Radio Guide

Radio Technology for Engineers and Managers

July 2005

Appreciating Armstrong's Legacy: Seven Decades of FM

Inside Radio Guide

Steve Hemphill was inspired on January 31st of last year to recognize Armstrong's tremendous contributions to wireless communications technology while attending a candlelight remembrance of the 50th anniversary of the inventor's tragic suicide at River House on New York City's East Side.

Then, on June 11th, 2005, high-fidelity, static-free sounds of music, talk, and radio drama returned to the original FM band, from atop the Palisades of Alpine, New Jersey. WA2XMN signed on at 42.8 MHz, operating at 250 watts ERP under an experimental license for a special broadcast commemorating the 70th anniversary of Major Edwin Howard Armstrong's first demonstration of Frequency Modulation.

Radio Guide

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Cover Photo: Armstrong tower as it appears today.
Courtesy of Mark Humphrey

Radio Waves

by Barry Mishkind – Editor

Remembering the Major

Last month, Steve Hemphill and friends gathered to celebrate the Major Armstrong's contributions to broadcasting, including the 70th Anniversary of the first FM transmissions – in the very building Armstrong had used as a lab. There is no question "history" was in the air.

Major Edwin Armstrong (1890-1954) was a true pioneer broadcaster, developing many of the technologies we rely upon to this day to transmit information and entertainment to listeners all over the world. From the super heterodyne circuit to FM transmission, Armstrong proved himself a brilliant inventor who could see the heart of a problem and find a way to make the physics work.

Unfortunately, Armstrong was less successful in his relations with his contemporaries. An intensely private man obsessed with his work, his tempestuous career which, while interesting and exciting reading (including 42 patents, WWI military service leading to promotion to the rank of Major, friendship and enmity with David Sarnoff, etc), also lead to his untimely death.

Mark Humphrey's account of Steve Hemphill's quest to build and operate an Armstrong-style transmitter is on page 4. The celebration and history behind it helps us realize how important were Armstrong's inventions.

Seventy years later, here we are, at the beginning of another mode of transmission – digital transmission – which some tout being as revolutionary as FM was to AM.

But, as I read Mark's report, a melody kept running through my head – a variation rather shamelessly adapted, with apologies to four mop-headed lads out of the 60s. Can you hear it?

"It was 70 years ago today,
Major Armstrong taught the band to play.
The audio was all clear and bright,
FM was designed to sound just right.
So may we introduce to you:
The sound you've waited for all these years,
Major Armstrong's all new FM band!"

Remembering Major Armstrong

Celebrating 70 Years of FM Transmission

by Mark Humphrey

[ALPINE, New Jersey] High-fidelity, static-free sounds of music, talk, and radio drama returned to the original FM band on June 11th, 2005

From atop the Palisades of Alpine, New Jersey, WA2XMN signed on at 42.8 MHz (or Mc as it was called then) with 250 watts ERP under an experimental license for a special broadcast. It was to commemorate the 70th anniversary of Major Edwin Howard Armstrong's first demonstration of Frequency Modulation.

AN IDEA FORMS

Steve Hemphill was inspired on January 31st of last year to recognize Armstrong's tremendous contributions to wireless communications technology while attending a candlelight remembrance of the 50th anniversary of the inventor's tragic suicide at River House on New York City's East Side.

Another engineer in attendance that evening was Renville "Ren" McMann, who began working for the Major at Alpine as a teenager and went on to develop new technology for television with CBS Labs. The two realized that a public event in honor of Armstrong's work was long overdue – and what could be more fitting than a broadcast of Frequency Modulation, preferably in the "low band" where the first experiments took place?

The wideband station was built over the past six months by Steve Hemphill of Solid Electronics Labs in Newtown Square, PA, with the support of Chuck Sackermann, Jr. of CSC Management, present owner of the Alpine tower site that was constructed by Armstrong in 1937.

IN ARMSTRONG'S FOOTSTEPS

As a skilled engineer, Steve has long been fascinated with early FM broadcast equipment, particularly the General Electric "Phasitron" transmitter, a sixty-year-old design he first encountered at his high school station, WHHS in Haverford, Pennsylvania.

Several years ago, as a "labor of love," he built a working replica of a Phasitron exciter, which was displayed in Belar Electronics' booth at the 2003 NAB show in Las Vegas. One of the most intriguing broadcast tubes ever developed, the Phasitron used an external field coil, driven by an audio amplifier, to phase-modulate the output of a crystal oscillator.

Steve found that he had enough spare parts left over from that project to construct another exciter, and the original GE circuit could be easily modified to operate in the low band.

Steve Hemphill and his Armstrong Transmitter.

With a modest RF amplifier – employing glass tubes, of course – and a basic antenna, he would have the necessary transmitting equipment for a tribute well-suited to the man who made FM a reality.

AN HISTORIC SITE

The next hurdles to overcome were selection of a transmitter site and FCC licensing. For the sake of historical accuracy, Steve first attempted to gain temporary access to the Empire State Building where Armstrong had given the first demonstration of FM in 1935.

Unfortunately the managers of that property did not share his enthusiasm. Antenna space atop "Empire" has become scarce since the destruction of the World Trade Center, and numerous security, safety, insurance, and labor concerns were raised, putting an end to further discussions.

However, the Alpine field laboratory, where Armstrong had spent the latter days of his career, was Steve's next choice. He contacted the Sackermann family; they warmly embraced his concept and began making arrangements to accommodate the special event.

Armstrong's laboratory and site of W2XMN.

Early Armstrong breadboarded oscillator and balanced modulator (foreground), with early FM receivers.

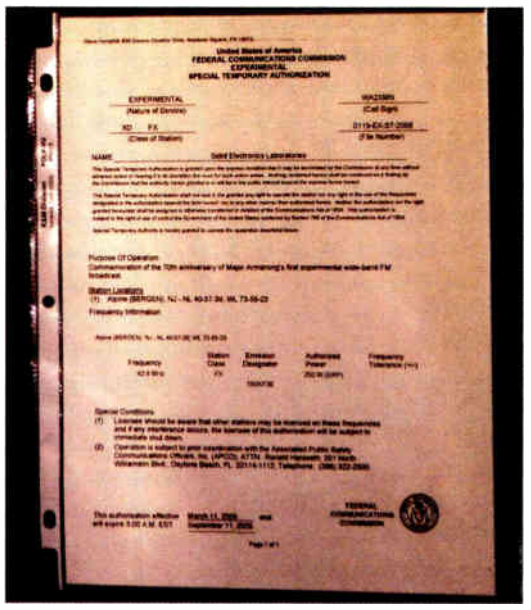
SEEKING A LICENSE

Since W2XMN, Armstrong's original station at Alpine, operated at 42.8 MHz, Steve began to investigate the possibility of licensing the same frequency.

After World War II, when FM broadcasting was moved to the 88-108 MHz segment, the former 30-50 MHz band was assigned to land-mobile communications – but in recent years, many licensees have abandoned the low-band VHF spectrum in favor of UHF, which offers better building penetration in urban environments. A search of the FCC database revealed just a handful of public safety users on 42.8 – none close enough to the New York metro area to pose an interference problem.

Steve was optimistic – but doubted he would receive permission to transmit the full 75 kHz deviation used by broadcasters. After receiving frequency coordination clearance from the Association of Public-Safety Communications Officials in New Jersey, New York, and neighboring states, he went ahead and filed an experimental license application with the FCC, explaining the purpose of the proposed temporary station.

Much to his surprise, the request breezed right through. Approval was granted to occupy a 150 kHz bandwidth with 250 watts of effective radiated power – and the Commission staff thoughtfully assigned the calls WA2XMN in recognition of the historic Alpine facility.



The FCC was very helpful!

GETTING IT READY

With the legal requirements out of the way, Steve began constructing the transmitter and searching for historic program material.

Carl Kraus, General Manager of WFDU at Fairleigh Dickenson University in Teaneck, NJ, and Barry Sheffield, the station's Program Director and Operations Manager, learned of the plans for the event and quickly pledged production support for the project. WFDU (sharing 89.1 MHz with New York University's WNYU) had begun transmitting from the Alpine tower in 1971, although long after Major Armstrong's station had shut down.

Steve considered building a horizontally-polarized turnstile antenna, similar to the design used by Armstrong, but space limitations on the tower presented a problem. Instead, he decided on a more practical and lightweight end-fed vertical dipole – a modified Cushcraft Ringo 6-meter amateur antenna – which was mounted on the top arm of the structure at 420 feet above ground level and 945 feet above the Hudson River.

He also departed from the technology available in Armstrong's day for audio processing, installing an Orban Optimod 8100 (with stereo generator bypassed). For the benefit of the great majority of listeners without a low-band FM receiver, WFDU agreed to simulcast the broadcast – and the audio fed to their transmitter was actually a relay of the 42.8 signal from an EH Scott receiver, coincidentally in accordance with Armstrong's vision of wireless FM networks.

ON THE AIR!

The ceremonies officially began at 11:45 AM on Saturday, June 11th, when emcee Carl Kraus asked Steve to "push the button," bringing the dormant frequency back to life.

Ignition!

WINS anchorwoman Judy DeAngelis then moderated a discussion between a group of panelists who had either known the Major personally or had studied his career.

Ren McMann, who worked six days a week at the Alpine laboratories during WW II on radar and other military projects said, "Armstrong would want to be remembered as a brilliant scientist and patriot who offered his inventions to our armed forces at no cost."

(Continued on Page 6)

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No, this product doesn't remove naughty words, but if you do run a profanity delay or simply have a buildup of digital latency, talent can't listen to the processed air signal. Instead, their feed is probably direct from the console. Compared to the air sound, this can seem weak, dull and lifeless.

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Remembering Major Armstrong

Celebrating 70 Years of FM Transmission

– Continued From Page 4 –

Also sharing their memories were Henry Dietz, former manager of Radio Engineering Laboratories, an early manufacturer of FM equipment; Robert Brecht, nephew of Edwin Armstrong's wife Marion; Jerry Minter, noted engineer and awards chair of the Radio Club of America; and Gil Houck, nephew of Harry W. Houck, who assisted Armstrong in development of the superheterodyne receiver.

The esteemed panel including some who met Armstrong in person.

Mike Katzdorn, who maintains a superb online collection of historic Armstrong documents (http://users.erols.com/oldradio/) also answered questions about the Major's life, along with Steve Hemphill and Chuck Sackermann.

LISTENING IN

The commemorative program (available for download at www.escmgt.com) continued with rare audio clips of early FM broadcasts, an interview with Tom Lewis, author of *Empire Of The Air*, and a radio dramatization of Lewis' book, originally produced by *Firesign Theatre's* David Ossman for American Public Radio.

A most fitting way to close out the broadcast was a recording of the February 25, 1954 final broadcast from Armstrong's experimental station at Alpine, which by that time was operating on 93.1 MHz as KE2XCC.

Those in attendance also had an opportunity to tour Armstrong's 1937 laboratory building, which has been converted to a museum filled with equipment that relies on the technologies he invented.

RECEPTION REPORT

How did the transmissions from WA2XMN cover? I listened in wide FM mode on an Icom 706 ham rig while driving from Alpine back to Pennsylvania and was surprised to follow the signal over 40 miles to Bedminster, NJ, near the intersection of I-78 and I-287.

Multipath characteristics of low band seemed a bit different than what we are accustomed to – I noticed some slow "picket fencing" but nothing serious. Steve resumed broadcasting for a few hours the following afternoon and I had no problem receiving a clean signal on a Watkins-Johnson/CEI 975 receiver in my shop, over 100 miles from Alpine, with nothing more than a vertical dipole at 15 feet above the ground.

And I enjoyed the mellow "tube" sound of the Phasitron exciter, as well as the tasteful processing – a welcome change from the typical New York or Philadelphia FM experience.

The positive feedback indicated the event was so successful that Steve and Chuck are looking forward to additional broadcasts later this summer and in coming years to commemorate the pioneers of broadcasting. One possibility: a re-enactment of a Yankee Network simulcast into New England.

Additional pictures courtesy of Mike Erickson.

Mark Humphrey has been engineering in the Philadelphia market for more than 20 years. Owner of XY-MARK Technical Services, he can be reached at mark@xy-mark.com

The Worst I've Ever Seen

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

– The Rather Curious Output Network –

Sometime the matching network between the transmitter and tower is not quite a work of art.

Joe DiPietro relates: "Back when I was in college I worked for a local Broadcast Engineer. He called me one day and said we had a job fixing up an AM transmitter site in preparation for the sale of the station.

"When we got to the site we found this amazing interface connecting the transmitter to the shunt-fed tower.

"Note the wire exiting via the window. There used to be a sheet of corrugated cardboard covering the open window. It apparently caught fire and all that was left of it can be seen nailed to the scorched window frame."

IN THE MIDDLE OF THE ACTION...
LIVE, FROM IRAQ.

Armed with little more than two microphones and a Matrix, Ted Leitner of XPRS, The Mighty 1090, broadcast his radio talk show LIVE during morning drive from the Al Asad-Marine Base in Iraq. Leitner is facilitating on-air live communication between troops and their families back home in San Diego, as well as bringing along special guests from the San Diego sports world, including several of the San Diego Charger Girls. "Keeping the spirits of our armed forces up is what it's all about," said Ted, "Nothing beats bringing a little piece of home to our troops stationed abroad. Thanks, Comrex!"

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COMREX

Transmission Guide

by Barry McLarnon, P.E.

Part 3: IBOC and the AM Receiver

This month Barry McLarnon's discussion of coverage issues in the age of digital transmission moves over to the AM band.

[OTTAWA, Ontario, Canada] Interference is, of course, in the eye of the beholder, and different people will have differing levels of tolerance for interference.

In the last two installments of Transmission Guide, we looked at how FM coverage is impacted by interference, and how the introduction of the hybrid IBOC system will change the FM broadcasting landscape. We now turn to the AM side of radio broadcasting, and here we will find many similarities with the FM situation – and a few huge differences.

One thing AM clearly has in common with FM: there is no such thing as "standard" receiver. In both cases, there is a vast range in performance from the receivers that are in use, and it is impossible to discuss coverage and interference in practical terms without considering receiver characteristics.

As with FM, interference in AM is dealt with by means of protected coverage contours, and protection ratios that, in theory at least, limit the strength of interfering signals on those contours to prescribed values.

ADDITIONAL FACTORS

There are, however, several complications that do not arise in FM, the most obvious being the dramatic differences between daytime and nighttime propagation on the AM band due to the appearance of skywave at night. The majority of AM stations are required to use different operational parameters during the day and night hours. We therefore have two quite different interference regimes to consider.

More so than in FM, the class of an AM station is an important factor in determining its protection from interference, so it is worthwhile to take a moment to review the various classes that exist.

Class A stations are the elite of the AM world, operating on the "clear" channels and providing coverage over a wide area. The number of Class A stations in the contiguous 48 states is fixed at 58.

Another class whose numbers are capped is Class D, the daytime-only stations that operate on the "clear" and "regional" channels. The FCC stopped issuing new Class D licenses in 1987.

Class C stations operate only on the six "local" channels, better known as the "graveyard" channels (1230, 1240, 1340, 1400, 1450 and 1490 kHz). There are roughly 1000 such stations in the US.

Finally, we have the Class B stations, representing the majority of AM stations. Most of them operate on "regional" channels, but a number of them have also been dropped into the "clear" channels.

AM DURING DAYTIME

Since daytime protection from interference deals only with groundwave propagation, the Rules are relatively simple, and similar to those for FM. With the exception of Class A, the daytime protected contour for all stations is 0.5 mV/m. Class A stations get better protection from co-channel interference, with a protected contour of 0.1 mV/m.

In all cases, the minimum D/U (Desired/Undesired) power ratio permitted at the protected contour from a co-channel station is 26 dB. Except for the Class Cs, all stations also get protection from signals on first adjacent channels. In this case, the protected contour is 0.5 mV/m (including Class A stations), and the minimum D/U ratio is 6 dB.

It is worth noting that Class A stations also get special consideration with regard to protection from stations on second adjacent channels. No other classes get protection from second-adjacents (except in cross-border situations – see below), which leads to some problematic situations that we shall examine in more detail when we consider the effects of IBOC operation.

Another aspect in which the Class As are afforded improved protection is in the recognition of the fact that skywave propagation does not abruptly turn on at local sunset and turn off at local sunrise.

Skywave interference can be appreciable during the "critical hours" (the two hours following sunrise, and the two hours preceding sunset), and many stations are required to adjust their powers and/or antenna patterns during these periods in order to provide increased protection to the daytime operations of Class A stations.

EVOLVING PROTECTION LEVELS

There is one more complication that must be mentioned. The contour protection system outlined above was adopted by the FCC in 1964; prior to that, the allocation methods were more complex and ad hoc.

In 1964, the D/U ratio for protection from first adjacent interference was established at 0 dB, which is presumably a typical value that existed at the time. The requirement for first adjacent protection was not improved to 6 dB D/U until 1991.

Stations that existed before 1991 do not have to provide this improved level of protection to other stations until such time as they make changes to their facility requiring a CP (the so-called "ratcheting" clause).

There are many cases today, therefore, where first adjacent signals can reach 0 dB D/U on protected contours, and likely some dating from early allocations where the D/U ratio is significantly less than this. The 0 dB figure also still applies to cross-border coordination with Canada and Mexico.

To complicate things just a wee bit more, it should be mentioned that there is cross-border protection for second-adjacents, and it applies to all classes of stations, not just Class A. The protection ratio in this case is set at -29.5 dB. In all cases, however, it should be remembered that the mandated protection for a given station does not extend beyond the borders of the country in which it is situated.

THE NIGHTTIME SCENE

At night, it is a whole new ballgame on the AM band. We will deal with the simplest cases first.

Class D stations obviously receive no protection (although some do have authorization for low power night operation, it is strictly on the basis of protecting other stations, and receiving no protection themselves). Class C stations receive no additional protection beyond that which they receive from groundwave signals during the daytime hours.

As in daytime, the Class As have the best protection at night. The protected contour for co-channel interference moves out to 0.5 mV/m, the same as for adjacent channel protection, but the D/U ratios remain at 26 dB for co-channel and 6 dB for first adjacent channels. Moreover, this protected contour now applies to skywave coverage (based on 50% availability). Only the Class A stations have protection for their secondary (skywave) service.

For Class B stations, the situation gets more complicated. In principle, the protected contour is 2 mV/m (groundwave); in almost all cases, however, interference on that contour is already well beyond that which would be allowed by the standard protection ratios.

THE NIF CONTOUR

Therefore a more pragmatic approach is taken: an appropriate contour is calculated on the basis of existing interference, called the *Nighttime Interference Free* (NIF) contour (also called the *usable field strength*, or Eu, in Canada and other countries).

The NIF is an estimate of the field strength of the desired station that will provide a minimum reception quality that is commensurate with the established protection ratios. It is calculated by means of the *root sum square* (RSS) method, which, in essence, estimates the total interference power, with appropriate weighting factors depending on whether the sources are co-channel or adjacent channel stations.

Most Class B stations have a NIF contour in the 2-10 mV/m range, though some are higher.

CAN YOU HEAR ME NOW?

The question then, is: Does the protected contour, whether it be the daytime 0.5 mV/m (or 0.1 mV/m, in the case of Class As) or the NIF (or nighttime 0.5 mV/m for Class As), represent the actual limits for good AM reception?

The answer, in general, is "no," particularly for daytime groundwave coverage. The protected contour is not a locus of constant interference level. The level of groundwave interference from a co-channel station, for example, may reach the 26 dB D/U protection level at some point on the protected contour, but it obviously cannot be that high on all parts of the contour.

Nighttime is a different matter, assuming that skywave interference is dominant. The level of interference may well be roughly the same around a NIF contour, since skywave field strengths are less dependent on distance. Even in this case, however, we cannot say that this contour represents the true coverage area without specifying the receiver characteristics, especially if major contributions to the NIF calculation come from adjacent channel stations.

RECEIVER CHARACTERISTICS AN ISSUE

When we looked at FM coverage, we were aided by the availability of a good deal of test data on FM receivers, thanks to the LPFM controversy.

Unfortunately, no such repository of information seems to exist for AM receivers. Perhaps this will change soon, as the NRSC AM Study Working Group is preparing to do tests on a range of AM receivers; however, their focus is on assessing the effects of reducing the audio bandwidth of AM signals.

In the meantime, we will focus on the iBiquity test results that compare the effects of interference with and without hybrid AM IBOC. As was the case with their FM tests, they tested only four different receivers, which is a woefully inadequate sampling of the AM receivers that are actually in use; but it is better than nothing.

For the record, the four receivers were a Delphi car radio (9394139), a Pioneer car radio (KEH-1900), a Technics component receiver (SA-EX110), and a Sony boombox portable (CFD-S22). These are the same receivers that were used for the FM IBOC tests.

IBOC ENTERS THE PICTURE

In many respects, the hybrid AM IBOC system resembles a scaled-down version of the FM system. A detailed comparison of the two systems can be found in my article from last summer *[**Radio Guide** July 2004, page 8]*.

There it was shown that the addition of the digital sidebands causes a drastic increase in the occupied bandwidth of the signal in both cases, making it a much more formidable source of interference. Unlike the FM case, the AM system does put some digital subcarriers directly under the analog signal; however, the vast majority of the digital power is still deposited into the first adjacent channels.

Moreover, the relative power of the digital signal is considerably higher in the AM case. A single FM IBOC digital sideband has a total power of -23 dBc, while a primary AM IBOC digital sideband (at 10-15 kHz from

(Continued on Page 10)

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Transmission Guide

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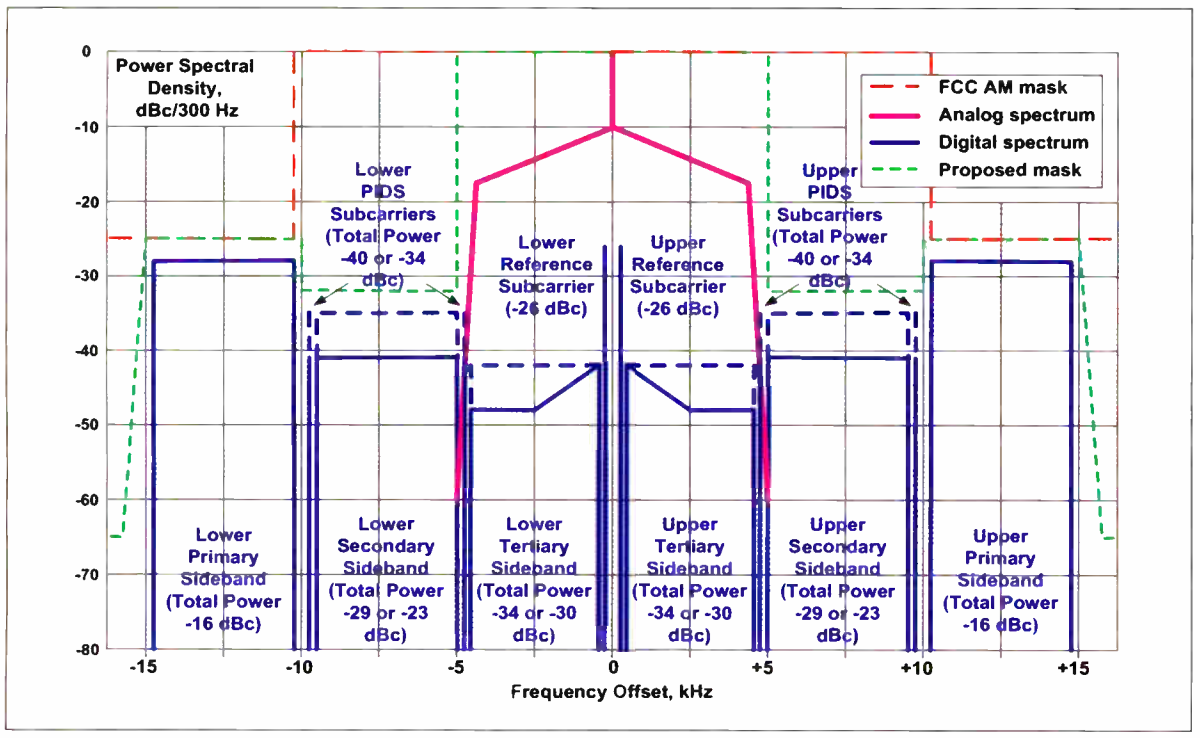
the carrier frequency) has a total power of -16 dBc. The total digital power dropped into a first adjacent channel is actually even higher, due to the presence of the secondary digital sideband at 5-10 kHz from the carrier, but we shall ignore its relatively small contribution.

It should be obvious by now, but it bears repeating: this system that is being adopted under the guise of "IBOC is really IBAC" ("on channel" is really "adjacent channel"). It therefore leads to new interference problems because of what might be termed the "IBOC sidestep."

An analog source of interference has a certain relationship with a desired analog signal to which certain protection Rules apply. If that interfering station goes IBOC, it is putting new signals on channels for which *different* protection Rules *should* be applied, but they are not.



Or, perhaps the station is spaced far enough that no protection Rules apply, but it is allowed to drop a digital signal onto a channel where Rules do apply – but again, they are not applied in this case. This is the result of the "emission mask loophole" that is the basis for justifying use of a hybrid analog/digital transmission system on the AM and FM bands.

As we did for FM, we shall examine the different interference scenarios separately, try to assess the impact on coverage, and then look at what may happen when IBOC is thrown into the pot.

CO-CHANNEL INTERFERENCE

When we examined FM, we found a surprisingly large range of receiver performance in terms of tolerance for co-channel interference. Since AM is a linear system, it seems likely that there would be less variation in performance from one receiver to the next.

If co-channel interference is at the protection level of 26 dB D/U, then it is reasonable to expect that, in relatively noise-free conditions, an AM receiver will deliver an audio output SNR that most listeners would consider acceptable. This assumes that both desired and undesired stations are using similar audio processing and pre-emphasis.

Subjectively, of course, a listener's response to the interference would be highly dependent on the program content of both the desired and undesired stations. It is worth noting that, outside of ITU Region 2 (the Americas), a higher protection ratio of 30 dB is the norm, indicating that 26 dB may be somewhat marginal.

This point is reinforced in ITU-R Recommendation BS.560-4 ("Radio-frequency protection ratios in LF, MF and HF broadcasting"), which states that a co-channel protection ratio of 40 dB is desirable for high quality AM reception, though it notes this value may be impractical for planning purposes. This document also states the co-channel RF protection ratio can be equated directly to the audio output SNR (assuming that the signals are strong enough that the interference power dominates the noise power).

ANALOG D/U RECEPTION

Some subjective listening tests with co-channel analog interference at 17 dB D/U were included in the iBiquity test suite.

Depending on the audio material used, the listeners rated the quality as "poor" or "fair." A 9 dB boost to 26 dB D/U would likely have been enough to get all scores into the "good" range. This tends to validate the notion that this D/U ratio roughly demarcates the limits of coverage in cases where the coverage is limited by co-channel interference.

As explained above, in daytime, this D/U ratio cannot prevail over more than a small portion of the protected contour; therefore, there can be coverage well outside the protected contour in areas that are not adjacent to the interfering station (assuming, of course, that receivers have adequate sensitivity and no other sources of significant interference are present).

At night, a NIF contour would be more representative of the actual coverage limits, assuming that co-channel interference sources dominate. In the case of Class A stations at night, one would expect greater deviations between the actual coverage and the protected contour, since the latter covers such a large geographic area, especially for secondary service.

SELF-INTERFERENCE REARS ITS HEAD

If we add IBOC to the co-channel interference, we have a close parallel with the FM case. With a co-channel hybrid IBOC signal at 26 dB D/U, the digital sidebands are too far down to cause any audible interference. The only exception is when these sidebands are on the desired station itself. With a moderate input signal level, the audio SNR (WQP) was measured by iBiquity with and without the digital sidebands present. The results are shown in **Table 1**.

In three out of the four receivers, the presence of the IBOC sidebands caused a significant drop in SNR. The most likely explanation is poor first adjacent channel selectivity, allowing the primary digital sidebands on the desired station (with a total power of -13 dBc) to become a significant source of interference power.

Unlike the secondary and tertiary digital sidebands, the primary sidebands are not mirror images of each other, modulated in phase quadrature so that they will produce little output from an AM detector. It is hard to say how noticeable this SNR degradation would be in practice, but certainly if the reception were marginal to begin with, it could be enough to push it over the edge into un-listenable territory.

It is worth noting that these results were obtained under pristine laboratory conditions, and results in the real world may differ, probably not for the better!

Manufacturer	Type	SNR *IBOC Off*	SNR *IBOC On*	Difference
Delphi	Car	45.1	44.3	-0.8
Pioneer	Car	45.5	39.8	-5.7
Technics	Component	47.5	38.5	-9.0
Sony	Portable	40.8	33.7	-7.1

Table 1: Effect of Host IBOC on Analog Audio SNR
(all readings in dB)

POTENTIAL COMPLICATIONS WITH DIRECTIONAL ARRAYS

Directional arrays are likely to be a particular trouble spot. Unless they are well behaved over the full 30 kHz bandwidth of the IBOC signal, there will likely be problem reception areas where the delicate balance of the hybrid IBOC signal is disturbed in some way. There are already anecdotal reports of such problems being observed, especially near pattern nulls.

Picture what will happen, for example, if the analog signal is nulled much more than one or both primary digital sidebands. Imperfections in the DA may also disturb the quadrature relationship of the secondary and tertiary digital sidebands, allowing more digital noise to bleed through into the analog audio.

Another point to consider: the power levels of the secondary and tertiary sidebands may increase significantly, creating even more potential for bleeding noise into analog receivers.

It is a little-known fact that the IBOC specification (now known as NRSC-5) includes a low/high power control in the AM system, which changes the power level of the secondary and tertiary digital sidebands (the ones at 5-10 kHz and 0-5 kHz from the carrier frequency, respectively).

ADDITIONAL EFFECTS FROM IBOC

In the high power setting, the power of the secondary sidebands is boosted by 6 dB, and the power of the tertiary sidebands is boosted by slightly less than 6 dB.

All of the test results submitted by iBiquity to the FCC to date were apparently generated using the low power setting, so this presumably would be the only mode currently permitted for interim AM IBOC operations.

Once the Commission gives its blessing to NRSC-5, however, stations may be free to select the high power setting unless there are restrictions placed upon it in the associated Rulemaking. The reason that the higher power setting is attractive is that it will help close the coverage gap that currently exists between the "core" (mono audio) digital service and the "enhanced" (stereo) digital service.

This low/high power option should not be confused with the 6 dB power reduction mentioned in the FCC's Rules for interim IBOC operation as a means of mitigating interference to other stations. This latter power reduction affects only the primary sidebands, and therefore is completely distinct from the low/high power control described above.

It is also interesting to note that there is no mention of any power level adjustments for the primary sidebands in the NRSC-5 specifications.

All of this thus far relates to on-channel interference. What about potential interference from adjacent channels? We will discuss the details next month, but here is a little hint of what is to come: Daytime Problems – and Disaster at Night.

A consulting engineer and author specializing in communications systems engineering, Barry McLarnon (VE3JF) holds a BS in Physics and MS in Electrical Engineering. His email is bdm@bdmcomm.ca

The routing switcher gets a new twist.

(About five twists per inch, actually.)

Everybody needs to share audio. Sometimes just a few signals — sometimes a few hundred. Across the hall, between floors, now and then across campus. Routing switchers are a convenient way to manage and share your audio, but will your GM really let you buy a router that costs more than his dream car? Unlikely.

If you need a routing switcher but aren't made of money, consider Axia, the Ethernet-based audio network. Yes, Ethernet. Axia is a *true network*. Place our audio adapter nodes next to your sources and destinations, then connect using standard Ethernet switches and Cat-6. Imagine the simplicity and power of Ethernet connecting any studio device to any other, any room to any other, any building to any other... you get the idea.

Routers are OK... but a network is so much more modern. With Axia, your ins and outs are next to the audio, where they belong. No frame, no cards, no sweat.

Scalable, flexible, reliable... pick any three.
An expensive proprietary router isn't practical for smaller facilities. In fact, it doesn't scale all that well for larger ones. Here's where an expandable network really shines. Connect eight Axia 8x8 Audio Nodes using Cat-6 cable and an Ethernet switch, and you've got a 64x64 routing switcher. And you can easily add more I/O whenever and wherever you need it. Build a 128x128 system... or 1024x1024... use a Gigabit fiber backbone and the sky's the limit.

Are you still using PC sound cards?
Even the best sound cards are compromised by PC noise, inconvenient output connectors, poor headroom, and other gremlins. Instead, load the Axia IP-Audio Driver for Windows® on your workstations and connect *directly* to the Axia audio network using their Ethernet ports. Not only will your PC productions sound fantastic, you'll eliminate sound cards and the hardware they usually feed (like router or console input modules). Just think of all the cash you'll save.

Livewire

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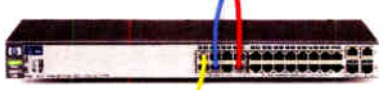
There's a better way to get audio out of your PC. No more consumer grade 1/" connectors – with Axia your digital audio stays clean and pristine

Put an Axia Microphone Node next to your mics and send preamplified audio anywhere you need it, over Ethernet — with no line loss or signal degradation.

Put your preamps where your mics are.
Most mainframe routers have no mic inputs, so you need to buy preamps. With Axia you get ultra-low-noise preamps with Phantom power. Put a node in each studio, right next to the mics, to keep mic cables nice and tight, then send multiple mic channels to the network on a single Cat-6 cable. And did we mention that each Mic Node has eight stereo line outputs for headphones? Nice bonus.

Put your snake on a diet.
Nobody loves cable snakes. Besides soldering a jillion connectors, just try finding the pair you want when there's a change to make. Axia Audio Nodes come in AES/EBU and balanced stereo analog flavors. Put a batch of Nodes on each end of a Cat-6 run, and BAM! a bi-directional multi-channel snake. Use media converters and a fiber link for extra-long runs between studios — or between buildings.

An Axia digital audio snake can carry hundreds of channels of digital audio on one skinny CAT-6 cable. We know you're not going to miss soldering all that multi-pair...



With a little help from our friends.
A networked audio system doesn't just replace a traditional router — it *improves* upon it. Already, companies in our industry are realizing the advantages of tightly integrated systems, and are making new products that reap those benefits. Working with our partners, Axia Audio is bringing new thinking and ideas to audio distribution, machine control, Program Associated Data (PAD), and even wiring convenience.

ENCO SYSTEMS INC

Scott Studios

radio systems

BALSYS

Axia is already working with some great companies. Like Enco Systems, Scott Studios, Radio Systems, Balsys Technology Group, and of course Telos and Omnia. Check AxiaAudio.com/partners/ to find out who's next.

Would you like some control with that?
There are plenty of ways to control your Axia network. For instance, you'll find built-in webservers on all Axia equipment for easy configuration via browser. PathfinderPC® software for Windows gives you central control of every audio path in your plant. Router Selector nodes allow quick local source selection, and intelligent studio control surfaces let talent easily access and mix any source in your networked facility.

Control freaks of the world, rejoice: intelligent Axia mixing surfaces give talent complete control of their working environment. Reconfigure studios instantly and assign often-used sources just where they're most useful.

"This sounds expensive." Just the opposite, really. Axia saves money by eliminating distribution amps, line selectors, sound cards, patch bays, multi-pair cables, and tons of discrete wiring — not to mention the installation and maintenance time you'll recover. And those are just side benefits: our hardware is about half the cost of those big mainframe routers. That's right... *half.* Once you experience the benefits of networked audio, you will never want to go back. AxiaAudio.com for details.

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A Non-Comm View

by John Devecka

Summer Chores

[BALTIMORE, Maryland] School's Out for Summer!

At any rate, it is for most of our students. Many of us are on 24/7/365 and do not get a break, even if most of our student staffers do go home for the summer. Of course, while they are home, they get to start mowing the lawn and taking out the trash.

Meanwhile, you also have summer chores to deal with for your station. Some of these vary, depending on the station's size, but all of them are important "little" things that will save you from dealing with "big" things when you would rather be barbecuing.

Inside the station there are many little things we avoid doing during the semester and need to address when things slow down a bit. Routine maintenance is one thing, but many issues are simply too time consuming to be dealt with while you are managing the full staff.

We start with one of the most basic tasks: cleaning up.

THE MAID IS "IN"

Do you have trackballs and mice on your computers? I would bet they could use a real "dismantle and cleanup" by the time summer rolls around. Careful cleaning will not only extend their life, but reduce the number of mistakes and grumbles from operators.

Don't forget the insides of the computers!

I also pull all of the computers out of service and vacuum their insides as well as their power supply fans. Dust buildup in your computers will do significant damage, from clogging fans to overheating boards and more. A few minutes effort makes all the difference.

For some great tips on how to clean and maintain computers, check out www.computerhope.com/cleaning.htm. This website is a wonderful collection of help topics for computer users and managers – and they are all free.

SOFTWARE CLEANUP

While we are working with the computers, now is also the time to make certain that every piece of software on your systems is:

1. Supposed to be there and not a "gift" from one of your students.

2. Up to date with the most recent versions/patches.

3. Necessary to be on that machine.

Once you are done with that (and this includes operating system patches and upgrades) I highly recommend you make a backup of each machine to CDs using Norton Ghost or your favorite backup software. Make sure you have installed the necessary security measures for the fall. (If you missed my columns a few months back on security, they are available on-line at www.radio-guide.com.)

Now that everything is up to date, purge all of the old working files – old interviews, jingles, class projects, etc. and defragment the drives. All of them.

This will take some serious time if you have large drives and audio servers. You may wish to consider building a small automation backup to run while you take everything else off-line. There are a zillion programs out there that will allow you to run a brief day of automation for little or no money. And, it will not hurt to have an emergency option hanging around the station if you ever need to take a studio off-line.

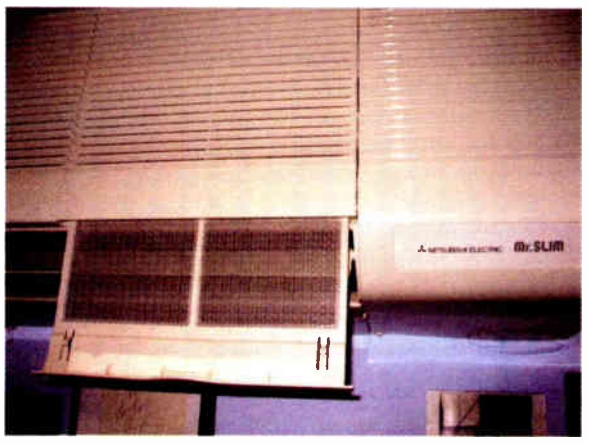
STUDIO FURNITURE CHECK

Speaking of studios: Now is the time I crawl behind and under and inside all of the studio furniture with a long vacuum extension – and clean out the backs of fans, wiring harnesses, hidden shelves, etc. I try to do this at least four times a year, but – well OK – do as I say, not as I do!

Quick, those dust bunnies are getting away!

While cleaning up, get a bucket and wash your foam microphone covers in a nice strong cleaner, rinse well, let them air dry and you will avoid growing new strains of TB in your studios. Or, if you are lazy and rich, buy a bag full of new windscreens.

I know these seem really obvious chores, but often those are the first things we all skip, figuring they are also the easiest to get back to: Change all of the light bulbs that look weak, remove and clean (or replace if not cleanable) all of the filters on your air handling equipment, clear out all the mail bins as well as all those other simple tasks that get everything ready for the next wave of staffers.



AC units run much better with clean filters.

Summer is also a great time to clean and reorganize the storage and shelving areas. Go to your local home store and get a variety of bins and clear drawer systems – then sort out all those loose cables, adaptors and connectors that you threw on the shelf all year long. Be sure to label the bins and the cables so anyone can find those contents, and also put them back correctly.

Other things to sort out include your field kits, to make sure everything is ready to go for events and interviews. *Change the batteries* in everything portable – it is the best cheap insurance you can get for field work. I try to write the date on the batteries with a sharpie so I know when I last changed them, just in case.

ENJOY THE SUN

Outside maintenance is just as important as indoors, especially for stations with limited engineering support. Take a trip to your rooftop systems, or look at your antennas and masts/towers with some powerful binoculars to make sure they survived winter ice and wind without new kinks, frays or other obvious wear.

Ideally, get a climber up to inspect everything for wear. It was not until we had the tower at my old college station climbed that we found a splice full of water – a splice you could not see from the ground. Without physically inspecting things, you might not find out about a potential problem until it is fully realizing its potential(!) – which usually happens at 4:59 PM on a Friday, in the rain.

Summer means the grass is growing, the paint is peeling and your signage is fading. Get to your transmitter site and check out all any/all issues you have to deal with there.

This is not how you want to have your signs to look to the public.

Make sure your have the grass at your site mowed regularly, repaint anything that needs it and make *sure* you replace worn out signs (RF, No Trespassing, etc.). This is both a legal and a sensible move, so other people besides me will approve.

FIXING PROBLEMS, EVICTING SQUATTERS

Site maintenance is critical for your operations and you can rest assured that winter months brought changes to your site. Whether that nice warm transmitter building housed a family of possum, or your fence now leans at a 45 degree angle from ice, you need to get up there and check things out.

Look for lines that may have been frayed (or chewed) and corrosion issues from water/ice penetration. This includes both your outdoor transmission and audio lines *and* those connected *inside* the buildings. For some reason, many rodents like the taste of wire insulation.

If you use FCC Part 15 unlicensed systems, it is time to check the tuning units, or the tuning circuits on each site and make sure that they are set properly. Most tuning systems for Part 15 units will drift a bit based on changes in your ground, electrical or other connections.

Take the time to inspect all of your physical connections for corrosion, wear and damage. Once you are sure everything is tight, recheck the tuning on your antenna (or carrier current) and make sure you have the best match possible.

DOCUMENT IT

It is also a good time to take fresh field measurements, outside and inside. Get a nice campus map, to scale, and choose consistent measurement locations. Mark the locations and define them carefully, recording your field strength readings, the equipment used and its last calibration date. Save the map in a safe place.

The FCC has very few restrictions on Part 15 systems, so they will hold you to them when they inspect. Make sure you can show them when-where-how you took your measurements. If you have students who help out with the tech side of things, make sure they know how to do this too. You will most likely be out of town when the FCC shows up and it is good to make sure you are covered!

If you run a vehicle for the station, this is also the time to look it over and give it the hard-core cleaning it needs: interior, exterior, underneath, inside the engine bay, etc. Then consider a tune up and oil change. If your station vehicle sees the abuse ours does, you want to make sure you do all of this at least once a year, even if the actual driven mileage is low. After all, you do not want to burn up the motor halfway to a big event, do you?

There is much more to do, of course, but for the moment, take a break and enjoy a cool beverage by a warm briquette fire – although that was probably started by the seniors as they left campus!

John Devecka is the Operations Manager of WLOY at Loyola College in Maryland. He loves working with students. But he treasures the quiet summer months, when he can get all those projects handled – at least that is his story. Got some additional suggestions? Let John know at wloy@loyola.edu

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SRC-32

The SRC-32 is a computer interface to the real world. Connection through an RS-232 or RS-422 serial port the SRC-32 can notify your PC software program that any of 32 -optically isolated inputs has been opened or closed and allow your software to control eight SPDT, 1-amp relays and an additional 24 open collector outputs. Communication with the SRC-32 can be accomplished via short burst type ASCII or binary commands from your PC (computer mode). Also, two units can be operated in a standalone mode (master/slave mode) to form a "Relay extension cord," with 32-channels of control in each direction. The unit can communicate using RS422 or RS232, at data rates up to 38400. The SRC-32 may be expanded to 128 inputs x 128 outputs. Optional external Ethernet capabilities may be added with the SP-1. The optional USB-RS-232 adapter may be added for USB operation.

GPI-32

The GPI-32 interfaces 32 optically isolated inputs to a RS-232 or USB port. The GPI-32 is equipped with both dual plug-in Euroblock connectors and two independent DB-37 connectors that may be interfaced directly to the DB-37 connectors located on the StarGuide II/III relay cards. Additional features; dual RS-232 connectors, one for daisy-chaining multiple units on the same legacy serial port and a DB-9 to interface to our USB adapter; LED indicators for power and input activity; twin power connectors allowing up to four units to be driven off of one power transformer. The GPI-32 is powered by a surge protected internal power supply. The optional RM-3 may be added for rack mount applications.

SRC-8 III

The SRC-8 III is a computer interface to the real world. Connection through an RS-232 or RS-422 serial port the SRC-8 III can notify your PC software program that any of 8 opto-isolated inputs have been opened or closed and allows your software to control eight SPDT, 1-amp relays. Communication with the SRC-8 III can be accomplished via short "burst" type ASCII or binary commands from your PC (computer mode). Also, two units can be operated in a standalone mode (master/slave mode) to form a "Relay extension cord," with 8-channels of control in each direction. The unit can communicate using RS-232 or RS-422, at data rates up to 38400. The SRC-8 III may be expanded to 32 inputs x 32 outputs. Optional external Ethernet capabilities may be added with the SP-1. The SRC-8 III may be set on a desktop, mounted on a wall or up to three units mounted on the RA-1, Rack-Able mounting shelf.

SRC-2/SRC-2x

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

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Field Guide

by Chris Ferris

ISP Sports Scores with the AudioVAULT™

[WINSTON-SALEM, North Carolina] ISP kicked off the past football season with a new Broadcast Electronics' AudioVAULT™ digital audio system, and our sports network has not been the same since.

A FULL SCHEDULE

Saturday night football was always a daunting experience at our radio studios in Winston-Salem, North Carolina. A typical Saturday during football and basketball season can mean seven or eight of the colleges we represent have games going on at the same time.

That is eight play-by-plays. Eight broadcast feeds. Eight uplinks to over 300 broadcast stations all over the United States. While we are covering the Virginia Tech Hokies for an audience tuned into over 30 stations in Virginia, we are also covering the Georgia Tech Yellow Jackets for another 33 stations in Georgia. Multiply this complexity by a factor of eight, and you pretty much have an idea of the challenges before us on a typical Saturday.

Did I mention we also supply sports coverage to Yahoo and RealNetworks for Internet streaming as well as XM and Sirius for satellite radio? It is like having eight different radio stations in the same building for seven to twelve action-packed hours, one or two nights a week.

HANDLING SPECIAL NEEDS

Our previous system worked, but would require an extensive set-up each week before we would run the Game Day broadcasts – not just for one game, but for each and every game. With this many balls in the air, we do a great deal of on-the-fly production – not the sort of operation typically supported by most digital audio systems designed for radio stations.

That level of operational complexity is why we stayed with a "sneaker" network for so long, until we got the Broadcast Electronics' AudioVAULT.

I discovered the AudioVAULT and Broadcast Electronics at the NAB convention. The folks at BE seemed to understand what we were trying to accomplish. Not only did they take the time to understand our operation, they seemed knowledgeable about the solution. Criss Onan, BE's representative, always came back with, "We can do that."

But what really locked it down for me was a visit to Auburn University. We had just acquired their athletic department's multimedia rights and I noticed that their network operation was completely integrated with a BE AudioVAULT. I had the opportunity to go there and see the AudioVAULT functioning; I was impressed, and decided to get a system for our studios.

SMOOTH OPERATIONS

This past season was the first when we could record a commercial, drop it into AudioVAULT storage, schedule it for each sports event, and forget about it. We need not spend hours entering in spots for billing purposes, one of many manual operations we have eliminated, thanks to the AudioVAULT.

During game time, the on-site engineer sends event coverage over ISDN from the stadiums into one of eight mini-studios – or boards with AudioVAULT workstations. Our main AudioVAULT server is set up to receive nine inputs, one for each college plus a spare, as live programming. Prerecorded interviews, liners, and commercials are stored by the AudioVAULT server and can be mixed in at any time.

Before each of the eight board operators is a dual screen – one a preview/record screen, the other the AVAir screen of program that is currently airing live.

AUDIO CAPTURING

On one side, BE set up two separate record events, one to roll through the game for archiving and another to capture actualities from the game, so our guys can edit them on the fly and make them available to other operators in the building for scoreboard updates throughout the game broadcasts.

We set up unique tabs for each of the eight sports teams, so any operator can click on a tab and download a highlight whenever they need it. Archiving the comlete games gives us the ability to chop up the audio into smaller segments or create a CD of the entire game at a later time.

During the week, ISP is using the AudioVAULT's AVProd module for commercial production; on weekends, announcers and board operators use it to edit out snippets of the game for use by others in the network as actualities by adding voice-overs to the piece, or run as-is. As for the Web access, all files are already saved as .wav files and are good to go.

This setup is probably something you might never see in a radio station, but it sure works for us. We have noticed a lot more interplay between the games, such as cross-promoting games and being able to ad-lib liners, or pull up "takeouts." This system's archiving feature alone is worth its weight in gold; no longer do we have to buy cassettes in bulk!

Chris Ferris is the Chief Engineer for ISP Sports in Winston-Salem, NC, a multimedia marketing company serving many major Southeast intercollegiate athletic programs. He can be reached at: cferris@ispsports.com

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	5 kW	1982	Harris MW5A
	10 kW	1988	Harris MW10B
	50 kW	1985	Continental 317C2
FM	1.5 kW	1987	BE FM1.5A
	2.5 kW	1984	Continental 814R
	3.5 kW	1992	Harris HT3.5
	5 kW	1982	Harris FM 5K
	6 kW	1995	Henry 6000D
	10 kW	1980	CCA 12,000E
	10 kW	1988	Harris HT-10
	10 kW	2001	Henry 10,000D-95
	20 kW	1991	Harris HT-20
	20 kW	1978	Collins 831G2
	25 kW	1980	CSI T-25-FA *(amplifier only)*
	25 kW	1982	Harris FM25K
	30 kW	1986	BE FM-30A
	50 kW	1982	Harris Combiner *(w/auto exciter-transmitter switcher)*

Miscellaneous Equipment

EXCITERS:
Used Continental 802B
New Nicom 20 watt Synthesized

USED MISC. EQUIPMENT:
Bird Test Load, 25kW Termaline, 50S
Bird RF Thruline Wattmeter, 50S
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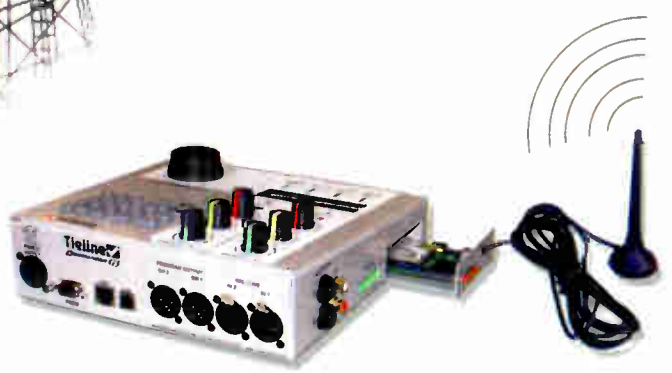

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Digital Guide

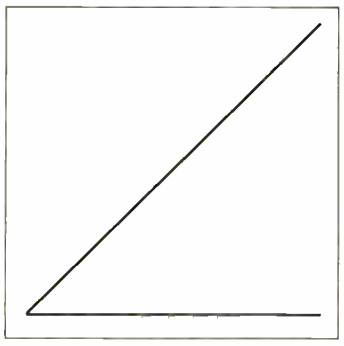
by Robert Meuser

Digital Transmission

Part 5: Adaptive Pre-Correction

[NEW YORK CITY, New York] Up to this point, we have taken a more or less general look at transmission but not any specific system.

Digital streams can be transmitted in narrow bandwidths by having the RF carrier represent various digital values with specific analog values of both amplitude and phase. By further breaking out the bit rate over interleaved carriers we can have a more rugged means of transmitting the digital information. However in order to work properly, both QAM and OFDM require linear amplification of the resulting signal.



Ideal Linear Amplifier Amplitude Response

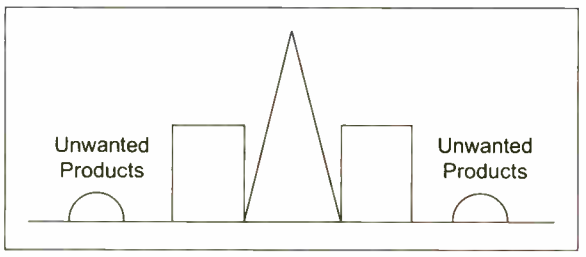
While linear amplification of digital signals can be achieved, much like running a TV transmitter, it can lead to a loss of efficiency and power output relative to analog transmission. We note with interest, then, some new information from the papers delivered at this year's NAB Convention dealing with linear amplification.

NON-LINEAR PRODUCTS

A problem with all linear amplifiers is that they are never totally linear. The less linear the amplifier the more distortion products are created. Such intermodulation distortion is a big problem in most digital systems because it can create interference in nearby channels.

As an example, the IBOC system proposed for VHF operation has digital carriers covering the spectrum of approximately +/- 130 kHz to 200 kHz from the assigned channel center. In a system where distortion exists there will be intermodulation products. The largest of these products will be the sum and difference of these frequencies.

This means that a station on 100.1 could have intermodulation products extending from 99.5 to 100.7, or over six full channels. With a really poor amplifier, even more distortion products are possible. In current lingo, these products are often referred to as "shoulder pads."



Generic IBOC signal with IM distortion (shoulder pads).

Obviously some means must be available to prevent the out of band emissions.

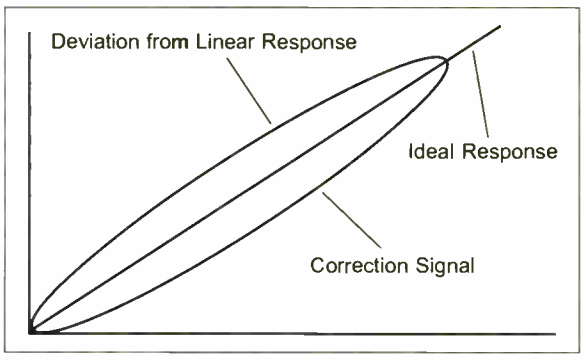
ADAPTIVE PRE-CORRECTION

Harris first presented a paper at NAB 2004 that discussed the ability to apply adaptive pre-correction to the DAX medium wave transmitter. The process essentially pre-distorts the amplitude and phase components separately to produce a corrected combined signal at the output.

At VHF frequencies the process is a bit different, as all VHF systems currently use TV-style linear amplifiers. This year both Harris and Nautel presented papers explaining how a similar techniques can be applied at the exciter level that anticipates the distortion in the following linear amplifier. Each company takes a different approach in achieving a similar result.

In one implementation, the exciter uses a look up table to generate a non-linear curve that is opposite the linear amplifier's deviation from an ideal straight line. The idea is that the two non-linear curves cancel, resulting in a straight-line response.

This looks good on paper but in the real world external factors will determine the ultimate amplifier performance, which will vary over time. To deal with this problem, a form of feedback is used.

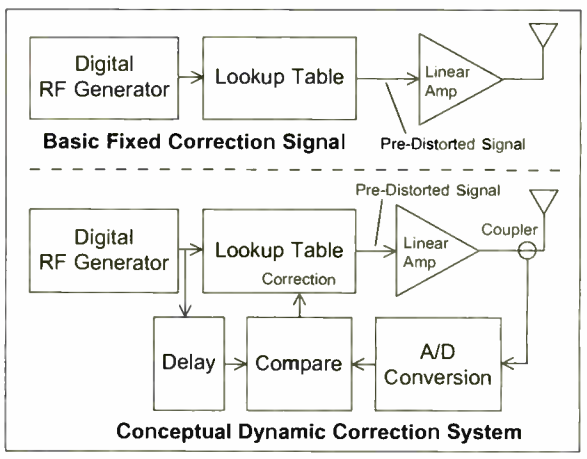


Corrected Response

DYNAMIC CORRECTION

Due to both the delay involved with digital signal generation and potential dangers of real time feedback (if it were possible), something slightly different is employed. The undistorted – and still fully digital signal – is delayed and compared to a digitized signal returned from a coupler that samples the transmitter output.

The correction process described can be thought of as a dynamically modified pre-distortion system. Such techniques can be applied to other transmission systems, thanks to the power and availability of DSP processing.



Conceptual Dynamic Correction System

Like all the systems that preceded it, digital transmission has its own technical nuances that require good engineering and ongoing research. We will look at those developments in the future.

Robert Meuser is always keen to follow and help others understand the latest technologies for broadcasting. He welcomes your comments at robertm@broadcast.net

Tech Tips

by Bob Burnham

Shure SM-7 Microphone Fix

[DETROIT, Michigan] The original Shure SM-7 mounting assembly utilized an offset dual tubular metal piece with a threaded screw that attached to the screw-on mount for the microphone arm.

Mounting screw broken off in mount.

Unfortunately, with just a few years heavy use, the screw either becomes stripped or snaps off entirely, leaving the remaining broken screw buried in the tubular metal piece.

While is possible to drill out and re-tap the threads, save yourself the metal shop chore! Shure has redesigned the entire assembly, and the individual parts are readily available.

The tubular piece is replaced by the modified version. A brass insert fits inside (new to the re-design). A longer screw with a hex head attaches the microphone yoke to the tubular piece and threads onto the brass insert.

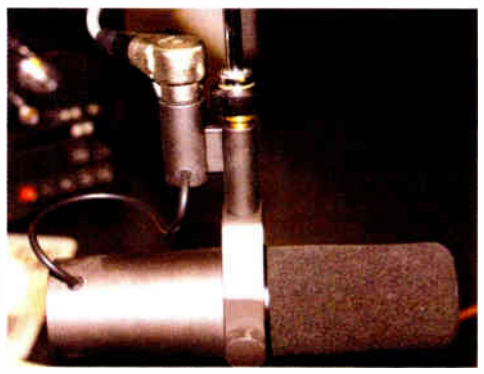
New kit from Shure.

The opposite side of the brass insert has threads matching the flat-head screw that goes inside the screw-on boom mount.

Do not forget to save the tiny set screw from inside your old tubular piece. It clamps the cable in place that attaches to the XLR pins.

DON'T FORGET THE SCREW! ⇨

The last photograph shows the finished repair of an older SM-7 that has been retrofitted with the new mounting hardware.



Bob Burnham does consulting and technical services for stations and studios in the metro-Detroit area for over 25 years. He can be reached bburnham@specshoward.edu

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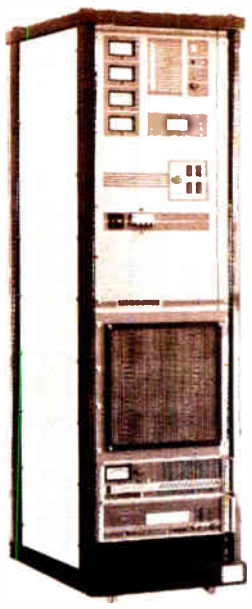

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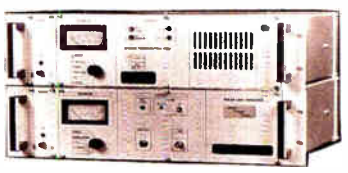

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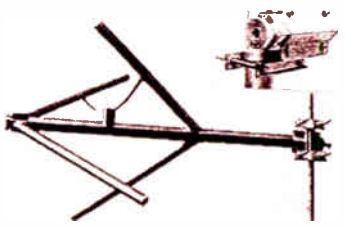

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Field Guide

by Art VanDolay

A "PowerClamp" User Report

[LOS ANGELES, California] My experience with PowerClamp Transient Voltage Surge Suppressor units began in 1988.

I was (and still am) the contract engineer for a Class B FM station in southern California. The station was experiencing a problem with their transmitter, which was located on a mountaintop – a two-hour drive from the station's studios.

ANNOYING OUTAGES

The problem was simple but annoying: almost every Thursday morning at about 8:00 AM, the transmitter would throw its main breaker and the station would go off the air.

This would require someone to drive up to the site, reset the breaker, and get the transmitter back on the air. Every time this happened, they would try to locate evidence of whatever caused the breaker to trip, but nothing was ever found.

The local utility company was contacted, under the assumption that the problem was power line related. They ultimately issued a 23-page report, explaining that it was not due to anything the utility company was or was not doing.

A SOLUTION

About this time I was contacted by a representative of Sine Control International. They claimed to have the solution to this problem, in the form of a highly effective surge suppression device. Since we were at our wit's end, I agreed to try one of their units.

Once it was installed, the problem went away and never returned. Ever since that experience I have been a big fan of these units, which are now marketed by Henry Engineering as "PowerClamp."

REPEATING MOVIE

A few years later, I became Chief Engineer of one of Los Angeles' major FM stations. They were using a pair of older tube-type transmitters. They too had the occasional problem with one (or both) of the transmitters tripping the main breakers.

And again, someone (usually me) had to drive up the mountain to reset the breaker.

Since "I had seen this movie before," I installed a PowerClamp Series 8 surge suppression unit. Again, the problem went away and never returned.

GOOD HABIT PAYS OFF

In the early 1990's we upgraded to a completely new transmitter plant on Mt. Wilson – the 6,000 foot mountaintop that serves Los Angeles with most of its FM and TV signals. I installed a pair of Continental tube-type transmitters at this site, which also housed another FM transmitter and a TV transmitter.

Taking a clue from my past experiences with mountaintop power, I installed a PowerClamp Series 8 surge suppressor on my transmitter's AC power input. It paid off. A few months later, there was a significant power line surge. The surge – or whatever it was – caused my transmitter to "hiccup," but it came back on the air after a few seconds. There was no damage.

Meanwhile, various transmitters in the same building from other FM and TV stations sustained very serious damage. (The cost of their repairs greatly exceeded what I spent on the PowerClamp unit.)

MORE STATIONS, MORE CLAMPS

I am currently the Chief Engineer for the Los Angeles cluster of several broadcast facilities under common ownership. Being responsible for many radio stations means my time is limited, and there is no room for "taking chances." For this reason, I have installed PowerClamp units on virtually every transmitter for which I am responsible.

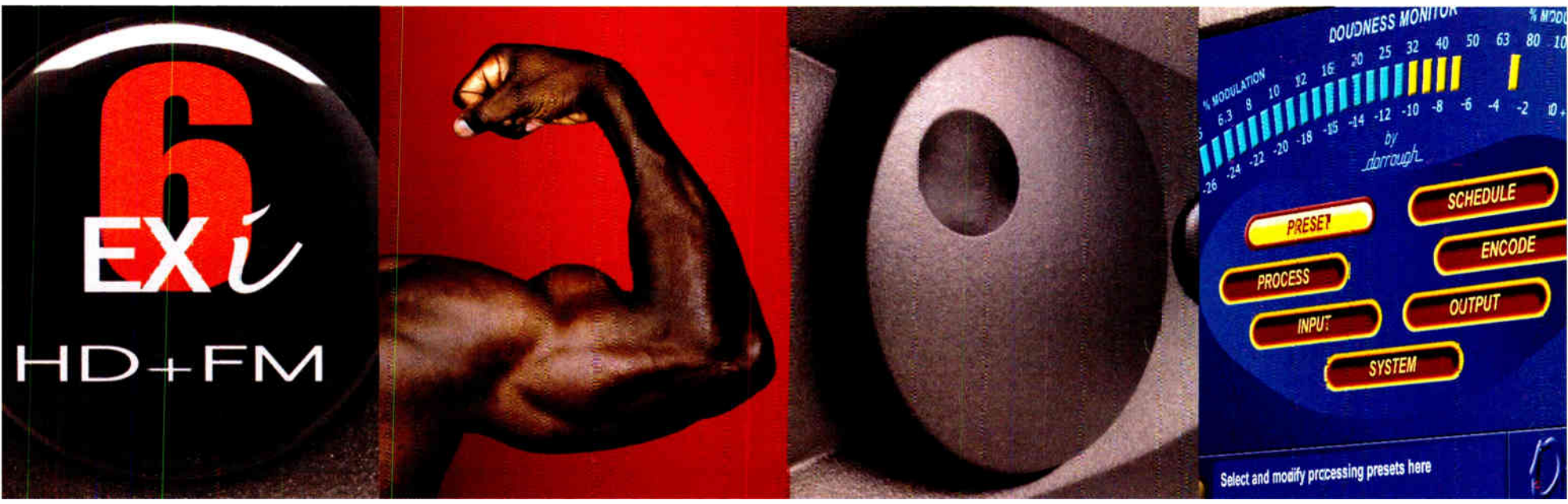
We had previously experienced unexplainable off-air episodes about once every four to six weeks. In over a year since the PowerClamp units were installed, we have not had such a re-occurrence

Another benefit I have also noticed is an increase in tube life. Our Harris tube-type transmitter formerly consumed final tubes about once per year. After installing a PowerClamp unit, tube life has increased. We are now 16 months into a tube and it is still going strong. I can only conclude that keeping voltage spikes out of the tube is having this positive effect.

I am convinced that PowerClamp TVSS units are well worth their cost. They have demonstrated their ability to eliminate power line surges and glitches that cause tripped breakers and serious damage to transmitter plant equipment. As the saying goes: "Don't leave (your transmitter) home without one."

For more information on the PowerClamp, see the Tech Guide on page 20.

Art VanDolay is a veteran engineer in the #2 market for many years. You can email Art at mail@radio-guide.com



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

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Tech Guide

by Hank Landsberg, President, Henry Engineering

PowerClamp TVSS: Theory of Operation

The purpose of the Tech Guide is to help explain what is going on "underneath the hood." We have asked Hank Landsberg to talk about the hows and whys of Transient Voltage Surge Suppression.

[SIERRA MADRE, California] A respected Los Angeles area Chief Engineer contacted me in 2003 regarding his experience with some very effective Transient Voltage Surge Suppressor (TVSS) units.

He had been using these devices, made by Sine Control International, for over 10 years with very good results, and thought the rest of the broadcast industry ought to know about them. I researched the technology behind the Sine Control units and, to make a long story short, Henry Engineering now offers them to the broadcast industry as PowerClamp TVSS.

WHY A TVSS

The purpose of a TVSS is to eliminate – or greatly attenuate – voltage spikes, surges, and similar disturbances on the AC powerline. These are the mysterious gremlins that cause unexplainable equipment problems in a broadcast studio or transmitter site: computers that lock up, pops, buzzes, and snaps in audio systems, and (worst of all) transmitters that trip their main circuit breaker for no apparent reason.

Powerline spikes and surges come in all shapes and sizes. They can be a few hundred volts above the normal AC voltage, lasting several hundred milliseconds. Or they can be tens of thousands of volts in amplitude, but last only microseconds.

Often they are caused by your local electrical utility company switching power sources and/or power customers on or off the distribution grid. Or, they can be caused by a utility customer using a highly inductive load, such as arc-welding equipment, a commercial printing press, x-ray equipment – or anything that consumes a large amount of power.

Large spikes can also be caused by lightning strikes near utility lines. This is especially true at transmitter sites, which are often at the end of a very long run of powerline: an effective antenna for lightning-induced voltage spikes!

There are several TVSS units available. What makes PowerClamp unique? Does it really work? What is inside the gray box? Here are the answers.

HOW IT WORKS

TVSS units are available in two basic versions: Series and Parallel. A series-installed unit is installed in series with the AC power input to, say, your transmitter. A parallel-installed unit is installed in parallel (to ground) with the main power input.

Series-installed units allow normal AC power to pass through them, but present a very high impedance to short-duration (fast risetime) transients, e.g., power spikes. The disadvantage of a series-installed TVSS unit is that if the unit fails, power to the load is interrupted. If the load is your transmitter, you are off the air! (This is a case of "the cure is worse than the disease.")

The advantage of a parallel-installed TVSS unit, like PowerClamp, is that power to the load can never be interrupted, even if the TVSS unit fails. But how can a parallel-installed TVSS unit attenuate powerline spikes and surges effectively?

CLAMPING

The best measurement of a TVSS units performance is its *clamping* level. The clamping level is the threshold voltage over which spikes and surges are eliminated or greatly attenuated.

The *lower* the clamping level, the *more* attenuation of powerline spikes, surges, and noise. PowerClamp's advanced technology yields the lowest clamping level of any parallel-installed TVSS unit available, with the reliability of a parallel installation.

Many TVSS units rely primarily on metal oxide varistors (MOVs) for surge suppression. The problem with this approach is that the MOV threshold must be well above the nominal AC voltage to prevent the MOV from overheating and/or distorting the AC waveform. This margin is normally 200% of the line voltage. Therefore, a surge or spike must be at least 200% above normal voltage *before any clamping occurs.*

For example, on a 120 volt line, a transient of over 350 volts will pass through without any attenuation. On a 480 volt line, a surge of nearly 1,500 volts will pass without attenuation. At the very least, these transients will cause unreliable and erratic behavior in electronic systems: tripped breakers, computer lockups, etc. At worst, they can destroy microprocessor-based equipment.

MULTI-STAGE ACTION

PowerClamp does not rely solely on MOVs. PowerClamp is a multi-stage hybrid device. It uses advanced rise-time-sensitive secondary circuitry in addition to MOVs to achieve a clamping level of just a *few volts* above the normal AC line voltage.

It is the combination of the *multiple attenuation circuits* that produces PowerClamp's extremely low clamping level. The MOVs in PowerClamp attenuate the transient to within a few hundred volts of normal; the secondary circuitry further reduces the transient to within a *few volts* of the AC waveform peak.

By responding to both voltage level and waveform risetime, PowerClamp's attenuation circuitry can differentiate between a slow (line-surge) and a fast (spike or transient), activating different stages of the attenuation circuitry, depending upon the amplitude and risetime of the transient.

Since the most destructive transients – lightning-induced spikes – tend to have the fastest rise-times, they will activate the all of the high frequency attenuation stages of the PowerClamp. All transient energy above the clamping level is instantly shunted to ground where it is dissipated.

An added benefit of PowerClamp's extremely low clamping level is that it not only eliminates transients, it also "scrubs" noise and harmonics from the line. "Spike noise," such as that from triac dimmers, motor commutators, and components that arc (as in laser printers, copiers) is greatly reduced by PowerClamp. (TVSS units using only MOVs cannot remove AC line noise.)

To prevent problems if the line voltage rises a bit, Powerclamp automatically adjusts the clamping level threshold via sine wave tracking circuitry. It maintains the clamping level even if the input voltage varies by as much as 20%, so normal voltage fluctuations do not affect its operation.

AVOID PROBLEMS

TVSS units that use only MOVs will often degrade over time. This is because the voltage drop across the MOV (caused by its high clamping level) results in power dissipation in the form of heat, which destroys the MOV.

This degradation causes the MOVs clamping level to gradually rise, reducing its surge attenuation. Eventually the clamping threshold will be so far above the AC line voltage that the TVSS unit will be rendered useless. PowerClamp takes a different approach, actually shunting the most destructive power spikes away from the MOVs, reducing their need to absorb energy.

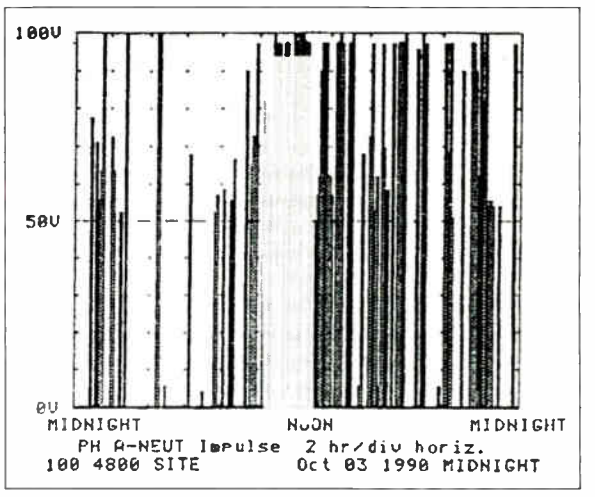
Our experience indicates that PowerClamp's extremely low clamping level and incredibly fast (1-2 ns) response time result in very low power dissipation within the suppression components. That allows consistent performance even after hundreds of powerful "hits" and many years of use.

In the event a power surge exceeds PowerClamp's capacity, its fuse will blow. But since PowerClamp is in *parallel* with the load, power to the load is not interrupted. You stay on the air!

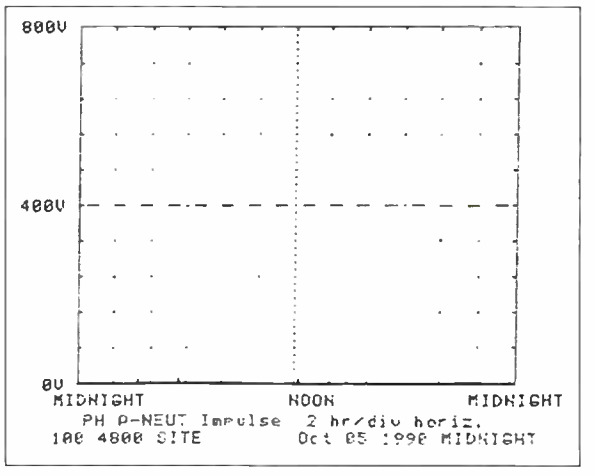
AN EXAMPLE OF EFFECTIVENESS

The following graphics depict the situation at a typical PowerClamp installation. Equipment at this location was plagued with erratic and unreliable operation, due to excessive voltage spikes on the AC line.

BEFORE: With an older TVSS unit installed, strip-chart recordings indicated 1,238 spikes over a 24-hour period, many of which were more than 100 volts above the normal AC voltage.



AFTER: When a PowerClamp TVSS unit was installed, only 3 spikes were recorded during the next 24-hour period. None were more than a few volts above the normal AC line voltage.



PERFORMANCE EVALUATION

Of course, a TVSS unit cannot be bench-tested like most other broadcast gear. The "next best test" is to hear other broadcast engineers' experiences. We have heard good reports from many users. We would be happy to share them with you. Just call or email us.

For more information about PowerClamp TVSS units, please visit www.henryeng.com.

Hank Landsberg, President of Henry Engineering, is a veteran broadcaster who has gone from station engineering to manufacturer of products used in stations everywhere. Contact Hank at info@henryeng.com

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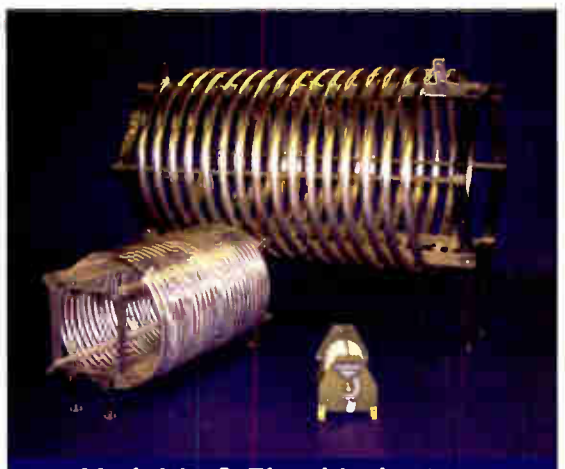

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Studio Guide

by Mark Shander

Choosing Microphones
Part 1

[PHOENIX, Arizona] Broadcast engineers and technicians always love a neat new tool to make better audio.

On the other hand, which tool is the right one is the source of endless debates at radio studios and production facilities. Everyone has a favorite microphone, preamp or processor, and everyone has at least a dozen justifications as to why they prefer a particular solution.

FINDING THE "RIGHT ONE"

Fueled by the interest in personal and portable studios, a lot of new products are vying for placement, especially when budgets are tight. There are a few tried-but-true champions, but also some newcomers – such as modestly priced condenser microphones – that may surprise you. Also, some of the newer dynamic microphones deliver quality sound comparable to their higher-priced counterparts.

Sennheiser is a manufacturer we have all come to expect great performance from. The MD-421 has been around a long time (in one form or another) and continues to be one of the most popular microphones seen in stations across the country. Its combination of silky-smooth sound combined with its famous presence peak helps it cut through the mix. The MD-441 has been used in situations where truer reproduction of voice frequencies is an issue.

The newest line – the Evolution Series – has several products worthy of serious consideration by any studio, regardless of a budget configuration. The newest is the Evolution Series microphones with the letter e before their model numbers.

The 900 series is the top of the line, literally, but I have come to find excellent performance in the 800 series, which delivers excellent price versus performance ROI. Sennheiser appears to be pushing the 900 series hard, and appearing to reduce the variety of models in the 800-series line.

THE SENNHEISER e800 SERIES

The current microphones most available in the e800-series include the e815s, an entry-level vocal microphone that might be best suited for karaoke, and the e825s. (Microphones with an "s" after the model number have an on/off switch – something you do not want in your studio, but musicians may desire on stage.)

The e825 has somewhat reasonable results – and could be used in a low-end studio or educational studio – but is not the microphone I would most recommend in the series.

Sennheiser e835

In fact, it was a surprise to me that the microphone I prefer in the 800 series is in fact the e835, which, despite its printed specifications, delivers a sound so similar to the Sennheiser MD421 with the bass roll-off switch in the *flat* position that I had to buy one immediately.

Rounding out the 800 line are the e845 and e865, with the e865 being a condenser microphone and the e845 a supercardioid dynamic microphone with specifications similar to the e835. As with many supercardioids, the proximity effect on the 845 is a killer – the closer you are to the microphone the more bass it seems to produce, and the further away you are the less presence you have.

BEST OF THE LINE

That is why I prefer the e835. It has a very uniform frequency pickup pattern that guarantees consistent sound performance, whether your talent gets close or is a bit further away than you would like. Presence is better off-microphone, too.

Without a doubt, if I had to standardize on a single Sennheiser microphone to create a dozen studios for an educational facility, the e835 would be my choice. It is very durable, sounds like something costing three or four time more, and even looks the part.

As far as mating with microphone processors, this microphone has a hotter output than most similar microphones from other manufacturers. The one I have also has a lower noise floor than my other microphones in its price category ($159 MSRP, $100 or so street).

I would suggest using a medium to heavy level of compression, with a slight boost to the low-end to add consistent proximity across the physical microphone placement axis. With a little tweaking, this microphone could easily stand side by side next to a Shure SM-7 or an RE-27. It is *that* good.

Mark Shander has spent a good part of his life talking into microphones and comparing their output. Let Mark know what is your favorite microphone at mark@shander.com

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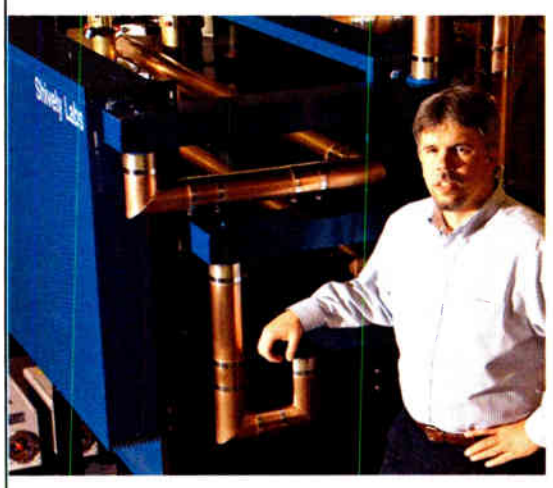

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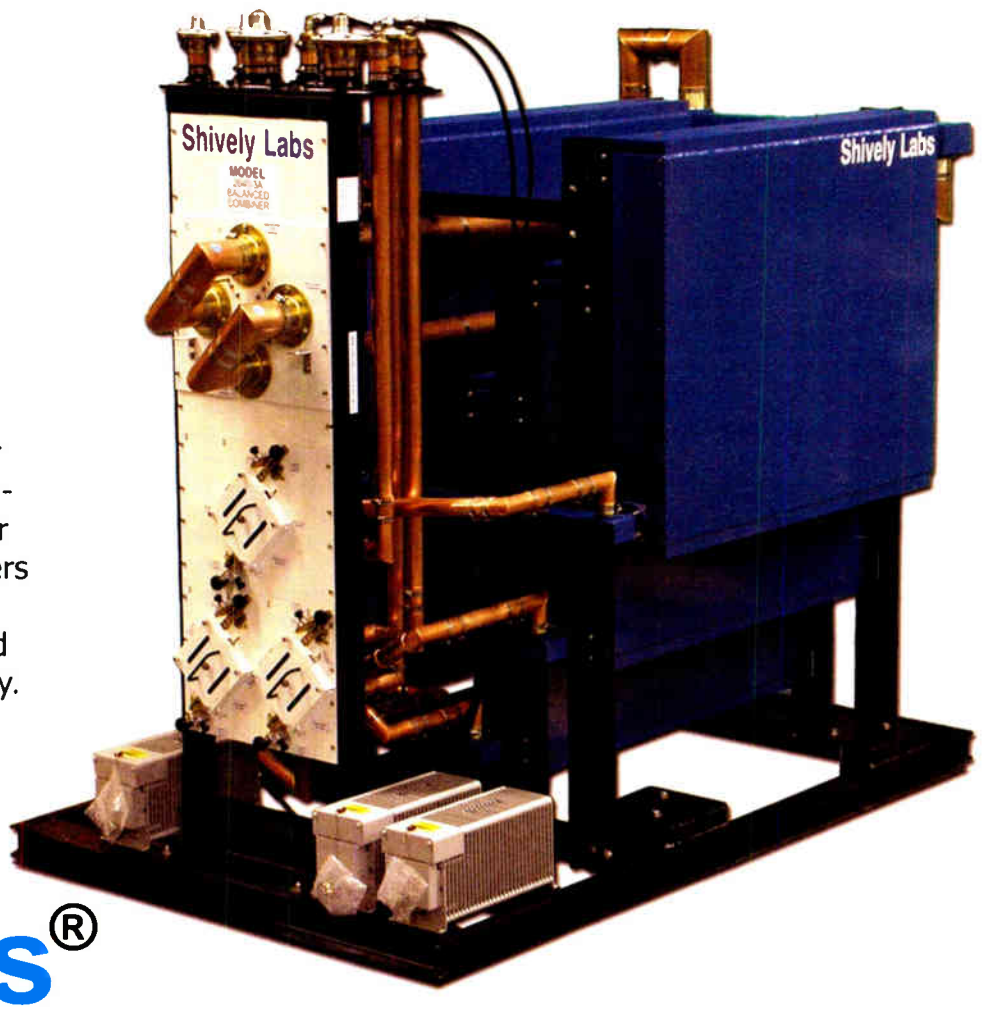

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HARRIS

by Alan White, Continental Electronics

Developing an IBOC Transmitter Using a Single Tube PA

[DALLAS, Texas] The emergence of digital transmission for radio has evolved from over a decade of overcoming technical challenges. However, the enhanced user experience now available with HD Radio™ technology (also known as IBOC) is not without its own challenges.

More stringent requirements on transmission equipment have led to the development of a variety of methods of implementing IBOC technology, often requiring new transmission equipment. This article will address FM IBOC in general, the different methods of broadcasting both the analog and digital signal, with a focus on the high power low-level combined transmitter developed by Continental Electronics.

IBOC BASICS

The IBOC signal is a digital multi-carrier OFDM signal that shares the same channel allocation as the analog FM signal, and allows both digital and traditional analog FM (Analog + HD) to be broadcast.

The digital signal is broadcast as a dual sideband to the analog FM, but 20 dB lower in average power and is within the FCC spectral emissions mask for FM broadcast systems. However, in an effort to reduce interference to other channels Ibiquity has specified a new spectral emissions mask that is more stringent than the currently accepted FCC mask.

Considering that a typical analog FM transmitter is not capable of meeting the new spectral emissions mask while passing the new IBOC digital signal, external equipment such as high-level and mid-level combiners, or separate radiation systems needed to be employed or new transmitter designs needed to be developed.

LINEAR AMPLIFICATION

The amplification of the digital signal requires a linearized transmitter to keep intermodulation (IM) products – also known as spectral re-growth – from causing interference and distortion problems.

The nature of a multi-carrier digital system is to have a high peak-to-average power ratio – as high as 10 dB. This high peak power can drive a power amplifier into compression, which is a non-linear region of operation, leading to spectral re-growth and distortion issues.

For this reason, the peak-to-average power ratio used in HD-only transmitters is approximately 6 dB. The peak-to-average ratio used in Analog + HD transmitters is approximately 1.3 dB. Trying to accommodate the peak power and operate the transmitter linearly reduces the average power output of a given device and reduces the efficiency.

Several methods of achieving the combined Analog + HD signal have been derived to handle the challenges of digital radio. Each of these methods has their own advantages and disadvantages.

LOW LEVEL COMBINING

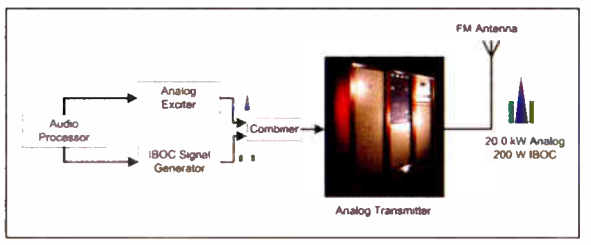
Low-level combining is by far the simplest and most elegant solution to generating the IBOC signal. It is a technique where the analog and HD signals are combined at the exciter level, thus requiring only one transmitter.

By using the same amplification path for both signals, an expensive high power combiner, additional antenna or additional transmission line will not be needed. Nor will a tower crew be needed to perform the installation. Additional floor space may also not be needed; cooling and AC power requirements are only marginally affected.

Historically, this has required a solid state transmitter that is linearized and has reduced power output to accommodate the 1.3 dB peak-to-average power ratio of the Analog + HD signal. This means a typical 10 kW solid-state transmitter is limited to about 7 kW of Analog + HD power. At the current state of the art, using a solid-state transmitter at higher power outputs is not as efficient as high-level or split-level combining.

However, by using an 816HD series single tube transmitter for high power situations, there is a significant improvement in overall efficiency over solid-state. This is due to the inherently higher efficiency of the 816HD transmitter and the lack of a combining system required in order to obtain a solid-state transmitter at high power levels.

As demonstrated at the 2005 NAB show, power levels in a low-level combined system can reach up to 17.5 kW in a single box solution using tube technology.



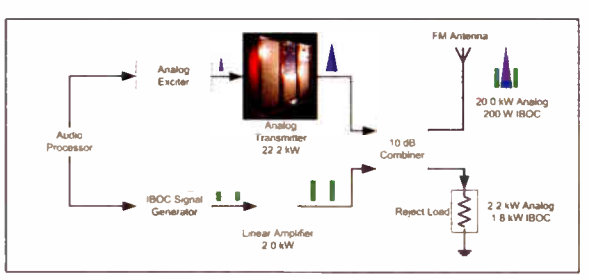
Low-Level Combining

HIGH-LEVEL AND MID-LEVEL ISSUES

High-level and mid-level combining techniques are similar and suffer similar disadvantages, with the mid-level combining scheme offering an improvement in efficiency over high-level combining. However, mid-level combining is far more complex to install correctly.

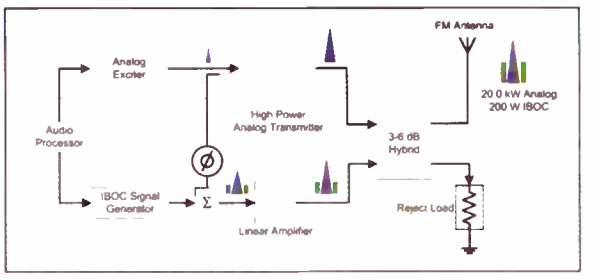
Both techniques require a high power analog transmitter and a medium power HD transmitter. The two transmitters are then combined into a common transmission line with a 3 dB, 6 dB or 10 dB coupler. Although a circulator is often required on the HD transmitter due to inadequate isolation from the analog transmitter, no additional antenna is required.

In the case of high-level combining 10% of analog power and 90% of digital power is lost as heat in an RF reject load. The analog transmitter therefore needs to operate at 11% higher power to make up for this lost power. This additional power may not be available in the station's existing analog transmitter, requiring the purchase of a new analog transmitter.



High-Level Combining

Furthermore, the power lost into the reject load creates a significant amount of heat in the equipment room that must be dealt with, often by increasing the cooling capacity, and additional AC capacity of the equipment room may be needed to power the new equipment. Finally, the additional floor space required in the equipment room may not be available.

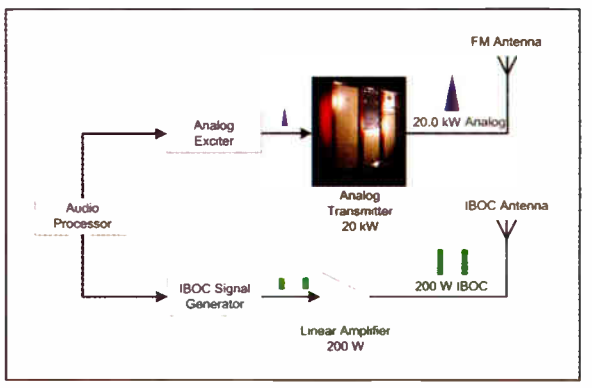


Mid-Level Combining

Mid-level combining is an improvement over high-level combining but with the added complexity of phase matching two transmitters and similar problems with heat, AC capacity and floor space.

SEPARATE RADIATION SYSTEMS

Separate radiation systems require the use of two RF paths, one for analog and one digital. This solution also requires two transmitters. However, the HD transmitter power requirement is only 1% of the analog power requirement. This may provide the best overall system efficiency but has numerous other drawbacks.



Separate Radiation Systems

The requirement of an additional antenna can often be very expensive due to the cost of the antenna, transmission line and installation. In addition, replicating the coverage area of the analog signal with the digital signal may be very difficult.

Dual input antenna systems are available that offer similar efficiency as separate antennas without the difficulty of the digital signal replicating the coverage area of the analog signal. However, a good deal of costs are associated with this solution, including a separate low power HD transmitter, separate feed line, a new dual input antenna, and a tower crew for the installation.

All in all, dual or dual input antennas may drive the costs to a level approaching that of other more complex solutions.

SEEKING A BETTER SOLUTION

If there were one "right" solution for transmitting IBOC there obviously would not be so many alternatives.

At Continental, we looked at the various methods of IBOC implementation and decided to look at the problem from the requirements side rather than the solution side. A requirements-based process involves listing the requirements such as complexity, purchase and operating costs, space required, conversion logistics and technical support.

After careful analysis we determined that the better solution for many higher power stations would be low-level combining because of the advantages over alternative solutions. Low-level combining offers many advantages:

1. Simplicity – A single transmitter does it all.

2. Space – Generally smaller than separate amplification systems.

3. Cost – Generally lower cost than separate amplifiers because of fewer components. Additionally, some existing analog transmitters may be upgraded to IBOC operation at modest expense.

4. Logistics – Almost never requires tower work to go digital.

(Continued on Page 28)

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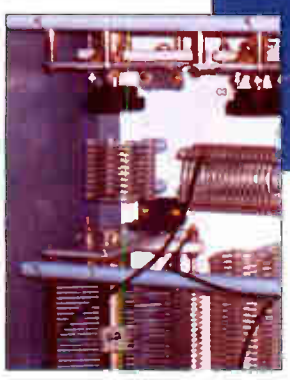

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RF Guide

by Alan White

Continued from Page 26

Even though these are compelling advantages, the low-level combined system has not been used extensively in high power IBOC systems. Until this new breakthrough there have been significant disadvantages in size, cost and efficiency.

TRANSMITTER DESIGN CONSIDERATIONS

In order to produce the complete IBOC signal a transmitter must produce about 35% more peak power that its normal analog FM power. Solid-state amplifiers require a certain number of output devices based on the peak power rating of the transmitter.

Factoring in that power supply and cooling are generally sized relative to average power, a low-level combined solid-state IBOC transmitter would likely be more than 25% larger than the equivalent analog FM transmitter.

Analog solid-state transmitters are already at a size and cost disadvantage over high power single tube designs and adding IBOC to the equation makes the disparity even greater. However, a 20 kW tube transmitter using the modern 4CX20,000E tube can produce the extra peak power required by IBOC without increasing its physical size.

MEETING THE LINEARITY CHALLENGE

The primary technical hurdle to overcome with any digital transmitter – whether tube or solid-state – is linearity. Non-linearities in the transmitter produce intermodulation products that cause out-of-band spectra and self-interference between the digital and analog signals.

Continental researched these requirements and has identified several design changes that will allow a single tube transmitter to meet all performance requirements for IBOC. Some of the changes include new operating points for the tube and a redesigned RF drive chain.

Convincing a tube to perform as a linear amplifier requires design elements often not considered in FM transmitters. This is because nearly all high power FM amplifiers operate in a high efficiency mode – the most common is the so-called class C mode.

Class C amplifiers are inherently non-linear but this is not important for constant envelope signals such as FM. Something that is usually not a priority in the design of class C amplifiers is the small signal gain and stability.

STABILITY ISSUE

Without a doubt, many readers are able to recite interesting examples of FM amplifiers that produce eye opening – and ear deafening – responses when RF drive is accidentally removed. This is indicative of small signal instability. But a very important requirement for any IBOC amplifier is that it must be linear and therefore must be stable in the presence of a varying input signal.

This requirement is already met by the final amplifier in the Continental 816-C series which utilizes the Eimac 4CX20,000E tetrode. The main reasons that the 4CX20,000E tube was chosen as the basis for IBOC development are its high plate dissipation rating and long tube life owing to its large cathode structure.

Developed by months of research into the combinations of linearity, efficiency and output power, we arrived at the optimum configuration for this tube. There are changes to both screen and bias operating points. The output cavity is essentially the same as the current 816-C series but the grid RF input has seen significant revisions to improve bandwidth, group delay and linearity.

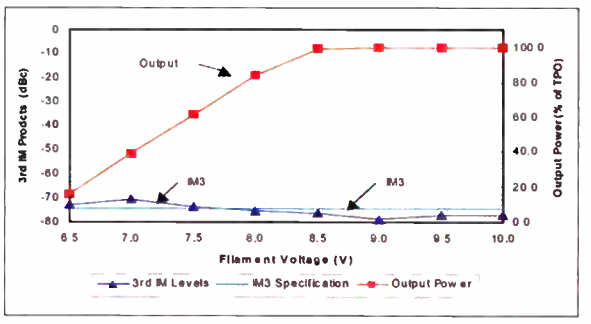
LINEARITY CONCERN AS TUBE AGES

Once the final amplifier met the linearity requirements additional tests were also performed on the tube to determine the effects aging will have on tube performance, particularly pertaining to linearity.

The concern here is that as a tube ages the free electrons available from the cathode diminish, due to the depletion of the thoria at the cathode surface. Typically this is observed as reduced gain and output power in analog FM transmitters.

Tests were conducted by lowering the filament voltage of the tube below the nominal operating point of 10.0 V to as low as 7.0 V to quantify the effect of having reduced the number of free electrons available from the thoriated tungsten filament to simulate the effects of tube aging.

These tests showed that a significant power loss, on the order of 25% or more, was observed prior to any noticeable effect on the IBOC emission mask. Therefore, the tube would most likely be replaced due to an inability to produce the licensed transmitter power output before a significant degradation of linearity occurs. The test results are shown in the following table.



4CX20,000E Filament Test Results

OTHER DESIGN ISSUES

There were significant design changes required in the input-matching network of the 816-C series to maintain linearity. But an equally big challenge involved the RF driver.

The 816-C was designed with a high efficiency class C solid-state driver. This driver is compact and requires few if any operator adjustments. However a new IPA was required to meet the stringent IBOC mask specifications. The new IPA consists of four push-pull VDMOS RF power transistors with a total P1dB of +59 dBm (800 Watts). This ensures that the drive to the grid circuit of the tube is clean.

An important concern with low level combing is the analog performance of the transmitter. Measurements show that critical analog specifications such as THD+N, IMD, stereo separation, etc. are not adversely affected by the presence of the IBOC digital carriers.

Even after all these changes the overall efficiency is every bit as good or better than a solid-state transmitter while at the same time costing less and taking up less space.

PRE-CORRECTION UNNECESSARY

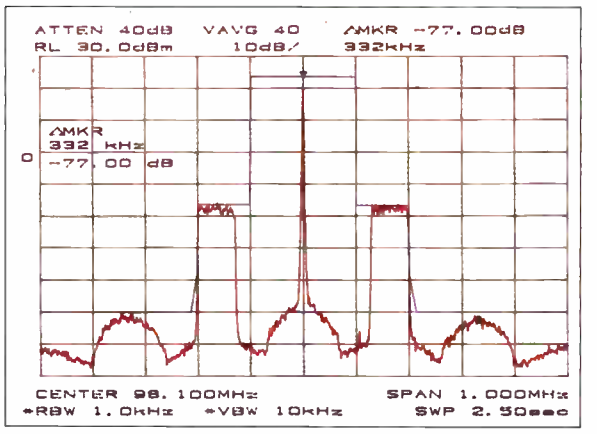
Continued testing and modifications to the tube and drive circuits of the 816R series transmitter yielded a rugged transmitter that exceeds previously accepted levels of output power for a low-level combined system. The 816HD now meets the NRSC recommendations on spectral emissions mask without the need for pre-correction.

The power dissipation in the tube is well under the manufacturer's specification with a manageable increase in operating temperature over the same tube in our analog transmitter.

Based on the test results, a 30 kW analog transmitter can deliver up to 20 kW of Analog plus HD power. Higher levels of output power can be achieved through combining of two 816HD transmitters to achieve power levels up to 35 kW.

THE EFFICIENT SOLUTION

After considering the various methods of generating the IBOC signal, it has been shown that the optimum solution for high power IBOC is a low-level combined solution.



Spectral plot of a CE 816HD at 18 kW TPO with IBOC mask overlay.

Low-level combining is by far the simplest and most cost-effective solution for most applications.

At lower power levels this can be accomplished using solid-state transmitters, but at high power levels a tube transmitter is much more efficient and appropriate. A single tube IBOC transmitter has been developed and demonstrated to be superior over competing solutions offering a simple, elegant and cost effective method of generating a high power IBOC signal.

All the other techniques for generating a high-power IBOC signal suffer from a common significant drawback. They require two transmitters, an analog transmitter and a digital transmitter, the power requirement for the digital transmitter varying depending on the specific combining technique. Thus, we conclude these other techniques are more complex and more expensive at the system level than the Continental 816HD.

Continental Electronics 816HD

At the same time, given the large installed base of Continental 816-C series transmitters already in the field, low-level combining may allow conversion of these existing transmitters at a very attractive cost.

Alan White, is a Broadcast Product Engineer specializing in current and future broadcast technologies for Continental Electronics Corporation. His email address is awhite@contelec.com

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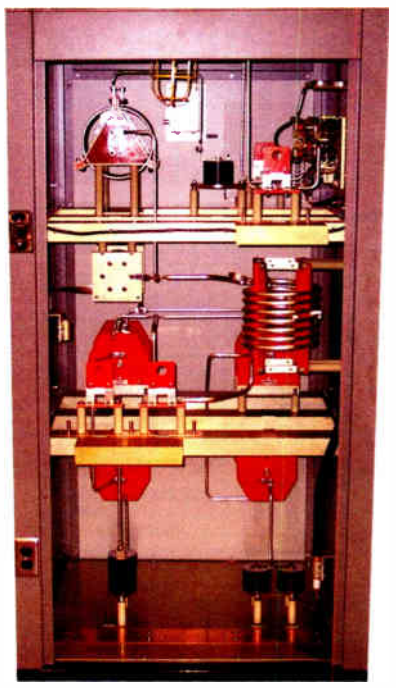

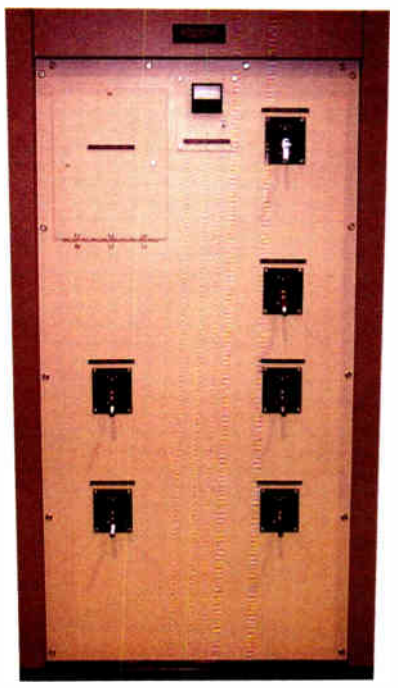

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Maintenance Guide

By Gary Minker

Part 5: Planning to Benefit from Line Sweeping

[LAKE WORTH, Florida] Some engineers have recognized the value of sweeping their antenna system, turning such testing into an annual budget item instead of an unplanned event.

However, there still is a political mine field to navigate: the dreaded memo from Mr. Personality. And he wants to know the answers to the tough questions.

1. Why is this low number good and what is this 1.006:1 VSWR all about?

2. Do you know how to read the report that you will get?

3. Has this been done here before and where is that report?

4. Other than the Line Sweeper, do we have to have any other contractors?

5. How long will we be off the air and will it happen again?

6. Did your crystal ball come back from the shop yet?

7. What are you going to do with this report?

You start to think the list will never stop but fortunately it does.

JUSTIFYING THE DECISION

By preparing, you can give your good friend in the front office an ear full. Sure, he is justifiably concerned about spending budgeted or un-budgeted funds for something that he does not understand. But the goal is to make sure Mr. Manager realizes Engineering is actually revenue producing and not revenue draining, and that you and your department are every bit as valuable as his prized herd of sales suits.

There are many approaches, but here is one suggestion: unless Mr. M. is technically inclined, just forget the jargon and explain why the antenna is more than a metal object d'arte hanging on the tower.

Just like a car needs to be checked out regularly to prevent overheating, for example, the same applies to that hunk of metal radiating thousands and thousands of watts. You may use some jargon ("here are the numbers on the Return Loss or VSWR Voltage to Standing Wave Ratio"), but be sure to focus on need to prevent "extra tower light syndrome," where the antenna appears as a small ("small" from 1,000 feet below) fire due to system deterioration.

Even more simply put: "High sales number good, Low return loss and VSWR numbers good, fire in antenna bad."

DETAILS

Of course you can tell him all the details from the report and what all the little wrinkles mean because your Line Sweeper (will take) took the time during the event to explain them to you; the material in the NAB Engineering Handbook also helps put the current inspection (and previous ones, if they were done) in proper perspective.

The other contractor question is a simple answer. If you are performing Line Sweeping as a maintenance issue you can justify a tower crew for the physical inspection very easily. Just tell Mr. M. it is imperative the antenna be visually inspected for damage, burns, lightning marks, loose or missing hardware, air leaks, bird dirt, salt crystals or other dusty minerals that corrupt the insulators when wet, and mechanical integrity to make sure that it is not going to fall off the tower and dent something.

And then take a deep breath.

ANOTHER BENEFIT

By planning ahead and having the tower folks on site, you only take the station down for one evening. If you find anything "funny" electrically, or there actually is a mechanical problem, they can make everyone a hero by identifying those problems and quite possibly even fixing them on the spot.

Even if more has to be done, you can plan the next outage instead waiting for the dreaded 2:00 AM phone call reporting "the field is on fire from flaming molten antenna parts dripping onto the dry grass."

All in all, here is hoping your visual inspection is clear and the photographs taken of the entire system are very boring; may your Return Loss, Time Domain, VSWR and Smith charts be flat like a mackerel.

USING THE DATA, LOOKING AHEAD

Now that Mr. M. is a happy camper, it is your turn. Keep your department is his good graces (as well as at the home office) by justifying the money spent on this dreaded maintenance. Set up a plan.

You need to lay hands (yours or your contractors') on everything at least one time per year, including the antenna and tower. Although the FCC only mandates that you inspect your lights quarterly for integrity and daily for proper operation, sleeping well at night comes from knowing there is nothing in your entire physical plant that has gone un-inspected for over a year at a time.

Anything that you cannot easily walk up to and touch should have its picture taken in detail (preferably in the daylight) but you "do what you gotta do." The word tower includes everything from the paint to the guy anchor foundations.

By the way, the word "guy wire" not "guide" wire, or the phrase "I have guide wires on my tower." Every time I see that I cringe, so please repeat after me: "I have guywires on my tower; I have a guyed tower." Thanks, I feel better now.

DOCUMENT IT ALL

Over and over again, you hear engineers preaching about documentation. Get as much as you can down on paper, even if you plan to be at the same job next year. After all, memories fade. Or, just remember this: while you are cursing your predecessor for not leaving you great records, is your successor at your last station saying the same things about you?

Regarding line sweeping, let us recap a bit about what should be in the report. Your report from the sweeper should contain some critical printed graphical data (see **Radio Guide**, March 2005, page 18). These graphs should include, Return Loss in Log Mag/dBm scale, Time Domain in linear distance (not useless "time in nanoseconds"), VSWR (which is electrically calculable from the Return Loss but easier for some people to read), and a Smith chart.

These four graphs provide a very concise view of the electrical health of the antenna. Return Loss and VSWR are the measurement of how much energy goes out to the world and how little of it comes back to you down the pipe to confuse your transmitter, and in the land of video make ghosts or no digital pictures.

Add to this your pictures of the antenna and its mounting, the tower condition, and any other data that helps show the status of the transmission system as a "snapshot in time." The combined report should be in your office and at the transmitter site itself.

WHY THIS IS IMPORTANT

In FM, high reflected power can louse up your stereo separation, warble like a birdie, cause synchronous AM noise, give poor tube life and of course cause the obvious system fire. (In NTSC TV, high reflected power can cause the usual FM problems for the audio and cause ghosts, poor color, or in digital, corrupt your data to the point that all the adaptive error correction in the world will not give the viewer a picture to watch.)

You might remember in the days of SCSI and Thin Net coaxial LAN that the data lines required those little terminations. These terminations helped to insure that the wire medium was as close to 50 Ohms as possible. This insured that the system VSWR was low enough so no aberrant reflections existed, so that there were no electrical collisions in the form of VSWR to corrupt the data.

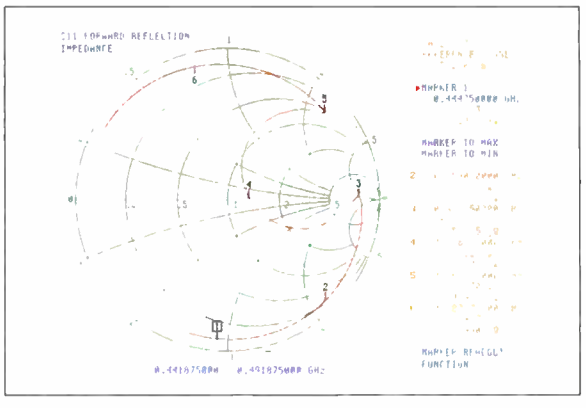
PCS, GPRS and all of the new forms of digital over-the-air services all require system return losses of better than -24 dBm. This is a real stretch in the world of RF communications considering that most manufacturers only guarantee their antennas to have a Return Loss of about -15 dBm or 1.5:1 – that with connector groupings having a value of greater than -30 dBm to insure the integrity of the data.

It is not that the loss of one or two percent efficiency of radiated power will make or break the signal, it is the corrupted information that the poor Return Loss generates that causes the problems.

Worse, a concentrated extra 100 Watts in a bad place such as a line section joint may – over time – cause super heating like a soldering iron. You know the rest.

TDR DATA

Ideally an antenna should be 50 Ohms j-0. This means that you have a resistivity of 50 Ohms and no reactances of any kind. For the more technically minded, the Smith chart is a round looking chart that has the ability once completed to tell you the actual complex impedance of your antenna system.



Time Domain graphs are actually a throw back from when time Domain Reflectometry was exactly what it said. A determination of the health of a component of the system was "pinged" by a square or half sinusoidal pulse from the TDR and a display would pop up showing the linear location of the parts in a time format. From this machine, you could tell the reactive value of a component to some degree and something about the impedance, but it was far from perfect.

The new TDR work from Vector Network Analyzers such as the Anritsu or other units and are actually frequency swept reflection readings of the same components in the system but the display tells you how they react electrically at the actual operating frequency instead of a pulsed signal. Arguably this difference in what some folks call the surge impedance verses the swept impedance can tell the whole story about your lower elbow and that slug that is in it.

Either way, you now have plenty of background information to embark on your great adventure – getting to know how your antenna system is operating in every detail. We both know that you will sleep better for it.

Owner of Radio Works R.F. Consulting in Lake Worth, FL, Gary Minker has analyzed hundreds of transmission systems. He can be contacted at gary@radioworksrfconsulting.com

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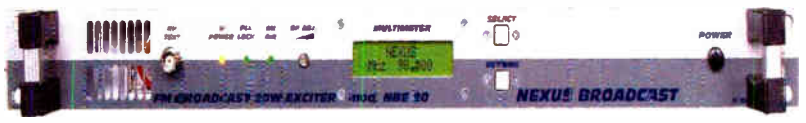

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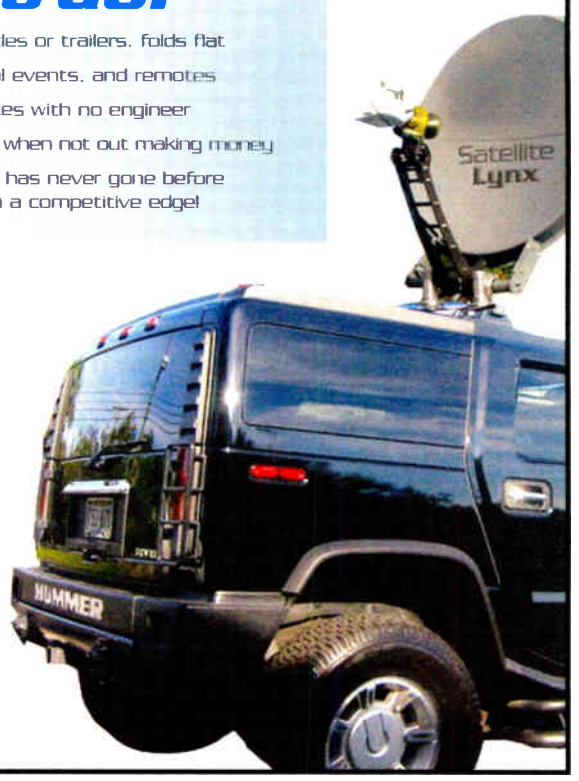

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Tech Tips

by Stanley Swanson

STL Monitoring
Intermod Sleuthing & Rackrails

[YUMA, Arizona] Are you sure your STL is "on frequency" and working? Here is a way to get a quick check on the STL status, as well as some other tech tips from ***Radio Guide*** *reader Swanson.*

Tip #1 – STL Monitoring

The KBNL transmitter was frequently off the air due to problems with our rural power company. But I wanted to be sure that it was a transmitter problem and not a problem at the studio.

So I bought a scanner that included the 950 MHz frequency band. I could hear the STL signal several blocks from the studio, even outside of the STL path. Although the audio was distorted because of the narrow bandwidth of the scanner, at least I could tell that the STL transmitter was on the air and had audio.

However, I noticed the STL seemed to be slightly off frequency according to the reading on the scanner. At first, I thought this was a problem with the scanner, but when I found that other STL frequencies were indicated correctly on the scanner, I knew our STL transmitter was off frequency and sent it away for repair.

Tip #2 – Chasing Strange Intermod

Intermodulation (commonly referred to as "intermod") is the production of frequencies equal to the sum and difference of integral multiples of the original frequencies. In practice, this is caused by a nonlinear circuit element. Solving intermod problems is sometimes a difficult task. Maybe these experiences will give you some idea of where to look.

My first experience with intermod was when we received a phone call saying my station was interfering with reception to ambulance calls in downtown Rochester, New York. "It must be a problem with your station," because we were told that it occurred only when WCMF was on the air.

The WCMF antenna was located on top of a bank building penthouse in downtown Rochester. Our first response was that the ambulance service should install filters to protect the ambulance receivers from interference. But that did not work.

Interfering Indicator

Finally, someone noted that the amount of interference seemed to vary with the position of a wind direction indicator owned by the city of Rochester for smoke abatement purposes, and located near the WCMF antenna. We also discovered the interference was a combination of the frequencies of WCMF, another FM station 4 MHz and 1000 feet away from us and a paging service 4 MHz from the ambulance frequency.

In most cases, intermod is caused by a combination of two frequencies, but in this case it was a combination of the frequencies of WCMF, the other FM station, and the paging service.

Eventually the wind direction indicator blew down, and the interference disappeared.

Diode on a Hot Tin Roof

When I moved to Laredo, Texas, I noted intermod at several places on the FM dial. These had audio which corresponded to FM stations located on a TV tower in Laredo.

One day I noticed the intermod had disappeared. As I knew the chief engineer at the TV station, I called him to learn if anything had changed. "No," he said, only that they "were working on the roof." "What kind of roof is it?" "Metal." "Oh!"

Problem solved! Obviously a metal contact somewhere on the roof had acted as a diode.

Guy Wire Trouble

In Yuma, Arizona, KYRM was accused of causing interference to a business frequency because KYRM audio could be heard on their frequency. The interference disappeared when a local TV station went off-the-air.

The TV antenna is located on a tower near the KYRM antenna. Finally, someone noted the interference varied when a guy wire for the KYRM tower was moved. The guy wire was near the KYRM antenna, although this was not obvious from the ground. The antenna was moved to a different leg on the tower, and the interference disappeared.

Tip #3 – Rack Screw Solution

Did you inherit one or more racks that use clips rather than having holes tapped for 10-32 screws? If so, I do not need to tell you about the frustrations with rack clips.

I found that the width behind the mounting strips on our rack is greater than 19 inches, more than enough space to mount Middle Atlantic RRF Rackrails behind the mounting strips. The Rackrails are tapped 10-32 with standard spacing, and they come in lengths from 3-1/2 to 78-3/4 inches. Their Web site www.MiddleAtlantic.com gives a complete list of the available lengths.

Stanley Swanson is CE of KYRM, Yuma, AZ – sswanson@hcjb.org

DA Q&A

by Ron Rackley

Transmission Line Matching – How Critical?

[SARASOTA, Florida] **Question: Although our antenna monitor and monitor point readings are within their licensed limits, the transmission line operating impedances at the phasor cabinet output indicate there are some mismatches on the 50-Ohm lines that run to our four in-line towers.**

For example, the Operating Impedance Bridge (OIB) shows the tower #1 line impedance as 60 +j 30, tower #2 as 55 +j 2, tower #3 as 51 -j 12 and tower #4 as -6 +j 125. Does this mean mistakes were made when the system was originally tuned or that something has gone wrong since? And, will these mismatches result in poor system bandwidth?

Answer: Most importantly, since the parameters and monitor point field strengths are normal, it does not appear that any significant changes have happened since the proof.

While some of the symptoms could individually be indicative of a problem, taken together they paint a picture of a fairly typical four-tower in-line directional antenna with power division that feeds most of the system power into one or both of the two interior towers and feeds very little power into (or receives power from) the end towers. The power division impacts how transmission line operating impedances must be viewed.

DIFFERING PURPOSES

In a DA, the transmission line from the transmitter to the phasor serves to provide the proper load for the transmitter's final amplifier and should be matched to its characteristic impedance.

The transmission lines connecting the phasor and ATU networks in a DA system are different. They function, in a sense, as circuit branches to set the current and voltage relationships between the circuit nodes to which they are connected in the system. They do not necessarily have to be matched to their characteristic impedance; sometimes they serve better when they are not matched – but attention still must be paid to the degree of mismatch that may be tolerated in them.

There are four major concerns when lines are mismatched: staying safely within the power rating of the line, avoiding currents and voltages that exceed the component ratings of the networks connected to them, the bandwidth impact of the line mismatches themselves, and the bandwidth impact of having networks on either end of the line adjusted outside their design ranges.

LINE MATCHING

The lines that carry most of the input power, as the tower #2 and tower #3 lines evidently do, should be matched to low VSWRs for all of these reasons. A VSWR of 1.2:1 is generally adequate for such lines and both fall within this range.

The tower #1 and tower #4 lines are probably mismatched because little power flows through them – their main purpose being to set the current and voltage relationships between the phasor front-panel controls and the ATU network components. If little power flows through them, mismatches that would be intolerable for lines carrying high power cause little concern.

In fact, there are good reasons to intentionally mismatch such lines – for example, being able to control the parameters of a tower with very low power (or one with so close to zero power it can be either positive or negative with slight parameter changes).

With such towers, precise matching to the line's characteristic impedance – even if possible – will prove futile if the parameters are changed even slightly because the base impedances are very sensitive to the ratios and phases of all of the towers of the array.

BANDWIDTH CONSIDERATIONS

It is not unusual to find line mismatches within directional antenna systems that have poor bandwidth performance, but the bandwidth problems are not necessarily caused by the line mismatches. Commonly, the same basic DA pattern characteristics that cause poor bandwidth – due to low base operating resistances within the system – also lead to situations where transmission lines are significantly mismatched whether intentionally or unintentionally.

Unfortunately, these characteristics are a function of the basic array geometry and pattern shape – and usually cannot be improved without specifying new tower locations on a larger and differently shaped piece of property.

There are situations where improved line matching can improve bandwidth, when the transmission lines of the high power towers within a system are seriously mismatched, but the amount of improvement possible may still be limited by the DA pattern's inherent characteristics.

BRIDGE INSERTION EFFECTS

Measuring true transmission line operating impedances with an OIB is more difficult than most people realize, as insertion effects cause the parameters to change which, in turn, changes the tower impedances and line matching. This effect is much more significant for low power towers.

In order to precisely know an operating impedance, it is necessary to make adjustments to restore the correct antenna monitor parameters with the bridge in the circuit for each measurement – something that is not normally done. The impedances that can be measured by simply inserting an OIB give easily repeatable reference information and the resulting impedance differences are not great for high power towers where matching matters the most.

ATTEMPTING BETTER MATCHES

If it is desired to experiment with adjusting ATU networks to try to achieve better matches, carefully document every move that is made so that it can later be undone. The process of getting the correct parameters and desired line matches at the same time is a very complex one – requiring that many variables be "juggled" simultaneously.

Even for highly experienced AM antenna engineers, at some point all of this can come down to simple experimentation to "see what happens." Of course, for a system that has operated normally for some time, doing nothing is often a reasonable course of action.

Ron Rackley finds directional antennas fascinating, and is happy to share his thoughts. However, due to his existing commitments and travel schedule, he regrets being unable to reply personally. If you have suggestions for future topics, please send them to editor@radio-guide.com

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FCC Focus

by Bruce Eisen

Proper Contact With the FCC

[WASHINGTON, D.C.] It may be that you are a station owner, a general manager, or an engineer. No matter which, anytime you are waiting for news about an application your station has pending at the FCC, it seems like any official action requires a cicada's life cycle.

Is there any way you can speed things up? Or, does the FCC simply move to a different drummer? Perhaps you do not have a communications lawyer. Or maybe you do, but you do not want to spend any legal dollars to have someone assay something that you think you are qualified to handle. Let us discuss some ways to reduce frustration and lost hairs.

THE ALTERNATIVES

Here are the big questions: should you pick up the telephone and call the FCC Bureau that is holding your application hostage? Should you just sit back and let nature take its course, growing ever older in the process? Or, should you bite the bullet and call the lawyer to make an inquiry on your behalf?

These are extremely important considerations because the life of a radio station may depend on the timely processing of applications at the FCC. And yet, we all know that the agency can take forever in accomplishing what appears to us to be the simplest task, i.e., reviewing a proposal and processing it through to conclusion – hopefully a "grant."

What causes the apparently unreasonable delays that we are encountering? If you collar a staff person, he or she will tell you that it is a matter of backlog. Thus we have the idea placed in our minds that there is a huge pile of paper or electronic application material that must painstakingly be reviewed – one-by-one – by appropriate staff before something pops out in the form of a construction permit for your station (or perhaps a letter).

The issue is how best to move the process along and, more particularly, who should be the point person. Perhaps you think it really does not matter who makes the inquiry. Think again. It may be critical.

THINGS CAN QUICKLY GET STICKY

Communications lawyers are presumed to be experts in staff relations and skilled in successfully prosecuting applications on behalf of their clients. But is that always true? Some years ago, I was involved in a super-charged television case where one of a number of issues designated for hearing included an "ex parte" issue against an applicant.

The FCC's "ex parte Rules" are a complex of "do's and don'ts" that relate to contacts between the staff and applicants or their representatives. It is enough to say that one cannot advocate the grant of an application to certain staffers if the application has previously been opposed by another party and the opponent has not been told about the contact.

One of the attorneys in my TV case had aggressively pushed her client's application. However, following allegations by a petitioner and an independent investigation made by the FCC's Inspector General, it was decided that a question had been raised whether or not the attorney had crossed the line and advocated a grant as opposed to simply seeking a status report on the application (as if any attorney seeking a status report for a client's application is not *really* advocating its grant!).

After many months of litigation, pleadings and appeals, the lawyer was admonished for the allegedly overzealous prosecution of her client's application. Technically, under the issue, her client could have been disqualified. So the fact that a lawyer is making the inquiry is not a guarantee that he or she is going to be very effective.

EX PARTE IS EXTRA RISKY

It is never advisable for an applicant or an employee of the applicant to contact the FCC independently if the application at issue has been contested, formally or informally. The risks are just too great.

Even if no death penalty ensues, the delay caused by an inappropriate contact will likely be far greater than normal and could result in more significant legal costs to cure the predicament of making an unauthorized ex parte contact.

If an application has been pending for what you believe to be far too long a time, and if that application is the subject of an objection or petition, the best way to handle the matter is to request an attorney to make an inquiry at the FCC as to how long it is likely to take before the application is acted upon.

The lawyer will then use his or her past relations with the FCC staff and knowledge of the FCC's Rules to get a timely answer as to when action can reasonably be expected. Sometimes the answer is correct, sometimes it is off by a generation or two. But at least it will give you a frame of reference as to when action can be expected and perhaps allow you to make plans accordingly.

WHEN THERE IS NO EX PARTE

Thankfully, most applications pending at the FCC are uncontested. So, is there a problem if you make an inquiry yourself? Some lawyers warn their clients that under no circumstances should anyone but the lawyer make the contact. That sounds awfully self-serving. But, there may be good reason for that belief.

I am not giving away any secrets when I state that sometimes there really are ties between members of the bar and the staff at the FCC. Some attorneys pride themselves on their ability to develop relationships with the staff so that when the time comes, the attorney, at least, believes that his or her relationships forged with the staff are responsible for quicker action.

Of course, that cuts both ways. Some lawyers are lousy at building bridges to the staff and may actually defeat the purpose of the contact!

In our next column, we will consider some successful approaches to FCC staff that can get you the information you seek.

Bruce Eisen, of Kaye, Scholer, has been a communications attorney for some 20 years. If you have a question regarding the FCC Rules and Regulations, send them to Bruce at beisen@kayescholer.com

Survival Guide

by Rich Wood

The Care and Feeding of Your Competition

[EASTHAMPTON, Massachusetts] In May, the President and CEO of a major group owner added a third Nuclear Option to our lives. One is too horrible to imagine but the most recent probably will affect broadcasters more than all the others.

TARGET PROMOTES WAL-MART

I can only imagine how many engineers reading this have been asked to provide a feed to a satellite radio service, just to appear to be on the cutting edge of something.

In a way, it is a little like Target allowing a Wal-Mart sign on their building. It will be interesting to see if program suppliers (stations, networks or one-man shops) will risk losing their terrestrial affiliates, who provide huge numbers compared to an individual satellite channel.

In a sense, as Yogi once said: "this is Déjà vu, all over again." I recall being very surprised when NBC-TV began promoting MSNBC using its network affiliates, essentially telling viewers they should go away from broadcast to cable. There is no benefit to the local affiliate. However, the stations rolled over and played dead; apparently, the network had a very strong upper hand.

In our case, the satellite providers have no hand other than a trendy perception. It seems to me that we are enabling a competing technology and aiding and abetting our own demise by allowing shows we pay for, either in cash and/or inventory, to be used to compete against us.

If this option spreads you can expect major changes in the face of radio, Talk Radio in particular. Most syndication is barter. A few major syndicated shows now charge stations both cash and inventory. In exchange, stations have the expectation that no one else will intrude on their turf within either mileage or market clauses.

Right now the competition is minimal and it is ripe for a line in the sand.

AN EXPLOSIVE SITUATION

I sense a cold war is developing. In one case, a station cancelled a network show because it also appears in their market on satellite. The network refused to let them out of the contract. That tells me the network values the satellite exposure more than their terrestrial affiliates – not a good precedent to set. The network feels it has the upper hand and has forgotten it has nothing without its affiliate stations.

While many have refused advertising for XM and Sirius because of their bashing of terrestrial radio, none but Saga Communications has done what most competitive organizations in other industries do. They refuse to provide aid and comfort to their competitors, emergencies excluded.

Any show carried on either satellite service will not be carried on a Saga station. Saga is going to enforce the normal market exclusivity clause contained in most syndication contracts.

Saga and the other groups who are considering the same policy will never be in a better position to demand the market exclusivity they expect. Not many program providers will be willing to lose radio stations just to have their shows fall from the sky.

DEALING WITH THE TEMPTATION

About a year before XM launched its birds I was approached at WOR by an XM representative wanting me to put our programming on the service. The owner and I said no because it would bypass our network affiliates (and their local spots) in violation of our contracts with them.

Since that time, a number of program suppliers have trampled each other to get their product, for no compensation in many cases, on the satellite services. Even before them, some TVRO operators wanted the same permission. We did offer to provide original programming to XM, separate from our on-air shows – same with Sirius. However, this was not what they wanted.

The cutting edge appears to be aimed at our throats and it looks to be sharp. How sharp depends on how many stations and groups follow Saga's lead.

STAY TUNED – LIVE AND LOCAL

This may be the perfect impetus to do more "live and local." Many listeners complain of the lack of local service. If group owners are serious and do not cherry-pick their battles, there will have to be much more local programming, assuming the program providers cross the line and remain on satellite. The risk is great; many highly rated shows already are on satellite.

Unfortunately, we often give little more than lip service to being unique. If we share our programming with competitors, whatever uniqueness we might have goes up in smoke made up of data bits. The smoke is always black.

As it is, we find ourselves saddled with the "cookie cutter" label. This gives even our most intelligent critics more ammunition in predicting our death. Ultimately they may see us as little more than terrestrial translators.

Will fledgling services like Air America grow their affiliate base by crowing about being available somewhere else? Will mature shows wither as strong groups, committed to exclusivity, cancel them in favor of something they feel they own in their markets?

EARTH vs SKY – RADIO'S NUCLEAR OPTION

This brewing war will require networks and syndicators who allow their programming on satellite services to make a life-altering decision: stay with the satellite folks and call the station groups' bluff or leave with the date that brung them – and return to serving the terrestrial radio stations that made them what they are, providing far more audience than satellite will for many, many years to come.

Shows that syndicate themselves could quickly wind up dead in the water once this finally comes to a head. Maybe this is the call to arms – radio needs to return to being unique.

Rich Wood has programmed stations and networks for over four decades, and now operates Rich Wood Multimedia, a programming production consulting company in Western MA. Contact Rich at: richwood@pobox.com

Tool Guide

Tool Tips and Applications

Soldering Tip Care and Use

When it comes to soldering irons, "the tip is the tool." The rest of the iron holds and heats the tip and controls its performance. But the tip is the critical component that must transfer heat efficiently and reliably to the connection point. Inadequate or improper tip maintenance is a leading cause of soldering problems. What is the best way to avoid trouble? The key to good tip maintenance is to keep the tip tinned with a thin coating of solder at all times.

This solder coating also forms a heat bridge between the tip and the parts being soldered. It is difficult to heat parts efficiently with a point contact alone, as occurs with a "dry" (un-tinned) tip. With a tinned tip, the coating tends to flatten out as the tip touches the connection, creating a larger surface contact area – which in turn forms a more efficient heat path.

Proper tinning also optimizes tip life. Most tips consist of a copper base material, plated with iron to prevent erosion. Iron, however, tends to oxidize rapidly. When oxidation occurs, the tip becomes covered with a black or brown scale, which will not wet with solder – greatly reducing heat transfer. This is commonly known as "burn-out." Burned out tips are usually discarded, though they may often be cleaned carefully with a fine abrasive and re-tinned.

To prevent burn out, always keep the tip tinned with a thin coat of solder – not only during soldering but also when the iron is sitting at idle in the holder.

Very often, an operator will wipe the tip clean before returning the iron to the holder and will not re-tin the tip until starting the next soldering task. This will cause rapid burn out. Also be sure to tin new tips as soon as they are heated to the solder melting point; otherwise, they can burn out within minutes.

TIP FAILURE PROBLEMS

Another common cause of early tip failure is the use of active fluxes, either as liquids or cored in the solder. They can cause rapid surface oxidation, which forms pinholes in the plating. The tin will then enter into solution with the copper base material, creating large holes or pits on the tip surface.

Be aware that the water-soluble fluxes, which are corrosive at high temperatures, can be especially damaging to tips. Many companies use water-soluble fluxes only during wave soldering followed by thorough aqueous cleaning to reduce flux residue on the circuit board.

The use of wire solder cored with water soluble flux during touch-up and rework operations will still result in very rapid tip failure. One way to minimize the problem is by using a non-corrosive rosin core flux during rework.

The use of "no-clean" fluxes is increasing worldwide. "No-cleans" are designed to be used for soldering very clean parts where minimal cleaning action is needed. This very mild cleaning action is usually insufficient to clean normal oxides off soldering iron tips. After a short amount of use the tip becomes badly oxidized, will not wet with solder and exhibits the "burn-out" appearance of black or brown scale coating the working surface.

To clean tips oxidized due to using "no-clean" fluxes, it is best to flush the tip several times with a rosin activated flux cored solder, such as Kester #44. This should remove the oxides, unless the oxidation has been allowed to build up excessively. Once cleaned, the tip surface should be covered with a thick coating of solder. *(Courtesy of Cooper Hand Tools)*

For a full, on-line Weller® Soldering Products catalog, visit: **www.cooperhandtools.com**

For additional information, contact Cooper Hand Tools Customer Service

Phone: **919-362-1670**

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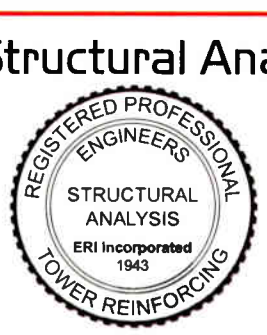

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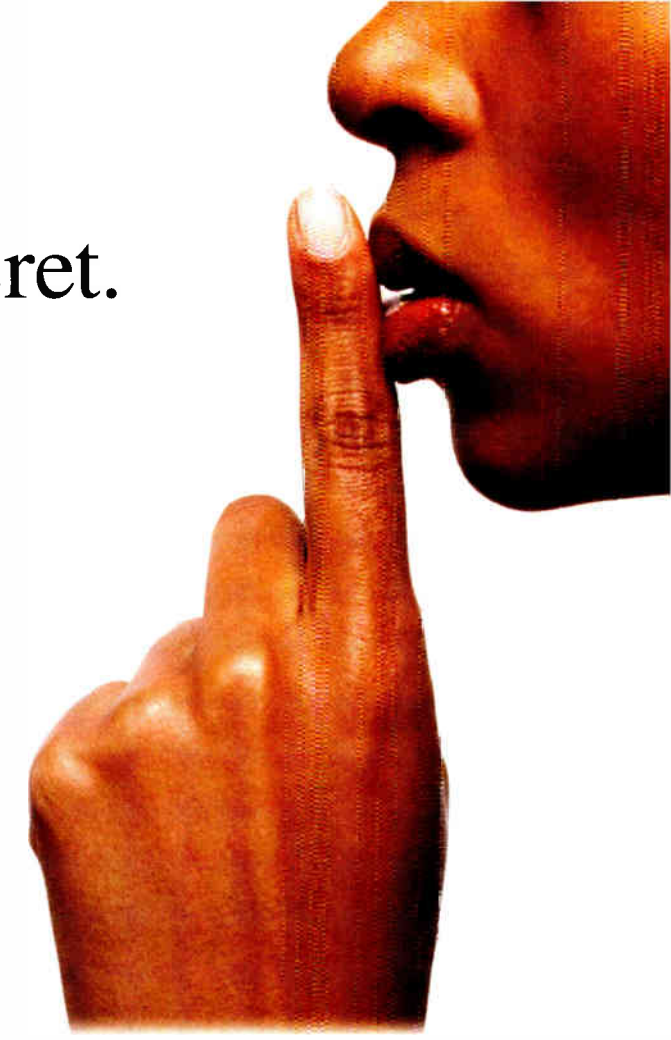
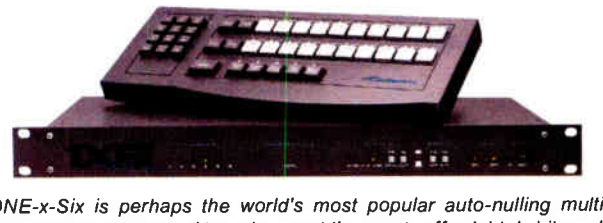


Every day, more than 750 broadcasters rely on TWOx12 twelve-line phone systems to insure their critical talk radio programming. Two advanced digital hybrids deliver the best caller audio possible, thanks to our famous Digital Dynamic EQ. Status Symbols visual call management (a Telos exclusive) helps producers screen calls easily, without guesswork.

Planning a big, consolidated build-out? Consolidate your phones as well with Series 2101, the world's only multi-studio talkshow system. Series 2101 lets you expand your facility's call capacity when needed — allows control of up to 96 callers and 32 studios. Not only that, Series 2101 uses high-quality digital phone lines to deliver caller audio that's next-room clear (and help reduce Telco wiring, too).

At Telos, we're all about choices. Take our Desktop Director (right), it works with TWOx12 and Series 2101 systems, can be expanded to control up to four hybrids or up to 24 lines when used with Series 2101, and has a built-in handset, speakerphone and headset jack. Or, choose the new Call Controller (left) and "bring your own phone" for screening... even works with wireless phonesets.



ONE-x-Six is perhaps the world's most popular auto-nulling multi-line phone system. Also the world's most affordable! Like all Telos talkshow systems, ONE-x-Six integrates with our optional Assistant Producer software to allow fast, intuitive remote screening via LAN or WAN connections.

Naturally, we are obligated to protect the identity of clients who use Telos talkshow systems. We would no doubt get a Stern warning from any user whose name we revealed.

But rather than Rush to superlatives, let us just be Frank'n get to the point. When you're ready for the world's best talkshow system, the answer is Clear; it's as easy as ABC. Whether your station is located in Salem or Susquehanna, Telos has a broadcast phone system just right for you. Why, the possibilities approach Infinity.

In our eyes, reliability is King. After all, if there's a failure, you can Kiss your ratings goodbye. You need your phone system to be a Citadel of Mega reliability. Not to Mix metaphors, but you need something Hot, Lite on the pocketbook, and full of Power. Really, it's Radio One-oh-one.

And unlike gear with tech as dated as an old Bonneville, Telos talkshow systems undergo constant improvement. With us, it's a never-ending Saga of advancement.

Telos. Striving for Greater Media through advanced technology.

(And don't worry... we'll keep your secret.)

Telos

AUDIO | NETWORKS

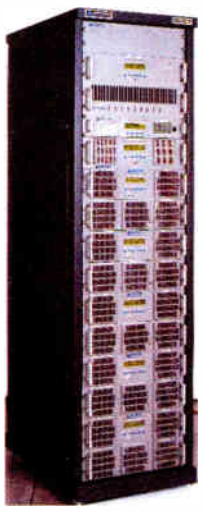
www.Telos-Systems.com

Gear Guide: AM and FM Transmitters Exciters and Power Amps

Armstrong Transmitter

FM2000B – Solid State FM Transmitter

www.armstrongtx.com • 315-673-1269



The Armstrong's Series "B" Solid State FM transmitters feature exceptional quality and reliability. Built for the real world these RF Workhorses are designed with maximum redundancy.

Armstrong uses a building block approach to its Series "B" with the FM2000B amplifier in various multiples to achieve higher powers. The FM10000B for example consists of five FM2000B amplifiers externally combined , exciter and driver contained in a single cabinet.

This design philosophy gives the user the maximum redundancy available in a Solid State Transmitter. Each 2000B amplifier has three power supplies sharing the load, however only two are required to easily achieve full power output. So if a power supply should fail you maintain full transmitter power output.

Complete system status is available, as is individual amplifier status. Each Series B transmitter, is HD Radio Compatible has VSWR foldback and optional power factor correction is available which guarantees the best overall efficiency.

Bext

XL-300 – 300 Watt FM Transmitter

www.bext.com • 888-239-8462

The XL 300 is a lightweight, compact 300 W FM Transmitter joining the higher power Bext XL Series.

As on all the transmitters from Bext, frequency and all other parameters are user programmable. When connected to a PC, Transmitter functions can be viewed locally or via remote through a modem, and parameters can be programmed or reset.

One of the many applications for any of the XL Series Transmitters is as a stand-by unit connected to a Bext broadband FM antenna as a back up for multiple stations – where the transmitter can go on the air by remote on any frequency.

A built-in Stereo Generator and Limiter are optional.

In the same 19" (W) x 51/4" (H) x 19 1/2" (D) enclosure, Bext offers also the XL 500 (500 W) and the XL 1000 (1000W).

Broadcast Electronics

FXi 250/60 – FM and HD Radio Exciters

www.bdcast.com • 217-224-9600

Providing outstanding RF and audio performance, the FXi 250/60 were designed to address current and future FM analog and HD Radio requirements.

The FXi 250, with 250 watts output, and the 60-watt FXi 60 are the only exciters deliverable today that provide FM analog, HD Radio and FM-plus-HD Radio operation with mode switching available on-the-fly. As the FXi 250/60 is a fully-embedded solution, there is no PC-based HD Radio equipment at the transmitter site.

The integrated Engine module modulates the HD Radio OFDM carrier for implementation of HD Radio multicasting using second generation architecture. The HD Radio stream can also be decoded and tapped from an AES output.

Direct-to-Channel RF frequency generation results in the best RF specifications and performance. DSP control provides exceptionally precise parameter adjustment using the front panel video menu system. An RF output low-pass filter permits direct on-air use.

Broadcast Electronics

E Series – Solid State AM Transmitters

www.bdcast.com • 217-224-9600

Using a patented power module design, the E Series solid-state AM transmitters from BE offer unsurpassed power economy and the most efficient performance. Cooler operation temperature extends transistor life. Two models are offered – the AM 2.5E operating up to 2,750 watts and the 5.5 kW AM 5E.

The E Series design includes redundant power supply and plug-in RF power modules. Maximum audio quality can be achieved at all power levels. An RF output matching network is built in so no external matching components are needed. Other features include integrated voltage regulation from 196 to 252 VAC, built-in stereo modulation monitoring, and a built-in output matching network.

Both E Series models are HD Radio™ compatible and provide a full range of metering, status and remote control functions. As with all BE products, the E Series provides many years of trouble-free operation.

Continental

816HD Upgrade – for 816R Series FM Trans.

www.contelec.com • 800-733-5011

Continental recently unveiled what is being considered the "most elegant" solution for HD Radio™ broadcasting. Low-level combined FM+HD using a single transmitter for higher power levels than were previously possible.

For their customers, with TPO levels from 10 to 18kW or combined for TPO levels to 35kW they are offering upgrades for all 816R "C" Series FM Transmitters. This allows broadcasters using these transmitters the opportunity to upgrade to HD broadcasting for much less than the cost of a complete transmitter or other IBOC implementation option. The field upgrade includes a Continental HD signal generator and will require Continental Engineering to be on site for approximately three days.

This solution eliminates the requirement for: second HD transmitter, lossy combiner systems, second antenna, tower crews, etc. required for most other proposed HD systems. 816HD Transmitters can also be purchased new and factory tested for FM+HD.

Energy-Onix

ECO – Grounded Grid FM Transmitters

www.energy-onix.com • 518-758-1690

The most popular FM transmitter in the Energy-Onix product line continues to be their one-tube, grounded grid ECO transmitter. These transmitters offer reliability, power line efficiency, attractive prices and relatively low tube costs.

They sell one ECO transmitter every day and have hundreds of satisfied customers. They will shortly be experimenting with the application of DRE encoders to produce multiple digital, mono and stereo programs.

By the end of July they expect to have a quantity of systems in the field. If they perform as predicted, expect a number of non-interfering, multi-program Energy-Onix FM stations on the air with DRE by the end of the summer.

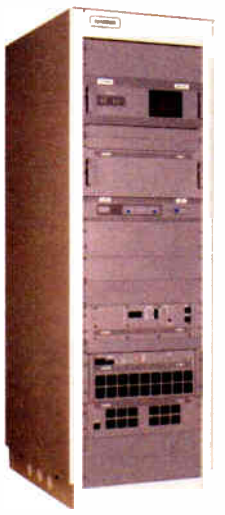
The DRE system requires no change in the station's existing analog transmitter, antenna, STL or processor. All that is required is a three foot length of RG-58U between the encoder and the SCA input to the exciter.

Gear Guide: AM and FM Transmitters Exciters and Power Amps

Harris

Mini-HDC – Low Power FM Transmitters

www.broadcast.harris.com • 800-622-0022



Harris recently announced extension of its MINI-HD line of low power FM transmitters to common amplification.

The new MINI-HDC was shown at NAB 2005. Previously available only as an HDS (digital only) product, the new HDC line will allow stations with 600 watts or less of analog FM power to implement HD Radio™ in a single rack footprint.

Harris MINI-HDC is available in four analog TPO power levels: 75, 150, 300, and 600 watts. Digital power is 1% of rated analog power. The product may be configured with either the Harris DIGIT or the Supereiter analog exciters.

All models of MINI-HD (C and S versions) include a 3-year warranty on the RF power amplifier and power supply.

Larcan USA

25W FM Transmitter – 25W-5kW FM Series

www.larcan.com • 303-665-8000

Their FM Transmitter Series delivers exceptional audio performance and reliability within an all-inclusive compact design.

Developed and built with the same renowned LARCAN design and quality of their television broadcast products, their FM solutions combine proven transmitter technology with rugged performance and superior RF output. A compact design with clear and consistent results – Larcan's FM transmitter series is the best choice for broadcasters looking for the ultimate in made to measure FM broadcast solutions.

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- Field Tuneable – Fully Synthesized
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Nautel

M50 – Direct-to-Channel Digital FM Exciter

www.nautel.com • 207-947-3693

The M50 integrates seamlessly with the NE IBOC signal generator for IBOC transmission in fully digital or hybrid modes.

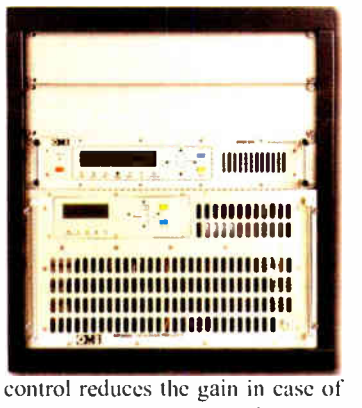
Direct-to-Channel modulation gives superior signal reproduction and eliminates analog up conversion. The M50 utilizes digital adaptive pre-correction that constantly corrects the output spectrum. The ability to adopt to power level and VSWR variations ensures emission mask compliance without the need to adjust correction look up tables. A built-in programmable time delay on all inputs is ideal for HD Radio audio bypass or synchronous applications.

A built-in DSP generator interpolates AES/EBU digital data or L & R analog audio to produce a digital stereo composite signal. Dual SCA generators and RBDS/RDS coder are also built in. The M50 is frequency agile and six programmable preset audio source, power and frequency configurations are selectable via local or remote control.

OMB

EM-2000 – FM Solid State Transmitter

www.omb.com • 305-477-0973



The EM-2000 is a 2,000 watt FM transmitter made up of the EM-25DIG (or EM-20/30) exciter and the AM2000 FM amplifier. The AM2000 includes eight independent 300W high-efficiency MOSFET-Technology amplifying modules, fed by two independent switching power supplies.

The EM-2000 includes an output low pass filter, EMI filters and an internal transient suppressor. The LCD display shows the amplifier parameters: supply voltages, modules currents, forward, reflected and input power, power loss in the internal unbalance load and temperatures.

All events and alarms are stored in the amplifier control system memory. An Automatic gain control reduces the gain in case of excessive driving power. The EM-2000 also has a Smart temperature protection and a Reflected power protection built-in, which reduce the output power when a dangerous level is detected, and stop the amplifier if the power reduction is not enough.

Besides, Analog Telemetry, Digital RS-232 telemetry and remote control are included.

PTEK

FM250E – LPFM Transmitter

www.ptekpower.com • 408-448-3342

In mono operation the FM250E features an audio input impedance of 600 ohms balanced, and audio input level of +10 dBm for 75 kHz deviation.

Mono audio frequency response is +/- 0.5 dB, flat or 75 microsecond pre-emphasis, 20 Hz to 15kHz, with a THD of 0.15% max. The 20 Hz to 15 kHz FM S/N Ratio is 70 dB min., below 75 kHz deviation at 400 Hz. Asynchronous AM S/N (AM Noise) is 60 dB RMS. Synchronous AM S/N Ratio is 57 dB below carrier reference.

In wideband operation the input is composite unbalanced 10k with an input level of 1.25 V RMS for 75 kHz deviation (SCA unbalanced 10k). The FM250E features direct carrier frequency modulation to 100 kHz deviation, with a wideband amplitude response of +/-0.5 dB from 20 Hz to 100 kHz.

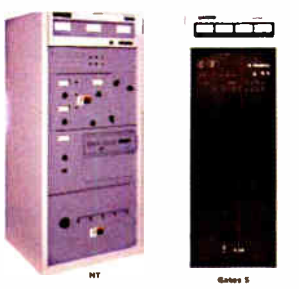
The FM250E's rated power output is 250 watts, with frequency range of 87.7 to 108 MHz, in 200 kHz steps. Frequency Control is phase-locked-loop frequency synthesis from a high stability master oscillator, with a frequency stability of +/- 1.2 kHz.

Output Impedance is 50 ohms with an "N" female connector. VSWR limit is 1.5:1 for full power. Harmonic attenuation is 70 dB, minimum.

Transcom

Used AM/FM Transmitters and Exciters

www.fmamtv.com • 800-441-8454



Transcom Corporation offers used transmitters and exciters for AM and FM radio. They can save you thousands of dollars on many popular makes and models. They are currently featuring the following group of late-model Harris transmitters:

- Two 1988 Harris HT10, 10 kW FM Transmitters on current frequency 105.9 MHz, each with 1995 Digit Exciters.
- One 1991 Harris HT20, 20 kW FM Transmitter with 2nd Generation Digit CD Exciter, on current frequency 98.1 MHz.
- Two Gates 5, 5 KW AM solid-state transmitters, one on 1260 KHz and the other on 1420 KHz.

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Service Guide: Radio Equipment Products and Services

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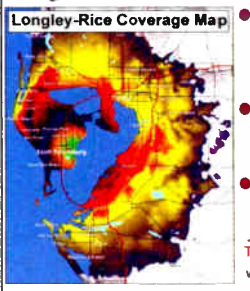

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Send your information for publication to: **radio@rconnect.com**

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Ethernet Remote Control & Monitor

The **easi-8** remote monitoring and control system uses an ethernet connection, with set up and access from any WEB browser. Designed for placement on, adjacent to, or in equipment cabinets, the easi-8 provides monitoring of eight voltage or binary status inputs and contains eight built-in Form C relays for control of devices. Versatile email options are used for reporting conditions.

The **easi-8**'s inputs were designed to be especially robust. The unit accepts input voltages ranging from 50 mV to 160 VAC or DC; four 'virtual' channels allow indirect power calculations or other functions by computing the product of two metering channels. Relay outputs are rated at 24 VDC, 2 A or 120 VAC, 1 A.

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The **easi-8** is available now and sells for $1,295.

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2005 Radio Guide Event Calendar

List your radio or broadcast events, meetings and conventions here.

Email your information to: radio@rconnect.net

Texas Assoc. of Broadcasters (TAB)
Aug 3-5 – Austin, TX – www.tab.org

Nebraska Broadcasters Assoc. & SBE-74
August 10-12 – Lincoln, NE – www.ne-ba.org

IBC2005 Conference
September 8-12 – Amsterdam – www.ibc.org

SEA-CON 2005
September 15 – Boeing Museum of Fight , Seattle
www.sea-con.org

2005 NAB Fall Radio Show
September 21-23 – Philadelphia – www.nab.org

33rd Annual SBE Chapter 22 Broadcast Expo
September 28 – Verona, NY – www.www.sbe22.org

Audio Engineering Society (AES)
Oct 7-10 – New York, NY – www.aes.org

Madison 2005 Broadcasters Clinic
Oct 11-13 – Madison, WI – www.wi-broadcasters.org

SBE National and 2nd Annual Engineering Expo
Oct 19-20 – Grapvine, TX – www.bee2005.org

Pittsburg Chapter 20 Regional SBE
Oct 20th – Pittsburgh – www.broadcast.net/~sbe20

Boscon, Boston & SBE 11
Oct 25-26 – Marlborough, MA – www.bos-con.org

SBE Chapter 16 Regional Convention
October – Seattle – www.broadcast.net/~sbe16

CAB-2005 Canadian Assoc. of Broadcasters
November 6-8 – Winnipeg – www.cab-acr.ca

SBE Certification Exam
Nov 11-21 – Local Chapters – Sep 23 App Deadline

Prophet Introduces Next-Generation MusicGen Pro

MusicGen Pro, a next-generation breakthrough system in professional music scheduling, has been introduced for radio station broadcasting by Prophet Systems Innovations (PSi), of Ogallala, Nebraska.

MusicGen Pro integrates directly to a radio station's digital automation system and allows the creation of the most complex music rotations in an easy and foolproof way. Compatible with most digital automation systems, MusicGen Pro is designed as an upgraded version of Prophet's popular MusicGen system.

The new enhancements featured in MusicGen Pro include better print, import and export options; rules for multiplay scheduling for theme and list events; creating individualized custom coding and rules; and an improved user interface.

The exclusive hourly stacking method uses a different stack for each hour of the day, so that when a song plays today at noon, it's on the bottom of the stack on the next day at noon. This gives each song in the stack a chance to play before the song repeats in the hour. Non-music programming is included with the core music scheduling software, so you don't pay extra for this valuable function. Non-music programs include jingles, promos, liners, legal IDs and newscasts.

- Compatible with most automation systems; built exclusively for the Windows® operating system.
- Automatic software update feature.
- Automatic database conversion capability.
- Scheduling flexibility includes non-musical events.
- Customized reporting capability.
- Multi-station enterprise pricing.
- Single and enhanced hourly stacking scheduling.
- Automatic history reconciliation.
- 24/7 support from Prophet's top-ranked service dept

Designed and developed from the ground up exclusively for the Windows operating system, MusicGen Pro is setting the new standard for music scheduling systems.

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For more information on complete end to end digital radio solutions including the Orban Optimod-FM 8400 Signature Series call us today at 1-800-622-0022.

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