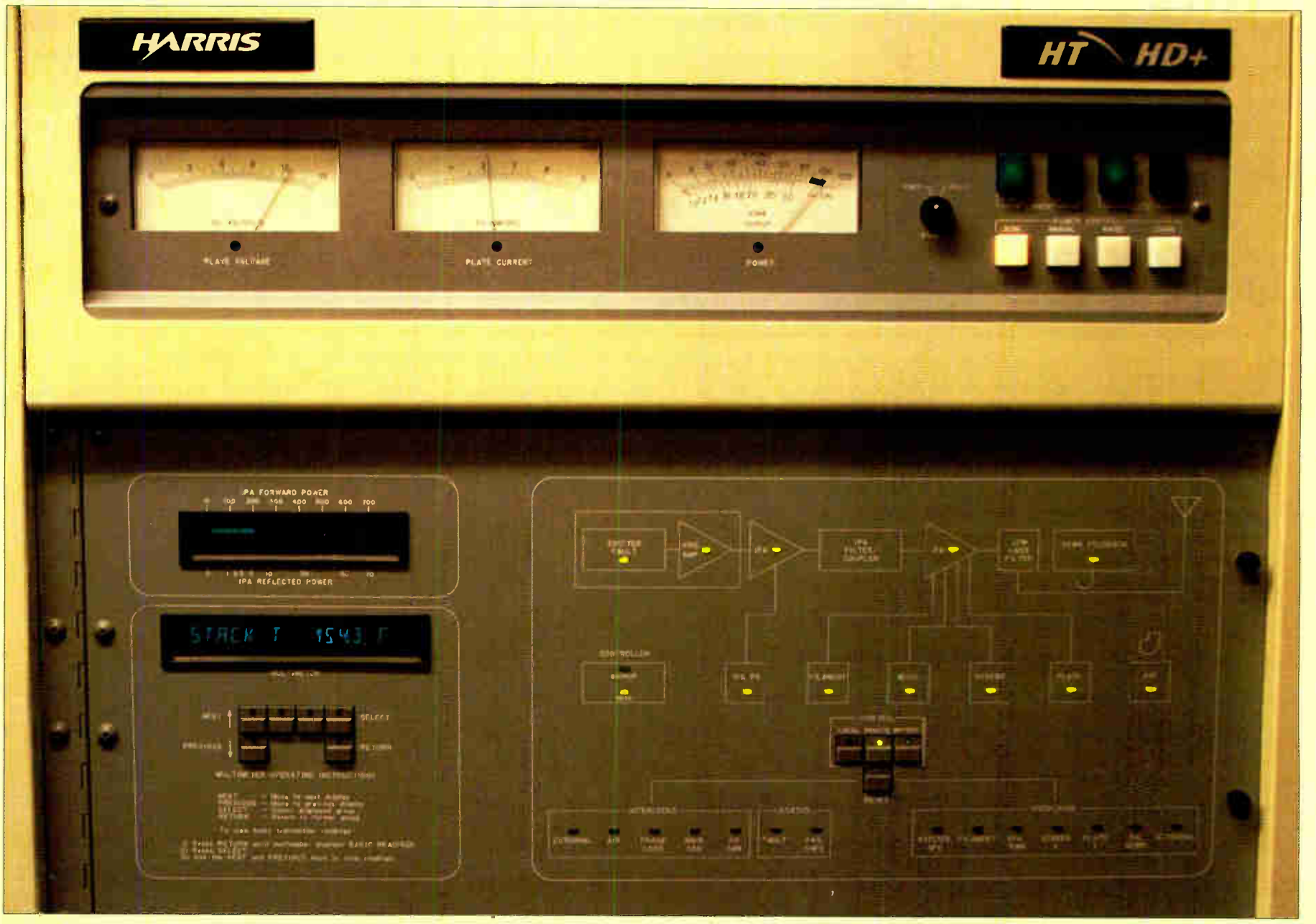
Radio Guide

Radio Technology for Engineers and Managers October 2006

Turning Up the Power On HD Radio



Inside Radio Guide

Harris' First HT\HD+ Tube Transmitter Goes On Line

Page 4

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Radio Guide

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Radio Waves

by Barry Mishkind – Editor

Choices

Choices can be good. That is why cars come in different colors. That is why there are menus in restaurants. That is why ... well, please insert your favorite illustration here.

Of course, you do not always get your choice. Sometimes the restaurant runs out of your choice. Sometimes the whole concept gets derailed by marital concerns. And, yes, there are always business considerations behind choices.

The choice of any thinking engineer would be a digital broadcasting system that would bring crisp, clean audio to AM and FM stations without causing interference, eliminate multipath, provide additional audio and data channels, be received on low-cost radios, including portables, and foster world peace. Or a reasonable facsimile thereof.

Well, as of this moment, we are still waiting. Even the NRSC, as Charlie Morgan explains on page 8, sees the iBiquity IBOC system as an imperfect system with trade-offs.

However, HD Radio is here now and manufacturers have been working hard to make the system perform as well as possible. Linear tube transmitters are now increasingly available to get higher powers for low level combined systems. A good example is the new Harris HT\HD+ profiled by Greg Savoldi on page 4.

There are other systems. Demonstrations of DRM and FMeXtra transmissions have been received with interest by many, especially those hoping for a system that will be fully compatible with the existing analog transmission system. (You will find Lyle Henry's initial report on FMeXtra on page 12.)

It would be nice, though, to see abundant, cheap receivers for any and all of these systems.

There are choices. We may or may not like the choices currently available. We might even feel the right choice is not to choose as yet. But there is ongoing effort and we need to learn as much about the choices as we can. – *Radio Guide* –

Harris' First HT\HD+ Tube Transmitter Goes Online at WCOL-FM, Columbus, OH

by Greg Savoldi
Regional DoE, Clear Channel Columbus

Until this year, higher powered stations converting to digital had some difficult choices. Solid state was expensive at the needed TPO and tube transmitters had insufficient linearity. Now, suitable tube transmitters from several manufacturers are reaching the power levels necessary in one box. Greg Savoldi shares his experience with the new Harris HT\HD+.

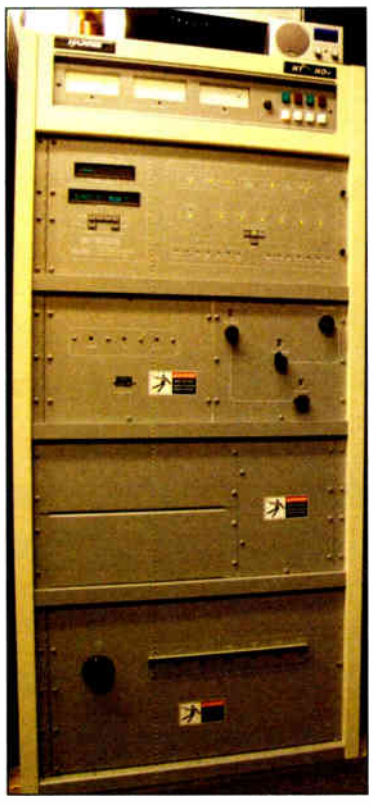
From studio to transmitter, engineers are always looking at new technologies to reduce costs and deliver new efficiencies. The birth of HD Radio has introduced an entirely new set of cost-associated challenges to the radio station and, although HD Radio delivers exceptional audio quality and new programming opportunities among other benefits, there is a financial side that can adversely affect the bottom line.

THE COST FACTOR

On the transmission side to this point, most broadcasters have turned to solid-state technology for HD Radio. However, solid-state transmitters can be expensive for high-power HD Radio stations.

WCOL-FM in Columbus, Ohio, running a transmitter power output of 17.5 kW, is one such station. Solid-state technology at this power level is more costly because two transmitters are required to broadcast at this power level. Broadcasters operating in high-power HD Radio now have an option to costly solid-state technology in the form of the single tube transmitter.

Previously, HD Radio common amplification in a single cabinet much above 8 kW was unattractive due to cost and space requirements in the transmitter room. Tube transmitters can achieve this at a significantly lower cost – somewhere around 60 percent less than the cost of an equivalent solid-state transmitter. The tube advantages allow broadcasters to amplify much more power in less space at a lower cost.



The Harris HT\HD+

THE HT\HD+

Harris recently announced its HT\HD+ high-power tube transmitter, which not only offers these cost and space advantages but allows stations to install a single transmitter to maintain both analog and digital broadcasts. WCOL is the first station to go on the air with HT\HD+.

The transmitter is a modified digital version of Harris' field proven HT35, a well-designed, well-built transmitter that has been in the field for over 20 years.

The power efficiency of the HT\HD+ is a key differentiator to competitive tube transmitters on the market. Coupled with Harris' RTAC (real-time adaptive correction) design, this transmitter is achieving higher plate efficiencies than other vendors. This translates to lower power bills, less heat in the transmitter room, longer tube life and less stringent AC requirements to cool the room.

BUILT WITH PROVEN DESIGNS

The linearization, or "flattening" of these transmitters is similar to the way TV transmitters are built to pass the wideband requirements of video. Harris has brought this same technique to bear for FM transmitters operating at high power levels.

The RTAC system provides the excellent efficiency to make high power HD Radio cost-efficient. With the HT\HD+, Harris is achieving this with a minimum redesign of the transmitter. A few tweaks were required to flatten the transmitter for HD Radio transmission. However, it is phenomenal that Harris avoided sacrificing serious amounts of efficiency or vastly modifying and rebuilding this transmitter in the process.

Our experience with the HT35 provided an immediate level of comfort and familiarity with the HT\HD+. Our first FM25K, a vintage 1983 model, was put into standby service in 2003 and has proven to be a very reliable backup. This transmitter has since been moved to our backup transmission site. An HT20, purchased in 2003, now serves as the primary backup to the HT\HD+ at our main transmitter site.

INSTALLATION

WCOL's primary site is a "community site building" with two floors: TV transmitters on the bottom floor, and FM transmitters/combiners on the top floor. A local moving company placed the transmitter and 1,900-pound power supply via forklift through the second floor garage door. The old transmitter was removed and the HT\HD+ was in its place in only three hours.

**The WCOL transmitter room.
The new HT\HD+ is on the right side.**

Site preparation was immediately simplified since the footprint of the HT-HD+ is so similar to the FM25K. The transmitter was installed in a low-level combining (common amplification) configuration which eliminated the need for additional RF switches, reject loads, combiners, injectors, circulators and other complementary systems necessary in high-level combining.

The RF output and other connections to the transmission feed line were all within several inches of the old transmitter – additional transmission line lengths were custom designed in Quincy to ensure transmitter tuning and unwanted harmonics would not be an issue. The time spent on electrical re-wiring and RF plumbing was minimal, making this one of the most efficient and expedient installations of my career.

FAMILIAR LOOK AND FEEL

The transmitter has few changes from its "straight analog FM" predecessor. From the outside it looks exactly like an HT35 that came off the Quincy production floor. It is essentially a linearized version of the HT35 designed to handle HD Radio transmission.

As with the original HT35, the new transmitter's front panel GUI is full of information regarding parameters and transmitter status. At a quick glance, an LED flow chart clearly displays faults of any kind. It also offers traditional metering for plate voltage, plate current, forward power and other readings.

Signal flow and metering.

Upon opening the transmitter it is again apparent that the design is very similar to the HT35. The split design spreads out the internal components so the high-voltage power supply is separate from the main cabinet.

There is a huge advantage to this design, as it makes it easier to analyze the transmitter and perform maintenance. The PA deck, tube cavity and underside of the socket are very easy to inspect and maintain. For cooling, air is drawn into the lower rear of the transmitter and a large duct is positioned over the transmitter to suck out the exhaust air into the 7.5 ton A/C system.

Speaking of maintenance, we are planning to pull down the transmitter every six months. Our transmission facility is climate controlled with year-round AC, eliminating outside air and its contaminants. Still, any transmitter with 12.5 kV plate voltage is going to be a magnet for dust. This makes minimizing outside contaminants important.

A wipe down of all HV points and hands-on inspection of the rig is standard, with a run up on the dummy load for cross-reference of parameters compared to the on-air load. The transmitter will receive a more thorough inspection on an annual basis. The tube will be pulled out from its cavity for a full cavity inspection, with a more thorough cleaning required for the entire transmitter.

FLEX – AS IN FLEXIBLE

The HT\HD+ design also allows for certain levels of bypass using its FlexPatch feature.

For example, it is possible to bypass the IPA preamp, the IPA itself, or even the PA tube to stay on the air at reduced power, although excitation levels, tube saturation, class of tube operation and biasing are all different in HD Radio as compared to analog. This means we could stay on the air in an emergency configuration although HD performance would be degraded. This beats the alternative if you do not have a backup transmitter.

That said, the transmitter offers many redundancies, both in the RF chain and the control system. A backup,

(Continued on Page 6)

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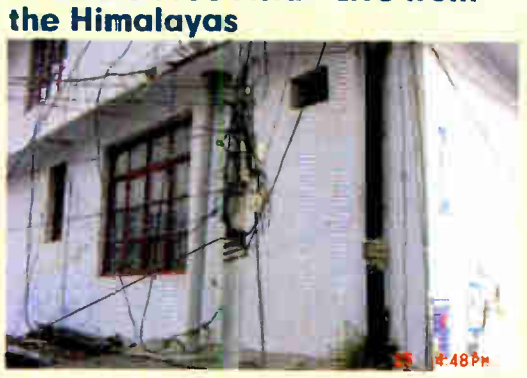

"The results [with ACCESS] were especially reliable considering that Dharamsala has one of most "problematic" Internet infrastructures that we have come across." — David Baden, Chief Technology Officer Radio Free Asia

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COMREX

Harris' First HT\HD+ Tube Transmitter Goes Online at WCOL-FM, Columbus, OH

by Greg Savoldi
Regional DoE, Clear Channel Columbus

– Continued from Page 4 –

"basics" control system provides essential readings to keep the transmitter running in case the main control system fails.

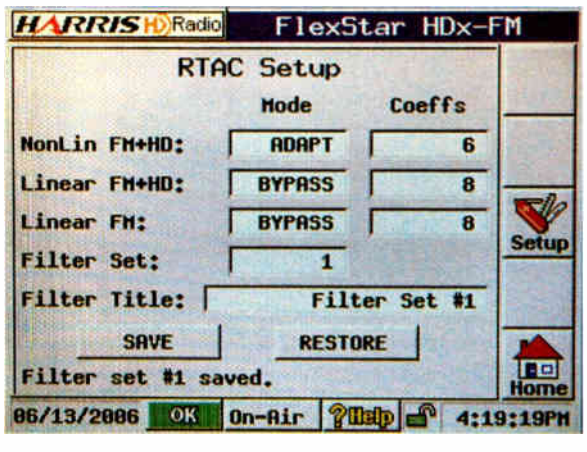
The controller runs on a very extensive and comprehensive logic-based microprocessor – well ahead of its time given the mid-80s design period. If the main controller receives any damage, the transmitter will intuitively jump to the backup controller. It can also alert engineering, via connection to a status alarm on a remote control unit, of the pending fault.

FLEXSTAR AND RTAC

The RTAC operation is essential to the transmitter meeting the mask compliance for HD Radio. The *real-time* aspect of this system is what sets it apart from other vendors using static precorrection.

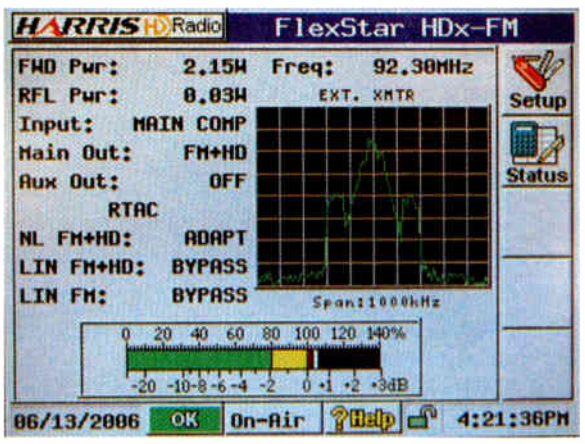
WCOL feeds into a constant impedance combiner system (three other stations operate with us on one of the two master panels), rather than directly into an antenna as most stations do. Because of the wideband nature of the panel antenna and combiner isolation, we enjoy a fairly consistent load year-round, regardless of icing conditions and such.

In HD Radio, factors such as group delay and bandpass characteristics are essential to improving performance of that "wider" signal. RTAC analyzes everything in real time and adjusts the correction factor on the fly so the mask remains compliant. Harris implements this technology by having the exciter make the power adjustments instead of the screen voltage on the PA.



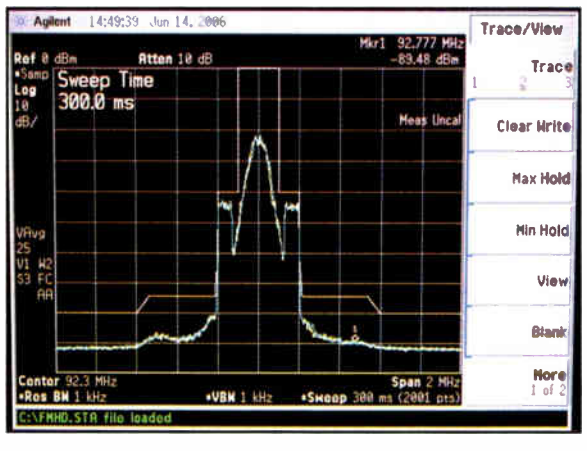
The RTAC is part of the FlexStar exciter.

Pre-correction is adaptively implemented through the transmitter's FlexStar HDx-FM exciter. The power output of the exciter is then adjusted to meet the mask requirements by compensating for changes in transmitter power levels. This is all achieved intelligently through the closed loop RF feedback sample, taken on the output side of the external low-pass filter and fed back to the Harris FlexStar exciter.



The FlexStar includes a spectrum analyzer as part of its status screen.

Without RTAC, the transmitter would likely struggle to meet the mask requirements. The RTAC system is engaged and viewed on a spectrum analyzer built into the exciter. Within a few seconds, the levels drop right into and then comfortably under the mask requirements. The entire approach is very impressive and cool to watch!

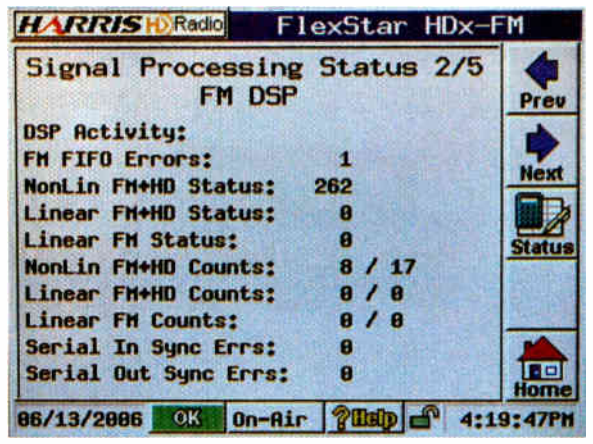


An external spectrum analyzer verifies the signal is well within the mask.

The FlexStar exciter, the heart of the HT\HD+, is a different animal from previous generation exciters. Harris built this exciter from the ground up with HD Radio in mind. It is very stable, lightweight and offers an intuitive GUI with various important readings and diagnostics. In fact, when I first picked up the FlexStar, I thought Harris forgot to load some essential hardware in the box! However, the small size and weight are achieved by high density FPGA technology.

AUDIO HANDLING

The FlexStar exciter also continues Harris' track record of audio improvements with each passing generation. The FlexStar HDx-FM has a very smooth, silky, transparent sound we love from a pure FM aspect. For HD Radio implementation, the DSP design offers many improvements over the PC design utilized in the previous generation.



One of the DSP screens on the FlexStar.

Overall we found the FlexStar exciter to be stable and full of useful diagnostic information; it looks good and sounds good.

The FlexStar product range and HT\HD+ operate together for WCOL's multicasting initiative. Unlike the current Exgine architecture favored in much of the industry, we have opted to install the HDE-100 Exporter at the transmitter site.

We originate our FM/HD and HD2 AES audio at the studio and transport them as separate audio feeds on a Moseley StarLink. This allows us to do much of our critical audio processing at the transmitter site, where the exciter, HD2 importer and other equipment reside. This arrangement offers more flexibility for alternate audio paths to the site in case of STL issues.

An easy installation and solid operation makes for a pleased engineer.

Harris' constant communication throughout the planning and installation process allowed this project to run as smoothly as possible. From cooling to power consumption questions to the actual launch of the transmitter, Harris engineers were always available to answer our questions. Three months in, we are extremely pleased with the HT\HD+'s operation.

Greg Savoldi is the Regional Director of Engineering for Clear Channel Radio in Columbus. Ohio. He can be reached at gregsavoldi@clearchannel.com

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Transmission Guide

by Charlie Morgan

The NRSC and Standards for Broacasters

From time to time we hear about the activities and recommendations of the NRSC – the National Radio Systems Committee. Most recently, it has to do with the ongoing IBOC standards issue. Charlie Morgan offers us an inside look into the NRSC and its activities.

In order to understand the NRSC involvement in the development of the IBOC standard it is important to understand what the NRSC is and what it is not.

THE NRSC

The National Radio Systems Committee (NRSC) is a standards setting committee. It is concerned with studying and developing standards that relate to the transmission and reception of radio broadcast signals in the United States.

The NRSC is mostly made up of broadcasters and receiver manufacturers, with membership open to all individuals or businesses having an interest in the technology being studied by the committee. Total NRSC membership varies over time but is generally around 100 and all members are not necessarily members of all of its subcommittees.

The NRSC has no paid staff nor does it have any income or budget. All committee members are responsible for their own expenses. The NRSC does have two sponsors – the Consumer Electronics Association (CEA) and the National Association of Broadcasters (NAB) – who provide the necessary staff support and cover any expenses incurred by the activities of the committee. For example, the NRSC often meets in space provided by the NAB and CEA in conjunction with the annual conventions.

ORIGINS

The NRSC had been in existence for many decades before it was reconvened in 1985 to study the effect of pre-emphasis and bandwidth of AM transmission in light of the fact that the bandwidth of AM receivers had been gradually decreasing.

The outgrowth of these studies led to the NRSC AM pre-emphasis and de-emphasis curves and bandwidth standards. The NRSC work fostered a reduction in adjacent channel interference and is now part of the FCC Rules.

Later, the NRSC developed its RBDS standards, which govern the display of call letters and program information on the receiver. Such displays have become very popular in new receivers over the past few years.

NRSC AND IBOC

For several years the NRSC followed the early developments in digital radio as it was discussed within the CEA. These discussions included IBOC and other digital systems that would require new spectrum, including a system being developed in Europe – Eureka 147.

Early in the process, it became apparent to me and most of the broadcasters involved in the CEA committee that the in-band/on-channel (IBOC) approach was best suited for providing a reasonable transition to digital radio for US broadcasters.

IBOC and only IBOC would allow a transition to digital that would treat all broadcasters, large and small, equally. All broadcasters could make the transition on their own timetable and no existing broadcaster would be left behind in a future auction or spectrum grab.

SYSTEM EVALUATIONS

In late 1992 the NRSC formed its DAB (Digital Audio Broadcasting) subcommittee to investigate and evaluate only IBOC systems. This led to the testing of an early IBOC system developed by USADR and these tests were conducted separately but in conjunction with the testing of the Eureka 147 system by the CEA.

The result of these tests suggested that while both of these systems had merit, neither seemed to function well enough to be suitable for adoption as a Digital Broadcasting System for the United States. This meant, "back to the drawing board" for USADR and a pause in activity by the NRSC DAB subcommittee.

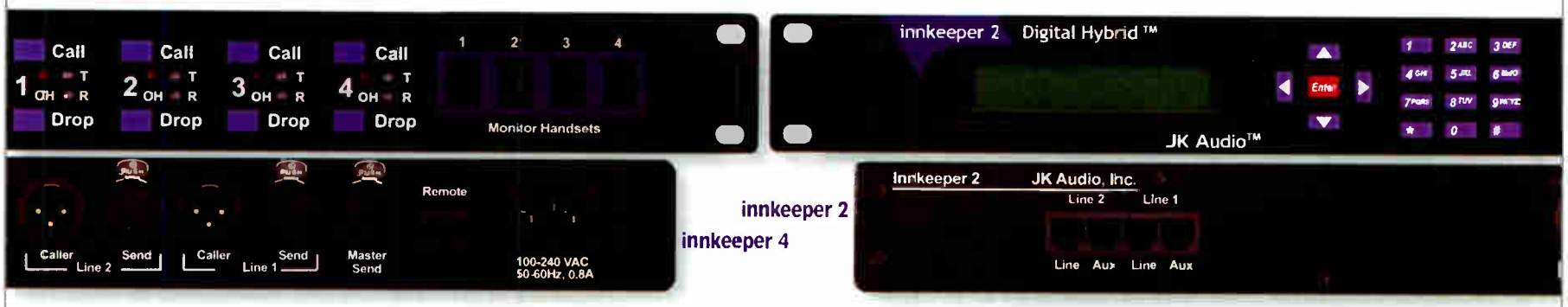
Early in this process, the NRSC recognized that the design of an IBOC system was extremely complex and that we were not in a position to create a standard but only to evaluate complete systems that were presented to us and, if applicable, adopt a system as a standard.

It is also important to note that – early in this process – the NRSC stated that it would evaluate only systems that would include both AM and FM. We (the broadcasters involved in the NRSC) wanted to insure that, in the development of Digital Broadcasting, AM stations would not be left behind.

TESTING BEGINS

In February of 1999 the NRSC reconvened its DAB subcommittee in response to a request from

(Continued on Page 10)



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Innkeeper 2 and 4 feature Auto-Answer/Auto Disconnect for use in on-air applications such as telephone interviews and talk shows as well as behind the scenes applications like intercom, monitoring and conference room full duplex applications.

When your application calls for multiple digital hybrids that are smart enough to know how to handle the workload, innkeeper 2 or innkeeper 4 are your best choice - by a long shot.

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Transmission Guide

by Charlie Morgan

The NRSC and Standards for Broacasters

Continued From Page 8

Digital Radio Express (DRE) to evaluate its IBOC system. Shortly thereafter, USADR and Lucent Technology also requested that their systems be evaluated by the NRSC.

Designing test procedures to properly evaluate these three different systems was something new for the NRSC. The test procedures needed to withstand the scrutiny of all proponents as well as the many other interested parties of today and the future. This task was very time consuming but also very necessary.

AFTER THE IBOC MERGER

Well into the development of the test procedures and before the evaluation process, DRE, Lucent and USADR merged their technologies and formed iBiquity. The merger of all proponents into one system made the task of the NRSC much simpler. No longer was there a need to compare opposing systems. The NRSC moved forward with its evaluation of the iBiquity system that we know today as HD Radio.

The NRSC evaluation report for the FM system was completed in November, 2001 and the AM report followed in April, 2002. Both reports were submitted to the FCC for consideration in their ongoing Rulemaking on Terrestrial Digital Radio.

On October 10, 2002 the FCC issued a Report and Order that selected IBOC as the Digital Radio technology for the United States and authorized interim operation on a voluntary basis. The Commission also announced its support for a public and open process to develop formal IBOC standards for both AM and FM.

In response to this request, the NRSC began its standard setting process and on April 15, 2005 the NRSC issued its standard (NRSC-5) for both AM and FM IBOC

WHERE WE ARE NOW

IBOC is not perfect. There are trade-offs particularly concerning potential interference to adjacent channel analog stations. However, as stated in both the NRSC documents and the FCC Report and Order, these are "acceptable trade-offs given the larger public benefits at stake."

It is not my intent to argue the magnitude or merit of these trade-offs here, but I would like to make a few pertinent observations:

• Is IBOC without flaws? No, but both the NRSC and the FCC have stated that they believed the advantages of IBOC far outweigh its shortcomings.

• Could a better DAB system be designed? Certainly, but not without finding new spectrum. There were only three IBOC systems ever in development and the IBOC system specified in the NRSC standard is an outgrowth of all these technologies.

• No new spectrum is available in the United States for Digital Radio and if it were available, there would be no assurance that accommodations would be made available to all existing AM and FM broadcasters.

• Eureka 147 has been in operation for more than ten years. It is an excellent system but, with the exception of some success in Great Britain, it is "dead in the water" in both Europe and Canada. In contrast, HD Radio is actively pursued by US broadcasters and, in less than four years, nearly one thousand stations are in operation in more than 160 markets from New York to Price UT.

• There is much concern over adjacent channel interference with the AM HD system, particularly at night, and these concerns are valid. This shortcoming is the result of the propagation and overcrowding of the AM band and not simply the IBOC system design.

It is hoped that the vast improvement of quality and robustness of the AM digital signal will make up for these shortcomings. The alternative to AM IBOC is for AM remain in the analog mode while all other communication systems go digital.

PARTICIPATION ENCOURAGED

As stated earlier, NRSC membership is open to anyone who has an interest in its activities and information on joining the committees or any of its subcommittees is available at the committee's web site www.nrscstandards.org.

A copy of the Digital Radio Standard (NRSC 5) and other NRSC standards are also available at the same website.

Charlie Morgan has 53 years of experience in broadcast engineering, most of which has been with Susquehanna Radio. He has served as Chairman of the NRSC since it was reconvened in 1985. He can be reached at ctmorcom@verizon.net

A clickable list of all the URL's listed in the ***Radio Guide*** articles:
www.radio-guide.com/URL.htm

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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Digital Guide

by Lyle Henry

Extra! Extra! FMeXtra!

FMeXtra: Digital audio for FM stations. Immediately adds two stereo channels to an FM stereo station. Uses existing transmitter and antenna. Does not bother the neighbors. More bits, with or without an IBOC system. Inexpensive: $8,900.

As you can imagine, my ears perked up when I heard about FMeXtra two years ago. So I immediately contacted the developer, Digital Radio Express (DRE) in Milpitas, CA and drove up to Silicon Valley.

What is this interesting technology?

SUBCARRIER EXPERIENCE

As a background, I have been working with FM analog subcarriers for over 35 years, listening to their limited frequency response, poor mono audio quality, frequent high background noise and crosstalk.

But FMeXtra had 20 kHz stereo audio against a background of silence. Sampling was at 48 kHz and a bit-rate of 48 kbps. However, audio response of 15 to 17 kHz sounded more than adequate and uses lower sampling and bit rates.

I learned that the system uses a high-speed digital stream running as an SCA. It has lots of error correction and uses AAC+ and voice-optimized codecs. And it sounded so much better than most streams with higher bit rates that I had been hearing on the Internet. In fact, AAC+ now permits stereo down to 12 kbps that sounds surprisingly good.

PUTTING DIGITAL TECHNOLOGY TO WORK

Before we discuss the techie stuff a bit more, perhaps you might like a short history of how FMeXtra emerged. Back in 1996 David Murotake and David Maxson presented a paper at the NAB Engineering Conference about their tests using the SCA spectrum for digital broadcasting.

The paper was entitled *Breaking the Sound Barrier: How to Broadcast Digital Audio on Your FM Carrier.* Unfortunately, it took all the available spectrum and required 5 to 6 bits/Hz to get fair audio quality. The signal needed to be more robust, but audio coding technology just was not up to the task at the time.

Separately, Norman Miller, Dwight Taylor, and Derek Kumar had formed Digital Radio Express, which developed and patented certain IBOC technologies. These were later licensed to USA Digital Radio (USADR). That finally became the iBiquity of today after merging with a Lucent Technologies division.

DRE then decided to concentrate on digital audio technology that could be easily added as an SCA on existing stations. The cost savings to broadcasters would be immense since new transmitters, combiners, or antennas would not be needed. No new air-conditioning requirements, either!

BETA TESTING

So I started begging to test this marvel and, after a while, got some beta gear. More recently, two production encoders and several late proto-type radios arrived. Since last winter I have installed and evaluated FMeXtra on some 20 stations in California, New Mexico, Illinois, Minnesota, and Wisconsin. Others are operating in various places throughout the U.S. as well as overseas.

The encoder is a Windows XP two rack-unit computer with Lynx audio and SCA generator cards. CD players, Flying Cows, Optimod-PCs, or other digital sources plug into the XLR inputs which accept AES or S/PDIF signals. One can also directly stream Internet audio through the system using an Orban Opticodec.

Typical test setup, including FMeXtra encoder at bottom.

Installation is quick and simple.

- The encoder has a BNC output connector.
- Just connect that to an SCA input on the exciter.
- Then drive away to see how far the signal goes.

Adding two digital stereo stations to existing analog stereo stations in as little as 20 minutes says this technology is easy to work with. Yes, I timed one install from opening the transmitter site gate to driving away!

(By the way, in the test setup photo you may notice the SCA monitor shows 151% modulation. Since this is an analog monitor, it perceives the digital signal as loud noise and the reading is meaningless.)

EVALUATING COVERAGE

Testing with a number of stations, I drove hundreds of miles to check the coverage in various directions. The antenna used was a quarter-wave whip with a magnetic mount, placed in the middle of the roof to minimize directional effects.

Typically, the first dropout would be at about the 60 dBu contour unless there was a big hill close in the way. Reasonable reception would then continue to the 50 dBu contour – and beyond in most cases.

The results have been excellent. I had worried that a digital SCA might be somewhat fragile and have holes when listening in a moving vehicle, even fairly close to the transmitter. However, that did not happen. One of the reasons is that there are a couple of seconds of buffering, sort of like satellite radios have for when the signal is briefly blocked.

RECEIVERS

Radios have been slow in coming, but it is expected that production radios should become available about the time you read this.

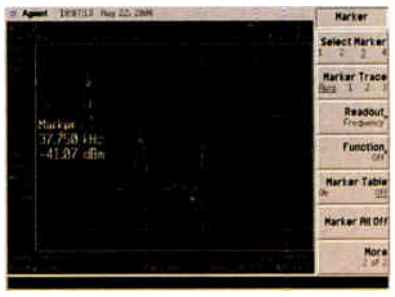
Lyle explains SCA and digital broadcasting.

As HD Radio manufacturers also discovered, digital receivers tend to generate RF noise which has proven difficult to keep out of the tuner's front end. But that has been solved in the FMeXtra radios now. The recent prototype is more sensitive than my trusty Technics ST-9030, is far more selective, and has great sound. I love this radio.

OPERATIONAL MODES

FMeXtra uses COFDM-type multicarrier modulation techniques with error correction and IF equalization in the receiver to minimize multipath effects. Several different modes of operation with different data densities are available, as are the bandwidth and number of bits allocated to each channel, wide or narrow, that is part of the data stream. Additionally, FMeXtra is remarkably flexible as to where the bits are placed in the FM baseband spectrum.

Best of all, the signal appears as white noise, so there are no birdies or other effects on the main channel programming under multipath conditions



A spectrum display of FMeXtra data stream.

A mono station could literally use the entire spectrum from 20-99 kHz for a gigantic data stream of up to, say, 300 kbps at one of the higher densities. Stereo stations may want to use 55 to 99 kHz, or 61 to 99 kHz if they are running RDS.

Indeed, by mixing and matching mono and stereo channels, along with differing sample and bit rates, it is possible to add at least four digital channels to an existing stereo station or even more if the station is in mono, all with decent sonic fidelity. A narrower data stream at 67 or 92 kHz can also be selected if an analog SCA must remain. One of those can carry two channels at 20 kbps using low density, more at higher density.

Stations will thus have many options depending on intended use. Some may even want to send a stream point-to-point to feed an AM, for example. This fixed type of operation can stack the data deeper than what might be appropriate if mobile reception is the goal.

REGAINING/REUSING SPECTRUM

There will be room for other services below RDS if stations should choose to run mono. Conventional or digital SCAs could be run above RDS as well.

Also, while RDS is a reasonably robust signal, it is very inefficient use of the spectrum by today's digital standards. Far more station related data can be carried in less space as part of the FMeXtra signal.

To illustrate: RDS occupies 55-59 kHz with a 2 kHz guard band on each side, a total of 8 kHz. The raw data rate is 1.1865 kbps, but the throughput is typically just a few hundred bits/s. Even the lowest density FMeXtra signal adds a throughput of 8 kbps to this spectrum, easily ten times as much.

A BETTER REPLACEMENT FOR TRADITIONAL SCA

Stations will certainly be interested in adding more stereo program channels to their signal, but there are many other possible uses.

One owner I talked with plans to carry his AM signal in stereo on one of the FMeXtra channels of his wide coverage FM station. This will really help the AM coverage, especially at night.

Other possibilities are today's traditional SCA users, such as services for the blind, shut-in, and foreign language broadcasters. Since many of the latter like to operate on a subscription basis, FMeXtra offers encryption and receiver addressability – if the subscriber does not pay the monthly fee, the radio stops working.

Regarding compatibility with IBOC, I understand that digital radios can be built to receive both IBOC and FMeXtra at no additional parts cost. It is just lines of code in software.

As indicated above, my observations regarding coverage are experiential at this point. A follow-up article will provide more detailed information, measured data, and comparisons. A slight disclaimer/disclosure: I do not sell FMeXtra or represent DRE, but am doing minimal consulting for them related to interfacing with typical radio station gear.

Lyle Henry, aka The Radio Doctor, is a Los Angeles-based engineer who has consulted on FM and SCA issues all over the world. Contact Lyle at lylehenry@fastmail.fm

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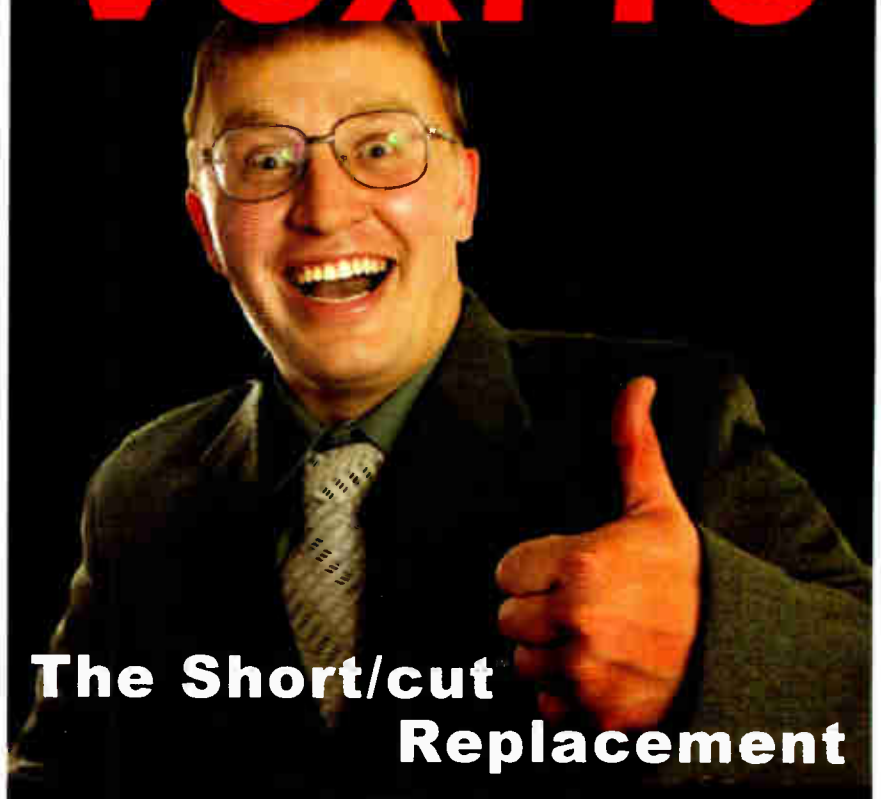

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Monitoring Guide

by Alan Alsobrook

Measuring AM Modulation

Part 2 – More Positive than Negative

Once a transmitter has been set for the proper modulation depth to prevent -100% (carrier cut-off) and any resultant splatter, it is time to observe the positive peaks. Alan Alsobrook returns with some geometric observations.

In contrast to the limit of 100% for negative peak modulation (a limit you really do not want to reach – as it is carrier cut-off), the FCC Rules at Section 73.1570 (b)(1) allow positive modulation peaks up to an absolute limit of 125%

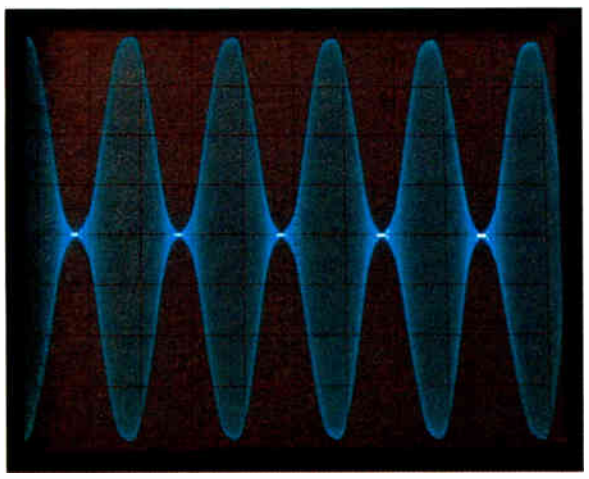
This takes advantage of the natural asymmetry in the human voice along with the finest unnatural asymmetry controls available on most any processor produced in the last 30 years.

LOOKING AT THE SCOPE

To an extent, measuring positive modulation using an oscilloscope is the reverse of looking for the negative – instead of looking for the carrier "pinch-off" at the center line, we are looking for the excursions towards the edge of the scope screen. As we did last time, we will use an oscilloscope to look first at a sample of the transmitter's RF output.

In order to calibrate the scope for 125% peak modulation – assuming the normal eight-vertical division scope – start by adjusting the scope gain such that the unmodulated wave form is 1.6 graticules above and below the center line.

Once this is set up each graticule will represent 31.25% modulation, each small hash representing 6.25%, and the top and bottom lines will indicate 125% positive. The optimum condition is when the modulation peaks just kiss the top and bottom lines without going over and you do not see any bright spots at the centerline.



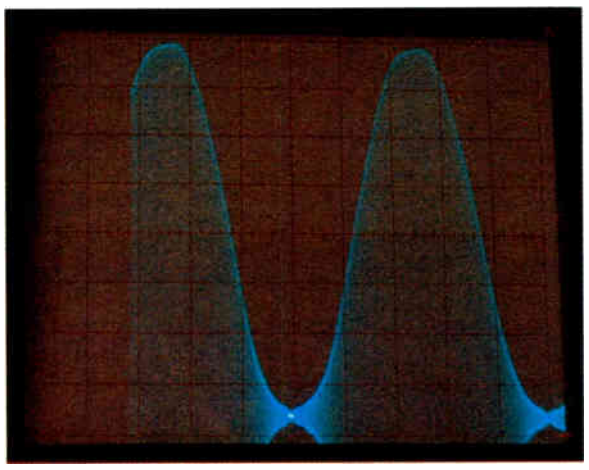
With the oscilloscope calibrated for 125% positive modulation, this transmitter is running right at the limits.

To clarify one item that is often confused: the downward going waveform beyond 1.6 graticules below the centerline is also positive modulation. In this configuration, negative modulation is shown only in the area between 1.6 grads above and below the centerline.

HIGHER RESOLUTION

Alternatively, if you would like to gain a higher degree of resolution, you can set the "zero line" 3.2 graticules below the center line, by grounding the input lead and then adjust the channel gain to bring the top of the unmodulated carrier up to the center line.

This now displays only the upper half of the waveform (each graticule now represents 15.6% modulation and each hash mark between graticules a little over 3%), but it allows for a closer look at the peaks with a bit better resolution.



Looking only at the upper half of the waveform.

If you have things calibrated correctly, the top line of the screen is effectively 125% positive modulation. You do not want to see any excursions go above the top line.

The difficulties of determining the modulation using this method is that depending on how the triggering is set on the scope you may not see the shots with the highest peaks. I have noticed on the newer LCD scopes that it is often very difficult to get the scope to trigger where it is easy to see the uppermost excursions.

TRAPEZOIDAL DISPLAY

A second method of measuring modulation with an oscilloscope, often referred to as the trapezoidal method, can provide easier interpretation of the modulation levels.

For this method, you will need a scope that has an X-Y option, normally a dual-trace or better. This measurement uses the same set up as before, but with an added input and utilizing the X-Y mode of your scope. The added input will be sample of the audio input to the transmitter.

This sample has to be after the processor and is typically picked off the processor outputs or the transmitter input. The tricky part of this is that you cannot just hook up your scope to that audio line since the input to the scope is unbalanced and the audio line should be balanced. Connecting the scope directly would ground the audio line and knock the audio level down greatly, not to mention the hums and buzzes that might show up.

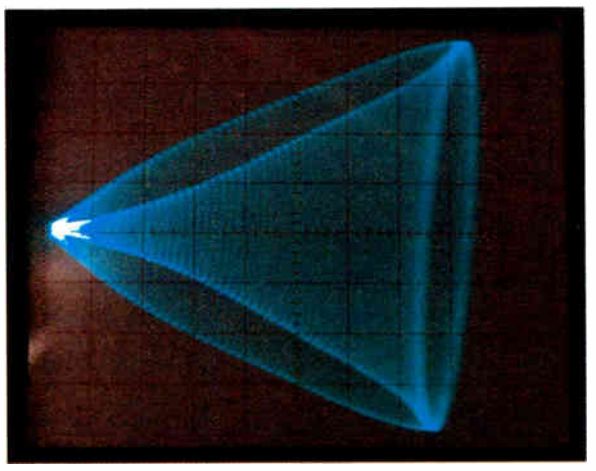
LOOKING AT THE TRAPEZOID

What you will need to hook this up is some sort of isolation. I use a 10K Ohm - 10K Ohm, 15 kHz rated transformer to do this. Using a high-Z transformer such as a Triad SP-66 allows a sample to be picked off the audio line with only a very slight amount of loading that is negligible in most situations.

A distribution amplifier may also be used; just make sure it is at exactly unity gain going to the transmitter and that the phasing is correct. Some even have said that the audio sample point should be from the output of the transmitters' modulator section, I think that is getting just a bit over zealous, not to mention quite dangerous.

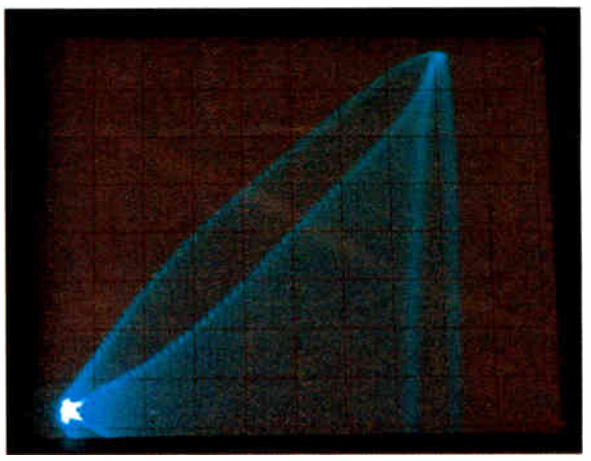
This audio lead is connected to the X-axis of the scope and the RF lead is connected to the Y-axis. Once this is hooked up with no modulation, you should have a single vertical bar. As we did before, set the Y-axis gain to give you the proper amount of vertical deflection without modulation (e.g. 1.6 graticules above and below the center line).

As you add modulation you should see the scope display open up to a trapezoid that looks like a left arrow. The X-axis (audio) channel gain can be adjusted to give the best display and is not critical other than keeping the display within the edges of the screen. I prefer to adjust to a point that it just fills the screen.



Positive modulation peaks are shown along the vertical axis, negative modulation is shown as driving the trapezoid toward a point.

Once again, the results you are looking for are no excursions above the top line on positive modulation. (For the negative modulation you are looking that there is no flat line sticking out to the left from the point of the waveform.) Others with whom I have spoken are familiar with the axis of the pattern being rotated; if you prefer that type of display then simply swap the X-Y inputs and reverse the instructions.



Looking at only the top half of the waveform, 125% is shown at the top-right of the screen, -100% is when the bottom left goes to a point.

In the pictures presented, you will notice what appears to be a Lissajous pattern. This is caused by a small amount of RF getting into the audio sample. As you can tell, it takes some effort to get this test set up working, although the result it a very accurate display of your modulation peaks.

Of course, the best, easiest, and most accurate way to measure AM modulation is to have a calibrated monitor on hand. One of the current digital models like the Wizard from Belar will provide data to prove compliance with the FCC Rules.

Despite the relaxing of the Rules in recent years, a working modulation monitor really should not be considered an option, but rather an important piece of test gear for any station. Having been fooled a few times, I do not trust the oscilloscope method as much as I used to. It still is a valid method of determining modulation but you have to be very careful when setting it up and interpreting the results.

Next time we pass the baton to Lyle Henry for some comments on the various options you have to measure FM and SCA modulation.

Alan Alsobrook, a frequent contributor to Radio Guide, is a contract engineer and ABIP inspector based in St. Augustine, FL. Email Alan at aalso@bellsouth.net

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Studio Guide

by George Zahn

The Condenser Microphone

Getting the best sound means picking the right microphone for the job. As George Zahn shows, this requires taking several factors into consideration.

At the outset, we asked you to consider the critical fact that virtually every recorded music note, sound effect, or voice originates at a microphone. Given that different types, or families, of microphones function in dramatically different manners, the properties that make them different also make them suited for various areas of recording.

Just as I would not derive the full benefit of zipping along the Autobahn in my Toyota Echo, cruising a Hummer through a Greenpeace convention, or tooling into the local biker joint on my Schwinn Stingray, you will not get the full benefit of a microphone's technology by using it on the wrong instrument or in the incorrect location.

MICS HAVE CHARACTER

Last time, we lovingly likened the dynamic microphone family to dogs, but not in a derogatory manner. Rather, we focused on the qualities of dogs that make them so loveable – durability, dependability, and predictability.

While the dynamic microphone family is not great for high frequencies, they do stand up to the most brutal conditions. The dynamics can handle high sound pressure levels and rough handling, and deliver consistent quality, albeit not the greatest response across the entire frequency spectrum.

Now, we look at the second of the three major microphone families, a group that would send Dr. Phil to the couch. They are enticing yet complex, capable of greatness yet sometimes finicky, and versatile yet expensive. If the dynamics are the "dog" microphones, the condenser microphones are the "cat" microphones.

The AKG C-3000 condenser microphone.

You will find them in recording studios everywhere and they are a must for your microphone arsenal if you are planning to record any string instruments or want the best compromise of price versus really rich voice quality for your purchase. Let us see how the condenser, or capacitor microphones, purr.

BUILDING ON A "TENUOUS RELATIONSHIP"

As we indicated, we are moving up a bit in overall quality and price here, although I would like to repeat that you can find some cheaper condensers that cost less than the better dynamics. Of course, you usually run the risk of "getting what you pay for" at the lower price points in any microphone family.

It basically comes down to what you need: a microphone to use for your home vacation video that you might show to your neighbor (if they will sit still that long), a microphone that is going to record music going into millions of iPods around the globe, or a digitally recorded music hall concert.

The moving element in the condenser family consists of a very light "floating plate" which is often a flat, round, charged piece of mylar. It is tenuously suspended a very short distance (microns) away from an oppositely-charged "fixed plate." The two plates form a "capacitor," hence the original name for this family. When the floating plate moves, it alters the electro-static balance between the two plates and that creates a very weak electric audio signal.

As we learned from the dynamic microphones, weight plays a key role in determining how well the microphone responds to frequencies. To recreate a sound at 15 kHz, the microphone's diaphragm or floating plate must vibrate the corresponding 15,000 times per second.

Pure inertia in a dynamic microphone prohibits most of them from being able to accurately move that quickly. Even the absolute best dynamic microphones will have a difficult time reproducing the higher frequencies in the musical spectrum. The condenser element is lighter, and therefore, more conducive to "hearing" those higher frequencies, and that is what makes this family indispensable for music and some voice reproduction.

TUBE BE OR NOT TUBE BE

If you have heard about the relatively new group of "tube" microphones, you will want to know that they are part of the condenser family. The goal of the tube microphones is to provide the brilliant high frequencies of the condenser family with the "retro" warmth of older tube amplifier technology.

Many artists feel that the "warmth" or trueness of the audio from these microphones rival the impeccable quality of more expensive ribbon microphones. It still boils down to this: microphone choices are highly subjective and if you can try one before you buy it, it is a great idea to do so and see if the sound truly fits your needs.

Now we all know that nothing in life comes without a trade off, so what is the catch? Why do we even deal with dynamic microphones if the condenser family is generally "more true" across the frequency spectrum?

Here is the "411" on the baggage of condenser microphones: Condensers need to be powered and they are not as effective in high humidity conditions as dynamics. They tend to be more expensive and at least one sub-family of the condensers has a limited shelf life.

FROM A WHISPER TO A ROAR

We mentioned that the small, light plates of the condenser microphone create a very weak audio signal. That signal would be nigh unusable if it were not for a small amplifier built into the microphone (usually located in the handle). This amplifier elevates the audio signal enough to allow the condenser microphone audio to be easily mixed with the more robust signal from dynamic microphones.

The floating and fixed plates also need to be charged, and the power to the microphone is used for that purpose as well. That power is supplied by one of three sources depending on the model of microphone: a battery, an external plug-in power source, or by phantom power which is supplied to the microphone down the cable from a multi-channel mixing console.

Condensers can be finicky about the specific power rating that comes from the outside source. For example, if a multi-channel console is not pumping out the correct power for that microphone, it likely will not work with that phantom power source.

For that reason, many upper-end microphones also come with their own "plug-in" power sources. The source plugs into an AC outlet and has a barrel connector that inserts between the console and the microphone to provide the power needed. Phantom or plug-in power supplies are obviously more dependable than battery power and are suggested especially in live sound applications.

ELECTRET MODELS

Electret condenser microphones offer a slightly lower price point within the condenser family. The electrets range from the built-in variety on many cassette and digital recorders to the Shure SM 81, a relatively inexpensive but good quality microphone for piano or string work.

The electret microphones have a "permanently" charged floating plate. The ion-charged coating on the floating plate lasts 15-20 years and many manufacturers allow you to return the microphone for a replacement plate for a fee after the charge on the plate eventually wears out. The very thin extra coating on the floating plate does add a slight weight, and again, any additional weight can prevent the microphone from reproducing highs.

In addition, electrets still need power for the onboard amplifier, so the only real difference is a slightly lower price than you would pay for a true condenser microphone.

THE BEST COMPROMISE

First we get you all excited about condensers, then we hit you with the drawbacks. Why do we even deal with these temperamental denizens of microphonedom? To be honest, the condensers are the best compromise of overall frequency response and price. They cost more as a family than dynamics, but they perform better if you understand their limitations.

A good example of a basic true condenser at a reasonable price is AKG's C-3000. This model is one of the staple microphones used on many of Public Radio producer Jeff Towne's recordings for the Echoes living room concerts with John DiLeberto.

The microphones are versatile over a wide array of bright string instruments and, in this case, they are used in a controlled indoor environment. On a personal note, I have used some condenser microphones outdoors in summer concerts in Cincinnati with 90-plus percent humidity. They have generally performed well even under such duress. Still, in the words of most disclaimers, "your results may vary."

THE MIC WEARS PADS

While the condenser's built-in amp is a critical tool to have much of the time, realize that if you are miking a very loud sound source, most quality condensers have a 10 dB pad, which allows you to attenuate the audio entering the amplifier to avoid overload distortion within the microphone. (For the novice, if there is a switch with a "-10" on your microphone, you are dealing with a condenser.)

A Shure SM 81 with the 10 dB pad engaged.

Remember that the amplifier in a condenser microphone is just that – a stupid amplifier. It lacks the ability to judge when incoming audio is getting too hot, so when it reaches a certain point, it will definitely clip.

If there was an Emmy awarded for "Worst Use of a Microphone on a TV Talk Show" it would have to have been the late, late Morton Downey, Jr. show which welcomed dramatically opposing sides on a

(Continued on Page 18)

Studio Guide

by George Zahn

The Condenser Microphone

Continued from Page 16

volatile topic with a baiting and rowdy audience. The opponents stood at podia called "Beef Boxes" and shouted at each other in front of the frenzied crowd.

The microphones at the Beef Boxes were Shure SM 81's when a dynamic microphone would have been a much better choice. Even with the 10 db pad activated, the microphones were often driven to distortion as the poor little amplifiers in the microphones just clipped away like a lawn mower! Any dynamic microphone, possibly a Shure SM 58 at a third of the price, would have performed better.

MULTIPLE ELEMENTS

There is one other benefit to condenser microphone design: it is possible to put two individual elements in one microphone enclosure, or capsule. By changing the electrical response between those two elements, we can create different pickup patterns from one microphone.

A "switchable pattern" condenser microphone can have patterns ranging from omnidirectional to unidirectional to a figure 8 (bidirectional) pattern. Please keep in mind that the bidirectional pickup pattern of one of these switchable pattern microphones looks less like a smooth "figure 8" and more like an apple core.

Selector switches permit pattern selection, as well as output level and bass rolloff.

The side rejection can be pretty severe, but remaining on-axis at 0 degrees or 180 degrees will provide nice pickup.

Some of the most famous and popular switchable pattern true condensers are the classic Neumann U 87 or U 89 (often seen as a classic vocal microphone in music videos) or the popular piano microphone AKG C-414. Many will purchase microphones such as the 414 in matched pairs if they intend to do any coincident or stereo piano miking.

SEEN EVERYWHERE

You will find condensers in many other applications.

Most of the better lavalier microphones for TV work are now nice quality condensers. Many stereo microphones (two individual elements in separate capsules providing a left and a right output on one microphone handle) are condensers, including the Neumann USM-69.

Specialty microphone series such as the Schoeps Colette System Microphone (one handle with many interchangeable elements, each with its own pickup pattern) are geared around the lighter condenser element. Even the Neumann "dummy head" microphone setup for binaural recording uses two condensers built into the noggin.

So there we have it: the finicky, complicated, yet unavoidably wonderful world of the condenser microphone. It is good to have at least a few of these around if you plan to record or broadcast music or want extra detail on voice work.

Fortunately, unlike the proverbial cats and dogs, the dynamics from our last article and these condensers do get along well the studio or at the remote.

TIEING IT UP WITH A RIBBON

So now you know all about the main microphone families. Well, actually there is one more – the one that was made popular in radio's Golden Age, the one Johnny Carson demanded to be on his desk, the one that exceeds the condenser in overall quality and possibly has the richest history and the richest sound of all microphones.

Next time, we will wrap up our microphone overview with the ribbon microphones.

A part of the renowned staff at WVXU (when it was at Xavier University), George Zahn is the Station Director at WMKV-FM in Cincinnati, OH. George can be contacted at GZahn@lifesphere.org

Contract Engineering

by Scott Cason

How to be a Contract Engineering Star

In 1979, The Statler Brothers had a song hit on the charts called "How to be a Country Star." In it they detailed, in tongue-in-cheek fashion, traits needed to be a country music star such as whispering like Bill Anderson, "Yo-yo'ing" like Roy Acuff or telling jokes like Minnie Pearl.

Hearing that song on the radio the other day got me to thinking about how to be a "broadcast engineering star." Or, more specifically, what it takes to go out on your own to be a contract engineer for broadcast stations.

I came up with a few ideas I would like to share with you in the event you are contemplating leaving the safe, corporate world of engineering and entering the wild, wild west of contract engineering.

POST CONSOLIDATION

One of the results of consolidation over the past decade is engineering talent suddenly finding themselves under-employed or out of employment. Some of these folks found their way into cellular and land-mobile services.

However, many others just could not get radio out of their systems. After spending 12 years in television, I eventually made my way back to my first love, radio. Still, I grew tired of the corporate grind of being Chief Engineer for six radio stations and being constantly tied to a cell phone.

Therefore, in December of 2004 I left corporate radio and formed my own engineering, contracting, and consulting firm. I have not looked back.

A JOB NOT FOR EVERYONE

One thing that I must emphasize: it is not for the weak of heart. You must be a self starter with the uncanny ability to sniff out work where there normally would be none. (I have had mixed results with this ability.)

I recommend planning in advance – start at least a year in advance of your flying solo. Work on getting your name out; call and network with station owners and managers. Possibly have several clients already lined up for regular work before just going cold turkey.

As you do this, be careful to steer clear of any appearance of conflict of interests with your current employer. I went so far as to not call on stations within the market in which I was employed until after I had left my employment there. Most of them already had full-time engineers anyway. I concentrated at first on contacting the smaller stations out in Kentucky, Indiana and Tennessee.

THE "COVERAGE AREA"

A major issue to decide on is how far you are willing to travel from home. This is something that each individual person has to resolve for themselves.

Since I have a younger daughter, I decided on a 250-mile radius of Louisville and drew a circle with a 250-mile radius on a road map. I then grabbed a copy of the M Street directory and started calling. I never have been much of a sales person, but making cold calls will teach you quickly.

Lesson #1: Do not take "no" personally. Some radio stations already may have contract guys they use. Some may simply not have any upcoming projects and some owners do not realize the importance of good engineering practices as yet. Also, realize the time you call might not be a good time for the person to whom you need to talk.

INTRODUCTIONS

Keep your introduction short and sweet. Then ask for an address where you can send more information about yourself and what you do, so that they may read it at their leisure (and, one hopes, be more receptive to it). Keep the mailing short, too. Outline your past experience, what you have done, and where. List a couple of people (with their permission) they can call for references and a way to contact you should they need your services.

After getting over my initial shyness, I came to enjoy this part. Especially talking with receptive owners and managers who wanted to engage me in a little more than just who I am and what I do. In fact, I wound up talking to one station owner over in Benton, Kentucky for an hour and a half! A key trait is the ability to sell, since you will be selling yourself and your services to station owners and managers.

Lesson #2: If you ever expect to get any work, you must make a good impression. If an owner/manager went so far as to ask me to meet with them I wore a coat and tie for that first meeting. It surprised several of them because they expected me to show up dressed like Johnny Fever. I made the impression they will not soon forget.

By the way, the more talents you have, the better off you will be. For some, transmitters are "where it's at." Others like computers, and still other folks like working on audio equipment. Now if you can work in all three areas, your stock goes up and opens up more places you can work. Personally, I love transmitters. But I will not turn down a job installing a new automation system or moving a studio or two. Sometimes other engineers will feed you work in areas they prefer not to handle.

One final thought on introductions: do not embellish your abilities. If you want to ruin your reputation real fast, tell a station owner you can do something then, when it is time to prove it, fail. Managers and owners network the same way engineers do.

THE MONEY PART

Lesson #3: Do not expect to immediately bill what you are presently making in salary. Do have some backup cash for you to live on until work starts to roll in. Or a part-time job.

This is why it is good to have several clients lined up *before* you leave your current job. I have known some guys who were lucky enough to get a contract close to what they made in salary. But those situations are few and far between. It would be best to not plan for it, but have some sort of backup plan "just in case."

Part and parcel of generating enough income: carefully calculate how much to bill. You do not want to undercut yourself (do not forget tools, taxes, and health insurance), nor do you want to cut yourself out of the market.

I knew already what other contract engineers charged in the area, how long they had been doing it, and what they could and could not do for a broadcast station. I settled on a figure that, so far, the market seems to be supporting.

You will also need to be flexible. Some clients like hourly charges, some want to see charges based on a full day's work or what you would charge for an entire project. Engineers who know AM directionals can charge more than engineers who do not; engineers who can work on IT systems can charge more than engineers who cannot.

THAT "OTHER" PAPERWORK

You can keep up with most of your accounting and billing activities in computer software that is very affordable. I rely on QuickBooks. You easily can find out how much income your business generated and the expenses associated with making that money. It can also tell with a few clicks what clients still have outstanding invoices.

You should also find a reliable accountant and an attorney who are familiar with small business affairs. My accountant put me on the right track on how to file the quarterly tax reports to the IRS and the State of Kentucky. He is really going to earn his money over the next few months when we settle up with Uncle Sam.

An attorney will come in handy for several reasons. After I drew up a standard maintenance and service contract, I had him look it over to make sure it conformed to Kentucky's laws. The contract will be useless if it cannot stand up to the laws of the jurisdiction in which you do business.

Sadly, without a doubt, you will run across a client or two who just will refuse to pay your invoices. An attorney will help in navigation the laws of your jurisdiction in getting paid. Often, a well-written legal letter from your attorney is enough to show an owner/manager that you mean business.

The thing to remember about accountants and attorneys is their fees go up in direct proportion to the work they do for you. Therefore, use their services wisely.

MAKING IT HAPPEN

Once you have staked out your territory, put your shingle out, and figured out how much to charge, what is next? Well, now you wait a bit; it will take time for people to find you. But you still have to do your part.

Lesson #4: Promote yourself. One inexpensive way to do this is with a website.

I registered my company's name and put up a simple website outlining who I am, what I do, and how to get in touch with me (http://www.lagrange-com.com). I then put the website address on everything I can. Business cards, stamps, letterhead, even the return address on my envelopes has my website address on it. It is also kind of cool to have my email address with my company's name in it!

But the best way to get your name out is word-of-mouth from others. Obviously, though, they have to know about you to "pass it on." For example: two of my clients had a need; they called other owners and found someone they knew with the information I mailed out earlier. I also registered with the SBE as a contract engineer and gave them the contact information.

NETWORKING

Network with managers/owners. Joining your state and/or regional broadcasting association is a great way to do this. Regional broadcasting gatherings are good places to meet managers and owners and talk to them about your engineering abilities and their engineering needs. Plus, the state associations have some pretty good golf outings for the members.

As you drive by a small radio station, stop in for a visit. As with cold phone calls, you do run the risk of showing up at a bad time. If that is the case, leave a couple of business cards and make a quick departure. If you are dressed for a Hawaiian vacation, change your shirt. Remember: first impressions.

Network with other engineers. You can always learn something new from someone else – and your name will be at the top of their list if they need backup or a spare set of hands. And Barry Mishkind runs a great mailing list that has engineers from all over on it (www.radiolists.net). You will find many engineers more than willing to help anyone with an honest problem or question that needs to be answered.

Scott Cason is indeed a contract engineer. He is based in Louisville, KY. His email is: scott@lagrange-com.com

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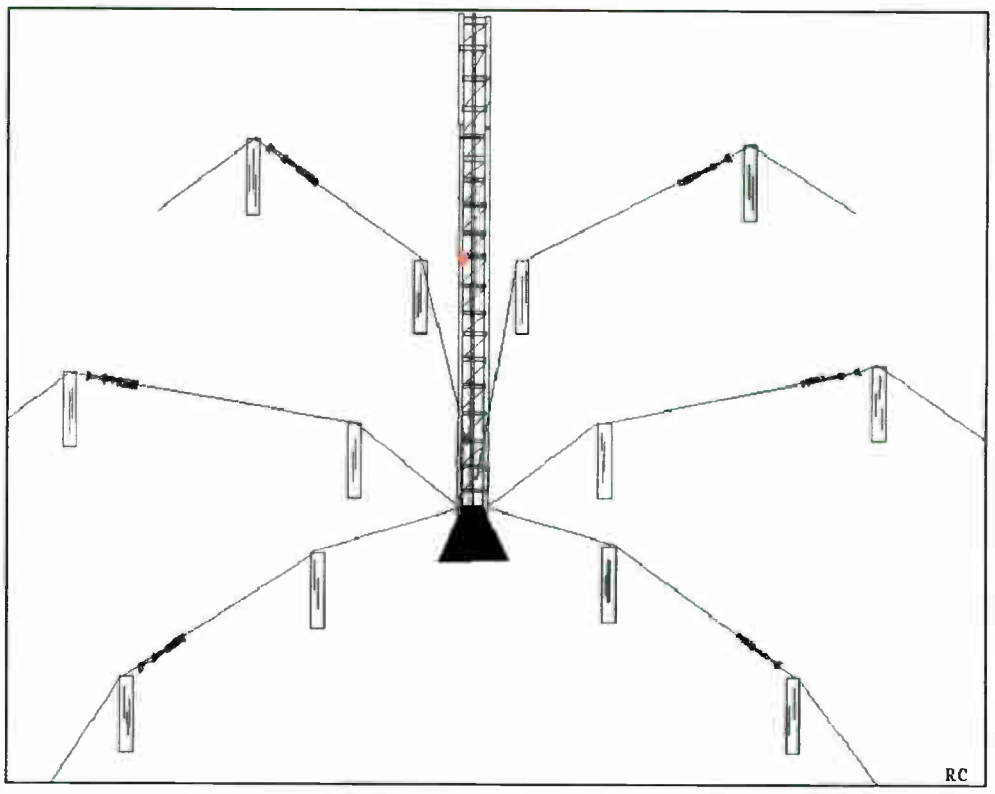

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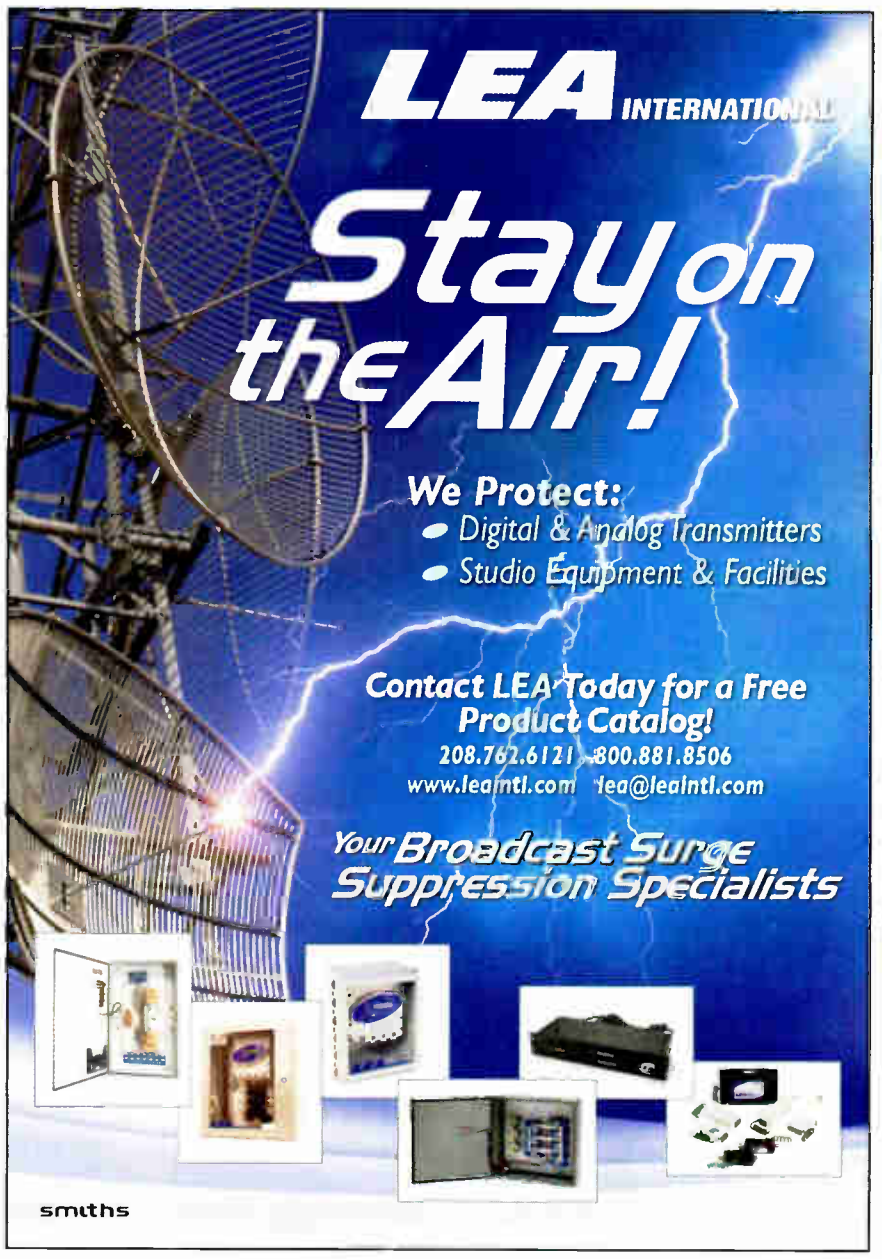


Radio History

by Kevin Webb

Tesla and AC Electricity
The Personal and PR Wars with Edison

2006 is the 150th year since Nikola Tesla's birth. For many, Tesla – possibly the true Father of Radio – remains "The Forgotten Inventor." For that reason, we are featuring a number of articles on Tesla and his inventions. As you will read, Kevin Webb has a passion for the truth about Tesla's life.

In many industries, fame comes not necessarily to whoever has a pioneering idea or invention, but who was the better "promoter." As examples, the history of the early years of broadcasting is often deemed obscured by the claims of the Westinghouse and AT&T PR Departments for KDKA and WEAF. But, in terms of our story today, it started well before that.

A small warning before we get started: if you are a big fan of Thomas Alva Edison, hang on because this is going to be a bumpy ride. Seriously. Because Edison, "The Wizard of Menlo Park," electrocuted a live fully-grown elephant. Absolutely fried it alive until it could stand no more on its own. On purpose. In front of a huge mob of people and the press.

And he did it all to prove a perverse point: that Nikola Tesla's invention – AC electricity – was evil and dangerous, but Edison's DC power was so very safe. But that is not nearly the worst of it. Get ready to be shocked (pun intended).

TRUE HISTORY IS NOT ALWAYS PRETTY

While it seems like you might have peeked at the end of this article already, you have no idea as yet what terrible fact climaxes this story about Edison (one of America's "beloved" inventors) and Nikola Tesla.

On the other hand, as you read, it may well dawn on you why Tesla's name largely has been lost to history – and how effective marketing, however cruel, kept Edison's name above that of a genius who was arguably (some would say unquestioningly) the superior inventor.

Keep in mind this is not tabloid gossip or history embellished. In fact, the entire sickening public display was one of the first events recorded with a new technology invented by Edison[1] that captured moving images on film as irrefutable evidence! The scene captured on film was replayed for audiences everywhere. Sadly, Edison apparently convinced the ASPCA that electrocution was a more "humane" way to kill an elephant than by hanging it.

THE AC DC FIGHT

The reason Edison had Topsy the Elephant murdered with Tesla's AC power in 1903, in front of a wide-eyed mob at Coney Island in New York, was to demonstrate "the horrible consequences of alternating current."

Edison was hoping to so thoroughly disgust people and make them shun AC power that there would be such a huge groundswell of negative publicity and such uproar from the public that no one would dare convert to AC power. 'AC was *not* to be trusted because, well, it is evil! And dangerous! Do not get near it or it will kill you and ruin this country.' Or so Edison wanted everyone to believe.

Edison was quite willing to kill to prove his point. Sadly the elephant was only the *partial* culmination of numerous animals put to death in such a grisly and public display via these staged electrocutions, all in a lurid campaign to smear Tesla's good name.

As you can imagine, there was also a significant amount of money at stake.

NEGATIVE CAMPAIGNING

When Edison could not argue his point against alternating current logically, he resorted to a smear campaign against Tesla and AC power with scare tactics. "Just as certain as death [AC power] will kill a customer within six months," he declared.

In reality, quite the opposite was true. The DC power infrastructure was so inefficient that DC generating stations had to be placed every one and a half miles. Massive copper cables were required to transport the DC current.

When it rained and the ground became saturated, the large buried cables leaked enough power that horses were electrocuted in the streets of New York City. People were receiving significant shocks as well, some resulting in death, all because the thick DC cables leaked so much power to the earth around it.

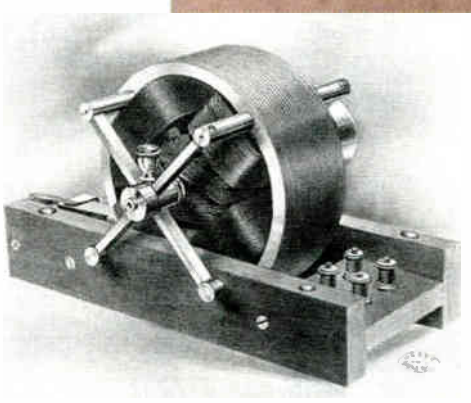
However, the giant PR machine had already snapped into action.

A DIFFERENT BEGINNING

Ironically, Nikola Tesla was a huge fan of Edison's when he first arrived in the US in 1884 literally fresh "off the boat" as a newly immigrated Serbian with four cents in his pocket.

Armed with a letter of introduction from Charles Batchelor, Manager of the Continental Edison branch in France, Tesla approached Edison to inquire about a job. "I know two great men and you are one of them; the other is this young man," said the letter of introduction. The timing was perfect as Edison had an immediate need for an engineer. Tesla was hired immediately and set out to fix one of many emergencies.

During his introduction, Tesla attempted to explain his theories for alternating current saying it was the wave of the future. Edison's response: "Hold up! Spare me that nonsense. It's dangerous. We're set up for direct current in America. People like it, and it's all I'll ever fool with."



AC or DC, that was the question.

A LONG-STANDING ENMITY

Though Edison admired Tesla's amazing work ethics where he most often worked 18 hour days, this set the stage for their eventual falling out. Edison was simply too financially invested and was too proud to admit AC was a superior system.

As related in an earlier article, Edison offered Tesla a large sum of money to solve a vexing problem. When Tesla, after a year of hard work, solved the problem, Edison reneged on the agreement, trying to turn it into a joke. Tesla literally turned his back on Edison and walked away, forming his own company. Edison never forgot how his former employee "turned" on him.

Edison mistakenly believed that the carbon filaments in his light bulbs would only work best with DC. It took more than twenty years after AC began flowing from the Niagara Falls generating station for Edison to finally admit his error in not understanding AC's superiority over DC.

TWO INVENTORS, TWO SOLUTIONS

The early debate of AC vs. DC was fast and fierce:

Nikola Tesla: "Alternating Current will allow the transmission of electrical power to any point on the planet, either through wires or through the air, as I have demonstrated."

Thomas Edison: "Transmission of AC over long distances requires lethally high voltages and should be outlawed. To allow Tesla and Westinghouse to proceed with their proposals is to risk untold deaths by electricide."

Tesla: "How will DC power a 1,000 horsepower electric motor as well as a single light bulb? With AC, the largest as well as the smallest load may be driven from the same line."

Edison: "The most efficient and proper electrical supply for every type of device from the light bulb to the phonograph is Direct Current at low voltage."

Tesla: "A few large AC generating plants, such as my hydroelectric station at Niagara Falls, are all you need. From these, power can be distributed easily wherever it is required."

Edison: "Small DC generating plants, as many as are required, should be built according to local needs, after the model of my power station in New York City."

WESTINGHOUSE ENTERS THE FRAY

George Westinghouse, who made his fortune inventing the railroad air brake, quickly recognized the benefits and potential financial reward of a vastly more efficient method of delivering power to the world using Tesla's AC power. He even shared Tesla's idea of using Niagara Falls hydroelectric potential.

Tesla and Westinghouse worked together to adapt Tesla's single-phase system. Westinghouse's engineers originally chose 133 cycles as the preferred standard. However, Tesla explained this would not do as his original AC motor was designed to work best at 60 cycles. After months of expensive testing the engineers realized Tesla was correct and from that point on 60 cycles became the standard.

Once Edison found out about Westinghouse and Tesla working together to create the alternating system, he was so outraged that he set out to discover or "manufacture if necessary" the hazards of AC current. Personal pride and Edison's ego were at stake, not to mention the fortunes he made from DC power.

CRANKING UP THE ANTI-AC PR MACHINE

George Westinghouse himself had said "I remember Tom [Edison] telling them that direct current was like a river flowing peacefully to the sea, while alternating current was like a torrent rushing violently over a precipice. Imagine that! Why they even had a professor named Harold Brown who went around talking to audiences ... and electrocuting dogs and old horses right on stage, to show how dangerous alternating current was."

It was Harold Brown, hired by Edison, who wrote a letter to the New York Post describing how a boy was killed after touching a telegraph wire running on AC current.

(Continued on Page 26)

by Kevin Webb

Tesla and AC Electricity

Continued From Page 24

Edison's henchmen, including the good Mr. Brown, first began roaming the boroughs of New York in the 1880's, armed with a sheet of metal connected to an AC generator by a pair of wires. Edison paid neighborhood children 25 cents to catch stray animals for this demonstration. Dogs and cats soon began disappearing from around Edison's laboratory in West Orange, New York.

DEMON-STRATIONS

A small cute little kitten or puppy was placed on the sheet metal. Edison then connected the two wires to the AC generator and announced to spectators, "Ladies and gentlemen, I shall now demonstrate the effects of AC current on this dog." A lethal AC voltage electrocuted the helpless little animal in front of shocked and sickened spectators. It was at these events that the term "electrocution" came to be used.

Eventually full-grown cats and dogs were used, then calves and small ponies and, you guessed it, full-sized horses and cows. The ultimate culmination of the "war of the currents" came about when a murderer on death row in New York State was to be put to death with a new invention called the Electric Chair.

Edison employees Harold Brown (who was a part of the public killings of animals) and newly hired Doctor Fred Peterson designed the first practical electric chair to publicly demonstrate that DC current applied to lab animals left them tortured but not dead. They then applied AC power to show how swiftly AC killed. The electric chair was designed to use AC power and was driven by Edison's desire to show that Tesla's AC was more lethal than Edison's DC.

Doctor Peterson headed the government committee to select the best electric chair design while still on Edison's payroll. AC power was, not surprisingly, chosen as the best method for the state's prison system. Westinghouse refused to sell any AC generators for this purpose (and even paid for the death row prisoner's appeal). Edison and Brown provided the AC generators needed for the first person executed by the electric chair on August 6, 1890.

PR WORKS

Of course we now know that AC is not "evil" – unless you have been "bitten" while working on an open circuit![2]

It is hard to believe Edison stooped to such a sickening level because of his abject fear (and/or enormous personal pride) that AC electricity would replace Edison's extremely lucrative DC power infrastructure in which his company, General Electric was deeply invested. Yes, *that* General Electric, now known as GE.

Edison's brilliant marketing of himself and his image was so thorough and remembered for the ages that you may still remember him as a kindly, even grandfatherly character that single-handedly created hundreds of inventions. The truth is many of his *employees* actually did the real inventing while Edison simply claimed the credit for the inventions as his own.

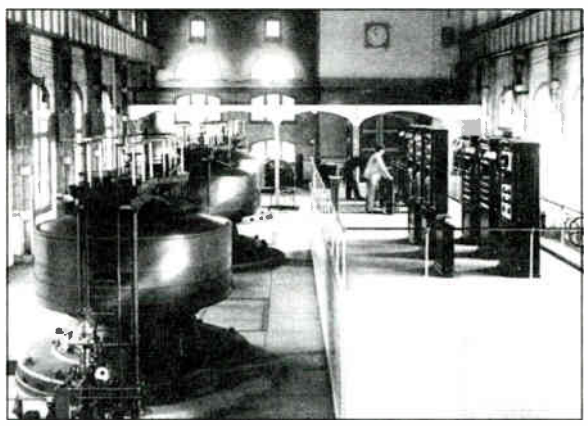
Curiously, *The Smithsonian Book of Invention* completely omits Tesla and credits Edison(!) with the development of today's AC power system. The first edition, written by Dr. Bernard S. Finn, contains many mentions to Edison in the chapter entitled "The Beginning of the Electrical Age" but Tesla's name is omitted altogether.

As a final insult a caption under a picture of the Niagara Falls generating station reads "When the Niagara Falls power station began operating in 1895, it signaled the final major act in the revolutionary drama that began in Menlo Park in the fall of 1879." None of this is true. Yet people have been so brainwashed by Edison's highly effective marketing of himself and his image, Tesla's name has all but been forgotten.

CRUEL IRONY

Even Westinghouse was recognized for the advancement of AC power which, simply put, completely revolutionized the industrial world and ushered in a new era of convenience through effective power transmission.

In 1912, Westinghouse was awarded the Edison Medal by the American Institute of Electrical Engineers for his "meritorious achievements in the development of the alternating current system." Tesla's name faded into the background.



The power plant at Niagra Falls.

One more important fact of history needs to be illuminated: Shortly after November 16, 1896, when the big switch was thrown at the Niagara Falls generating station for the first time, Westinghouse's electric company was ripe for a takeover by the robber barons at that time.

Westinghouse appealed to Tesla asking for a way out of the royalties that were rightfully due Tesla from his inventions. In a generous and history-making gesture, Tesla tore up the contract thus releasing Westinghouse from having to pay a penny. At that point Tesla gave up a huge financial fortune for the sake of mankind.

Of the 13 patents listed on the Niagra Falls generator, nine belonged to Tesla.

Tesla so believed in AC power's ability to revolutionize the world that he let go of a contract that would have paid him many millions of dollars. It has been estimated that with the wealth he could have made from his inventions he would have been the Bill Gates of his time. In return, he was often forgotten, sometimes even crudely edited out of pictures – for example, in one with Albert Einstein and Charles Steimetz: http://www.radlab.com/information/tesla.html

On the other hand, Edison was (how shall I say it in a polite way?) *not* a very nice person. In fact Edison's actions in this "War of the Currents" were cruel, evil and vindictive at the very least. Edison's fight against Tesla was certainly based on the fact a lot of money was at stake, but many believe Edison had a personal vendetta against his former employee.

AN INTERESTING "WHAT IF?"

Just stop for a moment and imagine what could have been accomplished had Edison – who truly was a prescient individual in his own right, even as he appropriated other's work as his own – opened up his heart and mind and worked *with* Tesla instead of against him.

"*Were we,*" remarks B. A. Behrend, distinguished author and engineer, "*to seize and to eliminate the results of Mr. Tesla's work, the wheels of industry would cease to turn, our electric cars and trains would stop, our towns would be dark, and our mills would be dead and idle.*" And that could apply to AC electricity alone, never mind Tesla's more than 700 patents.

And as Paul Harvey would say, "Wash your ears out with this:"

"I do not think there is any thrill that can go through the human heart like that felt by the inventor as he sees some creation of the brain unfolding to success. Such emotions make a man forget food, sleep, friends, love, everything." – Nikola Tesla

Here are some addition reading references and pictures of Nikola Tesla:

- www.pbs.org/tesla/ins/index.html
- www.teslasociety.com/ac.htm
- http://inventors.about.com/od/hstartinventions/a/Electric_Chair.htm
- www.teslasociety.ch/info/CHICAGO_1893/index.htm
- www.teslasociety.ch/info/galerie/bilder/G42.jpg
- www.swehs.co.uk/docs/kphotos/teslamtr.jpg
- www.kerryr.net/images/pioneers/gallery/niagara_falls_lg.jpg

1. Actually motion pictures were invented by one of his employees somewhat against Edison's wishes. Edison thought it was a waste of time and would be of no value. But that is another story for another day.

2. While DC may be a more efficient application of power and perhaps "cleaner" than alternating current, DC current cannot travel over long distances via small cables like AC current can without suffering significant losses through resistance. In time, AC became the transmission standard for public utilities, utilizing voltages of 100 kV and higher, which were transformed down to lower voltages for residential, office or industrial use. Although less efficient, manufacturers had to make their motors and appliances compatible with the national electrical grid.

Kevin Webb feels Tesla got the short end of the "PR stick," especially from some of Edison's cruel tricks. The General Manager for Tieline Technology in Indianapolis, IN, Kevin can be contacted at kevin@tieline.com

Here is a clickable list of all the URL's listed in the Radio Guide articles:
www.radio-guide.com/URL.htm

FCC Focus

by Cary Tepper

Station ID Requirements

Everyone knows from Broadcasting 101 that each radio and television station must provide on-air identification throughout the day and night. However, people often are confused as to exactly what verbiage is required, and when.

SIMPLIFICATION

In 1968 the FCC commenced a proceeding to simplify the requirements for the broadcast of station identification announcements by AM, FM and TV stations. At that time, stations were identifying themselves at the top and bottom of each hour, as well as at quarter hour intervals.

Many stations were improvising on these IDs and included information beyond the station call sign and community. To some extent the integrity of these IDs was in question.

When the Rule revision proceeding concluded, the FCC emphasized that "licensees are expected to observe the regular identification times unless there is a substantial reason in the form of undesirable interruption to program continuity for not doing so, and if an announcement at the regular time is omitted for this reason, to present it at the earliest opportunity."

THE ID

As a result of the 1968 proceeding, the station identification placement requirements of FCC Rule 73.1201 are (1) at the beginning and end of each broadcast day, and (2) hourly, as close to the top of the hour as possible, at a natural break in the programming.

Although the FCC's Rules do not define "natural break," the administrative history of the station identification rule indicates that there is no iron clad moment that should be labeled a "natural break."

The FCC suggested that a natural break occurs at the end of a regular period in a sporting event, the end of a live or recorded musical selection, the end of a live musical performance, or at the end of a variety or drama show. A natural break also occurs if there is an intermission.

CONTENT

Your station's identification should consist of the station's call sign immediately followed by the community or communities specified in its FCC license.

You are also permitted to insert the licensee's name, the station's frequency, the station's channel number and/or the station's network affiliation between the call letters and station's location. And, you are permitted to include additional communities in the ID so long as the community to which the station is licensed is named first.

In the early 1970s, several radio stations were found to have included content in their station IDs that misled their listening audience into believing that the radio station was licensed to a community other than the actual community of license. These stations were fined $2,000. So be sure to announce the station's actual community of license first should you wish to include additional nearby communities in the ID.

Although you are not required to include your station's operating frequency in the ID, you are required to announce the actual dial position if you choose to include frequency information. Therefore, if you broadcast on 101.3 MHz, you cannot announce "WXYZ 103, New Town." The correct ID would be "WXYZ 103.1, New Town."

SATELLITE STATIONS AND SLOGANS

If you operate a radio station that has secured a studio waiver from the FCC which permits that station to operate as a "satellite" of another radio station, the originating station may make identification announcements for the satellite station.

Each broadcaster must remember not to confuse its station's slogans with the required station identification. Slogans such as "The Coast 98," "Z-93 FM" or "Sacramento's Original Oldies 107.3" are not acceptable station IDs for FCC Rule 73.1201 purposes. Such slogans can immediately follow a proper station ID, but they are no substitute for the real thing.

Although it is rare for the FCC to issue a Notice of Violation simply for failing to broadcast a proper station ID, when station ID violations are coupled with other operational problems, the FCC has fined broadcasters up to $1,000 for *each* instance of improper station identification.

MAINTAIN OVERSIGHT

If any portion of your broadcast day is leased to a programming broker, you need to implement steps to require the broadcast of proper station IDs during that leased time. The FCC will hold the owner of the station responsible for any improper IDs broadcast by the programmer, regardless of any contract language in the programming agreement to the contrary.

Please remind your on-air staff of the proper station ID requirements. Tape a small sign to the on-air desk or studio wall with suggested language for all station IDs. Some very simple steps will keep you FCC compliant.

Cary S. Tepper is a principal of the law firm Booth, Freret, Imlay & Tepper, PC in Bethesda, Maryland. Mr. Tepper represents hundreds of commercial and noncommercial radio and TV stations. He can be reached at (301) 718-1818 or tepperlaw@aol.com

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Radio War Stories

by Phil Alexnader

The Tale of the FM Upgrade

Most of the time, aside from the tall towers involved, FM antenna installations are easier than AMs, especially if the AM is directional. Of course, that is now. A few years ago, things were a bit different...

Step with us now, into the Waaaay Back Machine for a tale of how a little station out in the "boonies" became an early Class B FM in a time when everyone was asking, "What's FM?"

FM HAS A SECOND CHANCE

It was a time long ago, about 40 years, or perhaps a bit more, and the FM band had just begun waking from its doldrums. The FCC had decreed a brand new system of station classes and mileage separations to go along with them.

At the time, I was running engineering for a small group of stations headquartered in a small town where they simulcast their AM program on FM with a little Gates FM-1B feeding an Andrew eight-bay "V" horizontal antenna on the side of the AM tower. We radiated almost 7 kW ERP.

That tower had its own story. It worked as an AM tower. And I am sure it thought it was an AM tower. But in reality, it was the remaining relic of the boss's misadventure into UHF-TV; a station that went dark with the realization that TV needed support from a larger market and was not just "picture radio."

It was a monster tower for a kilowatt small market daytimer not far above the middle of the dial and its 400+ feet made a great platform for a side-mounted FM. At least that is what we thought at the time, although the tower had its own idea, as we later learned.

AN OPPORTUNITY TO BUILD

Without waiting for an allocation table, I checked the mileage separations. *Yes!* We met the criteria for a full power Class B FM station under the new Rules and I explained this to the boss the next time he came to town.

I think I mentioned something about a time limit and that we should start thinking about filing for a power increase to 50 kW ERP in three or four months, when I had finished another project – building a three-tower directional AM about 100 miles away.

The boss exploded, asking why I wanted to wait. He wanted to file right then and there. "But, but, but, I can't be in two places at once," I protested. "And as soon as we file, the FCC will send us a grant, then what do we do?"

He chomped on his cigar, smiled, and told me I worried too much; the FCC *never* gave him a response in less than six months and I should (to clean it up a bit for a "G" rated publication) get busy and get the application done so he could sign it before he left town at the end of the week.

I put my work plans at the distant AM site on hold and canceled my trip that week in order to do the application. It all happened in a blur of little sleep and, at the end, I received my "see, that wasn't so hard, was it?" rhetorical question as he signed it on Friday afternoon.

THE TELEGRAM

One month later, almost to the day, his son, who acted as the station manager, called me at the AM job site and told me "we had a telegram that said something about an application being granted for the FM," and did I know anything about it. *(Editor's note: In the "Waaaay Back" time when Phil was young, the FCC used telegrams to send messages to stations.)(Author's note: Hey! Watch out with that "when Phil was younger stuff" or I may say something about Western stations getting messages via Pony Express when a certain editor was younger.")*

Meanwhile, the AM project was going sour in a hurry because we had a phasor that refused to phase, and it was clear pulling the pattern in and proofing it would take much longer than we thought originally. With the thought that I should write an application for extension of the FM CP, I told him to post the telegram on the board in the transmitter room and we would deal with it later – much later.

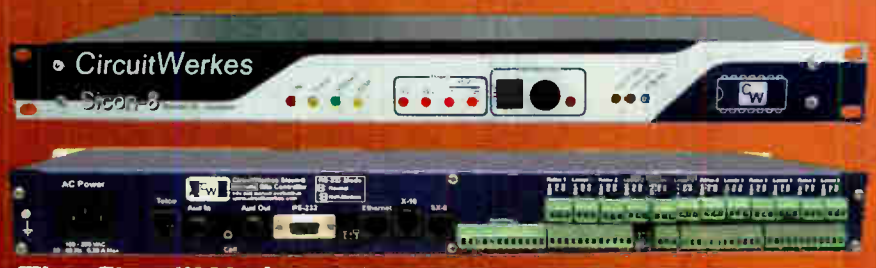
Fast-forward a few months: The AM project was done and the application for license to cover was filed. The application for FM extension had been filed because the CP was only a few weeks from its expiration date. And now, with a second telegram, our story really begins.

ALMOST, BUT NOT QUITE READY

With our not-so-new CP posted and a 90-day extension attached, the equipment ordered, delivery dates established, new power and breaker panel in-

(Continued on Page 32)

The New Sicon-8 Voice Remote Control



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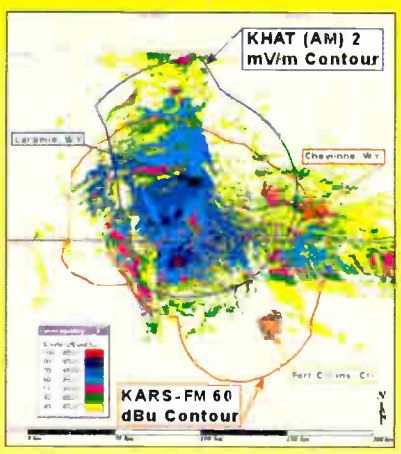

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Radio War Stories

by Phil Alexnader

The Tale of the FM Upgrade

Continued From Page 30

stalled, you might think we were ready to install the brand new Gates FM-10G when it arrived and begin operations at 50 kW. At least that is the way the boss saw it. But I had a few doubts and, as I mentioned, the tower definitely had other ideas.

In other jobs, the only time I had seen a VSWR meter move above 1.1:1 was during severe icing when someone forgot to turn the heaters on before the bays iced. The little FM-1B, however, seemed quite content to hang at about 1.7 on a year-around basis, moving slightly higher if we had icing conditions.

I had checked the meter with the transmitter connected to a dummy load, calibrated it, and there was little doubt that too much RF was going the wrong way in the pipe. However, with 1,000 watts from the transmitter going up 3-1/8 inch rigid line to an antenna rated for at least 10 kW input, it had never been a problem. However, it seemed logical that life might not be so simple when we began squirting 7,500 watts into the same pipe. Indeed, that is how the "investigation" began.

READY FOR A CLIMB

A tower crew was scheduled for the annual tower light bulb replacement so I got the brilliantly dumb idea of going up for a look at the antenna and transmission line while they were there to help. When you are young, foolish and *know* you are invincible, anything seems possible. And it *was* over 40 years ago.

The tower crew arrived on the appointed day and I explained what I had in mind. They grinned a little and said, "It's your neck – and we like extra money." So, the adventure began. While the crew did their usual work on the lights I packed a bag with adapters, wrenches, a 20-Watt dummy load and a VSWR meter. We signed the FM off the air for the afternoon because we *knew* everyone listened to the AM until it signed off at sunset.

Then, I reduced the output of the 50-Watt driver to about 20 Watts and checked the VSWR meter and dummy load. That worked, so we connected the driver directly to the transmission line, buckled up my trusty Klein belt – and up the tower I went.

I should add that all my previous climbing had been going just far enough to adjust AM sampling loops, but how much more difficult could it be? After the first 50 feet, I knew I was about to learn the answer. (OSHA would not exist for another ten years and safety equipment was a simple lineman's belt for resting on the way up.)

THE THRILL OF HEIGHTS

There was no safety harness, no lobster claws, nothing but hands and feet, arms and legs. Crazy? Yes, but that is how the tower crew did it, so I did the same – just a lot more slowly. As I said, anything is possible when you are young and foolish – and I was all of that. *(Ed. Phil, we will remember you said that.)*

I gave the climber the bag of tools and started up. The tower was hot and the FM line was grounded so caution was the order of the day. That tower had a very painful bite and my first one, a few months earlier, was enough to last a lifetime.

The tower was one of the old Stainless types that had nothing but legs and horizontal cross members so the sides were just like a ladder, but what a ladder! The "rungs" of this ladder were about two inches in diameter and they were over two feet apart.

Climbing that thing was a workout, and that is an understatement. My belt also got a good workout; each time I climbed about 25 "rungs" it was time to buckle up, lean back in the belt and take a break.

THE INVESTIGATION

At the top of the transmission line I put on an adapter, the VSWR meter and dummy load, called to the ground crew to have the RF turned on and got a good power indication, then moved step-by-step through the antenna checking each two-bay pair separately.

If you have never seen a multi-bay Andrew "V" at close proximity, they were constructed of two-bay pairs connected to combiner boxes. In other words, a four-bay antenna had two "V" pairs and a combiner box, and an eight-bay was two four-bay antennas with the combiner boxes fed by another combiner box – which is to say the antenna's RF feed branched like a tree.

Since each "V" pair was a complete antenna by itself and had a 50 ohm input, it made checking the sections on the tower a simple task, at least in theory.

(Continued on Page 34)

Radio War Stories

by Phil Alexander

The Tale of the FM Upgrade

Continued From Page 32

NOT WHAT WAS EXPECTED

The first check was inserting the VSWR meter between the top of the transmission line and the entire antenna. Hmmmm, 1.7:1. I naively thought the problem must be in one of the bays. After checking all four two-bay sections and the plumbing work that entailed, I knew something was drastically wrong.

The readings ran the gamut from 1.4:1 up to 2:1, and it was now clear that there was no way we were going to complete the CP without a modification and a new antenna.

The trip down the tower was only slightly easier than going up – those wide spaced "rungs" again – but somehow I managed not to slip, and staggered away from the tower on legs whose muscles were somewhere between the consistency of soft rubber and warm Jello.

A FUN CHAT WITH THE BOSS

The boss was in town that day so I crept into his office and began that "we need to talk" conversation that every engineer dreads. He asked, "Well, what have you been up to?" "Oh, about 400 feet in the air," I wisecracked, hoping in vain to lighten the mood.

Then he asked what I had found and I said something about "nothing good," asking if he wanted the long version or the short one. The smile left his face as he asked for the short one and I told him there was no way to make that antenna work for higher power; that the only answer I could see was a new antenna.

He sputtered and nearly bit his ever-present cigar into pieces, saying it was not possible, that a new antenna would cost almost as much as the transmitter we had on order, and he could not understand why we had to have a new one.

Finally, I told him I had been there and seen what I had seen; if he did not believe me, the tower crew was there and he could go up and check it himself. He groaned, "We really have to have it, do we?" I said yes, he did, unless he wanted to burn up a brand new transmitter and never get the power increase working.

So we ordered a new antenna. But, hold on, that is not quite the end of the story.

A "DEAL"

The boss found a "deal" on a new Gates Cycloid antenna that had been canceled after it was built for a station two or three channels lower.

That antenna was tuned on the ERI range at Newburgh, Indiana, perfectly on frequency, but when the tower crew installed it and I checked it with 1,000 watts, to my horror, I saw VSWR at 1.7:1. So, we did an improvised frequency domain reflectometry (FDR) scan – which in those days we called a panoramic sweep.

The sweep showed a very good VSWR curve except it was centered about 400 kHz below the operating frequency. I called Chester Newcomb, who was the manager at ERI in those days, and explained the problem. He expressed some doubt and said he wanted to see it for himself. One thing he could not understand was how I had managed to sweep the antenna with any kind of accuracy and, except for the result, I was not talking.

USING WHAT YOU HAVE ON HAND

I suppose the statute of limitations has expired, so I can say it involved an old Gates tube-type exciter fed by a TV sweep generator borrowed from a local shop, and an ancient oscilloscope fed from the Gates FM-1B's reflectometer, which had an adjustable output. Anyone listening in the wee hours of the morning when we did the test would have heard a *very* loud 60 Hz hum across the middle of their radio dial for about half an hour that night.

It was a clever combination of using equipment at hand and it got the job done. I was not sure how the Rules applied. In theory, the Experimental Period Rule did not differentiate between AM and FM in those days and I doubted we caused interference to anyone between 1:30 and 2:00 AM.

In any event, I thought the results spoke for themselves and said nothing about the "measurement method."

A PROBLEM SOLVED AND A LESSON LEARNED

Chester Newcomb and his crew arrived the next day with an HP Panoramic Analyzer and other equipment from their lab. By noon, we saw the result. Thousands of dollars of test equipment confirmed what I had said; the antenna was perfect, about 1.07:1, if only our frequency was two full channels lower.

Chester and his crew spent two days, finally using a hydraulic jack to spread the plates before the antenna would tune to frequency. After that, the power increase had only minor glitches that are always part of a new installation.

We filed for the "License to Cover" and the station remains on the air today with the third generation of the family now in charge. Today, we know what happens when an FM antenna is side-mounted, but then everything was new and we were learning as we went.

By the way, I should mention the station was almost in the center of the band and the tower face was exactly thirty inches across.

Phil Alexander is a contract engineer and frequent contributor to ***Radio Guide****. Phil's email is dynotherm@earthlink.net*

Tech Tip

by Dave Mandelbaum

Solving Sage-Endec EAS Power Supply Problems

By now, it has happened to almost everyone using an Sage-Endec EAS encoder-decoder. Either you find the machine has a seemingly endless string of "System Startup" messages stored and an inoperative device or your staff reports that when the machine tries to handle an alert it usually appears to reboot, losing the alert.

ANOTHER BAD WALL-WART

In most cases, these symptoms have proven to be caused by a failing power supply module – that cheap "wall-wart" originally supplied with the Endec.

The problem is caused by the apparent failure of the output filter capacitor in the power module causing high ripple and limited current capacity from the supply. Depending upon the state of the capacitor, the system might or might not boot up.

If there is enough current to start the machine, what usually happens is that when the Sage's printer begins to print out the report of the POST, the high current required causes the power supply voltage to dip below the acceptable input value required by the Endec. The Endec then shuts down, the heavy load goes away, and the cycle begins all over again.

A LONG TERM FIX

Most stations experiencing this have just replaced the power supply module – at quite an expense if purchased from the manufacturer's rep. Others have tried power supplies from alternative sources. A few have tried to cut open the wall-wart, find a capacitor to fit, replace, and reseal.

But now, here is an easy fix that will repair the original power supply or – as preventive maintenance – will add many years to the life of the original supply and avoid future failure.

Using an Xacto knife or single edge razor blade, split the power supply cable positive and negative leads for about 4 inches. Strip about a quarter of an inch of insulation from each lead and install a 4,700 uF at 25 Volts (or higher) capacitor across the power supply output cable.

Instead of trying to make repairs inside the power supply, an external capacitor is quicker and easier to attach.

You will note that the lead with the white stripe is positive; do not "flip" the wires when attaching them to the capacitor.

I placed the capacitor assembly in a snap-together chassis box available from Simco Enclosures (www.simco.com) to tidy up the whole assembly.

You may wish, depending upon where the Endec is mounted, to place the capacitor a bit further back from the tip; the placement is really up to you. The completed project looks clean and neat.

The capacitor fits inside the plastic box.

For just a few dollars and a few minutes of your time you can resurrect or possibly add years to the performance of your Sage-Endec power supply. Sounds good to me.

The capacitor is safely inside the box.

Dave Mandelbaum is a contract engineer and product manufacturer in Southern California. Contact him at dave@dmengineering.com

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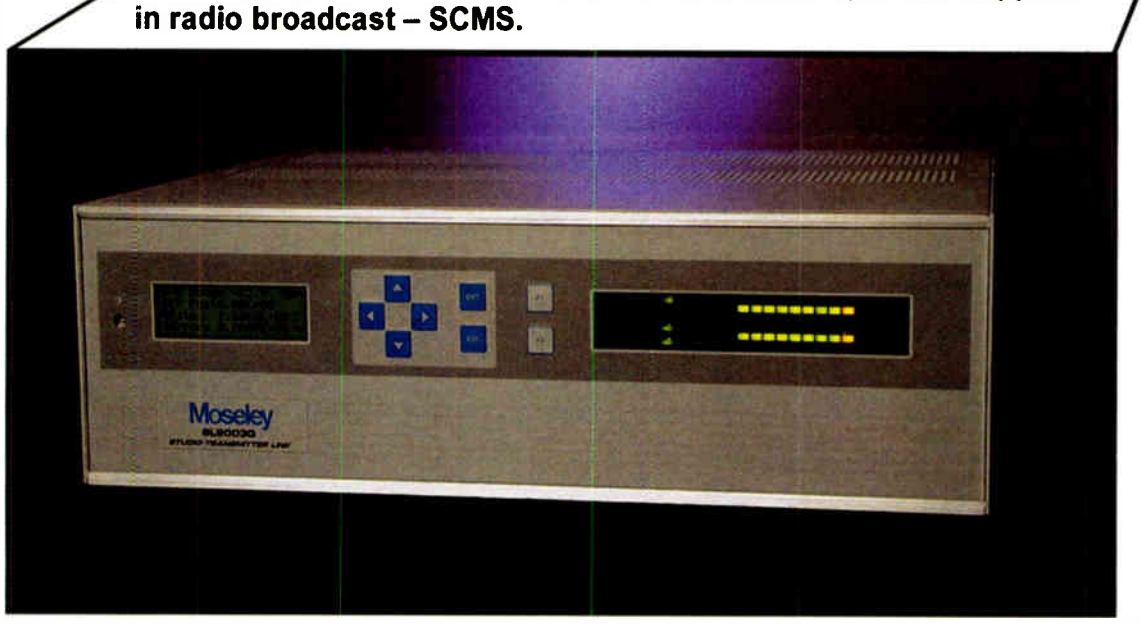

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Station Guide

by John Hingsbergen

Putting an NCEFM On The Air

Did you ever have the desire to put a new station on the air? An Ohio man found out that all it takes is an investment of $50,000-$60,000 ... and plenty of time.

It took over seven years to get the Cincinnati area's newest non-commercial station on the air. Bill Spry is President of Spryex Communications, the licensee for non-commercial WMWX. "We got the CP and man, I'll tell you what, it was fireworks," related Spry with all the excitement of a new parent. "Once I got that, the next call I made was to PSI and ordered the antenna."

The four-bay directional antenna is on a tower near Brookville, Indiana. The station signed on in August at 88.9 FM with an ERP of 4,600 watts, licensed to the small Ohio community of Miamitown, on the west side of Cincinnati, near the Indiana border.

FROM DREAM TO CONSTRUCTION

Spry was one of the early advocates of Low Power FM and a member of the Community Radio Coalition that filed petitions requesting authorization of the LPFM service.

He is also the "idea creator" of the Raduga automation software, a system he specifically markets to LPFMs to help them get around FCC Rules for local program origination. With a hard drive full of music, liners and spots, any station can "produce" its own programming, following a format that is able to be cloned onto many other stations.

WMWX is Spry's first effort at building and programming a Full Service non-commercial station. Together with his wife Rhonda and friends like Sean O'Connor, he managed to get it on the air after a long process that included negotiating with other applicants for the precious 88.9 MHz. frequency.

He discovered the channel through ComStudy software and was the original filer for it, only to face competition when the FCC opened the licensing process. The application was then tied up at the FCC, since it has no method of resolving the mutually-exclusive filings for non-comm channels. The group went as far as asking Ohio Congressman Steve Chabot for help, to no avail.

General Manager Bill Spry glows brighter than a final tube next to the WMWX transmitter.

Ultimately, Spryex prevailed as two other applicants "went away," leaving only Georgia-based Community Public Radio. "We motivated him monetarily to go away," quips Spry.

CONSTRUCTION

The original plans for the station included a religious format at 400 watts non-directional. After finding the Indiana tower site, plans were changed to a 4,600 watt ERP directional. The location is only 20 feet lower than the highest terrain in Indiana.

The station's transmitter is a Silicon Valley, acquired from "Praise FM," WQRP in Miamisburg, south of Dayton. According to Spry, WQRP General Manager Joe Laber called and said, "Hey Bill, I've got a transmitter. If you wanna buy me a laptop, I'll give it to you." "So I bought him a laptop and ran."

In addition to the Windows computer running the Raduga software, another critical piece of equipment at the WMWX transmitter site is a Broadcast Warehouse DSPX processor that Spry describes as "awesome."

The 60 dBu coverage contour for WMWX includes the Indiana communities of Brookville, Bright and much of Batesville. Ohio coverage includes the small towns of Harrison, Dent and Ross as well as the Community of License. There is also good coverage in parts of Cincinnati's west side, giving the station, according to Spry, an area population of 1.8 million.

OPERATIONS AND PROGRAMMING

Spry's approach to operating WMWX is similar to the way he programs two LPFMs in Northern Kentucky, mainly driven by terrain limitations.

Spry and colleagues plan to focus much of their community programming on Cincinnati's Western Hills and Price Hill communities. Otherwise, the new station operates a voice-tracked music format under the identity "ClassX," a mix of classic rock and AAA. The music library consists of over 4,000 songs and is growing every day. Spry hopes his station will attract listeners who have lost their love for radio due to the lack of musical variety.

Instead of originating from a remote studio, WMWX is programmed via on-site automation running the Raduga software. Live programming, such as a weekly jazz show from the studio in the basement of Spry's Hamilton, Ohio home is delivered via AirLink, a 128 kilobit IP-based system. (Despite assurances he has received from Orthogon Gemini, Spry is not convinced a terrestrial STL will do the job largely because of a hill on the 34 mile path between his studio and the transmitter.)

WMWX' first "remote" originated at the Boone County, Kentucky Fair.

AirLink also allows Spry and his crew to take the station on the road to events such as August's Boone County Fair. With this system, the entire station can go on the road.

He also plans to attract volunteers with a "passion for radio." Volunteer Sean O'Connor, whose "day job" is in medical billing, has been working for years, brokering high school sports coverage on Cincinnati area stations. His marketing and promotional efforts on behalf of WMWX will likely include similar sports coverage in the future.

OPERATING AS A NON-COMM

O'Connor says, "One of the biggest challenges is getting people to realize that there is a left side of the dial." With their entry into non-commercial broadcasting, the Sprys, O'Connor and others involved with WMWX believe they will draw new listeners from the 24 to 54 year-old demographic into the "reserved band."

According to O'Connor, "A lot of people don't even know there is a left side of the dial." For Spry, no matter where the station is on the dial, "I want to bring radio back to what it used to be and we want to get the community involved again, but we want to do it in a commercial sounding manner."

Bill and Rhonda Spry in their home-based studio.

Regarding financial support for the station, Spry and crew are already soliciting underwriting funds from area businesses, including an aggressive campaign of on-air promos. "It's going to be tough," he says.

"Cincinnati is a competitive market. We're hoping to get more support from Indiana now that WIFE is moving." (That Connersville, Indiana commercial FM is in the process of relocating to Cincinnati, taking away a major service near the WMWX transmitter.)

Another option for NCE stations is individual listener support but Spry says they will think about that in the future.

HD RADIO & NEW TECHNOLOGIES

Spry is no fan of HD Radio and FM multicasting, calling it "a joke" due to its limited coverage and sideband interference. In fact, Spryex was a signatory to comments opposing IBOC, filed with the FCC in 2000.

"All the big broadcasters were screaming about the interference that low power would cause but what about IBOC?" he said. Aside from the interference and the expense in converting existing stations, Spry says "Analog sounds better."

Instead, he is putting his efforts into more traditional broadcasting, saying "We don't need a bunch more channels that people hate."

GOOD LOCAL RECEPTION

Rhonda Spry, who is working on underwriting and marketing for the new station, says, "The first night we went live, the phones were ringing off the hook." She and husband Bill have both had the experience of receiving "thumbs up" from other drivers when out on the road in the ClassX van, boasting, "People are finding us."

Spry is cautious in describing plans for expansion of his operation, saying he has two translator applications pending and will be willing "to branch out if the opportunity would arrive." For now, the crew is busy adding to the music library, looking for underwriting support and promotional opportunities.

From a technical point of view, they would like to move to studios closer to the transmitter and get a terrestrial STL when finances allow. And, in the spirit of a true non-commercial broadcaster, rather than spending $15,000 to try the Orthogon Gemini "Wireless Bridge," he would love to find something "experimental" that he could try at little or no cost.

During his nearly 40 year career John Hingsbergen has been a DJ, a program host, News Director and producer. Since 2000 he has been Program Director at WMUB-FM at Miami University in Oxford, Ohio. Contact him at: hings@fuse.net

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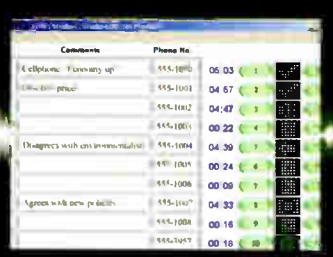

Assistant Producer enables talk show production via LAN or WAN. Status Symbols, Caller ID support, instant messaging and caller database are just a few benefits. Supports touchscreens, too.

Tech Support Forum

by Ted Alexander

Tech Support Follies

Listening in on More Customer Support Calls

In recent months, Ted Alexander has been sharing a behind-the-scenes look at the tech support business - perhaps the most important connection between manufacturer and customer. The stories are real, only the names have been deleted to protect the truly weird. As he points out, Tech Support representatives have to be ready to help solve all sorts of problems.

When lightning strikes or power surges, unprotected equipment connected to the outside world sometimes gets "zorched" (a highly technical term meaning the unit is now able to function more or less as a doorstop).

Naturally, this prompts a call to the Tech Support Department. Sometimes the call is from an owner who just does not understand why we cannot produce "lightning proof" equipment.

"IT ZORCHED ITSELF AGAIN"

Tech Support Rep. "Hi. Tech Support, can I help you?"

Unhappy Zorched-box Owner: "Yes, you can. I want my money back on my Kodak (sic)."

TSR: "What's wrong with it?"

UZO: "It keeps blowing out. I've had it up to you guys three times in five years, each time for the same problem. Each time you told me the ISDN card was bad and it cost a lot to replace it."

We quickly looked up the service history of the unit and learned the customer was in a southern state. The unit was installed at a night club where it had been in service for years. In those five years, it had been sent in for service three times, each time because it had been hit by lightning.

TSR: "Sir, have you installed any surge protection on the electrical or phone lines for this unit?

UZO: "Why don't you just make them stronger so they are "lightning-proof."

TST (Considering inviting the caller to validate Ben Franklin's kite flying experiment): "Sure, sir. We would love to do that. But the unit would cost $1,000 more.

UZO: Surely you have a cheaper solution.

TSR (biting tongue so as not to suggest the caller should be connected to a Van de Graff generator): "Perhaps not connecting it to the outside world during a lightning storm?"

"IT JUST WON'T PASS ANY AUDIO"

Reading and having a basic understanding of the tech manual and how the unit operates would seem elementary, right? So, you will understand why remaining calm and polite to the following caller took a bit of effort.

A customer had sent in a unit that he could not get to operate. We checked it over on the bench and found it met all specifications. It worked just as it should.

Tech Support Rep: "Hello, Tech Support."

Puzzling Customer: "Can you tell me what was wrong with my unit?"

TSR: "Yes, we found no problem with the electronics. What was wrong was that your input and output pots were both turned all the way down."

PC: "So, all you guys did was turn up the pots?"

TSR: "Yes."

PC: "Then why do I have to pay for repair time when nothing was wrong?"

Sometimes it makes an experienced engineer sit and wonder just what is going on "out there."

Here are a few more of the more puzzling statements tech support people have heard more than once:

- "I don't have time to read the manual."
- "It's dark in here, couldn't you guys have included a panel light?"
- "We can't afford surge protectors"
- "The line usually fails about 5:00 in the morning, but that's too early for me to get there to see what's happening on site. Don't you have a remote indicator?"
- "You'll have to pardon me. I am an engineer but not a technician."

"ARE YOU SURE I CAN'T DO THIS?"

New digital processors can do almost anything to a station's audio and hopefully are adjusted so that the expected listener is delighted with the sound of their favorite station. However, sometimes, a station engineer (and we use the term somewhat loosely this time) finds an additional use for his processor.

In this case, an engineer of a low power FM station just loved his Omnia processor. He was using the composite output from the Omnia to drive his transmitter, so he had the AES/EBU output port available. Now, he wanted information on how to make a digital recording from it so he could transfer the processed audio to a CD-R.

This fellow was talking about how proud he was that he just purchased a new "digital" recorder. He wanted a "pure" digital output from the processor, without any D/A conversion between processor and recorder. After a short discussion of wiring to an AES XLR connector, he said he could get a cable "made up locally" to interface between his processor and his "digital" recorder.

As I listened, he went into a little detail about how he got "Jim's Crab Shack and Cable Store" to wire up an XLR to a 1/8-inch plug (not a good sign). Then, several days later, he called saying he could not get the contraption to work. He said that the "cable store" used the "standard" XLR pinout, but when he plugged it all together, he said "It made a terrible noise!"

It took some effort, but I did not say to him, "No kidding."

HAVING THE RIGHT TOOLS FOR THE JOB

Telephone companies and their circuits have been mystifying all sorts of people over the years. Just the fact that a #5 crossbar system with thousands of mechanical relays worked well was a great technical achievement. Then switching was made part of some on-premises equipment and it became "electronic."

Unfortunately, many facilities are not well equipped to deal with many aspects of the electronic systems. Furthermore, some employees do not seem to grasp even an "overview" of what is happening. Day by day, we find we are getting more and more calls like this typical example.

Tech Support Rep: "Good morning, Tech Support."

Station Tech: "Hi. About one out of five times my telco line doesn't drop after a caller hangs up."

TSR: "What kind of line are you using?"

ST: "It comes from our PBX."

TSR: "OK, first of all, does your PBX send proper POTS CPC codes?"

ST: "Huh?"

TSR: "Does your PBX provide a loop current drop at the end of a call?"

ST: "I don't know."

TSR: "Can you connect a scope to the line, measure the off-hook and on-hook voltage, and see if you get a momentary loop current drop when a call ends."

ST: "I don't have a scope."

TSR: "Does the unit turn off when you unplug the telco line?"

ST: "Yes, but we still don't get program-on-hold to come through."

TSR: "Have you checked the audio at the input connector?"

ST: "I have no way to do that."

TSR: "Well, until you can make those measurements, I can't really be sure what the exact problem is."

The sad thing is, you know what is next: the caller runs down the hall and tells his boss that the Tech Support guy is "baffled" by the problem. Meanwhile, the Tech Support guy is ruminating on a station with no test equipment. ("Here; hold these wires while I throw this switch...")

PCB LEVEL REPAIRS

On the other hand, there are veterans in our industry who are basic, good troubleshooters, adept at component level troubleshooting and component replacement.

However, they often became expert at a time when components were large enough to see without a magnifying glass – and those components mounted in holes on single sided PC boards. Those guys know when to let the surface mount device (SMD) repairs be done at the factory. Well, most of them, anyway.

Tech Support Rep: "Hi - this is Tech Support."

Zealous Tech: "Hello, I found a chip resistor on the motherboard cracked. Can I replace it myself?"

TSR: "We don't recommend that unless you have special tools or, at the least, a pin sized soldering tool and a very steady hand."

ZT: "Well I'll give it a try anyway."

Several days later the customer called back to arrange for factory service. He had attempted to solder a surface mount device to a six-layer motherboard, and it looked like he used a 100-Watt soldering gun. He turned a simple repair into a $1,200 motherboard replacement.

The consensus in the repair department: perhaps this fellow should stick to installing car stereos.

ANSWER THIS, PLEASE:

Finally, we close with a few more of the questions our tech support people regularly field:

- "Can your box make my cell phone sound any better?"
- "Do you have any 'pull' with the phone company?"
- "Why can't we get better audio with our 9600 baud dial-up modem connection speed?"
- "What's a mix-minus? Minus what?"
- "Can't you guys make anything that speeds up Internet audio?"
- "I have an INSD question ... my INSD doesn't work."
- "I can't understand the instructions. Can't you just tell me the shortcut?"
- "I know it's not your product, but can't you tell me how to make it work?"
- "My intern dropped it yesterday and now something's loose inside. Do you know what it may be?"

The cool, calm, collected voice on the other end of your call to Telos/Omnia/Axia tech support may well be Ted Alexander's. A well-experienced former chief engineer, Ted can be contacted at Ted AMFMTV@aol.com

A clickable list of all the URL's listed in the Radio Guide articles:
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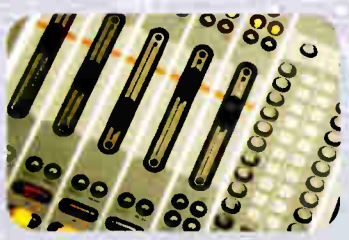

"I think **Axia was the perfect choice** for Kaya FM. We have all the functionality we wanted, and we got it for half the price of systems with less features. In fact, we've already ordered another new Element control surface! Axia is a technical dream... I can't imagine a better fit for our station."

— *Russell Pope, Operations Manager*
Kaya FM, Newtown, Johannesburg, South Africa

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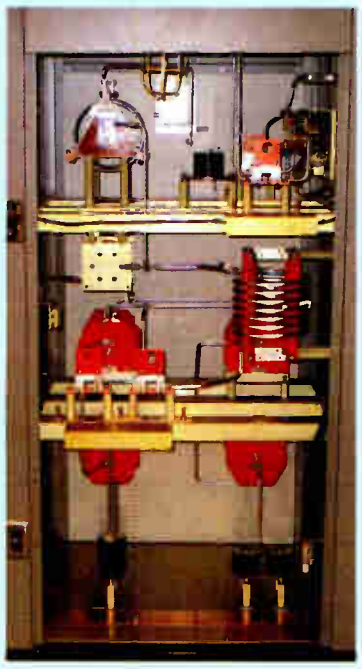

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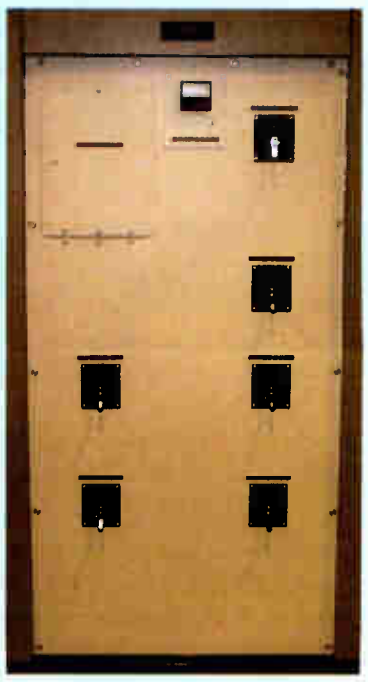

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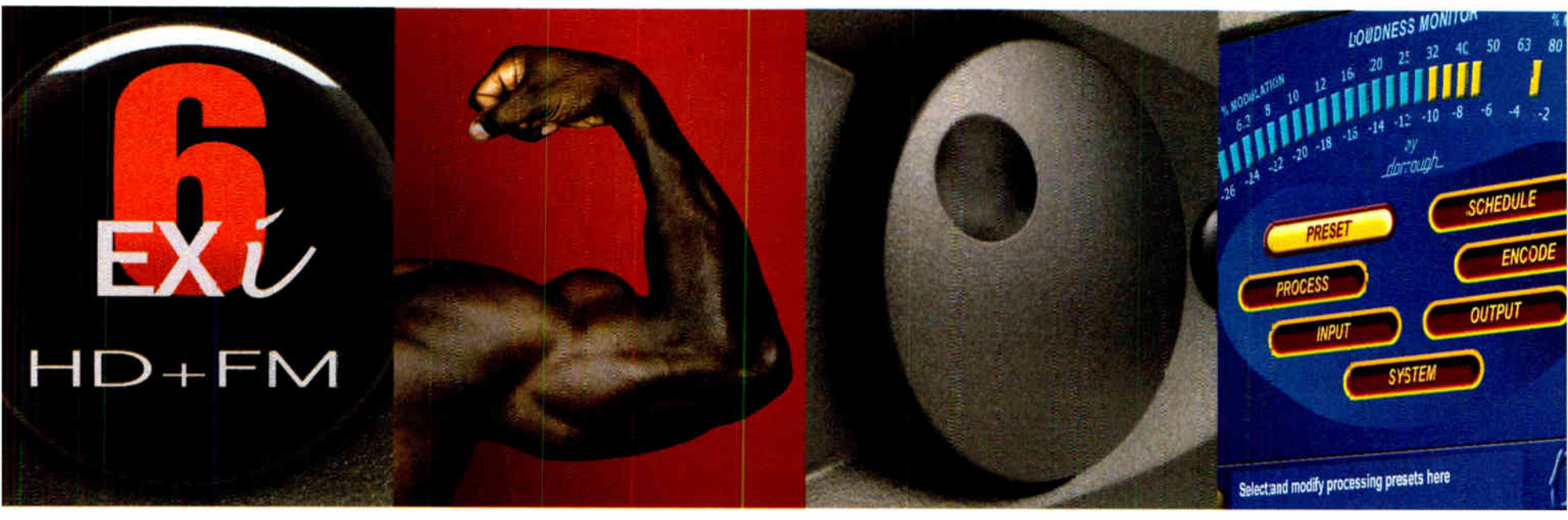

Omnia 6EX*i*

The Ultimate Upgrade.

Omnia-6 is the standard by which all other processors are measured. In the last few years, thousands of leading stations in the world's top markets have upgraded to Omnia. In fact, Omnia-6 has been so successful that some competitors have just given up; others are mere shadows of their former selves.

So why do broadcasters love Omnia-6? The *sound*. The clean, pure, crystal-clear sound (bone-shakingly loud, if you want) that's become the choice of #1-rated stations in New York, Los Angeles, Tokyo, Paris, London, Rome, Sydney and Beijing. The other guys tried to match its winning sound... and failed. So they've settled instead for trying to copy its innovative features.

Features that Omnia pioneered — like dual, simultaneous processing paths for HD Radio™ and conventional FM at no extra cost. The world's first non-aliasing digital clipping system, with composite clipping for the ultimate in competitive loudness. The high-precision Multi-Band Look-Ahead Limiter (invented by Omnia) for perfect HD Radio processing. The six-band limiter for conventional FM, with adjustable crossovers for surgically-precise control over your signature sound. An integrated Dorrough™ Loudness Meter. And of course, the groundbreaking 96 kHz, 24-bit platform that delivers full 20 kHz bandwidth for HD Radio broadcasts. Always innovating.

Which is why the **new Omnia-6-EX*i*** makes perfect sense. With **integral HD Radio Diversity Delay** that helps digital broadcasters eliminate analog connections to the HD exciter, ensuring independent analog and digital program streams. And the exclusive new **LoIMD Clipper** that actually **suppresses intermodulation distortion** to deliver audio that's cleaner, clearer and more detailed than ever — no matter how aggressive your processing. (If you already own an Omnia-6, don't worry – there's a low-cost upgrade to give your processor full-fledged Omnia-6EX*i* power.)

A lot of muscle? You bet. No wonder the competition is running scared.

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