

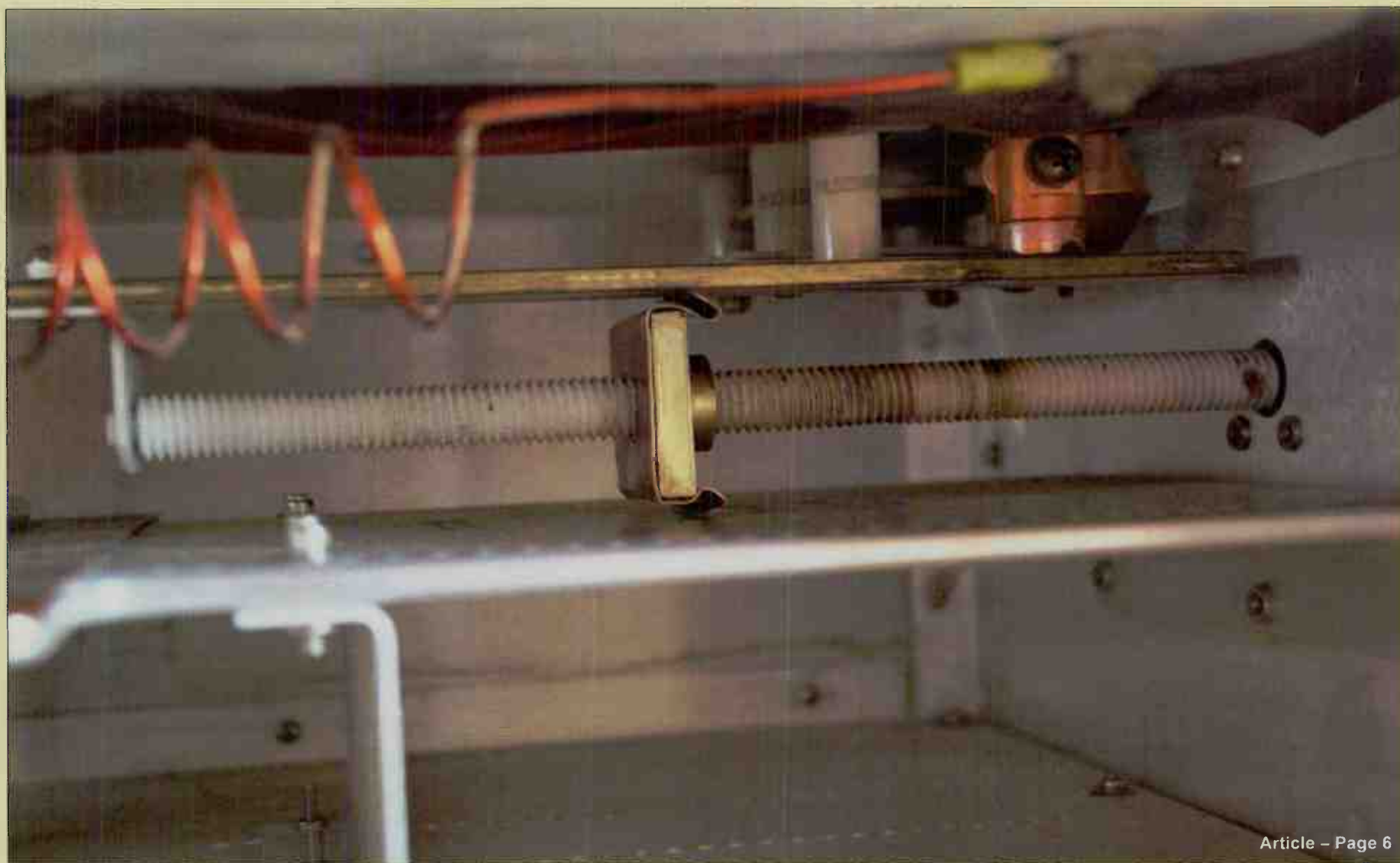
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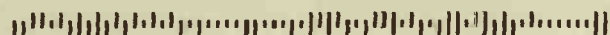
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March-April 2021 – Vol. 29, No. 2

A Little Bit of This ... A Little Bit of That



Article – Page 6



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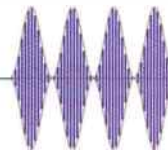
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Critical Content for Radio

Cover Story – by Scott Schmeling (page 6)

A Little Bit of This ... a Little Bit of That: "We, as Broadcast Engineers, are a resourceful bunch. Our resourcefulness is born of necessity. For example, when we have a transmitter down we do whatever it takes to get back on as soon as possible. We don't stop for lunch and the day doesn't end just because it's 5:00 o'clock. For example, if a part has burned out and we don't have a replacement, the first thing we do is look around to see what we can "MacGyver" together to get back on the air."

FCC Focus – by Gregg Skall (page 12)

Is Your Website Privacy Compatible: "There is a growing movement among the states to pass on-line privacy laws that require websites to warn visitors how the information they leave on the website, intentionally or not, can be used and how they can protect their privacy. These laws can expose the website owner to lawsuits and civil damages. Even if your state has not passed such a law, it is important to know what states have, as many of them will reach out to wherever their citizens visit on-line."

Tech Topics – by John Marcon (page 40)

Combiners in Solid State AM Transmitters: "Things changed a bit in the 70s. A firm from up north in Canada, called Nautel, built and sold a 2 kW solid state AM transmitter in 1974. Nautel was a relatively new player in those days but little did anybody know that they would be a big name later. Then in 1976, Harris (now Gates) introduced the MW-1 AM and, according to an old Harris brochure, it was "the world's first FCC type accepted" kW level AM solid-state transmitter. However, this transmitter is not a PDM and it used BJTs, not FETs. Apparently, FETs were not available back then."

TWART
THIS WEEK IN
RADIO TECH

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A Little Bit of This ... A Little Bit of That

Or, There's a Little MacGyver in All of Us

by Scott Schmeling

Happy Spring, everybody! I hope you're all staying healthy. Last Sunday I walked up to our church's front door as a couple of friends were entering. The *first* thing I said to them was, "Have you had your shots?" That seems to be one of the top topics these days. As I write this, I'll be getting my second shot this Thursday.

This issue I'm doing sort of a "potpourri" of items. Some repairs, some hints, and something to think about.

We, as Broadcast Engineers, are a resourceful bunch. Our resourcefulness is born of necessity. For example, when we have a transmitter down we do whatever it takes to get back on as soon as possible. We don't stop for lunch and the day doesn't end just because it's 5:00 o'clock. For example, if a part has burned out and we don't have a replacement, the first thing we do is look around to see what we can "MacGyver" together to get back on the air.

Case in point – some time ago we had a Harris HT-10 that we couldn't get to tune up properly. After opening the back of the cavity we could see the problem. The finger stock on the loading slider had burned off and was no longer making good contact.

The loading slider is a square piece of copper with finger stock on the top and bottom that slides between two metal surfaces. That copper piece is fastened to a thicker piece of brass with a threaded hole in the center. A piece of threaded nylon rod (or maybe it's Teflon, I'm not sure) goes through that hole. One end of the rod goes through the front of the transmitter and is coupled to a knob. As the knob is turned, the block with the finger stock "rides" back and forth, changing the loading. Needless to say, this is not a piece that is normally included in the spare parts kit.



Temporary Load Fingerstock

Looking around, we saw a piece of copper strap that was big enough to cut a replacement that could be put roughly in position – at least close enough to get us back on the air. We did, it worked, and a replacement was ordered the next morning. MacGyver would have been proud!

On another HT-10, there appeared to be some intermittent connection somewhere in the tuning or loading area of the PA. We could bring the transmitter up, but as we adjusted tuning and loading it would very suddenly drop completely off. We discovered as I "released my frustration" on the front panel, that gently slapping a certain area with the heel of my hand would bring it back on. The emergency fix? Using some red wire-marking tape, I put a RED X on the spot to "SLAP."

At least once, one of the announcers had to go out to the site because the transmitter had dropped off. You can imagine what they might have been thinking when I told them to look for the Red X and to slap it (not too hard) with the heel of their hand. And what they thought when it actually *worked!*

Sometimes a temporary repair becomes more long-term. We have an AM whose antenna is, quite literally, in a *swamp!* Actually, it's more of a slough, but we call it "The Swamp." When the station was built in 1946 it was farm land – now it's a wetland. The acidity of the water must be very high because this water literally *eats* copper strap!

One time, when the readings were all "wonky," we put on the waders and went out to the tower base where we found the water had eaten away part of the strap between the ATU and the tower base.

We weren't able to silver solder a piece back in, but we *did* have a Vice Grip! So we shined the copper as much as we could and clamped the Vice Grip down good and tight. When we fired the transmitter back up, readings fell right into place. We "found" that Vice Grip a few years later, just where we left it. At that time we *were* able to silver solder everything for a more permanent solution ... at least until the water eats the copper again.



Vice Grip on Copper Strap

Another time we had a Dolby Digital STL that was experiencing intermittent audio drops. I don't remember all the specifics, but I discovered that when I pressed on the shield covering of one of the circuit cards it stayed on. Again, Vice Grip to the rescue! I gently applied a Vice Grip to the cover and the circuit card and ... Voila! That Vice Grip remained in service until we replaced the STL.

I HATE MICE! I honestly don't know what God had in mind when he created them. At one of our AM sites, we have a Nautel ND-5 that has a rather large opening at the top where the coax connects. Over time, mice would go in through this opening and chew up wiring and do all sorts of damage. After replacing the damaged cables, I used some 3M 130C Linerless Rubber Tape to fasten some Hardware Cloth (coarse metal screening) to cover that opening. My plan is to replace the tape with aluminum strips, but for now the tape is working just fine and the Hardware Cloth is keeping the mice *out!*

Here's another use for that 3M 130C rubber tape. We had a leak in one of our FM transmission lines that

unfortunately let water in. Of course, gravity will cause the water to travel down the inside of the coax and settle at the low spot – where the line comes off the tower and heads toward the building. You can usually tell if you have water in your line by doing what I call a "Slosh Test." *Push* the line sideways then put your ear to the outer jacket. If there's water inside you'll hear it "sloshing around." That water is also going to cause a very high reflected power reading.



Mouse Deterrent

The quick fix (as much as I *hate* to do this) is to drill a small hole on the bottom side of the line at its lowest spot. **BE SURE THE TRANSMITTER IS OFF BEFORE YOU DO THIS!** If you imagine the corrugations of the outer conductor as "hills and valleys," drill on a "hill" because it's going to be easier to patch. Before you drill your hole, cut away some of the outer jacket. It will make it easier to drill on the hill – then be sure to patch that hole. I use several layers of the 103C and one or two hose clamps.



Draining Water from Helix

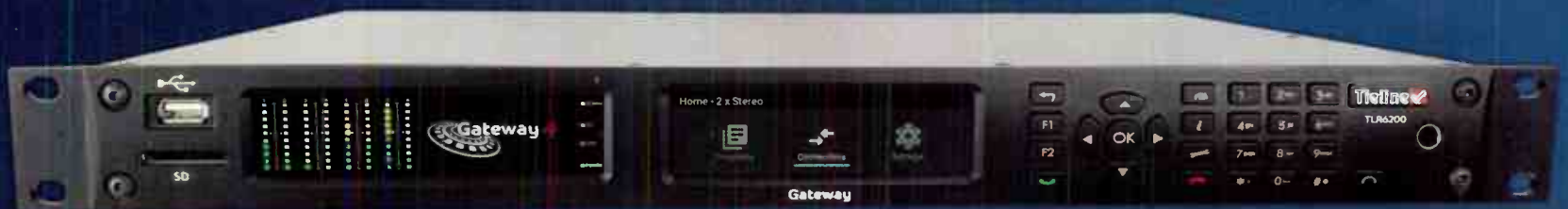
I want to mention one more thing – and this *may* be the most important of all. Most of my transmitter sites, like yours I'm sure, are out in the middle of nowhere. I've heard stories of other Engineers who stepped outside or went to their car or truck for something and ended up being locked out because their keys were in their jacket pocket – *inside* the building. A few years ago I started carrying a key to my van in my pants pocket. This proved invaluable a few weeks ago when I stopped at one of our sites. When I got out of the van to unlock and open the gate I unknowingly hit the lock button and didn't discover it until I walked back to get in. Yes, the engine was running – and my phone was *inside* the van. It would have been a long, cold walk into town if I didn't have that key in my pocket!

That's going to do it for now. Until next time ... stay positive, test *negative* – and Keep it between 90 and 105!

Scott Schmeling is the Chief Engineer for Minnesota Valley Broadcasting. He can be reached via email at scottschmeling@radiomankato.com

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Berliner: The Man Who Made Us Better

A Scientific Innovator and Discussion of Modern Microphones

by George Zahn

May 2021 marks a significant anniversary of the birth of Emile (Emil) Berliner who was born on May 20, 1851. His may not be a household name, but he is credited with improving design that eventually has made our studio microphones and turntables possible. The man born in Hanover, Germany would come to the U.S. in his teens and would eventually be tied to the development of the microphone, the lateral cut Gramophone phonograph, as well as music composition, and designs in aeronautics including airplane engines and a prototype helicopter in the early 1900s created with his son.

To borrow a slogan from BASF (“We Don’t Make the Products You Buy; We Make the Products You Buy Better”), Berliner didn’t invent his audio contributions that evolved into our microphones and turntables of today, but he was a catalyst who took early notions of audio transduction, and found creative and revolutionary ways to improve the model and increase viability.



Emile Berliner (May 20, 1851 – August 3, 1929)

For example, Berliner deduced ways to improve on the Edison cylinder from 1877 which stored audio on a hand cranked metal cylinder covered with a thin veil of tin foil. Berliner also looked at the 1857 patent of Frenchman Édouard-Léon Scott, who created a device known as the Phonograph. By the 1890s, Berliner was recording on horizontal recording medium discs made of hard rubber or metal.

Now Hear This

Maybe even more profound and even earlier in his prolific career, Berliner was looking at ways to transduce sound into audio for transmission. Alexander Graham Bell had created a rudimentary microphone in the mid 1870s with a moving armature. Bell had the system working in two directions. Shortly afterward, Bell was trying a liquid-based “transmitter” element using a form of variable contact to make audio from sound.

Berliner spent about six years working for Bell after the liquid microphone was designed and improved on it. He took a small steel ball and placed it against a metallic diaphragm that would move to sound. This carbon-button (or loose-contact transmitter as Berliner called it) microphone design was patented in 1876-77 at roughly the same time that Edison was filing for his own patent. Berliner would lose the patent war in 1892, but his design was adopted by Bell, who purchased the rights to Berliner’s creation for some \$50,000.

We always try to look forward in this column, but in this case, it’s good to glance back so we can better understand the way that microphones work today.

We’ll check some of the major microphone families, their pros and cons, and a timeline of how microphones have made their impact on broadcasting.

“Frequency” Asked Questions

As we strive for the best sound possible for our stations, it’s important to know the strengths and weaknesses of microphones that are the starting point of all of our talent “sound.” There may be no more contested debate among broadcast professionals than a preferred microphone. Each model of mic has its own strengths and frequency response, the fidelity across the frequency range that a microphone will reproduce sound. Less expensive microphones may often indicate a frequency response of 20Hz-19kHz, which really tells us nothing specific about fidelity.

Without a range of plus or minus a number of decibels over the range, we don’t know the quality of the microphones. For example, a better indication: a frequency response of 20Hz-19kHz +/- 2dB is a dependable microphone, meaning that the mic will reproduce that width of the spectrum with only a variation of no more than 4 dB (plus or minus 2 dB) difference in output of audio from bass to treble.

What affects frequency response? That can range anywhere from quality control to the type of element (the part of the microphone that actually transduces sound into audio). In general, the heavier the moving part of the element, the less likely it will be to reproduce higher frequencies as well as bass frequencies. The moving part of the microphone is in many ways analogous to our ear drum.

Sources including mynewmicrophone.com can give us a view of how the three big broadcast microphone families came about. These were all advancements on Berliner’s and Edison’s designs. They generally include the dynamic or moving coil family, the condenser family, and the ribbon family. The lower cost/lower fidelity carbon microphone was with us for a long time, and was a staple in telephone handsets will into the second half of the 20th Century, but was replaced in broadcasting circles fairly early.

“Family” Background

The first dynamic, condenser, and ribbon mics came into development in the late 1800s, but not commercially viable until the late 1920s and early 30s. Neumann was among the first makers of condenser microphones. The element includes two parallel charged plates, one in a fixed position and another that floats and acts as the diaphragm to move and react to sound. The floating plate is relatively light and excellent, as a rule, for moving quickly to high frequencies. While these mics are used more in music and voice recording studios, they can be used in broadcasting for everything from voice to live music.

Condenser microphones also tend to produce a very low audio levels compared to its counterpart. For that reason, the microphone has a built-in amplifier. In normal situations, the amplifier bring the microphone’s output to an audio level similar to dynamic or ribbon mics. In the instance of using the condenser microphone in a high sound pressure level environment, most higher end con-

denser mics will have a 10 dB pad that attenuates the audio between the element and the internal amplifier that prevent distortion within the microphones.

The condenser is a strong mic for a wide, flat frequency response in general. They do need external or battery power to operate as a charge needs to be applied to the two plates. Many consoles will provide phantom power to operate condenser microphones. If these microphones are used outdoors in incredibly high humidity conditions, moisture in the air can diminish the performance of the microphone.

The ribbon microphone is often associated with early broadcasting (imagine the vertical pill-shaped design of the 77DX from RCA). The ribbon mic element features a thin, usually corrugated, strip of metal suspended in a magnetic field within the microphone. The earliest models of the ribbon were very fragile since the ribbon attachment was very tenuously attached to allow for quick vibration of the ribbon.

The drawback of the ribbon microphones, at least in the early days, was the its fragility. Overall, these mics were known for their warmth and crispness that helped the early announcers of the halcyon days of broadcasting. Using them in vigorous use or high wind situations would be a problem.

“Wrapped Up” in Dynamics

The dynamic, or moving coil, microphone is among the most durable families, as a rule. The element is the heaviest of all the families, so perhaps not always the best choice for bright instruments. It is what the alternate title describes. The moving part is a diaphragm attached to a post with a metal coil wrapped around the post. It vibrates within a magnetic field, and creates audio.

I saved the dynamic microphone for last simply because it is the most prevalent microphone used in many studios. The dynamic microphone family tends to be among the lowest cost and most durable of the families. There is one tradeoff. The heavier element of the wrapped coil on the post, makes the element harder to move at high frequencies.

There are more to making calls about our microphones than just what the family of microphone that model is. A lower quality condenser microphone may be a worse choice than a decently made dynamic mic. Cost is a factor in “getting what you pay for.” Other critical considerations are the pickup pattern of the microphone. Each model generally has its designed pickup pattern, unidirectional (in varying options from standard cardioid to shotgun patterns), bidirectional (figure 8), and omnidirectional.

Some condenser microphones are made with two elements so that the microphone can exhibit different pickup patterns at the flip of a switch, a great option for different recording needs. Other key features can be found on microphones that are unidirectional, including a bass roll-off switch, which is used to reduce some bass exaggeration from proximity effect, which results from using the microphone very close to a sound source. That can be an advantage of working a unidirectional microphone close for announcers who need more bass “umph” in their delivery.

It’s a good thing to occasionally review the microphones in our studios. Consistency of microphone can help our sound in many cases, but some announcers may find themselves excelling on different microphones. The key is balancing that consistency and cost value of the microphone.

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: g Zahn@mkcommunities.org

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Transmitter Site

To Insulate or Not to Insulate

As the seasons change, those of us in snow country are beginning to prepare our transmitter sites for the onslaught of Old Man Winter.

For some of us, this year's winterization may take on a new twist.

Insulation and Heat or Air Conditioning

Many transmitter buildings are nothing more than wooden or concrete block shacks on mountain tops or in empty fields. Over the years, we may have depended on the heat generated by our tube transmitters to provide "heating" of the shack. This was usually adequate for us to get out of the frigid temperatures while performing preventative maintenance, but in most cases it was never as warm as it should be, to work in complete comfort. Nonetheless, we worked through the chills to get the job done.

Some of us have relied on portable electric heaters when the "box" was off the air and we were called in for the off-air emergency – transmitter off the air equaled no heat in the shack. What heat may have been left after the shut down quickly escaped through the unblocked nooks and crannies in the walls, or was replaced by the bitter cold that quickly found it's way in.

It's Time to Rethink Our Shacks

Today, one thing most often overlooked, when new solid state transmitters are installed, is transmitter building insulation and a source of adequate heat or air conditioning (AC) to keep the building at a temperature comfortable not only for our new transmitter but for us, when we arrive on site for maintenance or that emergency call.

In warmer climates the installation of a solid-state transmitter may trigger the need for AC to be installed. Our old tube monsters were more heat tolerant than their solid-state cousins. If you are in a warmer climate the same procedures for insulation hold true, only in your case we're talking cooling not heating.

Shop for the Right Unit

For convenience and expediency, some sort of electric heat should be installed. There are several types available at home centers or industrial supply houses. A unit designed to keep rooms at constant temperatures would be the preferred method vs. the smaller, exposed coil type, portable electric or flash heaters designed to quickly warm a small space. Luckily, for those who just need AC, even the most economical window units are designed for continuous duty.

Management May Think You're Crazy

More than likely, when you bring up the subject of insulation and heat or AC at the transmitter shack you will meet resistance from management because they don't have a clear understanding as to why it is needed now, when it wasn't needed in the past.

So, it is important that you have all your ducks in a row before meeting to discuss the need.

Meeting Prep

Go to the shack and make measurements of the walls and ceiling. Rather than estimating the project cost, take your measurements to a building supply store or home center. Discuss the project with the personnel at the contractor desk

or customer service. They will be glad to create an estimate for you. I would do this even if I were going to have the project done by a contractor or handy man. This way you know what the materials cost so you can be sure you're not being overcharged.

If you choose to do the project yourself you still may want to get an estimate or two from local contractors so you can show management how much you will save the station. Another option to consider would be to enlist the aid of the local high school or community college shop instructor. The instructor may take on the project as a teaching tool for the class. So you get free labor for the project and you can "supervise" vs. doing the labor yourself.

There may also be a tax credit the station can take advantage of for becoming more energy efficient by insulating the building. Check with an accountant on this.

When you meet with management you will have to help them understand how this project is now a vital necessity before the arrival of winter, if you're in cold country.

Half Empty or Half Full

In your research it is important to remember projects like this are a trade-off. The more you insulate, the lower any heating or cooling bill would be, but the higher the cost of the project. The less you insulate the higher the cost of heating/cooling bill, but the lower your project cost will be. The key here, however, is to get some insulation in place. Some is better than none at all, and more is better than less.

On one hand you need to keep the heat or cool in the building, on the other hand you're not insulating a living space so you probably won't need to use 2x6 construction and six inches of insulation rated at R-19.

Before You Start

Now that you have the green light, inspect your building. During the daytime, go inside, shut off any lights and allow your eyes to adjust to the darkness. You want to find any "light leaks" that may exist – make a note of where they are.



A crack found during a lights out inspection. This is an easy entrance for a field mouse and blowing cold air. The fix? A new door sweep cost \$5.

If you see light, you know that cold or hot air will enter here and, depending upon the leak's location and size, mice, snakes, rats or other critters will use the same place to come in from the weather. Remember, an adult Norwegian Rat, the most common here in the States, can squeeze it's body through a hole the size of a quarter.

You can imagine what size crack a field mouse can squeeze through.

Plug the Holes

You should start your insulation process by plugging these leaks. To keep out critters you could use a heavy metal mesh immediately against the wall and then use expanding foam insulation to plug them up, from both the inside and outside. If your leaks are around cables, steel wool will help protect from critters and expanding spray foam insulation will stop drafts.

With this step complete, you are now ready to begin the rest of the project.

Studs and Insulation

If you have a wooden building with open studs you're in luck because you only have to insulate in the existing wall cavities. With a concrete or block building, insulating walls can easily be constructed out of 2x4's. If you are doing it yourself, a quick visit to a home center or a web site like DIY.com will get you the information needed to properly construct a "stud wall."

Remember too, you'll need the proper anchors to attach the base plates, the headers, and the 2x4's across the top of your wall, to the floor and ceiling. Since your wall isn't a weight bearing or support wall you won't have to double either the header or the plate.



Most likely you will want to place your studs 16-inches on center (16 inches from the center of one stud to the center of the next stud) – standard width insulation is made to fit. In addition to the normal construction tools – power saw, hammer, level, square, and measuring tape – don't forget a good staple gun and lots of staples, to secure the insulation to your studs.

Here again, if you aren't sure, discuss the project with someone more knowledgeable.

Insulating is fun ... NOT!

From experience I suggest you wear a long sleeve shirt, gloves, goggles, a hat and a paper mask when you insulate. The last thing you need is to breathe in fiberglass fibers, which can cause damage to your lungs, sinuses and throat – or get a case of the itchy skin irritation because of exposure. A set of Tyvek coveralls would be great to keep fiberglass off your clothes as well.

Other safety and installation tips are available at your local home center, or you could go to an insulation manufacturer's web site for handy tips as well.

Sealing the Deal

Once the insulation is up, you'll need to finish the walls to help seal the cold out and to prevent insulation sag. Remember to insulate the ceiling as well, to prevent heat or cold loss there. All your other efforts will be a waste if you leave the ceiling untouched. – Radio Guide

Social Distancing

SINCE 2015

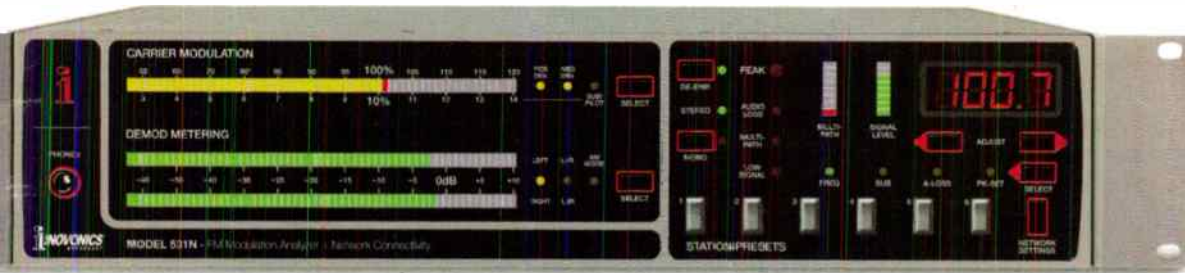
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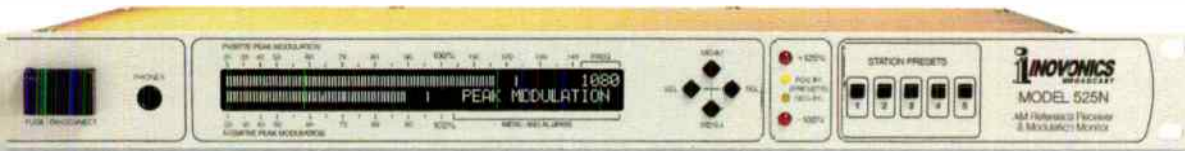


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Is Your Website Privacy Compliant?

Privacy in the Age of the Global Internet

by Gregg P. Skall, Member – Telecommunications Law Professionals PLLC

In the January-February *FCC Focus* article, I focused on your websites and the importance of ADA compliance on-line. As important as that may be, an even more important consideration is assuring that your website is in privacy compliance. There is a growing movement among the states to pass on-line privacy laws that require websites to warn visitors how the information they leave on the website, intentionally or not, can be used and how they can protect their privacy. These laws can expose the website owner to lawsuits and civil damages. Even if your state has not passed such a law, it is important to know what states have, as many of them will reach out to wherever their citizens visit on-line.

Federal Privacy Enforcement: There is no federal scheme regulating privacy on the Internet in the United States. While the Federal Government has passed several laws, which protect privacy in specific areas, the closest the Federal Government comes to regulating Internet privacy are enforcement actions taken by the Federal Trade Commission under section 5 of the Federal Trade Commission Act of 1914, which prohibits unfair or deceptive trade practices. The FTC utilizes section 5 to prosecute a company when it violates its posted privacy policy, such as selling a user's data when the privacy policy states the company will not do so.

State Privacy Law: Due to the dearth of federal regulation, some states have begun to enact Internet privacy laws. The most sweeping legislation so far is the California Consumer Privacy Act of 2018 ("CCPA"), which seems to serve as a model of sorts for other states. The CCPA grants California residents four protections with regard to their data on the Internet: (1) the Right to Know, (2) the Right to Delete, (3) the Right to Opt-Out of Sale, and (4) the Right to Non-Discrimination. Notably, the CCPA has the potential to hold businesses anywhere in the world liable, if that business meets certain revenue or collection limits. Should a business fall under the purview of the CCPA, then the business must have a privacy policy on its website that explains what information the website collects, how it is collected, how it is used, how it is retained and for how long, what rights the CCPA grants, and how to exercise those rights. In addition, the CCPA requires that businesses provide visitors to their websites with information on how to "opt-out" or "unsubscribe" from having their information collected or used and, if the data is sold, at the time of collection, allow the visitor to request that their information not be sold.

While the CCPA only protects California residents, it could affect businesses that collect California residents' information through the Internet, and the trend among states is to follow that model. For example, in March of this year, Virginia passed its own Internet privacy law, the Virginia Consumer Data Protection Act ("Virginia CDPA"), which grants Virginia residents similar rights and protections as the CCPA. The Virginia CDPA will not go into effect until January 1, 2023, but, like the CCPA, it can affect non-Virginian businesses if the business meets certain collection or revenue requirements. Such businesses must post a privacy policy, with specific information, on their website. One notable difference is that the

Virginia CDPA requires that businesses obtain affirmative consent prior to collecting a visitor's information, as opposed to merely offering an "opt-out" option. Nebraska has also passed an Internet privacy law, which requires businesses subject to the act to post a privacy policy. Though only three states have passed Internet privacy laws, over eleven states, including states like Texas, Utah, and Florida, have introduced Internet privacy bills in their state legislatures in the last year, several of which mirrored the CCPA, and at least five others seem to have Internet privacy on their agendas in 2021. As no state's Internet privacy laws are identical, it is important to keep all these states in mind when designing your website.

International Privacy Law: International laws can also apply to U.S. businesses. The most sweeping international Internet privacy law is the European Union's General Data Protection Regulation ("GDPR"). Like the CCPA, it grants EU citizens specific rights with respect to their on-line data and requires that websites visited by EU citizens have privacy policies explaining what information they collect, how its collected, how it is used, how it is stored, what rights EU citizens have, and how EU citizens can utilize their rights, among other things. Unlike the CCPA, a business is subject to the GDPR if just one EU citizen visits its website. Another notable difference is that the GDPR requires website owners obtain affirmative consent from visitors to the site prior to collecting the visitor's information, rather than offering a simple opt-out option.

What to do? Every broadcaster webpage can easily attract visitors from across the country, and even around the world. To protect yourself, and as a matter of good policy, you should consider adopting a well provisioned Internet Privacy Policy, which can be accessed from every page on your site. Even if your state has not enacted Internet privacy laws, the trend in many states to adopt a law that is as expansive as the CCPA suggests that a website's policy should comply with the most restrictive state laws. If you adopt something less, revisiting it for future edits or modifications will require continued vigilance. You should consider including the following in your privacy policy:

Personal Information, Log Data, and Cookies etc.: Internet privacy laws require that a website's privacy policy explain what type of information is collected, how it is collected, and how it is used by the website owner or operator. To comply, a privacy policy should describe any information that you collect (e.g., Personal Information, Log Data, Cookies, etc.), explain what each of these pieces of information is, and how it is used. Avoid ambiguous terms. Will it be used for marketing, promotions, or shared with business partners or advertisers? Is the information ever sold? Is the Log Data used to administer the site or used in the aggregate? Are Cookies used to authenticate information or to optimize user experience? Is any of the information you collect ever shared with third parties, and if so what sorts of third parties and for what purpose? The explanations need not list every type of data or use but should provide the general categories of what information is collected and

how the station uses the information, to alert visitors of what they can expect if they provide Personal Information, Log Data, or access to Cookies.

Opt-Out: Most Internet privacy laws require privacy policies to include a description of how a visitor can "opt-out;" a response to consumer complaints of unwanted emails. Your privacy policy should, provide a clear explanation for how users can opt-out of receiving future emails, mailings, calls, etc. or modify their information. This may be done in the "Contact Us" section, or by describing any method the visitor may use to request that you remove their information.

Sale of Data: You should also include a clause stating whether the station sells or does not sell user information. Most Internet privacy laws are concerned with protecting visitors from having their email address end up on a listserv, which then spams the visitor with emails that were never requested or anticipated. If you do not sell the information collected on your website, a clear statement stating that would be helpful against the more extreme Internet privacy laws.

Links: If the website includes links to sites that are not operated by the station, you should consider including an appropriate warning, such as: "If you click on a third-party link, you will be directed to that third party's site. We strongly advise you to review the Privacy Policy of every site you visit. We have no control over, and assume no responsibility for the content, privacy policies or practices of any third-party sites or services whose links may be posted on our webpage."

Children's Privacy: In the United States, the Children's On-line Privacy Protection Act prohibits the collection, use, or distribution of information of children under the age of 13. As most broadcasters do not target such a demographic, you should consider a statement such as: "Our website is not designed to address anyone under the age of 18 ("Children"). We do not knowingly collect personally identifiable information from children under 18. If we discover that a child under 18 has provided us with Personal Information, we will permanently delete such information from our servers immediately. If you are a parent or guardian and you are aware that your child has provided us with Personal Information, please contact us."

Compliance with Laws: Make certain to disclose that the station will disclose visitor Personal Information where required to do so by law or subpoena.

Changes to Privacy Policy: Include a statement that the station may update its Privacy Policy from time to time without prior notice, which will be effective when posted. Advise visitors to review your Privacy Policy periodically for any changes.

Contact Us: Include a section describing how visitors can contact you with questions about your website or privacy policy. If they should use this information to opt-out, provide a clear statement that they should do so.

This article is only a brief outline of the most important considerations to be included in a website privacy statement. Proper consultation with your legal professional is always important to assure proper coverage and adequate protection.

This column is provided for general information purposes only and should not be relied upon as legal advice pertaining to any specific factual situation. Legal decisions should be made only after proper consultation with a legal professional of your choosing.

Gregg Skall is a member of the law firm of Telecommunications Law Professionals PLLC. He frequently lectures on FCC rules and regulations, represents several state broadcaster associations and individual broadcasters and other parties before the FCC.

The astonishing new **Bluetooth Audio Gadget**. So much better than taping your phone to the mic.



There are plenty of ways a smartphone could be useful on air. Playing recorded audio, voice clips or music, for instance. How about using a SIP client as a codec? Or Skype or Zoom or social media sound? And of course, putting callers on the air. If only there was a professional bidirectional audio interface for cell phones...

Problem solved. The Bluetooth Audio Gadget makes it easy to put a smartphone on the air. Just pair your phone, and the Bluetooth Audio Gadget automatically negotiates the optimal codec algorithm (usually APT-X for Android, AAC for iPhone). Balanced audio I/O connects the Gadget to your console. The sound quality is amazing. And the Bluetooth Audio Gadget is bi-directional, so you can even send mix-minus to your caller.

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World Radio History

Intermod: A Virus Coming to a Tower Near You

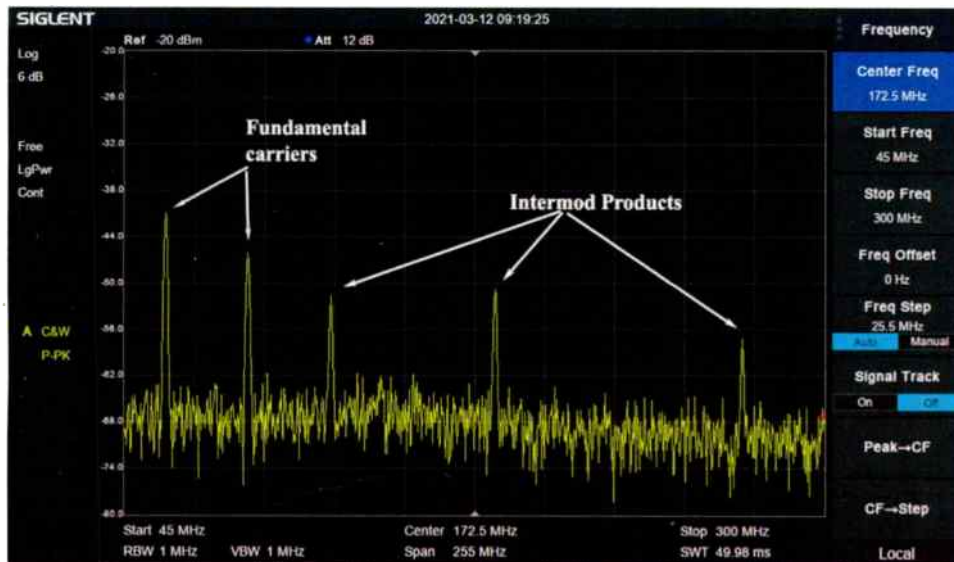
by Roger Paskvan

Well, it wasn't even three months since I wrote about a similar topic for those small market stations that rent out tower space. ("Good Engineering Practices Can Save Tower Site Problems," *Radio Guide*. November-December, 2020.

I received a call from a client that read that article and was having some serious problems keeping customers on their tower in a town close to the Canadian border. Arriving at the tower site, everything looked good from the outside but the instruments told a different story. I was told that all the problems seemed to start after they put a hospital paging system on the tower. This is where it begins:

So let's take a brief look into this radio virus called intermod. Intermod is defined by Wikipedia as: *The mixing of two or more different frequencies, caused by nonlinearities in a radio system. The intermodulation between frequencies will form additional components at frequencies that are not just at harmonic frequencies (multiples) but also at the sum and difference frequencies of the original two or more frequencies and at sums and differences of multiples of those frequencies.*

Now that's a real mouthful and rightfully so. What it means in simple radio talk is two or more radio stations (A and B) transmitting on the same tower find a place where dissimilar metals (like Copper/Aluminum) bolted to your tower, cause frequency mixing producing multiple mathematical outcomes. These outcomes are referred to as mix products from such things as harmonics (the 2x, 3x, 4x etc. times the station frequency) producing new frequencies around your tower site that now can bother other tower users. (See Figure Below)



Another serious place for this to happen is within the components of the user's radio system. Radio signals A, and B come down a renter's antenna, mix together inside their transmitter, then go back out that antenna and interfere with other users on that tower. Yes, these other users will be hearing strange signals on their radio receivers known as intermod interference. The mix products can even be much more complex such as 2A-B; 2A+B, 3B-A etc., the permutations can just go on. In fact without a computer program to do all these calculations, it is almost impossible to isolate what is happening. Each site is uniquely different, factors such as the age of the tower, rust, and how many radio customers are on that same tower, play a big role. (Painting a tower to prevent rust does more than keep it pretty.)

So if you have this virus called intermod, there are several computer programs that can do the math. Some of the more popular ones are: Intermod Analysis System, Intermod Assist, Intermod Calculator, and even the old standby Comshop that

runs in XP on any virtual PC. All the frequencies in use on your tower are loaded into this program and the combinations are calculated and displayed. The program can predict the new generated frequencies and what tower customers are going to be affected by these new frequencies. The program performs the clinical diagnosis.

Once you have identified the hits and what frequencies are causing the intermod, now you can look at the individual radio systems that make up these combinations. To further complicate things, tower renters with intermittent transmit, such as paging systems, two way radios etc. make this process much harder. For example, a third order hit may need frequency A, plus frequency B, plus paging, and must be transmitting at the same time for the new mix product to occur. This gives realism to the often heard complaint; I only hear the noise once in a while or during the midday. Broadcast stations are the easiest to locate since they are always transmitting and the mixes constantly occur. Two way radio stations that are on and off just add complications to the location fun.

Once you have figured out the combinations that are causing the intermod to occur, it's now a matter of shutting things down, one at a time, to see if the problem goes away. It usually does, but that is not the solution. Yes, you can order the offender off your tower – problem solved. You basically eliminated a key component to the mix equation. That particular intermod mix cannot occur anymore. Usually you have to work with the lease customer and/or their technical personnel to figure out a solution that allows them to be on the tower so you can continue receiving rent.

The solution to any intermod problem is to eliminate one of the mix components or the place that the actual mixing is occurring. As I said earlier, this could be either on the tower involving dissimilar metal rectification thus causing signals to mix or inside one of the offender's transmitters, re-radiating back through their antenna. If the mix is on the physical tower, it may be very difficult to locate. A tower climber can check for loose hardware and rusted areas to hopefully

locate the spot. Sometimes, moving the customer's antenna up or down on the tower can fix the problem. If your tower is poorly maintained, bolts are loose, and everything is rusty, it may be a lost cause to find the outside mix. In this case, removing the offending frequency (rental customer) from your tower may be the only practical solution before you lose all your rental customers. Cleaning and painting your tower on a regular basis may be long overdue.

If the mix is occurring in the customer's radio equipment, that is an easy fix. We just need to identify the offending user and stop the frequency from getting into the customers equipment so the mix cannot occur and re-radiate to cause harm. The weapon of choice here is usually a band pass filter installed in series with the renter's antenna. The band pass filter is tuned to the customers channel and only passes that one frequency to or from the antenna. If any other frequencies come into the filter, they are eliminated, therefore taking a member out of the mix equation, thus preventing the mix from occurring. A band pass

filter not only allows one frequency to pass, but stops all harmonics from re-radiating out of each antenna location. In stubborn cases, a magnetic device called a circulator can be installed in addition to the band pass filter to further suppress unwanted mix products. The circulator only allows radio energy of a particular frequency to travel in one direction, thus stopping the path for outside frequencies to come into the customer's equipment and mix.



As I previously preached in my November *Radio Guide* article, every user on your tower should have a mandatory band pass filter on their radio system. It is just plain good engineering practice on a multiuser tower site to keep things clean. For two-way users, the cost of this filtering equipment is minimal. For the small market broadcaster running some high power, you're going to spend \$12-20,000 for a large band pass cavity filter. The fact that your radio station is running high power just impacts the mixing problem at a greater level. High power radio frequencies can do all kinds of funny things, causing mixes to occur in the strangest places. My most remembered story was this lady that lived across the street from our new AM radio station. She called the station and told us that she can hear music and talking coming out of her kitchen sink drain. It sounds so funny, but she said it is loud and clear and talks all day. When I went to her residence, sure enough there was music coming out of her kitchen sink drain just like a speaker. It was a classic case of the radio station being rectified by two dissimilar metals in the garbage disposal below the sink drain. The pipe was iron and the disposal was copper. Grounding the drain pipe cured the problem but I never forgot it.

So call this article an introduction to this virus called intermod. The vaccine is mandatory filtering on all tower users' equipment. I don't expect small market tower owners to be able to isolate and fix all their own intermod headaches but a general knowledge of the subject always helps. May I suggest a professional radio consultant or working with your local two-way dealer in your area to resolve your intermod tower problems.

To conclude the original story of the client up north, the intermod mix ended up being a sum addition of their FM radio station mixing with an on/off paging carrier that ended up intermittently wiping out the local sheriff's radio, all on the same radio station tower.

Luckily, the radio station had a band pass filter on its antenna. I added filters on the paging transmitter and the sheriff's radio system. The two offenders could no longer mix and everyone is now happy on that tower.

Many small market owners neglect the tower site, since it is usually off the beaten path and in the woods. If you're going to rent to other tower users, make sure each and every customer of yours has a band pass filter on their antenna. Also, keep your tower maintained, painted and in good condition.

Roger Paskvan is a Professor of Mass Communications at Bemidji State University, Bemidji, MN. You may contact him at: rpaskvan@bemidjistate.edu

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The Linux Connection, Etc!

Linux, Servers, Virtual Machines, and "Engineering Stuff"

by Tommy Gray CPBE CBNE

More Neat Linux Stuff

This time I have several things to tell you about that will stir your interest no doubt. These are meant to add additional "Candy" to your Linux Experience as an engineer. Hopefully by now, if you have been following my articles for the last year or so, you have a working Linux Mint Cinnamon (LMC) computer to work with. This time I am going to talk about a few things. First you may remember from last issue (Jan/Feb-21) time I was telling you about a very nice and powerful little VNA (Vector Network Analyzer) I found and also a small Spectrum Analyzer. I will show you some Linux software to enhance the operation of these little jewels and add additional versatility to them. As always, it is "free," no strings attached! Another thing I want to tell you about is a program that is in the Software Manager of LMC that will allow you to run your old DOS programs on your Linux machine.

First, Software for the NanoVNA

I mentioned last time that I purchased the NanoVNA SAA-2N VNA. It cost me just a shade over \$100 including shipping. I got this one instead of the others that are out there for a little over \$50 (yep, that is correct), because the smaller ones had a smaller screen and had SMA connectors. This one is also Version 2, which is a better option in my opinion. Now I don't know about you, but personally I am not about to take SMA connectors into a transmitter site! Mine has "N" connectors.

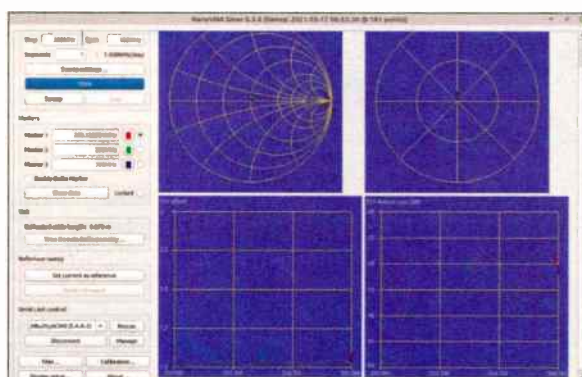
Free Software

The first software I tried, and the one that has the most versatility, is a program called "NanoVNA-Saver." I suggest that you first do a little reading about the NanoVNA from the "Horses Mouth" so to speak. There is a website I recommend you start with for your V2 at <https://nanorfe.com/nanovna-v2.html>. Don't go to other sites until you have been completely through this one, as it is the most comprehensive and has the most useful information. Now there is something you need to know here. These software files run under Python. I will talk about that later as it is a very powerful cross-platform development option for someone wanting to get into powerful programming in a way that you can easily start from scratch. Once you have read up a little, there is a link in the side menu there for the NanoVNA-Saver software.

Now the options there are not really easy to follow for someone without some programming experience. I was a programmer for years so it was not hard for me, but you will want to spend a lot of time reading up and watching Youtube videos regardless. There are a ton of very useful videos out there that will ease your learning curve for both the software and the analyzer. Saver is extremely versatile. One software option can also run under Windows (Boo Hiss!). Look that one up for yourself. Next you can find a picture of the NanoVNA-Saver software. Keep in mind that when you add the software to the analyzer you have opened up a whole new world of capability, as there are things you can do with the software that you cannot do with the standalone analyzer (increased measurement points, etc).

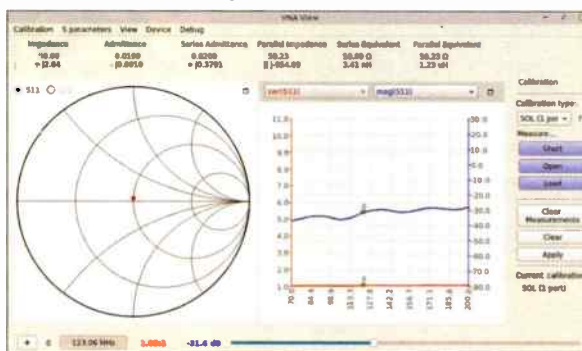
NanoVNA-Saver Software

This image is with a 50 Ohm load connected to the unit as that was all I had in the shop to use at the time. It is also not calibrated but even without calibration it is close. One thing to remember. *Never* do measurements until you have calibrated your analyzer with a Cal set. Fortunately the NanoVNA-SAA-2N comes with a very nice Cal set. Note that the screen can be configured any way you want it and can show any or all of the available measurement types in the unit – and there are many. I just dropped four on the screen to show what it could look like.



NanoVNAQT Software

In the image below, the same load is connected but I used a calibration from a transmitter site I was at earlier in the week, so it is off slightly. With a good calibration, the measurements are very accurate.



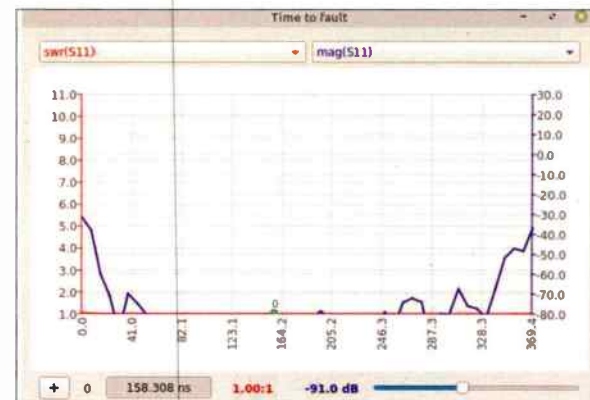
Distance/Time to Fault

One handy feature of both software packages is the DTF function as I call it. It can tell you how long a piece of coax is, tell you where a fault in a line is, and can be used for additional functions. The image in the next column is a picture of the "Time to Fault" screen. It will show you time in Nanoseconds which are easy to convert to feet using a simple formula. The slider at the bottom of the screen will move a marker along the display until it reaches the fault point and from that you can determine where a coax is bad. As you move the marker, the value changes to follow your marker and displays the location in the box to the left of the slider.

Time to Fault Screen

I would suggest reading everything you can find on both the NanoVNA and the TinySA (spectrum analyzer) I mentioned in the Jan/Feb-21 issue. There are also a ton of tutorials on Youtube and other places on the Internet that

help in learning how to use your units. I think I have probably given you enough to work on for now – more to come in later issues. As I mentioned, these software packages are for your Linux Mint Computer, but there are other versions available for Microsoft products and I think for MAC as well. Oh, did I mention there is also an Android app for your Android devices? Check it out.



DOS Programs and Applications

Just when you thought DOS was history, Linux comes to the rescue. Recently I was looking at some of my old DOS based engineering programs I used to use and love, and was wishing there was a way to run them under Linux. Well of course there is WINE for some Windows programs but a lot of our favorite DOS based apps and games are no longer able to be run and have been resigned to a space in the storeroom or trashcan. Save your DOS programs folks!

In the LMC software manager there is a program some of you may already be familiar with called "DOSBOX." Once you install it and run it, you can mount a "C" drive with a simple command and you can then run your DOS programs in it, on the old familiar black and white DOS screen. I remembered that I had run batch files to start most of my old software so I pulled out my favorite old engineering utility called RFS, put out by RF Specialties, and viola, it ran perfectly in DOSBOX on my Linux Mint Cinnamon computer.

If you have been around for a while you remember creating batch files. I always created one I called "menu.bat." That way all I had to do was to put it in my autoexec.bat file and it would give me easy access to all my favorites. Well, DOSBOX also has an autoexec section in its configuration file where you can do everything you need. I added a line to automatically mount a "C" drive, which is actually a folder on the desktop of my LMC computer called DOSPROGS – inside it is a folder for each program. In root of the "C" drive I have a "menu".bat that is called in the autoexec, as well as batch files I named "1.bat", "2.bat", etc. Each one is a startup script for a particular program.

Now I realize that there are ways to code a menu script, but to me this was "cheap and dirty" so to speak. To run a program I simply select a menu option by number and hit enter. From there the individual batch file starts the program and when I exit the program, it takes me right back to a clean screen with a menu. The menu is simply a text file that is called in the menu.bat batch file.

I am out of space, so next time I will give you example batch files for DOSBOX, and links to some of the old programs that are still around.

Until Next Time!

Tommy Gray is a semi-retired veteran broadcast engineer currently staying busy doing Engineering and IT in the gulf south, through "Broadcast Engineering & Technology LLC", a Louisiana based Consulting and Contract Engineering Firm serving the US. www.BEandT.com

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World Radio History

Flame Out!

by Steve Callahan

Recently, I had the opportunity to try some new technology that is really old technology but, in reality, is actually a blend of the old and new technologies.

A cellular telephone carrier rented some space on an AM tower in an area where their coverage needed some improvement. This project took over a year from the first meeting to actually turning the cell site on. That delay was due to it being winter in New England and all the delays and problems caused by Covid during 2020.



Cell-site Radios on Tower

The usual characters came to the initial meeting at the tower site. There were consultants, project managers, representatives of the cell carrier, subcontractors ... and me. They didn't have a clue as to how they were going to utilize the well-placed tower as a cell site and still have the AM tower, which was part of a two tower directional array, operate within the parameters of its FCC license.

I had recently read a paper from Dr. Bobby Cox at Kintronics that explained how they utilized an inductor made from a hybrid cable to get the necessary DC across the tower base with little or no effect on the tower itself. The collective minds thought that would be a good solution. I contacted Kintronics and if we sent them the cable and the required horizontal and vertical cable lengths, they would custom-build an inductor box – or what we started calling the iso-box.

The anatomy of a cell installation has changed radically over the past few years. Gone are the days when they put very expensive concrete shelters on site that required multiple runs of coaxial cables up to their sector antennas on the tower. In the good old days there were racks of equipment and racks of power supplies and battery banks in the concrete shelters. Today, they use weather-tight racks that have heaters and air conditioning built in and another adjacent weatherproof rack with their backup batteries.

Most importantly, they don't use coax to interconnect anymore. To eliminate the racks of radios in the shelters, the radio heads have moved to the tower and are located right behind the antennas. This means that they can use fiber to connect their modems in the waterproof shelter to the radio heads on the tower. This was good

news to me because I wasn't looking forward to having six isocouplers clustered at the base of this tower and the impact that would have on the tower's base impedance tuning. Fiber across the base of a hot AM tower would work just fine ... except that the new hybrid cable, along with multiple fiber strands, also had six copper pairs to transfer the necessary DC power to the radio heads on the tower. Those copper pairs just couldn't bridge across the hot tower base.

The tower crew did some very careful measurements of the cable run needed from their equipment cabinets near the street to where the iso box would be located at the base of the tower. The crew then did very careful measurements from the iso-box at the base of the tower to the altitude on the tower where the radio heads would be mounted. The measurements had to be ultra precise because the hybrid cable came in one continuous piece with no breaks or connectors except on the ends. The cable is also expensive enough not to make a mistake at this point.

It took several months to get the iso-box on site but, in the meantime, the subcontractor was getting the concrete pads for the two weatherproof boxes ready. They had to locate the concrete pads far enough away from the directional array so they wouldn't dig up any of the ground system. It was also beneficial to be close to commercial power and fiber connections on the utility pole at the street.



Kintronics Isolation Box

The plan was to mount the iso-box on a concrete "floating slab" just a few feet from the tower which would not require any digging up of the ground system. The tower crew heeded my advice and ran the vertical portion of the hybrid cable up the inside of the tower. Tower crews generally hate to do this and especially because this hybrid cable was approximate two inches across and is relatively inflexible. However, going inside the tower cuts down on windloading and makes tower painting in the future much more effective. It also looks better than having a tied bundle of cables running up the outside on a tower leg.

The radio heads went up on the tower relatively easily and the tower crew did a good job of running the vertical hybrid cable up the inside of the tower and

running the horizontal hybrid cable back to their equipment shelters by sharing the radio station's existing above ground cable run

The iso-box did come tuned for the station's frequency and tower height, but it also came with a variable vacuum capacitor to ground, to provide a way to fine tune the tower's parameters, back in line with what we started with, before the radio head ad hybrid cable installation on the tower.

Up to this point, everything was going smoothly despite the impact of weather and Covid. However, I visited the site one day and saw that the tower crew hadn't used any of the three grounding points provided by Kintronics to tie the iso-box into the station's ground, but they had just driven a common copper ground rod in the ground by the iso-box's leg and clamped a piece of green, #10 ground wire from the iso-box's leg to the ground rod, ignoring the copper strap on the tower base just two feet away. I explained the science of RF grounding and a piece of copper ground strap was quickly acquired and soldered to the station's ground strap and connected to the convenient strap connections on the iso-box.

One day, a neighbor mentioned that he saw sparks and flames at the base of the tower and then I noticed a rather ugly burn in the hybrid cable. It seems the tower crew had clamped the hot side of the hybrid cable to a convenient piece of tower lighting conduit which just happened to be at ground potential. They had clamped the hybrid very tight to the conduit and my best guess is that the 5 kilowatts of RF on the inner shield of the hybrid cable arced through the thin plastic cover insulation to the ground and then burned, until it burned itself out. The damage was limited to just the area where the clamp was on the hybrid cable.



Burned, and Now Spliced Cable

Remember, this is hundreds of feet of continuous cable, so the contractor elected to open up the burn and see what was left. Fortunately, the fibers were all right and the DC pairs needed splicing – and then a whole lot of tape and sealant was needed to wrap it up.

Next, I opened up the iso-box and found that all five of the porcelain insulators were broken. They were either broken in transit or someone had torqued stainless steel screws down into porcelain threads. Fortunately, a recent upgrade of the station's phasor yielded some surplus insulators that replaced the broken ones.

Tune up took about an hour and now the station's parameters are back and the cell site is ready to turn on. All in all, an interesting project.

Steve Callahan, CBRE, AMD, is a member of the engineering staff at Entercom Boston. Email at: wvbf1530@yahoo.com

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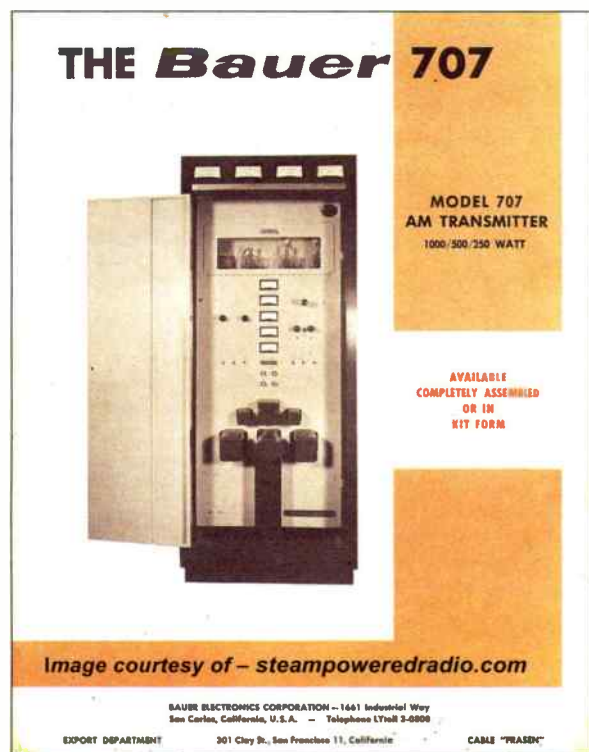


Transmitter Topics

Remembering the Bauer FB 5000J and Others

by Michael Bradford

This past Monday I was discussing the exceptional Bauer line of AM transmitters during our weekly engineers' coffee gathering, going all the way back to the late 1940s. Those were the years when Fritz Bauer was literally making small transmitters in his garage. Back in those days, Class IV AM stations were limited to 250 Watts and likely covered a single town and small surrounding community. Then in 1960, the FCC abandoned the Class IV power range and introduced the Class C power range of 1,000 Watts, theoretically doubling daytime coverage. Consulting engineer and Bauer's friend, Bob Hammet, suggested that he, Fritz, Paul Gregg and Ed Edison form a new company and build 1,000 Watt transmitters full-time. Together, they designed a robust yet simple 1 kW AM transmitter in anticipation of what they believed would be a nation-wide demand for 1,000 Watt transmitters.



This model was known at the Bauer 707 and made its debut at the 1960 NAB show. It was an instant hit – the 707 used tubes you could find at your local radio/TV repair shop and all the power tubes were 4-400s. The feature that made them even more desirable was that you could buy the transmitter in “kit” form for under \$3,500. You got the same chassis, transformers, wiring harness and extensive metering as a 707 built at the Bauer plant, but shipped in kit-form directly to your station. Engineers loved the kits; working carefully, you could build one in about two weeks.

When done, an engineer from Bauer would travel to your site, check every circuit and confirm FCC compliant operation. Only then would you get the official FCC nametag affixed. Because the engineer had built the transmitter, he had first-hand knowledge of every tube socket, every meter, every wiring harness and every connection. Back then, the FCC required a station's engineer to “camp out” at the transmitter site, so they could often build one while on-duty, saving the station owner extra hours of labor time.

The first Bauer transmitter I ever laid eyes on was at WCCW back in 1961 and it was a 5 kW model FB-5000J. It was the first commercially produced AM transmitter to use solid-state rectifiers for the 12-phase HV power supply, with solid-state plug-in rectifiers for the modulation, screen and oscillator supplies. It was clean, easy to work on and it sounded great on the air. This was back in the days when the FCC required annual Proof of Performance tests on all transmitters.



That Bauer FB 5000J met and surpassed every requirement for noise, distortion and audio bandwidth. You could switch the studio monitor between “console” output and “off-air” output and hear no difference. One day in the late 60s, I heard a low-level audio tone underneath the programming and was having difficulty figuring where that tone was being generated in the transmitter. Then-chief engineer, L.D. Greilick, set up a little test jig on his bench with a B&W audio oscillator, a small AM radio and two headphones. He told me to take a “long breath” while broadcasting the weather forecast so he could isolate the tone's frequency by heterodyning it with the oscillator. We determined the frequency was coming from somewhere in a 12-phase DC power supply circuit.

As WCCW was a day-timer on 1310 kHz, sharing that frequency with WKNR in Detroit, we signed off at sunset and headed out to the shack. Circuit searching found a little auxiliary micro-switch mounted on a HV contactor that had failed – that little switch controlled filter circuits and without it, no audio filtering occurred. A trip to Fitzpatrick Electric in Traverse City produced a replacement switch and, after midnight, we turned the transmitter on for a test and no tone was present.

The next time I ran into a Bauer transmitter was at WFYC, 990 kHz, in Ypsilanti, Michigan. This transmitter was a full 10 kW model and filled the whole room. You had to remove the doors to perform maintenance as there wasn't enough room to fully open them. I worked on the

phone with Bauer's Paul Greg to convert that transmitter to AM Stereo. The station was sold to Tom Monaghan of Ave Maria Radio in Ann Arbor, after undergoing a massive build-out to include Kintronic phasing and coupling equipment, new towers and a whole new ground system. That 10 kW Bauer has long since been replaced but back in the late 1980s you could still call the Bauer Transmitter Company and talk with Paul Greg. He knew these transmitters inside and out and his help was always just a phone-call away. If you needed a part he didn't have in stock, he would direct you to the manufacturer.

In a previous article, I mentioned Electro Voice speakers and microphones, which, at the time, were made in Buchanan, Michigan. Well, here it is 2021 and the beloved EV 635A microphone is a healthy 55 years old. The original 635 was intended for stand-mounting only and was difficult to use in the field. The 635A was for hand-held as well as stand mounting and thousands were sold all

over the world. Many engineers worried that the 635A might disappear when Bosch bought EV but the EV division had no plans to stop making the 635A. A slightly longer version was introduced that TV reporters had requested, along with a matt black model – but you can still buy an “original” 635A brand new from numerous sources.

Back in the 70s, EV salesman, Greg Silsby, carried a “squished” 635A with him for show-and-tell, that had been run over by an 18-wheeler during an NAB show. He liked to plug it into your production room console and prove that it still worked. I don't think Frank Sinatra would have chosen it for a performance, but you couldn't deny the robust design and construction.

When I built WBNZ in Frankfort, Michigan, back in 1978-79, we used 635As on-air and for remote broadcasts. I recall the time when the station got permission to broadcast the summer festival on the beach in Beulah. The street was blocked off and there were food vendors and all sorts of booths along the beach. I was busy stringing and taping a 4-conductor telephone cable across the vacated street in order to broadcast from the middle of all the excitement when the local sheriff stopped me in mid-project to say I couldn't run that cable across the road, whether it was blocked off or not! What to do?

Well, there was a little creek running under the road through a culvert not far from where I wanted to be located. I got an empty milk carton from a nearby store, secured the top on, tied the phone cable to the handle and floated it under the road in that little creek. Voila! The sheriff was a little miffed but I had followed his direction and nothing ran “over” the road. That was back in the day when you could call the local phone company on a Monday and have a modular jack nailed to a telephone pole by Thursday for a remote.

Well, the soldering iron is hot and I have about 12 XLR plugs to connect to as many cables for a project, so I'll ring-off for now and head for the bench and the 5th cup of coffee since noon. Be safe and stay warm!

Michael Bradford began his career at WCCW in 1962, A CPBE since 1984, and currently a contract engineer. You may reach him at: mbradford@triton.net

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STL Via Stream

by Bob Reite CBT

Ever since the FCC eliminated the main studio rule, owners are purchasing stations in remote areas with no local presence other than the transmitter site. This site has a C band dish and receiver to pick up a network feed, an automation computer to run the legal ID, underwriting announcements and some long form programming that is produced at the company headquarters halfway across the state. The transmitter, transmitter control system and antenna, complete the equipment list. There is an Internet connection at the site that was recently upgraded from HughesNet to a terrestrial radio link with more bandwidth.

The automation computer is a PC running CentOS Linux and the Rivendell automation system – this was chosen because it was free. Every night at 23:30, the RDCatch program checks for new content on the air computer at the company headquarters using SSH.

The production people have to remember to name the file with what RDCatch expects. The file name is of the format: **name-of-program YYYYMMDD**. The date must be either today's date or a date sometime in the near future for this to work. Otherwise one must log in remotely and manually import the new audio file.

After a particularly heavy snow, I got a call from the client that this station was off the air. Dialing into the Sicon-8 transmitter control was successful, so we knew

that the site had power. The transmitter was operating at licensed power. Using DWService, I logged into the automation computer and confirmed that the Rivendell rdairplay program was running. One handy feature of the Sicon-8 controller is the air monitor feature. We have an FM tuner plugged into the audio input of the Sicon-8 and by dialing "95" one can monitor the station for 15 seconds ... the station was silent. I fired off a legal ID on the automation computer and heard it on the air monitor. Presumably the legal ID and other local content on the air computer were being broadcast, but the EWTN network feed, which is the majority of the content on that station, was unavailable.

I contacted the local engineer to see if he could make a site visit to find out what was wrong; I suspected snow on the C Band dish. He reported that the site was inaccessible due to ice. In fact, the locals call that site "Ice Mountain" because icy roads are really bad there. Since I did have remote access to the air computer, he suggested that I shut down the automation and connect to our station stream, since there was now enough bandwidth to manage a monophonic audio stream.

Streaming From Scratch

There was only one problem. Our audio stream was from the station cluster commercial content. Since the station that

was down is in the reserved band below 92 MHz, this could not be used. So I had to build a streaming system from scratch, using the audio from the non-commercial air computer at company headquarters that feeds another non-commercial station over a Comrex link. This computer is a Window 7 machine running the Simian automation system.

The Plan

First install an Icecast2 steaming server and audio encoder directly onto the non-commercial air computer. Before touching the far end, I wisely planned to test the stream from my home office, before attempting anything on a computer half a state away that was currently inaccessible in person. Once I confirmed that I had a working audio steam, I would then attempt to play the audio stream from the air computer at Ice Mountain, using the web browser already installed on the air computer.

Fortunately Icecast2 has a binary installer for Windows, so I was able to download, install and configure that. After setting up the router at HQ to forward port 8080, I was able to access the Icecast2 status window proving that I had connectivity.

Next task was to install an encoder to feed the Icecast2 server. I first tried the popular BUTT (Broadcast Using This Tool) encoder. It seemed to work at first. However I could not get the audio routing on BUTT to follow what the automation system was sending to the "audio out" jack. I could either get the EWTN network from "audio in" or the local playback, but not both. I then tried "Rocket Broadcaster." This program worked correctly mirroring the "audio out" jack. The only downside is that the free edition only allowed the 128 kbps sample rate. I was hoping to run at 64 kbps to save bandwidth, but as it turned out the link was OK at 128.

(Continued on Page 28)

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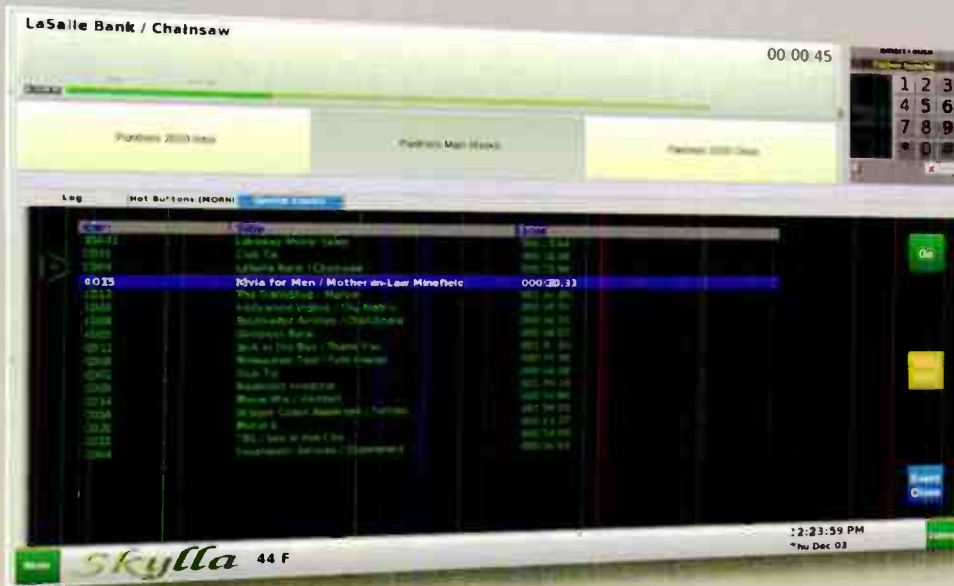
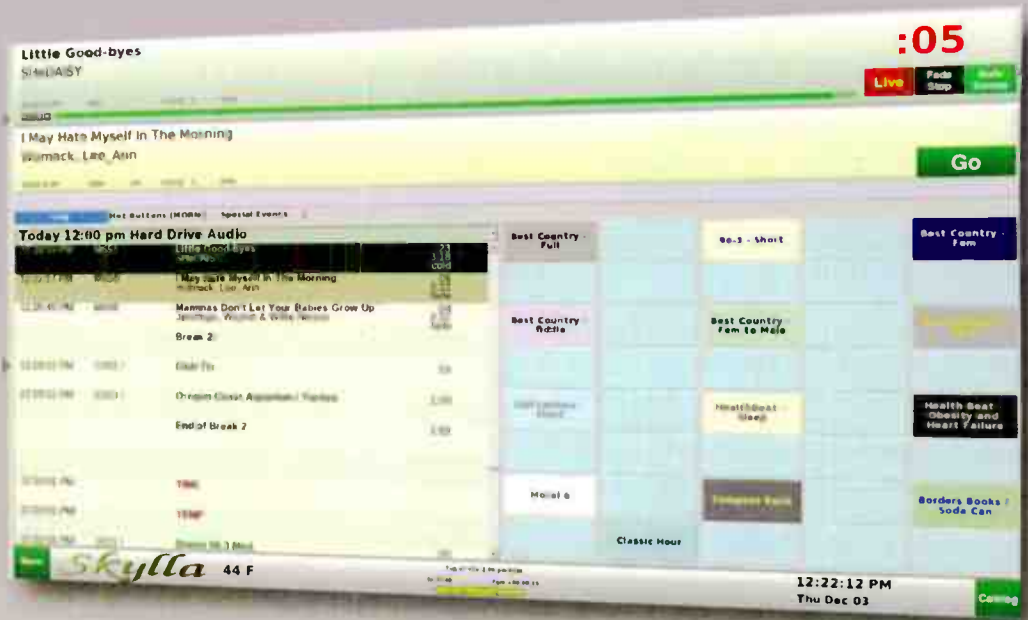
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STL Via Stream

– Continued from Page 26 –

The last thing to do was to record a new legal ID that included the additional station.

The Far End – Fits and Starts

Now to work on the far end. Now I know how the operators at NASA must feel when sending commands to a Martian probe. If they make a mistake and crash the computer, there is no going out to fix it. With the bad road at Ice Mountain, the transmitter site might as well have been on Mars. It was definitely a case of “Think before you type.”

To avoid the risk of installing a program remotely, I first tried to access the stream with the Firefox web browser already installed. While the stream connected, there was no audio from the Sicon-8 air monitor. I then realized that Rivendell was hogging the audio output, so I had to disable that and carefully set the audio routing. I got audio and thought I was good.

I checked the Sicon-8 air monitor the next morning and it was dead. Logging back into the CentOS machine at Ice Mountain I found the Firefox web browser locked up. I started looking into installing another audio player. While I had to be root to install programs, I always ran the programs as the ordinary “rd” user to be safe. I tried VLC media player and, like the web browser, it was not stable enough. The best solution was to keep it simple with the command line mplayer program. Even better, I could write

a shell restart script that would look for any error message indicating that mplayer had crashed, wait 60 seconds, then try again. The verbose text output of mplayer is sent to dev/null so that it does not clutter up the screen with text that nobody will ever look at.

```
#1/bin/bash
#replace xxx with actual IP address
while [[ $(mplayer http://xxx.xxx.xxx.xxx:8080/stream > dev/null 2>&1) -eq 0 ]];
do sleep 60;
done
```

I could also use the Icecast2 Admin web page to see how well things were doing. After logging into the admin page, I could execute “List Clients” and see how many seconds user agent Mplayer had been running.

This seemed to work. It ran for about three days then crashed again. But at least the CentOS computer at Ice Mountain was still running and I could log in and view the log files. Nothing in the system log files really jumped out at me, but what I saw indicated a possible buffer overflow.

Since it did run for a couple of days, I decided to add a couple of “cron jobs” to shut down the whole player system and restart it on a daily basis in the early morning when there would be few if any listeners to hear the one minute gap in programming.

```
#1/bin/bash
#first stop mplayer
pkill -f “mplayer”
#next stop the restartscript
pkill -f “restart.sh”
```

A cron job is to a Linux/Unix machine what a “Scheduled Task” is to Windows. The first cron job shuts down mplayer using this script at 5:58 in the morning every day. The second cron job runs the restart script again one minute later at 5:59 every day.

Success At Last

This temporary stream based STL has been running for two months now. We are even considering leaving this up permanently since it is working so well now, or at least until it is decided to have new unique programming on that station for the Ice Mountain audience.

Bob Reite operates his contract engineering firm, Telecentral Electronics, Inc. servicing radio stations in Pennsylvania and New York state and may be contacted at br@telcen.com

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Do it Anyway

by Jim Turvaville

As I observe what would have been my late father's 91st birthday, with a great deal of humor I often realize how much we all tend to morph into our parents. For some of us that's earlier in life than others; for most it's when we get into our senior years that the harsh reality comes crashing in upon us. My dad used to always tell me, "son, when you get old, everything will remind you of a song." Well, 42+ years in radio have pretty much ruined me long before I thought I was getting old, and for a long time now nearly everything reminds me of a line in a song. It's only when I've gotten older that the mechanism in the brain that keeps the mouth from spouting those song lyrics at random begun to malfunction.

In my regular weekly routine, I assist a lot of my radio station clients with a lot of things, some of which are not exactly engineering related. However, much like everything reminding me of a song, having an Engineering wired brain, it seems that just about everything I do also gravitates back to my Engineering career and work. Here's the latest example of such an event.

I have a volunteer place on the board of directors for a little non-profit that runs a small Christian radio station. As a part of that position, I assist them with some remote management of the station, specifically in programming

and keeping their automation system running. That occasionally requires some simple audio editing for the station, and this past week I was touching up a local short form production that airs on the station. In that little 4 minute devotional, the speaker noted that for 20 years she had a quote by Mother Teresa on her refrigerator, and it compelled me to go look up the quote myself.

Not only did I find the quote, but I also found a nice lesson on what this amazing woman has contributed to the poor, sick and dying of the world. It comes from her book *A Simple Truth* where, in her own words, Mother Teresa shared the thought and experiences that have led her to do her extraordinary charitable life's work. The book gives voice to the very simplicity and self-sacrifice that gives her the strength to be the remarkable spirit who has dedicated her life the poorest among us.

Here's what it says:

People are often unreasonable and self-centered.

Forgive Them Anyway

If you are kind and people accuse you of being self-centered,

Be Kind Anyway

If you are honest, people may cheat you.

Be Honest Anyway

If you find happiness and people are jealous,

Be Happy Anyway

*The good you do today may be forgotten tomorrow.
Do Good Anyway*

*If you give the world your best and it may never be enough.
Give Your Best Anyway*

*For you see, in the end, it's between you and God.
It was never between you and them anyway.*

And just like those random daily conversations that always remind me of song lyrics, this little saying flooded my mind with how it so strongly applies to my work.

Let me re-phrase Mother Teresa like this:

Your Program director or Sales Manager may make unreasonable demands of you to do things that are not even a part of your job and expect you to be in two places at one time while still keeping the stations on the air in the middle of a hurricane—and never bat an eye or come back later and apologize for being a jerk;

Forgive them Anyway

If you bring coffee and donuts to the morning show crew because you were up 2 hours before them at the tower site to fix transmitter problems so they could be on the air at full power, and they make fun of you on the air for kissing up to the staff;

Be Kind Anyway

If you get approval to buy some new piece of equipment but suddenly you find out you can buy \$40 worth of parts and fix it and it will work just as well as spending \$1,600 on a new one; and you do that but the boss doesn't seem to notice at all and no one in accounting cares that you just saved the company \$1,560;

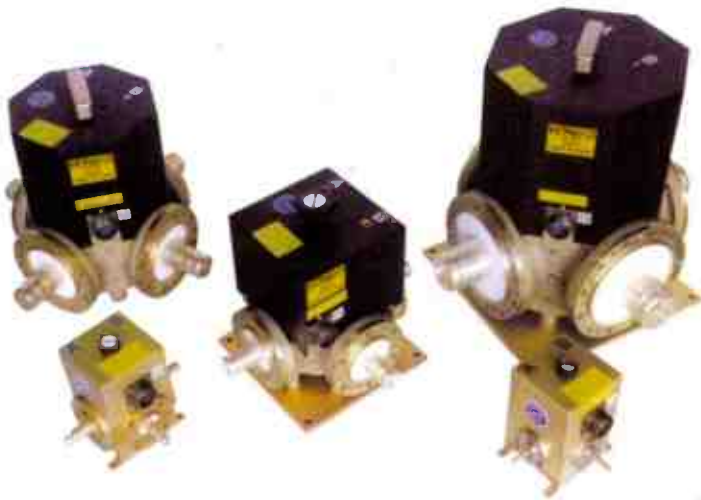
Be Honest Anyway

(Continued on Page 32)

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If you put in your time at your day-job, have a couple little Mom & Pop stations that you help every now and then on the side, run the sound system at your church and volunteer at the local Chamber of Commerce to set up the 4th of July sound system so your entire town can enjoy the fireworks show and you go home at night and have the calm assurance that you've done something today that made a difference in someone's life; but people say you are a busy body and just want to have your fingers in everything;

Be Happy Anyway

If you have that friend who quit their day job as a radio engineer at a corporate owned group of stations and joined a foreign missions organization and is now in West Africa working for a shortwave radio station that is broadcasting the Gospel to the darkest places on the planet, and you send them money every month to keep them operating, and your friend fed and with shoes on his feet while he's doing something you appreciate but do not have the luxury to do yourself; and no one you work with or any of your other friends know that you do this, and probably never will know that you do this;

Do Good Anyway

If you are re-wiring the equipment rack at the tower on top of the mountain that no one from the station but you has seen in the past 11 years; but you carefully label every wire, document the entire project in a notebook you keep

at the site, lace the cables into neat bundles that are neatly routed inside the rack, sweep the floor and bag up the trash to bring back down to the station to put in the dumpster, knowing that absolutely no one you work with or for will ever see any of it;

Give Your Best Anyway

For you see, what you are and who you are about, is you, and not anyone else.

Every one of those examples is true from my own personal experiences. Just like that song lyric in your head, I bet most of you thought of similar situations in your mind while reading it as well. It's certainly not uncommon in our line of work.

The term "self-confidence" is not just having confidence in one's own self, it also implies that it comes from within one's self, and only we can truly spawn real self-confidence. Yes, we may use our knowledge and experiences as a springboard for that confidence, and we may listen to motivational speakers and we may read good books, but in the end it comes from within and it's based on who we are when no one is looking.

I'm a college dropout – I have no formal degree to my name for the basis of my 42+ years of engineering work and I have a 7 page resume of accomplishments in the broadcast industry. I spent a long time years ago, backing up in my career and tracking down the things I'd done, and who I worked for through the years, in order to compile that list. But that 7 pages has never been published, never been printed and handed to a prospective employer, or even shared with a friend; because no one knows the nearly equally long annotation of my failures. I quickly remind anyone who wants to give me accolades for completing some project, that

I can no more define myself by my successes than I can define myself by my failures.

Do you realize how to never fail in life? Just never try anything.

I have a very nice network of contemporaries and clients who are constantly calling on me for help in a situation – something that I truly enjoy being allowed to do for them – and they often are so happy that I can help them on such random problems, but they have no idea that the vast majority of what I know and remember is based on the times I tried and failed at something, often several times over a great span of time, before succeeding and garnering a nugget of knowledge and wisdom that I can pass along to someone else. I have often said "we have to learn from other people's mistakes, since none of us will live long enough to make them all ourselves."

Thankfully I found the Society of Broadcast Engineers over 22 years ago and it allowed me to have a network of professional associates to build my non-formal education upon, and to work through their certification programs to hone my knowledge and experiences and actually have something to show for it with their accreditation. If you've not found that, I wholeheartedly encourage you to check them out at www.sbe.org or at one of your nearby Chapters.

And I may just have something new to put on my own refrigerator now.

Jim "Turbo" Turvaville is semi-retired from 42 years in full-time Radio Engineering and lives in Rural Wheeler County Texas in a "tiny house" where he maintains a small clientele of stations under his Turbo Technical Services (www.jimturbo.net) operation providing FCC application preparation and field work.

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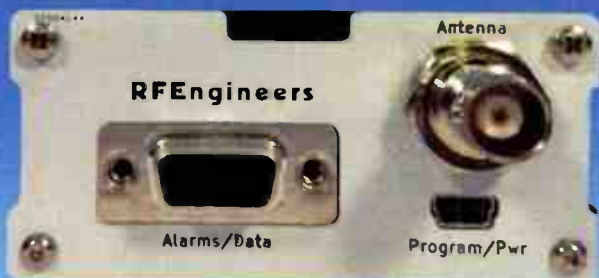
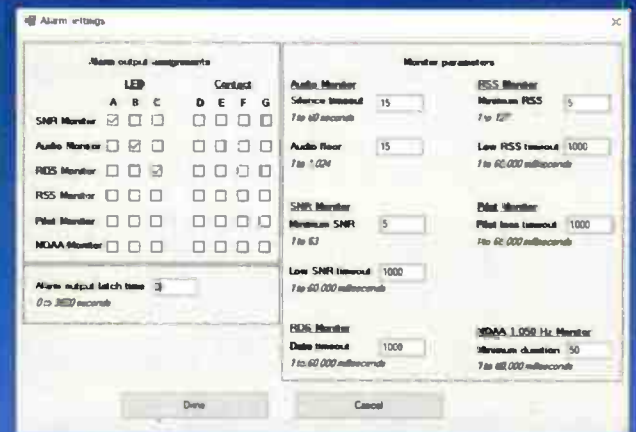
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Misc. Tech-Tips and Thoughts

I always enjoy getting emails from my readers. Some of you have made some very interesting and helpful comments. If you have something positive to contribute, I would love to hear from you. If you have some helpful technical advice or words of wisdom, please contact me at stuzeneu@sbe.org. Your help will be appreciated by the readers, and I would appreciate it as well.

Layoffs

I have been hearing lately that engineers at some big radio broadcasting companies have been laid off. I haven't checked to verify this, but I think it's true. If you are one of the groups that has been laid off, besides working on your resume, there are a few things you can do.

For starters, if you don't already belong to the Society of Broadcast Engineers (SBE) sbe.org. I highly recommend joining. Along with some great educational resources and certifications, the SBE offers a job board where you can look at some really good opportunities. There is also a resume bank where you can post yours.

The next thing you can do is visit indeed.com. This website is the place where you can search openings from all over the planet. You can also put your resume on the site and interested parties can contact you. Funny thing about this site is that recruiters don't always understand

the difference between an IT network engineer, and a network (as in radio network) staff engineer. Years ago I was listed on their site and kept getting offers for jobs as an IT network engineer—big difference between the two. So you need to be careful and specific about what kind of job you are looking for.

Radio Guide Advertising

If you are not careful with the above heading, you may think I am trying to drum up business for Radio Guide. What I am getting at, is I read the articles in this magazine, but I also read the ads. Sometimes you can find something really helpful for what you are doing. I have purchased several items from my dealer by reading the ads in this publication.

Henry "BackUPS™"

I was looking through the ads in Radio Guide one day and I saw Henry Engineering's new offering. I had to read the ad twice. I thought, "This is exactly what I need!" So I bought two of them. I don't normally do product reviews in this column, but I felt compelled to do so. This awesome little black box makes sure your equipment doesn't lose power as it constantly monitors your UPS and the commercial power and switches to which-

ever source is working, but defaults to the UPS. How many times have you wanted to change the battery in a UPS, but couldn't, because the UPS was connected to a mission-critical piece of equipment?



With the BackUPS, you can switch from UPS to commercial power in a second, and the equipment keeps operating while you swap out the battery for a new one. When you have finished replacing the dead battery with a new one, going back to UPS power is a very simple matter. In fact, the unit constantly monitors the UPS and commercial power. Once it detects the UPS is back on-line, it will automatically switch back.

I am currently using both units in my rack, and have disconnected the cord going to the commercial power to move it to another outlet. Immediately the BackUPS switched and my equipment never lost power.

(Continued on Page 36)



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Misc. Tech-Tips and Thoughts

– Continued from Page 34 –

I plan to buy more of these units. It seems like a great way to keep your equipment powered up at all times. There are more great features this box has to offer, but you can read about it in their ad or on their website, henryeng.com.

A Lesson I Keep Learning

I often underestimate how long it takes to complete a project. That's because I don't see the possible challenges ahead. When you calculate how long it is going to take to accomplish something, you need to take into account the unforeseen. Why am I mentioning this? It's because you can be frustrated that your project is taking longer than you expected, and that could add stress to your life. If there is anything as an engineer you don't need, it's stress.

There are times when you think you have carefully planned your work, only to find out there is something you didn't think of. For example, I purchased some Yellow Tec brand monitor holders. I assumed the monitor holders, or monitor stands, if you prefer, came with the hardware I would need to connect the monitors to the stands. No, that wasn't the case, so I had to order the screws to connect the back of the computer monitors to the stands. Again, my point is to allow yourself more than enough time to complete a task and don't get stressed about it. Unless you accomplish a particular project on a regular basis, it's easy to miss a detail here and there.

Creative Solution

When I was employed as an engineer with a large radio network down south, I was asked to install a headphone station in one of the studios. After checking the equipment room, I discovered we didn't have any. I then went on-line to search for a cost-effective solution. It was disappointing to learn some companies wanted a lot of money for a headphone station.

After returning to the equipment room, I discovered a box we weren't using for anything. It was previously used to match unbalanced audio to a balanced input. I took the box apart, removed the circuit card, and put it aside.



I installed a 200 Ohm potentiometer and a stereo headphone jack, and I was done. My headphone station needed to be powered by an amplifier, which I had in the equipment rack in the studio. So for a little bit of time and a couple of parts, I had a headphone station for next to nothing. Sometimes it's cost effective to make your own.

IT Inventory

Ever wonder what's "under the hood" of your computer? If you are extremely organized, or have a superior memory, you already know. For those of use who don't remember or aren't sure, there's a program to help you out. It's called Belarc Advisor. It's a free program (for personal use) that will give you quite a bit of information. According to their website, https://www.belarc.com/products_belarc_advisor, The Belarc Advisor builds a detailed profile of your installed software and hardware, network inventory, missing security updates, anti-virus status, security benchmarks, and displays the results in your Web browser. All of your PC profile information is kept private on your PC and is not sent to any web server. The Belarc Advisor is only licensed for personal use.



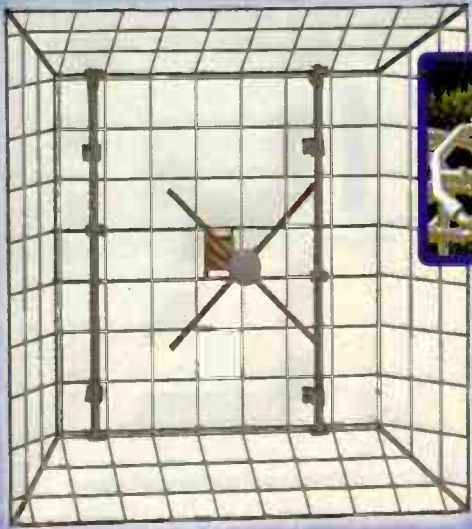

In case you weren't aware of it, here's a great website to look up a lot of detail about a radio station: www.fccinfo.com. You can find out if the station has an STL license, is owned by a group, and a lot more.

Have you discovered a very useful smartphone app? How about a really slick piece of software for your laptop or desktop? Or maybe you have discovered a very useful website that you can't live without. Please send me an email with all the details at stuzeneu@sbe.org.

The thoughts, ideas, and opinions in this column are my own, and do not necessarily reflect the views of Radio Guide or its publisher.

Steve Tuzeneu, CBT, is the general manager and chief engineer for WIHS 104.9 FM in Middletown, Connecticut. He is a member of the SBE, and an extra class radio amateur.

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Survival Guide

Hire Well – Save the Pain

by Sam Wallington

I hate firing people!

Nevertheless, there I was with the Human Resources representative sitting across from me and watching while I bumbled through yet another firing before providing the newly-released employee with their lovely parting gifts.

What had brought me to yet another firing? The first time I fired someone it was so painful I wanted to never do it again. Yet somehow I was back at the table, struggling with it again. This time it was worse because I actually liked the person I was firing. Unfortunately, they just were not doing the job.

Need for Change

I had been lucky many times and had hired some really awesome people. But I decided that my hiring processes had to change. I could not rely on luck anymore. It just is not fair to the person I might end up firing later.

I realized there were a number of problems. Somehow, my interview questions were not getting past the suit and tie to the real person. Though I checked the candidate's references, tested their technical skills, and had some good questions (such as, "What are your three greatest weaknesses?"), I was not getting to the deeper issue of their *attitude*.

Part of my problem was that I tended to hire out of desperation. I needed someone to fill the position *now*. There was no time to spend on finding candidates and interviewing them. In the end, I hired poorly and created even more work for myself. Then, because I was still too busy, I would put off firing them, causing further problems and getting even more behind. I had to learn to "hire slow, fire fast."

Evaluating Their Attitude

I needed to take more time and ask harder questions during interviews. Sure, I needed some quick "ice-breaker" questions, since most candidates are scared spitless when they first arrive. But I really needed to ask something more penetrating than talking about technical skills, and find a way to learn about their attitude.

Attitude often shows when people are frustrated, angry, or scared, so I wanted to know how they handle themselves in tough times. I decided to ask the candidate something about how they handled their biggest challenge or a conflict with a co-worker – but I would not accept: "Oh, I always get along great with everyone!"

Yes, they can still lie but often, if they tell me about a recent conflict, their true attitude still shows. Even a simple conversation about a previous job can reveal a lot.

If I hear the "my boss was a jerk" kind of comment, my "attitude radar" gets cranked up to 11.

Group Dynamics

It is useful to watch a candidate interact with a group of co-workers over lunch. As work-related stories are shared, I watch to see how the candidate reacts, especially when they share their own stories. Such conversation in a non-threatening setting can still reveal key information about their attitude (and many other things).

My interviews also had suffered because I was trying to impress them with how wonderful it was to work here (and for me!). More effective is giving them a truthful, but worst-case, scenario to chew on. The best candidates have excellent and realistic attitudes, realizing that any job involves some hard days and challenging circumstances. That is when they show their true attitudes of strength, persistence, and humor.

Finally, when checking references, instead of asking the typical questions (e.g., "did they work for you from 2003 to 2007?"). I started asking questions like, "What did you enjoy about having them on your team?" because those responses get to the root of what I am seeking.

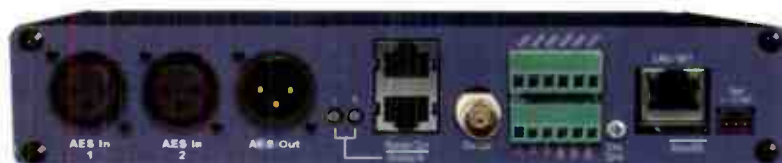
Unfortunately, there is no guarantee that I will never have to fire someone again. But implementing these changes has certainly reduced the possibility. Instead of grumpy and bitter team members, I hear a lot of laughter and cooperation. Instead of hearing excuses for things not being finished, I get to hand out a lot of praise for projects completed well.

I would say that is worth the time and effort it took to learn to hire well.

Sam Wallington is VP of Operations and Engineering for Educational Media Foundation. He can be reached at swallington@klqveair1.com

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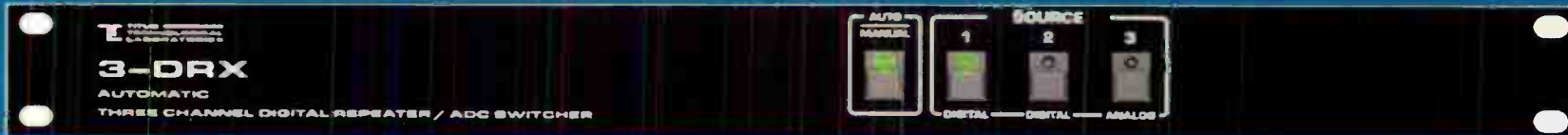


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Combiners in Solid-State AM Transmitters

by John L. Marcon, CBRE CBTE 8VSB Specialist

Back in the late 60s to early 70s, few if none thought of combining transistor amplifiers to achieve high power transmitter output. Firstly, there were really no suitable transistors and secondly, vacuum tubes can be built to whatever power level was needed. Power levels of up to 100 kW can be made with just one tube. Above 100 kW, they may combine two PA tubes or use a single tube again like the Eimac X-2159 which has a plate power output of more than 2 megawatts. It was indeed the heyday of the monster amplitude modulated transmitters.

But with the drive to save on electricity cost and for environmental considerations, people started looking at developing high efficiency devices. There is no doubt that designers back then were geniuses when building RF circuits from the small to the megawatt transmitters. Even the Ham operators can design and build their own transmitters using off the shelf tubes. But the air was already filled with visions of high-power solid state, which was the next step in the evolution of amplifier design.

Unfortunately, expertise in the RF field does not translate to expertise in solid state. Sometimes when you are good at something, you tend to stick to it and then fail to see that another thing is needed to get to the next level. As it turned out, it is expertise in switching amplifiers that was needed. In those days most RF engineers were quite an expert on class A to C amplifiers. However, solid-state amplifiers are class D, which is not really far off from the other classes of amplification, but still a new learning experience for many. Some were working already on class D even in the 60s but it was mostly in power supplies and they were using vacuum tubes. In fact, it was only in 1953 that the first bipolar junction transistor (BJT) came out.

Things changed a bit in the 70s. A firm from up north in Canada, called Nautel, built and sold a 2 kW solid state AM transmitter in 1974. Nautel was a relatively new player in those days but little did anybody know that they would be a big name later. Then in 1976, Harris (now Gates) introduced the MW-1 AM and, according to an old Harris brochure, it was "the world's first FCC type accepted" kW level AM solid-state transmitter. However, this transmitter is not a PDM and it used BJTs, not FETs. Apparently, FETs were not available back then. The one thing new with it was that the PAs were in class D. Before the end of the 70s, a highly efficient Field effect Transistors (FET) called HEXFET was introduced by International Rectifier (IR). This helped the manufacturers build even more powerful amps.

The H-bridge Switching Amplifier

By the 1980s, Harris, Nautel and others were producing multi-kilowatt, solid state AM transmitters. Harris with their digital AM and the others with PDM, all solid-state. The common thing about these transmitters? They use the H-bridge (or full bridge) switching amplifier configuration. It became somewhat the standard among manufacturers when it comes to the

basic amplifier building block. By using four FETs in an "H" configuration, the bridge made it possible to have twice the power compared to a class AB amplifier. In a way, this bridge is a sort of a "combiner" also for using four FETs.

Interestingly, I cannot find any record as to who invented the H-bridge amplifier. However, there was a patent in Nov. 6, 1973 by Mr. James R. Drehle entitled "Switching Circuit for Inductive Loads" which shows four transistors in an H-bridge configuration much like the one shown in **Figure 1**.

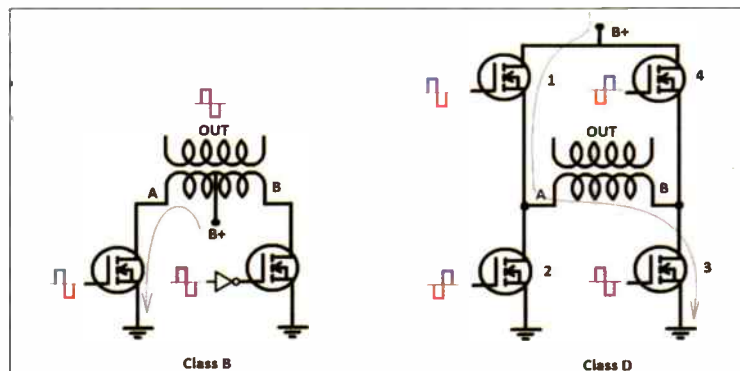


Figure 1: Comparison between a push-pull class B and Class D bridge amplifier. A higher B+ can be used because of the two FETs in series. The current goes through the whole output transformer (A to B) unlike the class B where it only passes through half the transformer.

The H bridge was also widely used in motor control. Looking at the Figure 1 right side, if you replace the transformer with a DC motor, the clockwise and the counter-clockwise rotation of the motor can be done with the 4 transistors. Transistors 1 and 3 runs the motor in one direction and transistors 2 and 4 turns it in the opposite direction. Adapting this method to amplification, the switching of the transistors will actually yield an AC square wave on the transformer. That square wave can be used as the carrier frequency for an AM transmitter. With all these in mind, the design engineers already had plenty of resources from the electronics industry to be able to make a high-power RF H-bridge amplifier in those early days.

With the basic building block solved, the next step was to combine the output of these amplifiers. Somehow, the combiner becomes the key to the further development of the solid-state transmitter. A poorly designed combiner can result in low efficiency and poor reliability. Combining amplifiers is nothing new. It has been done since the early days of broadcast. However, combining H-bridges is not exactly the same as combining tube amplifiers. I am sure there were a few burn outs or blow-ups during the experiments.

There are a few industry accepted specs for an RF combiner: power handling, isolation, insertion loss, matched impedance, and bandwidth.

1. Power Handling – For two identical amplifiers, a combiner should have an output level at least close to twice that of one amplifier. If there are three identical amplifiers, the output should be three times the output of

one amplifier. The combiner must be able to handle this power level. Power handling also relates to the efficiency of the combiner.

2. Isolation – On a combiner with two or more amplifier at the input ports, signal from one amplifier must not flow to the other amplifier and vice versa. All the signal should come out of the output of the combiner. Otherwise, there would be serious problem with oscillation. A 25 dB or greater isolation is a good spec.

3. Insertion Loss – Like all system or devices, combiners tend to absorb some of the power coming from the input ports. As the combiner is "inserted" within the system, hence the name, a power loss occurs. Designers made sure that this loss is at its minimum. A 0.1 dB insertion loss is a good spec.

4. Matched Impedances – The impedances of the input ports must match the impedance of the input amps. Likewise, the impedance of the combiner output must match the next stage in the system, be it the output network or transmission line. Mismatch will result in

reflection and this would not be good for the amplifiers. Combiners in AM transmitters are usually set to 50 Ohms in each port and they are usually well designed to maintain it all the time.

5. Bandwidth – Lumped elements on a combiner will tend to make the combiner narrow band. The design engineer must make adjustments on the circuit so that it operates properly within the required bandwidth.

We will look at three combiners used in AM solid-state transmitters used today: the Wilkinson combiner, the 60-degree combiner by Nautel and the Series type.

1. Wilkinson

– This is a very popular type of combiner, not only in AM but also in the higher frequency bands. The basic two-port Wilkinson consists of two quarter wave line segments at center frequency F_0 . The two are tied together at one end (output) and the other ends connect to the amplifiers (inputs). For 50-Ohm amplifiers, a 100-Ohm resistor is connected between the two input ports. The quarter wave lines are used as transformers such that the signal from the first port going through the two quarter waves (a half wave) will be inverted at the second port, cancelling the signal coming from port 1 to port 2 through the 100-Ohm resistor. Because of this, the combiner has high isolation and low loss. The quarter wave line segments can be replaced with LC elements. Wilkinson can be used on an N number of combiners. For example, one transmitter that I worked on has an 8-way Wilkinson combiner.

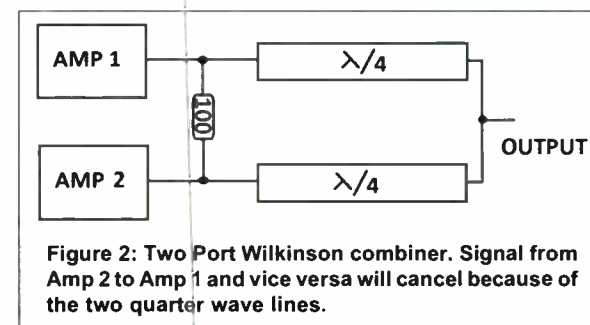


Figure 2: Two Port Wilkinson combiner. Signal from Amp 2 to Amp 1 and vice versa will cancel because of the two quarter wave lines.

2. "60 degree" combiner – What is one weakness of a Wilkinson combiner? The balancing resistors. This #2 combiner does not need resistors.

(Continued on Page 42)



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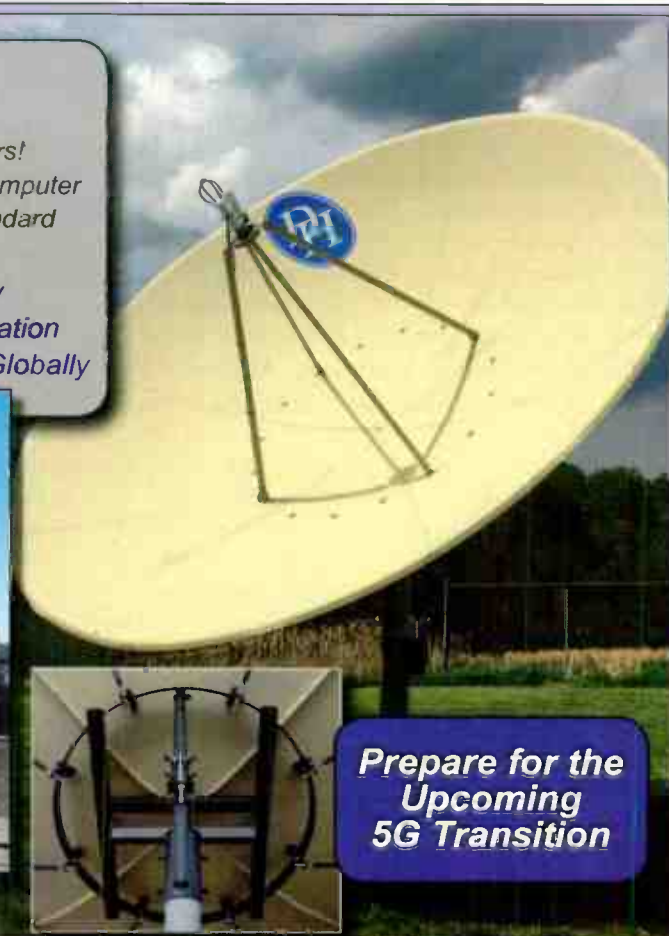
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The 60-degree (of the carrier frequency) combiner is a form of parallel combining that was invented by Dennis Covill of Nautel in 1988. The patent states: "The present invention relates to a combining network for use in combining a plurality of coherent radio frequency sources. The combining network is comprised of a plurality of arms, one for each radio frequency source." The electrical length of each arm L ranges from 55 +m(180) to 70 +m(180) degrees. This combiner needs four or more inputs so that a loss of one amplifier would not severely affect the common point impedance. Each arm can be converted to a series inductor with a lumped capacitance on the load. This combiner has been used by Nautel for a long time in their AMPFET, ND, XL and NA series. However, a few years ago they switched to the next type of combiner.

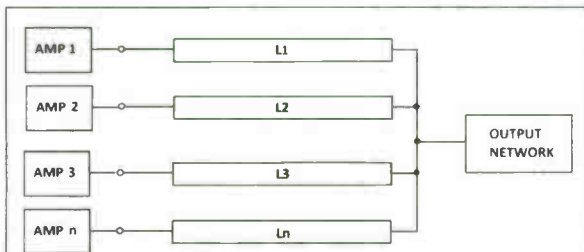


Figure 3: "60 degree" combiner from Nautel. A minimum of 4 amps are needed to have an acceptable isolation between amps.

3. Series Combiner – It seems that the simplest way to combine amplifier outputs is to connect them in

series. Many station engineers are familiar with this type because the Harris DX series transmitter has used this combiner since the 1980s. The output of each amplifier card is a toroidal core transformer stacked vertically, and a copper pipe passes through the center of the stacked cores. The core winding is the primary while the pipe segment within the core acts as the secondary. The pipe is essentially the sum of all the "secondaries." The bottom end of the pipe connects to ground and the top connects to the output. This is just quite an elegant solution. However, since the output is connected to the high impedance point of the combiner, it is a bit sensitive to lightning surges, unlike the parallel combining which has a low impedance.

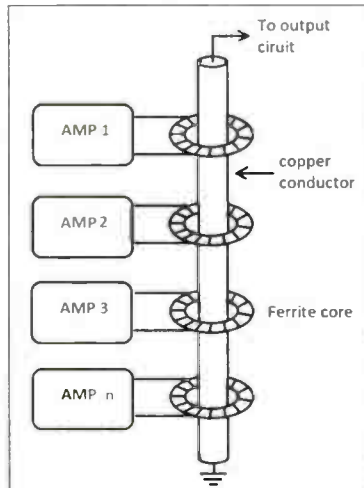


Figure 4: Series combiner. A copper conductor passes through the output toroidal cores of the amplifiers.

The shift from tubes to solid-state was an important part in the history of broadcast technology. Its impact on the overall energy costs savings since the beginning was tremendous. To figure out the critical pieces of the transmitter such as the H-bridge amplifier and combiner was a fantastic engineering feat.

Reference:

1. Goran Pavlakovic and Silvio Hrabar (2018). High power Shortwave DRM transmitter in Solid-State Technology. *Automatika*, 59:2, 158-171
 2. Covill D.H. (1988). Radio Frequency Combiner. Tantalum, Canada. Patent No. 4,785,267. United States Patent
 3. Drehle, J.R. (1973). Switching Circuit for Inductive Loads. Fort Collins Colo. Patent No. 3,770,986. United States Patent
- John L. Marcon, CBTE CBRE 8VSB Specialist, is the Chief Engineer for Victory Television Network (VTN) in Arkansas, with international experience in both Radio and Television Broadcast, and has an Electronics Teaching background.

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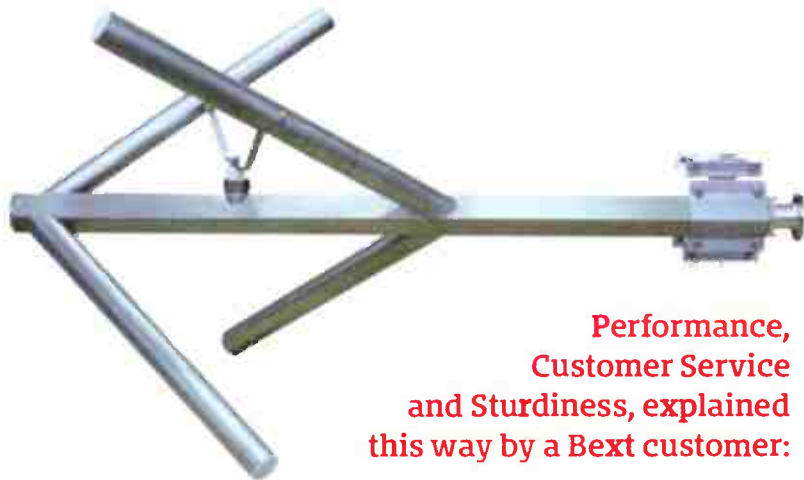


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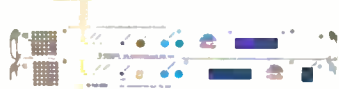
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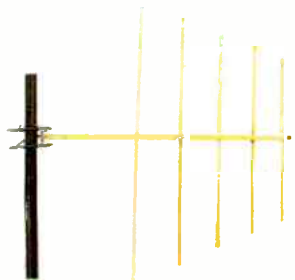
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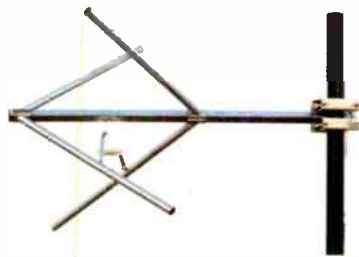
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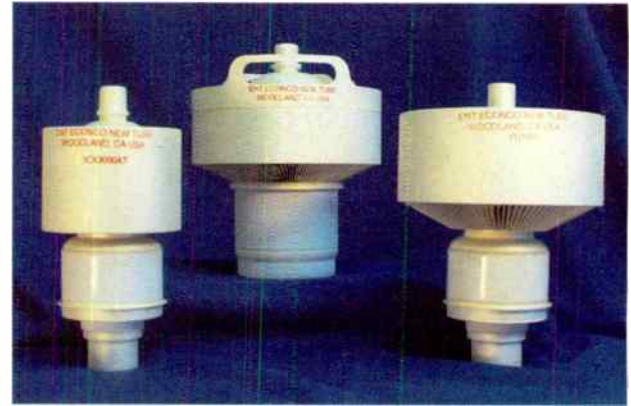
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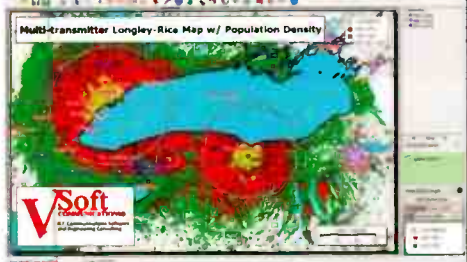
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TRACKING THE FALL AND RISE OF RECORDS

By Ron Erickson

When was the last time you cued up a record during a live show? Thinking back, we were still playing records on the air in the 70's, but sometime late decade, even into the 80's, many stations had switched to carts for everything. This required having more than two or three triple-deck machines in the control room. Yes, carts held all audio through the Eighties; spots, promos, jingles and songs. So, there has been more than a generation of young radio talents that have never back-cued a 45 RPM or album cut. For that matter, live back timing into an ID and network newscast also seems to be a lost art as well.

Something new was brewing while many of us punched the play buttons on those cart decks. Back in '82 two companies, Sony and Phillips, were busy inventing the "Digital Audio Compact Disc." By 1984, The Recording Industry Association Of America (R.I.A.A.) noted the first commercial sales of CD's at \$103.3 million dollars while sales of vinyl commanded a whopping \$1.5 billion. Around 1988, I was on the air at KWJJ AM & FM in Portland. The FM studio had two CD decks installed with a limited amount of discs in a CD wall rack behind the jock, as I recall. That was the first time I tried playing CD's live on the air. The station bought consumer style CD Decks and with the push of a wrong button, the CD ejected – mistakes were made. As much as the format would allow, I stuck to playing carts.

That same year, 1988, CD sales overtook Album sales and a presumed vinyl death spiral had begun. By 2007, CD sales in the USA had risen to \$2.1 billion, while vinyl album sales went down to the bargain basement with only \$532.2 million sold. Still seems like a lot of money? Sure, but when you consider that records used to have sales in the billions, a paltry half-a-mil seems anti-climatic. But then something surprising happened. Consumers started buying more vinyl. A slow trend at first, but it gradually picked up speed. The September 6th 2019 issue of *Rolling Stone Magazine* published a story about increased LP sales, with the headline, "Vinyl Is Poised To Outsell CD's For The



Liz Dunster



First Time Since 1986." Checking in with the sales figures more recently, R.I.A.A. reported these music sales figures for 2020: Albums \$619.6 million while CD sales hit only \$483.3 million. Where has all the real money gone in the music industry? Paid Music Subscription Services, with a lions share of the sales, coming in around \$7 billion dollars. Quick side note: R.I.A.A. is the organization that declares an album as Gold, Platinum, or even Double-Platinum.

I reached out to numerous people to get more of the story. I found Erika Records in Buena Park California. In a business filled with men, Liz Dunster (see photo above) managed to start Erika Records from scratch in 1982 and created a very successful business that not only survived the lean times, but has now added more record pressing machines.

Company project manager, Ma Nerriza dela Cerna (photo below) spoke with me about it. She explained that Erika Records is one of the only places where special shaped and/or colored records are made. They can also create picture discs as well. Unique products are one thing that helped bring Erika Records through the leaner days, along with the fact that Erika can press almost any amount of 7" and on up to regular 12" albums and of course any size disc can be pressed as a 45 RPM or for album playback. No order to small or too large for them to produce. Erika presses records for well known musicians as well as folks just trying to get a break.

I wanted to hear what two of the best known tech radio talk show hosts had to say about analog vinyl. I've had previous contact with both of them and consider them business friends. First I called Kim Komando and enjoyed a pleasant conversation that took me back to a time when I was the PD at News-Talk 1580 KGAL. I put both of these shows on the air many years ago. *The Kim Komando Show* is a three-hour weekly radio program airing on over 400 stations across the USA and on demand. Dubbed America's



Company project manager
Ma Nerriza dela Cerna.



Kim Komando

Digital Goddess®, Kim shares the latest gadgets, breaking tech news and privacy tips to help you stay safe and secure when you're on-line. Here is what Kim had to say:

"For casual listening in the car, digital sources are acceptable, but if you want to feel the music, you need to hear the record. We have an extensive record library which includes 45's loaded on a jukebox. It's fun to punch the numbers and wait for favorites. My husband has the big stereo system in his office. Records are warmer sounding ... it's like you can feel the music. The fact is, with an album you can hold the cover, read the liner notes, look at the photos ... it all adds to the listening experience."

For the past 26 years, Dave Graveline has hosted a nationwide tech radio talk show called *Into Tomorrow*.

Here is Dave's take on why vinyl has not only survived as a music source, but has now re-emerged as the preferred "own it and keep it" for personal stored music. Quoting Dave, "true audiophiles appreciate that the sound quality you get from playing vinyl on a quality turntable – with a quality needle – just can't be beat. While CDs sound "good enough" for most casual listeners, the sound is compressed – though obviously not as bad as an MP3. Someone who truly appreciates music – and all the hard work that goes into creating it – will want to hear it with quality that is as close to the studio original quality as possible. That's something a good record player and amp can deliver – and a CD cannot."

What have we learned? Casual listeners don't care if it's an open wav file or an mp3, but real music lovers want to hear the music from vinyl, because it's closer to what the musician and studio wanted you to hear.

With this in mind, wouldn't it be great if a smart radio station programmer hired talent again and put turntables back into studios? Perhaps this could be a new attraction to gain listeners at commercial operations.

At the LPFM I help operate, I prefer to play records on the air whenever I must be live.

Graham-Studios furniture package. Graham-Studios builds a very neat old school studio furniture package. I had them sink the turntables into the desk and the design is easy to work and is out of the way when not used. Questions? Feel free to E-mail me.

Ron Erickson may be reached at ronerickson@gmx.com or at 541-460-0249.



Dave Graveline



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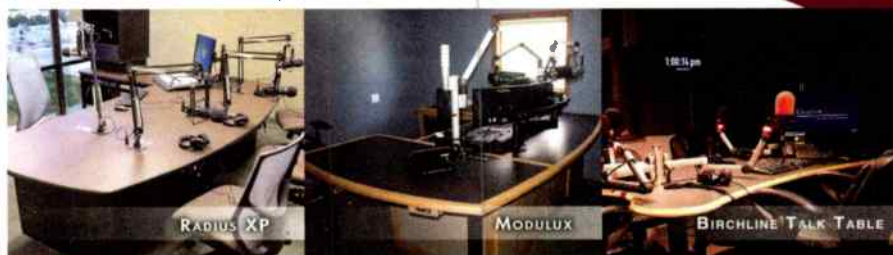
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