Radio Guide

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March-April 2009 – Vol. 17, No. 2

Axia PowerStation Lowers the Entry Point for Digital Audio

Inside Radio Guide

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Radio Guide

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Cover Photo:
Axia's Mike Dosch with the latest addition to the product line – the PowerStation.

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PO Box 20975, Sedona, AZ 86341
Phone: 928-284-3700 Fax: 866-728-5764
Ray Topp *(Publisher)* radio@rconnect.com
Barry Mishkind *(Editor)* editor@radio-guide.com

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Radio Waves

by Barry Mishkind – Editor

Have you packed your walking shoes? Hurry. It is Spring NAB Show time.

If you can manage it, you should be there. It may involve some difficult budgetary choices. But Las Vegas room rates are low this year, and some airline packages (air/room) are downright cheap. Yet, strangely, we hear some companies do not want their people to go.

That is unfortunate, since the biggest reasons for attendance are the prime opportunities for continuing education. Whether you attend one of the manufacturer's seminars or visit one-on-one on the show floor, you will come away with knowledge valuable to you and your employer.

By the way, do not forget the 17th Annual Lunch Gathering at Noon on Tuesday. (For additional information, see www.oldradio.com/nab.htm)

DOING MORE

Indeed, gaining the knowledge, training and expertise that characterizes a radio engineer is as important as ever.

But more must be done. The struggle for respect continues. Some good efforts exist on the state level, but there is little national effort to educate the owners and managers. In far too many places, the local engineer is completely on his own.

Radio Guide tries to do its share. In addition to our articles, we were the first – and only – publication to develop a three day, *hands-on seminar* to help engineers better understand transmission systems and their maintenance – at a cost affordable even by contract engineers.

Keep watching. ***Radio Guide*** is planning something new to benefit the engineering community. *– Radio Guide –*

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Axia PowerStation Takes IP-Audio to a New Level

by Matt Thomas

Telos launched its Axia Audio division in 2003 to bring a new idea to broadcast plants: a standards-based routing infrastructure that would bring consoles, peripherals, phone systems, computer workstations – any audio equipment – together into one powerful network.

Using Ethernet and a protocol called Livewire, real-time uncompressed IP-Audio (sometimes referred to as AoIP) streams could be instantly routed between users; thousands of signals at a time. Six years later, Axia has well over 1,000 consoles and routing networks in the field – and dozens of partner companies who have used Livewire to join the Axia network.

At NAB 2009, they will unveil PowerStation, a new console/routing system that consolidates all the elements of an IP-Audio studio into a single rack-mount device.

A NEW CONSOLE CORE

We sat down with Axia President Michael "Catfish" Dosch to learn more about this new product. Michael has a long history in the professional audio industry, but is best known for his work as principal console designer at PR&E during the 1980s and 1990s.

Q: How did the idea for PowerStation originate?

Michael Dosch: Our clients tend to be very passionate about Axia. From the very beginning, they raved about how Axia saved them installation time compared to traditional methods, the money they saved using Ethernet instead of cable bundles, and how much easier IP-Audio was to work with than everything else. The PowerStation concept came out of discussions with multiple clients about how to make Axia consoles even better. Putting everything in one box was a client idea. So was adding redundant power.

Q: What is PowerStation? What does it do?

MD: PowerStation is our new console core; it represents the next generation of IP-Audio. What previously would have required multiple devices now is consolidated into one single, easy-to-deploy device.

Q: "Next generation of IP-Audio"? What do you mean?

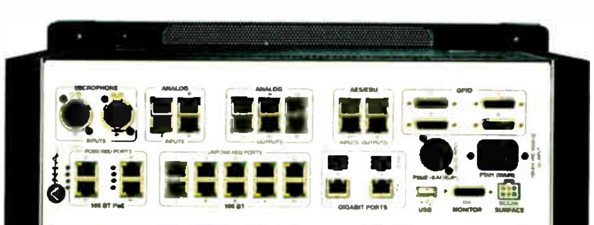
MD: Axia originated the idea of using Ethernet to route broadcast-quality audio around the radio plant. After six years, we've gathered a lot of experience and client feedback, which we've put to use designing PowerStation.

INSIDE THE BOX

Q: So what is inside?

MD: PowerStation has a very powerful DSP mixing engine, a super-duty power supply, digital and analog audio inputs and outputs, plus GPIO for device control and a built-in Ethernet switch for expansion. It's very easy to set up and use – you simply connect PowerStation to an Axia control surface and you have a complete console. It can be a stand-alone console or it can connect to other PowerStations or other Livewire equipment to create a networked studio complex.

Q: I thought all Axia gear was networked. What do you mean by "stand-alone console?"



The rear panel of PowerStation showing microphone inputs, analog and AES inputs & outputs, GPIO ports and multiple Ethernet expansion ports.

MD: It's simple: the back of the PowerStation has all the audio and logic connections needed for a radio console. Connect your devices and your Axia control surface and you have everything you need. No external network is required; it's all in the box. Of course, you can expand beyond the stand-alone console whenever you're ready. There are plenty of Livewire ports on the back of the PowerStation to connect computer workstations, phone systems, processors, and even more PowerStations.

Q: PowerStation has redundant power?

MD: Yes, this was a result of some client requests for a backup console power supply. But here's the twist: since PowerStation contains the studio's mixing engine, audio I/O, and Ethernet switch as well as the console power supply, adding backup power safeguards not just the console, but the entire system. So PowerStation gives you redundant console power, redundant mix engine power, redundant power to the Ethernet switch – backup power to everything.

Q: I see a connector for the backup power; it is a separate unit?

MD: There are two parts to PowerStation: Main and Aux. You always have a Main. The Aux unit is optional, and when you add that, you get the backup supply. Plus, it doubles the amount of audio inputs and outputs and logic ports.

EXPANDABLE

Q: Let us say you have a PowerStation Main and Aux but you need even more audio I/O. What then?

MD: Simple; Just plug in an Axia Audio Node to one of PowerStation's Ethernet ports. Audio Nodes have eight inputs and eight outputs each, and are available for Analog, AES and microphone sources. Of course, you may not need as much discrete audio I/O as you think.

Q: Why is that?

MD: Well, more and more broadcast equipment suppliers – companies like 25/Seven, AudioScience, ENCO, International Datacasting, BSI and others – are making products with built-in Livewire capability. And these connect directly to one of PowerStation's Ethernet ports, so no additional analog or digital audio I/O is required. These devices speak to the Livewire network natively. The added bonus is that these devices connect with just one Ethernet cable for all of their inputs, outputs and GPIO control, so hooking them up takes, literally, about ten seconds.

SIMPLIFYING SETUP

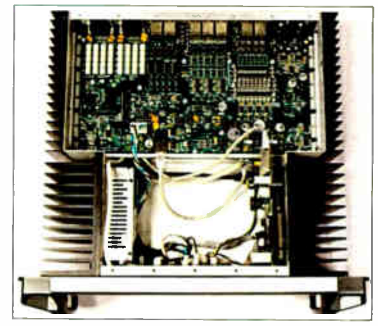
Q: Critics of IP-Audio have said that systems are too complicated to set up. Does PowerStation address this?

MD: Yes. PowerStation comes preconfigured with basic console functionality; everything is accessible using your standard web browser. All you do is plug in your sources and then give them friendly names. These same friendly names show up as available network streams and on the console channel strips. There are also more advanced features, if you want, such as multi-studio networking.

Another feature that dramatically eases setup and deployment is something we call Simple Networking. We realize that not everyone is building a big, multi-studio complex, so our engineers designed in the ability to daisy-chain up to four PowerStation studios using the built-in Gigabit ports. This creates a networked studio complex without the need for an external core switch. Of course, if you want to add more studios, or add PowerStation to an existing Axia studio complex, just connect it to your core switch.

Q: What other features does PowerStation have that might not be readily apparent?

MD: Take a look at the heat sinks on each side. PowerStation is totally fan-free. We know how important it is for studio equipment to be silent, so we designed PowerStation to dissipate heat without the need for cooling fans. It also means one less moving part, as well.



A cover-off shot shows the audio I/O board plus the power supply and DSP board mounted vertically to heat sinks.

Sometimes clients need to connect studios that are in different parts of a building, or sometimes in different buildings altogether. PowerStation's switch has two SFP ports, so you can actually network them directly over long distances using fiber connections.

AN ECONOMICAL CHOICE

Q: Obviously, you need a console to work with PowerStation.

MD: Yes, PowerStation connects to our Element 2.0 console. Connection is very easy; there's just one cable between the two for power and control.

Element 2.0, the newest version of Axia's popular console.

Q: I have heard of Element, but not "Element 2.0." What is new there?

MD: Our philosophy is one of constant refinement and improvement. We solicited ideas from Axia clients, and recently released a major update to Element that includes new features like headphone processing and voice processing from Omnia, a virtual mixer that lets clients build customized utility mixes, such as might be useful when running automation or satellite systems, automatic mix-minus on every fader, and a record mode for phone calls that automatically delivers a split feed to the recording device of your choice.

Q: So, how does the cost of a PowerStation studio compare to a discrete Axia build?

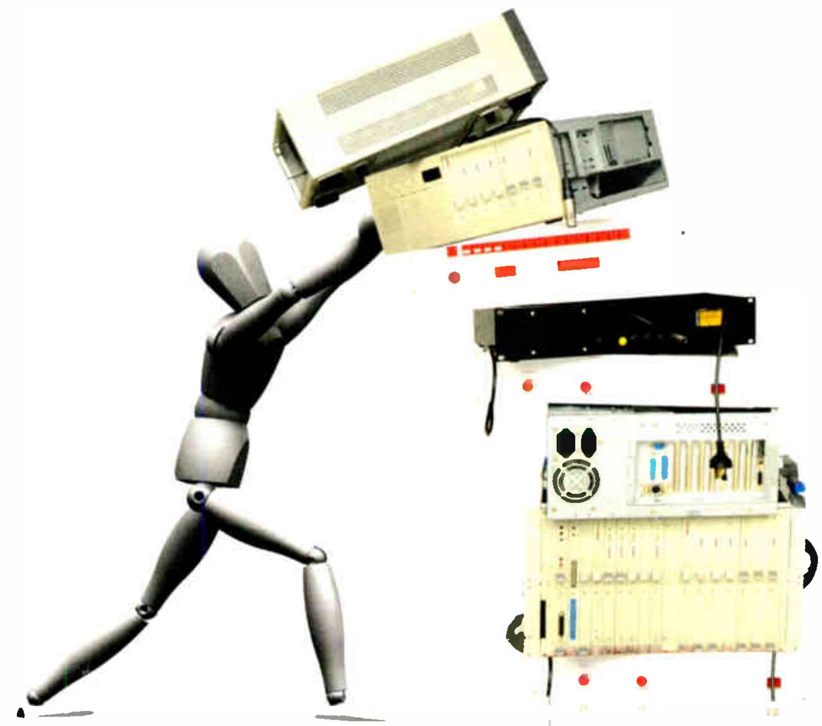
MD: PowerStation will usually save money when compared to the multi-box solution – as much as 25%.

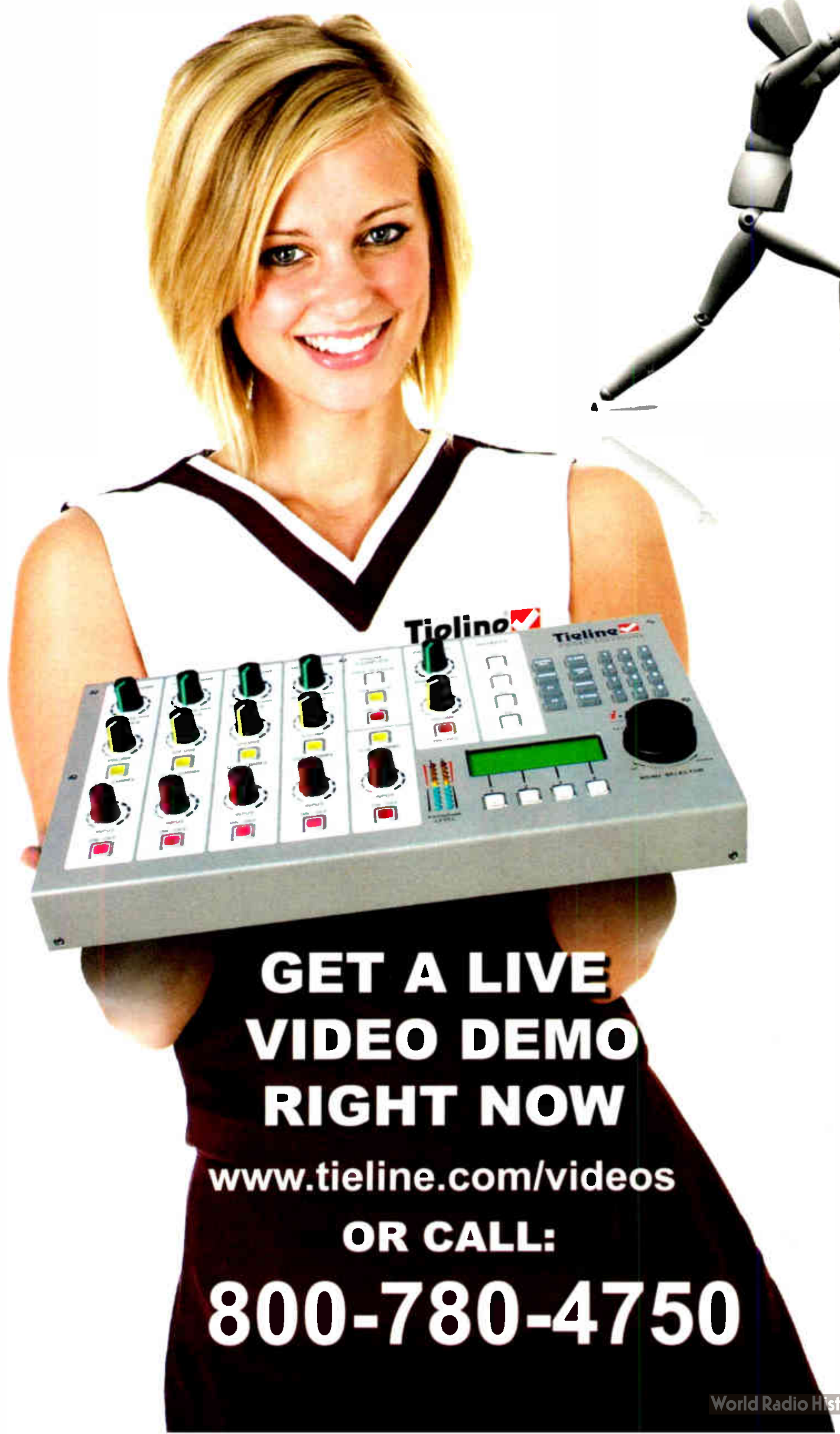
Q: Are there any other new items that we should watch for at NAB?

MD: Yes, we're expanding our line of router control accessories, including programmable soft switches, XY control panels, *et cetera*. We also will be bringing an Axia Intercom system that seamlessly integrates with our consoles – based on Livewire, of course.

Matt Thomas is a freelance technical writer based in Naugatuck, CT. He can be reached at matt@betweenbrain.com

How do you fit an entire remote truck in a single box?





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FCC Focus

RFR Compliance is a Shared Responsibility

by Cary Tepper

A radio station in Oregon that leased antenna space on a multi-tenant communications tower structure was recently fined $10,000. The FCC cited the station because its "broadcast operations contributed at least five percent of the RFR levels, exceeding the maximum permissible exposure limits applicable to facilities, operations or transmitters, thereby placing hundreds of people at risk."

The FCC's actions should serve as a wake-up call to all communications providers that share their transmitting site.

RFR LIMITATIONS

Part 1 of the FCC's Rules and Regulations contains provisions implementing the National Environmental Policy Act of 1969, and Rule 1.1310 defines the maximum permissible exposure ("MPE") limits for certain transmitters, including those that serve the radio and TV industry. The exposure limits are defined in terms of spectrum frequency, field strength, power density and exposure time.

As you probably know, there are guidelines for occupational-controlled exposure (such as tower maintenance crews) and general population-uncontrolled exposure (such as members of the general public that might work, reside, or traverse near the transmitting site).

With regard to the Oregon situation, the FCC took issue with the uncontrolled exposure limits. Automobile access to the site was restricted but hikers, skiers, and members of the general public were easily able to get close to the communications tower.

VIOLATION

The FCC determined that the collective RFR exposure limits from all the tenants on the tower structure placed the general public at risk, especially since there was inadequate signage and no physical barriers such as fencing.

Apparently the Oregon broadcaster admitted the possibility of RFR problems in its license renewal application and promised to resolve the issue but never submitted any follow-up information. About three years later, in response to a complaint, an FCC Inspector determined that the site was RFR non-compliant. The FCC concluded that the Oregon broadcaster and the other tenants on that tower never took the proper measures to bring that site into compliance.

It is important for broadcasters to understand that each tenant on a communications tower is automatically assessed some level of contributory responsibility for RFR compliance and general tower maintenance, even if they are not the owner of the structure. This is consistent with other FCC Rules and Policies that place some level of responsibility on all tenants on a tower structure, to ensure that the antenna structure registration is accurate and that the tower lights and paint are properly maintained.

PREVENTING PROBLEMS

Broadcasters should keep in mind that any new tenant on a tower will impact their RFR liability, as will any equipment that might become defective. If another broadcaster messes up and causes RFR issues, strict interpretation of FCC policy says that your operations will be considered to be a contributing culprit unless you take steps to fix the problem.

Determining whether a potential health hazard might exist at your transmitting site is not always an easy matter. Factors which you must consider include (1) the frequency of each RF signal being transmitted at that site; (2) the transmitter power output (TPO) and effective radiated power (ERP) of each user at the site; (3) how long someone will be exposed to the RF signal(s) at a given distance from the tower structure; and (4) what other antennas are located nearby.

All the tenants on a tower should cooperate, periodically measuring the overall RFR compliance, ensuring proper fencing is installed around all towers located in areas which are easily accessible to the general public, and making sure that all RFR warning signs are conspicuously visible to the general public. These common sense measures are often ignored so please double check what measures are in place at your tower site(s).

RFR COMPLIANCE GUIDE

Although many broadcast owners and managers are intimidated by engineering issues such as this, it is important that all key personnel at your station have a fundamental understanding of RFR compliance.

The FCC has a booklet entitled *"A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance."* This is a relatively easy to read booklet, and should be available for all your personnel to look at in your studios. You can obtain a copy free of charge from the FCC's web site or by sending me an email.

Although the booklet is no substitute for engineering counsel, it does succinctly summarize the FCC's Rules and Policies in this area, provide basic guidance on how to determine if your site is categorically excluded from RFR exposure limits, and contains a handy checklist so you can self-evaluate your RFR compliance status.

Cary Tepper is a principal of the law firm Booth, Freret, Imlay & Tepper, PC in Bethesda, Maryland. Contact him at tepperlaw@aol.com

The First AM Low Profile Kinstar Antenna Commences Operation at KCST-AM in Florence, OR

by Tom F. King, Kintronic Labs

More and more communities and neighborhoods across America are growing tired of the proliferation of cellular telephone and other towers. The result is the establishment of revised local zoning laws lowering the maximum allowable height for new structures – often below usable heights for AM stations – and creating expensive headaches for many of those stations.

FCC-APPROVED SOLUTION

A solution for AM non-directional station operators has finally appeared. On January 11, 2009 the first Kinstar low profile antenna was placed on the air by KCST-AM Radio in Florence, Oregon. The station operates on 1250 kHz with 900 Watts daytime, 37 Watts at night.

Conceived by Star-H Corporation, particularly Dr. James Breakall, Professor of Electrical Engineering at Penn State University, and developed into a marketable broadcast product by Kintronic Labs, the Kinstar antenna was officially Type-Accepted by the FCC on October 25, 2005.

It is approved for use by fulltime omnidirectional operation in the AM band in the US market in accordance with Public Notice DA 05-2741, entitled *"Media Bureau Adopts Simplified Application Procedures for AM Nondirectional Kinstar Antennas."*

ELIMINATING ZONING ISSUES

KCST owner Jon Thompson was faced with needing to replace his 57.89 meter (190 foot) tower. The site chosen by his engineering team, 1.3 miles from the old site, faced a local zoning height restriction of 72 feet, less than four-tenths of the original height.

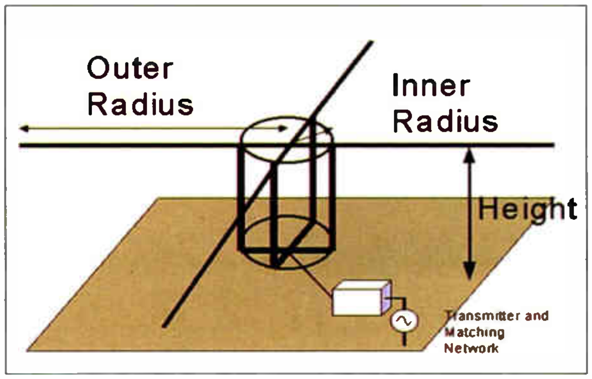
Contract engineer, R. Sparks Scott, recommended that KCST consider the Kinstar antenna. Further investigation with his consulting engineer, Bob McClanathan, PE, showed that a suitable Kinstar antenna could be installed, with a maximum height above the ground of 70 feet, to eliminate any legal zoning issues.

Also realizing that he would have no tower painting required with the Kinstar, Thompson saw the decision to go with the Kinstar as a logical move that would save substantially on long term maintenance costs.

ELECTRICAL DETAILS

The KCST Kinstar was designed in accordance with the scaled electrical dimensions that were defined by the experimental antenna that was operated under FCC experimental license WS2XTR for operation on 1680 kHz. The design was licensed by the FCC as a top-loaded antenna.

With an electrical height of 63 feet and top loading of 134 feet, the KCST Kinstar was installed using five 85-foot wooden utility poles and standard pole line hardware and cable. All of the anchors were screw anchors buried in the soil using a hydraulically-driven auger, and therefore no concrete was required in the installation. A utility company out of Portland completed the construction in one and a half days.



The Kinstar Antenna design for KCST.

All antenna wires were insulated from ground and the supports, and the four vertical were interconnected via a common ring at top and bottom. The KTL Model LTU-1B-1600 antenna matching unit used lumped element matching. A 120-radial quarter wave ground system was installed following the antenna installation.

The feed point at the base of the center pole of the Kinstar antenna showing three of the four insulated vertical elements with the associated commoning ring.

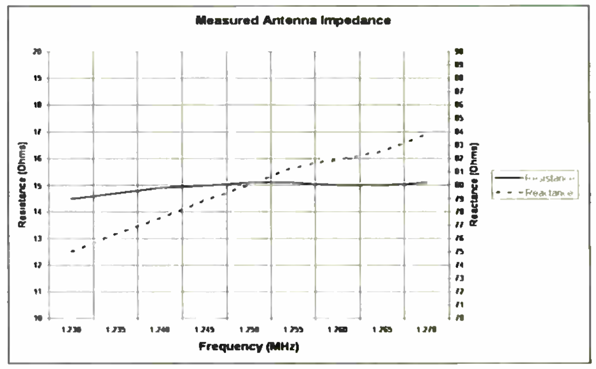
CHECKING THE BANDWIDTH

Another advantage of the Kinstar antenna is the wide audio bandwidth that it offers in comparison to the typically narrow-band characteristics of electrically short AM antennas.

The inherent audio bandwidth performance of the Kinstar is evidenced by the less than 2 Ohm variation in R and the less than 10 Ohm variation in X over the 30 kHz bandwidth of a typical HD radio channel.

Following the initial antenna tune-up and commissioning of the transmitter operation into the antenna, Bob McClanathan responded as follows: "This past Sunday, January 11, I worked with Jon Thompson and Sparks Scott at KCST in Florence, Oregon to complete the ATU adjustments and measurements for their new Kinstar AM antenna.

"I am very impressed with the quality of the antenna construction and the operation is much better than expected. The impedance at 1250 kHz is Z=15.1 + j80.0 Ohms and is flatter than a pancake +/- 20 kHz. Would be excellent for IBOC, but fortunately KCST is not going there.



The antenna drive impedance for KCST's Kinstar as measured at the output J-plug of the antenna matching network by Bob McClanathan, PE.

"The Kintronic ATU is of excellent quality as usual, and built for easy impedance measurements. Very little adjustment was necessary to set the T for Z=50 +/- j 0 at the transmission line input. The KCST Kinstar is excellent in performance."

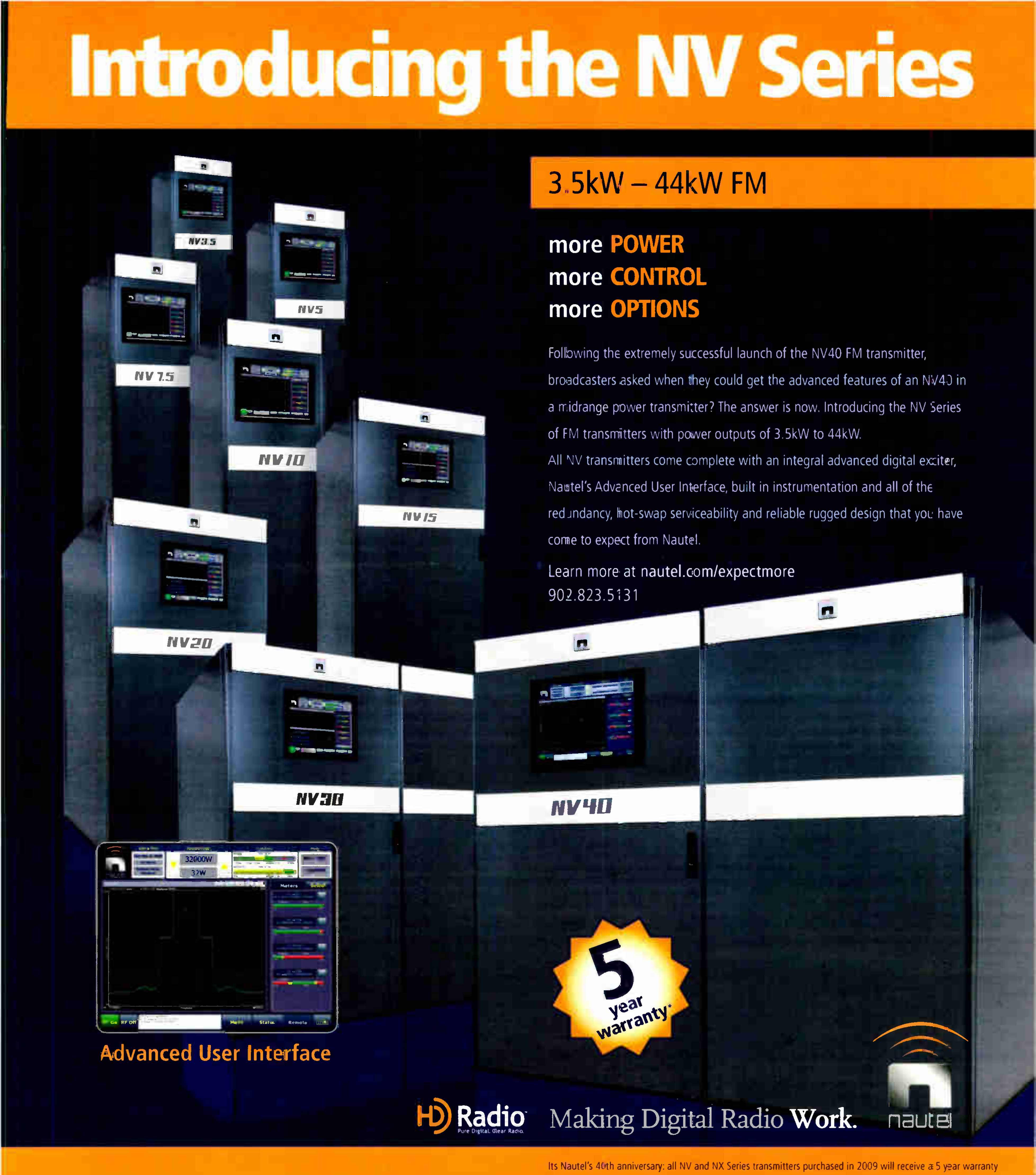
NO NEIGHBORHOOD PROBLEM

McClanathan also reported: "I met a neighbor near the antenna site who is very pleased with the unobtrusive and nearly invisible appearance of this antenna. When considering the FAA restrictions, local zoning, and neighborhood objections, this Kinstar will certainly prove valuable and popular for non-directional AM antenna sites."

With the height of the Kinstar pole supports falling below the average height of trees in the nearby forest, the antenna blends into the background rendering it invisible to the passers by on the coastal highway. As a result the Kinstar is clearly an environmentally friendly antenna technology.

An overall view of the KCST Kinstar antenna, showing the center feed at the left, three of the five total support poles, and the transmitter building on the right. The STL dish is installed on the pole closest to the transmitter building.

Tom King is the President of Kintronic Labs, Inc. in Bristol, TN. You can email him at: tking@kintronic.com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Transmission Guide

Taming the AM Workhorse

Part 3 - Setting RF Networks in the ATU

by Phil Alexander

For many engineers, especially those caring for non-directional stations, the Antenna Tuning Unit (ATU) at the base of the antenna is something of a mystery, since they rarely need to look inside – and even more rarely have the test gear to measure what is inside the cabinet. However, understanding how it matches the RF can be invaluable in case of component failure. Phil Alexander continues his discussion of RF networks.

In our previous articles in this series, we examined the formulas for matching network development and discussed the practical aspects of adjusting network reactances and using load (tower) reactance to optimize our network.

This time out we will use the same network we developed in the last issue and explore what we must do to translate our design into a practical, working ATU to match the original tower we started with in our first installment. We will do the calculations to send the power down the transmission line, matching it to the tower, and providing a properly driven radiator with the phase angle necessary for proper alignment of our array.

And we will do all this with nothing more than a common, ordinary RF bridge. It does not matter if yours is a simple non-directional 1 kW local station or a multi-towered blowtorch, these principles apply to nearly all stations except for some of the Class A 50 kW non-DA's that use special coupling circuits for driving their towers.

JUST FINE TUNING

First a word about phasing in an AM RF transmission system. Phasors do two things: they adjust the power level going to each branch of the array and they allow minor adjustments of the signal phase angle of each branch. That is generally all they do and it is all they can do.

In most arrays, the bulk of the phase shifting happens in the transmission lines and matching networks. This is why it is not possible to understate the importance of correct impedance matching and correct phasing in each ATU.

FROM BAD TO WORSE

On the other hand, lightning breaks ATU's. Also ATU's get old and chemistry takes its toll oxidizing and corroding connections in ATU's, changing their performance.

However, problems start when well-meaning operators sometimes try repairing ATU problems without fully understanding how an ATU works. Sometimes an ATU must be repaired with a capacitor that is "close" but not exactly the value the designer of the transmission system intended. This gets the station back on the air, but the phasor may have a problem compensating for the altered design.

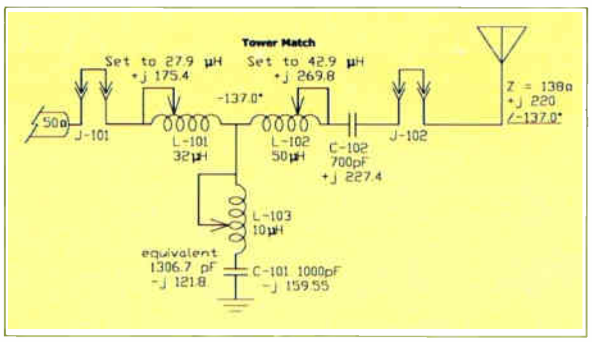
It does not matter that the alteration was unintentional. One or more of the phasor controls is now almost at the end of its travel, and keeping the phase monitor at the correct parameters has become difficult. Then disaster strikes and the culprit is a capacitor in an ATU that has become tiny pieces and gunk all over the inside of the ATU enclosure.

What to do? Obviously, replace the capacitor and get the station back on the air. That done, the result is that now you cannot bring the phase monitor readings back into line. The pattern simply will not line up correctly. Again, the question, what to do?

REASONING IT OUT

Consider the possibility that the phasing delivered by the ATU is not – and has not been – the phasing the transmission system designer intended for that ATU – for a long time. Troubleshooting a directional array is beyond the scope of these articles, but let us assume that after carefully considering the alternatives, that conclusion makes more sense than any of the other possibilities.

Having read the previous installments of this series, you have checked your files, found the tower base operating information and know you need to match a 50 Ohm line to a tower with a base impedance of 138 +j 220 Ohms with a phase delay in the network of 137 degrees.



The ATU at the tower.

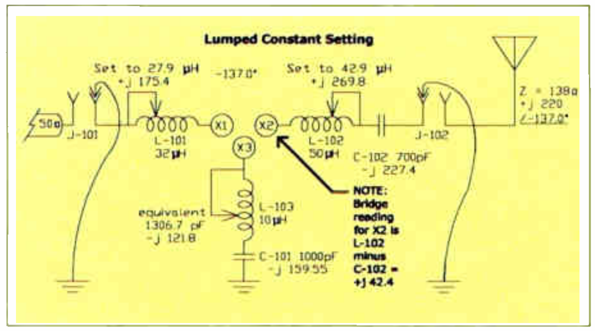
Up to this point, we have learned how to calculate the values of this network, including incorporating the tower reactance into the network. But in many cases – in fact, in most cases – tower reactance is not included in the network because the advantage may be relatively minor compared with the case we wrote about in the last issue. However, inclusion of tower reactance opens up additional methods useful for the final adjustment of the network. Using some of them, we will tune both of the networks we developed in the last issue.

STARTING POINT

The first step of network tuning or adjustment of any network is setting the lumped-constant components (the coils and capacitors as a unit) to their calculated values as closely as possible, realizing that will probably not be the best adjustment needed for good performance. This is because simply setting lumped-constant values does not eliminate all the effects of stray inductance, capacitance, or coupling of the conductors that connect the network and ground it.

While a radio frequency bridge is the commonly-used instrument for adjusting the lumped-constant values of a network, it will be measuring reactance only. In this mode the resistance dial of the bridge is set at zero and is not moved from that point.

Lumped-constant setting begins with disconnecting the ATU input and output connections and grounding them. The next figure (Lumped-Constant Setting) shows doing this by pulling the J-Plugs from the input and output and installing low inductance ground straps. Notice that the drawing also shows breaking the center of the Tee apart so that each of the three sections of it can be measured to ground.



Lumped-Constant Setting starts by disconnecting the ATU from the world.

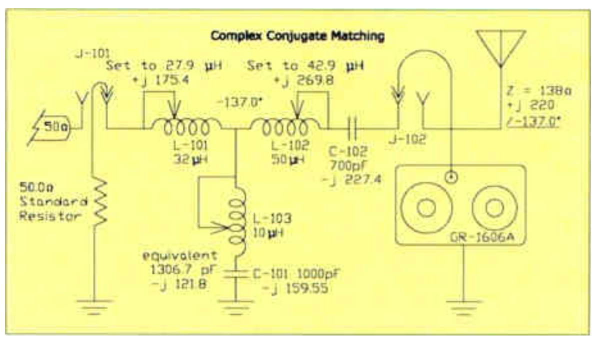
By making the measurements this way a single instrument setup can make all three readings. If the measurements are made with an older, passive bridge such as a General Radio RF Model 916 or 1606 impedance bridge, stray effects are minimized, saving quite a bit of time.

Regardless of how the work is done, the X1, X2, and X3 values are set according to the information developed – for our purposes the values from our last installment. For the first exercise, these will be the values developed before the tower reactance was integrated into the network.

In this case X1 is set to +j 175 Ohms, X2 to -227 +43 or -j 184 Ohms and the shunt branch (the end of which is grounded by the circuit) is set to -j 122 Ohms. As we found last time, this not the best network for matching this tower to a 50 Ohm line. Still, it can help show a method of adjustment that gives a very accurate match with a simple RF bridge, a method that has been used for over 70 years very successfully.

BUILDING THE NETWORK

After the lumped-constant values are set, connect the Tee center back together, remove the input strap to ground, and replace it with a calibrated 50 Ohm non-inductive resistor or accurate (exactly 50 Ohm) small dummy load. Set up the instrument to measure the output of the network as shown in the second figure.



Looking at the output of the network.

If the matching network is adjusted correctly, looking into its output and through the network at a 50 Ohm j 0 resistor on the input will show the complex conjugate of the radiator's operating base impedance. (Note that for our purposes, the simple translation of "complex conjugate" is "tower base impedance with j sign inverted.")

Reading the transformation of the 50 Ohm reference to the complex conjugate of the base impedance tells us two things about its performance. First, it shows that the network transforms the resistive base impedance of the

(Continued on Page 14)

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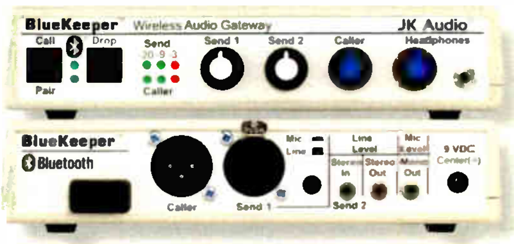

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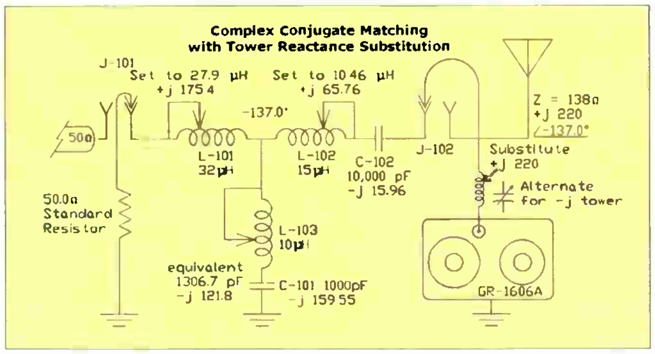
Taming the AM Workhorse

– Continued From Page 12 –

tower to 50 Ohms. Secondly it shows the insertion of a reactance that is equal and opposite of the tower base. When added to the tower base reactance the result is non-reactive.

In most ATU's, the stray reactances and couplings are the same in the complex conjugate measurement and in operation, especially if the bridge is located at the point that the tower connecting lead to the tower exits the ATU enclosure. Often the arrangement for taking this measurement is easiest with the bridge resting outside the ATU with its unknown terminal very near the tower lead connection.



Substituting for the tower's reactance.

MATCHING THE TOWER SIDE

Minor adjustments to X2 will primarily shift the reactance inserted for cancelling or offsetting the tower's reactance, while adjustments to X3 mainly affect the resistive transformation. There may be some interaction requiring small adjustments of both X2 and X3 to get a correct result, however X1 should not be changed from its lump RF constant setting.

Another useful tool is a precision General Radio variable capacitor having a maximum range of about 1100 pF that may be used as a substitute for a capacitive tower reactance. Ebay frequently has these. If you are brave, you can calculate an alternate measurement impedance number, however physical substitution is often more useful, especially when doing the work at 3:00 AM.

Leaving X1 untouched assures that when the complex conjugate of the tower base impedance is measured at the exit of the ATU, the phasing (controlled essentially by X1 and X2) will be very near the design value. All adjustments should be small ones if the lumped-constants were set carefully. When it appears there is a need for a large change it is a good idea to double check the lumped-constant settings, especially the grounding of the of the bridge and connections from the bridge unknown terminal to each of the three lumped-constant branches.

Incorporating the reactance of the tower base impedance into the network means the final adjustment must be done differently because part of the X2 lumped-constant reactance is within the tower and is not available for measurement. There are ways of addressing this problem.

The first is substitution of the tower base reactance into the test lead of the RF bridge. In other words, it is sometimes possible to insert a reactance equal to that of the tower between the measuring point at the output connection of the ATU and the RF bridge connection, which allows using the complex conjugate method as previously described.

Remember that a coil wound closely wound over a 3/4-inch PVC pipe form with small diameter #22 or #24 enameled copper magnet wire will be only an inch or two long for an inductance as large as 100 uH. Thus, insertion of a temporary coil on the unknown terminal of the RF bridge is a simple substitute for +j in the tower impedance.

THE ATU INPUT

Another solution that is useful with a non-directional tower is measuring the network's input impedance directly with the bridge, while fine tuning X2 (reactive) and X3 (resistive) for 50 j 0 Ohms at the network input with the tower connected to the output terminal of the ATU.

Similarly, in a directional array, adjusting all ATU inputs to 50 j 0 Ohms using an active bridge has been a common method for about forty years, and can be valuable. Nevertheless, always remember that before these readings can be fully correct, the array must be operating at its design parameters (all phases and ratios must be exactly as licensed) so the dynamic tower base impedances will be correct. As above, X2 is the reactance adjustment and X3 adjusts the resistance transformation.

The full process of tuning a DA array is a topic for another day, however it is a reiterative process where achieving array operation at exactly the design parameters of phase and ratio is the most important consideration. Except for power losses and undesirable VSWR voltages, exact matching of line impedance to the tower base impedance is less important. Thus, in a DA array, phase change across the network is the most important factor.

A regular contributor to Radio Guide, Phil Alexander has long experience in building, maintaining and repairing RF networks. Contact Phil at dynothem@earthlink.net

Operations Guide

Avoiding the Single Point of Failure

Part 3 - Studio to Transmitter Checklist

by Stanley B. Adams

Radio engineers are often asked to do more with fewer resources. Yet, with the current difficult economic conditions, even more diligent attention toward maintaining our systems, their redundancy, Single Points of Failure, and restoration is required.

In avoiding Single Points of Failure (SPF), it is important to have some mode of Fault-Tolerant thinking behind it. In other words: if something fails, what can we do to prevent other things from failing at the same time and/or speed up the repair time?

Such a mindset arranges for duplication of parts, signal paths, and other such things in a physically and electrically diverse layout. The idea is to avoid having any "bottlenecks." Three important aspects of failure prevention, IT conditions along with power and air conditioning, will lead our thoughts for this article.

KEEPING THE SYSTEM GOING

In many station configurations, you will find the spoke and wheel concept. The spokes can be thought of input sources toward the hub which could be a console or, in many cases, servers and "smart hubs."

Additionally, many broadcast stations are IT driven. So the hub not only functions as the "focal point" for all input sources, it actually is the "smart" arbitrator of what goes back out along one of the spokes. Thus, engineers have to be IT technicians too, battling Single Points of Failure as diverse as the physical server to software patches and anti-viral programs.

QUICKLY LOSING IT ALL

In 2001, I was taking an audit of major market cell sites; pictures were to consist of structures, antennas, base stations and warning FCC/FAA signage. Telling you how many hundreds of digital photos I took and very professionally placed on my network computer would only bring back the ulcers.

We had a humongous IT department keeping Exchange and SMS servers up to date with the latest patches. With a work group of over 60,000 people, anti-viral concerns never entered my mind. Then it happened.

A worm infested my network machine which held all of my pictures. The worm not only caused a DOS (denial of service) attack but it corrupted every type of visual file that it could find. Several months of work went down the drain. Fortunately, they were just audit pictures which could be replaced.

On the other hand, a similar attack could rapidly wipe out your thousands of music selections, voice-overs, commercials, and most anything else stored on your server.

The point is that there is an ongoing war against hackers, script kiddies, or even employees bringing infected files in from home via CDROMs or flash drives. If there is only one person familiar with the IT equipment, that could present a Single Point of Failure if they ever go to the transmitter site, out on a remote, home, or on vacation. Just as there should be backup equipment in the audio or RF chain, there should be more than one person familiar with the IT plant.

If your station is one that relies on Microsoft systems to make everything work you may be interested in a program that they have (http://www.microsoft.com/systemcenter/dataprotectionmanager/en/us/default.aspx). Microsoft provides a variety of storage management tools integrated into various storage solutions to help storage administrators provide manageable, reliable, and cost effective solutions.

PROTECTING HARD DRIVE DATA

Then there is the frozen hard drive, or unbootable hard drive. This should be a priority on your individual checklist against Single Points of Failure.

Plans for duplicate facilities and a data manager should be put into place. Harris markets what appears to be an excellent product that adds a high degree of robustness to the IT part of the business, but small stations can still rely on duplicate drives, backup computers, and smart hubs.

Small or large operations can benefit from the cluster method of protection. Running the same application on two or more servers helps ensure high application availability if one of the servers fails. Clustering software controls the fail-over process so that the application continues to run on the second server, without any loss of data and without interruption in service.

Clustering offers other benefits too, including greater processing power, access to increased storage capacity, and better I/O performance, due to an increased I/O paths between servers and storage.

KEEPING THINGS COOL

Cooling and power conditioning will surely enter the equation for our IT items, as well as the rest of the studio plant. New systems are packing more power and more heat in less space, jeopardizing IT performance. Dense blade servers and high-performance, hyper-sensitive computers and equipment demand a highly-regulated room environment.

Clean cool air – and plenty of it – is essential to prevent problems. Have your main air conditioning plants serviced on a regular basis. If your entire building requires air conditioning, even in the winter time, make sure that all compressors will support those temperatures and that your low pressure cutoff switches are able to handle the lower start up pressure.

Many of the large broadcast chains have a totally enclosed computer room with racks of gear sitting upon computer floor tiles where air is constantly circulating, much like a Leibert Air Conditioning System. Smaller stations may use a pair of window air conditioners set on differential thermostats or larger systems depending up on size and heat load. In addition, Grainger sells large portable floor fans that I have used in major switch and transmission offices. While not proper air conditioning, it will keep your system up until a final fix occurs.

POWER OUT OR POWER UP?

Relying on just one power feed can subject a station to unnecessary outages. For example, having all of the STL transmitters on the same power line is very much like having the coax strung through the same port-hole in the building where some falling ice can take them all out at once. Can you say "bottleneck?"

One solution is to have more than one power source. Sometimes different feeds from the power company are possible. Other times, the most effective solution is a UPS system, properly sized for the facility.

Additionally, power conditioning and UPS backup are important in alleviating power spikes and surges. A large and fairly expensive surge clamp needs to be on all incoming power. It should have lights that show each section is working properly.

RESERVE POWER AT HAND

An effective UPS plan should go beyond the simple Belkin or APS UPS system. Beyond the obvious issue of those small batteries going bad without warning, just testing them is a time consuming issue itself.

On-line double-conversion systems like Emerson's provide better protection than other types of UPS because they completely isolate sensitive electronics from the incoming power source, remove a wider range of disturbances and provide a seamless transition to battery power. Always the preferred choice for the data center, double conversion systems are increasingly displacing other types of UPS in network access rooms as overall network availability requirements rise. (See Clay Freinwald's article on page 22.)

As with air conditioning, smaller operations will have to make adaptations to mitigate the inability to purchase large units. Nevertheless, saying there is no money to do it right merely invites complete loss of power during local emergencies.

HANDLING VOLTAGE DROPS

Burt Weiner, out in Los Angeles, mentioned a problem during momentary outages, even quick power dips. Sometimes the 5 Volt rail will drop just low enough to cause the logic to get tangled up. He recommends a relay and timer circuit so that if the power goes away for more than a few cycles, the circuit would interrupt the power supply's primary power for 10-15 seconds, ensuring that things go all the way down and would properly re-start.

Weiner also has "had experience with some UPS systems that would run down and then require a trip to the site to restart it. Not all of them will return power once they have run down before commercial power returns. The above simple circuit could be wired across the re-start button of UPS supplies that are not smart enough to figure out what had happened."

"WHO DO YOU CALL?"

When the power goes out, who gets called first? Many an engineer has expressed frustration when a staffer spends time calling him first, rather than the power company.

Therefore, it is smart to make sure everyone knows where the posted numbers are for emergencies such as loss of power, air conditioning, program sources, or phone loops. The faster experienced hands can get there the more *quickly* they can evaluate faults and restore service.

By the way, these critical numbers should be prominently posted – not covered over by posters or other materials.

GETTING THE SIGNAL TO THE TRANSMITTER

Now here is one of the hardest parts, at least as I look at it. How are we going to ensure the studio signal gets to the transmitter in remotely located sites?

Studio to Transmitter Links (STLs) are usually the main path, but a damaged dish, coax, feed dipole, etc., can cause a lot of dead air. Having some spare, used STL or RPU equipment, some foam Heliax, and a used dish often can at least put some signal on the air until you get all of the pieces put back together.

Although fidelity may suffer, sometimes a decent alternative is a POTS (Plain Old Telephone Service) or a remote control line that you can use to send audio to the transmitter. We also have options like remote gear or cell phones that will work. Furthermore, new IP solutions allow Internet/Ethernet connections. While latency may rear its ugly head, at least you are one the air!

CHECKLIST

The ideas in the above material have been summarized in a checklist text file that you are welcome to download at www.radio-guide.com/checklists/studio.htm

Of course, since every situation is different, you may have some ideas to share; we can add to the checklist. Since the depth of backup and reserve varies by station – for example, some stations have six or more audio paths to the transmitter site – you may well have ideas new to the rest of us.

Until then, take a moment to review your studio flowchart or quick restoration list, making it as fool proof as possible.

*Stan Adams is a frequent contributor to **Radio Guide**. Contact him at stanleybadams@yahoo.com*

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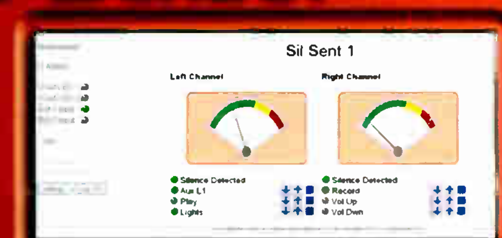

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Radio Guide Hall of Achievement

Recognizing those who have made real contributions to the broadcast profession. by Scott Fybush

Paul Willey

More Than "Just Another Old Engineer"

There was a time when just about every small town had a Paul Willey – the engineer who had been at the local station for decades, had done work at every station within a hundred miles, and had built (or rebuilt) half the stations in the region.

Approaching his 79th birthday and enjoying a comfortable retirement split between his home in North Adams, Massachusetts and a vacation home on Florida's east coast, Willey described himself to ***Radio Guide*** as "just another old engineer."

But those who worked with him over the years would choose different words.

"Paul Willey is the last of a dying breed of engineer," says Tom Jay, longtime host at WSBS(AM), Great Barrington, Mass., one of the stations where Willey worked for most of his career. "If Paul Willey can't fix it, it can't be fixed. The knowledge he has is just phenomenal. He's the engineer's engineer," Jay says.

PIED PIPER OF VERMONT

Willey's career began in a place and time where anything electronic was foreign – the 1930s-era remote "Northeast Kingdom" of Vermont where the few radios were still battery-powered. Willey recalls the monthly trek into town to get the batteries recharged "was the only trip into civilization for all our living supplies."

Afflicted with polio at age 15, he spent a year undergoing treatment that included time in an iron lung. Eventually, Willey ended up at a state trade school in St. Johnsbury, VT, where he graduated with a diploma in Radio. After further studies at the Massachusetts Radio School in Boston, he begin his radio career back in St. Johnsbury at WTWN, followed by stints at WIDE in Biddeford, ME and WDEV in Waterbury, VT, where Willey spent the latter half of the fifties as part of a five-man engineering staff tending the station's three-tower directional array.

His time in northern Vermont included a brief and most unusual excursion into the recording business. Asked by a farmer to find a way to record the sound of a scared rat, Willey locked himself in a closet with several rats and an early Magnecord tape recorder.

What happened next? "PETA was not around then, or I would have been in big trouble for sure," Willey says. After testing the squeals of several rats, Willey and the farmer found one particular tape that, when played back loudly, scared off the rats that were plaguing the farmer. Never one to miss a business opportunity, the farmer proceeded to have records pressed of the rats squealing – under the "Pied Piper Records" label.

START OF A 45 YEAR RUN

Willey's next move would be his last. In 1960, he signed on as chief engineer of what was then a two-station group, WMNB in North Adams and WBTN in Bennington, VT. Under Don Thurston, who arrived as general manager shortly after Willey came to the station, WMNB would become the core of Berkshire Broadcasting, which remained Willey's employer until he retired 45 years later.

At Berkshire, Willey oversaw several generations of equipment. WMNB (now WNAW) progressed from the old RCA it was using in 1960 to a Gates BC-250, later field-modified into a BC-1T, then to a Harris MW-1A, and eventually to a Gates One.

FM was all but unknown in the Berkshires when Willey came to town, but that soon changed. Willey built the area's first FM stereo facility for the little college station at Williams College, WCFM, then followed that in 1964 with the first commercial FM stereo signal in the area, 100.1 WMNB-FM (now WUPE-FM).

As Berkshire Broadcasting grew, Willey took on responsibilities with the company's additional stations, which grew to include broadcast properties as far away as central Massachusetts and the southern Berkshires, a background-music service with clients as far away as central Vermont, and a paging service that operated through much of the seventies.

Tom Jay remembers a ride up to the WBBS transmitter site atop the Catamount Mountain ski area: "He throws me in the back of his four-wheel-drive vehicle and says, 'Come on, we're going for a ride,' and he takes me up to the transmitter shack on top of Catamount, with me holding on for dear life up the hill, and he said – 'this is nothing!'"

SIDE TRIP

Willey owned a portion of the paging operation, having come up with the idea while taking a management course at Purdue University in Indiana. Without the capital to build the paging company himself, he brought the idea to Thurston, who provided start-up funds in exchange for just over half of the company, which was eventually sold to one of Willey's partners in 1979.

Still busy at Berkshire Broadcasting, Willey added additional duties in the seventies when he began his own contract engineering sideline, then added a used-equipment firm to the mix. "I honestly cannot think of one station that I missed in western Massachusetts, eastern New York and Vermont," Willey says of his time as an itinerant engineer.

His work included construction of six brand-new FM stations, including two commercial outlets, WHGC in Bennington, Vermont (now WBTN-FM) and Berkshire Broadcasting's WBBS, Great Barrington (now WAMQ). He also served on the planning committees for the NAB Broadcast Engineering Conference in 1973 and 1976.

ENGINEERING ANOTHER GENERATION

Willey says his proudest accomplishment came after he retired from the Berkshire stations at age 75. (When Thurston sold the station in 2005, Willey left too, telling him: "When you walk out the door, I'll walk out with you.")

In the years since, his involvement with radio has been focused on college stations in western Massachusetts, including WCFM, the Williams College station he converted to stereo back in the early sixties, then rebuilt completely a few years ago.

"Working in small-time radio, you're always constrained money-wise," Willey says," but after I retired, I finally got to build a radio station the way I really wanted to build one."

Paul Willey at WCFM

With a budget of more than a quarter of a million dollars, Willey says "nothing was saved from the original station" as it moved to a new studio location and a new transmitter site. In keeping with his long-time preference for Harris equipment, Willey outfitted WCFM with PR&E consoles and a Harris QUEST 1KFM transmitter.

When not wintering in Florida, Willey remains busy with WCFM and his other college clients.

"I believe, over the years, that I have served this profession well," he says – and ***Radio Guide*** agrees, proudly inducting Paul Willey into our **Hall of Achievement**.

*Scott Fybush is a regular contributor to **Radio Guide**. His email is scott@fybush.com*

Tech Tips

by Mike McCarthy

Breakout Panels for Satellite Receivers and More

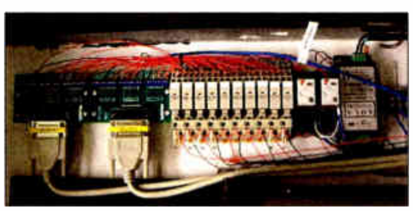
As the industry converts to the newer XDS satellite receivers, stations sometimes need to build new breakout panels to route the programs and remote control commands to the studio automation systems.

The DB-25 breakouts from Winford Engineering allow the B-Tools switcher closures to be brought out to an external location. The same can be done for the new MAX receivers. Thus eliminating a mess in the back of the racks.

We control two automation systems, plus tone encoders, by using a combination of breakouts from various receivers and triggers to DPDT relays, then back to 25-conductor breakout adapters going to two BTI switchers. All the jumping is done outside the racks on the wall where it is easy to install/change/test/debug/add more.

USING DIN ISO STRIPS

I use 35mm DIN ISO9000 rail strips for mounting relays, contactors, terminal strips, power supplies, and all sorts of things which need mounting in a rack, in a transmitter, on a wall, or really anywhere. You can buy the 35mm rails in six-foot long strips from Grainger for less than $40.

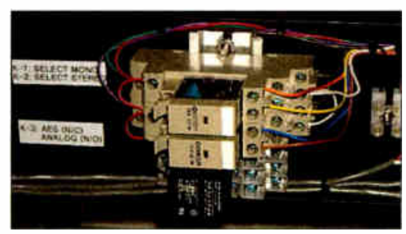


Building a breakout on a DIN ISO rail.

This long group of relays is used to matrix incoming satellite feeds to two automation systems.

The ISO strips are really nice to add relays and other universal things since DIN rails are a worldwide standard. The DIN mounting strip made the physical aspect of the project relatively simple – simply mount the rail next to the power strip or on a 3RU panel on the rear side.

I am using the DIN rail on just about anything for which I need a relay or can apply the concept. Snap a device/socket to the rail, wire, and go. If you need to mount more than one device, it is a real time saver.



Quick easy relay mounting and connection.

If you need to convert a transmitter remove control from 120 V or 12 V, just mount six or eight relays with a small rail-mounted power supply on a single rack panel. Pre-wire and go.

The rail eliminates aligning relays, related mounting issues, and is a real time saver. Several sizes of DIN strip are available. The one shown is 35mm.

Mike McCarthy, CSRE, CEA, is Director of Engineering for Newsweb Radio Company in Chicago, IL. You can contact Mike at mmccarthy@newswebradio.net

Antenna Guide

An Interesting Facet of the Venerable Yagi-Uda

by Ron Nott

Every broadcast engineer is familiar with the most popular VHF and UHF directional antenna in use today; there are many millions of them worldwide. It is commonly called a Yagi. But that omits recognition of a significant participant – really it should be called the Yagi-Uda antenna.

TURNING PROBLEM TO SOLUTION

By the 1920s, the problem of re-radiation from metallic objects in the near field of an antenna was well known. During this early history of radio communications development, Yagi was a high-ranking professor at a university in Japan and Uda was a young junior (or assistant) professor.

What they did was to turn this re-radiation problem into an advantage by placement of parasitic elements at certain distances away from an active or driven element. Consider first the simple three-element Yagi-Uda. There is a half-wavelength driven element in the center, with another element parallel to it on one side and a third parallel element on the opposite side.

By experiment, they learned that if one parasitic element was slightly shorter than the driven element and the other parasitic element was slightly longer, by manipulating the spacing of these elements, the antenna would have increased gain in the direction of the shorter element. The shorter element was named the director and the longer was named the reflector.

Each of the parasitic elements intercepts radiation from the driven element and then re-radiates it with a time lag based on their distances from the driven element. By experimenting with parasitic element lengths and spacing from the driven element, they were controlling the phase relationships between them, which resulted in forward gain to the antenna. Adding more director elements provided greater gain in the forward direction.

Evidently they learned that adding reflectors did not have the same effect, so today a five-element Yagi-Uda usually has a reflector, a driven element and three directors. This is because, in addition to re-radiating the energy from the driven element, each parasitic element also intercepts energy from its fellow parasitics, so that by the time the signal leaves the front end of the antenna, the pattern becomes very complex with all the intermingled fields. Today's computer programs combine them all into a single pattern shape which is all we need in practical use.

WHAT HAPPENED TO UDA?

Returning to the history of this antenna, Uda did most of the experimental work by transmitting out to a ship at sea. Because the technology for VHF and UHF transmission was limited back then, much of his work utilized HF radio. He was able to map pattern shapes and determine antenna gain, front-to-back ratio, etc. Front-to-back ratio is valuable in rejecting unwanted signals.

So if Uda did most of the hard R&D work, how come the antenna is commonly called a Yagi?

By the 1930s, the Japanese had this antenna quite developed, so Professor Yagi (having the seniority) made a trip to the United States to tell us about it; junior professor Uda had to stay in Japan to keep working on it.

Yagi spoke before several sessions of the old IRE (Institute of Radio Engineers), and the antenna was received with great enthusiasm. The trade publications of that day printed stories on it – of course giving Yagi the credit.

The Yagi-Uda antenna has a long history, and today's radio engineers and ham radio operators still keep experimenting with various element spacings, element lengths, and number of elements. In its early days, users believed the boom should be non-metallic, often being made of wood, but now booms are usually made of metal tubing. An outgrowth is the log-periodic antenna, much of its development being done by engineers at Collins Radio Co. who were also ham operators.

This leads to a curious phenomenon that I discovered by accident several years ago.

DEFECT OR FEATURE?

Some 20 years ago, a station engineer called stating that he believed the Yagi antenna I had sold him was defective. It was a Scala HDCA-5, which has an excellent reputation, so I told him to bring it to me and I would test it.

Our residence is on a hilltop that is seven miles from the FM station with pure line of sight, so I calculated the voltage that I should receive from the antenna terminal. Sure enough, the Scala Yagi was right on the money – it was not defective.

However, the station had a circular polarized antenna, so I decided to see how the Yagi performed in the vertical plane. It was just as good. But I noticed something: as I rotated the boom of the antenna through 45 degrees, the signal increased considerably. I checked it several times to prove consistency. Then I rotated it to the opposite side and when it went through 45 degrees, the signal *decreased!* In fact, the decrease was about the same in decibels as the increase on the other side.

EXPERIMENTATION

Then I wondered whether the station antenna was set up for right-hand or left-hand circular polarization. Perhaps this caused the signal to increase on one side and decrease on the other, depending on the rotation, by adding the H and V signals on one side, while subtracting them on the other.

While pondering this, I noticed a panel of steel roofing material lying on the ground. Could it be getting into the act? Yes, holding the antenna above it had a distinct effect. The distance of the Yagi above the panel caused significant variations in signal strength.

It occurred to me that if a CP signal reverses rotation upon being reflected from something such as a steel building, this effect might be used to advantage. For example, if the Yagi is to operate a distance from the station that provides a marginal signal, one could get a boost of a few dB. Furthermore, it might be used to reject a reflected signal.

Performance might be enhanced by placing a reflector (as above) a distance from the Yagi – in fact, it may be necessary to work at all. Maybe the reflector could be of grid construction rather than a wind-loading piece of sheet metal.

However, having other rats to kill, the experiments ended with me making a mental note that I should investigate further, but it never happened.

Why do I not experiment further to determine if this is really so and then optimize performance? Basically, because I am old and tired (and maybe a little lazy). I present it here for ambitious young antenna engineers to develop into a potentially valuable idea. Please take it with my blessing, but I would appreciate learning of the results.

Ron Nott operates Nott Ltd. in Farmington, NM, where he provides a wide variety of antenna systems and services. Contact Ron at ron@nottltd.com

Can a radio console be over-engineered?

(Only if you think "good enough" really is good enough.)

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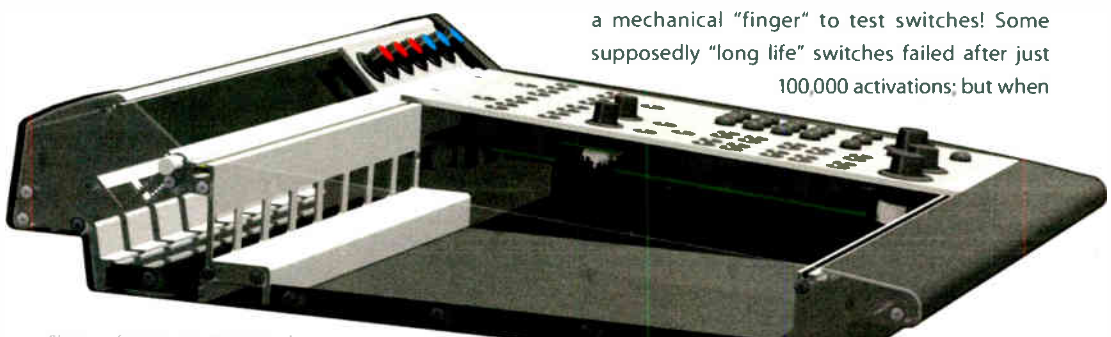
Building a great console is more than punching holes in sheet metal and stuffing a few switches in them. Building a great console takes time, brain-power and determination. That's why Axia has hired brilliant engineers who are certified "OCD": **Obsessive Console Designers,** driven to create the most useful, powerful, hardest-working consoles in the world.

Beneath the surface

There's more to a great board than just features. **Consoles have to be rugged,** to perform flawlessly 24/7, 365 days-a-year, for years at a time. So we literally scoured the globe for the absolute best parts — hardware that will take the torture that jocks dish out on a daily basis.



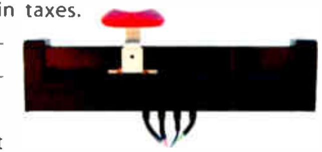
Element frames are constructed from custom aluminum extrusions for maximum rigidity. Module face plates & console side panels are machined from thick plate aluminum. Even the hand rest is a beefy extrusion. All this heavy metal means even the most ham-handed jock can't dent it.

First, Element is fabricated from thick, **machined aluminum extrusions** for rigidity and RF immunity. The result: a board that will stand up to nearly anything.

With so many devices in the studio these days, the last thing anyone needs is gear with a noisy cooling fan. That's why Element's **power-supply is fanless**, for perfectly silent operation inside the studio.

Element modules are **hot-swappable**, of course, and quickly removable. They connect to the frame via CAT-5, so pulling one is as simple as removing two screws and unplugging an RJ — no motherboard or edge connectors here.

Faders take massive abuse. The ones used in other consoles have a big slot on top that sucks in dirt, crumbs and liquid like the government sucks in taxes. By contrast, our silky-smooth conductive-plastic faders actuate from the side, so that **grunge can't get in.** And our rotary controls are high-end optical encoders, rated for more than **five million rotations.** No wipers to clean or wear out — they'll last so long, they'll outlive your mother-in-law (and that's saying something).



Element's **avionics-grade switches** are cut from the same cloth. Our design team was so obsessed with finding the perfect long-life components that they actually built a mechanical "finger" to test switches! Some supposedly "long life" switches failed after just 100,000 activations; but when our guys found the switches used in Element, they shut off the machine after **2 million operations** and declared a winner. (The losers got an all-expense-paid trip to the landfill.)

Element's individual components are **easy to service.** Faders come out after removing just two screws. Switches and rotary volume controls are likewise simple to access. And all lamps are LEDs, so you'll likely **never need to replace them.**

Engineers have said for years that console finishes don't stand up to day-to-day use. Silk-screened graphics wear off; plastic overlays last longer, but they crack and chip — especially around switches and fader slots, where fingers can easily get cut on the sharp, splintered edges. We decided that we could do better.

Element uses high-impact Lexan overlays with color and printing on the back, where it **can't rub off.** And instead of just sticking the Lexan to the top of the module like some folks do, our overlays are **inlaid on the milled aluminum module faces** to keep the edges from cracking and peeling — expensive to make, but worth it. For extra protection, there are **custom bezels** around faders, switches and buttons to guard those edges, too. Which means that Element modules will **look great for years.**

By the way, those on/off keys, fader knobs and bezels are our own design, custom-molded to give **positive tactile feedback.** The switch is flush with the top of the bezel, so it's easy to find by touch. But if something gets dropped on it, the bezel keeps the switch from being accidentally activated.

More than just products

Even the best products are nothing without **great support.** So Axia employs an amazing network of people to provide the best support possible: Application Engineers with **years of experience** in mapping out radio studios... the most knowledgeable, **friendly** sales people in the biz... Support Engineers who were formerly broadcast engineers. Plus a genius design team, software authors who dream code... one of the **largest R&D teams** in broadcast.

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Consoles

Practical Engineering

Why a Good UPS Plan Will Save Your Day

by Clay Freinwald

The first lesson about UPS's is to get one before you need it. The second is to make sure it is ready to work when a power outage hits. Here, Clay Freinwald discusses some of the key aspects that should be considered in putting a practical UPS system together.

Having been in this business well in excess of 40 years, I have seen a lot of things come and go. In the "Good Old Days," broadcast equipment was, by today's standards, built like a tank.

When I started, transistors and IC's had yet to come along and every piece of equipment in your racks came with a line cord. (Standard IDC power cords are a new invention).

You simply plugged in the desired piece of equipment, turned it on, and sat back to enjoy the glow, knowing that if anything bad came along the power line, the primary fuse would blow and that would protect the equipment. If it did, you replaced the fuse and you were back up and running; any transients that made their way inside the equipment before the fuse blew were usually handled by the rather robust linear power supply. Life was good.

LOSING THE GLOW

In time Fire/FET-based equipment began to be replaced with gear that did not glow in the dark – and the day of the transistor was upon us. Basically, little three-legged gizmo's replaced the glowing objects. Later equipment sported those black caterpillar-looking devices and, before we knew it, the IC age was upon us.

The new equipment had features which dazzled us but mostly operation was simple: plug it in and it ran. The line fuse was still the main protection, although now it was rated at a fraction of the current. Life was still good.

Along the way the IC became smarter and, with that advancement, we got equipment filled with sophisticated chips that would enable features that were Sci-Fi only a few years previously. Some of this equipment was based on another invention: the Personal Computer. Like all its predecessors the PC also had a line cord, and we simply plugged it in. But life was not so good because we quickly learned that some of this wonderful stuff was quite fragile.

ENTER THE LINE FILTER

The designers of this new generation of electronic equipment learned that their precious little feature-rich boxes could not simply be plugged in because they were not at all forgiving of power line bounces, glitches, spikes, and other things that earlier electronic gear simply ignored. One power line flash and very quickly life got bad.

Due to the costs involved in trying to make their machines immune to power line issues, we were introduced to some new equipment – the power line filter/conditioner. This was a gizmo that was inserted between the power outlet and our sensitive gear. Usually a collection of low-pass filters and MOV's, the filter/conditioner was supposed to keep the nasty stuff from harming our precious electronic babies. You probably have a number of these gizmos under the bench to this day.

However, the problem took on a new spin when some of this new equipment became "confused" after a spurt of nasty AC arrived at the line input or, worse yet, when a complete lack of power happened along. Our good old tube stuff would ignore this kind of thing, thanks to big capacitors in their power supplies etc., and usually just keep working through short power outages. But not some of the newer creations.

The solid-state gear's reaction was to either stop working ("freezing" and requiring a manual intervention) or would have its mind scrambled, causing them to do things that were not intended. This is when we began to better understand the term "un-documented features."

ENTER THE UPS

Before long, we were replacing the little AC filters and installing a new and bigger box: the UPS, or Uninterruptible Power Supply. These were billed as the ultimate form of protection for our equipment, making make it immune to the ravages of the power company.

UPS's became a mainstay in many broadcast plants, especially in critical applications where equipment failure due to power line issues was not an option. Some stations installed big ones, large enough to supply power to an entire TOC or more. Others opted to install a number of smaller ones figuring that there was safety in numbers and that this scheme would prevent the failure of a $.05 part from taking down lots of gear.

Today, it is well understood that these critters can be life savers, protecting everything from automation computers to consoles to the processors, STL, and other gear in the racks. As a result, broadcasters have invested in them by the thousands.

It is worth noting that the term "UPS" is often applied to two very different pieces of equipment. Unfortunately, like a lot of things, UPS's are purchased based on the belief that they will protect our equipment because that is what is implied by the name. It is, therefore, necessary to understand the differences between two types of equipment that share the same name. Further complicating the matter, the equipment that we are trying to protect does not always require the same degree of protection.

DEFINING UPS

It is important to understand that not all UPS's of this type are the same. Some are very basic and, perhaps, crude. Others provide a good deal of true isolation from the Mains.

The most common unit called a "UPS" – and often the least expensive – is basically just a "Backup Power Supply."

A typical small back-up power supply.

What this means is that during time when the Mains are misbehaving, these UPS's will provide a degree of filtering against line "nastiness," and when the power source reaches some threshold of nastiness or goes away entirely these units will switch their outputs to a built-in inverter that will operate built-in or external batteries for a period of time. For much of our less-fragile equipment, this is good-enough.

Unfortunately, we may find ourselves chasing a problem created during the time that these UPS are still connected to the Mains *before* they switch to their inverter. In these cases, our fragile equipment can be getting its brains scrambled while the UPS is making its decision what to do. The solution to this problem may be to utilize what is called a "true UPS."

A true UPS is perhaps what the term UPS really was meant to describe – that is, to be un-interruptible. These often include ferro-resonant or Sola type transformers as part of their design. The input of these units charges a battery while their inverter works all the time providing AC output.

A true UPS with an external battery.

During periods of voltage spikes, brown-out, or total power loss, the UPS continues supplying the normal power feed until the battery is exhausted. The control and diagnostic display shows the condition of the UPS, allows testing, and permits a complete bypass for maintenance.

The great thing about this design is that your finicky equipment is quite isolated from the outside world and – one hopes – just keeps on working.

CHOOSING THE RIGHT UNIT

There are a number of decisions that must be made when it comes to buying the right UPS for the job – or evaluating the existing UPS system at your facility. Here are some things to check:

1. Do you need true UPS or not? As we have noted, it is important to balance the level of protection provided by a UPS model with the needs of the equipment being protected. Having a back-up system restore power is of little use if the switching delay is long enough to cause the electronics in the console to reset everything to "off."

2. What is the connected load to the device? I often see UPS's that are not sized properly, either too big or two small. (One engineer put a 1000 Watt UPS on the input to a 1 kWAM transmitter.) And be alert to "load-creep" – where more and more gear is plugged into a circuit, eventually exceeding the UPS's ability to deal with it.

3. How long do you need the UPS to perform? This is based on battery size, whether or not you have a back-up generator, and how long it takes to start and restore power in the event of a more protracted outage. Of course, longer UPS runtimes means bigger batteries and that could well mean space and ventilation issues.

4. Do you want one (or more) large UPS's or wish to have a larger number of smaller ones? The decision to use large UPS's should consider the fact that you are putting a lot of things in one basket and are creating a Single Point of Failure (SPF – see Stan Adams' article on page 16.) problem that could come back and bite.

5. For those that are planning on using a large UPS, another question: should I be using a conventional electronic battery charger/inverter system or should I consider a fly-wheel system? These are certainly interesting as they are not very big and you do not need a large bank of batteries.

(Continued on Page 24)

Practical Engineering

Why a Good UPS Plan Will Save Your Day

– Continued From Page 22 –

UPS'S BREAK TOO!

Do not forget what Murphy says about these things: the more complicated a system, the greater number of parts there are to fail! That being said, the engineers' best defense is *redundancy*.

I am always amazed at how broadcasters will have spare antennas, transmitters, exciters, studios etc., and yet these stations who pride themselves with their layers of redundancy, still have locations where they have come to rely on a single UPS.

Over the years I have come to learn and appreciate the following: I have no idea of how many times the UPS has saved my bacon, but I can count the time that it has fried it!

What I mean here is simply this: I know that UPS's do prevent equipment problems created by power line issues. But their introduction into any system, increases the parts count of that system and therefore creates a more complicated system with more things to go wrong – and they occasionally will.

INCLUDE TRANSFER SWITCHES

UPS's can and will fail. Do not let such failures cause you to have to make those 3:00 AM emergency trips to the stations facilities to bypass the new smelly UPS.

We all know the advantage of having an automatic transfer switch for our auxiliary power generator systems. Otherwise whenever we had a power failure we would have to run to the station to plug things into the aux-power outlet.

The rule is simply this: if the equipment down-stream from *any* UPS is critical to the operation, install a transfer switch there as well.

A Pulizzi auto-switching power controller.

There are a number of firms that make these switches, and they vary in terms of complexity and features. Pulizzi/Eaton and APC are among those that come to mind.

Back side of the Pulizzi transfer switch. One plug goes into the UPS output, the other into Mains (or a second UPS). The eight outlets feed critical or finicky equipment.

POWER PROBLEMS SOLVED

Entercom in Seattle is an example of a cluster that has been burned more than once by a failed UPS. And when that UPS was located at a snowed-out transmitter site in the middle of the night, it was not a pretty picture.

Today 100% of their UPS's have an automatic transfer switch located downstream from each UPS so that – when one fails – the equipment following has a chance of continued operation by being automatically re-connected to the Mains.

A server room at Entercom Seattle showing four UPS's (two different types) and automatic transfer switches.

Whether stations elect to deploy large UPS's that power lots of critical equipment or small ones that serve things you cannot do without, it is a best to install a transfer switch to automatically switch the load to a backup feed.

Just remember that redundancy is a great way to fight off Murphy issues – and automatic redundancy is even better.

*A veteran radio engineer based in Seattle, WA, Clay Freinwald is a frequent contributor to **Radio Guide**. Contact Clay at k7cr@blarg.net*

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SINCE 1963

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 will 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.

As Bill Sepmeier shared with me recently, 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. They 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 the Vice President of Engineering for the Educational Media Foundation in Sacramento, CA. You can reach him at swallington@emfbroadcasting.com

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Heavy Metal

RCA's Transition to Design & Manufacture

Part 4: BTA-50G/H/J - The Ampliphase

by J.S. Sellmeyer, P.E.

Our discussion of RCA's radio broadcast history has gone from its early days as a marketer for GE and Westinghouse low-level modulated transmitters to the design and manufacture of some of the most famous high-level modulated tube transmitters in history. Jack Sellmeyer brings the history of RCA radio broadcast manufacturing to a close with the Ampliphase series.

RCA sold the BTA-50F-1 into the early 1950's. This transmitter would be the last high-level plate modulated 50 kilowatt transmitter marketed by the company.

Its replacement in late 1955 was the BTA-50G, the first domestic application of the "outphasing" or "Ampliphase" modulation system offered commercially in the United States. The first BTA-50G transmitter was reportedly shipped to WINS in New York City in December, 1955.

A NEW TYPE OF MODULATION

"Outphasing," as a method of generating amplitude modulation of a radio frequency carrier, was first described in 1935 by a Frenchman, Henri Chireix. It was applied in Europe in the late 1930's, most notably to a high power broadcast transmitter in Luxembourg which was captured by the Allies during the latter part of the war and used to transmit instructions to the underground in occupied Europe.

The system was not widely used in the United States until RCA introduced the BTA-50G in 1955. It has been reported that in the early 1950s, RCA acquired the rights to what they called the "Ampliphase" System, as well as the engineering knowledge to produce the system from an external source, the engineering department of the McClatchey Broadcasting Company.

This was not the normal practice for RCA.

MCCLATCHEY BROADCASTING

The McClatchy Newspaper chain in California was one of the early broadcasters in the western United States with operations on the west coast and in Nevada. The group was headquartered in Sacramento, the state capital.

There, McClatchy owned station KFBK, a Clear Channel (I-B) station operating on 1530 kilohertz.

FCC records indicate that KFBK was issued a modification of its construction permit in mid-1948 to change the type of transmitter to a composite transmitter. The permit also authorized construction of a single-pattern directional array using a pair of full-wave Franklin antennae. (In late 1949 the company was also issued a construction permit for a power increase for its station KOH in Reno, Nevada to five kilowatts. The permit for KOH also specifyed a composite transmitter.

Both of these transmitters were designed and built by McClatchy engineers in Sacramento. These are believed to the first outphasing or Ampliphase designs built in the western hemisphere. The KFBK transmitter was licensed as the main transmitter until its replacement in 1969 by an RCA BTA-50H1S model.

The McClatchy 50 kW transmitter. Notice the spare finals on the desk, base up. Courtesy: Dale Harry

OUTPHASING

The system generates amplitude modulation indirectly by phase modulating two independent radio frequency channels out of phase which, when combined in the RF output network, produces the amplitude modulated carrier.

This is accomplished by adjusting the phase relationship of the two channels to 135 degrees at carrier, then modulating them in inverse phase so that, when each channel is retarded by 22.5 degrees, the difference between the two vectors is 180 degrees and the output of the system is zero. This is the trough of the envelope at 100 percent negative modulation. Conversely, when the phase of the two channels is advanced by 22.5 degrees, the envelope is modulated 100 percent in the positive direction. Figure-1 illustrates the vector relationships of the two channels.

(Continued on Page 30)


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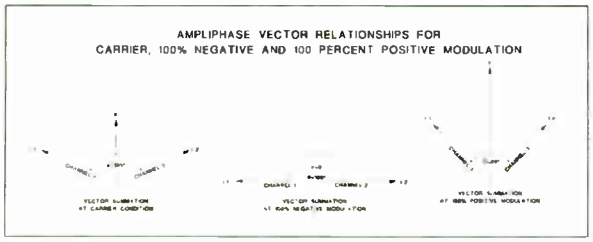
Heavy Metal

RCA's Transition to Design & Manufacture

– Continued From Page 28 –



Further advances in phase result in higher positive modulation until the two vectors approach zero degrees difference – and bad things begin to happen. It all sounds very simple but, as they say, "the devil is in the details." A truer statement was never spoken!

HIGH EFFICIENCY, HIGH QUALITY

The system has several attractive features including reasonably high AC to RF conversion efficiency and relief from the necessity of using expensive iron core modulation transformers and reactors. Very wide frequency response is possible because of the absence of large iron core components in the audio path. The system is capable of very low harmonic distortion when properly adjusted.

However, these features came with a penalty in the form of very complex circuitry to generate the two phase modulated RF channels and distort – or is it "predistort" – the laws of physics to make the system linear.

A SMALLER FOOTPRINT

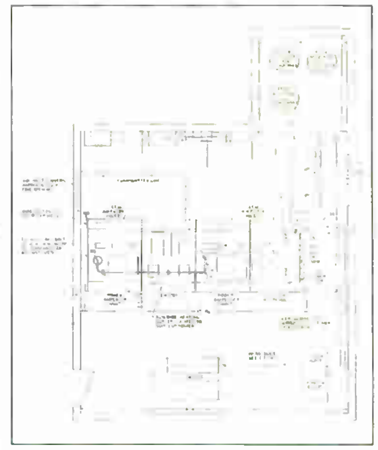
The BTA-50G transmitter was significantly smaller than its predecessors, being largely self-contained in four freestanding cabinets with their front panels attached to the cabinet frames.

The RCA BTA-50G

No longer were external blowers or external ductwork required to direct the cooling air to the areas needing it. The three blowers used in the transmitter were self-contained in the two RF Amplifier Cabinets and the Rectifier Cabinet.

The three high voltage plate transformers were located in a protective cage or transformer vault, if required by local ordinances, external to the main cabinets. The voltage regulator transformers and all switchgear were located on a vertical surface external to the cabinets, usually on the wall immediately behind the cabinets.

Wiring ducts carrying the AC and control wiring were normally installed on the walls or overhead between the top of the transmitter cabinets and the switchgear and transformers.



The 50G's suggested floor plan

TUBES 'O PLENTY

The BTA-50G, the first of the Ampliphase series, holds the all-time record for tube count at the 50 kilowatt level, both in terms of raw numbers and in number of different types. The transmitter used a total of 74 tubes of 15 different types, including the 17 tubes in the standby exciter/modulator. Many in the industry regarded this as a step backwards; the low tube count and the simplicity of the BTA-50F had been great selling points!

The BTA-50H, the second of the series, cut that by half, reducing the tube count to 37 total of 13 different types by replacing the mercury vapor rectifiers with solid state rectifiers and making the standby exciter/modulator optional. The BTA-50J further reduced the tube count to a total of 18 tubes of 8 types by incorporating a solid state exciter and drive regulator.

With all of the added complexity of the Ampliphase process, the overall AC to RF conversion efficiency was improved by only four percent over the BTA-50F1.

(Continued on Page 32)

RCA's Transition to Design & Manufacture

– Continued From Page 30 –

Overall Power Consumption at 50 kW RF Output

Model	Unmod	25% Mod	100% Mod	Efficiency
50-D	140 kW	Not Spec	175 kW	43%
50-E	110 kW	120 kW	156 kW	48%
BTA-50F	116 kW	124 kW	158 kW	47%
BTA-50F1	96.5 kW	105 kW	138 kW	54%
BTA-50G*	94 kW	100 kW	130 kW	58%

(* The G, H and J models had similar power consumption figures.)

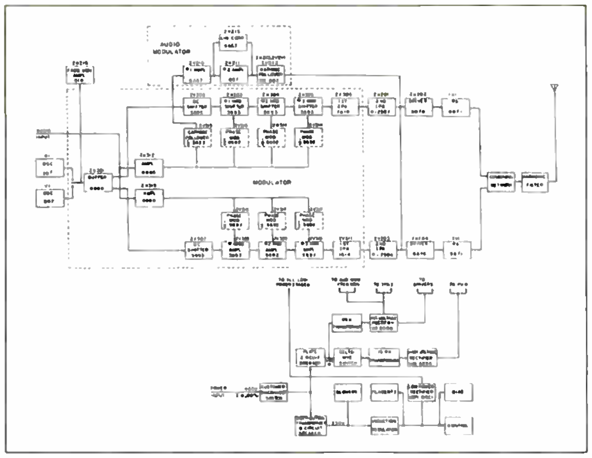
A LOOK INSIDE THE 50G

Let us start our discussion of the various sections of the BTA-50G by taking a look at the transmitter's basic block diagram.

The BTA-50G and BTA-50H used the familiar UL-4392 Oscillator assembly as the RF source. Two units were furnished with independent, oven-mounted crystals equipped with front panel pushbuttons to select the oscillator in use.

The BTA-50J eliminated the independent vacuum tube type oscillators and incorporated solid state oscillators.

The UL-4392 and its predecessor were originally designed about 1935 and were used in all RCA 50 kWAM transmitters from its inception until the late 1960's when the solid state Ampliphase exciter was designed.



BTA-50G Block Diagram

DUAL EXCITER/MODULATORS

The output of the selected oscillator was fed to one of two independent "Exciter/Modulator" units. Either of the Exciter/Modulators could be selected for use on the air with the other as a standby unit in case of an on-air failure. The RF oscillator drove a buffer amplifier whose output was split into two identical signals which were shifted in phase by 180 degrees to drive the subsequent phase modulators, of which three were required in each RF chain.

The audio input signal fed two independent audio amplifiers out of phase which drove the phase modulators for each of the RF chains. The audio stage of the #1 RF chain also fed a cathode follower which provided audio drive to the "Drive Regulator." The Drive Regulator operated as a grid modulator in a subsequent Class B RF Driver stage which, in turn, drove the Class C RF power amplifiers.

The three phase modulators of each RF chain operated in cascade or series with the output being a linear phase modulated RF output. This signals were amplified by a single ended class C RF amplifier in each chain which produced a few Watts of radio frequency power to drive a 4-250A tetrode also operated in class C. This stage drove the RF driver stage of each chain. These two class C stages effectively limit any incidental amplitude modulation component appearing on the two phase modulated RF chains.

RF DRIVE

The RF Driver of each chain was grid-modulated by the Drive Regulator to clean up some mathematical problems at the trough of the envelope.

Several critical adjustments were present in the Drive Regulator which dealt with linearity of the RF envelope and, consequently, harmonic and intermodulation distortion products in the modulated signal. These adjustments interacted with all of the interstage tuning adjustments of each of the RF chains. This is the principal reason the Ampliphase system developed a reputation for troublesome operation.

The RF Driver stage drove the RF Power Amplifier stage of each chain. The two RF power amplifiers were coupled together to a common combining point by a pair of Pi networks.

Following the combining point, the balance of the output network consisted of a low-pass filter with deep notches at the second and third harmonics and matching sections for the designed load impedance. The output network consisted of very robust components.

FIELD MODIFICATIONS

The BTA-50G underwent several field modifications in its early years. The G model began life with a new high

(Continued on Page 34)

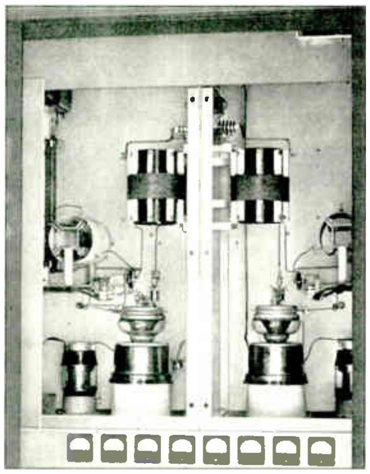
Heavy Metal

RCA's Transition to Design & Manufacture

– Continued From Page 32 –

voltage rectifier tube, the 6894. The 15,000 Volt rectifier used twelve of them in a conventional three-phase full-wave configuration. Two tubes were used in parallel, with equalization reactors in the plate circuit of each tube, in each of the six positions.

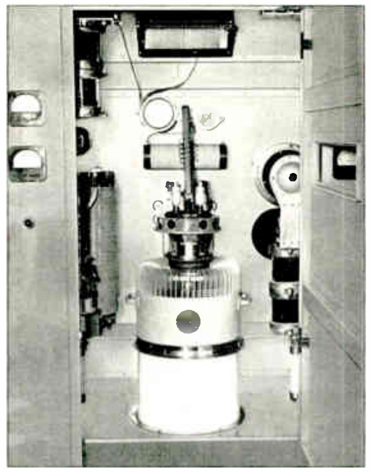
However, early on problems developed with the tubes in the form of premature failures. A service bulletin was issued covering the first 24 transmitters to change the type of rectifier tube to the 857B, a rugged, widely-used rectifier tube developed in the 1930's and used in all of the RCA manufactured 50 kilowatt transmitters up to the BTA-50G.



The 50G RF Driver with the original 5762 tubes.

The BTA-50G design initially used a pair of 5762 triodes, an RCA developed tube which was widely used in RCA AM, FM, and television transmitters in the late 1940's through the early 1970's for the RF Driver stage.

This tube was apparently replaced in the early production radios with 6076 tetrodes as RF Drivers and 5671 triodes for the RF Power Amplifiers. These are the same tubes the BTA-50F1 used in the modulator and RF Power Amplifier.



The 50G PA Amplifier used 5761 tubes.

These tubes had an excellent service life, often exceeding 80,000 hours in the previous transmitter, and were retrofitted into several other transmitters, both RCA and Westinghouse.

DRIVER AND PA TUBE CHANGES

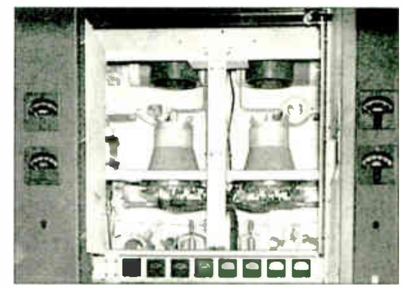
The BTA-50H and J versions of the transmitter were the same physical size as the BTA-50G. The principal difference between them and the G version was elimination of all of the mercury vapor rectifier tubes and replacement with solid state rectifiers. All of the rectifiers were changed to silicon types.

At the same time, the RF Driver and Power Amplifier tube types were also changed to newer types. The 50H and 50J models used a pair of 4CX5000A tetrodes for the RF Driver stage and newly developed Machlett 6697 air-cooled triodes in the RF Power Amplifier stages.

KFBK replaced its original 50 kW with this BTA-50H1S in 1969

The probable reason for the tube change in the driver stage was replacement of a tube considered obsolete by the production date of the later models. The 4CX5000A is also a more robust tube. The reason for the replacement of the 5671 is unclear.

The 6697 has a filament power rating only 85 percent of the 5671, which may have lead to a shorter lifetime. The required airflow is significantly greater that that required for the 5671, at much higher pressure. This required a heavier blower to deliver the required pressure.



The 50H and J RF Driver used 4CX5000A tubes.

(Continued on Page 36)

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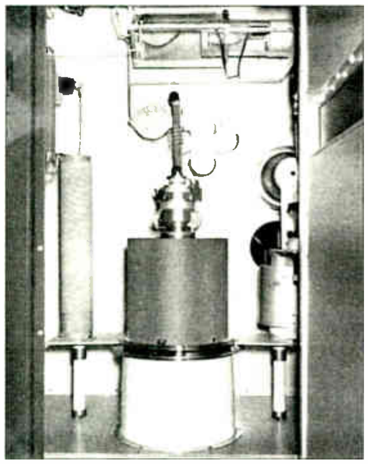
Heavy Metal

RCA's Transition to Design & Manufacture

– Continued From Page 34 –

The only significant advantage of the 6697 over the 5671 is weight: the 6697 weighs only 29 pounds vs 228 pounds for the 5671. Thus no tube jack was required to change tubes. This probably resulted in a manufacturing cost savings on the order of one thousand dollars.



The 50H and J PA Amplifier used 6697 tubes.

The other significant difference in the original BTA-50G and the BTA-50H/J series is the elimination of the second exciter/modulator unit. Space was provided for a second, optional, vacuum tube exciter in the BTA-50H. The BTA-50J used a newly designed solid state exciter housed in a three rack-unit high, modular assembly similar to that used in the television studio equipment line of the mid-1960's. Space was available in the RF Driver cabinet for installation of a second exciter for backup purposes.

In addition to its popularity in the United States and Canada, the 50 kilowatt Ampliphase transmitters enjoyed a healthy export business. At least thirty of the BTA-50G models were produced.

DIFFICULTIES

Around 1974, RCA began production of Ampliphase transmitters at the five and ten kilowatt levels, using the solid state exciter developed for the fifty kilowatt transmitters.

Unfortunately, although sales were good, the low power transmitters rapidly developed a poor reputation for reliability and overall air quality. Some even referred to the series as the "Amplifuzz," when distortion reached annoying levels.

However, as with the 50 kilowatt transmitters, the distortion problems were due to the intense maintenance requirements needed to assure top quality on air performance. Few of the smaller stations were equipped with the specialized test equipment required to properly maintain the transmitters – and fewer still had technical personnel trained to perform the required maintenance.

THE END OF THE LINE

RCA produced Ampliphase transmitters at power levels of 100 and 250 kilowatts from the mid to late 1950's until the end of production when RCA closed down its broadcast manufacturing around 1980. Many of these went to Africa for service in government-owned networks and stations.

One 250 kilowatt radio operated as a "Border Blaster" at XERF, Acuna, Coahila, Mexico in the late 1950's through the early 1970's. Wolfman Jack got much of his early exposure hawking goods to the vast U.S. audience during the nighttime hours from "Del Rio, Texas." Another 50 kilowatt Ampliphase radio operated on a pirate ship as "Radio Caroline" off the coast of Great Britain in the 1960's.

Although no accurate production data is known to exist, it is probable that RCA produced at least 30 BTA-50G transmitters and is thought to have produced 30 more BTA-50H transmitters beginning in 1960 and 12 BTA-50J models beginning in 1970.

The last BTA-50J transmitter left the factory in 1978 near the end of RCA's lifetime. The total of 72 transmitters is probably more than the total number of fifty kilowatt transmitters of all previous series produced under the RCA name prior to the Ampliphase series.

And with that, RCA's activities as a manufacturer went into the history books.

R.I.P.

A pictorial look at the entire series of RCA 50 kilowatt transmitter can be found at www.oldradio.com/archives/hardware/RCA/50.htm

Jack Sellmeyer has been designing, constructing and maintaining broadcast equipment and stations for over five decades. Jack can be contacted at jack@sellmeyereng.com

Tieline Connects VoIP Via Satellite

by Charlie Gawley and Glenn Davies

ABC Radio Australia's "Breakfast Club" program broke new ground recently when they connected and broadcast for several hours from Cambodia using a Tieline Commander codec and a BGAN (Broadband Global Area Network) satellite terminal.

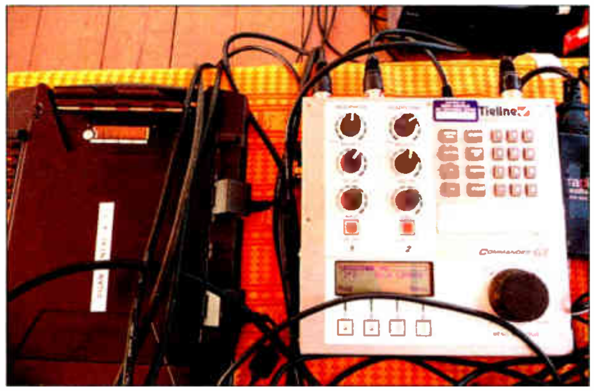
It was the second year that Radio Australia had visited Cambodia to broadcast live from the Water Festival in Phnom Penh, an important event and a great opportunity for Radio Australia to meet listeners throughout the region. This was the first attempt by Radio Australia at broadcasting over satellite IP, and there was some nervousness prior to the OB because it was impossible to test the connections before arriving on-site.

LONG DISTANCE REMOTES MADE EASY

Broadcasting IP over satellite connections is now a relatively simple task. With BGAN you can broadcast from wherever you can obtain a satellite signal.

All Radio Australia had to do was set up the satellite terminal, connect a LAN cable between it and the codec, and dial the IP address of the codec in Melbourne. The Tieline IP is suitable for all radio and television broadcasts, including HD radio, television and Internet broadcasting.

Ryan Egan, Technical Producer for Radio Australia, operated the codec and Thrane & Thrane satellite terminal in Phnom Penh. He connected reliably at 24 kbps and used the Tieline "Music" algorithm to send both music and voice programming live to Radio Australia's studios in Melbourne. The program audio was then rerouted back to Cambodia over Intelsat and transmitted to local audiences.



The BGAN satellite terminal and Tieline Commander plug into each other.

Using the Tieline IP codecs provided reliable, live FM quality audio over the Inmarsat global satellite network for several hours. Radio Australia has found the Tieline Commander to be very portable, which is critical when travelling extensively into remote regions. It can literally be packed into a briefcase and taken virtually anywhere.

CLEAN, STABLE AUDIO

Radio Australia often broadcasts from remote locations throughout the Asia-Pacific region. Some of the other places they have broadcast from using Tieline codecs include Indonesia, Vanuatu, Papua New Guinea, Samoa, the Phillipines, and Fiji. If a POTS/PSTN line is available in these regions you are generally lucky if you can connect at between 16 - 19 kbps, and high quality FM audio cannot be achieved at these bit-rates.

BGAN IP connections provide higher bit rate connections and higher quality audio, with much greater flexibility.

The broadcast from Cambodia worked very smoothly. Throughout the Radio Australia network everyone was happy with the reliability and audio quality of the broadcast. Ryan remarked that the program audio connection was very stable over many hours. He also sent the mix-minus return feed from Australia back to the local PA in Phnom Penh for playback of news during breaks in the broadcast.

COST EFFECTIVE

BGAN is now available in the US as well as throughout the majority of the Pacific region. Radio Australia and other broadcasters throughout our region are gearing up to take advantage of the increased satellite footprint and use IP over BGAN more often. The introduction of BGAN to US broadcasters opens up new opportunities for doing long distance remotes there.

Apart from the flexibility of IP broadcasting over BGAN, it also provides a cost-effective data solution. When compared to the broadcast Radio Australia did the year before, satellite ISDN B-channel data cost around $4,000 – the same broadcast a year later using IP over BGAN cost around $1,300!

You can expect to hear a lot more about satellite IP in the coming months as more broadcasters take advantage of the cost advantages and flexibility provided by remotes broadcast through satellite channels.

Charlie Gawley is a Business Development executive at Tieline and Glenn Davies is a consulting engineer in western Australia. Contact them at glenndavies@bigpond.com

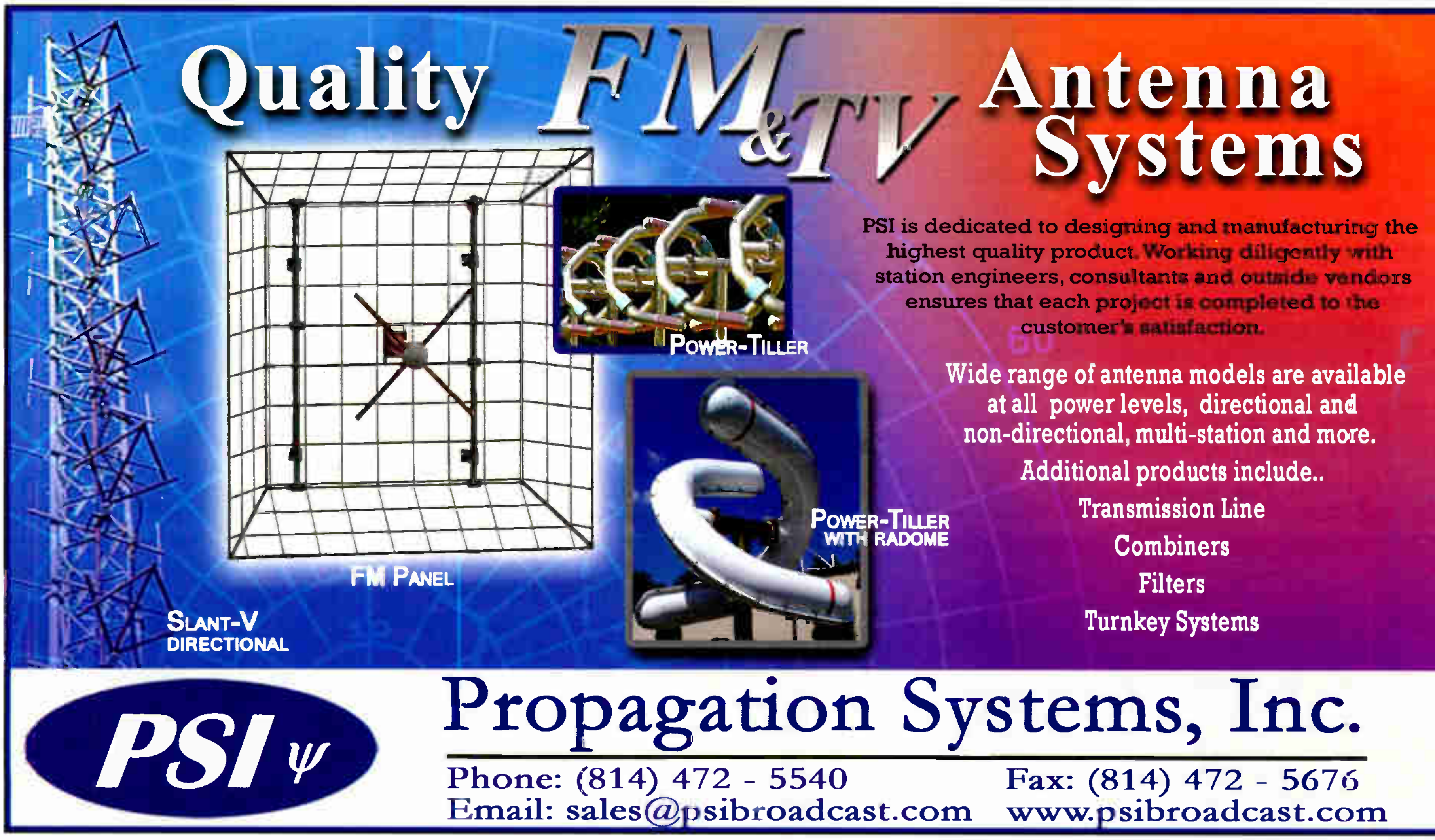


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photo by Chriss Scherer

Road Testing the PowerAIM 120

by Alan Alsobrook

After reading Jack Sellmeyer's nice article (***Radio Guide*** March-April 2008 p.20) about the PowerAim 120 from Array Solutions, along with seeing it in action at the ***Radio Guide* AM Transmission Seminar**, I just knew I had to have one of these critters. So I finally bit the bullet and ordered one in January.

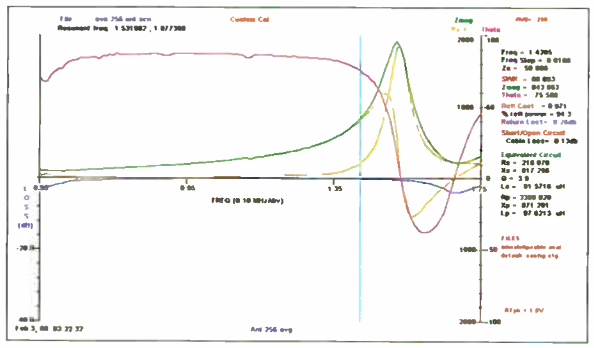
The PowerAim 120 in Alan's camera case.

PUTTING IT RIGHT TO WORK

Of course, once I had it in my hands I had to figure out what kinds of diagnostic displays it could produce. After doing a few test sweeps, I determined my OIB is going to be getting a great deal of rest. Being able to sweep the entire AM band in two minutes – and see the results – is something that would have taken an entire night with a bridge.

It also does not seem to get squirrelly when you get into high-Z loads like an OIB will.

After getting used to it in the shop, the time had come to do some real work. A diplexer I maintain had been getting a bit flaky of late, so I put the AIM to the task of figuring out what exactly was going on. The first screen shot is a broad sweep of the 380-foot skirted antenna, used for stations on 1240 and 1420 kHz.

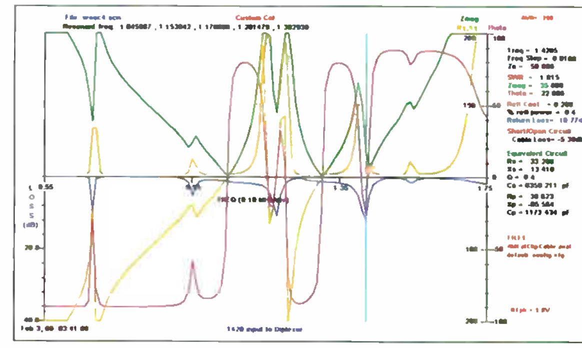


A sweep of the antenna.

From this I was able to see for the first time exactly how the antenna was reacting across the entire band. From the graph you can easily tell that the upper frequency carrier of 1.42 MHz is riding on the slippery up-slope heading towards the half-wave point. At 1420 kHz, the resistance was 210 Ohms, with a reactance of +817 Ohms, difficult to read on my OIB but clear on the screen.

CHECKING THE ATU INPUT

Next I looked at the input to the ATU and observed an interesting mess. Instead of 50 j 0, the transmission line was matching into 33 -j 13 Ohms.



A wideband sweep looking into the ATU.

I also noticed that this mess changed drastically on carrier frequency when I opened the J-plug leading to the far side filters. That little tidbit let me know I had troubles in the far side filters. Now to figure out exactly what was causing the problem.

Measuring the series filter, I saw that the reject frequency had moved about 15 kHz from where it was supposed to be set. When you think about how much energy would have been passing through that filter and then dumped by the shunt filter, it makes me wonder how I was even getting a signal on the air. On the Power AIM display, an easy way to determine the resonate frequencies is to look and see where the theta (phase shift) crosses zero.

(Continued on Page 42)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Field Guide

Road Testing the PowerAIM 120

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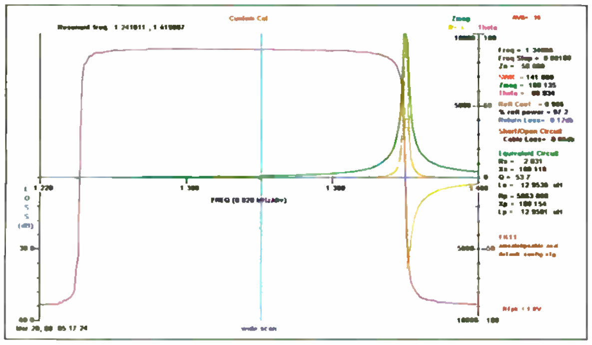


The purple line shows the resonance at both operating frequencies.

Of course you can look at other things such as where the signal peaked or dipped, depending on which side of the trap you were looking. With a few other tweaks and adjustments – verified by another quick sweep – and the diplexer was once again operating nicely. A quick check with the FIM showed that the signal strength had increased as well.

The experience made me think that if you are running combined stations, it is probably a good idea to double check the tuning networks once or twice a year to make sure they have not drifted, causing a serious signal loss.

I can see many applications other than antennas – transmitter PA work comes to mind. Testing caps (for value) is another item you can do quickly; doing this over a wide frequency range seems to give a good indication of hidden troubles, not to mention the ease of tuning of an ATU match point to any desired value.

MINOR ISSUES

Now that I have discussed good side of the PowerAIM 120, let me mention a few things I did not like about it. (Of course, I had to set about correcting what I saw as deficiencies.)

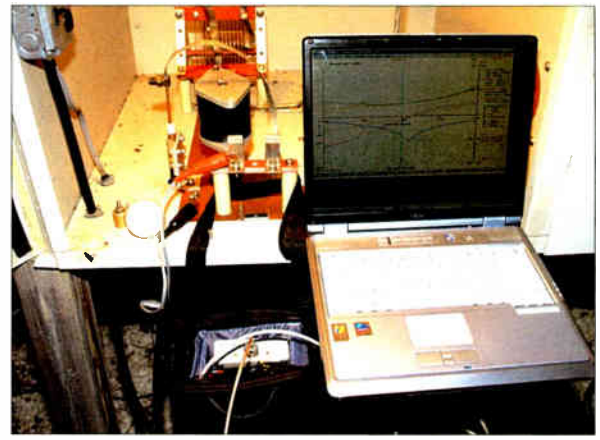
First, it arrived with a big Pelican case designed to house the PowerAIM 120 along with a laptop, something that I will likely never use. And I was really depressed to find there were no test leads included as part of the package.

The final items that made me grumble a bit were the calibration loads, which were not very accurate at the higher end of the PowerAim 120's operating range, and that you will also need to provide your own RS-232 to whichever cable you will need to interface with your laptop.

MAKING IT ALAN-READY

So I quickly made a test cable, using some RG-400 along with 1/4-inch flat braid and some 40 Amp clips.

Next I borrowed the precision OSL from an Anritsu Site Master to do several calibrations and save them for future use. Next up was to put the Pelican case in storage. I then nicely fitted the AIM and battery into a small camera bag, complete with an RS-232 cable already attached and the battery all hooked up. Now when I go to deploy on a test all I need to do is connect the test cable to the front and plug the RS-232 cable to my laptop.



The PowerAim 120 is easy to take out and set up in the field.

Before I made these modifications, I had been out to try the PowerAIM 120 and it was taking me 15 to 20 minutes to get set up and make a measurement.

After moving to the camera bag, I could pull up to a site, make the measurement, and be back in my vehicle in five minutes. If I have to make a minor adjustment, who knows, it might be as much as ten minutes before I am ready to depart!

---

*A periodic contributor to **Radio Guide**, Alan Alsobrook, CSRE, AMD is a contract engineer based in St. Augustine, FL. Contact Alan at radiotech@bellsouth.net*

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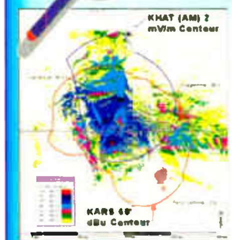

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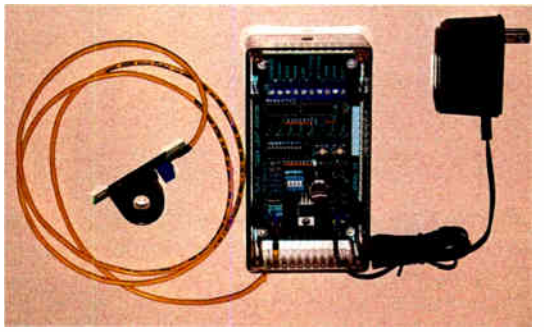

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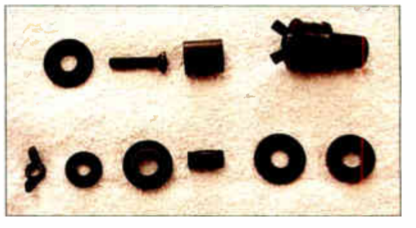
We Re-Condition

Pacific Recorders BMX I-II-III, AMX, ABX and RMX, Stereo-Mixer and Mixer News-Mixer products.

We have replacement Wind Screens and Blast Filters for the SM-5B microphone.

We now have SM-5B hanger hardware as shown in the photo.



See the "News-Update" page at our website.

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Celebrating Our 27th Year
Serving Our Customers

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OUTSTANDING specifications and pricing on professional quality receivers for **EAS**, station monitoring and translator applications.

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JK Audio BlueKeeper Wireless Audio Gateway

JK Audio combines Bluetooth Wireless Technology with professional audio electronics in a convenient desktop design.

BlueKeeper allows you to send mic and line level signals into your wireless phone while maintaining excellent separation between your voice and the caller. The stereo output jack on the back of the unit provides your voice on one channel and only the caller's voice on the other channel. The balanced XLR output jack contains only the caller's voice.

BlueKeeper pairs to your cell phone like a Bluetooth wireless headset. This professional microphone preamplifier provides a dramatic improvement in sound quality. BlueKeeper also pairs to Bluetooth equipped sound cards and music players in full bandwidth stereo A2DP mode.

The 3.5 mm stereo line input jack allows recordings to be sent into the Bluetooth device. The 3.5 mm stereo line output jack provides your full bandwidth send mix on the left channel and Bluetooth caller audio on the right channel. The headphone output gives you a mix of the XLR input, 3.5 mm input, and Bluetooth audio.

Features:

- Bluetooth Wireless Technology
- Female XLR mic/line input.
- Caller XLR line output.
- 3.5 mm stereo line input.
- 3.5 mm stereo line output, left = send mix, right=caller
- 3.5 mm mixed mono mic level output contains both sides of the call.
- 3.5mm stereo Headphone jack, mixed send and caller.
- Send and Caller signal level LEDs.

Power: 120-240 VAC power supply (included).
Size: 7" x 6" x 1.6" (18 x 15 x 4.2 cm)
Weight: 2.2 pounds
Available through authorized dealers May 2009.
JK Audio will be at NAB Booth N2125

JK Audio, Inc.
815-786-2929 • www.jkaudio.com

Henry Engineering Announces the New PowerSwitch™

PowerSwitch is an automatic "fail-safe" AC power controller that switches AC power to Backup equipment if Main equipment fails.

PowerSwitch was developed for use with Arbitron PPM™ encoders. If a PPM™ Monitor is used, the PowerSwitch will automatically switch to the Backup PPM™ encoder if the Main encoder fails. This redundancy with automatic backup ensures that radio stations never lose ratings data in the event of a fault with their main PPM™ encoder.

PowerSwitch can also be used as a "remote rebooter", to reboot a PC at a transmitter site or other remote location. It can also be used in any application where AC power needs to be remotely turned on or off.

PowerSwitch on display at NAB Booth N8215

Henry Engineering
626-355-3656 • www.henryeng.com

DM Engineering Audio-Pod System

Tihs microphone on-off controller, with integrated stereo headphone amplifier, is the ideal solution for remote broadcasts, talk studio applications, or whenever you just need from one to four Mic/Headphone stations.

The Audio-Pod module is available with or without a high quality-low noise mic pre-amplifier with switchable phantom power. The system may be configured with up to four Audio-Pod modules with one Power Supply.

DM Engineering
800-249-0487 • www.dmengineering.com

Tieline Technology Announces New IP Codec

Tieline has announced the development of a low cost, high performance stereo IP codec, for main or backup Studio-to-Transmitter Links, audio distribution and simple remote broadcast links.

"Tieline's new Bridge-IT IP codec is the perfect solution for low cost, point-to-point IP audio links," said Darren Levy, Tieline Technology's International Marketing Manager. "Bridge-IT will deliver studio quality audio over a variety of IP data networks such as wired and wireless WANS, LANS, the Internet, satellite IP, Wi-MAX and Wi-Fi."

Bridge-IT allows you to tailor your codec to suit your own individual requirements. You can buy encode or decode only versions, or both, depending on your requirements. Bridge-IT has an SD card slot for failover playback of prerecorded audio and the unit's user friendly menus can be fully programmed using comprehensive front panel hardware that includes a keypad and LCD display, or by using a web interface.

"It is SIP-compatible and will connect to all major brands of codecs, as well as to our existing G3 range of codecs. Tieline is also implementing a Traversal server solution for very simple negotiation of firewalls, automatic address book population of other codecs in your network (codec buddy list) and one-touch dialing," said Levy.

Bridge-IT comes with a range of high performance broadcast algorithms plus optional AAC LC and AAC HE. Standard algorithms include 16 Bit 22 kHz linear audio at less than 12 ms encode delay for uncompromised audio, G.711 G.722, MPEG Layer 2 and Tieline Music. The Tieline MusicPLUS algorithm also provides 22 kHz mono, dual mono and stereo with 20ms encode delay at under 100 kbps.

Tieline will be at NAB Booth N8123

Tieline Technology
317-845-8000 • www.tieline.com

FINAL STAGE

RADIO ROUNDUP

The Radio Guide Event Register

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

2009 OAB Annual Convention
April 16-17, 2009
Renaissance Hotel and Convention Center, Tulsa, OK
www.oabok.org/Conventions/index.html

NAB 2009 Spring Convention
April 17-23, 2009
Las Vegas Convention center, Las Vegas, Nevada
www.nabshow.com

NAB Radio Show 2009
September 23-25, 2009
Philadelphia, Pennsylvania
www.nabradioshow.com

SBE 22 Broadcast and Technology Expo
October 6-7, 2009
Tuning Stone Resort and Casino, Verona, New York
www.sbe22expo.org

127th AES Convention
October 9-12, 2009
Javits Center, New York
www.aes.org/events/127/

Wisconsin Broadcast Clinic
October 13-15, 2009
Madison, Wisconsin
www.wi-broadcasters.org

Radio Guide Advertiser Info – Mar/Apr 2009

Advertiser - Page	Website
Altronic - 34	www.altronic.com
AM Ground Systems - 41	www.amgroundsystems.com
Armstrong Transmitters - 41	www.armstrongtx.com
Arrakis - 31	www.arrakis-systems.com
Axia - 21	www.axiaaudio.com
Bay Country - 43	www.baycountry.com
Besco - 43	www.besco-int.com
BEXT - 41	www.bext.com
Broadcast Devices - 38	www.broadcast-devices.com
Broadcast Electronics - 24	www.bdcast.com
Broadcast Software Intl. - 4	www.bsiusa.com
BSW - 14	www.bswusa.cm
CircuitWerkes - 17	www.circuitwerkes.com
Comrex - 1, 5	www.comrex.com
D&H Antennas - 40	www.dhsatellite.com
DM Engineering - 47	www.dmengineering.com
Davicom - 20	www.davicom.com
Econco Tubes - 43	www.econco.com
Fanfare - 43	www.fanfare.com
Gorman Redlich - 41	www.gorman-redlich.com
Harbach (Peter Dahl) - 47	www.pwdahl.com
Henry Engineering - 2	www.henryeng.com
Inovonics - 37	www.inovon.com
Intrinsicnet (MySine) - 30	www.plussine.com
Jampro - 36	www.jampro.com
JK Audio - 13	www.jkaudio.com
Kintronic Labs - 9	www.kintronic.com
LARCAN - 37	www.larcan.com
LBA Technology - 25	www.lbagroup.com
Lightner Electronics - 39	www.lightnerelectronics.com
Logitek - 15	www.logitekaudio.com
Mainsource - 47	www.mainesource.us
Micro Communications - 42	www.mcibroadcast.com
Nautel - 11	www.nautel.com
NAB 2009 Show - 35	www.nabshow.com
OMB America - 27	www.omb.com
Omnia - 48	www.omniaaudio.com
Pristine - 8	www.pristinesys.com
PSI (Propagation Systems) - 39	www.psibroadcast.com
RAM - 28	www.ramsyscom.com
RF Specialties - 33	www.rfspecialties.com
SAS - 29	www.sasaudio.com
SCMS - 19	www.scmsinc.com
Shively - 32	www.shively.com
SystemsStore - 26, 47	www.systemsstore.com
Telos - 23	www.telos-systems.com
TFT - 40	www.tftinc.com
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