Radio Guide

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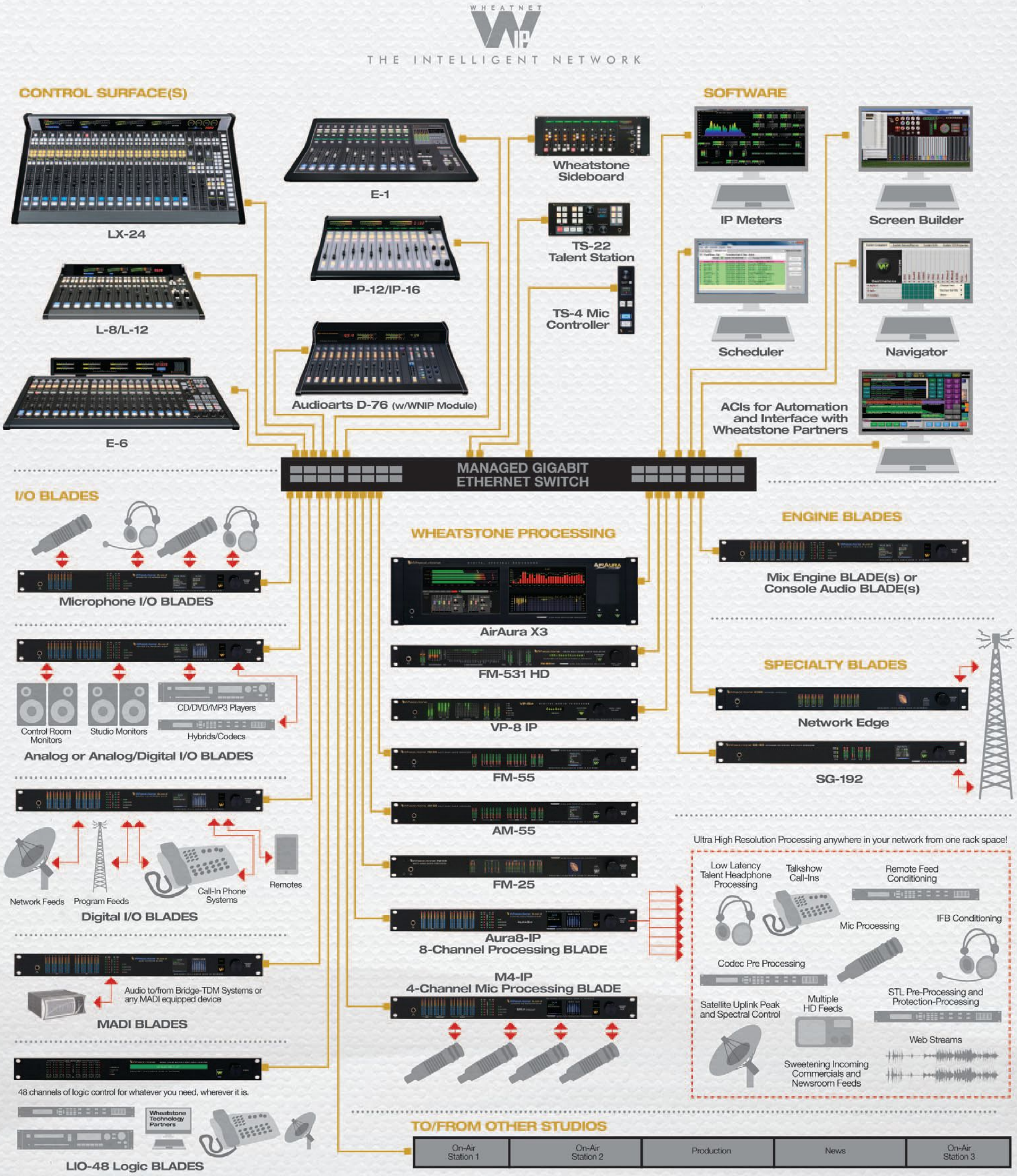
July-August 2015 – Vol. 23, No. 4

Solving the FM/HD1 Time Alignment Problem



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EAS Participants Required to Receive Updated Codes: *"As of July 30, 2016 Radio EAS participants will be required to be able to receive both the national alert location (000000) code and the NPT event activation code. Prior to the deadline it is essential that you verify that your EAS equipment either already has that capability or, if not, arrange for a software upgrade."*

Chief Engineer – *by Scott Schmeling (page 20)*

If It's Not One Thing, It's Two – or Three: *"The receive signal level was marginal, so we added an Advanced Receiver Research RF Pre-amp on the receive line. By the way, have you ever tried these pre-amps? If you have a signal that's not quite good enough, whether it's a 950 microwave, or a 161 or 450 RPU, Advanced Receiver Research makes a preamp for the job. I'm not going to go into detail but suffice it to say, they can quite literally save the day!"*

Cover Story

HD/FM Time Alignment and Blending

Why the Problem Exists and How to Fix It

by Ben Barber, President/CEO of Inovonics

What's the Issue?

HD Radio licensed by iBiquity is a system for simultaneously broadcasting a digital carrier with the same content as the analog FM Radio broadcast. In addition to broadcasting the same content, multiple other channels of audio can be broadcast at the same time on HD2, HD3, and HD4 channels, but for the time alignment discussion, HD1 is the audio channel we'll look at.

We are all familiar with the issue of "channel surfing" with HD TV. When you tune the station there is a delay while the TV buffers the sound and picture, and only after a few seconds of "black" do you finally get to enjoy your program. HD Radio does the same thing. To alleviate the annoying "silence," while you wait for your receiver to buffer the HD Radio audio, your radio plays the analog FM audio for a few seconds until the HD Radio stream syncs, and then transitions from the analog FM to the HD Radio broadcast. If both audio signals are time and level aligned, you should experience a seamless transition from the FM to HD1 audio.

The problem arises when the analog and digital audio sources are not perfectly lined up, or when there is a volume difference, or if the analog and digital audio is 180 degrees out of phase. This causes a stuttering of the audio, a repeat of the audio, or a null or drop out in the audio as the receiver blends from analog to digital.

Hey, It's No Big Deal – Or is It?

You might not think this is a big issue, or one that is only present when someone initially tunes to your station, but the fact is that if the receiver is moving and conditions are constantly changing as in car receivers, the radio may be blending back and forth between FM and HD1 frequently. This is "unlistenable" to the very people you want to tune into your station and never leave.

There are many instances of consumers buying a new vehicle and driving off the lot, only to bring the car back stating that the radio has an echo, skips, repeats or stutters. The unfortunate outcome is that the auto dealer can do nothing about this situation, other than recommend turning the HD Radio function off or listening to a different station. Listeners soon become frustrated and start shopping for a new "favorite" radio station. Clearly, this is *not* what stations broadcasting HD Radio want listeners to do!

As station engineers you have heard the complaints, and station managers have constantly been on your case about making sure things are lined up. You diligently check your alignment and manually dial it in, but next week the complaints are back. This is due to the time alignment between the FM and HD1 audio drifting over time which is due to network conditions, all equipment not being GPS-locked, or some other anomaly in the HD Radio system.

Even worse, if you are using two separate audio processors, the FM and HD1 alignment will simply *never* be lined up perfectly, as two different audio processors take different amounts of time to work their magic on the audio feeding FM and HD1.

The spec for alignment from iBiquity is ±3 samples, which even under the best conditions is a hard spec to dial in, and an even harder spec to keep locked. Incidentally, iBiquity announced at the NAB 2015 that they are implementing a monitoring network that will "... help identify potential stations issues ..." in markets across the USA, and will be notifying the engineering staff when they are out of spec.

What Can Be Done?

There are a number of solutions available to savvy broadcast engineers and each has its advantages and disadvantages.

The first and best thing to improve the problem of drift is to have all your HD Radio gear (including a single audio processor) at the transmitter site and hardwire it all together in one location. This avoids the issues related to network congestion, buffering and multiple audio paths to the transmitter. But if you don't have the bandwidth needed to get all your audio sources to the site, you simply can't do it. Also, if you have HD2, HD3, and HD4 channels, you'll need even more bandwidth, which may be downright impractical.

If you're up on the latest news from the NAB, you'll remember hearing about a couple of monitoring companies that can correlate the FM and HD1 audio and then send the delay offset to either the Exporter or your audio processor so it will adjust the audio with its built in delay. This could be an acceptable solution, but the capture and correlate range is quite limited, and you're relying on multiple boxes from different manufacturers to "talk" to each other and to play nicely together.

At the NAB 2014, Alan Jurison said, "Somebody needs to make a box that goes in line with your HD Radio audio and fixes the issue 24/7," which we thought was a great idea. A single-box solution that can be placed in either the FM or HD1 audio path, receives FM and HD1 simultaneously, correlates the audio, and then gently and inaudibly ramps your audio to where it needs to be so that both paths are perfectly aligned.

Inovonics JUSTIN 808

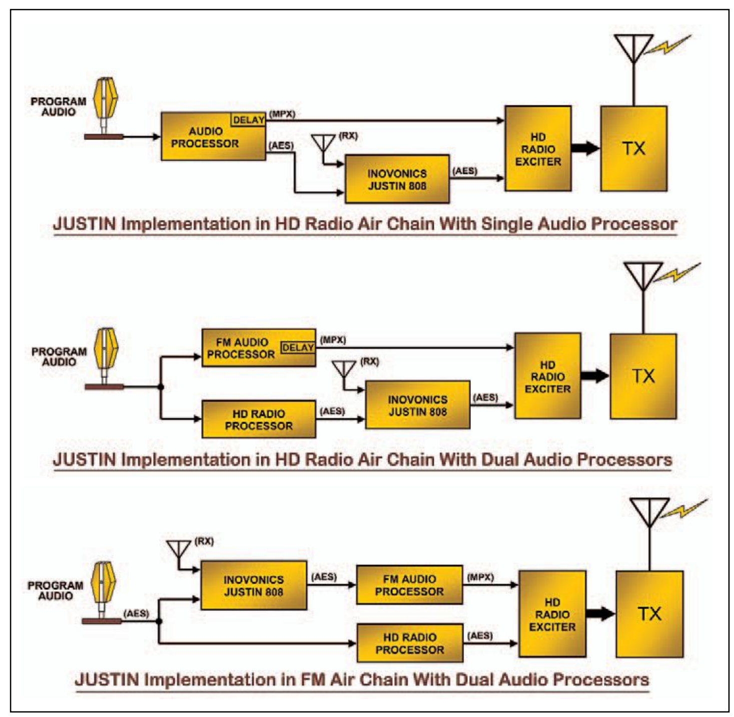
Can a Single Box Do Everything?

The Inovonics JUSTIN 808 is the single-box solution to the problem of diversity delay drift. It's simple, elegant, and it works!

The JUSTIN 808 can correlate and add up to 16 seconds of delay into the audio chain. If it's in the FM air chain, you can do all of your delay in the JUSTIN 808 and turn off the diversity delay in your existing audio processor. The other advantage is that you can put the JUSTIN 808 into "Ballgame" mode and either instantly jump the delay in or out, or ramp it slowly for a more seamless effect.

If the JUSTIN 808 is placed in the HD1 audio path you can take advantage of a very slow AGC. Once the FM and HD1 audio streams are correlated and the correct amount of delay has been inserted, the JUSTIN 808 measures the perceived loudness difference between the FM and HD1 sources and can very slowly adjust the level of the HD1 audio so that it matches the FM level. This is another important step in having the blend function operate seamlessly – so there is no sudden increase or decrease in the volume as the receiver blends back and forth between FM and HD1. During correlation, the JUSTIN 808 also monitors the phase between the FM and HD1 audio and if there is a phase reversal, the JUSTIN 808 can alert the operator, and make the correction all on its own!

During the beta testing phase of the JUSTIN 808, we placed a number of units around the country, including Boston, Maine, New York and Los Angeles, and received critical feedback from our team of test engineers.



JUSTIN Implementation in HD Radio Air Chain With Single Audio Processor

JUSTIN Implementation in HD Radio Air Chain With Dual Audio Processors

JUSTIN Implementation in FM Air Chain With Dual Audio Processors

Saul Perez of Emmis' KWPR in Los Angles said, "... The Justin 808 provides the confidence needed that time alignment between the FM and HD signals are as accurate as possible ..."

Paul Shulins of Greater Media Boston said, "... I am so far very pleased with the reliability and performance [of JUSTIN 808] in a high RF environment at the Prudential Building in Boston. This is the kind of thing that will help make HD Radio better for listeners, car dealers, and the industry in general, by eliminating blending problems ..."

So What Else is Under the Hood?

The JUSTIN 808 comes packed with a number of "must have" features including all sorts of diagnostic graphs showing FM, HD1, AES audio levels, correlation, and time delay differences.

Everything that can be seen on the front of the box can also be viewed remotely though any Web-enabled device – whether it's your smart phone, tablet, or PC. The user can view the information in real time as well as go back and review or download the previous day's graphs, showing the overall system delay and the corrections that were made behind the scene in order to keep everything aligned. Of course Email and SMS/text alerts can be set up and triggered, as well as remote control though GPIO and SNMP. There's also a setting to email logs Daily, Weekly and Monthly for data collection and retention.

Finally, the JUSTIN 808 firmware is easily upgraded in the field, so as new features and functions are added, the box can be made "factory fresh" with the latest and greatest firmware, at no charge to the end user. *– Radio Guide –*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Studio Site

FAQ: Frequency Asked Questions

Increase Your IQ about EQ and Microphones

by George Zahn

In our last visit, we visited some areas of studio audio processing including microphone pre-amps, plus compressors and limiters. This time, we go more in depth on one of the more common, and sometimes misunderstood, audio processors, the equalizer. Several issues ago, I featured different types of equalizers, so I won't go into as much detail on the difference, other than a very quick primer.

The most common consumer/semi-professional equalizer is the graphic EQ, an equalizer split into either single octave, half-octave, or third-octave set frequency increments. The controls fade up to increase a center frequency (or down to decrease), and looking at the controls from left to right you get a "graphic" illustration of how you have shaped the frequency spectrum from bass on the left through the midrange (center) to treble on the right. Many pros do use these graphic EQs as well.

A parametric EQ is less user-friendly, but far more precise, offering variable center frequencies and bandwidths (the amount of adjacent frequencies pulled up or down with the center frequency), and the ability to even more accurately fine tune the frequency response of an audio source. These units require a bit more attention to detail and can be incredible tools for anything from a music recording to adding some punch to a vocal in a spot.

A third EQ is the selective variable EQ which would be more commonly found on a multi-channel console in a music recording studio (and in some radio facilities). These offer some limited EQ for each incoming audio source and may feature a high and low shelving EQ plus one midrange control on basic mixers.

Peeking at Peaks

The graphic and parametric EQs will allow you to do some of the tricks mentioned here. Here are some fun tips and tricks to make your EQ more effective:

Need to replicate the sound of your announcer on a telephone for a spot? It's really simple to do with an equalizer. Just attenuate (drop) the frequencies that don't pass through the phone. You can simply drop out all frequencies below about 300 HZ and above 3500 Hz. You can then adjust the remaining frequencies to your taste or to compliment any background audio on the spot.

A variation of that EQ – boosting of the human voice from approximately 500 HZ to 4 kHz – is used on many spots to help the voice cut through background noise when heard on car radios. Quite often, the un-EQ'ed voice is heard, followed by a delayed and EQ'ed voice to drive the point home.

I once encountered an AM station owner who was running a CD changer for overnight music programming. He set up a timer to play his legal ID, but he didn't have the equipment to drop the volume of the CD changer when the ID played. He didn't have an EQ, but he did record the legal ID over a phone line and boosted the volume to have the ID heard over the music content. Primitive but clever!

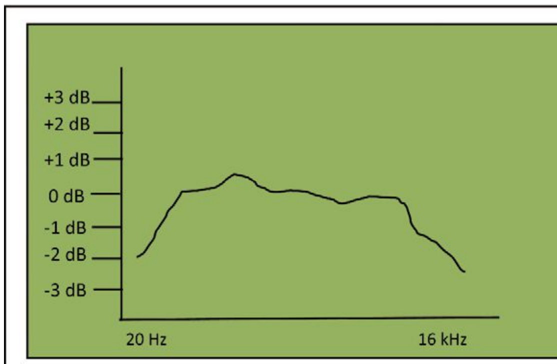
Sibilance, Sibilance

If your voice sounds mushy and less intelligible, perhaps from a microphone with little high frequency response, you can try an EQ boost at 3.5 kHz to 4 kHz. This is the area where human sibilance ("S" sounds) or "T" sounds happen. Likewise, you can battle someone with over-accentuated "S" sounds by pulling down some frequencies between 4 kHz and 6 kHz.

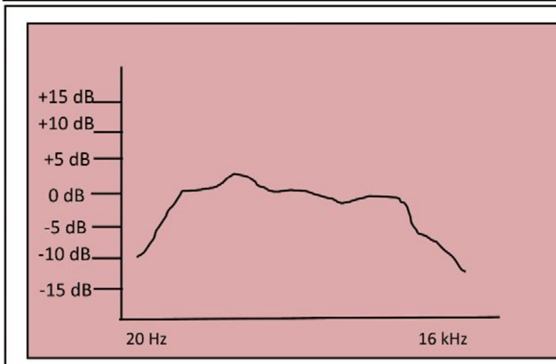
For standard voice, though, keep in mind when shaping the human sound, that for most of us, the fundamental tones of the human voice range from roughly 80-200 Hz for men and 160-300 Hz for women (many singers will obviously transcend these frequencies). It's amazing how many of us, when equalizing a voice, tend to jump to 1 kHz or higher settings, when most of our actual voice is in the upper bass and lower midrange.

There are always overtones within any instrument, from our voice (nasality or shrillness), to a piano, to a bass. The overtone is at the next octave, or doubling of the frequency. If I hit a piano note at 440 Hz, the next overtone is 880 Hz, then 1760 Hz, 3520 Hz, 7040 Hz, 14,080 Hz, etc. The human hearing range, on average, runs from about 20 to 30 HZ at the most bass response (we can feel bass below that frequency but not hear it), up to about 16 kHz on the upper end.

If you're dealing with an audio recording or a live situation with hum caused by electrical interference, the core frequency in the U.S. is 60 Hz. A parametric EQ would allow you to deftly "notch" out a very slim band width at 60 Hz to eliminate the issue, with little else of the audio mix affected. You could also set notches at 120 Hz, 240 Hz, etc. if there are additional harmonic hum frequencies. In doing some research, I located a particularly helpful reference tool on EQ settings, to try for a variety of issues, at the website of audio equipment manufacturer PreSonus: **https://www.presonus.com/community/Learn/Equalizer-Terms-and-Tips**



Microphone A : Frequency Response 30 Hz-16kHz plus/minus 1dB



Microphone B : Frequency Response 30 Hz-16kHz plus/minus 5dB

Graphic Example

While we're discussing frequency issues, here's a separate concern. Let's say we're investigating two equally priced microphones. All other factors being pretty much the same, I want to know how true to fidelity the microphone will be when it comes to faithfully capturing and reproducing the sounds that come into it. To do that, we may receive a frequency response graph which indicates (within a number of decibels) how much the design of the microphone affects the output at various frequencies.

"No variation" or a straight line at O dB on this graph is a good thing. I other words, I want the microphone to give me the exact same audio quality as the sound that comes into it. No microphone is perfectly transparent, so we look at the variance to get the flattest frequency response possible. Shown above, are graphs for Mic A and Mic B. See which one you'd buy?

The varying line on each graph is exactly the same shape. Savvy consumers immediately look on the left side of the grid to see what the variation in dB is. Mic A (green) is the mic to go with since the variation on the left is in 1 dB increments. While the line still looks somewhat jagged, keep in mind that variations of less than 3 dB are very minor. Conversely, Mic B has swings of plus or minus 5 dB. That's a 10 decibel swing – youch! Some advertisers use this "billboard" effect. Just as little imperfections on a billboard are hardly visible from the expressway, increasing the dB scale on the left makes microphone imperfections seem less noticeable when "zoomed out."

This came to mind as I recently used a consumer/semi-pro microphone for a remote recording. I was skeptical since the microphone's frequency response was listed only as 50 HZ to 15 kHz with no variance given. Before recording, I actually tried the microphone against a Shure Beta SM58 and a Sennheiser MD 421. Needless to say, the microphone, an Audio Technica $80 model, did better than I thought against the pricier 421, although lacking the crispness compared to the $300+ Sennheiser. It did give the SM 58 a run for its money at a lower cost than the Shure mic.

The exercise reminded me that microphones and most audio gear is still subjective. On a sub $100 microphone, I didn't expect an exact frequency response graph. But it is important for all of us to remember that it's easy to list a device's frequency response as something like 20 Hz-20,000 Hz, which looks great at first glance. Without the plus or minus decibel rating, it doesn't tell us anything about the actual transparency of the device. In most cases, it will come down to what we think gives us the best audio, and in many cases, that comes from direct experience hearing the microphone or other device in action somewhere.

One of the points I've driven home many times before is for stations to try to borrow or get a loaner on items such as microphones to see how they fit with your studio, announcers, and on-air processing. Engineers can often affect these loaners through colleagues or through companies with which your station frequently does business.

Do you have some favorite low-cost options that you and your engineers feel work as well as the more expensive model? Let us know some of your stories of how you cut corners and ended up with excellent quality!

*George Zahn is a Peabody Award winning radio producer and Station Manager for WMKV-FM at Maple Knoll Communities in Springdale, Ohio. He is a regular contributor to **Radio Guide** and welcomes your feedback. Share your stories with others by sending ideas and comments to: gzahn@mkcommunities.org*

Operations Guide

The Portable People Meter

An Idea Whose Time Has Gone?

by Mike Callaghan, Chief Engineer, KIIS-FM (retired)

When the Portable People Meter (PPM) was first introduced by Arbitron (now Neilsen), there were varied opinions about whether it was a good idea or not. While many broadcasters rejoiced that there wouldn't be any reason to hammer out the call letters mercilessly to make listeners remember them, there were others that feared the meticulous and unbiased certainty of the system would keep everything a little too honest; people that really liked certain stations would no longer be able to fill their diaries with favoritism.

The people meter was supposed to be undeniably accurate.

And when it first came on the scene, it became obvious that there had been favoritism in the diary-keeping. Some niche-formatted stations dropped precipitously in the ratings. They cried foul, and Arbitron vowed to take another look and correct any errors they might find. But for the most part, most radio broadcasters accepted the Arbitron numbers as truth, and the ad agencies did as well.

It was no secret how the system worked; an inaudible set of tones were mixed in with the music or talk. While humans couldn't hear them, the so-called "Portable People Meters" provided by Arbitron would pick the tones up, and it would record the time of day and the specific ID for the station the listener was being exposed to. This went into memory built into the device. When the user got home and retired for the day, the meter would go into a "base" that would do two things; it would recharge the people meter, and it would extract the station/time of day data and relay that back to Arbitron. Once Arbitron had gathered the information from all the people meters in a market, it would massage the numbers and the result would be market ratings and rankings.

One result of the abandonment of the diaries was that some stations seemed to drop when the people meter arrived – specifically, talk stations and classical outlets. They still had ratings, but not the numbers they were used to. Early attempts at explaining this seemed to emphasize that, while most stations had dense, consistent modulation that always provided plenty of material to mask or hide the hidden carriers, talk stations, with their frequent pauses, and classical stations, where real loudness can be a sometimes thing, didn't have the same foundation for the hidden carriers the rockers had.

It turns out that the tones don't even get sent when a station goes into dead air. Classical outlets, with the pauses between announcements and between music, don't get imprinted at all during the silence. And even the pauses between spoken words on talk stations can keep them from being credited. The specific algorithm Arbitron uses for these formats isn't clear, but there's a definite lack of penetration existing here.

In addition, there's no way of knowing where the people meter will end up while it's being carried by the Arbitron participant.

It could be clipped to a belt where it will hear everything, or it could be in a purse where everything is muffled. Or the wearer might be sitting in a quiet bedroom while listening to the radio, or they could be in a car filled with screaming kids, or in a noisy pickup truck on a bumpy road. These last cases would make it hard to decode the hidden tones, and the station wouldn't get credit.

And up until recently, there wasn't anything a talk or classical station could do about it. At this spring's NAB in Las Vegas, Telos subsidiary TwentyFive 7 Systems introduced an in-line processor designed to help correct this issue. Called the Voltair, it has a number of features to help insure a station gets all the credit it has coming.

While all the operating details are kept quiet, we can assume it does something to keep the subaudible tones from going away during pauses. It reduces the level of the tones so they aren't objectionable, but at least they're still there. When loud music is being played, it analyzes the spectral content and boosts the tones so they're louder; maybe even to the point of being slightly noticeable, but again, helping to insure the people meters will hear and register them.

There are supposedly 10 different carrier frequencies, spaced between 1 kHz and 3 kHz. Different carriers are activated depending on which ones can be used without becoming obvious to the listener.

Another feature is that the station can select how aggressively the device processes the tones. Drive time would be a good example of when listeners are likely exposed to a noisy environment. This makes them less likely to notice the boosted carriers. So this would be an ideal time to boost the Voltair's activity level. The device allows users to "day-part" different processing levels.

Does it work? Stations using the Voltair do report ratings increases after installation. Which brings up an interesting point. How can the ratings be accurate when some stations boost the subaudible tones, while others don't? Does using a Voltair give you an unfair advantage? Let's admit it does give you an advantage, but you really have to want it. The Voltair sells for $ 15,000. That's a lot, but deciding on the purchase becomes simple math. If it can boost your ratings by 1/4, say, how much does that translate to in terms of increased billing and bragging rights? In a major market, it can be an easy decision.

If you invested in a Voltair, would you go public and reveal it to the competition? Probably not. As a matter of fact, the fewer people that knew you were using it, the better off you'd be.

Your ratings would increase, and your program director would bask in their glory, but the hidden box in the rack room would remain a secret. The Voltair fills three rack units, but if Telos made a much smaller version, without all the displays and eye candy, I'd bet you could arrange to meet the station owner at midnight and sneak it into the program line without anyone knowing – not even the engineers, because again, the fewer people that know, the better.

Another thing is that the effect of the Voltair would pretty much be instantaneous. The ratings could make their full jump in just two rating periods, depending on where the cycle was the day of installation. That could be a dead give-away, so it would make sense to gradually increase the Voltair's effect over a few months. Then it would look as if programming changes had made the difference, which is what you would want other stations and the agencies to think.

In Canada, the ratings provider is owned by the Canadian broadcasters. And on June 15th, 2015, the Canadian broadcasters decided they wouldn't use the Voltair. They want to take time to really study and understand the Portable People Meter's shortcomings. Clearly, something is wrong here. Arbitron hasn't been forthcoming enough. Should broadcasters be divided into two camps, the have and the have-nots? Ratings are the lifeblood of radio stations. Stations live or die by the numbers. The ratings can determine who gets promoted, and who gets fired. Admittently, there are stations that can't afford to spend $ 15,000 to bolster their numbers. Why should they suffer?

It's becoming pretty obvious about who is to blame for this situation. It's not the radio stations, and it's not TwentyFive-7 Systems. The people that gather the ratings are to blame. They developed a system with now-obvious faults, and started using it to gather data without looking down the road to unearth the problems with the missing carriers. It was just a matter of time before someone would catch on and start capitalizing on the deficiencies the People Meter brings with it, in its current iteration.

If a station doesn't want to spend the money on a Voltair, are there other solutions available to them? Perhaps. If you know what frequencies the People Meter encoder uses to trigger the hidden tones, maybe you could inject just a little energy in that range to trick it into leaving the carriers on all the time. It would be something your listeners could hear as low tones behind the talking or in between the songs. But it would mean you'd always be sending at least something to the People Meters.

You would want to be very careful about the levels you used, as I understand the hidden carriers can get really objectionable if they get too loud. So you'd have to choose how objectionable you want your specific station to be if this was how you chose to go.

In the final analysis, the People Meter is broken – it can't measure audience numbers accurately. Some stations have loud dense program material, and others just have voices. Or they have music where soft passages and dynamic range is important to them. Now we know the People Meter cannot be fair to both these broadcasters.

Until a solution is found and implemented, the ratings will have to be accepted as flawed. And without valid ratings, all radio stations will suffer from the ambiguity.

The comments, opinions and suggestions offered in this article by Mike Callaghan, are his alone, and are not necessariliy those of Radio Guide.

Mike Callaghan was formerly the Chief Engineer at KIIS-FM in Los Angeles, CA. His email is: rg@mike.fm

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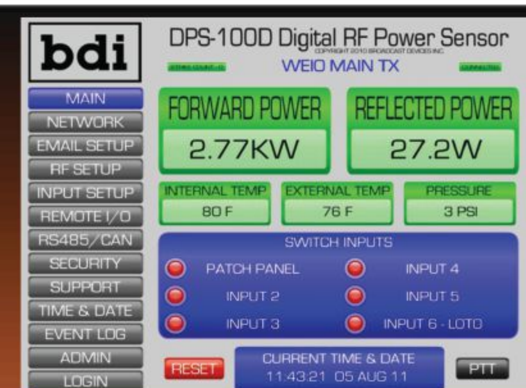

The DPS-100D and SWP-200 are part of a growing number of RF site management products offered by BDI. The DPS-100D true RMS RF power meter offers industry leading features and performance. The built in web server provides remote access and control of all vital parameters. Supports SNMP for remote control along with other popular network protocols. The DPS-100D RF Power Meters can also be daisy chained as part of a simple or complex RF transmission monitoring system using standard CAT 5E STP cables. Put one anywhere you want to monitor RF FWD/REF power. **Need RF switch control?**

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Audio Guide

Loudness Meters and Descriptors

by Paul Figgiani

The modern Loudness Meter is now considered an essential tool in any audio production environment. In order to comply with industry standard Loudness specifications, a full understanding of a Meter's descriptors is a necessity.

A few modern DAW's now bundle suitable Loudness Metering options. For example Steinberg's Cubase and Nuendo include proprietary tools. Adobe Audition CC includes a customized version of Loudness Radar created by TC Electronic. There are also many third party options available as AU, VST, and AAX plugins.

Standard Peak Meters vs. Loudness Meters

Standard Peak Program meters measure and display proportional voltage of a digital audio signal. They do not represent the perceptual characteristics of audio over time. A well designed Loudness Meter will display extensive numerical and graphical references that represent how humans perceive audio. Loudness Meter values and descriptors update in real time and provide accurate readings for various indicators including Program Loudness and Maximum True Peak amplitude.

Some Loudness Meters – depending on the design of the Meter and the host application – are also capable of off-line measurements. In Pro Tools this would be an Audio Suite process. You can also accomplish this in Logic Pro X by initiating and completing an off-line bounce through a compliant Loudness Meter.

Time Scales and Descriptors

Loudness measurement specifications include three main descriptors: ***Program (Integrated) Loudness, Maximum True Peak, and Loudness Range.***

• Program Loudness

Program Loudness is the average (perceived) loudness of an audio segment measured in it's entirety. It is displayed on an Absolute scale in LUFS (Loudness Units relative to Full Scale), or LKFS (Loudness Units K Weighted relative to Full Scale). LUFS is utilized in the EBU R128 spec. LKFS is utilized in the ATSC A/85 spec.

There are two related descriptors that represent more of a real time indication of measured Loudness: *Momentary Loudness (M), and Short Term Loudness (S).*

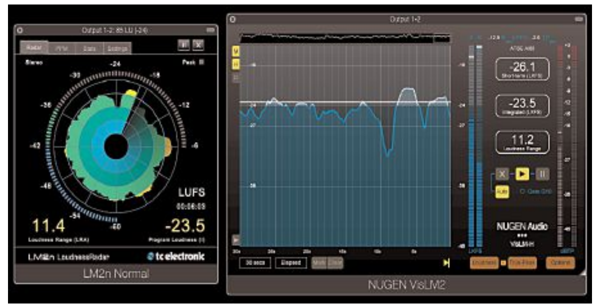
The Momentary Loudness descriptor is measured within a 400 ms window. The Short Term Loudness descriptor is measured within a 3 second window.

Short Term Loudness guidelines are often specified in platform compliance specifications. For example the EBU R128 s1 document titled "Loudness Parameters For Short-Form Content" recommends -18.0 LUFS for Maximum Short Term Loudness.

Short Term Loudness values over time are often displayed using a graphical reference as designed by the developer. TC Electronic's set of meters (with the exception of the LM1n) display Short Term Loudness on a circular graph referred to as Radar. Nugen Audio's VisLM 2 meter displays Short Term Loudness on a grid based histogram. Both versions work equally well.

• Maximum True Peak

The True Peak (TP) indicates maximum peak values that may be higher than what a standard sample Peak meter is capable of displaying. True Peak meters accurately detect and display these values.



TC Electronics "Radar" Graph

Maximum True Peak awareness is especially important when converting a lossless audio file using a lossy distribution codec. For example a WAV file with a sample Peak ceiling of -1.0 dBFS will almost certainly loose headroom when converted to a low bitrate MP3.

• Loudness Range and Dynamics

The Loudness Range is displayed in "LU's" (Loudness Units). This represents the unbiased statistical differences in loudness over time. It indicates how much the Program Loudness varies throughout the entire duration of a segment. This descriptor can help operators decide whether dynamic range compression may be necessary.

Some meters support the display of the Peak To Loudness Ratio (PLR). This is a numerical reference of headroom, or the difference between the Program Loudness and Maximum True Peak. Low PLR readings indicate narrow dynamic range.

Gate

There are elements that influence how a Loudness Meter reads and translates values. For example program segments with wide dynamics, low level effects, or long periods of silence may result in inaccurate Integrated Loudness measurements over time. This would render results that fail to meet a target specification after normalization.

To alleviate potential bias issues, a specification Gate (G10) temporarily pauses loudness measurements when the signal drops below a relative threshold in highly dynamic audio, thus allowing only prominent foreground sound to be measured.

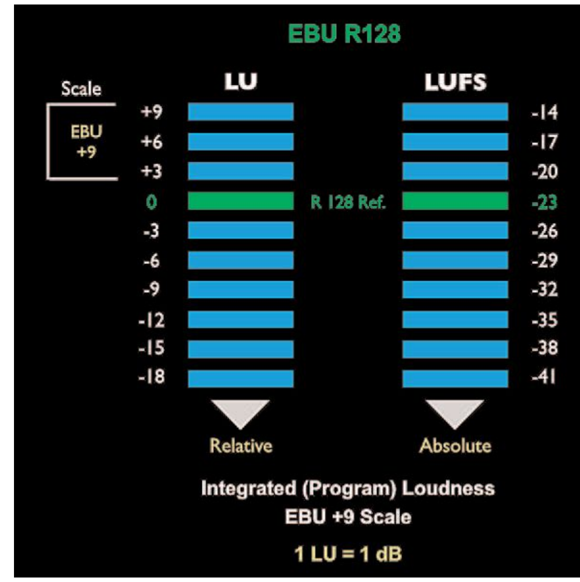
The relative threshold is -10 LU below ungated LUFS. Momentary and Short Term measurements are not gated. There is also a -70 LUFS Absolute Gate that will force metering to ignore extreme low level noise.

Absolute Scale, Relative Scale, and Customization

Most Loudness Meters support full customization. Operators can specify Integrated Loudness targets, True Peak targets, meter resolution, and various scales.

As noted, Integrated Loudness is displayed on an Absolute scale using LUFS and/or LKFS. Loudness Meters can also use a Relative scale that displays Integrated Loudness in "LU's" (Loudness Units). A Relative LU scale corresponds to an Absolute LUFS/LKFS scale, where 0 LU would equal the specified Absolute target.

In practice, -23 LUFS in EBU R128 is equal to 0 LU on the Relative scale. For Internet/Mobile, -16.0 LUFS would also equal 0 LU. Note that the operator would need to first define the proper Integrated Loudness target in the meter's Preferences in order to conform.



In the following image a -16.0 LUFS test tone is displayed on an Absolute and Relative scale using Nugen Audio's VisLM 2 Loudness Meter:

LU and dB Relationship

1 LU is equal to 1 dB. So, for example, you may have measured two programs, where Program A checks in at -20 LUFS, and Program B checks in at -15 LUFS. In this case program B is +5 LU "louder" than Program A.

Meter Placement

Loudness Meter plugins are most commonly used for on-line (Real Time) measurements. The meter must be inserted in the DAW at the very end of a processing or mix chain, preferably on the Master channel. If the inserts on the Master channel are post fader, any change in level using the Master Fader will result in a global gain offset that will affect the entire mix. The meter would then (over time) display the altered Program Loudness.

If your DAW's Master channel has pre-fader inserts, the Loudness Meter should still be inserted on the Master Channel. However the operator would first need to route the mix through a Bus and use the Bus channel fader to apply a global gain offset. The mix would then be routed to the Master channel where the Loudness Meter is inserted.

If your DAW totally lacks inserts on the Master channel, Buses would need to be used accordingly. Setup and routing would depend on whether the buses are pre or post fader.

Paul Figgiani is an independent audio producer/engineer with extensive experience producing Podcast Audio since 2004. He is the founder of www.producenewmedia.com Paul currently provides media post-production services and consulting for a select group of clients. Email: ptfigg@producenewmedia.com Twitter: @produceNewMedia

FCC Focus

EAS Participants Required to Receive Updated Codes

by Peter Gutmann

The FCC has announced some improvements to its Emergency Alert System (EAS), largely to remedy problems identified in the first nationwide EAS test that was held in November 2011.

First, the FCC created a new header location code for a national alert. The test had attempted to simulate a national alert by using the two-digit code for Washington, DC. However, some distant participants rejected the alert as being local and out of their area of concern. Rather than transmit multiple distinct location codes for each area (which would have required multiple alerts, as each alert is limited to 31 location codes), the FCC has created a new location code comprising six zeros ("000000") to be used in the EAS header to indicate that an alert is relevant to the entire U.S. and thus will trigger receivers throughout the country.

Next, the 2011 test had taken the form of an Emergency Action Notification (EAN) which requires mandatory priority, allows for an indefinite duration and triggers an automatic reset functionality. The result proved to be burdensome for some stations and confusing to some listeners. For future tests, rather than emulate an EAN, the FCC has created a National Periodic Test (NPT) Code, with limited priority and a maximum length of two minutes.

As of July 30, 2016 Radio EAS participants will be required to be able to receive both the national alert location (000000) code and the NPT event activation code. Prior to the deadline it is essential that you verify that your EAS equipment either already has that capability or, if not, arrange for an appropriate software upgrade.

The FCC also is implementing an Electronic Test Reporting System (ETRS), the use of which will be required following any NPT. Although the FCC claims it will consider waiver requests to file on paper from stations that do not have Internet access, such instances would seem to be extremely rare nowadays.

The ETRS will consist of three parts, much like the on-line reports used for the November 2011 test alert results. The first part is to consist of identifying information and is to be filed within sixty days of the date when the ETRS is rolled out, and then updated yearly thereafter. The second part is to be filed within 24 hours of a test and will require a simple certification of whether the test was received and transmitted. The third part, with detailed information concerning explanations of any complications, would be due 45 days later. Built into the ETRS will be several additional features: pre-population of information already in the FCC database, an ability to correct prior filings within 30 days and the generation of receipts to acknowledge timely filing.

Other changes will require video outlets to improve the legibility of displays and to ensure coordination of audio and video information, but of course these will not affect radio.

Broadcasters can take some comfort in the FCC's focus on improving EAS and its recognition of the essential role that we play in providing access to timely and accurate emergency alerts. Yet the national test that triggered this initiative was way back in 2011 and full implementation is to be deferred until next summer. You might ask why the FCC is taking so long to attain non-controversial improvements to a system that is recognized as a critical component of our national security (or, in its own words: "a resilient public alert and warning tool that is essential to help save lives and protect property during times of national, state, regional and local emergencies"). That's a very good question!

Anything We Do or Say Nowadays Impacts Public Perception

A word of warning about personal websites and social media postings – watch out! Like all businesses, radio stations are becoming increasingly sensitive about comments posted by their staff on presumably personal media.

This reminder is prompted by a Pittsburgh radio DJ who was suspended indefinitely after making a comment on Instagram about Freddie Gray, who died in Baltimore police custody. The posting consisted of a picture of Gray, a 22-item rap sheet of Gray's arrests from 2007 through early 2015 and the following comment: "He was pretty busy before he was unjustly killed at the hands of the Baltimore PD."

The DJ claimed that he was trying to make a nuanced point: "My intention was not to justify Freddie Gray's death. It was to highlight that his arrest record does not justify his death. I'm sorry I was not more clear." Indeed, the original post does seem to apportion criticism to both Gray and the police. Nonetheless, despite the clarification and apology, management suspended the DJ and issued their own statement: "We are dedicated to presenting journalistic integrity as well as being sensitive to our listeners and their concerns." While one might question what journalistic integrity has to do with this (and, indeed, the degree to which mainstream radio dabbles in journalism at all nowadays), the suspension clearly was based on a desire to avoid offending listeners.

At the risk of stating the obvious, stations that once had seen a lucrative future in generic all-music formats are belatedly rediscovering the need for real personalities to engage listeners. A natural consequence of that shift is the strong identification of staff with the station itself. Indeed, stations actively encourage their staff to become as visible as possible in the community in order to serve as a constant reminder of the integral connection between stations and listeners.

A corollary of that sensible model is that staff functions as ambassadors of the station's brand and can no longer draw a bright line between their private and professional personas and activities. Seen more broadly, we are increasingly entering an era in which we have no truly private life away from our jobs (or at all, for that matter). This applies not only to owners and management but to all employees – both those who tend to be out front and to those behind the scenes.

Virtually anything we do or say nowadays, regardless of the context, impacts public perception of our professional associations. Included in that behavior are social media postings, commentary, critiques and opinions that we may intend solely as individual expression but that invariably come to reflect upon our station. So think carefully and consider the consequences before expressing an opinion other than in the most purely private way!

Let's face it – for better or worse, forever gone are the old days when letters, phone calls and private conversations could be assumed to be private. This imposes an obligation on both sides of the employment relationship. Employers need to protect themselves against the damage that staff may cause, even inadvertently. This can be done through clear policies and carefully-crafted employment agreements supplemented with constant reminders. Employees need to be increasingly careful about the opinions they express – and when and where they express them.

At this point you might ask: what about the First Amendment? Doesn't it protect our freedom of expression? But it's essential to note that the First Amendment applies to actions by the government. Even so, courts have upheld restrictions on government employees' social media commentary. In one case, they upheld disciplining a police officer for having posted a comment criticizing a fellow officer's conduct. In another they upheld the termination of a firefighter for racist conduct during a parade. The line seems to be drawn at conduct that undermines functioning or impairs public confidence in a public body.

Even if not directly covered by the First Amendment, the extent to which purely private employers can impose restrictions on speech is far from clear at this point but indications are that employers have a lot of latitude.

Consider another recent instance that involved a zoo employee who posted an Instagram selfie with a caption reading: "at work serving these rude ass white people." Faced with complaints, the zoo administration stated: "This employee's statements in social media are in violation of our policies and do not reflect our institution's values. We have zero tolerance for these kinds of divisive behaviors."

She was fired. Unless she can show discrimination based on a protected class, that action is likely to stand. Relevant for our purposes, her selfie showed her wearing a cap with an animal logo, which presumably was part of her uniform and served to identify her employer. That may have trumped her right to vent her personal frustration on line.

A recent Supreme Court decision may provide an indication of where social media expression is heading. A man was convicted of threatening his estranged wife with extreme harm on the basis of "rap style" tirades he posted on Facebook. Although he claimed that his rants were therapeutic to relieve his frustrations, the trial court found the threats sufficiently specific to be understood by a reasonable person as actual threats, and in fact his former wife testified that she felt endangered.

The Supreme Court reversed on the ground that a criminal conviction requires a determination of actual intent. Yet the justices did not suggest just how such intent is to be reliably determined. Presumably such a determination would depend upon a consideration of context. Unfortunately, that's the same vague and highly subjective standard that the FCC uses in assessing indecency cases – a quagmire which we would hope to avoid for routine social media cases.

Of course, civil employment issues are subject to a lower standard of proof than a criminal conviction. Yet for casual opinions the question remains largely unanswered – to what extent can a private employee be punished for merely expressing a viewpoint?

Until courts provide useful guidance, it would seem wise for staff to avoid any on-line conduct or content that could be considered detrimental to an employer.

Peter Gutmann is a partner in the Washington, DC office of the law firm of Womble Carlyle Sandridge & Rice, LLP. He specializes in broadcast regulation and transactions. His email is: pgutmann@wcsr.com

ACI Solution to FM/HD Time Alignment

A built-in feature of Wheatstone processors can bring FM/HD diversity into perfect sync.

by Jeffrey A. Keith, CPBE, NCE
Senior Product Development Engineer, Wheatstone Corporation

When the FCC authorized IBOC HD technology for FM in October 2002, most of us in the industry had little knowledge of how complex the HD system was; it has only become more complicated over the years as new features and capabilities have been added.

IBOC experienced growing pains in its early days, as do most technologies. I recall many colleagues mentioning that their HD gear had "locked up again." Usually only a reboot of the HD hardware was needed. As there were few HD listeners then, most stations weren't terribly concerned that their HD signal was off the air again. What they were concerned about was the HD hardware *also* taking the FM analog signal off the air – the signal that was paying the bills! (It had probably funded the HD installation, too.)

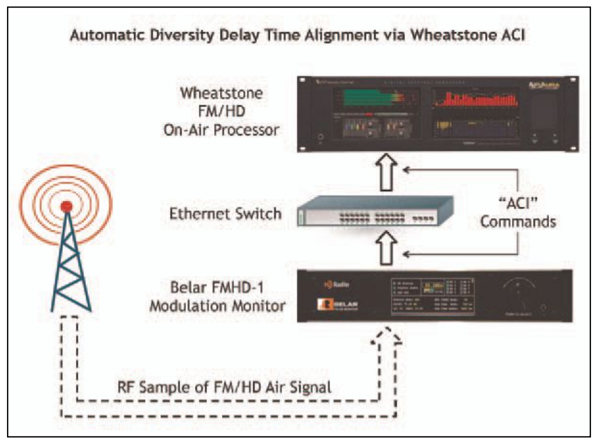
If you're unfamiliar with early HD hardware, you're wondering why a station's FM analog signal would go off the air when the HD encoder died. It's because one of the functions the encoder provided was diversity delay to time-align the analog and HD signals. Since the analog audio had to pass *through the HD gear*, when the HD hardware went down, so did the analog signal.

It was probably out of sheer frustration that station engineers began calling the manufacturers of other gear in their air chains, asking if a diversity delay could somehow be added. One obvious candidate was the station's on-air processor. Thus was born a new processing feature! Once FM on-air processors gained the ability to handle diversity delay, stations began to rearrange their air chains to separate the FM and HD audio as close as possible to the program source. This allowed the HD system's hardware to misbehave without affecting the FM analog signal.

Some stations that split their air chains happily discovered that even though their FM and HD systems didn't share a common synchronizing clock such as GPS, when using the diversity delay built into the on-air processor, FM/HD time alignment remained virtually perfect. Unfortunately, other stations weren't so lucky; those ended up needing to make frequent adjustments to keep their FM and HD audio in reasonable sync.

Even today, some of those stations are still making manual diversity delay corrections to keep their FM and HD in sync. But they don't need to! Recent advances in FM modulation monitor technology have made it possible to eliminate diversity delay drift and maintain virtually perfect audio synchronization (plus or minus one digital sample, or about 20 microseconds). Legendary manufacturer Belar Electronics offers a software upgrade for their FMHD-1 modulation monitor that adds the ability to continuously measure time offset errors using an RF sample. It then calculates the correction required to bring the timing error to zero.

Wheatstone and Belar joined forces during the summer of 2014 on an exciting HD time alignment project. The goal was to merge Belar's new error measurement technology with the ACI (Automation Control Interface) protocol common to all Wheatstone on-air processors. Belar's addition of ACI allowed the FMHD-1 to send real-time diversity delay corrections to the processor over an Ethernet network.



Wheatstone's ACI is a secure, proprietary TCP/IP-based network protocol designed for communication, monitoring, and control. For nearly fifteen years, ACI has found utility for interfacing not only Wheatstone products, but also other broadcast equipment: audio processors, consoles and surfaces, automation systems, and audio routers. The list of ACI-equipped Wheatstone products is long; if it's a Wheatstone product and it connects to a network, chances are it also has ACI built in.

It wasn't very long after the press release announcing the Wheatstone/Belar project that calls began coming in, asking what our ACI protocol actually was and what it could do. Although various automation and playout vendors had been using it for years, now there appeared to be real interest in learning what its other capabilities were. The fun had just begun! To try to answer these questions, I'll make some very general comparisons between the "tweaking" capabilities of analog and digital on-air processors – my focus here at Wheatstone.

Historically, an analog audio processor's controls were physical, mounted on the front panel. Both its location on the panel, as well as its silkscreened label, identified each control for the convenience of the user. Physical controls also had fixed physical limits, beyond which they couldn't be turned. Unless you were handy with a soldering iron, understood audio processing circuitry, and knew how to change component values, a control's physical limits kept its effect on the processing within the range the designer intended. Adjusting a control on an analog processor was easy – if you were in the same room. You walked up to the unit, grabbed the knob, and just turned it.

The controls for today's digital processors are very different. Most controls are virtual, having no physical knob. Each is assigned a unique digital identity and adjustment range by the designer. These reside in the processor's software engine, and in many cases can be easily changed without even plugging in a soldering iron (no more burned fingers!).

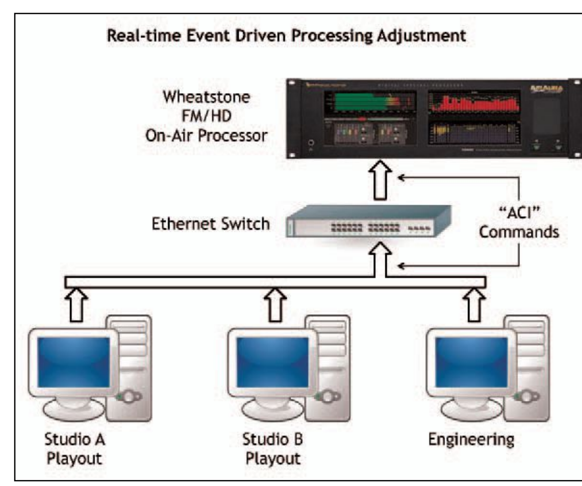
What is also different about a digital processor is that user controls and their settings can be reached from a distance, whether it's inches of cable between the software engine and the processor's front panel, or thousands of miles between the processor and a PC running its Graphical User Interface (GUI) software. Using a software-based GUI or Wheatstone's ACI protocol, anything that has a "knob" or a "button" or a "value," can not only be changed from a distance, but also inspected. This underlines another difference between analog and digital processors, and it's not minor: to see where a particular knob is set on an analog processor you have to physically walk up and take a look at it!

Wheatstone's ACI protocol provides easy and secure access to the "guts" of our on-air processors – one processor, or racks full of them. Interested in checking a setting on a processor? Use the ACI to ask that knob on that processor where it is currently set, without disturbing the setting. Much of the functionality available in the ACI protocol for monitoring and control is available without aid of the software GUI.

What else can be done with ACI and Wheatstone's on-air processors? For starters, you can ask the processor what its current preset is. Or, you could ask it for its operating temperature. Maybe you only need to know which optional features are enabled. Maybe you need to know which audio input is active and whether audio is present on the backup input. You can even ask the processor which processing sections are turned on.

While it's certainly cool to be able to ask your on-air processor questions and get instant answers, what if you're just not in an asking mood right now? Suppose you're in a telling mood? What then? This is where things get *really* cool!

I mentioned earlier that every one of our on-air processors' settings has an assigned identity stored within its software engine. That's really not very different from how other digital processors on the market work. But on our processors, every one of those settings can also be controlled via our ACI protocol!



One of our customers uses a virtual GPI signal (SLIO, or Software Logic I/O) from his Wheatnet-IP audio routing system to change inputs on his AirAura X3 processor. If he wanted or needed to, he could do even cooler things like reducing the AGC's band 3 threshold by 1.62 dB while an SLIO signal goes logical high and then setting it back to its original value when the SLIO goes logical low. ACI makes all such things "easy peasy."

We recognize that a few other manufacturers are offering alternative solutions to the diversity delay drift problem. More than one of those is a standalone hardware box which must be installed in the air chain to measure and make delay corrections. Wheatstone believes it has a better solution than adding another potential point of failure in the air chain: a network-centric solution that, throughout our ten years in on-air processing, has been a built-in feature of every single Wheatstone on-air processor from the beginning. *– Radio Guide –*

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"I found it (JUSTIN 808) to be very easy to set up and install, but most importantly, it gets the job of time and amplitude alignment done perfectly, so the blend is virtually undetectable."
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RF Guide

The Unintentional Listener

by Steve Callahan

For regular readers of my articles, you've followed my long adventure of winding my way through the maze of regulatory requirements, to activate a former AM transmitter site and move my existing radio station there, with increased power and minimal impact to the audience.

I'm happy to report that, after a cold and inhospitable winter, where access to the tower site was greatly hampered by a total snowfall of 105 inches, the new site is now up and operational. It's been a challenge to move equipment from the old tower site to the new tower site without interrupting the on-air signal. Even though the sites are only about six miles apart, it's been an exercise in careful planning to move what *can* be moved at the right time.

However, it occurred to me that anyone who has activated a new AM site in recent years probably has seen a condition on the station's license but hasn't taken the time to really learn what's involved with it. This condition says, *"Licensee shall be responsible for satisfying all reasonable complaints of blanketing interference within the 1V/m contour as required by Section 73.88 of the Commission's Rules."* Of course, Section 73.88 then refers you to Section 73.318 (b), (c), (d), which explains that permittees who commence program tests, replace their antennas, or request facilities modifications and are issued a new construction permit, must satisfy all complaints of blanketing interference which are received by the station during a one year period. Resolution of complaints shall be at no cost to the complainant. These requirements specifically don't include complaints resulting from malfunctioning or mistuned receivers, improperly installed antenna systems or the use of high-gain antennas or antenna booster amplifiers. Mobile receivers and non-RF devices like recorders and audio amplifiers are also excluded. If the site is shared by two or more permittees, the cost of remedying a problem is shared unless the problem is exclusive to just one of the permittees. Following the one year period of full financial obligation (which starts with the commencement of program tests) licensees shall provide technical information or assistance to complainants on remedies for blanketing interference.

What does this all mean to you and to your neighbors? The fastest way to aggravate your neighbors and get them complaining to the local FCC Field office and the local city council is when that "darned radio station is deliberately interfering with my telephone!" – and they don't know who to call for help. Admittedly they are frustrated and don't understand what is happening. It doesn't really have to be a big problem if you take some preventative steps in advance by visiting them before you turn on the transmitter or if you walk into an existing problem, get out into the neighborhood and solve their problem.

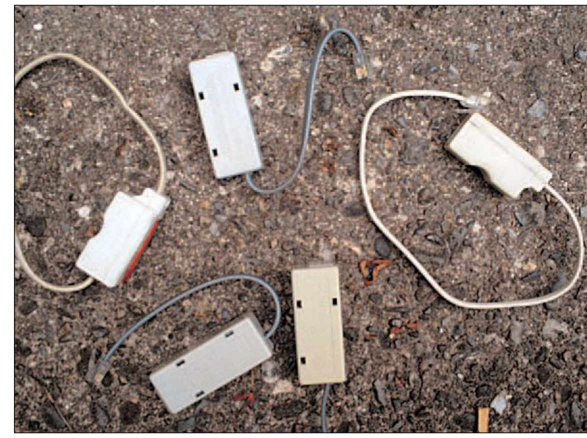
I've had more than my fair share of calls from listeners who have had the local radio station coming in over their telephone. I grew up in a town that had a large shortwave transmission facility and I learned at a young age how to fix my friends' phones, turntables, and tape decks with Radio Frequency Interference or RFI. Thankfully, you don't have to worry about complaints involving turntable pre-amps or tape decks these days. The proliferation of VOIP phones has also cut down on the number of copper POTS lines in use, but there are still lots of them in some areas.

My "Box of RFI Tools" consists of several types of snap-on phone filters (for single line and two lines), filters for hard-wired installation, and filters for handset coiled cords, an old-fashioned "bullet-proof" desk-type telephone, a telephone company-style butt set, and copies of several very good RFI handouts from the FCC. One was produced by the FCC's Boston Field Office decades ago, but is very well written and is still helpful today. Another good RFI handout is the FCC's "Interference Handbook" of which I have probably given out dozens of copies because it is still so informative. It clearly demonstrates TVI or television interference which was common in the days before cable coverage was so extensive. In some rural areas you still will run into TVI from an on-mast TV signal booster, which is now excluded by Section 73.318(b).

Telco-Style Butt Set

Use an old Western Electric phone for testing.

I worked at a 50 kW station once that had several vocal complainants with the station coming in over the phone lines. Being a good neighbor, putting a simple filter on their phones, and giving them some free education, solved their problems. Near another station, one neighboring house had nine wired telephones in a three bedroom house. If you ever find yourself in such a mess, disconnect all the phones and listen to the line side of the "demark" or "point of demarcation," where the lines come in from the telephone company. If it's clean there, then add back the phones one at a time until the problem re-occurs. Chances are very good that just one phone was the problem and the others work just fine. You can then try to convince your neighbor to make do with only eight telephones or you can give them a new telephone which you know is RFI-proof. Make sure you let your neighbor listen to the problem on your butt set before and after your efforts. Also, leave a copy of the FCC Interference Handbook with your name and number written on it. I always tell them to ask their neighbors if they are also having RFI problems and to pass my name along if needed. Their tone will change quite quickly from "that darned radio station" to "that nice fellow from the radio station."



There's a wide variety of telephone filters available.

At one station I worked at, my first job was to go around and deal with all the RFI complains that had piled up over the years of three ambivalent, absentee owners. I just started at the top of the list and worked my way down. One thing that you will see in the field are some wireless handset telephones which are quite susceptive to front end overload. After all, they are little transmitters and receivers in the field of a much stronger transmitter.

Some brands are better than others, but generally they are not going to work. I then offer to provide a free wired phone, and it's up to the neighbor to accept the free phone or keep using their wireless phone. I've also run into a bad bunch of "Princess-style" telephones with the keypad in the handset. They are make great radios and if the RF is being demodulated in the handset, no snap-on filter will help.

This type of phone can be an unintentional "radio."

One word of caution when you're out in the field. I've seen many, many homeowner-wired basements with a multitude of "red dot" splices and recycled wiring. I've only gone as far as to offer one homeowner some new, good quality twisted-pair data cable for him to install. But you *do not* want to, and shouldn't, rewire his house, even though it would be the solution to his RFI problems. You also don't want to modify any of his wiring or phone sets beyond the point of installing the filters.

Every RFI call is different and you learn something new with every one. It's extremely satisfying to solve a neighbor's problem and then see how appreciative he or she is, and know that chances are good that they will become an "intentional" listener to your station and not an "unintentional" one.

Steve Callahan, CBRE, AMD, is the owner of WVBF, Middleboro, Mass. Email at: wvbf1530@yahoo.com

If It's Not One Thing, It's Two – Or Three!

by Scott Schmeling

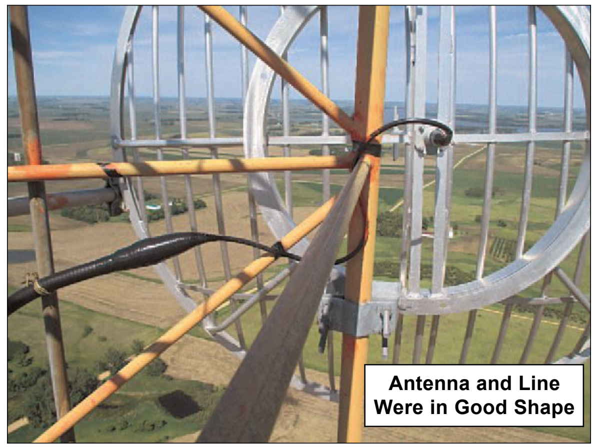
We all like it when everything is working like it should. For example, when our STL systems are working properly and the audio is getting to the transmitter, all is good. However, when something happens to cause the STL to not work (and audio *not* get to the transmitter) things are not so good. That's when we have to put our troubleshooting hat on and go to work on it.

One of our stations has a 29-mile STL path. The receive antenna is a 6-foot Mark antenna at 600 feet up the tower. *Most* of the time it's solid, but every now and then there is an issue. That was the case last June.

Just to give you a little history, we're using a Moseley 6000 series transmitter and receiver with the digital encoder and decoder. The receive signal level was marginal, so we added an Advanced Receiver Research RF Pre-amp on the receive line.

By the way, have you ever tried these pre-amps? If you have a signal that's not quite good enough, whether it's a 950 microwave, or a 161 or 450 RPU, Advanced Receiver Research makes a preamp for the job. I'm not going to go into detail but suffice it to say, they can quite literally save the day! (www.advancedreciever.com)

This tower gets severe ice during the winter and the ice has scored a direct hit on the STL antenna even though we have an ice-bridge above it. (In early spring, 2013, the falling ice destroyed the bridge and did serious damage to the antenna.) We noticed a bad spot on the Heliax and replaced that, also. So the line and antenna were both new.



Antenna and Line Were in Good Shape

At some point, we started getting a high Bit Error Rate (BER) which would cause the audio to mute momentarily. But over time the errors were increasing and audio drops were more than we could accept.

There is another tower very near ours and (while grasping at straws) we thought perhaps a signal transmitting from that tower was affecting our STL. We installed a band-pass filter hoping that would filter out the offending signal, but no luck. So we put in a notch filter for our frequency – still, we had a high BER with the RF preamp in place. Fortunately, there was enough receive signal without the amp, so that the system was usable but with very little headroom.

Last summer we scheduled a tower crew to check the system and peak the antenna. When we arrived on site and "eyeballed the situation" the antenna looked to me like it was pointing more to the north than it should be. We got out our maps, compass and GPS, and confirmed the antenna should be aimed more to the east.

When the climbers got to the antenna they radioed down that the antenna was pointed as far to the east as it could go before running into the tower leg. The question now, how could it not have been peaked? All we could figure was that it must have happened when the antenna was replaced. So they moved the antenna to the adjacent leg. This time we were able to go through the peak and get the maximum signal. Although the receive RF level was still not as high as I would have liked, we were at least able operate, and the Bit Error Rate was low enough that the audio was not muting, even without the RF preamp.

Now let's jump ahead to June of 2015. Signal level dropped to the point where it muted completely. Keith Wright (Ops Manager and my assistant) went out to check things. Just in case, he took a Tieline codec and a Verizon Jet Pack (mobile hot spot) with him. Lucky he did, because the STL was not coming back! Keith connected the Tieline and we were back on the air.

The next week when the tower crew arrived, we talked them through discussing what might be found, and

(Continued on Page 22)

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– Continued from Page 20 –

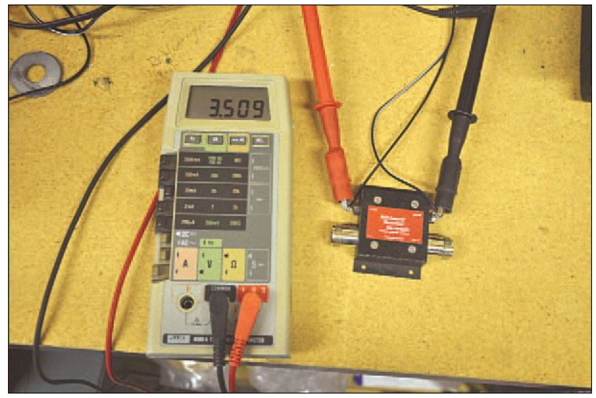
what the options might be. The climbers took a replacement feedhorn and a new pigtail and started to climb. In the meantime, I started investigating the RF pre-amp/BER issue.

You know how, when you're driving on rural roads, you have the opportunity to think through things? Of course, your primary attention is on the road, but you can also contemplate other things – things like why an STL system isn't working, for example.

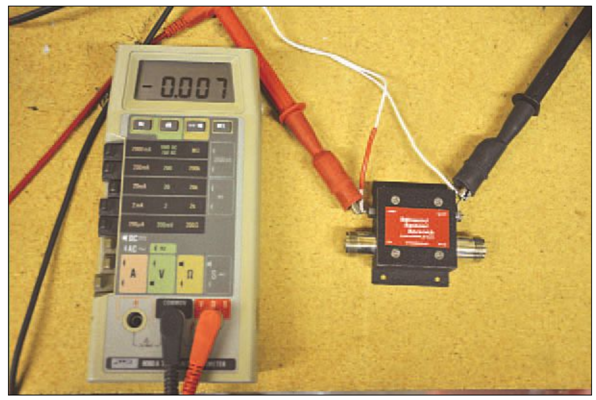
While driving to the site that morning I was doing just that and remembered something from a few years ago. I remembered that my friend Mark Persons had told me about an issue he had experienced with these preamps. His symptom was different – his was an analog system and his symptom was a hum in the audio. Mark traced the cause to a high ripple voltage on the 12 Volt DC power supply (wall wart) for the pre-amp.

That got me thinking ... if high ripple would cause a hum in the audio of an analog STL, could that translate to noise in the data, hence a high Bit Error Rate on a digital STL? I didn't have a scope with me, but I did have a couple DMM's (Digital Multi-Meter). I plugged the power supply into an outlet, set my meter for AC voltage at the lowest voltage setting (200 mV) and put the probes on the leads. I actually had to go two scales higher to read the ripple voltage of 3.5 Volts AC on that DC! (Actually, the DC voltage only measured 9 Volts.)

I connected a different 12 Volt supply and checked the ripple. This one was a very respectable 0.007 Volts.



High ripple on the existing power supply.



New power supply solves the problem.

On a scope that would be a nice flat DC. I probably should have thought of that myself long ago, but with the absence of any audible *hum* I frankly didn't think about it. One problem solved.

In the meantime, the tower crew had discovered something, too. In fact, they found *two* things. The feedhorn was slightly bent, and the jumper to the antenna had been damaged! Both pieces were replaced.

The antenna jumper had been damaged.

With the jumper and feedhorn replaced, receive signal level was, again, very usable. With the addition of the RF pre-amp we again have plenty of headroom.

Thinking back on this situation, there are a few important "take-aways:" First, is the importance of sharing information with other engineers. Mark's mention of the power supply ripple prompted me to check my supply. The second might be that you can check ripple voltage with a DMM. You usually think of checking that with a scope. Next is the Advanced Receiver Research RF pre-amps. Like I said, they can be a lifesaver. And finally, it's a good idea to have some spare pigtails (and a replacement feedhorn).

That it for now. Until next time, keep it between 90 and 105!

Scott Schmeling is the Chief Engineer for Minnesota Valley Broadcasting. You may email him at: scottschmeling@radiomankato.com

Time to Align: Belar and Wheatstone

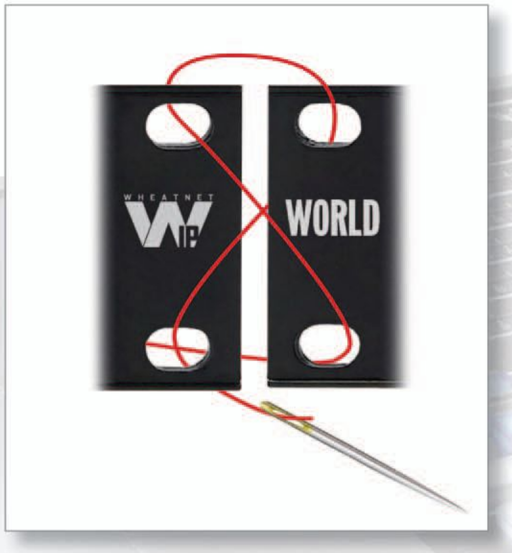
We went live in New York and Detroit with a Wheat processor and Belar's ADC algorithm to determine the success of HD radio and analog signal alignment in blended areas.

Tests so far look promising, indicating a consistent and seamless HD blend to analog whenever HD Radio coverage is less than robust.

"We've had the system on since the beginning of May and the delay between the analog and HD has been within one sample. It was pretty close before, but now it's spot on," said engineer Brian Kerklan with WMUZ-FM in Detroit, a market chosen for its ties with the auto industry. Belar's FMHD-1 continuously measures FM/HD time alignment and transmits closed-loop diversity delay corrections back to the Wheatstone on-air processor via our ACI interface.

For the entire story... INN25.wheatstone.com

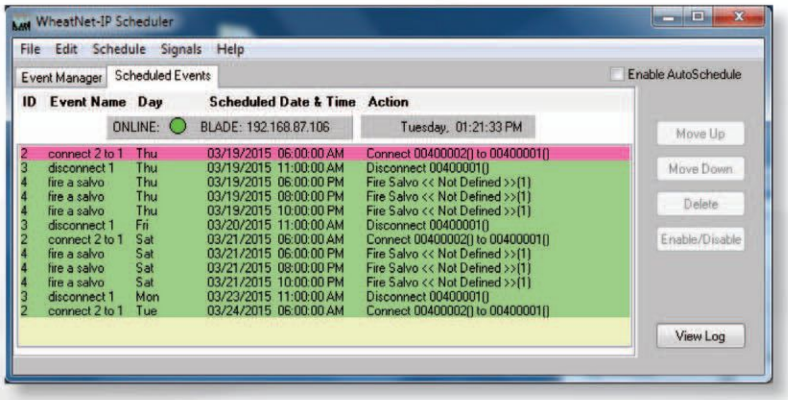
ACI: It's Wheatstone's DNA Needle and Thread



We have built into all of our audio processors a control protocol we call ACI, for Automation Control Interface.

ACI is how Belar's FMHD-1 with new ADC algorithm tells our audio processors what corrections need to be made for a consistent and seamless HD blend to analog whenever HD Radio coverage is less than robust.

ACI operates over the locally connected network via TCP/IP and can touch any parameter on the processor, whether it's a setting for the diversity delay, recalling a preset, changing input sources, modifying output levels, or even lowering just the AGC band three threshold by 1.62dB during some externally triggered event. Most of the program automation systems can also talk ACI, as can our console surfaces, so ACI brings new possibilities to our audio processors as well as the WheatNet-IP system.



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Life on the EDGE: STL via IP Microwave

Any wireless IP microwave system will work as an STL, just as any camera (or phone) can take a picture. But as to how far and how robust, and for how much, that's when the picture starts to get a little fuzzy.

Wireless IP radios connect directly into the WheatNet-IP audio network for a straight hop out to the transmitter site as a main or backup STL, or as a VoIP communication link (in lieu of expensive cell service). When you put up an IP link from the studio to the transmitter, your transmitter site immediately becomes part of your Ethernet network. Audio from a WheatNet-IP audio network I/O BLADE or EDGE unit connects directly into the IP wireless radio through RJ-45 connectors, and because it's all IP, that means you can carry audio, video, voice-over-IP, and data of all kinds. Back and forth. Both ways.

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Seeking Solutions for Copper Theft

by Curt "Cowboy" Flick

Broadcast facilities, power substations, and many other infrastructure sites have been losing stunning amounts of metal to thieves. This is not something happening "over there" but right in our own backyards and antenna farms.

Supply and Demand

Crack-heads and other lowlife thieves have discovered what they see as an attractive way to get a quick buck. Not enough to make a living, but as a way to get their next "fix."

With "scrap" metal going for record prices, no questions asked, at many scrap yards, tremendous damage is being done, and repair costs are escalating. New laws are proposed to control the problem in some places, unfortunately with only limited success.

In some cities, manhole covers are being stolen or entire neighborhoods stripped of street lighting, risking accidents and potential death to innocent bystanders. However, while a manhole cover is worth maybe five to twenty dollars on the scrap market, the copper in your radials, strap, coax, wire, and air conditioners is worth considerably more per pound – and often easier and less risky to steal. It is every manager's nightmare.

Now, compare the thief's chance of being seen and arrested while stealing a manhole cover compared to his chance of being seen and arrested at your (often remote) transmitter site?

Thieves have the time to watch the patterns of who comes to your site, and when. They think they know how to get in, steal the copper, and get out without getting caught. And all too often, they can.

I would be surprised if you could replace a ground system for less than about $8,000 per tower, depending on your specific soil conditions. Worse, a new ground system could disappear even before it has been fully installed. A freshly-plowed field will signal to the thieves that you have just put in some fresh scrap for them to steal. And fresh copper is even easier to pull out than old copper, so they will do more damage faster the second time around. Scratch another $8K.

After all, they have already proven to themselves that they can do it, with minimal effort.

Collateral damage also can be a problem. First, thieves will test your security by breaking any lights. Then they cut through your FCC required fencing to steal your copper – and now *you* are in violation of ANSI RF Rules!

Should a child come through the fence and get themselves electrocuted at your plant, you are liable! In this case, you are *guilty* until proven innocent, yet a thief who cannot be expected to know what kind of hazard they caused is still innocent until proven guilty.

Scrambling For Ideas

How do we stop them? Many suggestions have appeared on Internet mailing lists, in various articles, and in conversations.

For example, some suggest painting the copper used at our sites with something to make it appear less as metal and more as something "worthless" to the thief. Others suggest using metals with less scrap value, supposedly to make it less attractive to the thieves, such as copper-weld steel wires in place of higher value copper for ground radials.

But this will not prevent theft. That depends on thieves evaluating an ROI (return on investment) in a logical, businesslike manner – which is a pipe dream. Thieves do not have the intellectual capacity nor desire to realize the ROI is not there until after the damage is done and you are off the air.

Yet the real problem is not the copper, the aluminum in power lines, or the steel in a tower. The problem for us, is the replacement and repair costs.

Beyond Copmmon Sense

Again, it is not about ROI. The thieves just do not care. It is strictly about their time available – which is virtually unlimited – and their need for their next "fix."

To them, it is well worth wrecking your transmitter plant in hopes of obtaining five or ten dollars at the scrap yard. They never even consider the hundreds of thousands of dollars of damage they can cause in the process, nor the disruption to the broadcast business, if a new tower has to be purchased, shipped, and stacked – and the week or so to plow in and reconnect a new ground system.

After all, these are people that risk their lives to steal live high-lines from power stations – an obviously (to us) stupid plan. But they only see the "free" metal for the taking. Clearly, their own life is worth less to them than the $31 worth of scrap they might get if they do not die. They never consider the possibility of losing their lives for a few dollars as a poor ROI. *They just do not think that way.*

Understanding the Root Problem

Replacing copper ground radials with something of less dollar value on the scrap market is not a solution. It does not even begin to address the issue, shown by someone recently

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being brazen enough to cut down an entire tower for the hope of scrap value,

We can talk about using steel, and other less than valuable materials. But the thieves work cheap – and at great risk to life and liberty. "Value" has an entirely different meaning to them than to us. We *must* accept this as fact or we will never find a workable solution.

We must stop thinking like practical engineers and think like the wacked-out, worthless scum of the earth. Understand what *they* value and their selfish me, me, me attitude. Only then can we stop them.

Finding Viable Solutions

In other words, start thinking about *what will stop them.* Laws and rules merely keep honest people honest. Honest law-abiding citizens are not our problem, hence laws, signs, and rules will not help.

Start by realizing that – even to them – time has some value. In other words, make it cost them time and effort, so that the prospect of invading your site becomes unattractive to them. Really, nothing else will work. Fortunately, your costs in slowing or stopping them certainly will be less than that to repair the damage they do, plus any off-air revenue losses.

There are ways to make a site less attractive to a thief, but we need to make it *completely* unattractive, actually *repulsive*, in order to stop them. I personally favor junk yard dogs and armed guards, but protecting your property is illegal in many places, so some other way is needed. About the *only* way to win is to make it so difficult to remove metals that the thieves decide it is more cost effective to spend their time elsewhere.

Beyond Paint and Tar

For instance, painting and tarring will make copper less attractive to the scrapper but the thief will not know that until after the damage is done. Meantime, the thief will not care. Once he has destroyed your plant, the only difference it will make to him is that now he needs to go out and destroy another facility to finally achieve his goal of getting high.

So we are back to making him work so hard for the metal that he gives up. One suggestion is to pour cement plugs every five feet or so along the length of AM ground radials. Cement can be a good start.

I am thinking as one of those guys who plows in radials, lays and bonds straps and screens, tunes ATU's and such – and at the same time trying to think as a spaced-out crack-head with nothing to live for but my next fix.

If we were to encase the copper – not in something that simply marks it, as the thieves will not care – but in something that makes it extremely difficult to remove, this can have the desired effect.

Encased in Concrete

Paving the entire radial field is one thought, but not really practical. On the other hand, all it might take is merely dry-sacking (pouring a powdered mix) the entire radial with an inch or so of concrete as it is plowed in. It will absorb moisture from the ground and cure into a hard concrete mass, encapsulating the copper radials in a relatively short time.

The result is that the copper will be exceedingly difficult to remove and not worth much if they still take it.

Installation will a bit take longer, yes. More work initially, yes. More cost initially, yes. A low-maintenance, one-time solution? Perhaps. We are not talking about terribly high quality concrete, and it may or may not actually encase the radial wires, but it *will* make them more difficult to remove when (not if) the thieves come calling.

There are several other products that create a "goo" with water and "set" around the radials, preventing them from just being "pulled" out. The added time and effort is likely to be a turn-off to a thief.

More Options

Another approach is plowing radials much deeper, say two feet instead of the normal six inches or so. Depending upon your local conductivity, plowing deeper can have much the same effect without the risk of the lime in the concrete mix destroying the copper itself, over time.

When was the last time your transmitter site was visited? A human presence works. Can you afford a full-time guard? Probably not, so we need to be a bit more creative. Infra-red motion detectors, cameras, perimeter alarms, and so on, all have their place, but are not a panacea.

You will probably only need to catch them once, along with a high probability of capture in the future, to gain a reputation as someplace not to go a stealing. It may cost an extra $10,000 for added security, Internet-based webcams watching the site, and flood lights mounted and powered on the tower and around the buildings. But the cost of doing nothing is too high.

Do *Something*

The point is that a comprehensive security approach is no longer an option in our society. It is mandatory to create the impression that a broadcast station is not the place to go stealing stuff. If we can do that, we will all benefit. But it will not be easy – and likely not cheap.

We cannot ignore this problem any longer. It is a cost of doing business. The probability (not just a possibility) of actually being apprehended will cause even them to pause, and possibly go elsewhere.

What can we do? What is certain is that we must do *something*. Otherwise it is simple "pay me now or pay me more later on." Much, much more. – Radio Guide –

Transmitter Site

Logical Troubleshooting Techniques

by Tommy Gray, CBRTE CBNE

Hey! The transmitter just went off the air!

I will bet every one of us have heard that statement at one time or another! It is the last thing an engineer wants to hear. We know what comes next when we hear it. We gather our thoughts, grab our tools, and head out to the site to see what has to be done to get the signal back up and make everyone happy. Now I want to make you aware of one thing that you can count on as a broadcast engineer. Transmitters only go down on nights, weekends, holidays, when you are at the movies, a ballgame, your kid's birthday party, your anniversary dinner, etc. That is just the way it works. Any veteran engineer can say "Amen!" I have no doubt that you could add a few others to the list too. This is when logical troubleshooting can save your bacon!

Where to Start?

Component-level repairs and troubleshooting are fast becoming as obsolete as bubble gum and bobby socks. These days, we have folks who spend the better part of their career just swapping complete units or modules, and never get into the "heart of the beast" so to speak. Admittedly, so much of the equipment we use is very complex, and requires specialized tooling and equipment to repair. This is not to mention that many pieces of hardware (especially studio hardware) contain proprietary parts and software and frankly the manufacturer's prefer you "stay out of their house."

One thing, however, that still requires logical troubleshooting is the broadcast transmitter. Newer solid-state units and newer designs have made them very reliable when compared to their counterparts from say 20 years ago. There are times however, when you need to get into them and perform emergency repairs to get your station back on the air fast. This is when being, as Mr. Spock would say, "Logical" helps. You can waste a lot of time being hit and miss with your troubleshooting.

Getting Started

Of all the things I do as an engineer, the one thing that is my passion, is RF work – I love working on transmitters. I don't hire out to do it much these days, but I do get a lot of calls to help others and do so willingly as a volunteer. I have worked on just about everything in the industry at one time or another and still do when I get the chance. Based on my experience I want to share a few things that I feel will prove helpful.

Rule Number One

First, I want to share with you one thing I have learned after over 45+ years as an engineer. Rule number one, when approaching a failed transmitter – 90% of all transmitter failures will prove to be something simple. Therefore, begin first by, *"Looking for something simple."* Examine the situation and see if you can spot something. Let me give you a few examples of simple real world situations.

Recently, I got a call from a young engineer who had a CCA 35000G FM transmitter down (usually a very good transmitter). He was very green and just getting started in his career as an RF engineer. I have been mentoring him and he is very sharp in his field (He is a licensed aircraft tech who helps take care of a few transmitter sites in his hometown area as a contractor). He already has a lot of logical training as a result, and catches things quickly. He was puzzled, however, as the transmitter was still on, but making no power. It had plate voltage, about 1/2 Amp of plate current, and no RF output.

I had him shut it down, kill the breaker (he was there by himself, which I do not recommend, unless you have absolutely no choice, then be extremely careful!). I had him to use the grounding stick and make sure everything was completely off and no voltages were present.

Next I had him to open up the transmitter and look for anything that might be burned up (wiring, components, etc.). When he did, he said everything looked good and normal.

Then he pulled the cavity door to look inside. Immediately he said, "There is a capacitor blown up and pieces of it are everywhere. It looks like the PA tube is fried too!" Keeping with the "most things are simple" premise, I said OK, clean everything up, grab a new cap and install it. He put in the new cap, then he said, "What about the PA tube? It is burned black!" I had him text me a picture (Don't you love cell phones?). Once I saw it, I immediately concluded that it was probably fine, just a little dark and tarnished as they are sometimes after several months in service.

I explained to him that, since there were no overloads, the transmitter had voltage and a little current,

(Continued on Page 32)

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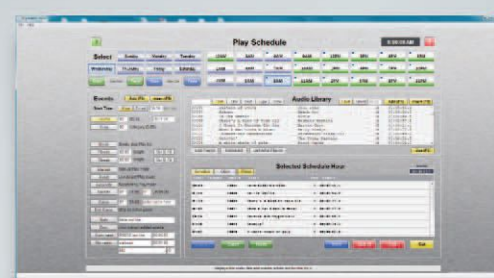

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Transmitter Site

– Continued from Page 30 –

normal filament voltage, etc., that probably all that was wrong was the cap. (It was the IPA coupling cap, hence no drive and no output.) A quick check of the exciter showed normal drive. Well, when I had him put it back together, and warm it up, we first tried it with the power turned way down, and in low power mode. As you can guess, it came up and he said, "It's making about 30%." We let it cook for about a minute or two, then I had him go to high power and start running up the power slowly. After about 5 minutes, we were back to full power, everything looked good, and I said, "All that is left is for you to touch up the tuning, clean everything up, fill out the maintenance log, and go home. He was ready to swap out the PA tube, but all that was wrong was a simple doorknob cap.

This past weekend, I went down to help another young guy on a transmitter that, "Would not turn on and he could not figure out why." I applied the "look for something simple first" principle, and as I opened up the front door, there in a dark corner behind the door, was a tripped plate breaker he had not noticed. As it turns out, they had to use the backup the other day while doing PM. (You *do* run preventive maintenance and not wait until something fails to – don't you?)

The building is air conditioned and the backup was very cold from sitting for a long time. He had turned it on after the normal 3 minute time delay and it ran for about 1 minute, then had an arc in the PA cavity that tripped the plate breaker. I instructed him to wait for at least 10-15 minutes with the filaments on before applying high voltage, to allow the blower to dry out any moisture and condensation. We turned the breaker on, waited ten minutes and the thing came up and ran normally. Case closed.

Look for something simple and be logical!

Admittedly, all transmitter failures are not simple (but most are). When there is nothing simple, you have to get ready to go deeper. That is when you either call in someone with "deeper" experience, or if you already have it, you start going logically into the box.

Rule Number Two

This brings us to my Rule Number Two: *"Look for something Obvious."*

• 1. Have you done a complete visual inspection of everything, looking for broken and/or burned up components and wiring?

• 2. Is there a ready light, or a time delay light, alerting you that it has timed out?

• 3. Are there any overload lights – plate current, HV, etc? Are all visual status indicators normal, etc?

• 4. Are the blowers running and do you have normal filament voltage (in the case of a tube transmitter)? No air means no filaments – hence no turn on.

• 5. Are there interlock lights to let you know that you have all the interlock switches made up – air interlock, door interlock, panel interlocks? No interlock means no high voltage!

• 6. What noises do you hear when you try to turn it on? Are there pops, arcs, etc. Do you hear relay sounds, like things are trying to turn on?

What is Not Working?

Once you ascertain what is not working, you are in a better place to narrow down the problem. Depending on the type of transmitter, you may be able to pull out modules, or turn breakers and switches off, to bring things up one stage at a time. Some solid state transmitters can have power supplies disconnected, and PA modules removed to allow troubleshooting the lower level items, such as Low Voltage Power supplies. As you determine what is working, you can put things back in, one at a time until you know what is bad. Unfortunately, this will not work with all transmitters – it depends on the design.

Example of the easy: Grounded Grid transmitters (Energy-Onix, CCA, CSI, etc.) are very easy to troubleshoot in the HV chain. If you are getting PA overloads, you can simply disable your exciter output, remove the high voltage lead from the top of the tube, turn the HV on and see if it holds then. *WARNING: Before you touch anything use the grounding stick!* If the HV comes up with the plate of the tube disconnected (make sure to secure the lead somewhere that it cannot arc!) then the tube is probably bad. If it still overloads, then you may have bad rectifiers, a bad choke, or a bad filter cap. From that point you need to grab the schematic, go through the thing from the AC input to the DC output and see what it bad. Of course you also need to, once again, look for signs of arcing you may have missed. An arc can fool you into thinking that you have bad components.

There are many different types of transmitters out there, and they all function in different ways. They also require slightly different troubleshooting methods, but I can tell you this they *all* require *logical* troubleshooting to fix. Sometimes you get lucky and there is something obvious, but when there is not, logic prevails! I will try to share more of this with you in future articles. Happy Troubleshooting!

Tommy is the Senior Director of Broadcast Engineering and Technology at KSBJ Educational Foundation.

From the Ground Up

Making the Plan Happen

by Jim Turvaville

There is the universal conundrum pertaining to the Engineering World: You have 3 Choices: GOOD – FAST – CHEAP. Pick any 2.

• If you want it GOOD and CHEAP, it will not be FAST

• If you want it GOOD and FAST, it will not be CHEAP

• If you want it FAST and CHEAP, it will not be GOOD

After two major studio moves for a client in the past four months, each under different circumstances, I have clearly seen the necessity for good planning on a project. With it, even a huge project can be mastered with minimal down time and unforeseen problems – without it, even a small and seemingly simple project can come back to bite you severely. I will not begin to give you the complete process for any specific project, but there are some common general preparatory steps that certainly should be considered.

Advance Time

In the first of my recent studio moves, it was a last-minute necessity caused by a new landlord at the studio location. On about the 10th of the month, the station was told to be out of the building by the end of the month – and it just *had* to be February, the shortest month on the calendar! This is by no means ideal or desirable when it comes to having to move a radio operation, with many factors to be considered on the infrastructure that keeps a station operating behind the scenes. With just two days prior to the scheduled move, a new location was finally secured and the entire move took place in just six days, from start to finish. That included satellite downlink removal and reinstallation, arranging a tower crew to take down and put up the new STL path, and re-align the receive end at the tower.

A temporary ISP was utilized, while the needed 30 days for the regular provider was ticking away for a proper install. Only by great fortune did the new landlord go out of their way to accommodate the station and its unique needs for operating. It certainly could have been very ugly and time consuming if all of the stars had not aligned on the project. Even at our best, downtime for that single station was still in the several hours range during the move.

In the second project, we knew almost a year in advance of the need to move, and had a location picked out a full three months prior to the move-out date, with access to it for over a month prior – a very good situation for all parties involved. There was time to arrange with the Telco provider for lines to be moved in a window that fit the move dates; time to order backup and new gear for satellite downlinks and server rack installations; time for the new landlord to install dedicated electrical circuits for the studios and server room. With sufficient planning time, we arranged for all 5 of the stations at the studio to be temporarily transitioned to one of the company's other locations and operate from there for a full week. That meant down time was in the range of 15 seconds per station as we switched the audio feed from the old studios to the temporary operation, and another 15 seconds as we switched from the temporary studios to the new operations. Quite a contrast when one has advance time for preparation.

Hands On Deck

As a contractor, I usually work alone and am accustomed to handling small projects without any additional help. With both of these studio projects for a client, I had the luxury of being on the team with three other highly skilled individuals, and was reminded of the value of many hands to the labor. With the Corporate Director of Engineering, the I.T. Director and one other Engineer along on each project, I was just part of the team to make it all happen. We worked together smoothly and efficiently, "eating the elephant one bite at a time," with a daily white board of punch items and delegation of duties.

On the first project, with little advance planning, we did a lot of thinking on our feet, brainstorming while busy and making some snap decisions and plan changes in mid stream. It was not ideal from a technical perspective, but we worked together to see the project through, in spite of some crazy last minute situations that flew up in our face. We had to dismantle their only satellite downlink in the rain, move it to the roof of a five-story building (in the rain as well) and

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From the Ground Up

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get it back up for operation while the station was off line. Management understood the situation and had a great attitude, even stepping in for some hands-on dirty work as needed; and of course, approving throwing money after a problem when time became the impossible factor. (Remember, GOOD and FAST are not CHEAP!)

On this project, I saw clearly the need for hierarchy being defined from the beginning – know who is the leader, who makes the tough decisions; and it is the duty of the others on the team to empower that individual and give them sufficient information on which to make good decisions. This is not the time for a power grab or getting one's feeling on a cuff; this is the time for mutual respect and teamwork for a common goal. I felt fortunate to be on that team and put my own blood sweat and tears into the project; the reward of a good job done was shared by all. In spite of the circumstances, we came together as a technical team and the station looks, sounds and works great as a result.

On the second project, with almost a year to plan, there were several sit-down planning sessions with management, programming and technical – all having the opportunity to speak into their respective areas of concern. Management had a thorough understanding of the technical needs for a new location, and Programming had the ability to speak into the aesthetics and ergonomics of building new studios. In this project, the station was downsizing from 3 studios to only 2, and the server room was shrinking from 5 to 4 racks. With time and good communication, the needs of the staff were able to be accommodated in how the new studios would be laid out, and the technical staff was able to plan carefully on rearranging the racks to maintain and increase flexibility and functionality in a smaller space.

The Telco/ISP provider was able to carefully plan a cut-over to the new location at 6:00 a.m. and the staff did not miss a beat on their expected functionality. We had the luxury of buying a new satellite downlink and getting it shipped in, assembling it on the roof of the new studio building with no hassle. The IT guy had time to pull cables, assemble racks, get on-air, production and streaming computers up and running without the hassle of being in an off-air situation. Remember, GOOD and CHEAP are not FAST, so if you can plan and have the time, you can do it properly and still keep within your budget.

Out of Control

On both of these projects, I was keenly reminded that on any project, there are things that are out of your control. Wisdom requires us to know what they are ahead of time, and plan on how to manage your schedule around others. Wisdom also says to have a "Plan B" for when those schedules change with little or no notice. Here are a few ideas for consideration:

1. Your Telco/ISP will always have lead times that you cannot change, and their "install" date will almost never be the first one they set for you. Do all you can to have a backup plan, as well as a backup to the backup plan, for how you will keep phones and Internet connections working during a move. I've used a Cradlepoint router (or similar) with a USB 4G modem to plug my office network into while the ISP was installing. It's not great, but if your cell provider has good service then at least the GM can check email on his computer with some sense of normalcy.

2. Putting up a satellite downlink and an STL dish very likely will involve local zoning regulations or business development covenants. Meet with the responsible parties early and often, and drown them with plans, drawings, photos and information – they need to be your friends, not your foes.

3. Your new landlord may have to deal with local zoning for any improvements to the property you need for a radio operation; be his best friend as well, with lots of communication, plans and drawings, to make what is required to be done as easy as possible. Also, invite the new landlord to come by as you are working, to show them the "insides" of what makes a radio station tick – they are usually not at all knowledgeable of what actually is required for what you do in his building, and most often I've found them thrilled to be invited to see the work in progress as well as the finished product.

4. Your new neighbors may be very shocked at what goes on to build and operate a new radio station in their building. Go out of your way to meet them and explain that some of the sounds they hear now are only temporary! Be mindful of their business and do all you can to not interrupt their workflow while yours takes place.

They say "those who fail to plan, plan to fail" and Engineering projects typify that axiom very well. Don't let your project fall into that stereotype; make a good plan and reap the rewards of success.

Jim "Turbo" Turvaville is semi- retired from 36 years in full-time Radio Engineering and maintains a small clientele of stations under his Turbo Technical Services (www.jimturbo.net) operation providing FCC application preparation and field work.

Practical Engineering

Electro Static Discharge (ESD)

by Dave Mandelbaum

After over 50 years in the Broadcast, Manufacturing (both commercial and military) and Quality Assurance fields, I have found an area that appears to be somewhat ignored by the Broadcast Industry. That is the area of ESD prevention in both the manufacturing and repairing of broadcast products. I have often seen pictures in broadcast publications of assembly areas with printed circuit assemblies being built with little regard for ESD protection, and the catastrophic results that can happen down the road in the product lifetime when it may "mysteriously" fail. We are all ESD generators and need to realize that precautions should be taken to minimize the exposure of sensitive circuits and components to ESD.

In the following article we will discuss the following:

1. What is ESD and why learn to control it?
2. What damaging effects can ESD have on our equipment and station?
3. How is static electricity generated?
4. What are the different levels of damage that can be expected from an ESD event?
5. What are the factors that promote ESD generation?
6. Just how does ESD damage components?
7. What can we, as Station Engineers, do to help reduce ESD damage?
8. What equipment is used in ESD suppression?
9. What do conductive, dissipative and insulative mean?
10. How does all of this work to reduce the possibility of ESD damage?

What is ESD?

As early as the 1400's, European and Caribbean forts were using static control procedures and devices to prevent electrostatic discharge ignition of black powder stores. The age of electronics brought with it new problems associated with static electricity and electrostatic discharge.

Although lightning strikes are the most obvious and devastating form of ESD, we will discuss the not so obvious forms of the problem and ESD generation.

As electronic devices became faster and smaller, their sensitivity to ESD has increased. Furthermore, ESD impacts productivity and product reliability in virtually every aspect of today's electronics environment. The age of electronics brought with it new problems associated with static electricity and electrostatic discharge. Control of these unwanted discharges may save expensive and critical pieces of equipment from failing immediately – or in the future.

How is Static Electricity Generated?

Controlling electrostatic discharge begins with understanding how electrostatic charge occurs in the first place. As a general rule, static electricity or electrostatic charges may be generated when two surfaces come in contact, then rapidly separate resulting in the generation of charges being built up on the two surfaces. Both materials may start out electrically neutral. When the two materials are placed in contact and then separated, negatively charged electrons are transferred from the surface of one material to the surface of the other material. For example, a person walking across the floor generates static electricity as shoe soles contact and then separate from the floor surface, or similarly, an electronic device sliding into or out of a plastic bag. Once the charge is created on a material, it becomes an "electrostatic" charge. This is the first half of the ESD equation.

Electrostatic Discharge (ESD) is the rapid discharge of this electrical energy, (completing the equation), which may cause EOS (Electrical Overstress). EOS is the internal result of an unwanted application of electrical energy (an ESD event) that results in damaged components.

What Are the Different Levels of Damage That Can Be Expected From an ESD Event?

Direct catastrophic failures occur when a component is damaged to the point where the overstress renders the component *dead*, and it will *never* function again. This is the easiest type of ESD damage to find during testing. Latent failures occur when ESD weakens or "wounds" the component to the point where it will not stop functioning properly during testing, but over time, the wounded component will cause poor system performance and eventually complete system failure. This normally happens when the "wounded" component or assembly is subjected to additional stress such as high temperature or power fluctuations.

Some of today's ESD sensitive devices can be damaged by as little as 100 Volts. To show you the magnitude of the problem, when a "zap" or "shock" is felt by a person, the voltage of the electrostatic discharge has to be about 3,000 Volts or higher. Normal fabric and synthetic material-covered desk chairs may generate over 18,000 Volts of static charge when sitting down or standing up. And, everyone has experienced the shock received when walking over carpet on a low humidity day and getting nailed by touching equipment or light switches.

Again, a latent failure occurs when ESD has caused a current flow that does not have enough power to cause a total

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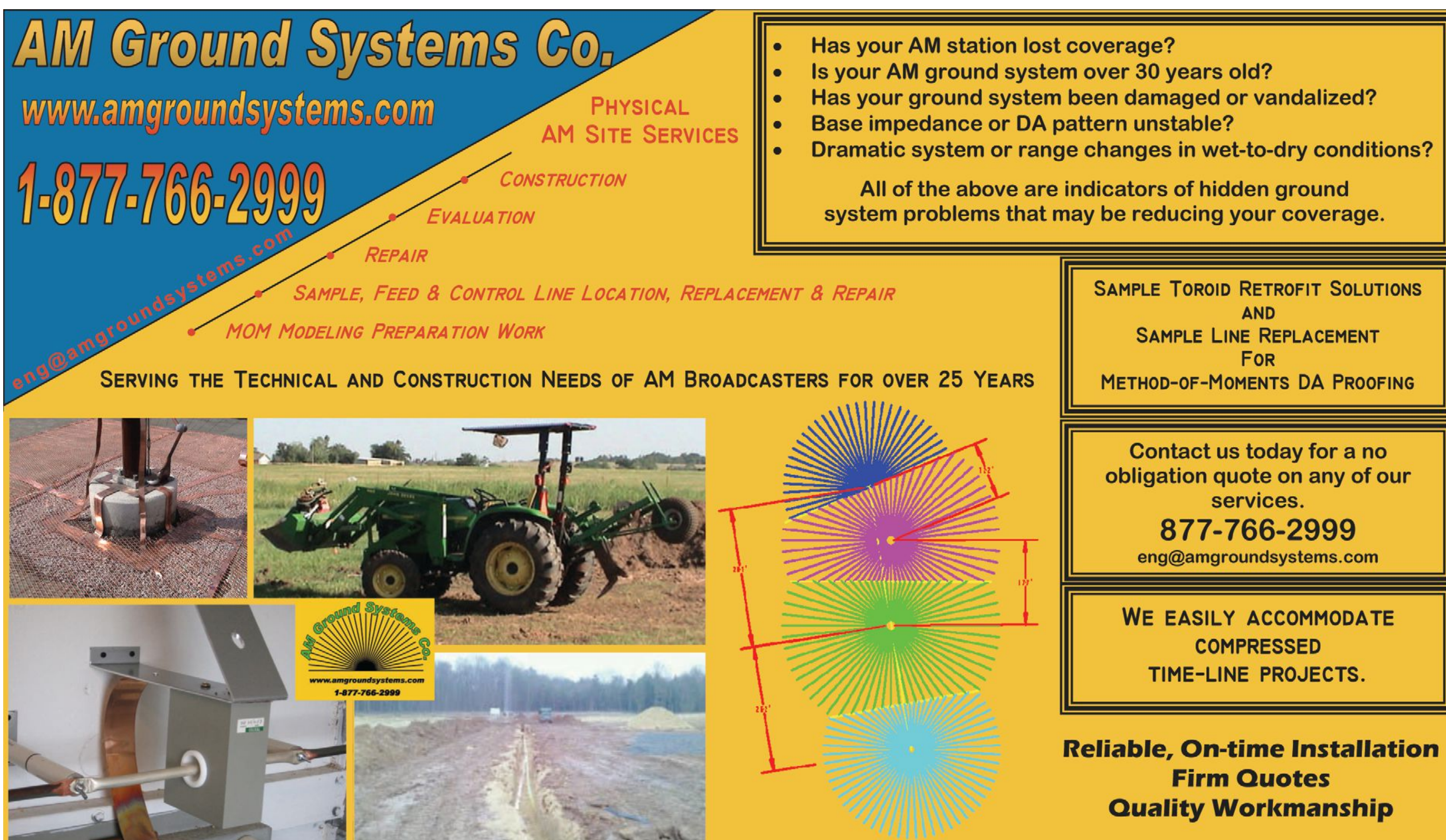
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Practical Engineering

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failure, but may work well intermittently, or under low stress situations. Latent failures may pass your bench testing procedures, but the damage may have already occurred – but not detected – only to fail at a later date or when under stress.

Some Everyday Sources of ESD

Work Surfaces – waxed, painted or varnished surfaces, untreated vinyl and plastics. ***Floors*** – sealed concrete, waxed or finished wood, floor tile, and carpeting. ***Clothes*** – Non ESD smocks, synthetic clothing materials. ***Chairs*** – finished wood, vinyl, fabric, and fiberglass. ***Packaging Materials*** – plastic bags, non-ESD bubble wrap, foam, Styrofoam. ***Assembly Tools*** – compressed air, synthetic brushes, heat guns, and blowers.

Static Electricity Voltage Examples

Source	10-20% RH	65-90% RH
Walking across carpet	35KV	1.5KV
Walking on vinyl floor	12KV	250V
Person working at bench	6KV	100V
Vinyl envelopes at work station	7KV	600V
Plastic bag picked at work station	20KV	1200V
Work chair with foam padding	18KV	1.5KV

Some Examples of ESD Sensitivity to Damage

Device Type	ESD Voltage Sensitivity Damage
V-MOS	30-1200 V
MOSFET, EPROM, GaAsFET	10-300 V
JFET	150-7000 V
OP Amp	190-2500 V
Schottky Diodes	30-2500 V
Thin Film Resistors	300-3000 V
SAW Devices	150-5000 V
Schottky TTL	1000-2500 V
CMOS	150-3000 V
DRAM	200-3000 V
Bipolar Transistors	300-7000 V

Theory on ESD Prevention

How do we minimize the charges that we build up? The human skin is a conductor. The amount of sweat or salts on the skin will determine the resistivity of the skin. Grounding the skin by using a grounded dissipative wrist strap will discharge your body, and by wearing a dissipative smock, you can guard against any additional static charges from clothing getting to the sensitive device or assembly. Working on a dissipative mat will also protect the devices from being zapped by the table surface, and create a way to slowly discharge any charges picked up by the device or assembly. Keep all common untreated plastics away from the assembly area. They cannot be discharged without the use of a special air ionizing blower system. Use an ESD approved and grounded soldering iron when making repairs.

Conductive, Dissipative, Insulative

OK, let's briefly discuss the three states of resistivity. **Conductive:** A material is deemed conductive when it is less than 106 Ohms per square. (Don't ask! We don't have the space to talk about square what.) **Dissipative:** A material is dissipative when it is between 106 and 1012 Ohms per square. **Insulative:** When the material is above 1012 Ohms per square.

Why does this matter? Well, if we are concerned about a rapid discharge that damages components, one surely doesn't want to use a conductive medium for ESD protection. That would subject the device or assembly to catastrophic stress during any discharge. Dissipative media limits the current flow of the discharge to an acceptable level and thus protects the device from rapid discharge, and also allows the discharge of the static electricity to take place at an acceptable rate. Insulative, (is that a word?), will not allow any discharge but will hold the charge until some unlucky device or assembly comes into its field to discharge it.

ESD Sensitive Device Packaging and Storage

What about pink plastic bags? Are they safe for storage? Simple answer – NO. Pink plastic bags prevent static build-up by having a surface material that will minimize static build-up when rubbed or stored with other materials. It will not prevent a static "zap" from going through the plastic and damaging what's inside. Use a metalized shielded bag for storage.

So What Can We Do to Minimize ESD Damage?

When handling ESD sensitive assemblies and components we should observe several basic rules:

1. Wear an approved and grounded ESD wrist strap when handling assemblies or components. (An approved wrist strap contains a 2 Meg resistor in series with the ground lead to prevent electric shock to the wearer.) Make sure the strap is in direct contact with skin.

2. And, use a grounded dissipative ESD mat to work on, and to place any ESD sensitive components upon while they are out of their protective bags.

3. Wear an approved ESD smock while at the work area. The smock should have dissipative qualities and snap firmly at the wrist.

4. Keep ESD sensitive components and assemblies in SHIELDED ESD bags during storage.

5. Use ESD safe tools and a grounded soldering iron when working on ESD sensitive assemblies.

6. Keep untreated common plastics away from the work area.

7. Keep the humidity above 30% if at all possible while working with ESD sensitive components or assemblies.

8. Momentarily ground yourself before plugging in Mic cables, earphones, or making other connections to equipment that may be damaged by an ESD event. Remember, you will probably have a significant charge built up just by walking up to the equipment.

9. Respect ESD caution labels. In most cases, (I have seen them on bags of hydraulic cylinders), they mean the device or assembly inside is ESD sensitive.

I hope that this article will help in saving you the frustration of latent or catastrophic failures in the future. Some equipment designs incorporate ESD protection and some do not. Just taking some precautions beforehand can avoid a lot of grief later.

Dave Mandelbaum is President of DM Engineering, a manufacturer of broadcast equipment. He has been certified by NASA/JPL as an ESD Instructor-Trainer and has taught ESD prevention in the aerospace industry. He can be reached at dave@dmengineering.com

Small Market Guide

What's Happening to Ancient Modulation in Small Market Radio?

by Roger Paskvan

As you have seen in this column, there have been a number of articles on AM radio. Mostly because AM is still a big deal in small markets and usually the hardened station synonymous with the community. The folkways of a small town provide an atmosphere that makes old habits hard to break. This plays a part in establishing small market AMs – still hanging on, but the current younger generation is sold on FM. So what is the real issue here? Is the AM radio band dead? More and more stations are going dark or migrating by way of FM. Is this transition inevitable?

This resultant dim future of the AM band has become a major concern for many existing broadcasters as consumers migrate more and more to their cell phones, tablets and crowded dashboards for crystal clear sound. Where they can, broadcasters by content are moving away from the staticy sound of the AM band, simucasting their news and sports games to the FM dial where it's become fact they can pick up younger listeners and the sound quality is outstanding.

Well these problems of AM are still with us, hanging on for close to 100 years of broadcasting. They fall in two major categories, static and fidelity. AM has been plagued by static since its inception. In the mid 30's Howard Armstrong was hired by RCA to eliminate static on their AM radios. He couldn't solve the problem but came up with the novel idea of FM. FM was a revolution in broadcasting, but no one wanted it and FM remained on the back burner until the mid seventies. Now the tables have turned. Everybody wants FM, and only a few continue to listen to low fidelity AM static radio, when better options are available. The lack of fidelity and extreme nighttime dial congestion make up the second set of problems that listeners must put up with on AM. What "Big Miracle" can be done to save our ancient modulation whales from total extinction? Well, the FCC is listening and efforts are underway to solve the crisis.

Full AM HD

In a number of Report and Orders, the FCC has been involved with a move to fix AM, but the wheels are turning very slowly. As we have suggested in a previous issue, making the entire AM band digital is a real proposal and on the FCC dinner table. The existing hybrid, analog + digital system has been in use for quite some time. It was designed to be a transition between analog and full digital but the last part has never been implemented. The NAB Radio Board authorized a special committee to study the problems of AM. This research group has been conducting tests of full bandwidth HD utilizing a number of cooperating AM radio stations around the country. The tests have been very positive even at night during HD skip conditions. Results of these tests will be made available sometime this year. Although this idea excites many broadcasters in the industry, the conversion cost of an old AM antenna array to the bandwidth requirements of digital, as well as a new HD transmitter, will remain a major factor.

The entire industry would have to adapt to full HD radio, including auto makers. This move would take possibly ten years and be a FCC mandate with a sunset date similar to the recent FCC TV industry makeover to full HDTV. Full band HD AM radio will save the AM broadcast band, giving current AM broadcasters

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Small Market Guide

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the ability to sound like an FM station on the AM dial. This HD transformation would give a breath of life into an old geezer and provide a means for small market AM stations to compete with larger FM's. Another positive is that the AM station can now cover the same contours with one third the transmitter power due to digital capture of HD signals in HD receivers.

A new AM Digital Band would obsolete many receivers.

Move to TV, Channels 5 and 6

The Commission is also considering another radical proposal to just shift the entire AM group of stations to the vacated spectrum of former TV channels 2-6. Of this spectrum, the primary interest would be with channel 5 and 6 since these frequencies are close to the existing FM band (just below 88 MHz) in this country. This opportunity would allow the FCC to widen the FM dial making room for more stations, something that has strong support from broadcasters. Although changes in radio receivers would be necessary, this may not be that technologically difficult since countries outside the USA utilize an FM band that already goes down into these frequencies of the former TV channel 5 and 6. It may be as simple as a firmware updates to existing radio chips.

This exotic move would solve the long sought after "static" solution to AM – and of course would be FM, plus possibly HD. A move of this significance could be mandated all digital from day one. This move would of course render the existing AM Frequencies 540-1700 kHz vacant, but that is no different that the TV move leaving channel 2-6 empty. A lot of AM transmitters would become boat anchors but that becomes the cost of doing business.

AM Translators

On the back burner of the FCC stove is also a proposal that would allow AM owners to apply for an FM translator in their city of license. This would give the AM station static free fidelity to compete with other FM stations and solve the nighttime directional problem that has given the AM stations an unfair situation after dark. FM translators re-broadcasting AM stations would dramatically enhance both the service and future prospects of many AM radio stations. The translator proposal is viewed by many AM owners as an initial transition from the crisis. There are many legal and technical problems that must be sorted out before the translator idea can become fluid. Some of these include AM only ownership, contour matching and signal coverage, one license per AM station and issues with contour fill vs. non-fill in stations. There is also the commercial and non-commercial bridge to cross before the FCC can come forth with a report and order.

AM broadcasters were encouraged in 2013 by statements from the FCC Audio Division officials stating that an AM-only window for FM translator applications would be forthcoming by the "end of that year." Such an AM translator window was thought by the FCC's Audio Division to negate the need for more dramatic AM solutions. We are now well into 2015 without any indication that such a translator filing window will open, but Mr. Pai indicates that the FCC is making progress towards this transition window for AM translator applications.

FCC Commissioner Ajit Pai is a dominant influence in making the push to upgrade the AM dial at the FCC. He has said on numerous occasions that the AM issues are one of his top priorities. He is confident that a constructive solution to this age old problem can be found in the near future.

References: Santos, Rob, "The Problem with the U.S. AM Broadcast Band," CQ Magazine, April, 2015, p. 60-63. FCC Report and Order #217, US Gov. Printing Office, June, 2105.

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Service Guide Radio Equipment Products and Services

RADIO ROUNDUP

The Radio Guide Event Register

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Texas Association of Broadcsters (TAB)
August 5-6, 2015
Renaissance Austin Hotel
www.tab.org/convention-and-trade-show

Nebraska Broadcasters Association
August 11-12, 2015
Omaha, Nebraska
http://ne-ba.org/news_and_events-convention.asp

WBA Broadcasters Clinic
September 13-15, 2015
Madison Marriot West, Madision, Wisconsin
www.wi-broadcasters.org

Ohio Broadcast Engineering Conference
September 23, 2015
Columbus, Ohio
http://oab.org/engineering/obec/

NFOC 2015 Communications Conference *(was SBE 22)*
September 23-24, 2015
Tuning Stone Resort and Casino, Verona, New York
www.nfoc.org/broadcast.html

NAB Radio Show
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