional, crude, and inaccurate devices. One should expect accuracy – something quite important – when one's health and well-being is at stake.

SHOULD I USE AN RF PERSONAL MONITOR?

This is an important question, to which there are many opinionated answers. Here is what I tell my clients:

If a person is going to enter any area where there is a chance of exposure to RF field levels above the MPE limits for Occupational/Controlled exposure, a monitor is almost always the best solution. These areas include any tower on which one or more television or FM radio antennas are located and on towers within 500 feet of a broadcast antenna.

In fact, I would not recommend anybody being allowed on a broadcast tower without a monitor, even when the systems are supposedly shut down. There have been many instances when systems have been turned on while climbers are on towers.

Consider the situation for which an FCC Notice of Apparent Liability for Forfeiture (NAL) was issued last year. A climber wearing a suit had been told that all three FM stations on the tower had been shut down. For some inexplicable reason, the climber shut off the monitor that he had.

However, when his legs got very warm and his RF suit started to smoke, he knew something was wrong!

WEAR THE MONITOR PROPERLY

Wearing monitors on your belt over the back pocket brings new meaning to the concept of CYA, but it is not the correct place to wear a monitor. And RF personal monitors do not work underneath RF protective garments.

Wearing an RF personal monitor under a RF protective suit may make sense to those who are not familiar with the personal monitors and suits; they might think that the monitor would simply detect what is getting through to the wearer, when this is simply untrue. *This is a very dangerous practice!*

RF personal monitors can be very useful tools when dealing with potentially high RF field levels. But you need to select the correct monitor for the job and use it correctly.

Finally, anyone who uses a monitor should be a trained RF worker in accordance with the FCC criteria for workers that are fully aware and able to exercise control.

Richard Strickland has more than 15 years of experience in the field of RF safety. He heads RF Safety Solutions LLC, which focuses entirely on RF safety issues for companies and government agencies. In addition to consulting, the company supplies RF personal monitors and RF safety signs. Richard may be contacted at RStrick@RFSafetySolutions.com or 631-698-6765

Processing Guide

by Cornelius Gould

Audio Processing for HD Radio

Part 3 – Masking the Dropped Bits

Getting the best sounding audio from digital transmission requires learning some new techniques. Cornelius Gould continues laying the groundwork for understanding the new generation of audio processors.

Audio coding technology has come a long way from the simplest form of bit reducing technology, as represented by Huffman coding. Of course, once we have a general idea behind how it works, we can take our understanding to the next level.

IMPROVING ON HUFFMAN

In order to make a useful audio data size reduction system, we need to have some pretty sophisticated algorithms in addition to Huffman Coding to really get somewhere. The first step towards an effective audio bit-rate reducing codec is to break the audio into smaller components.

If you split the audio spectrum into a bunch of bands, you can analyze the individual bands and their relationship with each other and obtain a tremendous amount of useful information. The algorithm used to do this frequency splitting function is called a "filter bank."

On modern codecs, such as AAC, the filter bank splits the audio into about 500 bands for analysis.

VISUALIZING THE AUDIO

The meaningful analysis of data from the filter bank can determine the amount of spectral masking needed to reduce the size of a digital audio file or stream.

To explain this portion of the discussion, let us draw some visual parallels. For example, on an average day while driving down the road, your eyes are "seeing" a lot of things. However, what we actually (mentally) see is an extremely filtered view of the world.

Unless there is something in the visual landscape that changes *just enough* to take our attention away from whatever we are concentrating on, we will never realize it is there. Our brains will simply throw away this extra "data" since it has little, if any, relevance to our survival at the moment.

It is this process of weighing the relevance of various stimuli from moment to moment that is the key to taking advantage of how much we can reduce the required amount of data in an audio (or video) file before it becomes just enough for us to notice that something is "not right."

This "just enough" point is the threshold of our sensory perceptual mask. The same thing is true with audio. Frequencies can be easily masked by our auditory system.

AN AURAL EXAMPLE

Here is an example to keep in mind as we move into the explanation of frequency (auditory) masking.

If two tones really close in frequency are playing at the same time, and are equal in level, we hear a combination of the two. If one of the tones is decreased just slightly in level, we will only hear the louder tone, and no trace of the quieter one will be heard.

If you have the equipment and know how to conduct the above experiment, try it. It is a very interesting exercise in auditory masking!

This tone example I have described is the *core concept* behind how to use audio masking techniques to reduce the amount of data in an audio file. The filter bank analysis algorithm within the bit-reduction codec looks at the spectral content, decides where the "just noticeable difference threshold" is for its human subjects, and operates just above that.

This is accomplished mainly in two different steps.

WHERE IS THAT MASKED AUDIO?

The first step is temporal masking. This is where audio levels across the frequency domain are analyzed for the loudest and quietest elements in the program material.

If a loud signal and a really quiet one arrive very close in time with each other, chances are we will not even perceive the quiet sound. The coding algorithm is written to assume this, so that the quiet sound is removed from the data.

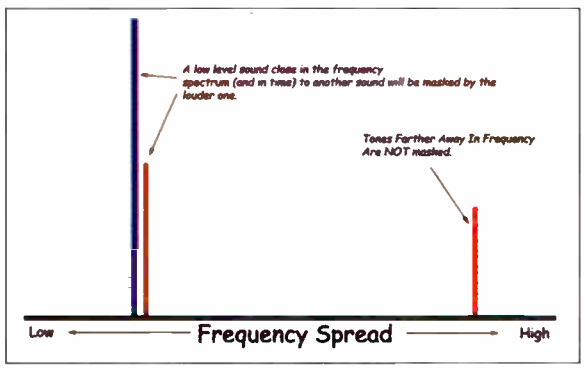
Whether or not that little sound can be successfully removed depends on the quiet sound having a similar frequency makeup as the louder one or the louder sound having enough spectral energy in the frequency range of the smaller one to mask it. (You should notice that this is our tone experiment used in a more complicated situation.)

A PRACTICAL EXAMPLE

Take a quick glance at our handy illustration and you will see that we have provided a visual snapshot representation of frequency and temporal masking.

The red line represents sounds at really high frequencies (treble region) while the brown and blue bars represent sounds at lower (near bass) region.

The blue bar is louder than the brown one, therefore sounds represented by the blue bar will mask those of the much quieter brown one. Although higher in amplitude, the sound represented by the blue bar does not affect the red one because of the frequency separation.



Effective masking requires the tones to be close in frequency and time.

AUDIO MASKING VS REALITY

A thing to remember is, in reality, there is not any masking going on. The masking is all in our heads, so to speak. The "auditory algorithm" in our brains assumes that the louder sound is more important than the quieter one, so we never "hear" the little sound.

To remove even more data, bit-reduction codec schemes will typically combine various data reduction algorithms.

Random noises, such as electronic hiss in recordings, are used in interesting ways. First of all, most of it can be removed and regenerated in the decoder portion of the system as random noise that falls in the frequency spectrum of interest. Locally generated noise is also useful in "smoothing over" some of the rough edges caused by the removal of so much audio data by the encoder.

This little technique also has the advantage of making a contribution to the reduction in the overall size of the digital audio data.

PUTTING HUFFMAN TO WORK

Now let us see how we can make Huffman Coding more effective for digital audio bit reduction.

One option is to add Huffman Coding to the "outputs" of the individual frequency bands of the filter bank after noise, frequency and temporal masking is used to remove audio that we would not normally hear.

Going back to last month's example of an audio file with a 60 Hertz hum in it, you will recall that I mentioned how Huffman coding can be used to eliminate the need to reproduce the 60 Hz hum in the background of the recording, thus removing a large amount of data. I then mentioned that just sending that entire audio clip through Huffman coding would do little, if any good without something more being done.

In this case, the low frequency filter banks (after all the masking reduction is performed) would only contain components of the 60 Hz hum. The Huffman coding algorithm can be presented with only this information and is now free to do what it does best – remove the repetition and replace it with a much simpler descriptor.

A modified form of the Huffman Coding concept is used in a new breed of High Efficiency codecs. These codecs include HEAAC (AAC Plus), MP3 Pro, and the codec used in HD Radio (which I suspect is at least a close relative to HEAAC).

A SLIGHT DETOUR

Before we move on, I should point out something about perceptual codecs.

Sometimes, it is best to run perceptual codecs at a sample rate lower than the source. The advantage of running codecs at lower sample rates is that it greatly reduces the amount of potential "artifacting" in the decoded audio, altough at the cost of lesser clarity.

This is why when using a standard MP3 codec, for example, dropping the sample rate from 48 or 44.1 kHz to 32 kHz sometimes provides the best quality for music. The drop in quality is minor, but the gains can be pretty dramatic.

With that out of the way, let us get back to this new technology.

SBR CODING

A relatively new coding scheme has been developed by Coding Technologies to meld two encoding processes. This scheme is called Spectral Band Replication (SBR).

SBR is basically used in this way: the main codec (I like to think of it as the "base codec") is run at half the normal sample rate of the desired target. For example, if you want to reproduce full 44.1 kHz digital audio (this is standard "CD Quality" audio), you would run the actual sample rate of the base codec at 22.05 kHz.

This will give you quality a little bit better than NRSC AM audio bandwidth from the codec with better overall codec performance. SBR technology is then used to recreate the energy lost by the lower sample rate.

PUTTING SBR TO WORK

The first step in the SBR process is to look at the high frequency makeup of the audio material on the encoder side of the bit-reduction system and create a series of simple descriptors (or cues) for use later in the decoder. This simplified data is sent out on a data stream embedded into the encoded digital audio stream.

Then the decoder looks at the spectral content of the fundamental tones in the high frequency area of the base codec and combines this data with the cues sent by the SBR encoder to refine the process.

Random noises present in the high frequency area are regenerated by the decoder and are also used to "smooth over" the overall regenerated high frequency content.

At this point, I think you may be beginning to see how the incorrect choice of audio processing can upset the delicate balance achieved by these perceptual codecs and provide a less than stellar example of the capabilities of HD Radio and web streaming to your listening audience.

This is where we will pick things up in next month's installment!

The Senior Staff Engineer at CBS in Cleveland, Cornelius Gould has experience throughout the region implementing audio processing that takes advantage of digital transmissions. Questions and comments should be sent to him at cg@cgould.com

We're all talk.

And all action, too.

All talk and no action? That certainly doesn't describe any radio station we've ever seen. With guest interviews, news and traffic feeds, live reports and listener calls to juggle, a talk studio is one of the most active places on the planet. Seconds count, and there's no room for mistakes.

That's why we created Status Symbols® for the Telos TWOx12 Talkshow System. Instead of flashing lights to decipher, there's easy-to-understand picture icons that give talk pros the information they need with just a glance. What caller's next? Who's screened, and who's just holding? With Status Symbols, you'll know instantly. And only Telos has them.

TWOx12 has lots more benefits. Like Digital Dynamic EQ, for uniform caller audio despite less-than-perfect lines. Twin DSP-powered hybrids for quick, no-hassle conferencing. A unique Dual Studio Mode that lets you use your 12-line phone system like dual six-line systems for extra flexibility. And TWOx12 is the world's only talk show system that can work with either POTS or ISDN lines to deliver exceptional caller clarity. Impressive? You'd expect no less from the company that *invented* the digital broadcast hybrid.

Is TWOx12 the perfect union of word and deed? Thousands of broadcasters worldwide think so. Why not see for yourself?

Telos
AUDIO | NETWORKS

12 lines, two digital hybrids, and superior audio performance. Desktop Director controller features handset, speakerphone and headset jack. Drop-in controls available for popular consoles.

New Call Controller has Status Symbols, DTMF pad and recorder controls (like Desktop Director), but lets talent use their favorite wireless phone or any standard handset for call screening.

Status Symbols show exactly what's what. Intuitive icons show calls locked on-the-air, which hybrid they're on, who's next in queue and more. So much better than a panel of blinking LEDs.

Assistant Producer enables talk show production via LAN or WAN. Status Symbols, Caller ID support, instant messaging and caller database are just a few benefits. Supports touchscreens, too.

First Look

by Kent Winrich

The Radiosophy MultiStream™

Like many others, I have been waiting for the release of the Radiosophy MultiStream HD Radio. It has shown promise, at least from the information on their web site (www.radiosophy.com).

INITIAL IMPRESSION

Radiosophy was showing their radio at the Harris and BE booths at NAB, connected to an internal transmitter which was broadcasting programming on HD 1, 2 *and* 3. As you can imagine, it generated a lot of interest.

This was my first chance to listen to HD3 and I was impressed with the audio quality. I was expecting it to be more digital sounding than it was.

I also found the radio to be more intuitive than the Boston Acoustics model (Just about everyone reaches for the volume control on the Boston Acoustics thinking it is the tuning control). The Radiosophy layout and operation was very clean and easy to use.

Some of the nice features include a digital audio output for connecting to your home system (as well as a set of good old RCA jacks) and a USB port to upgrade the firmware.

A closeup look at the MultiStream.

One thing that did perplex me is how the power gets applied. Even with the included docking station, you still need to use the "barrel" power plug. I would have thought the power could have been applied through the docking station.

THE QUESTION

Of course, the listening demos were in a very controlled environment. So the natural question is: how does it perform in the real world?

With all of the transmitters and other garbage going on in the exposition hall, we could not get any of the local stations in the building. No real surprise there.

But Tim Tushla from Radiosophy was kind enough to allow us a chance to take it outside, right at the end of NAB. So there we were, two guys in the alley between the Las Vegas Convention Center and the Hilton, looking for a power outlet. And found one we did.

REAL WORLD RECEPTION

Our first attempt was a little disappointing, as the stations would not lock into the HD signal for long. Then we noticed the antenna was still set to "external" from being in the hall. A quick switch to internal antenna and there they were, all of the local HD Stations – HD2s as well!

To say we were not in a prime location is an understatement. There was so much multipath that some of the analog signals had trouble. But we were able to lock onto the FM HD signals rather easily. The audio from the docking station was also quite impressive.

We did try the AM side, but there was too much noise in the area to even pull in an analog signal. Still, I am sure if we got out of the alley we could have picked up the only AM HD station in the market.

The word is that Radiosophy will begin shipping in late June. I know I will look forward to receiving mine!

Kent Winrich is the Director of Engineering for Clear Channel Radio in Milwaukee, WI. When he is not out testing radios in alleys, he can be contacted at: kentwinrich@clearchannel.com

Overcoming Challenges

by Sue Nail

Bringing the Radiosophy MultiStream to the Market

Radio people have been frustrated as they have waited for more IBOC radios to come out. The folks at Radiosophy have been fighting the same frustrations, but from the inside. Why is it such a slow process? Here is a peek at some of what is happening at Radiosophy.

It has been quite a ride for a small South Dakota company fighting to bring an HD radio to the marketplace.

SEEING A NEED

It was Bill Billings' love of radio that led him to research the possibilities surrounding NPR's Tomorrow Radio Project and HD Radio. Friends at KSUI/WSUI in Iowa City, IA felt the technology was radio's "next big thing" – but receivers were needed to make it a reality.

A former product manager at Gateway Computers, Billings knew the digital product market. Together with his wife, computer industry PR veteran Sue Nail, and Nail's former boss, Richard Skeie, they formed Radiosophy to design and build a line of digital radio receivers from the ground up.

The challenges involved with a business start-up – and there were many – grew out of the hectic pace of the technology business. "We encountered a number of surprises and issues that tested our group and individual resolve," said Skeie, the company's CEO. "The first and ultimately the largest hurdle was when our manufacturing partner lost its entire design team and simply abandoned the project as it was nearing completion."

OVERCOMING THE SETBACKS

A second manufacturer turned out to be too expensive and could not provide the tooling skills the company needed. Then came problems with incompatible CAD engineering packages.

"Fortunately, we found a top tier manufacturer that has been easy to work with," noted Skeie. "And they have top-tier engineers who really know the radio business."

Then, just as the company was about to begin the manufacturing process, RF sensitivity issues surfaced that proved difficult to resolve. The problem was compounded when several prototyping houses built faulty boards. All-in-all, these issues set the company timetable back by months.

Finally, radio sensitivity testing during the third week of April provided the improved results Radiosophy needed to achieve and the company initiated the engineering-run phase of receiver production.

A WORKING PRODUCT

Radiosophy had hoped to develop a truly portable digital receiver. Unfortunately, the HD Radio chipset's power consumption will not allow that development at this time.

Therefore, drawing from their experience with early laptop computers, the company's design team came up with the idea of a "transportable" receiver – one utilizing AC or DC power sources. "The radio is larger than originally planned," said Billings, "but the design was constrained by the technology."

The MultiStream HD will receive all current AM/FM signals including the new digital multicasting streams. The radio docks in a speaker base and includes an HD Radio indicator light and scrolling text capabilities, nine station preset buttons, which cycle through multicast streams, and an alarm clock with sleep, snooze and wake features.

One of the unique features of the MultiStream is the inclusion of a USB port, which will allow customers to update the receiver's software/firmware via the Internet, extending the useful life of the radio.

Power is run directly into the receiver, allowing the flexibility to remove the radio from the base and connect it to any existing sound system or home theater unit using RCA, optical and mini-jacks. An optional 12-volt power adapter and a special car adapter kit allows the MultiStream to be used in a car, boat or RV.

AVAILABILITY

"We are grateful for the many customers who stayed with us throughout this frustrating process," said Nail. "After a roller coaster ride only the bravest could endure, we're now very close to bringing our radio to market."

The company expects the first receivers to roll off the production line in late June of this year with a retail price of $269. Additional information, including special offers and programs for broadcasters can be found at www.radiosophy.com.

Sue Nail is Radiosophy's Vice President of Communications. Contact her at sue@radiosophy.com

"Some people don't like change. Change doesn't much care."

"I guess being the very first station to use Ethernet for audio routing has made WEGL a little famous! Someone's always on the phone: 'Tell me about your Axia system. What's the real story?'

"The real story is that two years ago, when our our old analog consoles began to fall apart, we put in an Axia IP-Audio network and SmartSurface. And I've never had a single reason to regret that decision.

"Sure, I was skeptical at first. But audio-over-Ethernet technology is compelling! Other companies just use CAT-5 to carry audio using proprietary protocols. Axia uses standard Ethernet to build a true network with uncompressed digital streams *plus* machine logic and program-associated data. No one else does that! I was a little concerned about dropouts and QoS problems, so we went to the Axia factory and assembled a network ourselves. It was easy to do, and it just *worked*. We were sold.

"The jocks took to the new board like fish to water. Show Profiles are their favorite part, since they can all have custom board setups. Some like their headphone levels blasting, some don't. Some like the mic on the left side, others on the right. I've got one guy who brings in his vinyl records every week for an oldies show; he's the only one who uses the turntables but when he loads his profile, they're ready to go.

"There were a few little bugs, but we had the very first surface! Axia support gave us new software right away and our problems were solved. Two years later, I'm more impressed than ever. I recommend Axia one-hundred percent.

"Since the first studio was installed, we've added a new production and interview studio, and we plan on building three more studios. It'll be all Axia — all the way to the transmitter."

— Marc Johnson, Chief Engineer, WEGL-FM
Auburn University, Auburn, Alabama

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A Quick Look Back at NAB 2006

by Barry Mishkind

Now that the 2006 Spring NAB Show is "in the books," the industry is back at it and looking ahead to the products and services announced at what some consider the main show of the year.

Once again, somewhat over 100,000 people registered for the convention, with some 25% coming from international locations. The Radio Hall was busy on Monday and Tuesday, somewhat less so on Wednesday, but traffic really dropped on Thursday (some even reported the music started a bit early).

LEAD-OFF ANNOUNCEMENT

April is when many announcements are made of new models and products, but perhaps the most interesting announcement this year was the marketing agreement between **Continental Electronics and Nautel Limited**.

Nautel's new CEO Peter Conlon and Continental Electronics General Manager John Udovich made a joint announcement that, while surprising, was a natural for both companies, expanding each company's lines.

In essence, Continental will re-label Nautel's transmitters with the CE logo and *service them from Dallas.* This gives Continental instant access to a fine line of solid state transmitters, both AM and FM. Nautel, in addition to beefing up its production line, gets to market Continental's high power, tube HD transmitters in Canada, supporting them from Hackett's Cove. Both companies will continue to develop new products in tandem. It seems like a win-win for everyone.

LOTS OF NEW STUFF

Since 2005 was the year the "budget dam" broke and new transmitters and antennas/combiners were purchased by the boatload for IBOC, it was only natural to see emphasis this year on the rest of the system.

BE had an interesting display wall, showing a complete system of products to get the audio from the studio to the listener.

A pictorial "flow-chart" of digital gear.

Not to be outdone, **Harris Corp** introduced nine new products, including significant enhancements to the Flexstar transmitter line – including a spectrum display right on the transmitter control panel. There was also a new console and IP audio streaming solutions, among the other new products.

There were several new models of gear designed to get the digital audio – and finding the needed bandwidth for several channels of audio – to the transmitter sites. Broadbanded STLs and IP audio solutions were in evidence in several booths, from **Broadcast Electronics**' Big Pipe to **Energy-Onix**' Tele-Link to **APT's** "Oslo" multichannel systems. Longtime broadcast STL providers **TFT** and **Moseley** were also among those on the floor with digital STL solutions.

IP audio transmission was shown to be useful not only in getting from the studio to the transmitters, but getting audio in from remote broadcasts. **Comrex** and **Tieline** had IP based gear that could be taken to a remote site and simply plugged in to the Internet for reliable connections from high speed modems all the way down to using cell phone data links.

On the audio processing front, **Omnia** announced a new one-rack-unit audio processor designed to bring many of the features of the Omnia 6 to stations of modest means. **Broadcast Warehouse** brought their expanded line of processors as well, including their new HD2 processor, priced under $1,000.

SEEING THE SIGNAL

Of course, once you get the signal on the air, it is handy to know if it is running to its full potential. **Inovonics** showed their new 532 HD modulation monitor, complete with a wide variety of diagnostic screens. **Belar** also brought its brand new FM-HD1 monitor to the show, as did **Audemat-Aztec** with their Golden Eagle HD.

The Inovonics 532 HD Monitor

Anritsu reached out to the broadcast market for the first time, showing their MS2721A Spectrum Analyzer, a lightweight portable laboratory grade instrument that is perfect for NRSC, IBOC or FM Spectrum measurements.

With multicasting on the minds of many show attendees, all the automation software companies were showing packages that could handle multiple program channels from one control point. **Prophet Systems**, **BSI**, **RCS**, and others had new packages that integrated new music scheduling approaches as well as monitoring and archiving solutions.

MORE DIGITAL STUFF

There was also quite a large display of **Digital Radio Mondial (DRM)** solutions at the Continental booth. Although most of it is currently designed for use in other countries, a 26 MHz transmitter was on the air and supplying audio to the booth from a transmitter on the edge of town.

The **Digital Radio Express (DRE)** system was also on the air in Las Vegas and was displayed in several booths. Running with an enhanced codec, DRE is a five minute install to add two – or more – digital stereo channels to an existing FM transmission system. Receivers are said to be "coming."

AM was not left out. Not only did **BE** expand their 4MX line to a 25 kW model, but **Kintronics** and **Phasetek** were on the floor to help AM stations deal with the bandwidth issues that IBOC has raised. Kintronics also showed some new contactor models for switching high RF current.

LOTS TO LEARN

In addition to the floor displays, there were, as always, plenty of engineering sessions set up by the NAB. Furthermore, several manufacturers – including **Nautel** and **BE** – put on special programs to help engineers better understand the new digital technologies, as well as the maintenance issues, that pertain to their products.

At **Nautel**'s meeting, there was even a lively question and answer session hosted by the technical and support staff

There was also a lunch to allow users to get to know one another – a valuable chance to network and find others with similar equipment and solutions.

Q&A with Nautel Staff

SPEAKING OF LUNCH

For many, Tuesday was the yearly opportunity to get together at Barry's Annual Lunch Gathering. Perhaps the largest group yet shared an hour or so of networking, away from the hectic floor.

Plenty to Eat; Lots of Chat

Thanks to **Prophet Systems**, **Shively**, **Comrex** and **Orban**, who co-sponsored the event, there were some really nice door prizes. And ***Radio Guide*** publisher Ray Topp was there, too, offering a Desk Organizer to everyone in attendance. (He was not suggesting that some engineers are not currently organized, was he?)

Among the door prizes, **Orban** gave away an Optimod PC1100 card. **Prophet Systems** came loaded with T-Shirts, pens, and screwdrivers. **Comrex** also brought some T-Shirts and a nice shoulder bag. And Tim Tushla from **Radiosophy** came over to show off their MultiStream HD radio and to *give one away* – just for the Lunch Bunch!

Radiosophy's Tim Tushla

Last year, the person who came the farthest distance to meet with us was recognized and it was announced that the person with the earliest license would be recognized this year. Bob Seaberg has held a commercial license since 1943 – an astounding 63 years! As the "senior member" of the group, he was awarded an IR thermometer/LED light from **Thermohawk**.

Other goodies spread around ranged from's additional **Thermohawk** units to a **Freeplay** radio that runs on solar power or a hand-cranked battery to some CD/DVD storage cases from **Disc Gear** to some innovative CDs from **Scratchless Discs** (with those little bumps to prevent damage). **Linspire** was again a kindly supplier of samples of software. And for those needing a calculator, **Bay Country Broadcast** supplied one for everybody in attendance.

There was even a "grab bag" box, where station swag and other items were exchanged after lunch. Then it was back to the floor for more equipment "tire kicking" and technical sessions.

All in all, most will remember the 2006 NAB convention as a positive experience. Now, we look ahead to the Fall Show, in September at Dallas! – *Radio Guide* –

Independent Talkback

A Headphone System with Selectable Talkback for Each User

FlexPhones Master

The FlexPhones Master is a professional Broadcast/Studio six channel distributed headphone system with independent talkback capabilities. Each of the six channels provides stereo program monitoring and selective talkback with interconnection via CAT5 cable to multiple Active Headphone Remotes (AHR-1) and/or Monitor Selector Interface (MSI). Multiple masters may be cascaded to form larger systems.

The FlexPhones Master is equipped with inputs for stereo program and talkback audio. Rear panel program and talkback trimmers are provided to pre-set maximum input levels. The microphone/line level talkback input is available via a rear panel plug-in euroblock connector, while the front panel XLR connector facilitates the use of a user-provided gooseneck microphone or headset. The front panel is equipped with a level control for local headphones with both 1/4" and 1/8" stereo headphone jacks. The six front panel talkback switches allow the user to independently communicate with each AHR-1 listener and can be configured to insert talkback audio into only the left or both ears and dim either or both program channels. Any combination of switches may be pressed, while the "All-Call" interrupts all listeners. The Talkback function can be remotely controlled. Six RJ45 jacks are provided to distribute audio and power via CAT5 cable to the AHR-1's, which conform to the Studio Hub format. Low-Z balanced audio distribution is used to preclude audio degradation with long cable runs.

AHR-1 Active Headphone Remote

The Active Headphone Remote (AHR-1) contains a stereo amplifier designed to work with any combination of high-efficiency headphones with impedances between 24 and 600 ohms. The AHR-1 is equipped with 1/8" and 1/4" headphone jacks, level control, user-configured utility momentary pushbutton and LED indicator. Two rear panel RJ45 jacks are provided for connection via CAT5 cable to the FlexPhones Master. The AHR-1 may be desktop mounted, under counter or with the optional HR-1/MP or HR-1/MP-XLR mounting plates, which may be turret or counter-top mounted.

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INNOVATIVE PROBLEM SOLVING TOOLS FOR BROADCAST

NAB

by Kent Winrich

Version 1.0

Going to your first NAB is a "different" experience. Kent Winrich got the chance to go for his first time this year and shares his reactions to the city and the convention.

My interest in radio started when I was four years old. We had an old TV and radio in the basement. Neither worked, but I was going to be the first four-year-old TV repairman. From then on I was hooked on electronics, but more specifically *radio!*

As I grew, I was of course the kid with the home radio station – spinning 45 RPM records for anyone that could listen. I would also hang out at the local station, WNAM, good ol' 1280 in Neenah, WI. I still remember those tubes glowing in the old RCA transmitter (or was it a Collins?).

A LARGER PERSPECTIVE

It was not until college that I even heard about NAB. "You mean there are 100,000 people like me that go and look at the newest radio equipment? They even have meetings about it? It just seemed so far out of reach.

My day-to-day job involves being hidden away in a transmitter building or dealing with promotions people that do not know how to work with a Marti, Vector or ISDN. So I do not really get much contact with other real engineers to talk about engineering. Most of my training gets done on my own.

But here I am, in my mid-forties and I finally got to go to *my first NAB!*

The North (Radio) Hall at NAB 2006

Looking at the seminars that were going to be held, I could not wait.

SOAKING UP THE INFORMATION

My first impression was: "Man, there are a lot of really smart people here." Listening to the papers presented, it was a real treat to sit in on these presentations and then discuss them with others, outside of the room.

Heading into the Radio Exhibition Hall, I felt like a kid in a candy store, except that I was actually going to take home some of the items there.

The Continental HD transmitter – the next one is *mine!*

It was so much easier discussing the products face-to-face with the people who make them, sharing with them my concerns, and getting immediate feedback on those issues.

Being at my first NAB, I noticed one problem: I was not part of the good ol' boys' network that has been built up by people attending for many years. Most people seemed to know each other, but as a newcomer, I was a tad on the outside. But I know that as I build acquaintances with many of you, that will change. I am thankful for Barry's get-togethers!

STRAY THOUGHTS FROM AN NAB FIRST-TIMER

It can be odd to consider what you "see" when exposed to a new environment. For example: I do not think there is a single chair in all of Las Vegas other than the meeting rooms. (Of course, they want you to sit at the slot machines.)

You meet the most interesting people on buses and taxis – especially in Las Vegas. I had one driver who used to work at Radio Ethiopia and wanted to get back into the business. Anyone have a need for an English/Ethiopian/Russian speaking journalist?

From my hotel room downtown, I could see no less than *forty-four* Internet access points – none of which I could use. Ugh. Maybe one of those Sprint PC cards will be next. Meanwhile, thank God for Krispy Kreme's free Internet access. Oh yes – and their coffee, too!

LAS VEGAS HOME OF THE STRANGE

Though Las Vegas claims to be a 24/7 town, you better eat when you can, or else the food goes away. Just try getting a lunch at 10:30 Las Vegas time (I live in the Central time zone) – you will be told to wait. And, contrary to popular belief, nothing in Las Vegas is free – everyone has their hand out!

TV ads for an attorney named Goeasy? I do not know about you, but I would not want *my* attorney to *Goeasy!*

By the way, next year I will not stay downtown. One can only see the Fremont Street experience so many times. And I am tired of the constant attempt at being entertained 24/7 by casino staff.

During my stay in Las Vegas, I did not spend one cent on gambling. The bottom line, though, is that I spent all of my time learning, traveling or meeting. All in all, I felt it was time well spent and I cannot wait until next year. Perhaps we will have a chance to meet then.

Kent Winrich is the Director of Engineering for Clear Channel Radio in Milwaukee, WI. You will find him at NAB 2007 or contact him at kentwinrich@clearchannel.com

FCC Focus

by Charles Dube´

Part 15 Interference Bites the FM Broadcaster

Imagine that you are driving to work on your regular commute and half-listening to your favorite radio station when suddenly you catch a few choice words that remind you of a Richard Pryor bit you heard back in college. The attack comes suddenly and is gone before you can touch the dial.

No, you have not been subjected to a paradigm shift or even a momentary lapse of consciousness. It was not an acid flashback (or reflux). Your radio was just hijacked.

PART 15 DEVICES

The ramping up of satellite radio and other means of digital music delivery has fostered a whole range of accessory devices. Some of these transmit a small radio signal to link a satellite radio receiver or MP3 player to an already existing FM car stereo or, in some cases, a home entertainment system. These mini-transmitters fall under the FCC's category of "Part 15" devices.

The FCC defines Part 15 devices as unlicensed radiators which conform to particular specifications regarding the amount of signal radiated and how the device is to be marketed. Part 15 covers a huge swath of electronics including hearing aids, biomedical telemetry, cordless phones, and business or personal computers.

The Part 15 Rules stipulate that no "harmful" interference should result from the use of such devices.

Some Part 15 devices are considered unintentional radiators (i.e. products that might generate RF such as DC motors, switching devices or television receivers). Others purposefully generate RF intended for use in close proximity; these are "Intentional Radiators" and have specific limits.

The FCC stipulates that the manufacturers instruct the user in the proper usage of these devices such as not to create interference to other services. However, the responsibility lies with the consumer and not the manufacturer to ensure the device actually is used in this manner.

INTRUDING SIGNALS

For broadcasters in the FM band, Part 15 devices used to retransmit audio specifically utilizing FM broadcast frequencies recently have generated a lot of interest.

In particular, with the growing popularity of new music and program delivery technologies such as satellite radio and digital storage devices (i.e. the MP3 player), a secondary market for devices that can transmit audio into conventional FM receivers has exploded.

Part 15, Part Nuisance!

Seemingly harmless and "flea powered," mini-FM transmitters have started appearing in numerous forms such as those being incorporated within the package of satellite broadcast receivers like the Sirius Sportster or as part of optional "car kits" like the JVC KS-K6012 which retransmits audio from any headphone jack's output.

The units range from fixed frequency transmitters set to 87.9 MHz to those offering a selection of eight to twelve FM channels; some are frequency agile throughout the FM broadcast band.

While most of these mini-transmitters are intended to link audio from a satellite radio receiver to a close-by existing car stereo, other transmitters such as C. Crane's FMT transmitter are designed to work in the house, linking a PC's webstream to the user's home entertainment system.

REACHING OUT

For the most part, it would seem that these mini-transmitters are benign – their signals only reach a short distance within walls or a vehicle, and they constitute a clever way to marry digital players and the existing analog hardware we already have surrounding us.

However, what is also beginning to emerge is an interference genie that may have permanently escaped the bottle. A fully legal Part 15 transmitter has the potential to broadcast to a surprisingly wide radius. I was able to receive the transmissions from one unit without an external antenna, and located inside a closed car, for about 75 to 85 feet before the signal became noisy.

Improper installation of these devices will exacerbate the potential for interference.

One common mistake made is the connection of a Part 15 transmitter to the car stereo's antenna input in a way which does not disconnect the vehicle antenna itself, usually through the lack of a bypass switch. The antenna then begins to radiate the transmitter's signal far beyond the design of the device in an illegal fashion.

"YES, WE ARE AWARE"

Since I occupy the "complaints" desk at our station so far as the listeners are concerned, when I first heard about these devices, the cynic in me began to silently await the first interference complaints. I figured that in the upcoming months, or perhaps years, I would receive an occasional "I didn't know the F-word was used that frequently in opera?" type of comment.

I did not have to wait long.

In the last few months my station has received several obscenity complaints from listeners. I can attribute part of this to the fact that, as an NCE station, we exist near the bottom of the dial. Along with being the most susceptible part of the band to propagation issues, it is also a starting point for many mini-transmitters' available RF output channel selections.

That, coupled with a sensitized public regarding obscenity in broadcasting, has ratcheted up a degree of concern that I think will only grow in proportion to the sales of these devices.

CONTENT ISSUES AND THE FCC

Of course, I do not mean to imply that satellite radio or streaming audio from the Internet necessarily is some sort of electronic den of iniquity, but seeing that those sources are currently unregulated in regards to content, retransmission into the FM broadcast realm seems to raise some serious legal and operational questions.

In regards to obscenity, I have been told by a representative of the FCC that any complaints against a given licensed broadcast station must be accompanied by substantial evidence.

It is from this evidence that a station's innocence most likely will be determined as any recordings or audio documentation of the event will undoubtedly reveal the nature of the situation. It will be up to the station, however, to be fully aware of the potential for interference, and to be clear and concise in informing the complainants about how this happens and why they might have experienced it.

WHEN TECHNOLOGIES CLASH

In densely populated areas, legal and illegal Part 15 FM transmitters have great potential to become an interference headache for both legitimate FM broadcasters as well as for listeners who simply wish to tune into their favorite program without having reception wiped out.

Yet, a simple search-engine query shows there are a plethora of hobbyists out in the world eager to find new ways to "hot-rod" their signals. It is not hard to imagine many of these illegal transmitters finding their way into resale markets or being used to extend "coverage."

We have seen how the sales of iPods and satellite radio receivers have skyrocketed. Will the consumer with the family in the car be forced to abandon their FM receivers for fear of subjecting them momentarily to "freely expressive" programming? Or will the interference itself drive them towards some other means of content delivery for their entertainment?

And who will "police" the FM bands for Part 15 devices which have been modified for greater power output?

The FCC's position on this is clear: Any device that is modified to operate outside of the emission restrictions – 250 uV/m at a distance of three meters from the device – is a violation of law and anyone possessing such a device which has caused interference is subject to a fine. The FCC will investigate complaints accordingly.

POTENTIAL TRANSLATOR PROBLEMS

Although I am not aware of this happening, my recent involvement in the construction of translator sites has spawned the question of whether or not these devices are capable of overpowering a host signal for the translator's retransmission, especially if a translator is located on the roof of a professional building or apartment complex.

This could lead to "hijacking" of a translator for minutes or hours on end, broadcasting some long term "unintended" programming, even some that potentially might be a threat to the host station's license.

Because this would be interference with a licensed service, this type of situation would be a federal violation. The only way to resolve such a serious situation might entail nothing short of a room-to-room search for the offending signal – and we all know how well that would go over with the denizens of most buildings.

Seeing that what we have experienced thus far has occurred in areas outside of our primary coverage contour, this kind of complaint might simply remain a minor irritation which we as broadcasters can kindly explain away to our listeners at this point.

However, if the interference becomes such that it becomes difficult for listeners to enjoy an FM station without being subjected to numerous intermittent interruptions, there may be potential for a serious impact to listenership, especially to non-commercial stations whose income depends upon the goodwill of its listeners.

Charles Dube´ is the Chief Engineer of WFCR, 88.5 MHz, in Amherst, MA. He flinches (lovingly) whenever his wife listens to her iPod shuffle on 87.9 MHz in her car. Commiserate with him at cld@wfcr.org

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A Non-Comm View

Mentoring Helps Students Prepare for Broadcast Careers

by Jeff Johnson with John Hingsbergen and George Zahn

Some university stations have built reputations as sources of news or classical music, for example. But often the staff is made up of professionals and this can lead to a situation where students are restricted from having real on-air experience as part of their education.

With universities shedding their broadcast stations at a rapid pace, it is becoming more difficult for a student interested in a broadcast career to find the right school where they can turn for hands-on experience and mentoring by seasoned professionals.

Two Midwestern universities are among those that continue to take pride in their NCE public stations and have on staff just such individuals. To get an idea of how their programs help students develop into broadcasters, we spoke with George Zahn and John Hingsbergen.

MENTORING IS ALIVE AND WELL

George Zahn is at WNKU, Northern Kentucky University, in Highland Heights, KY. He describes his approach this way: "Too many schools, including some major universities, are leaning more and more toward instruction of theory as the crux of the communications curriculum.

"Without some form of lab work and actual editing and production experience with critical decision-making in a 'real world' simulation or environment, we're training teachers, not artists."

Instead Zahn takes a different tack: "The first underpinnings of training someone new to media are basic terms and measurements. For example, without at least a slight understanding of amplitude and frequency, slightly more advanced concepts such as setting levels or frequency response for a piece of gear can be confusing. I can't stand a teacher who says, 'It's just that way. Don't worry about it.' just to drill something into a student's memory."

TEACHING THE TRADE

After a primer on terms and the differences between audio and sound, Zahn says it is most important to get the students or volunteers thinking like producers. "If they hear a great piece of audio or see a dynamic video, they need to be able to pinpoint what it was in that presentation that made it special.

"If they can think beyond the reaction of 'that was great!' to determine why it was different from anything they heard or saw before, they begin to understand the art that can make their audio or video production unique and they're open to a whole new layer of their profession or avocation. My goal is to help the students understand the component parts that make a production memorable."

Another key toward helping students grow is to draw upon their passion. Zahn points out that "Even the simplest task in audio or video should generate a degree of pride when it's done correctly. Whether it's a break done on a radio board shift or a completed production piece – it's important."

GET THE STUDENTS INVOLVED ON THE AIR

Over at WMUB at Miami University in Oxford, Ohio, John Hingsbergen explains, "For years, Miami University has considered the training of students to be an important role for the station and that continues to be a part of our mission.

"WMUB uses a fairly large number of students compared to many other public radio stations. In general, we usually have somewhere between 12 and 30 students involved as either board operators or as news assistants."

WMUB employs the concept of "Chief Board Operator." The Chief is an undergraduate student who has proven him or herself to be responsible and reasonably professional. This person deals with the routine scheduling of other student board operators and assists in the hands-on aspects of training.

TEACH ONE, TEACH MANY

Hingsbergen adds, "The way we are operating now is that, after I hire a board operator, I present them with our "Board Operator's Manual" and meet with them in a session during which we go over basic principles and rules.

(L-R) Andrew Webb, Miami University Senior, Special Education Major, Katie Collins, Miami University Freshman, Theatre and Mass Communications Major, John Hingsbergen.

"The Chief Board Operator then takes over and assists the newcomer with basic operational instructions. New board ops are also required to observe their more-experienced colleagues for a minimum of six hours before being scheduled for their first solo shift. During that first solo, the Chief sits in and makes sure all is going smoothly.

"Ongoing supervision and airchecking of the students is done by my Operations Assistant Ben James."

GIVE THEM THE WHOLE PICTURE

Zahn says students should get an early overview of the entire station's operation. "When starting out, most students don't understand that their best opportunity to learn a broad perspective at a station or studio is the first year. It's that chance to experience as much as you can before you get assigned or pigeon-holed into one area.

"Interns should be constantly keeping eyes and ears open for extra opportunities and work to convey a 'can do' attitude. That works well if they've actually applied what they've learned in the classroom and lab and can back up the 'can do' claim!"

Learning to do good production, on time, is essential. Zahn says "A production should be as polished as possible and done to spec. Too many students, and professionals alike, get lost by tweaking an edit until the proverbial cows come home and never meet the deadline. Make it great, but make it on time!

"I might add that audio and video teachers whose experience is strictly in theory cannot accurately convey what will be expected of new producers in the new world that awaits them."

In working with students, Zahn realizes that only a small fraction might ever become prolific editors, "but I stress the importance of empathizing with an editor when they may be in another position as talent, producer, writer, or engineer."

MATCH STUDENTS WITH ABILITIES

Not all students are suited for all functions. Hingsbergen recalls the day "when I arrived at the station in 2000, students were our local board operators and anchors for the afternoon drive news magazine, *All Things Considered.*

"As it happened, the very first day, I discovered a barefoot young man in ragged jeans resting on the floor of Studio D. I inquired as to whom he was and what he was doing, and he promptly informed me that he was that day's board operator and local announcer for *All Things Considered.*

"He was a very nice young man and I eventually came to admire his 1960's-style counter-cultural attitude, but his on-air performance was even worse than his appearance. I soon discovered that a different student was assigned to board op this important daily show each day of the week. This was a practice we changed within my first year on the job."

With the realignment of student board operator duties, WUMB improved the overall sound of the station immensely but, as Hingsbergen says, "we have lost some of the charm of those days when we would frequently find a bedroll and an alarm clock on the floor of the main control room."

THE RIGHT VOLUNTEERS

Another group of staffers which Hingsbergen found needing some adjustment in how they were used was the volunteers.

"When I decided to roll out a strip of local talk shows each day from 9:00 to 10:00 AM, I decided that we would need help in the form of volunteer producers and phone screeners. [Unfortunately,] we have had spotty success in this area.

"We have a couple of people who have been with us for a number of years and are working out great. But one of our earliest volunteers was a gentleman who identified himself as a big fan of public radio who would do anything to help us. He didn't really have the skills or interest in helping with substantive interview shows so we asked him to be the phone producer for our computer call-in, *The WMUB Help Desk.*

"After a few weeks observing with one of our staff, he was ready to take over the phones. He seemed to be doing a pretty good job until the show's host (also our General Manager) complained that it seemed to be taking a long time for callers to be 'processed.'

"Following some observation, I discovered that this fellow was engaging some callers in extended conversations, often trying to help answer the questions that were intended for our on-air 'guest experts.' He just didn't get the point that the calls weren't really for him."

Hingsbergen has since become a bit more discriminating in the "hiring" of volunteers, making it clear that the station considers their role to be an important job with standards similar to those that would apply to paid employees. Although some well-meaning people could no longer be used, station operations now run much more smoothly.

With the threats to independent public radio now being made by religious broadcasters buying frequencies and/or universities discarding their broadcasting arms as "irrelevant," but instead viewing them as a source for a quick "cash grab," it is refreshing to encounter university stations like WNKU and WMUB.

These stations are actively upholding the best traditional standards of "NCE" Non-Commercial Educational broadcasting.

Jeff Johnson is a Cincinnati based broadcast engineer. He can be reached at: Jeff.Johnson@goodnews.net

Field Guide

by Stevan White

Inovonics

Good Audio Processing is Not Always Expensive

As a contract engineer I get a lot of questions about which equipment is the best, which is the least expensive, and which is the best combination of the two.

The part of the country in which I work is largely populated by small to medium-sized markets. As a consequence, most of my clients are very cost conscious. Nevertheless, they still want to sound the very best they can.

Although there are those who might argue with me, I think the most bang-for-the-buck audio processor has an Inovonics logo on the front.

THE IMPORTANT PART

The most desirable feature of any Inovonics product is not the fancy front panel. They are clean and simple with minimal adjustments. It probably is not even the remote control interface that lets you dial in on a modem and remotely change parameters.

We also are not talking about sound quality – top-notch sound is non-negotiable. But price is important – and at half or less than their competitors, the cost of an Inovonics processor is a most desirable feature. Most of my clients ask if they will be getting a quality product for the price.

I have nothing against the other processors; I have used them too. But how impressed are listeners with the stylized front panel, slick knobs, buttons, and LCD screen? All they care about is what they can hear and any Inovonics processor will produce loud, clean audio that will not fatigue the listener. If they are not fatigued, they are less likely to tune somewhere else. Keeping you legal is a no-extra-cost bonus feature.

MAKING THE AUDIO "SING"

Here is a tip that might save you some frustration with any brand of audio processing: make sure you are operating it in its "sweet spot." That is when you get the most performance out of it without pushing it to its limits.

Inovonics makes this easy with the "gain-riding" AGC. There are several LEDs that show AGC activity. Just set the input trim pots so that the 0 dB and -5 dB LEDs are lit up most of the time and one is about as bright as the other. You can use program material for this but, to get the left and right channels properly balanced, connect one channel at a time and set each channel independently.

When you are satisfied with your adjustments, plug the other channel in and continue with the other settings. The quick-start section of the manual makes it easy and the results are the proof. No pun intended but, speaking of "proof," the processing can be bypassed with the simple flip of a switch.

COST EFFECTIVE AM PROCESSING

If you are a "less is more" type, like myself, the model 222 AM NRSC limiter will be part of your installation. This little workhorse has been around for a long time, and for a good reason: it works.

Inovonics 222 AM Limiter

The 222 is a bare-bones NRSC compliant peak limiter that can be used by itself or as part of a bigger system. The 222 does what it is supposed to do, and does it well. If you want a little extra "oomph" in your audio, try using an AGC, some EQ, or maybe an aural exciter as part of your audio chain.

For a more "full featured" AM system, I am also a big fan of the model 235 AM processor. It does everything you need for AM in a single rack space: gain-riding AGC, followed by variable low- and high-frequency EQ, 3-band compression, an asymmetrical limiter/clipper peak controller, and an NRSC low-pass filter.

Frankly, I would love to have a 235 for my ham radio station; if not a 235, at least a 222 (or, maybe I can find an old model 250 AM in good condition). But on an AM station, these boxes shine!

FM CHOICES

My favorite choice for an FM multi-band processor/stereo generator has been – and still is – the DAVID. When it was first introduced, it was called the "giant killer" or something like that. The first one was the model 715; then came the model 716 DAVID-II and now we have the model 718 DAVID-III.

Each new model included something that customers had asked for while keeping the cost reasonable. Both the model 716 and 718 are still available from the

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Field Guide

by Stevan White

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factory. The model 716 DAVID-II incorporates AGC, compression, limiting, stereo generator and composite clipper.

The Model 718 DAVID-III

Add EQ and multi-band compression/limiting to that and you have the model 718 DAVID-III.

Both of them are neatly tucked into a single rack space package.

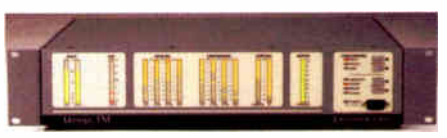
A few years ago Inovonics introduced the Omega_FM, their first all digital FM air chain processor. They describe it as a "powerful, software-driven digital processor and stereo generator that provides major-league processing at half the expected cost." It does.

DO IT ALL – EASILY

You can use the composite output to feed your analog transmitter and the AES/EBU digital output to feed your IBOC/HD digital transmitter. Connect a laptop computer to the serial port and you can adjust each parameter as much or as little as you like if the front panel adjustments just do not get you there.

If your Omega_FM suddenly goes south, as one did on me once, you can most likely use that laptop to zap it back to life. This was much better than the normal trip back to the factory for most any other unit; Inovonics tech support suggested that I try reloading the software before packing up the unit.

I plugged the computer into the network and headed to the "Downloads" page at www.inovon.com and found the necessary file. Within a few minutes I was ready to reload the Omega's operating software.



Like many top-end processors, the Omega can be controlled via software.

It was easy and, as with any computer, I rebooted it to allow the new software to be recognized by the unit and – in under thirty minutes – I had the Omega_FM back up and running without ever taking it out of the rack!

TEST DRIVE

As with most processor manufacturers, you can have a thirty-day demo on any Inovonics product to see if it is right for you.

Run one of these units for awhile and see if you still feel like you need a little something extra. Without spending a whole lot more money, I often try one of the inexpensive spectral enhancers made by Aphex, dbx, Behringer or BBE in front of it.

This combination has fooled many General Managers and Program Directors into thinking they have a little more than they really do. In fact, I know of a couple of instances where a station purchased one of the higher-dollar boxes and still found it "just didn't sound right" to the "golden ears" at the station.

At one of these stations, a contract engineer friend actually re-installed the Inovonics DAVID and an inexpensive "spectral enhancer" box behind the rack and then told the GM and PD, "I've made a few more adjustments. What do you think now?" They were once again happy because they sounded better than ever.

Of course, the higher-dollar unit was still in the rack, still had audio fed to it, still had blinking lights and dancing meters but now it was the "backup" air chain. Who knew?

Just us sneaky engineers.

A contract engineer based in Amarillo, Texas, Stevan White previously has sold broadcast equipment to the industry. Contact Steve at w5saw@pathwayz.com

Multicasting.

It's like trying to fit —

well, you know.

Management has decided to multicast. Which seems like a terrific idea — until you consider just how little bandwidth each channel will get. How will the sound of your station(s) survive these shrinking bitrates? Omnia can help.

New Omnia Multicast with SENSUS™ restores the fullness and depth that bit-reduction steals. Our DSP gurus teamed up with the codec experts at Telos (the folks who introduced broadcasters to MP3 and MPEG AAC). Together, they developed a unique suite of tools to pre-condition audio for HD Radio™ multicasting.

Omnia Multicast with SENSUS codec conditioning, Omnia Bass Management system and distributed look-ahead limiter significantly improves the sound of HD multicast and other bit-reduced streams.

SENSUS technology enhances punch, preserves presence, and reduces artifacts. Even heavily bit-reduced channels (like multicast) can be significantly improved by Omnia running SENSUS. And like all Omnia processors, Omnia Multicast delivers the smooth, clean, pure signature sound that grabs your listeners and holds them hour after hour. No wonder the top stations around the world choose Omnia over all other processor brands.

Multicast like you mean it... with Omnia Multicast.

Omnia
A Telos Company

OmniaAudio.com

EAS Watch

by Clay Freinwald and Richard Rudman

SBE's Vision for EAS:

Improved Public Warnings in the Digital Age

EAS promised to warn those at risk better than its predecessor, EBS. Many times it did not. Since EAS was launched in January of 1997, that promise has been substantially fractured.

On the other hand, where EAS works as designed, it is usually in places where broadcasters and emergency managers went far beyond Part 11 – they met each other on common ground to solve problems.

PRESERVING A VIABLE SYSTEM

There are those that have called for junking today's EAS as a failed system. However, the SBE does not agree, filing comments on January 24 of this year on Docket 04-296. The SBE's vision to recast EAS could give new hope for the EAS promise. It is worth a try to snatch victory for improved public warnings from the jaws of defeat.

Our position is that EAS must continue to play an important role as a legacy system in the distribution of public warnings by broadcasters to the public, enhanced and integrated with existing communications systems as recommended by the SBE and others.

This strategy will reinforce the unique value added by broadcasting to the warning picture – a value supplied by broadcasting to the public, in great detail, what they must do or not do as the emergency plays out.

Hurricane Katrina recently reinforced this unique role of broadcasting that goes beyond warnings. The lesson: broadcasting must continue to package distribution of public warnings with its traditional role to provide details that are difficult to convey in a warning.

PRIMARY MISSION

The roots of EAS rest in the soil of the Federal Government's primary warning mission for CONELRAD during the Cold War days of the 50's – a reliable way for the President could speak to the public rapidly in times of great national peril.

EAS was supposed to be an improvement in this mission, to warn faster and more reliably than the EBS that replaced CONELRAD. In many ways EAS is an improvement. Yet, like its predecessor, EBS, EAS still permits the system and its equipment to be used for public warnings issued from the National Weather Service (NWS) and Civil Authorities.

The FCC's Rules (Part 11) for EAS stop short of telling how to use the EAS for these other needs beyond very general guidelines. This incomplete descriptive leadership and guidance for local warning use has caused some states and areas to craft EAS local protocols to deal with the needs of their citizens.

Since 99.9999% of EAS activity involves emergency-life-saving messages from NWS and Civil Authorities, this should not have been a surprise. Other states did little or nothing, leaving the local emergency operations of EAS literally in a "sink or swim" mode.

SBE COMMENTS ON 04-296

The SBE took on the mission to assist other stakeholders to create a robust and reliable public warning system some years ago.

The SBE has and continues to carry out this mission not only at the national level, but also through all the SBE Chapters nationwide that support or directly manage many LECC's. Some of the sweeping changes the SBE made, although addressed to the FCC, may ultimately fall to the FCC's federal partners for review and action.

It is the SBE's hope that the federal partnership regarding emergency warnings the FCC alludes to in this FNPRM will implement sharing and discussion of suggestions to improve the warning process, no matter which doors they come through.

THE END OF LPS?

Doing away with the Local Primary (LP) stations is the most sweeping and controversial suggestion the SBE is making for the EAS. Local and State Relay networks (LRNs and SRNs) as perfected in Washington State and California would take their place.

The EAS Rules have within them an embedded assumption that the two LP stations prescribed by the Commissions Part 11 for the distribution of the Federal level Presidential Message also are adequate for distribution of Weather and Civil Authority sourced public warnings. This assumption has led to bottlenecks and failures.

The idea is to remove as many potential obstacles between government warning centers and broadcast stations. This means any broadcast station that survives can be a path to the public for EAS messages. If EAS no longer depends on LP stations, we have finally eliminated the old EBS "daisy chain."

ELIMINATING A WEAK LINK

It is instructive that, while broadcast stations still relay messages to other broadcast stations in many areas, this daisy chain topology remains as one of the most often criticized aspects of EBS.

Unfortunately many of the shortcomings of the EBS topology were not addressed and fixed, saddling EAS with an updated but still problematic version of the classic daisy chain. It is the SBE's idea that the role of broadcast stations should be limited to the job of reaching the public.

This is a mission that broadcasters constantly demonstrate very well especially during major emergencies.

To take EAS beyond the daisy chain model, we need to follow the lead of the NWS and their National Weather Radio (NWR) systems. These are essentially multipoint distribution systems that transport emergency warnings to broadcasters as well as citizens who have NWR Receivers.

The SBE submits this concept should be expanded to include state and local governments. It should be clearly incumbent for each local warning center to install and operate multipoint distribution relay systems to broadcasters for messages that they create. Just as with NWR, broadcasters can then relay this information to our listeners and viewers.

AN INFORMATION BOTTLENECK

The SBE feels we must not stop there. The time has come to fundamentally change not only the way messages

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EAS Watch

by Clay Freinwald and Richard Rudman

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are delivered from their sources, but the composition of those messages.

The FCC, in their recent Report & Order, added a number of communications systems to the EAS family that are all going to require embedding text messages in EAS. But the present Specific Area Message Encoding (SAME) protocol EAS message format was designed for radio – not for embedded text.

So while specific emergency message information beyond the preformed three letter EAS codes is contained in the EAS voice message section, there is no mechanism for dealing with real time text within the voice message format. This issue has recently plagued television, since that medium has a federal mandate to convey emergency information visually as well as aurally.

The short-term result has been less than ideal. Some TV stations have been faulted (if not cited) for not supporting warnings with real time text, others have opted out of the voluntary aspects of EAS.

A NEW MESSAGE PROTOCOL

The solution is obvious – the information contained in the voice message must somehow be delivered as real time text. Thankfully the vehicle for handling this chore is ready to go and that is the Common Alerting Protocol, or CAP.

Our vision for EAS sees a day when every broadcast station, and other personal receiving devices, will receive public warning messages from all authorized emergency message sources. Television stations, cable systems, and radio stations all will be able to receive the same accurate text messages embedded in EAS at the same time, integrating them into their formats thereby enhancing the number of stations participating in the EAS.

One way to do this is with text-to-speech technology that will let automated or unattended stations function more effectively as real time warning information sources.

OTHER RECOMMENDATIONS

The SBE's vision for the future of EAS also includes:

• Provision for Federal coordination for the entire national warning effort through a centralized authority.

• Bringing authorized emergency management warning originators into the EAS warning family. It is a marriage of necessity, not convenience, as most warning failures occur at the origination point. This marriage must take place so improvements in delivery and display will have meaning and value.

• Providing Federal-level support in the form of funding, training and education for EAS. EAS must cease to be an unfunded federal mandate.

• Providing reliable and high quality RF link spectrum between warning origination points and what the SBE calls WARSEPS (WARning System Entry PointS) by authorizing specific channels for this purpose and by changing the Table of Allocations so sharing of public safety and public works radio channels could fulfill this strategic need.

• Immediate consideration for a national needs assessment to implement new and expand existing distribution systems (SRN's and LRN's). These are critically needed to link the various government sources of EAS messages to the EAS entry points that distribute this information to the public. Without an accurate nationwide catalog of what needs to be fixed and reinforced to make EAS better, we cannot put a price tag on maintenance, repair and improvement.

• Acknowledging the Common Alerting Protocol (CAP) as the open standard used to distribute public warnings from government entities to public distribution systems.

• Requiring government entities to transmit to TV and cable systems a CAP encoded text representation of the voice message to insure people with impaired hearing or who have only text-based systems can receive EAS warnings.

• Mandating that receivers and set-top converters and certain other electronic receiving devices become warning appliances. The SBE is suggesting improvements to help remove the oxymoronic cloud that hangs over EAS now as a "voluntary mandate." Digital broadcasters will then have an EAS that can function without programming interruptions or blocking warnings from getting to their audiences.

WIDENING THE ALERT SYSTEM

One of the reasons the SBE's vision makes sense is that it is a plan to get warnings to people with hearing, sight or language issues that prevent or hinder reception of present-day EAS warnings. The fastest path to this new and more effective warning world would be for the FCC to establish receiver and set-top converter standards to turn these devices into stand-alone warning appliances.

Program interruptions could then be tailored for those directly affected. In most cases, there would be no need for a program interruption since the receiver or converter would make a warning noise or trigger an external alarm, send a local Wi-Fi signal, or dial a phone number.

As CAP is already established as a non-proprietary open standard language to allow warnings to flow freely, it makes it possible for video monitors or radios to store warnings and/or forward them, even if they are turned off or no one is around to watch or listen. Some EAS experts believe much or all of this will eventually come about with or without FCC action, but is more likely to happen if the FCC does see fit to act.

A TEAM EFFORT

The SBE's Comments were written and edited by the SBE's EAS Committee led by Clay Freinwald, SBE Vice President. The SBE's FCC Liaison Committee then reviewed the Comments before final approval by the SBE's elected Board.

Over one hundred parties filed Comments in this Proceeding. While most filing parties made selective responses to a few of the questions or simply stated a generalized opinion of what the FCC should do, the SBE's approach was to take almost all of the questions the FCC asked and provide detailed responses.

Anyone interested can read the complete SBE filing at: http://www.sbe.org/documents/SBE_EAS_FNPRM_all.pdf

Clay Freinwald, current Vice-President of the SBE and Chairman of the EAS Committee, and Richard Rudman, past President of the SBE, have been active in EAS matters for years. Contact Clay at K7CR@blarg.net – Richard is at: rar01@earthlink.net

Field Guide

by Mark Simpson

STLs: Getting From Here to There – Reliably

Moving audio from studio to transmitter is not always easy. Even when studios have a clear path to the transmitter, frequency congestion and interference issues can create some real headaches, especially when a station needs enough bandwidth to add the new digital services.

A reliable, wideband studio to transmitter link – that was the requirement we needed to meet when considering our options for a new STL system as part of our HD Radio conversion for KIIM-FM here in Tucson, Arizona.

The solution turned out to be a bit different from what we expected, but we got what we needed – and more.

BREAKING THROUGH THE CONGESTION

The KIIM transmitter site is located on top of Tucson Mountain, eight miles west of the studio. We are fortunate enough to have a clear line of sight to the transmitter site, but there are no Telco facilities. Everything must be sent via some form of microwave link.

KIIM is collocated with several FM stations as well as TV, two-way, etc. With most of the STL's pointed in the same general direction, Tucson Mountain is a bit of an RF nightmare. One thing that greatly affects reliability is interference – so keeping the STL's from interfering with each other is of the utmost importance.

Our primary STL link was a 950 MHz composite STL, with a 23 GHz system for a backhaul for our Marti receiver as well as remote control telemetry. The 23 GHz system was starting to fail, so we really needed to replace it with a system that had capacity for our current needs as well as available bandwidth for the HD Radio equipment. We also wanted enough extra capacity for any future needs.

LICENSED VS. UNLICENSED FREQUENCIES

Because reliability is always the main concern, when we started shopping for a replacement system, we wanted a licensed system. We have all heard of horror stories about an unlicensed STL system working just fine for years, then suddenly another station starts to use a similar system and you now have interference where you never did before. Since it is unlicensed, you have to take your chances.

Most options on the market for licensed systems were very expensive. Then I learned that Gregg Garcia, from Lotus Communications here in Tucson, recently employed a new system to one of his transmitter sites outside of Tucson. He put me in contact with Paul Davis of NuLogic, a dealer for Orthogon Systems located in Tempe, Arizona. As I had never heard of either company, of course I was a bit skeptical at first.

The system that Paul was discussing with me was the Orthogon Systems Gemini. It is an Ethernet Bridge that is capable of 45 Mbps. It is however an unlicensed system working in the 5.8 GHz band. I was even more skeptical after hearing that.

IMPRESSIVE STATS

All that was laid to rest when Paul sent me a screen shot of his computer that showed a weather radar snapshot of Tucson and the statistics page of a link between Tucson and Vail, Arizona.

Tucson experiences a very active monsoon season. The screenshot was during one of the heaviest monsoons of the season. I was amazed at one statistic. One statistic: the "Wireless Link Availability" entry was steady at 100.0000%.

After seeing those statistics, I asked Paul Davis for a system quote.

Attributes	Value	Units
Wireless Good Tx Packets	489,388 (+489,858)	
Wireless Good Rx Packets	5,253 (+5,251)	
Packets To Internal Stack	60,522 (+58,150)	
Packets From Internal Stack	9,682 (+5,501)	
Ethernet Rx Fragments	0 (+0)	
L2 Source Mac Address Conflicts	0 (+0)	
Arq Retransmitted Rx Packets	1 (+1)	
Transmit Data Rate	19.71, 19.58, 15.2, 19.71	Mbps
Receive Data Rate	19.71, 19.69, 16.90, 19.71	Mbps
Aggregate Data Rate	39.42, 39.27, 33.80, 39.42	Mbps
Transmit Modulation Mode	64QAM 7/8 (19.71 Mbps)	
Receive Modulation Mode	64QAM 7/8 (19.71 Mbps)	
Signal Strength Ratio	-1.5, -1.8, -2.3, -1.8	dB
Wireless Link Availability	100.0000	%
Code Word Error Ratio	7.467e-4	
Phy Code Word Error Counter	651,210 (+651,207)	
Elapsed Time Indicator	1 Day 00:23:20	
Statistics Page Refresh Period	3600	Seconds

Service stats for a Tucson to Vail link.

SYSTEM SPEC AND INSTALL

As part of NuLogic's service, they provided me with a site survey and recommended a complete end to end system. They left nothing out. The site survey noted that the path noise floor was considered dirty. That was probably putting it nicely.

The Gemini system he specified would use 2.5 foot external dishes with radoms. Tucson does not get snow but it is normally very windy, so the radoms help out with wind loading. You could not ask for an easier system to install. Installation at the studio end took about one hour.

A quick installation and we were ready to go.

The studio installation consisted of mounting the dish along with the radios on the tower and running a CAT5 cable into the building. NuLogic provided everything to do this including the lightning surge suppressor for the coax as well as the shielded CAT5 cable.

You will need four surge suppressors for the coax connections and four surge suppressors for the CAT5. One of the CAT5 surge suppressors will be mounted on the tower near the radio, the other one will be mounted near the ground buss in your rack room. The only other equipment is an Outdoor Data Unit (ODU) for each end. I mounted the Indoor Data Unit (IDU) in my equipment rack near a 10/100 switch. (The IDU's power cord should be plugged into a UPS.)

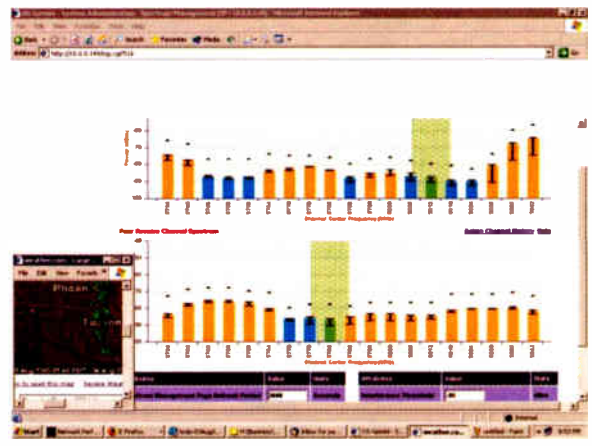
After that we headed up to the transmitter site. That side did not take much longer; aligning the system was incredibly easy.

The system starts up in maintenance mode. That consists of an audible tone emitting from the radios which are mounted right behind the dish. The person on each end of the link simply takes turns moving the dish from side to side and then up and down while listening for a higher pitch tone. We all know how cumbersome it can be to have a spectrum analyzer on the receiver end of the link looking for the highest peak while talking to the tower crew on a two-way radio. Usually they end up just missing the peak and it seems to take forever to get back to it.

THE WAY IT WORKS

The Orthogon Systems Gemini system is unique for an unlicensed system. It is vertically and horizontally polarized. The Gemini uses part of the bandwidth for system management.

The management system constantly monitors the entire spectrum to find the highest throughput available and moves the data around to achieve that goal. It uses Multi-Beam Space Time coding which transmits data on multiple beams to increase the probability of success. It also uses Intelligent Orthogonal Frequency Division Multiplexing (I-OFDM) which involves transmitting data on multiple frequencies.



System display of receive (top) and transmit frequencies.

This system results in higher channel bandwidth and greater resistance to interference and signal fading. Depending on the design of the system, the Orthogon Systems units are capable of transmitting distances up to 124 miles with no additional hops.

WHEN MULTIPATH IS GOOD

They can actually use multipath to advantage. If you do not have direct line of site, do not worry. Paul Davis from NuLogic set up a demonstration system that placed the radios on either side of a brick and steel building. It achieved maximum throughput.

With this system, we were able to send our HD audio, analog audio, Marti backhaul, telemetry, and LAN – as well as having room for much more. Because there are no Telco facilities and cell coverage is very spotty at the transmitter site, we plan on adding a VoIP connection to our PBX system, so we have a phone in our transmitter room.

It was very helpful to have the Gemini system installed ahead of the rest of the HD gear. How many times have you been out at the transmitter site only to remember you needed a manual, email or a phone number? Or worse yet, something happened at the studio that you know you could fix if you could simply VNC into the studio.

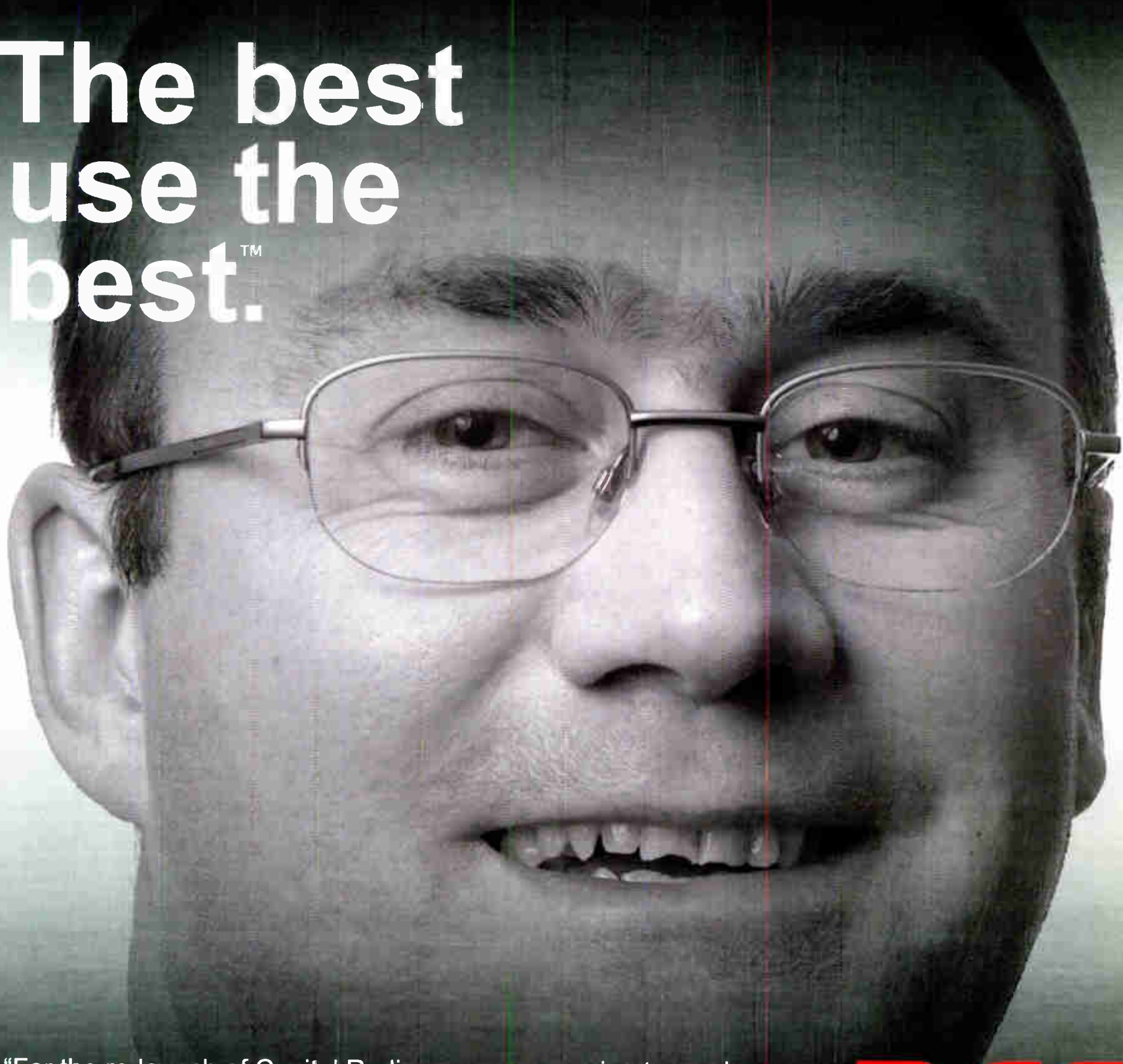
With the Gemini system, we now have that capability.

Mark Simpson is the Director of Engineering for Citadel Radio in Tucson, Arizona. You can reach Mark at mark.simpson@citcomm.com

MASTER CONTROL™

The On-Air Digital Studio

The best use the best.™



"For the re-launch of Capital Radio, our programming team chose RCS Master Control™ for its user interface, the flexibility of the Living Log® feature and integration with Selector®, while RCS UK accomplished installation and staff training within a tight deadline. We are delighted with the ongoing technical support from the RCS team."

John Sullivan
Head of London Technology
GCap Media plc.

RCS Sound Software®
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IT Guide

by Dana Puopolo

Voice Over IP

Getting the Right Service

In the April issue of ***Radio Guide****, Dana covered some of the fundamental aspects of Voice over Internet Protocol (VoIP) telephony. This month, he shares some information and tips on some commercial VoIP clients, plus some that you can configure yourself.*

The marketplace is scattered with VoP clients, some well received, others hardly known. We will survey the providers I have used at one time or another. I recommend them all, but we start with the two biggest ones: Vonage and Skype.

VONAGE

With over a million users, Vonage (www.vonage.com) is the most well-known and the 700-pound gorilla of the Session Initiation Protocol (SIP) VoIP providers. You can find their ads on every TV channel and their VoIP kits at Radio Shack, Staples and many other stores. Vonage usually even rebates you the cost of the Analog Telephone Adaptor (ATA).

Hook up is a breeze: you simply plug the pre-configured Linksys ATA unit into AC power and a port on your router and plug in a telephone. Then you log onto the Vonage web site or call their 800 number to set up your account. With a good Internet connection (we went over this last month) call quality is as good as with Plain Old Telephone Service (POTS), mainly because the POTS end of the call is the limiting factor.

Vonage offers two home plans; both feature unlimited incoming calls and outgoing calls to other Vonage users. The cheaper plan gives you 500 outgoing minutes per month of USA/Canada calling; the more expensive claims unlimited outgoing calling. They also offer business service, virtual numbers and a bunch of other features. International calling with Vonage is also quite reasonable.

You get to pick your incoming number from thousands of communities in the USA, Canada or the UK. Vonage will even port your existing POTS number over to VOIP if you wish.

SKYPE

A few years ago, Skype (www.skype.com) burst on the scene and Internet telephony has never been the same! It has over four million users as of this writing. Recently, Skype was sold to ebay for a couple of billion dollars.

Skype was developed by the same people who created Kazaa, the file sharing program, and under its hood it is much like Kazaa. Rather then use the SIP protocol, Skype uses a peer-to-peer protocol where certain computers become supernodes and are used for signaling. (Kazaa works this way, too.)

Skype's big advantage is that it works well over dial-up Internet connections, whereas SIP requires broadband ones. Skype also requires a computer for it to work, though many users now plug USB telephones into their computers rather then the ubiquitous headset/mike.

There is even a cordless Skype phone available. Radio Shack sells a Skype USB telephone. Rumor has it that there will soon be a stand alone Skype telephone. Skype's program is free and there is no cost to use it to call other Skype users. They also offer a connection to the PTSN (Public Switched Telephone Network; aka POTS) for a few cents a minute.

Skype's audio quality is impressive: 30 Hz to 5 kHz is common. I even know of radio stations that use Skype as a poor man's Comrex for remote broadcasts. One problem with Skype is latency. Depending on the supernode to which you connect the latency can run the gamut from practically nothing to unusable. I know of people who use Skype daily and their user interface is very user friendly.

SUNROCKET

You may have already received a direct mail piece for Sunrocket (www.sunrocket.com), which is quickly becoming a major player in VoIP due to their attractive pricing structure.

Their pricing is unique in that they offer a yearly price of $199.95 for unlimited USA and Canada calling. They also offer a free vanity number which is a second incoming number, similar to the multiple ring service that the phone companies offer. Like their main number, you can choose where this vanity number is located.

Sunrocket also has attractive international rates and gives subscribers a three dollar credit towards international calling each month. Sunrocket's one problem has been their quick growth has caused several service interruptions that have lasted up to half a day. Sunrocket mails you your ATA adapter pre-configured; all you do is hook it up and you are up and running.

PACKET 8

Packet 8 (www.packet8.com) was one of the biggest VoIP providers and still has one of the lowest monthly prices for unlimited service ($19.95/month for unlimited USA/Canada calling). However, until recently Packet 8 lagged behind in offering features, costing them the lead to Vonage; they are now trying to catch up.

Unlike the other major providers that use the G.711 codec, Packet 8 uses g.729, a lower bandwidth codec (32 kbps vs 80 kbps). This allows Packet 8 to work well on slower Internet connections and even some dial-up ones. Unfortunately, it also makes their call quality sound a lot like a cell phone.

Packet 8 sells their adapters at electronics stores like Fry's and Best Buy; they are also available on-line by mail.

VIATALK

Finally, Viatalk is a newer (and one of the better) VoIP services out there. They offer many pricing plans including a $199.95 unlimited yearly plan.

In addition to excellent quality, they offer one interesting feature called call record. You can push a code on your touchtone pad and the conversation gets recorded.

One unique thing about Viatalk is that while the other VoIP providers above all lock their ATA units, Viatalk does not. This means that you can use the second line on your ATA unit with another provider.

(Continued on Page 37)

IT Guide

by Dana Puopolo

Continued from Page 36

"ROLL YOUR OWN VOIP"

The providers above are all "plug and play" in that anyone can use them easily. Now we will look at some more esoteric providers.

Most of these providers will work on two types of telephones: hardware telephones and softphones. A hardware phone is literally that – a telephone connected to an ATA unit. A softphone is a program that runs on your PC similar to Skype. The difference is that these softphones are all SIP compliant.

FREE WORLD DIALUP

Free World Dialup (FWD – www.freeworlddialup.com) is the brainchild of Jeff Pulver, one of the founders of Vonage. Jeff is an amateur radio operator and envisioned a VoIP network that was completely free. To accomplish this he created Free World Dialup; it now has over 800,000 users worldwide.

Using FWD is simple: you simply go to the FWD webpage and click on the "get started" button. Once you have set up your account and downloaded your softphone (or configured your hardware one) you are done.

FWD is a closed system in that you can not call POTS numbers (except toll free) with it. Voice quality is superb.

There are POTS incoming numbers available for FWD however for free. One of them is IpKall (www.ipkall.com) which offers a free Seattle area incoming POTS number for your FWD. There are also portals where you can call a local number, then the FWD number you want when prompted. These are available all over the world.

FWD has become hugely popular with college students because they – not only can call each other via FWD – can also receive POTS calls with the methods above. Combine this with a cheap prepaid phone card (some as cheap as a penny per minute) for outgoing calls and you have a dirt cheap dorm-room telephone.

FWD also has conference bridges, caller ID and a lot of other nice features. Finally, Jeff usually opens up the FWD network for free USA/Canada/Europe POTS calling on holiday weekends. Free calls? How can you lose? My FWD number is 82850; give me a call sometime.

SIPPHONE/GIZMO PROJECT

Both of these are the brainchild of Michael Robertson, founder of MP3.com and later Lindows/Linspire. They are similar in that they both offer softphone and hardware telephone access.

They both offer free calls to other users and cheap prepaid POTS calls. You can also buy an incoming number for a nominal monthly charge. IpKall numbers can also be mapped to SIP/Gizmo numbers, so you can also have a free incoming POTS number.

My favorite is Gizmo Project because their USA rates are only a penny per minute. I have radio station clients that use Gizmo with ATA units for all their dial-9 outbound calling on their phone systems. One knocked their long distance bill down by over 90%! Voice quality is excellent; they even use the VoIP calls on the air for guest calls.

STANAPHONE

Stanaphone is a VoIP company offering free New York area incoming POTS numbers. All you have to do is sign up and one is yours – free! Prepaid USA outgoing calls are a reasonable 1.6 cents a minute. They also offer cheap international rates.

VOIPBLASTER, ET AL

I have saved the best for last this month – almost free unlimited USA/Canada and international calling. I say almost free because you have to put ten euros on deposit to activate this.

These sites are owned by the Finarea company from Germany and Italy. They work with both soft and hardware telephones. Not all countries are free although rates are cheap and you can draw down on your 10 euro deposit.

Different sites have calling to different countries, so use the one that offers free calling to the countries you want. One slight complexity: you are using a European connection so you must use the country code 001 to call back into the United States and Canada (001-(area code)-(number).

The quality of these services is pretty good, but not perfect. Also they are strictly one way services; no USA incoming number is available (though European numbers are available for a monthly charge).

Each of these sites features a different set of countries for the free calling. Check out each site until you find one that features the countries of your interest: www.voipbuster.com; www.internetcalls.com/en/index.html; www.voipcheap.co.uk/en/index.html; www.sipdiscount.com; www.voipstunt.com; and www.netappel.fr/fr/index.html (French site)

I personally use voipstunt, which offers free calling to over three dozen countries, including the US, most of western Europe, Japan, China, Taiwan, and New Zealand. Other sites offer free calls to Mexico, The Russian Federation, etc. Find the one that meets your needs and have fun!

WHERE TO GET PHONES

Finally, here are some sources for softphones and ATA units:

Softphones: X-Lite (My favorite free softphone; available for PC/MAC/Linux)

http://www.xten.com/index.php?menu=X-Series Also, another good softphone is the ExpressTalk softphone (http://www.nch.com.au/talk/).

ATA Units: My favorite units are made by Sipura, though the Linksys PAP2-NA is similar to the Sipura 2002. Try www.store.voxilla.com; www.voiphardware.com; www.voipsupply.com; or www.telephonyware.com

When buying an ATA unit make sure it is not locked to a particular provider. These units are usually available on ebay. You can also find them by using Froogle (froogle.google.com)

Next time we will show you how to configure these phones and make some calls.

Dana Puopolo is a contract engineer based in Providence, RI. Or is he? As with email, you cannot always tell where someone is with VoIP! Speaking of email, Dana is at dpuopolo@usa.net

The Worst I've Ever Seen

A Visual Display of the Good, the Bad, and the Plain Hard-to-Believe

What's That Buzz?

During the year, animals of all sorts seek out lodging any time they can get into your facilities. That is why you should make sure transmitter sites are regularly sprayed and sealed as much as possible.

But that does not help solve the problem with gear normally exposed to the elements. Antennas, ATUs, and other "inviting structures" also require regular attention – or you may attract uninvited guests.

Oh oh ... tread carefully!

SURPRISING SIGHT

Mike Pappas of KUVO recalls, "We were doing our annual fall dish inspection and what appeared to our wondering eyes? A wasp's nest!"

Mike continues: "Now I don't know about you, but I am not a big wasp fan. Something to do with being allergic to those bad boys makes me a wee bit antsy around them. So I get out a can of Hot Shot Wasp killer and get to it."

PROBLEM CLEARED

"Hot Shot Wasp Killer is the only product that I have used that will drop wasps right out of the air," Pappas says. "Its stream shoots 20 feet giving me a lot of "stand off" protection from the flying buggers and when I hit that nest with it they dropped right out of the air; it sounded like hail.

"Interestingly, after playing WMD chemical warfare with the wasps and removing the nest from the feed horn, we took a look at the Eb/No numbers on the demods and we didn't see any change. I guess they hadn't grown a large enough colony to block the feed horn, but thanks to our inspection program, they picked the wrong dish in which to build their nest."

Mike Pappas is Chief Engineer of KUVO in Denver, CO. He can be contacted at mpappas@qwest.net

Tech Tip

by John Stortz

Recycling AC Water

What do you do for water at a transmitter site where there is none available? That is, aside from carting it out to the site in jugs or bottles.

This is a problem that comes to mind anytime you get your hands dirty while at inside a transmitter or other mechanical device or merely want to do some cleaning at the site.

A WATER SOURCE AT HAND

Well, the air conditioners at the WKES transmitter site drip out about 55 *gallons* of water in a week. With a $16 plastic barrel and a few PVC pipe fittings, each of our two air conditioners can store about 55 gallons of water, suitable for washing stuff.

Adding an occasional cup of chlorine bleach helps keep the nasties from growing in the tank.

Right from the AC to the storage barrel.

RECYCLED WATER DOES THE JOB

To wash hands, I just insert both ends of a short garden hose into the tank, and then quickly remove one end. The siphoned water begins to flow.

With a small portable electric pump, it is easy to wash bugs and dirt out of the air conditioner coils, for example.

Plenty of water for hand washing, or small cleaning chores.

John Stortz is Chief Engineer of WKES in Lakeland, FL. Contact John at KA4FLX@aol.com

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Radio War Stories

by Phil Alexander, CSRE, AMD

Adventures in the AM field

(Confessions of an AMD in the Trenches)

Part 5 – Back to the Towers and Phasor

While taking a break from fixing a directional antenna, Phil has uncovered a "junk pile" in the station's back room and begun digging for treasure. Will he find something or just get lost in memories? Meanwhile, these guys still have a directional array to set right.

Amid clouds of dust, we sorted through the pile of neglected ancient equipment that had accumulated over the years in an unused back room of the station. It appeared to have been the CE's office in the days when directional transmitters were staffed by live engineers whenever they were on the air.

In fact, it was as though we had stepped into a fifty-year-old time warp.

MODERN ARCHEOLOGY

The equipment was from the '50's, '60's and '70's. Right behind an old PowerSide from the days of AM stereo, there it was: the case of a General Radio GR-916A RF bridge and, beside it, a General Radio bridge oscillator.

The case was very moldy. The cover lay off to one side. The manual was gone, probably turned to dusty mold, and the resistance dial was too filthy to read. One of the cables had rotted to mush with only the shield holding it together.

I was unable to guess if some intensive TLC would be able to salvage it without taking it apart and examining the capacitors for signs of corrosion of the aluminum.

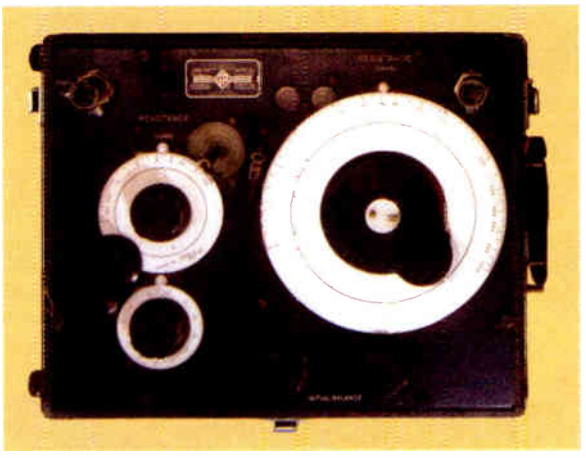
I suggested that the chief engineer might want to clean it with a vacuum cleaner and put it in a warm, dry location for a few weeks. He liked that idea so much there was no stopping him. He grabbed a vacuum and whisked away some of the dirt and set the old bridge on a bench. He said he had no idea what an old-fashioned "cold" RF bridge could do until he watched us use the GR-1606.

AM Memories – What is this junk?

SAME TIME, SAME PLACE

After a short twenty minutes of exploring the station's cache of antique equipment and explaining its former use to the chief engineer, it was time to get back to work.

I called Mr. Carpet and told him I was happy with the results on the day pattern, but we needed to do the same thing that night for the nighttime array. However, the additional tower of the nighttime array would complicate our task and make the nighttime pattern more difficult to realign.



Not exactly new, but it may clean up.

I asked him if he would rather give up two hours between 10:00 PM and midnight or an hour off each end of the schedule. After some negotiation and explanation, he agreed to sign off at 11:05, but said 5:50 to 6:00 AM was sponsored. He asked if we could be done by 5:45 AM and I agreed we would do our best.

SAME PROGRAM, BUT DIFFERENT TUNEUP

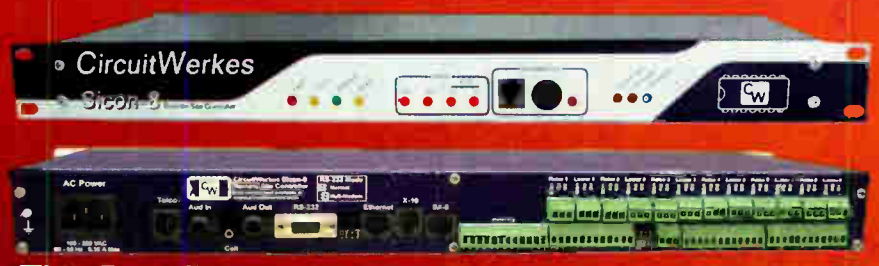
At about 11:00 AM we called it a day and agreed to start again at 10:30 that night.

Our work that night was very much the same as the night before, just a little more complex. We broke each of the nighttime networks apart at the center, set and measured the lumped constant reactances of each.

Then, after reassembly, we connected a precision non-inductive resistor between ground and network input and measured the output for the tower's operating impedance with the sign of reactance reversed.

(Continued on Page 42)

The New Sicon-8 Voice Remote Control



The CircuitWerkes Sicon-8 Voice Remote Control

- Use our pre-recorded voice responses or record your own!
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- No accessories necessary to control your site right out of the box.
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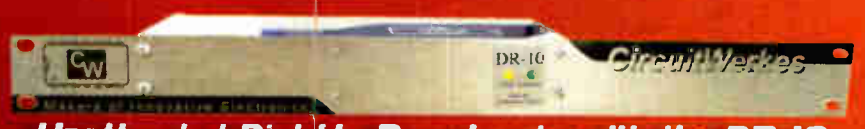

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Radio War Stories

by Phil Alexander

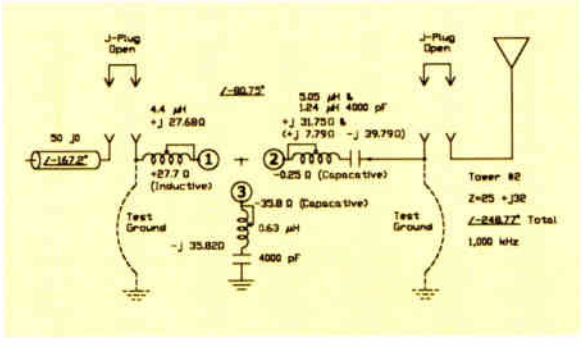
Adventures in the AM Field

Continued from Page 40

The CE was puzzled by the sign reversal and asked why we did that.

PASSING THROUGH ZERO

"First," I said, "we want to transform the resistive component of the impedance." He nodded because he understood this part, so I continued, "Then we need to cancel the reactive component, so if we adjust for the same reactance with the opposite sign ..."

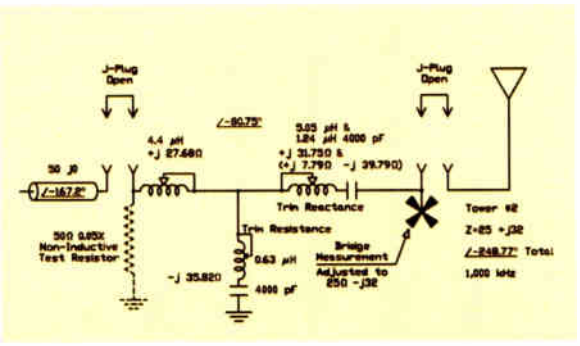


Measuring each branch.

"... the two cancel and you have a pure resistance," he chimed in. "Oh, I see. Now, I get it."

"Right, that way the output of the matching section of the network "sees" the resistive part of the tower's base operating impedance. But, remember that we also set the component values so we would have the same phase lag as the original design," I said.

I told him this was an important point, because simply adjusting for the correct impedance match alone is not enough. The coupling network is also an integral part of the phasing system and often has a much wider range of possible settings than the phasor.



Fine tuning the network.

REASONING OUT THE PROBLEMS

The CE thought for a second and said the networks must have changed quite a bit over the years or the controls on the phasor would not have been so far off when we fired it up the night before.

I told him it was probably a case of changes being made when capacitors were replaced and the phase controls likely ran out of range over many years. In other words, not that the phase delays in the couplers changed, but more a case of them being changed in the process of quick and dirty maintenance in times past.

"Then," he observed, "it really *is* important to keep records of all the individual reactance values of the network branches?"

I winked and said, "You got it." And, I meant that. It was clear this FM fellow was picking up AM RF principles very quickly.

His observation points out one of the most important maintenance tools of anyone operating a directional array: the maintenance log where every measurement and every component change, even every coil strap movement is recorded for later reference.

PRE-POWER CHECKS

We finished the last coupling network about 4:30 AM and returned to the transmitter building where I suggested we turn the power down as low as we could and start checking the phasor adjustments.

I wanted to get the pattern near correct adjustment before feeding it full power because I had noticed very significant changes in the coil straps as we worked our way through the coupling networks. Also, I expected the nighttime pattern would be a bit more interactive than the day array.

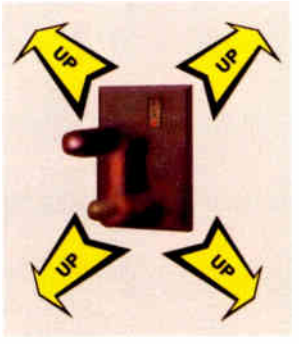
It was.

This time, not only did number three power work "backward," both the phase and power adjustments for the number four tower operated in reverse.

But, it really did not matter. One way was as good as the other if you knew which way to turn the knob, and reconnecting the phasor so all the cranks would work in an intuitive way was a nicety that time did not permit.

GETTING THE "FEEL"

After about twenty minutes the phase monitor reported values near FCC tolerance so we increased to full night power and continued making smaller and smaller adjustments. As the operation neared the exact licensed values I started making single adjustments and logging each one.



Which way is up may not be easy to determine.

When I had established how the controls were working, I asked the local chief engineer if he would like to give it a try and finish the job.

There was quite a bit of interaction between controls, especially between phase and power for each tower, but the major effect of each adjustment was more or less as

(Continued on Page 44)

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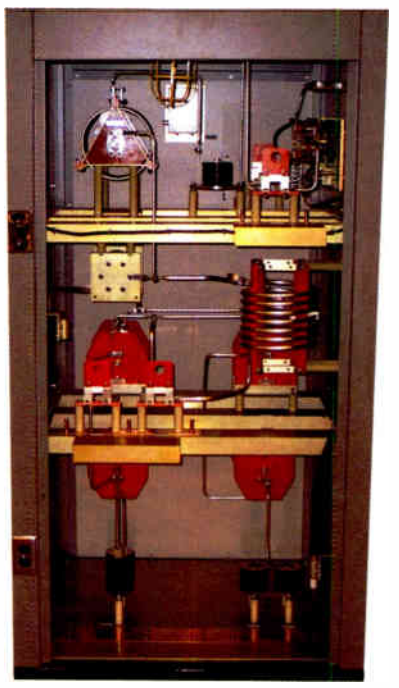

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Radio War Stories

by Phil Alexander

Adventures in the AM Field

Continued from Page 42

indicated above the control cranks, so I said, "Well gentlemen, if nothing else, it looks like we have taught the phasor something about reading its labels."

PUTTING IT BACK ON LINE

In the air monitor I could hear the announcer starting programming, so I said, "Let's watch it for a few minutes and see if it drifts, then go find some breakfast."

After about twenty minutes the operation appeared to be stable, so we headed for a nearby diner that opened early. For some reason, the coffee tasted better that morning, perhaps because I knew we had the station operating according to design.

Or, so we thought.

MONITOR POINT DISAPPOINTMENT

After breakfast we toured the monitor points and found one nighttime point remained at its limit, the rest were out. That was discouraging to say the least, considering all we had accomplished.

Next, we drove along a route that would take us across the various radials, doing a brief survey of the nulls in the critical area of the pattern, just as we had previously done with the day pattern.

It appeared one of them was not quite on its correct azimuth, so we checked the other side of the pattern and found essentially the same result.

This did not make sense. Either something in the environment, perhaps a tall cell tower, a water tower, or some other structure was affecting the night pattern, or else some of our readings were not trustworthy.

When this happens, where to start is always the question. The answer is always the same. Verify everything, then check it again, and then check it one more time. Usually, the problem is something simple, but even simple problems can be obscure until they are found. We had enough information to know the answer was not obvious.

We found the null about 5° too far west.

A little disheartened, we returned to the transmitter to go over the details again.

OVERCOMING THE SAMPLING PROBLEM

One of the things that made this system difficult was the phase monitor system.

I knew the phase monitor had been calibrated at the factory immediately before we began the array alignment and the toroid coils were factory fresh with certificates to match. The monitor said the correct currents and phases were going to the towers, but the field results disagreed.

Interpretation of the phase monitor system readings made little sense because this system was installed with unequal length sampling lines. For that reason, I had created a little spreadsheet to tell us the true phases at the towers based on the indicated phases on the monitor.

Unequal line length sampling systems are the most difficult to understand. However, understanding every phase delay in every circuit is necessary for troubleshooting, and nothing will be obvious until the differential delays and their phase monitor indications are completely clear.

I looked at the pattern and then at the true phase indications. I wished I was back in the office where I could model the pattern and see the theoretical effects of changes, but that was wishful thinking. We needed an answer – and we needed it now.

In these systems, I have always found making a complete diagram of the transmission system, *including the phase monitoring instrumentation*, becomes an invaluable analysis tool. In the old days, many trees were sacrificed for making these notes, but now a modern laptop and a spreadsheet program now really makes understanding phases clear and simple.

AN INSPIRED GUESS?

It seemed to me that the number four tower phase might be the problem. The nighttime-only use of this tower made it even more suspect. I looked at the spreadsheet and added an additional five degrees delay to the sample line, then adjusted the phasor delay in the spreadsheet to give the licensed monitor indications.

I remembered an old adage from a faraway time: "The pattern is what you measure in the field, not what it appears to be on the station's instruments. Always trust the field readings because they are reality, even when they are wrong."

"OK," I told the CE, "let's try to prove this one way or another. Put it in the nighttime pattern and take five degrees lag out, er, what I mean is make tower number four read five more degrees negative phase. I'll explain that later if it works."

The station now is working OK during the day, but not at night. It seems yet another hidden problem awaits Phil's discovery. It also seems he thinks he finally knows the answer. But, does he? Maybe next month he will finally unravel this puzzle and we will learn why the station has had so many problems for so many years. Could there be a simple solution hidden in the map of field readings?

Phil Alexander is a contract engineer who loves to diagnose and fix in RF transmission and AM directional station problems. Based in Indianapolis, IN, Phil can be contacted at dynotherm@earthlink.net

Tool Guide

Test, Tools, Tips and Applications

Scratch-Less Discs

Until now, disc makers have concentrated their efforts on packing more data onto the various discs as they introduced the new formats – CD-R, CD-RW, and DVD.

Now a Colorado company has rolled out an invention called the Scratch-Less® Disc aimed at preventing a treasured disc from ending up as a coaster. The disc is made with a series of 20 tiny bumps around the edge that raise it off a flat surface just enough to shield the important underside.

BUMPS ARE GOOD

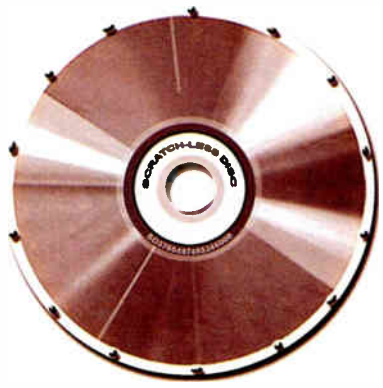
The bumps or Aero-Bumps™ around its edge elevate the data surface creating a Safety-Gap™. This gap is the disc's primary protection against scratches and scuffs by preventing contact. Simply put, if nothing comes into contact with a disc's data surface it will not get scratched.

In addition to the bumps and gap, all Scratch-Less Discs are further protected/improved by adding a scratch resistant polymer coating (Invisible-Safety-Shield™); the polymer was co-developed by General Electric. This coating creates a surface hardness similar to that of a piece of glass.

The coating transforms the surface in to a non-stick surface similar to a non-stick frying pan. This non-stick surface allows the user to safely and easily clean the disc without fear of damaging it. These combined bumps, gaps, and non-stick technologies result in not only "The world's safest optical disc," but a disc that is safe to clean and easy to handle.

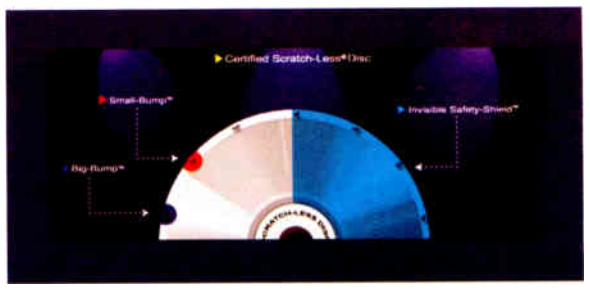
AVAILABLE NOW

The blank Scratch-Less discs have been available on store shelves in the US and 8 other countries since January. In addition to selling the blank discs, Scratch-Less Disc Industries has begun licensing its technology to music and entertainment companies that sell or use pre-recorded CDs and DVDs.



The current generation of Scratch-Less Discs are physically compatible with over 99% of existing optical Recording/Playback equipment. The goal is to achieve 100% backward compatibility as they improve their products.

"Since our debut at this year's CES show in Las Vegas, we have had nothing but positive reviews from the press and public," said Todd Kuchman, CEO. "We are proud to announce that we are in the final stages of producing both the world's first pre-recorded music CD-ROM and a DVD-ROM to be released on a Scratch-Less Disc."



Scratch-Less Discs special features reduce surface damage.

ADDITIONAL SOURCES

Kuchman hopes to encourage rental shops, retailers, and radio stations to ask their suppliers and or content owners to offer their digital content on discs protected by Scratch-Less technology."

Their goal is to raise awareness that the Scratch-Less Disc is a proven solution in both the pre-recorded and blank formats to the age-old problem of damaged discs.

Kuchman says his company is driven by a simple over-riding concept, summed up in a single phrase: "Because your valuable information is worth it!" For details look to: www.scratchlessdisc.com or call 1-720-344-9443

www.scratchlessdisc.com

SCRATCH-LESS™ DISC
CD - DVD & BEYOND

Consultant Guide

Radio Consulting Engineers

Gear Guide

Test Equipment, Monitors, Receivers, and Remote Control

Anritsu

MS2721A Spectrum Master

www.anritsu.com • 800-ANRITSU

The Anritsu MS2721A Spectrum Master is an advanced ultra-portable spectrum analyzer covering 100 kHz to 7.1 GHz. It features unparalleled performance and size at a modest price. It is excellent for AM and FM broadcast measurements because the greater than 85 dB dynamic range lets you make NRSC measurements on 50 kW stations without the need for an external carrier notch filter.

Unprecedented in handheld battery powered spectrum analyzers, the sensitivity and dynamic range of the MS2721A delivers the ability to measure very low level signals in the presence of huge signals. Coupled with many resolution and video bandwidth choices, you can configure the MS2721A to meet your most challenging measurement needs, whether you are searching for an interfering signal or performing NRSC measurements. You can upload your antenna calibration data into the instrument for calibrated field strength measurements.

ATI - Day Sequerra

M2.0 Modulation Monitor

www.daysequerra.com • 856-719-9900

DaySequerra's Model M2.0 Modulation Monitor with optional remote control capabilities is a powerful off-air monitoring solution for AM/FM analog and HD Radio™ broadcasts. Designed to meet the rigorous demands of the professional broadcast market, the M2.0 provides display of program specific data (PSD) for MPS and SPS Multicast signals, bright, accurate bargraph metering of HD Radio and analog programming, and an HD Radio digital-to-analog program time-alignment monitor.

The M2.1 option adds FM analog SCA injection level monitoring to the M2.0. The M2.2 option includes a proprietary PC-based application that, along with the network interface, provides remote control and robust alarm monitoring. The M2.0 along with options M2.1 and M2.2 have been certified by iBiquity and are now shipping to broadcasters.

Audemat-Aztec

GOLDENEAGLE HD Receiver

www.audemat-aztec.com • 305-249-3110

GOLDENEAGLE HD is a HD receiver designed as a powerful off air monitoring solution with optional remote control capabilities.

The GOLDENEAGLE HD can be installed at the studio, at the transmitter site or in any reception area. GOLDENEAGLE HD monitors automatically, in real time, the quality and continuity of several FM or/and AM and HD programs and notifies the relevant person of any problem by sending an alarm. GOLDENEAGLE HD offers innovative functions such as a spectrum analyzer, audio streaming and recording, automatic scanning, measurement analysis and storage as well as remote control.

Three versions are available: GOLDENEAGLE HD FM: includes 1 HD and 1 FM analog receiver. GOLDENEAGLE HD AM: includes 1 HD and 1 AM analog receiver. GOLDENEAGLE HD FM/AM: includes 1 HD. 1 FM analog and 1 AM analog receiver.

Audio Precision

2700 Series Audio Analyzer

www.audioprecision.com • 503-627-7350

Audio Precision has been designing and marketing audio test instruments for over two decades, helping customers worldwide design and calibrate audio products that meet or exceed the highest performance standards.

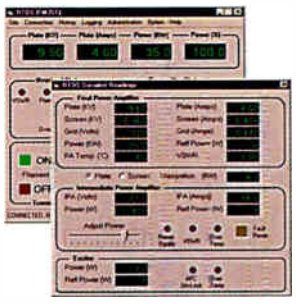
With comprehensive PC control, unmatched programmability, and the highest precision and sensitivity of any audio analyzer made, the 2700 Series has established itself as the benchmark for audio test and measurement. With four models to test analog signals, digital signals or both, there is a 2700 Series audio analyzer to match the most demanding audio engineering challenges.

The ATS-2 is a general-purpose instrument well suited to the design lab, broadcast facility or production line – anywhere high-precision, feature-rich audio test and measurement is required. Full audio analysis capabilities include sweeps, single-point measurements, spectrum analysis, multitone analysis and discrete harmonic analysis.

Broadcast Electronics

Remote Transmitter Diagnostic System (RTDS)

www.bdcast.com • 217-224-9600



Broadcast Electronics Remote Transmitter Diagnostic System (RTDS) offers unprecedented flexibility and access when monitoring select BE transmitter models. By providing useful diagnostic information, RTDS allows you to conveniently monitor your transmitters' performance without making a trip to a remote transmission facility. Access is via IP or modem connection.

The primary RTDS screen depicts an image of the transmitter front to easily check numerous parameters, such as power output, operating status and operating efficiency. All readings can be recorded, logged and printed. Able to run on a separate power supply, the RTDS can continue to operate despite a transmitter power supply failure.

The RTDS is sold as an option, installed at the factory or in the field. This system is currently compatible with all Broadcast Electronics' T Series and S Series transmitters and select FMi Series transmitters will be compatible shortly.

Belar

FMHD-1 HD Radio Monitor

www.belar.com • 610-687-5550

The Belar FMHD-1 is a state of the art HD Radio™ monitor designed to support the needs of today's broadcaster well into the future. The monitor decodes the HD Radio signal and analog FM signal simultaneously displaying HD Radio status, data, time alignment, and configuration information, as well as audio metering and RF/audio spectrums. The two rack high unit with 640 x 240 color LCD display and rotary encoder provide a detailed clean and simple user interface.

The Belar FMHD-1 includes these dynamic industry leading features; Frequency Agile Antenna and 2 High Level Inputs, RF Spectral Mask Analysis, 2 High Quality Analog FM Composite Outputs, 8 Analog Audio Outputs, 3 AES/EBU Outputs, HD Status, SIS, and PAD Data, Time Alignment Analysis, 4 Assignable Alarm Relays, RJ-45 Ethernet Interface, Optional Simultaneous Decoding of HD Main and Supplemental Programs

Gear Guide

Test Equipment, Monitors, Receivers, and Remote Control

Broadcast Tools

WVRC-8 Remote Control

www.broadcasttools.com • 360-854-9559

The WVRC-8 provides a cost-effective, one rack-unit solution for WEB based and/or recordable voice response dial-up transmitter site control. The WVRC-8 was designed from a user point of view, so all of the basic functionality you need to control your site equipment is included.

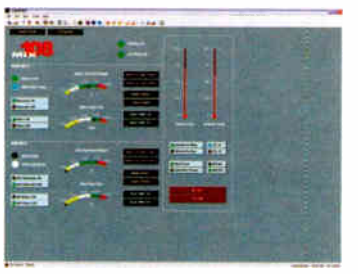
The WVRC-8 is equipped with a browser based function program scheduler and alarm logger, while the user may select from four different sounds to play when an out of tolerance alarm is generated. The WVRC-8 is equipped with eight high-resolution telemetry channels, while each of the eight optically isolated status channels may be configured for wet or dry input monitoring.

The eight control channels are equipped with relays for the raise/on and lower/off functions. The WVRC-8 is supplied with spoken words and phases in English, while the user is free to record words and phases in their own language.

Burk

ARC-16 AutoPilot® Software

www.burk.com • 978-486-0086



AutoPilot® 3 software for the ARC-16 has the control, monitoring and logging tools you need to manage broadcast facilities of all sizes. A powerful resource for unattended operation, AutoPilot gives you data logging, email alarm notification, automatic control, and Custom Views with drill-down display capability to transform the way you manage your remote sites.

Whether you are responsible for one site or many, AutoPilot minimizes downtime and saves trips to the transmitter while consolidating workflow to save you time.

Custom Views allow you to completely customize the monitoring and control interface to suit the demands of your operation. Now you can place meters, status indicators and controls anywhere on the screen, and you can show data and control equipment at multiple sites on the same display. Maps are included for creating geographic views of your operation with drilldown alarm management.

Chris Scott & Associates

LP-3 Standard H-field Antenna

www.scott-inc.com • 270-781-5301

The LP-3 standard H-field antenna is specifically designed for emission measurement of AM broadcast stations using a spectrum analyzer or other calibrated receiver. The electrostatic shielding provides unmatched E-field rejection, reducing electrical noise pickup normally associated with practical measurement environments.

The bi-directional null pattern allows greater than 25 dB reduction in interference from other carriers as well as attribution of subject emissions. Optimal broadband design permits accurate bandwidth and harmonic measurements. Antenna factor is documented to 10 MHz. Standard 1/4-20 female threads allows for precision positioning using a camera tripod.

The LP-3, introduced in 1994, has become the most commonly used antenna for AM NRSC testing. Other accessories such as tunable notch filters and high pass/low pass filters are also available. For more information see the www.scott-inc.com website.

CircuitWerkes

Sicon-8 Remote Control

www.circuitwerkes.com • 352-335-6555

The Sicon-8 is a modestly-priced, but very full-featured dial-up remote control based on modern voice recording technology. The Sicon-8 can speak in your staff's language because you can record your own messages. It is designed to be a complete solution for facilities with basic to moderate control requirements.

There is no need to buy anything extra to use the Sicon-8 because all metering, status and control connections are on the main chassis' depluggable screw terminals. The optional SX-8 expander chassis brings the total number of channels to16.

The Sicon-8 can be controlled from any dial-up telephone, an auto-answer cell phone or from its serial port. When the serial port is used, a free program, the Sicontroller, accesses all of the Sicon-8's programming, control functions and basic automatic logging. Internet interfacing is accomplished with an inexpensive Telnet to serial converter accessory.

Conex

DT-300 Telephone Controlled AC Switch

www.conex-electro.com • 360-734-4323

The DT-300 is a telephone controlled AC switch. It is designed to control the AC power of equipment located at remote sites such as resetting computers, STL's, transmitters, etc. by turning the power ON or OFF or for controlling pumps, lights, heaters, etc. Two independent relays are also included.

You can also command the DT-300 to turn a device on/off for a predetermined amount of time and then turn back OFF/ON. The ON/OFF time can range from 0.1 seconds to 999 seconds. You can also command it to continuously cycle on and off with independent on and off times. (for example, you could have a motor turn on for 3 seconds and turn off for 180 seconds.)

The separate relays can be programmed to operate in interlock, momentary, or latching modes.

Danagger

Plan B Classic

www.danagger.com • 604-689-4511

Danagger Audio works is now shipping its network-friendly Plan B Classic. The new model combines a digital silence sensor with voice notification and continuous replacement audio to provide a complete backup system for digital and analog air chains. Up to 75 hours of audio is stored on CD-R, DVD-R or Compact Flash.

The Plan B Classic can also insert local audio during network breaks and handle all related switching. A "Plus" option provides additional automatic switchover to a secondary external audio source. Plan B Classic's integrated 4-in, 4-out voice remote control and dial up listen line allow emergency live phone-to-air announcements with a separate secure password. Passive switching for main program audio provides transparent insertion into any program path.

Installation is simplified by the Plan B's compact 2U rack mount chassis, XLR connectors, pluggable terminal block and internal power supply. Additional features include RS232 monitor and control, built in stereo monitor speakers and headphone jack, and programmable system ID number for multi-site installations.

Gear Guide

Test Equipment, Monitors, Receivers, and Remote Control

Fanfare

FP-TRO-1 Receiver/Translator

www.fanfare.com • 800-26TUNER

fanfare 1-800-268-8637 FAX - 866-791-7443
P.O Box 386 Lancaster NY 14086 Email "proinfo@fanfare.com"
Look for us with Crown Broadcast Website " www.fanfare.com"

Fanfare FM continues to define high performance in a translator receiver with its FT1AP monitor. Fully decked with adjustable composite out, carrier sense and RS-232 serial data I/O, the FT1AP offers a 75 dB noise floor, -25 dB adjacent rejection and -80 dB alternate. Sensitivity is quite remarkable at 30 microvolts for 50 dB quieting in stereo.

Fanfare's new FP-TRO-1 goes one giant step further by offering a receiver translator that converts the input frequency of any FM base band signal (analog or HD-Radio™) to any in band, output signal. With no demod or remod, the carrier and base band remain intact and can be output to any linearized RF power amplifier. Utilizing the Fanfare FP-TRO-1 does not require any licensing. Specifications, while they have not been formalized, are believed to better the FT1AP by about 25% overall in terms of sensitivity and selectivity. In test, the noise floor has reached past 100 dB.

Gorman-Redlich

CMR Directional Antenna Monitor

www.gorman-redlich.com • 740-593-3150

The CMR presents a true ratio readout on the front panel on the 3-1/2 digit, seven segment, digital display. The CMR can accommodated up to 6 towers and 2 different reference towers.

Analog DC outputs are provided to remote control equipment through a DB 25 connector for studio monitoring at locations that are not co-located with the antenna array.

Individual towers are selected for ratio and phase readings by pressing a tower select button on the front panel for local operation. If the monitor is operated via remote control, the remote control equipment must provide a dry contact closure to select a tower for ratio and phase readings.

There is no ambiguity about phase readings in the vicinity of zero degrees. The sign will switch from a plus to minus sign at zero degrees.

Henry Engineering

LogiConverter Remote Control Interface

www.henryeng.com • 626-355-3656

The LogiConverter is a "swiss army knife" control interface that facilitates remote control of studio and transmitter equipment. It eliminates the incompatibility between control circuits and the device(s) being controlled, and provides an interface that is isolated, safe, and reliable.

LogiConverter has four opto-isolated inputs and four SPDT relay outputs. The input/output channels can operate independently, or in "start/stop" or "on/off" pairs.

LogiConverter can accept any momentary or maintained ground closure, dry contact, or DC voltage, and produce an isolated dry relay contact output. Front-panel DIP switches are used to program the output type desired: either momentary (pulse) or maintaincd (latched) outputs can be produced, with independent or start/stop modes possible.

LogiConverter is powered with a built-in AC power supply, and is 1/3 rack width x 1RU. An optional rack-mount shelf is available.

Inovonics

532 FM/HD Radio Monitor

www.inovon.com • 831-458-0552

The 532 from Inovonics is a comprehensive off-air Mod-Monitor for FM/HD Radio™, including HD multicasting. It is entirely menu-driven from the front panel and gives both graphic and numerical displays of signal parameters on the LCD screen and on LED bargraph readouts. This includes peak-responding presentations of total modulation and decoded analog and digital program channels, along with the injection levels of FM subcarriers and stereo pilot.

The unit includes a built-in spectrum analyzer to display the occupied-RF and FM-baseband spectra, and also decodes and displays the FM RDS and HD PAD program-associated text. Quantitative measurements of incoming signal strength and multipath effects qualify measurements and aid antenna alignment.

Full data acquisition is available through rear-panel serial, USB and TCP/IP network ports, which also allow quick firmware updates. Isolated alarm tallies enable remote indications of overdeviation, excessive multipath, and loss of carrier, program audio and supplemental HD programs.

NT Instruments - NTI

DL1 Digilyzer and ML1 Minilyzer

www.nt-instruments.com • 503-639-3737

Digilyzer DL1

This handheld 96k digital audio analyzer measures and monitors embedded audio and digital format carrier signals on 32-96K sampling rate, 8 to 24 bit digital audio signals. Functions include interface signal level, frequency and bit meter; plus Level, THD+N, frequency response, PPM/VU metering, and logging on embedded audio. LCD display, monitor speaker and scope mode, AES/SPDIF, and ADAT inputs are included. Optional MiniLINK PC interface. Price: $1,499.00

Minilyzer ML1

This handheld audio analyzer, with monitor and scope mode, measures absolute and relative level, frequency, THD+N, polarity, signal balance, frequency response, 1/3 octave spectrum analysis, and VU/PPM metering.

With optional MiniSPL or external mic, it adds Sound Pressure Level measurements and 1/3 octave RTA. Optional MiniLINK PC interface for storing data and operating instrument. Price: $579.00

Radio Design Labs - RDL

PT-AMG2 Audio Oscillator/Meter/Speaker

www.rdlnet.com • 928-443-9391

The RDL PT-AMG2 is comprised of a precision audio oscillator, precision level meter and speaker. The 700 Hz oscillator section features two outputs. The balanced XLR output is front-panel switch selectable for MIC or LINE level (pro level). The unbalanced output operates at -10 dBV (consumer). Output stability is suited to accurate bench top audio testing.

The audio metering circuit features two inputs, an LED meter and a monitor speaker. The balanced input is front-panel switch selectable for MIC or LINE input (pro). The unbalanced input operates at -10 dBV (consumer). Either input may be used to feed the metering circuit

The PT-AMG2 operates either from two internal 9 volt batteries or from an external 12 Vdc to 30 Vdc supply. Test leads and bench top support bracket are included. The balanced line levels (input and output) may be preset by the user to +4 dBu or +6 dBu.

Gear Guide

Test Equipment, Monitors, Receivers, and Remote Control

Sencore

DA795 DigiPro Digital Audio Analyzer

www.sencore.com • 800-SENCORE

The Sencore DA795 DigiPro Digital Audio Analyzer provides powerful digital audio analysis when troubleshooting digital audio equipment in studios, broadcast, and manufacturing plants. It provides digital audio analyzing features and functions normally found only on expensive bench test equipment, in a portable, easy-to-use and cost-effective package.

The DigiPro tells you what you need to know about a digital audio signal to resolve audio problems. The DA795 checks the digital signal delay through a device, determines if a device passes the digital audio bits without modification, and checks the RMS interface jitter on a digital signal. The DigiPro checks the digital audio word length, sample rate, bit activity, header information, flag errors, and carrier voltage.

The DigiPro measures the actual digital sample rate, word clock, and superclock frequencies. The DigiPro monitors the digital audio over time, capturing and showing errors that occurred.

Sine Systems

RFC-1 Remote Control

www.sinesystems.com • 615-228-3500

The RFC-1/B is an affordable, full-featured transmitter remote control system that connects to a phone line at the transmitter site and can be accessed through a standard or wireless telephone. Transmitter readings are reported with a natural sounding human voice.

The basic system consists of an RFC-1/B and an RP-8 Relay Panel that provides eight channels of telemetry and raise/lower control. Up to eight relay panels can be connected for a maximum of 64 channels. The RFC-1/B can be programmed to perform power/pattern changes and take readings automatically. It can also be programmed to alert station personnel during an out-of-tolerance condition. Accessories are available for surge suppression, monitoring tower lights, temperature sensing and printing logs.

A newly available accessory, model SIP-8, allows status relay sensing without needing an external power supply. Detailed descriptions, prices, vendors and a system configuration utility are available at www.sinesystems.com.

Statmon

Axess Remote Control & Facility Management

www.statmon.com • 310-288-4580

The new Axess 6.1 product suite exploits the power of Internet Protocol (IP) for the ultimate in multi-site, multi-user facility control and management.

Solutions feature the industry's most comprehensive device management and control capabilities including EAS remote operation, SNMP monitoring, MODbus communication, integrated SQL database, user configurable GUI screens and automated operation, alarm management and notification and complete data logging functions.

With an unlimited number of status, analog, control, event and information channels in each network enabled system, Axess is the solution for single site or sophisticated multi-site operation.

TFT

923A AM Modulation Monitor

www.tftinc.com • 408-943-9323

The TFT 923A AM Modulation Monitor is wideband to 40 MHz with a high level input. No tuning is required. It also has a carrier phase shift meter, a built-in meter attenuator and NRSC compliant monitor output. A internally generated RF calibrator is built-in. Three peak flashers (two "+" and "–" adjustable and one fixed at +125%) feature exclusive P.M.D.D. circuitry. An optional plug-in AM preselector is available for studio operation.

Titus Labs

MDA-8 Digital and Analog Monitor

www.tituslabs.com • 800-806-8851

The MDA-8 features six AES-3 digital sources and two stereo analog sources which can be switched to and monitored. Each of the AES-3 digital inputs feed an internal DAC on the MDA-8 with stereo balanced audio outputs from each digital input provided on the rear of the unit. This allows each digital input to be decoded with the stereo audio encoded on that input available as an analog output.

Each digital input is also monitored for digital errors and loss of audio on the source and will trigger an internal relay for remote alarm. The two analog inputs are also monitored.

The MDA-8 switched source is output on the rear panel (balanced stereo outputs), and has a front panel headphone jack that lets the user to listen to the switched source.

Another unique capability of the MDA-8 is connectivity to the internet via an RJ-45 jack on the rear panel. The MDA-8 has an internal web server that can be attached to a local LAN or to the internet.

WIT Inc.

easi-8 Remote Monitor and Control

www.witinc.net • 801-553-2353

The easi-8 Remote Monitoring and Control device has quickly become a solution for multiple industries. Radio, Television, Satellite Uplinking, International Shortwave, and ISP companies have all discovered the benefit of this new approach to monitoring and control. The engineers at WIT, Inc. designed the easi-8 with four major objectives: 1) Simple Set Up, 2) Network Accessibility, 3) Versatility, 4) Small/Lightweight and Affordable.

Simply plug the easi-8 into a computer network, point any standard browser to the easi-8 and you have a wide variety of programming and configuration options; SNMP capability, 64 time of day functions, scaleable to any number of inputs and outputs, four limit values for each input range, save and restore unit configurations. Universal inputs for metering or status, input ranges between 0 to 160 volts DC or AC and a web API interface for custom programs give the unit versatility. Two easi-8's can be mounted side by side in a 19" rack or directly mounted to the wall with the available wall brackets. Visit them at www.easi-8.com for more information.

Service Guide Radio Equipment Products and Services

Service Guide Radio Equipment Products and Services

Final Stage

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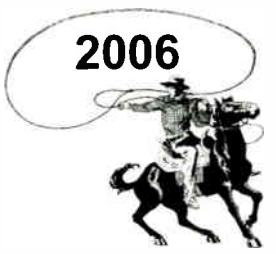
RCS - 35	www.rcsworks.com
RF Specialties - 33	www.rfspec.com
Satellite Lynx - 27	www.satellitelynx.com
SCMS Inc. - 30, 43	www.scmsinc.com
Shively Labs - 29	www.shively.com
Sine Systems - 32	www.sinesystems.com
Telos - 17	www.telos-systems.com
TFT - 23	www.tftinc.com
Tieline - 5	www.tieline.com
Titus Technology - 15	www.tituslabs.com
Transcom - 23	www.fmamtv.com



RADIO ROUNDUP

The Radio Guide Industry Date and Event Register

Email your dates and information to: ***radio@rconnect.com***

National & SBE • Regional & State • FCC Applications & Deadlines

NAB 2006
April 22-27, 2006
Las Vegas, Nevada
www.nabshow.com

Broadcast Electronics HD Radio Seminar
April 23, 2006 – Las Vegas Convention Center
2:00-4:00 PM, Room N-114
www.bdcast.com

Alabama Ennes Workshop – SBE Chapter 118
May 19, 2006
Orange Beach , Alabama
www.sbe.org/cal_index.php

SCMS Communications Conference
June 1, 2006
Charlotte, North Carolina
SCMSConference@laurenoriginals.com

Mid-Atlantic Broadcasters Conference
June 5-6, 2006
Atlantic City, New Jersey
www.njba.com

Northern New England Broadcaster's & SBE 110
June 22, 2006
Manchester, New Hampshire
bteffner@wcax.com

AM/FM License Expiration Dates
August 1, 2006
Delaware & Pennsylvania
/www.fcc.gov/mb/audio/renewal/index.html

BOS-CON 2006 Boston SBE Regional Convention
October 12-13, 2006
Marlborough, MA
www.bos-con.com

NAB 2006 Radio Show
September 20-22, 2006
Dallas, Texas
www.nab.org/conventions/radioshow/2006/

34th Annual SBE22 Broadcast & Technology Expo
SBE 2006 National Meeting
September 26-27, 2006
Verona, New York • www.sbe22.org

SBE Chapter 20 – Pittsburgh Regional Expo
October 12, 2006
Monroeville, Pennsylvania
www.broadcast.net/~sbe20

2006 Broadcasters Clinic
October 24-26, 2006
Madison, Wisconsin
www.wi-broadcasters.org

SEA-CON 2006
Fall 2006
Seattle, Washington
www.broadcast.net/~sbe16

Texas Association of Broadcasters (TAB)
53rd Annual Convention and Trade Show
August 9-11, 2006
Austin, Texas
www.tab.org/convention.php

– 2007 –

Great Lakes Broadcasting Conference & Expo
March 2007
Lansing, Michigan
www.michab.com

OAB Annual Convention and Engineering Conf.
Spring 2007
To be announced.
www.oabok.org

SBE Certification Exam Dates

Exam Dates	Location App. Deadline	
August 11-21	Local Chapters	June 9, 2006
November 10-20	Local Chapters	Sep. 22, 2006

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Bob Hensler
Vice President of Engineering
Colorado Public Radio

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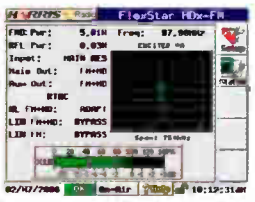

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