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Radio World
ENGINEERING EXTRA

April 4, 2007

IT INTERVIEW

Rob Speicher

Packet Tracker: Rob Speicher And the Role of IT in Radio

by Michael LeClair

The author is technical editor of Radio World Engineering Extra.

The way broadcasters handle program material rapidly is becoming a specialized branch of information technology. Once we are brought

SEE PACKETS, PAGE 8

WHITE PAPER

Spectral Regrowth Can Affect Digital Performance

Field Results Examine High-Level Injectors, Spurs Generated When Digital Transmitter Meets Analog System

by Bob Surette

The author is director of sales engineering for Shively Labs.

Intermodulation products, or spurs, can develop within the analog and digital transmitters in combined systems using high-level injection. In some cases, spurs can result in sub-optimal signal quality or even cause stations to interfere with each other's signals. The term spectral regrowth was coined to describe intermodulation products generated when a digital transmitter is added to an analog transmission system.

In the early days of digital implementation, external filtering was often used to eliminate or reduce interference. As the technology has evolved, however, only subtle adjustments to the system, such as the addition of a fine-matching transformer to the dummy load, have proven necessary to reduce distortion and interference to meet the FCC's digital FM mask.

There are two sets of spurs that have to be dealt with. The first set of spurs is generated within a digital transmitter as the two sidebands interact. The second set of spurs also is generated in the digital transmitter and is a product of each digital sideband combining with the analog signal. The signal level of these spurs is a function of the isolation between the analog and digital transmitters.

This paper provides a basic overview of how high-level injectors work, their weaknesses and how they can be best optimized, which is essential to the design, installation, tuning and operation of a modern analog/digital FM station.

THE FCC DIGITAL MASK

The characteristic FM analog/digital mask is shown in Fig. 1. The analog modulated carrier occupies +/-100 to 120 kHz, depending on how hard the modulation is pushed. As will be shown later, subcarriers (SCAs) can be part of this analog carrier.

The digital carriers start at +/-129 kHz and go out to +/-199 kHz. The digital signal is made up of two identical sets of 191 Orthogonal Frequency-Division Multiplex (OFDM) carriers. Just for general information, the mode of modulation for this signal is Quadrature Phase Shift Keying (QPSK). The power levels are referenced to the analog carrier or 0 dBc. One OFDM carrier is –45.8 dBc, when all 191 carriers are present for one side band the power level is –23 dBc, and when both side bands are added together the power level is –20 dBc. This is defined as the analog-to-digital ratio of 20 dB.

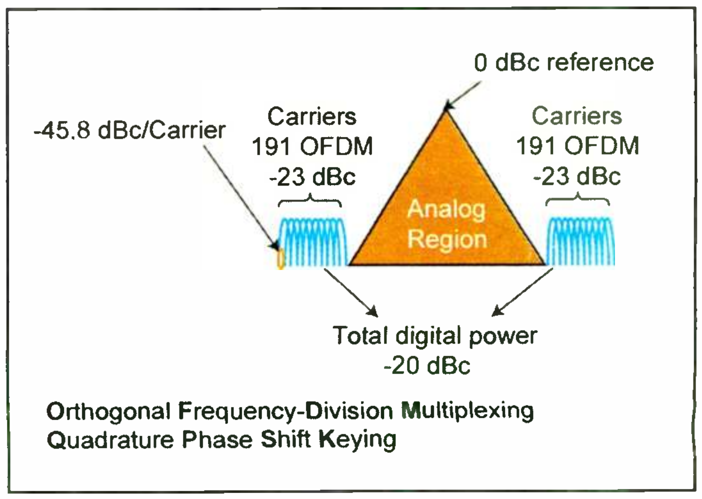

Fig. 1: Digital Power Distribution Referenced to the Analog Carrier

SIDEBAND-INTERACTION SPURS

In order to evaluate the first set of spurs that are generated inside of the digital transmitter, it is necessary to simplify the digital side bands. Fig. 2 shows that the center frequencies of the digital side bands are at +/-164 kHz from the center of the FM channel. That means that there are 328 kHz between the centers of the side bands.

If the third-order intermodulation products are evaluated, you will see that there is a set of spurs at +/-492 kHz (Fig. 3), between the second- and third-adjacent channels. At the same time there are

SEE SPURS, PAGE 12

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FROM THE TECH EDITOR

by Michael LeClair

The Big Expensive Birds In the Sky

A Look at the Whirlwind Growth of Satellite Radio And the Aftermath of an XM/Sirius Merger

It's hard to know exactly what to think about the recent announcement that Sirius Satellite Radio wants to purchase its rival, XM Satellite. The satellite radio industry debuted just a scant few years ago and in that short time has shaken the broadcast industry harder than anything since the introduction of television. Now the satellite radio industry itself is poised on the brink of a massive change.

Even before the first satellite launch many of the broadcast industry's observers predicted that there would not be enough room for two separate companies. This was before the number of channels that could be offered mushroomed with the advent of improved audio codecs — the same improved codecs that now power multicasting HD. Now there appears to be so much capacity that it makes it financially impossible for one carrier to get an advantage over the other without spending itself to death à la Howard Stern.

My impression of the satellite radio revolution was that it was marked with questionable business practices and technological games from its start.

The whirlwind growth of satellite radio has taught those of us in traditional broadcasting some important lessons. Most importantly, listeners want more choices of programs, and some are even willing to pay for greater selection. Secondly, commercials are more annoying than anyone ever wanted to believe. And finally, supplementary data is an important part of radio broadcasting — listeners want to see song title and artist on music channels.

Terrestrial broadcasting has begun to understand these lessons and has responded on all fronts. The rapid growth of multicasting HD Radio has been driven by the need to provide greater choice to listeners. Commercial loads have been reduced some and the new HD-2 channels are currently commercial-free. Finally, the use of RDBS has exploded after muddling along for over a decade with few adherents. These were all improvements listeners wanted.

In this sense satellite radio has caused a number of good changes to terrestrial broadcasting in response to the competitive challenge coming from above the atmosphere.

THE DARK SIDE

On the other hand, there have been darker aspects to how satellite radio grew.

To work at all in urban areas it required enormous terrestrial repeaters to saturate buildings and penetrate the relatively minor obstructions that would cause satellite signals to fail. The deployment of these repeaters at the last moment felt like an enormous bait-and-switch game. Instead of satellite radio we got satellite-distributed terrestrial translators, not only with giant power but also more than the entire FM band of frequencies to play with.

Imagine owning the entire FM spectrum in a major market in the U.S. Satellite radio owned that much in all the major markets, and it was all on the ground.

Then there were the pumped up subscription numbers. To make the business press notice them, both satellite services engaged in the practice of giving away free subscriptions in order to show meteoric growth.

However, the subscription fees were being paid by the marketing side of the corporation so in spite of growing revenue, the losses just continued to mount because they did not represent actual paying customers. Given the cost of operating satellites, losing money during startup was no surprise. However, many in the financial press were unfamiliar with the technology and were temporarily blinded by this game of three-card monte. Up until recently many wrote in gushing terms about the impending demise of terrestrial radio.

My particular pet peeve was the flooding of the marketplace with $20 satellite radio tuners, which used FM translators to connect up to regular consumer radios without wires (another lesson: consumers like wireless connections between their electronic devices). Using the FM band to try to take audience from regular FM stations was bad enough but these radios were designed to cause interference even to listeners who didn't want satellite radio. This deployment coincided with a marketing campaign that touted the digital clarity and reliability of satellite signals. Nice touch. Too bad it was a gross violation of the FCC's rules.

So on the whole my impression of the satellite radio revolution was that it was marked with questionable business practices and technological games from its start.

QUID PRO QUO

The FCC has already made it clear that the rules enabling satellite radio require that two separate entities must exist to prevent a monopoly. This position is untenable, as one of the companies could simply declare bankruptcy and it would not make sense to force the other to liquidate itself (just when it might have a chance to make a few bucks). A merger will have to occur, but obviously there have to be some changes to make up for the awarding of a monopoly.

Some suggestions have already been made. In one recent proposal, opening up the satellite system to outside programmers as a kind of common carrier was offered up. Additionally, it was suggested that some portion be reserved for non-profit use, similar to the way that the FM band was allocated way back in the days when New Deal Era thinking was still the dominant mode in government. These are good ideas and could be the basis of the quid pro quo that will allow the FCC to pass on the merger.

Given the behavior of the satellite radio companies in the past it would make sense to write these new regulations carefully. We are dealing with an industry that has demonstrated a willingness to play fast and loose with rules and regulations.

Other technological questions remain to be resolved in the event of a merger. XM and Sirius use different transmission systems. One will have to be shut down and what happens to all those consumers who bought the "wrong" radio? Should satellite radio be allowed to develop profitable local channels in major markets in order to save the system?

The first episode of satellite radio appears to be coming to a close. It has brought enormous change, much of which has been beneficial to listeners. Will the next chapter be as wild a ride? ■

IN THIS ISSUE

by Greg Friesen

Are Unlicensed Services Best for Wireless?

Such Links Yield Low-Cost, Rapid Bandwidth — But Also Interference, Delay and Loss of Service

Greg Friesen is director of product management for DragonWave Inc.

A vast amount of unlicensed systems have been deployed over the past few years to provide low-cost, rapid bandwidth. Many of these unlicensed bands, such as 900 MHz, 2.4 GHz and 5.8 GHz, have become cluttered with multi-point, point-to-point and consumer devices, such as cordless phones, wireless LANs and garage door openers.

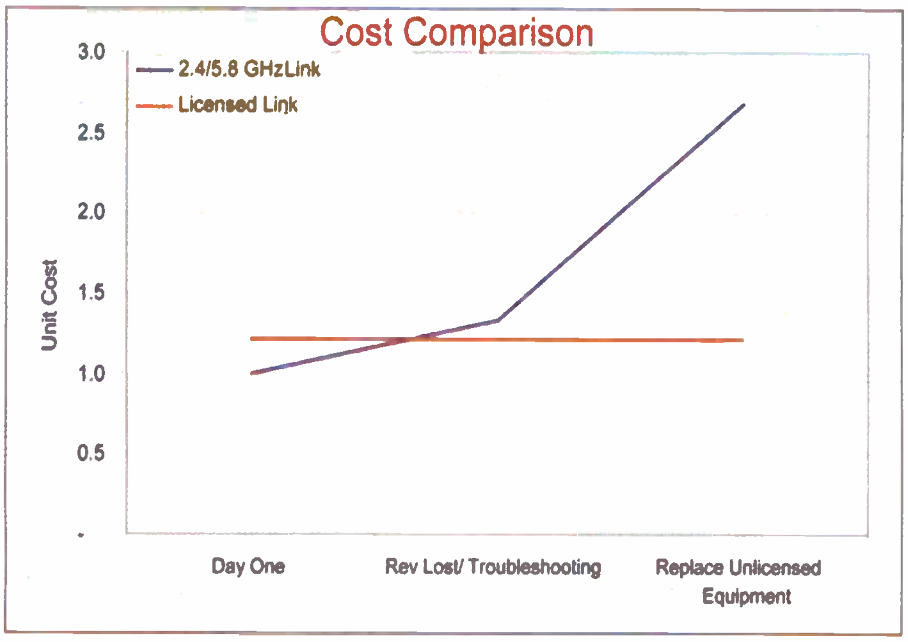
The broadcasting industry has used unlicensed wireless links to provide content and internal networks to broadcast towers and studios. In the past, the low-cost element of unlicensed has been attractive. However, as the interference in these bands increases, the reliability of an unlicensed link has become insufficient to deliver the high-availability service levels required for real-time radio and television content.

The large amount of ambient interference makes it difficult to find a channel in the unlicensed bands. Sometimes this interference can be coordinated against. However, if a link can be established there often will be reduced receive levels, which will result in a link with the following characteristics:

- Reduced throughput — Link will have to reduce modulation to cope with interference. This results in reduced throughput, and can take a 30 Mbps link down to a throughput of a few megabits per second.

- Reduced availability — Interference will reduce the fade margin, and therefore the resistance to dynamic fade events such as rain, or dynamic interference. This will drastically reduce the link availability.

There are two types of interference that have to be dealt with: static interference and dynamic interference. Static interference is caused from static sources such as point-to-point links, multi-point systems, wireless LANs.



Unlicensed solutions have low initial cost, but typically a higher long-term cost when operations and interference are accounted for.

Fig. 1: Cost of Interference

Even if acceptable link performance can be achieved, there is still large future risk that additional static sources will be added, which can further reduce the performance of the link or cause the system to be unusable. The operator's only recourse is to send a technician to the area to do a frequency sweep and try and identify an alternate channel or the interfering source, and coordinate with that interferer.

The other source of interference is dynamic interference, which is even more difficult to deal with. Dynamic interference is caused from sources such as cordless phones, baby monitors, garage door openers and wireless key fobs. These sources are changing constantly and therefore cannot be coordinated against. As these sources cause interference, they can cause loss of service, reduced bandwidth and increased delay and jitter, making it impossible to guarantee availability and throughput.

There are a number of options to handle interference in these networks. The first is to deploy new links in the low-interference unlicensed bands, such as the 24 GHz ISM band. The 24 GHz ISM band provides the rapid, low-cost characteristics of the 5.8 GHz band without the interference.

This option avoids many of the problems of the 5.8/2.4 GHz bands due to the following characteristics: the 24 GHz ISM Band is limited to point-to-point microwave and medical uses only; there are tight beam-width limitations allowing very narrow sources only; there are strict power limitations, preventing the "drowning out" of other links.

The combination of these characteristics, make the 24 GHz ISM band well suited for last-mile applications with required range under five miles. This range limitation is due to the output power restrictions of the band.

THE PRICE IS RIGHT

In addition, deploying licensed systems (11–38 GHz) also is becoming a more attractive option, as licensing costs and lead times are reducing. The cost of licensed equipment rapidly is becoming more affordable, with a 100 Mbps link available at a cost of less than $20,000 including antennas. A license in the common carrier bands in the United States costs less than $3,500 for a 10-year license including coordination, and can be acquired on a per-link basis. Licensing times are typically 30 days.

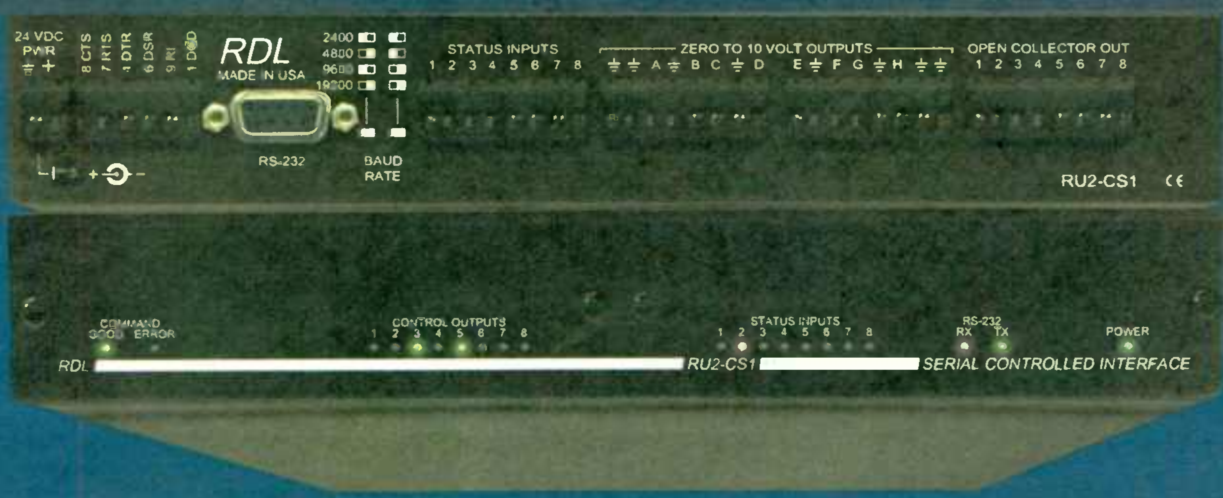
For wider deployments, area licenses such as 28 and 38 GHz often can be acquired from third-party license holders, at comparable costs. Licenses can be quickly and easily acquired by contacting a third-party coordinator, who will gather your required license information and coordinate the link through the FCC.

In addition, licensed systems offer extended ranges of up to 50 miles. Both licensed and 24 GHz unlicensed systems offer the following additional network benefits vs. an unlicensed 2.4/5.8 GHz system:

- Increased capacity — up to 500 Mbps full-duplex committed information rates
- No capacity variability
- Ultra-low delay — 0.1 ms per link latency vs. seconds of latency with 2.4/5.8 GHz
- Zero delay variability
- Deterministic and high availability — availability can be calculated, well understood and engineered at commissioning

SEE UNLICENSED, PAGE 6

GET EVERYTHING UNDER CONTROL



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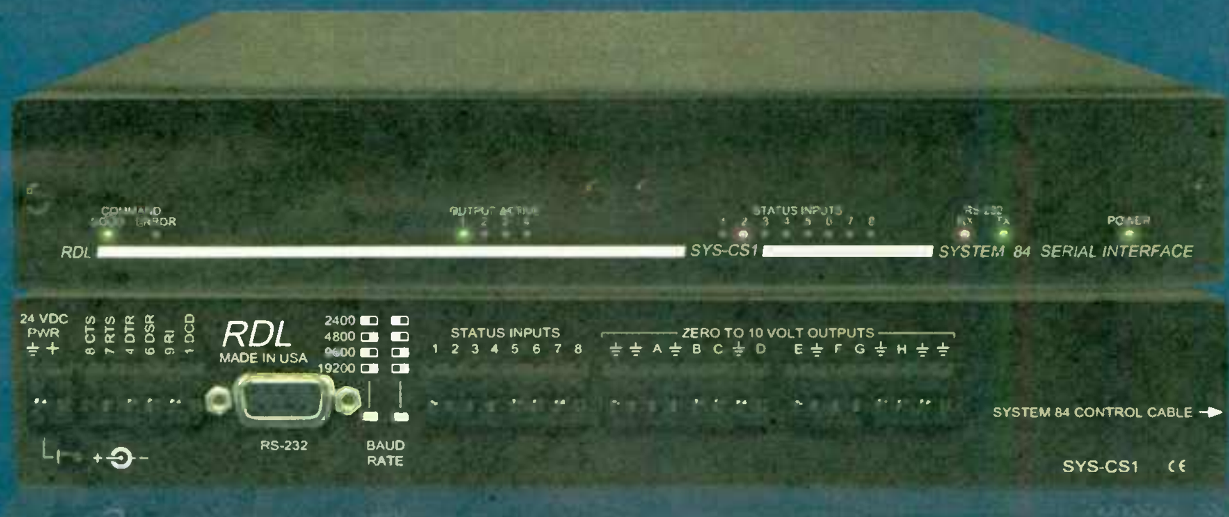
  Examples include sensing contact closures from satellite receivers or from RDL audio or video detection modules.
- •Rack mountable using RDL RU-RA3HD



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Unlicensed

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Although there is a small cost premium initially for a licensed link, it becomes much more cost-effective in the long term. A licensed link lets the customer avoid the cost of a future replacement link, troubleshooting costs and field visits required to replace the existing link. More important, it ensures customer satisfaction, and enables revenue growth rather than customer loss to poor performance.

The typical cost curve, not including revenue effects is shown in Fig. 1. These numbers are based on an internal study, based on Tessco list prices (available on the Web).

In many cases, a hybrid network makes the most sense. Using licensed systems in the core can eliminate self-interference, and can also extend the size of the core, enabling smaller access cells, which are less prone to interference. Either the 24 GHz ISM band or a licensed system can be used to harden the 2.4/5.8 GHz unlicensed network. There are three common strategies to harden an unlicensed network:

1. Replace unlicensed links with licensed links as they become degraded by interference — This is a reactive approach which is expensive, and results in poor network quality until the fix is implemented.

2. Deploy licensed links in the core network, and unlicensed links on short access links, with low interference and more than ample fade margin — This is an approach that results in less network churn, and medium service quality, but will still be prone to some interference on access links that have been deployed with 2.4/5.8 GHz systems.

3. A 100 percent licensed network — This network will result in the highest-quality services, with minimum customer complaints, allowing the operator to stand behind their service levels related to availability, delay and throughput. This also will ensure no network churn.

The three common deployment options are shown in Fig. 2.

These options present a variety of solutions to handling interference. The chosen solution will depend on how much equipment has been deployed, required service levels, budget, 2.4/5.8 GHz use in the area and desired throughput. The good news is that interference issues can be solved without a large cost premium.

Additionally, with proper planning, a high-quality network can be deployed on day one, avoiding future network churn and maximizing customer satisfaction. ■

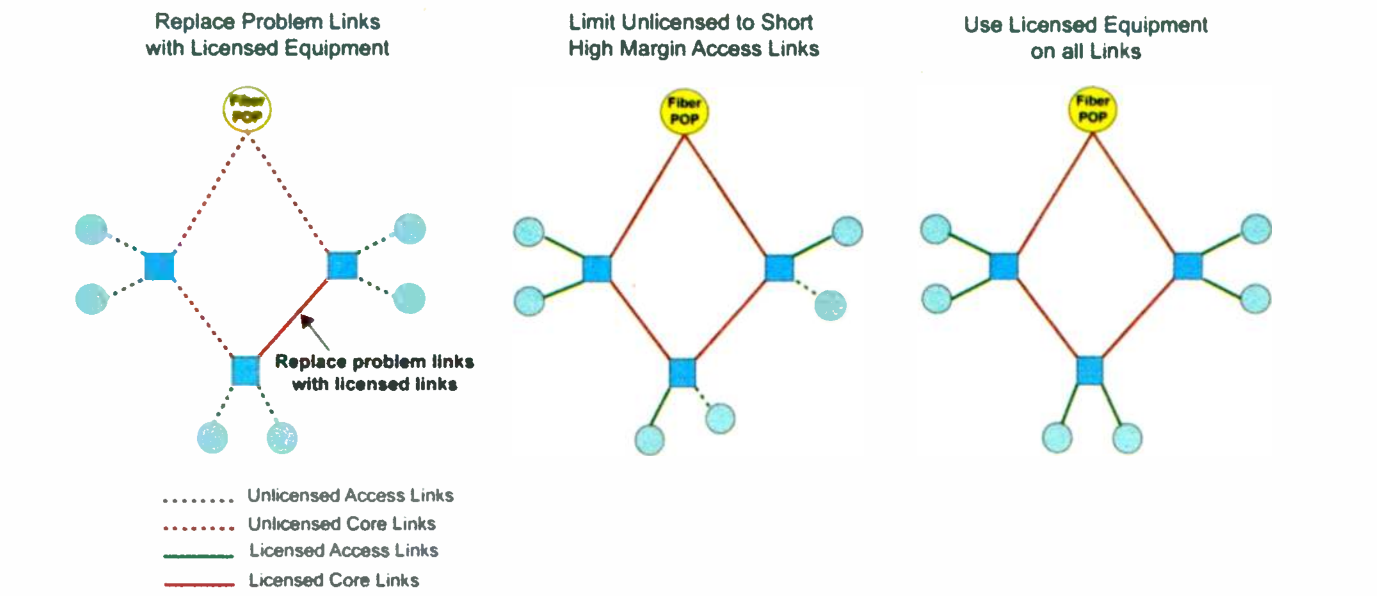


Fig. 2: Organic Growth Capabilities — Unlicensed

READER'S FORUM

Chew Toy

Guy Wire, there you go again, so obviously shilling for HD/IBOC. Here are a few things for you to chew on:

[From Radio Magazine, Jan. 4]: "In-Stat: Digital Radio Set to Take Off" — "In 2006, 73 percent of respondents to an In-Stat U.S. consumer survey were aware of HD Radio on some level." (*http://beradio.com/eyeoniboc/instat-digital-radio-set/*) This item, also reported by RW, shows that most consumers know about HD Radio, at some level, and this has been backed by the latest study on HD Radio by Bridge Ratings. (It downgraded the number of expected HD Radios sold, but it is still way too high).

[From Hear 2.0, Feb. 19]: "Sirius, XM, and HD: Consumer Interest Reality Check" — "While interest in satellite radio is diminishing, interest in HD shows no signs of a pulse." (*www.hear2.com/2007/02/sirius_xm_and_h.html#comments*) Ramsey's site runs Alexaholic Web statistics, which shows hits on *www.hdradio.com*, the go-to site for information on HD Radio, as a flat line compared to the decreasing interest in Sirius and XM Radio.

Google Trends confirms the lack of interest for HD Radio in this chart: *www.google.com/trends?q="hd+radio",+xm,+sirius&ctab=0&geo=all&date=all.*

Google Trends shows the amount of interest in HD Radio through searches for "HD Radio" — if you run Google Trends for just HD Radio you will see the upswing in HD Radio for 2006, but now the graph is in a steep decline — but interest in HD Radio, against Sirius and XM searches, is a flat line.

[And also] "Rethinking AM's Future (RW Online, Dec. 20, 2006)" — "Only 175 or so AM stations have even licensed AM-HD. For a number of reasons, quite a few have tried it and taken it off the air, or so the anecdotal evidence suggests. Ibiquity no longer reports in its public summaries whether a station is on the air." (*www.rwonline.com/pages/s.0044/t.557.html*)

As most everyone knows in the broadcast business, HD Radio/IBOC is a mess on AM, causing adjacent-channel interference and with only 60 percent of the coverage of analog.

Greg Smith
Olney, Md.

Overnight Sensation

Michael, I read your editorial ("Overnight Projects Yield the Most Rewards," Feb. 21) and it reminded me that although it's been a while since I did an engineering overnighter, I too remember them with fondness.

As a matter of fact, one of my first was when I was in high school. I would hang out at the local AM station, attempting to insinuate myself into the operation at every opportunity — and I actually was able to get school credit for this!

As it happened on this particular overnight session, I finagled my way into participating in a Proof of Performance test. I don't remember details, but it was fascinating for this 16-year-old.

The next morning, I was sleepless and bleary-eyed when I showed up for class. Little did I realize that it was the day we were to take the Florida Senior Placement tests (similar in scope to SATs), the achievement test that would determine my relative status among other high school juniors in the state of Florida.

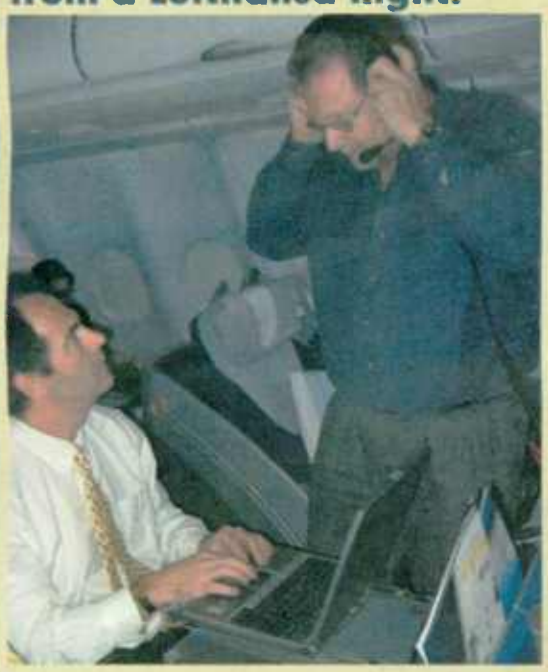
As difficult as it must have been, I must have been able to concentrate somehow; when we got the results back a few weeks later, I had placed in the top 4 percent of the state!

Maybe doing a "Proof" had sharpened my focus, I don't know.

David P. Reaves, III
Recklinghausen, Germany

Internet remotes... there's been talk.

Live from 37,000 Feet—No kidding—Live Broadcast from a Lufthansa flight!

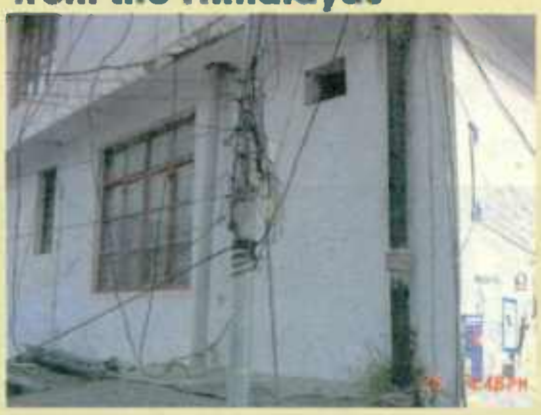


... successfully aired his three hour talk show from a commercial airplane [using ACCESS] at 37,000 feet on a regularly scheduled flight between Frankfurt, Germany and New York, US.

Peter Greenberg—Host of the syndicated radio program Travel Today

For the complete story visit http://remotebroadcasts.blogspot.com

Radio Free Asia—Live from the Himalayas



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

For the complete story visit http://remotebroadcasts.blogspot.com

Ski Mountain Remote

This picture, really demonstrates what ACCESS is about. This product truly has the ability to cut the wires.

For the complete story visit http://remotebroadcasts.blogspot.com

JAMN 94.5—Walk for Hunger

"ACCESS was used on the air exclusively for JAMN945 at this one. It was all over EVDO with a tremendous amount of active cell phones in the area. The ACCESS was connected to the Verizon wireless Broadband...

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Packets

CONTINUED FROM PAGE 1

into the world of packets, it is possible to take advantage of reliable computer networking systems for transport of audio as well as additional information about the programming that listeners want.

Packet technologies provide for long-distance transfers of program material that would have been virtually impossible using analog technologies, and with excellent quality. Additionally, today's radio equipment often includes Ethernet connectivity for advanced management and remote control. An understanding of the intricacies of Internet Protocol and network segmenting is becoming essential for broadcast engineers.

No radio group appears more committed to the use of computer networking technologies than Clear Channel. The person responsible for the IT systems that distribute its programming is Rob Speicher, whose title is vice president of operations, distribution development. Clear Channel has been at the forefront of using wide-area networks to connect a large number of stations distributed over large geographic distances. Speicher relates what drew him to the radio industry in the first place, and the importance of information technology in modern broadcast operations.

How did you get started in the world of radio?

Like many radio techies, my first foray into the radio world was with one of those RadioShack 100-in-1 kits when I was seven or eight years old. Building the radio project was one of those things with a good payoff, even if it did drift like crazy.

A career in radio, though, didn't cross my mind until my sophomore year at University of Central Florida in Orlando. I won an on-air contest for front row, limo and backstage to meet comedian Sam Kinison. I loved the experience, and, as I was wandering a bit aimlessly in college, I signed up for some radio and TV classes.

That led to a promotions internship at the former WDIZ(FM), 100.3 in Orlando, now WRUM(FM), a Clear Channel station. I was one of those crazy kids who'd do the bar remotes until 2 a.m., then be back up for the morning show at 5, all for nothing more than the fun and freebies. In fact, I think I lived on Domino's pizza trade for a year.

About halfway into my second internship, the evening jock was fired. They promoted a part-timer and had an opening. Neal Mirsky, the PD, gave me a shot, and of course I was awful.

Over the next year and a half, I did weekend and fill-in shifts, and I never really got much better. I knew I'd better look to some other area of broadcasting, as I'd never make it as a big-time DJ. I started working with the music director doing Selector work.

I had always been a computer geek, from Ataris to the 286 I had at the time. Selector seemed a natural fit. After graduation, RCS had an opening in its support department helping others with Selector and Linker, so I moved, in the winter, from Orlando to Westchester County, New York. I did phone support for a year, then transferred to Cincinnati to build hardware for the DOS-based Master Control system.

'A key ingredient is willingness to dig into something you've never tried before. Most new digital consoles are really just control surfaces for computers and routers. That has IT written all over it.'

That time building and implementing automation hardware exposed me to nearly every aspect of radio — programming to engineering to top management. It also was quite fortuitous that Jacor was headquartered in Cincinnati.

In 1996, RCS closed its office in Cincinnati and I went to work as the local IT manager for Jacor's cluster here. Of course this was the heyday of consolidation, so a year later I moved offices across the river to corporate to spearhead a project to put all the radio stations on a common computer-based digital platform, connected by wide-area network.

Seven years and several consolidations later, the project wrapped up and I transitioned into my current position with Clear Channel Radio. Our division is charged with distributing Clear Channel's content through other avenues than just traditional terrestrial radio or internet. We have established a nationwide network of sending traffic data over RDS to properly equipped navigation systems, for example. We also are working on several mobile phone initiatives, and of course, HD Radio.

I am very fortunate and honored to have worked with the top names in the industry, learning from folks like Jeff Littlejohn, John Hogan, Steve Gable, Andy Economos, Chip Jellison and Randy Michaels to name only a few.

How important is IT to the modern radio broadcast station or group? And how many people do you see working in broadcasting with a specific emphasis on IT?

IT is critical.

When I started doing IT for radio in 1996, the transition was already underway. I remember being asked to fix a Roland DM80. I had no idea how it worked, but it ran on an Apple so it was in my domain. Today nearly every critical piece of a modern air chain has an assigned IP address. Transmitters have GUI interfaces. Transport of audio is handled in IP packets instead of a pair of copper wires.

Clear Channel has a full IT infrastructure. CCIT is dedicated to the WAN, monitoring and business processes. That's a building full of people in San Antonio, plus scattered regional folks. In addition, we have IT man-

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Packets

CONTINUED FROM PAGE 8

agers in nearly every facility who work closely with engineering. The line is now quite blurred between the responsibilities of what was traditional IT and traditional RF engineering.

How is the role of IT evolving in our industry? What challenges does broadcasting present that are different from the more common business IT environment?

"Mission critical" is a phrase that takes on a new meaning for IT folks in the broadcasting world. I've seen folks come from a business IT background into radio, and it takes some adjustment to understand why you can't take down a server or change out a switch on your own schedule. If a key switch in the network fails, it could be as important as multiple transmitters failing. Losing your automation system or your HD-importer subnet could be dire.

Also, talent often broadcast their show to a remote market via voice tracking. If your infrastructure fails to deliver that audio on time, you have no show.

It used to be rare for the IT person to be paged overnight. Now they're 24/7, as much as an RF person.

What kind of qualifications would you look for in someone to work in IT for broadcasting?

At Clear Channel, we have opportunities in IT that run the spectrum. If you are well versed in Microsoft apps and servers, or in Cisco routing, or come from a more traditional radio background, you can find a place to work in the industry.

If you choose to work in the technical side of a radio station, then routing is extremely important these days — getting packets from point A to point B without loss and with minimal latency. When you are pushing audio around via IP, a flood of broadcast packets on your network will take your stations down. I really see some of the larger clusters of stations needing an IT person who really understands how to segment traffic.

Also, a key ingredient is willingness to dig into something you've never tried before. Even on the studio side, most new digital consoles are really just control surfaces for computers and routers. That has IT written all over it.

What are examples of how Clear Channel Radio uses Internet Protocol transport of audio on a daily basis?

HD Radio is first and foremost. The very nature of HD Radio could mean audio traveling over IP for extensive distances. Clear Channel has more than 300 stations converted to HD Radio, more than two-thirds of which are multicasting. That's a tremendous amount of audio to get from the studio to the transmitter site in UDP packets without loss or unacceptable latency. HD Radio broadcasts are really a data channel, and that has a lot of potential to deliver information to the vehicle particularly. So you have to consider data integrity to the transmitter as well as ensuring audio.

Clear Channel also does extensive Web streaming of our terrestrial stations, as well as made-for-Web content.

Clear Channel also provides programming to 11 channels on XM Radio. That audio is delivered via IP, using Harris Intraplex NetXpress to do the transport over a leased circuit.

It seems IP is becoming the universal means of communicating with new broadcast equipment. Why, and what are the advantages?

Addressability and centralized remote management. If you can give a device an IP address, you can control it from anywhere in the world. I currently have access to servers,

> **'The line is now quite blurred between the responsibilities of what was traditional IT and traditional RF engineering.'**

RDS encoders, etc., on my BlackBerry. I can remotely monitor, diagnose and repair a lot of stuff. How many times has a board op called the engineer to come in because, for example, a satellite show wasn't patched to the console?

Nowadays you tune your Starguide remotely, then access the interface to your Vistamax, and add a route for that user which shows up on his/her console, all while watching CSI on your sofa.

Broadcast engineers have to become much more conversant in networking, particularly with the rollout of second- and third-generation HD Radio systems. What's a good way to learn more about this complex subject?

HD Radio, as well as many other broadcast components, can require an extensive IT expertise. However, there are many solutions to a single situation. I think the key is to understand your alternatives and select the best one for your installation. It's definitely deeper than servers and workstations.

Speicher and several products featuring HD Radio or real-time traffic, including the Garmin nüvi 660 portable navigation system; and Boston Acoustics Recepter HD and Directed Electronics tabletop receivers.

This is where your routing gurus can earn their keep. Engineers may choose to take courses in networking, such as the Cisco certification, or anything related to the OSI (Open System Interconnection) model. Maintaining a quality-of-service level is of ultimate importance. Or you can throw bandwidth at the problem. Like I said, many choices.

The public Internet has long offered the potential for inexpensive transport of audio once it has been converted to IP. Are there ways we can use the Net to save money, but at the same time get good quality for our audio transport?

By and large, T1 or some private line is still the preferred choice. Clear Channel is, however, running several sites over DSL or cable. I think the DSL/cable solution is appropriate in many business applications, but unless you can get a guarantee of continuous throughput, it can be tough to run broadcast applications such as HD Radio.

That's not to say it's impossible, though. We do currently have a few sites pushing audio across a DSL. Public Internet service also is great for stuff like RDS data, site monitoring and remote access.

I think the time will soon come when the public Internet will be fast enough and buffering in devices will be good enough that you can push near real-time broadcast quality audio anywhere in the world. It's just not quite there yet.

Do you foresee a day when analog audio systems will no longer be needed at Clear Channel?

I can see how it would be possible, but I don't think it's practical in the near future. There's such a preponderance of existing analog infrastructure, that going digital just for the sake of being digital just wouldn't make good business sense.

What will the IT-based radio station of five years in the future look like?

That's a tough one. Predicting what patches will be released for Windows next week is impossible, much less five years out.

I certainly see stations going to IP-based systems as they move or rebuild because of their manageability and scalability, but you know, there is a lot of great analog equipment out there that will last for years to come. I mean I still have a turntable at home, but now I have a USB turntable that converts the great pops and clicks into my computer too. ■

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Spurs

CONTINUED FROM PAGE 1

a set of fifth-order intermodulation products at +/-820 kHz, which is just above the fourth-adjacent channels.

DIGITAL-SIDEBAND-TO-ANALOG INTERACTION SPURS

This second set of spurs is the result of the analog transmitter getting into the digital transmitter. Fig. 4 is a graphical illustration of where the spurs occur.

Fig. 5 shows a summation of the groups of spurs that were discussed in Figs. 3 and 4.

Fig. 6 is a photo taken of a spectrum analyzer showing the output of a digital transmitter, and as you can see the spurs are exactly where they are predicted to be and at a level that will cause interference.

Fig. 7 is a printout of the display of a spectrum analyzer, superimposing the spurs and the FCC digital mask.

THE WMKK CASE STUDY

Now for a case study. WMKK(FM)'s transmitter site is located north of Boston in the city of Peabody, Mass. (Fig. 8). When WMKK turned its digital transmitter on, spurs appeared at +/-828 kHz and caused interference to stations WBOS(FM) and WJMN(FM) within a half mile of WMKK's transmitting tower.

HIGH-LEVEL INJECTION

Before going further let's review the

SEE SPURS, PAGE 14

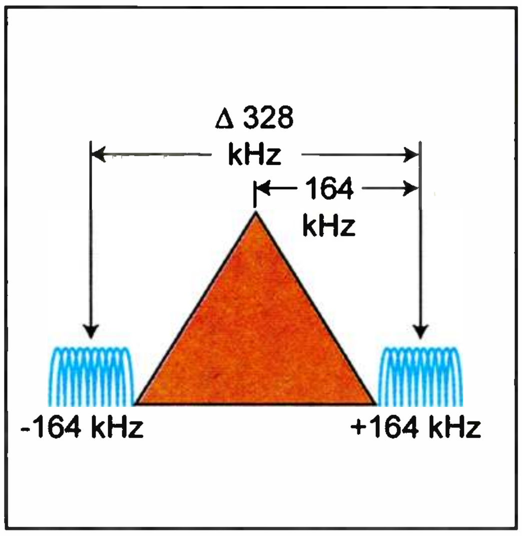


Fig. 2: Midpoints of the Sidebands in Sideband-Interaction Spurs

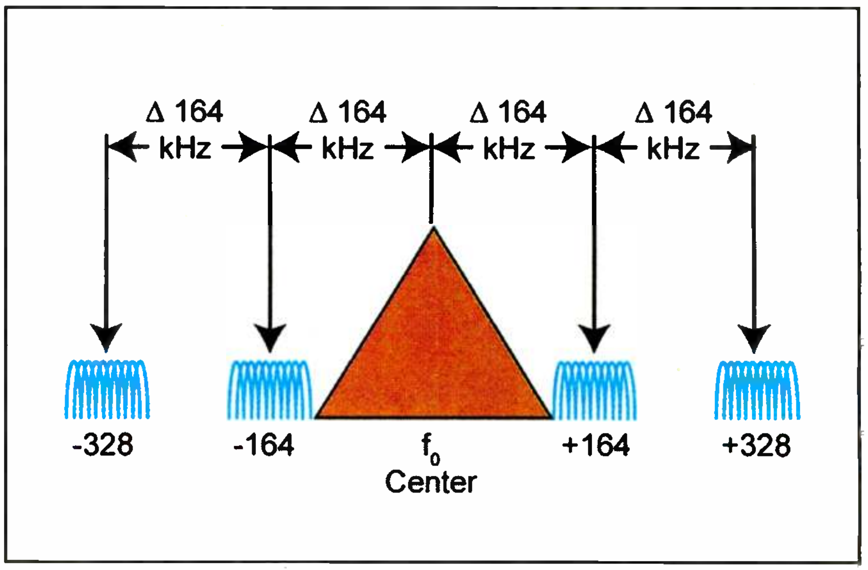


Fig. 4: Third-Order Digital-Sideband-to-Analog Interaction Spurs

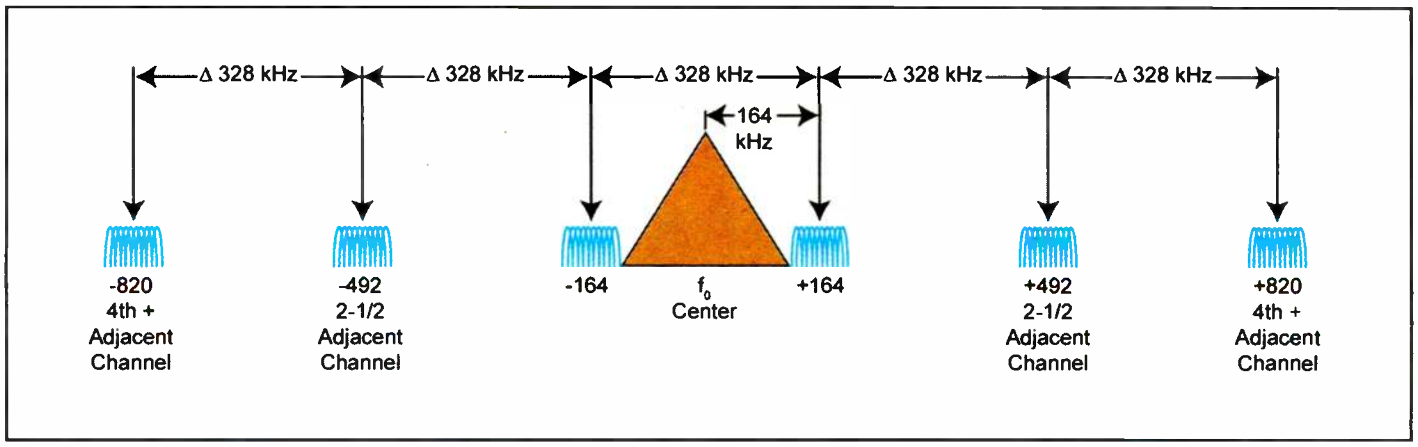


Fig. 3: Third- and Fifth-Order Sideband-Interaction Spurs at +/-328 MHz Intervals

MARKETPLACE

Dielectric Slot Antenna Addresses RF Safety

Dielectric says its TLP-LRFR slot antenna was designed to address concerns such as the use of RF energy and the demand for increased safety measures and regulation increases.

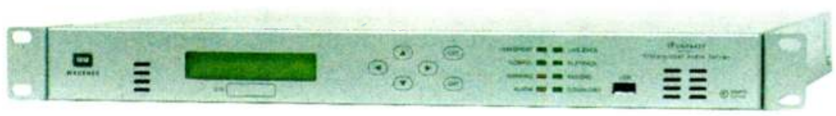
The TLP-LRFR antennas reduce downward radiation, which is critical in areas of dense population; are horizontally, elliptically or circularly polarized; and are available in building-top or short-tower installations. Beam tilt is 1.0 degree standard, with customization available. Custom azimuth and elevation patterns are available as well.

The company says its approach limits the power density below 50 percent of the MPE limits for occupational uncontrolled areas. The TLP-LRFR achieves a 3X reduction on power density near the antenna by focusing energy to the coverage area. It is suitable for digital or analog broadcasting, and features 1/2 wave axial slot spacing technology.

For more information, contact Dielectric in Maine at (207) 655-4555 or visit www.dielectric.com.

Regionalize Broadcasts With iPump

Wegener's 1 RU iPump 6420 media server is suitable for regionalization of radio broadcasts, which it says integrates file-based program distribution with live programming and blending audio through audio fades, mixes and pre-positioned station liners.



The iPump is an integrated digital satellite receiver, IP router and multimedia server. It provides digital and analog audio outputs as well as streaming functionality. Customized playlists, network control commands and audio programs transmitted to targeted iPump media servers can be stored to internal hard drives or output for live broadcasts.

The health of deployed receivers is monitored with return path connections via IP or modem links. Audio quality is maintained throughout the process as stored content is not re-encoded or re-compressed. AM/FM tuners provide an integrated technology to digitize the bookkeeping of advertisement plays. Audio digital outputs include two AES/EBU; audio analog outputs include three balanced stereo.

For more information, contact Wegener in Georgia at (770) 814-4000 or visit www.wegener.com.

Wireless Broadband Internet Remotes

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Clear Channel St. Louis

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- Grady Jeffreys,
Technical Manager,
Mackay Communications

"The remote was a spectacular success, in no small part thanks to the flawless sound which the Tieline G3 provided over the public Internet"

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Spurs

CONTINUED FROM PAGE 12

operation of a 10 dB high-power injector/combiner used to inject or combine the digital signal into the analog RF stream, often referred to as high-level injection or high-power combining. Fig. 9 is a cutaway view of such a high-powered injector. Because of the electrical characteristics of this large directional coupler,

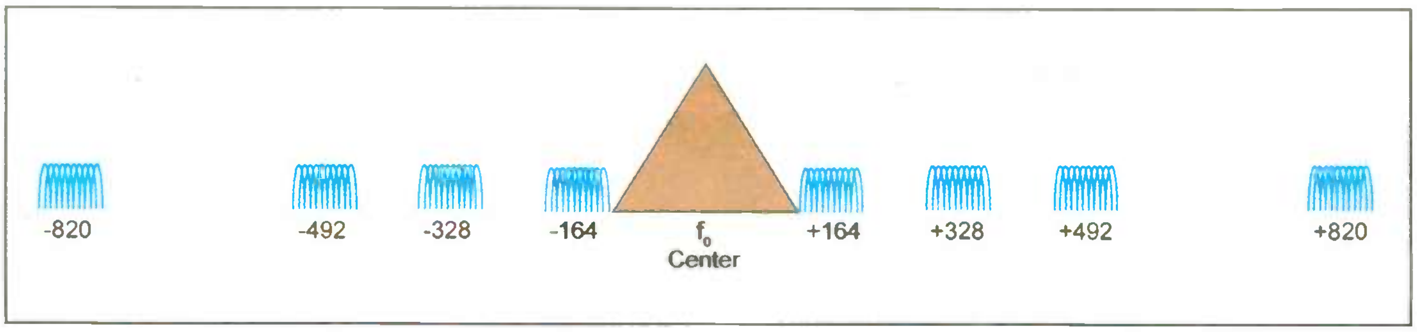

Fig. 5: Sideband-Interaction and Digital-Sideband-to-Analog Interaction Spurs

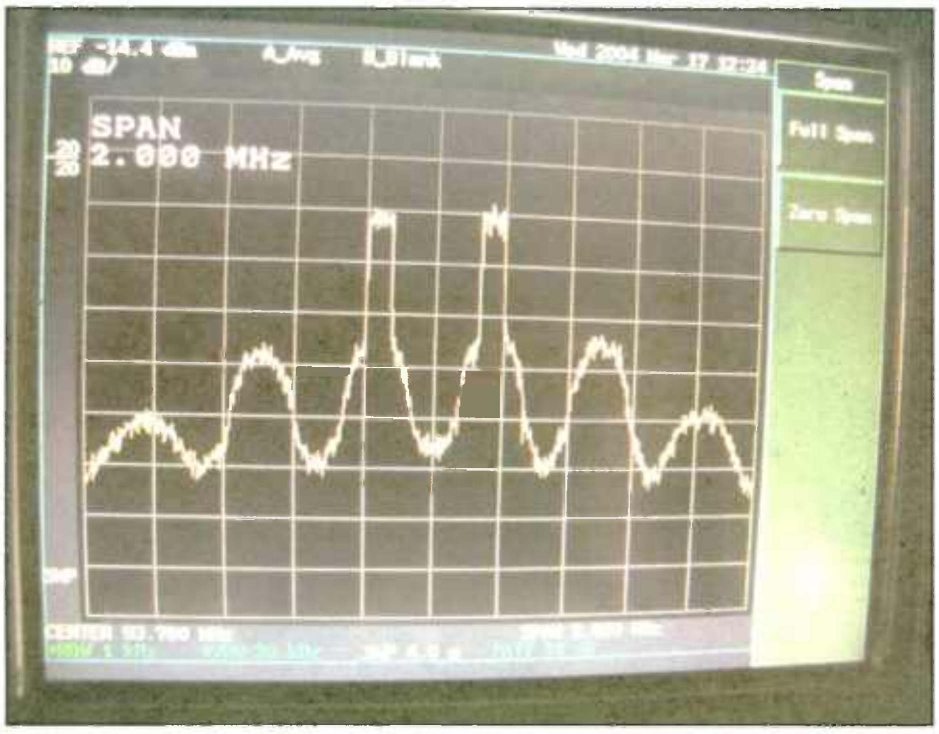

Fig. 6: Uncorrected Digital Transmitter Output

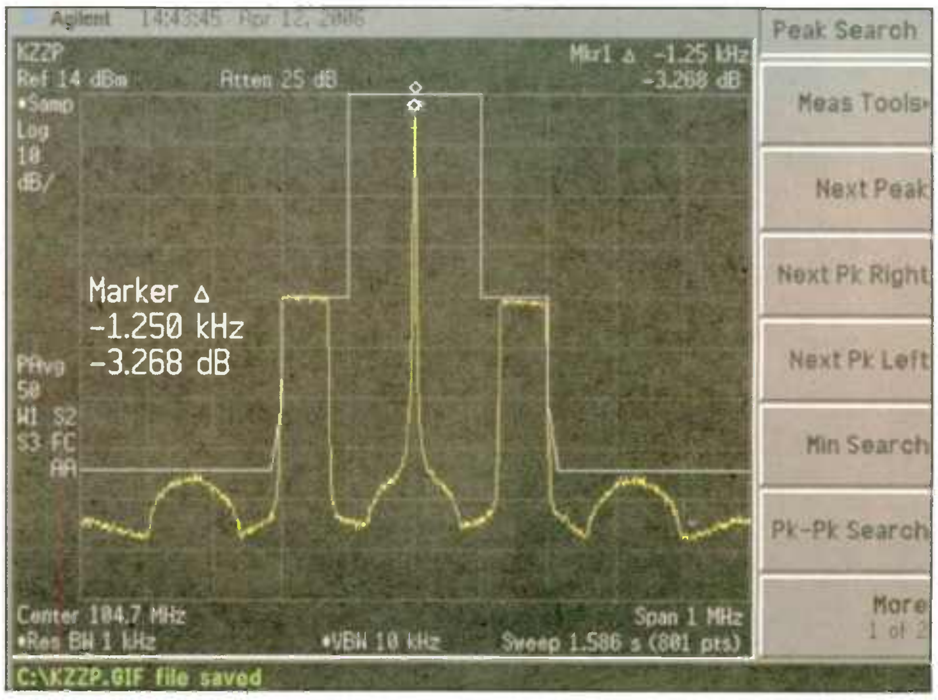

Fig. 7: Spurs vs. FCC Digital Mask

Fig. 8: Three Boston-Area Stations

10 percent of the analog power is coupled into the dummy load port of the injector. This 10 percent loss has to be made up by increasing the output power of the analog transmitter.

The proper analog-to-digital signal ratio of 100:1 is needed at the output of the injector. In order to attain this ratio, the digital transmitter output power is set at 10 percent of the analog power. Due to the losses of the directional coupler, 90 percent of the digital power is conducted to the dummy load port, and only 10 percent coupled to the main transmission line, for a net output of 1 percent of the analog power (see Fig. 10).

CORRECTING THE INTERFERENCE

In order to analyze this interference, a directional coupler was attached to the output of the digital transmitter and a spectrum analyzer was attached to the forward loop of the coupler. The photo in Fig. 6 clearly shows the interfering spurs at +/-820 kHz. The photo also shows a set of spurs at +/-492 kHz, and even though these spurs are strong enough to cause interference, there were no second- or third-adjacent stations in the immediate area that were affected.

In order to reduce the power level of the +/-820 kHz spurs, a bandpass filter (digital

SEE SPURS, PAGE 16

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Spurs

CONTINUED FROM PAGE 14

mask filter) was installed between the digital transmitter and the high-level injector (Fig. 11).

Fig. 12 is a plot of the frequency response of the filter being used to suppress the spurs. From the plot, the suppression of the spurs at +/-820 kHz is approximately 45 dB.

With the filter in place the spectrum analyzer was attached as before and Fig. 13 shows that the +/-820 kHz interfering spurs are suppressed below the noise floor

SEE SPURS, PAGE 18

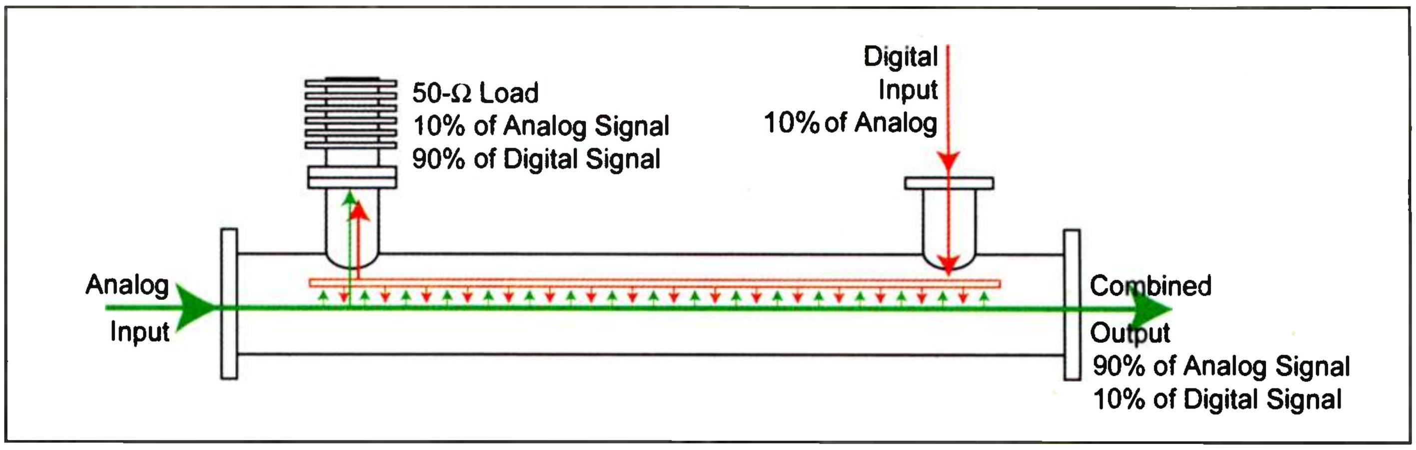

Fig. 9: High-Power Injector

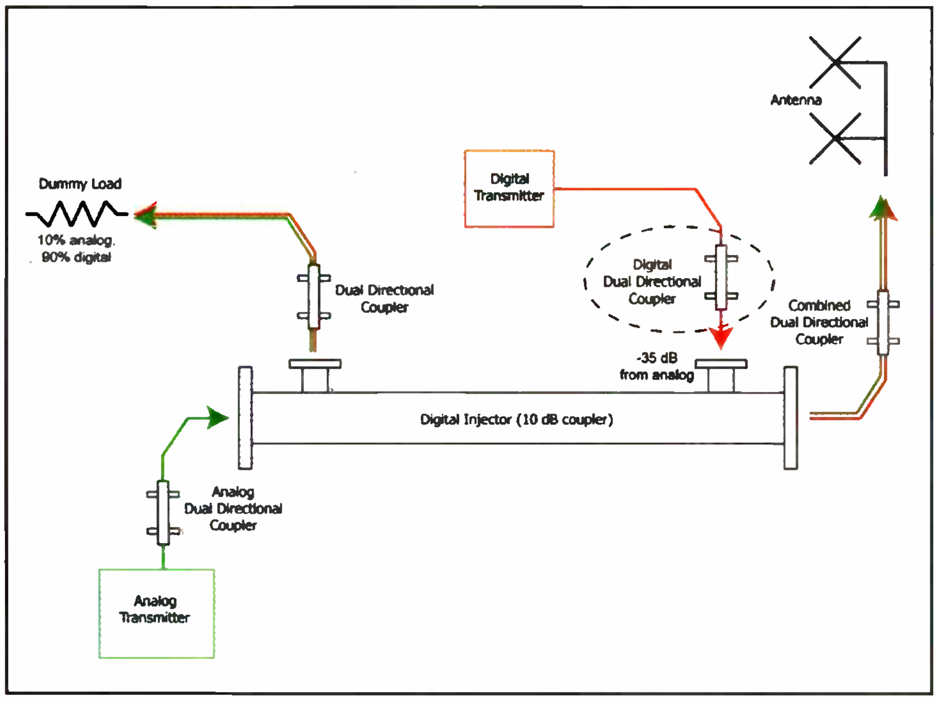

Fig. 10: Analog/Digital Transmission System With High-Level Injection

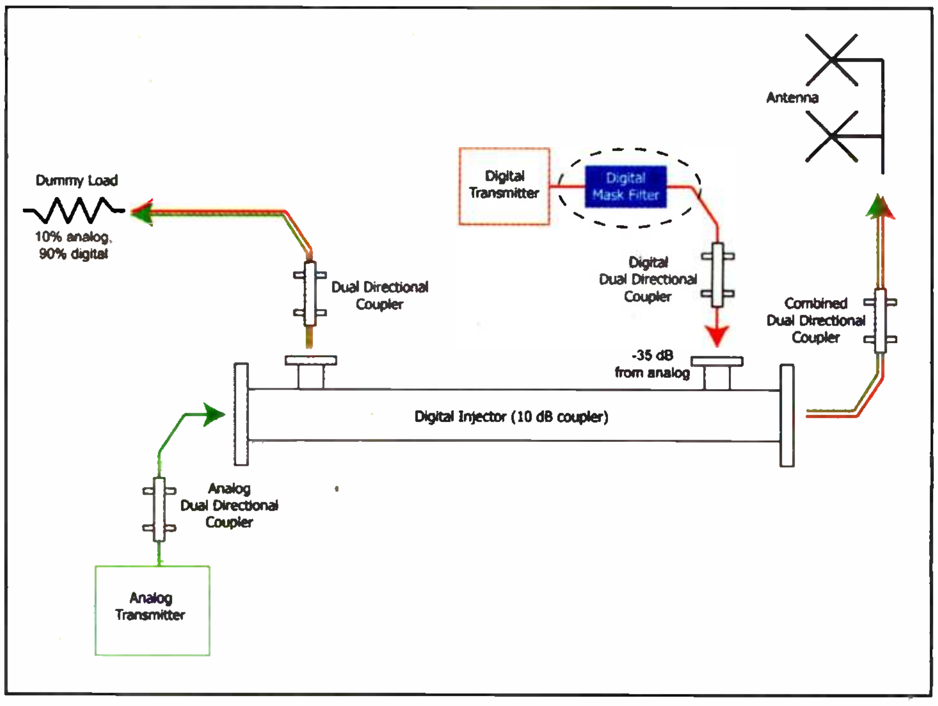

Fig. 11: Addition of Digital Mask Filter

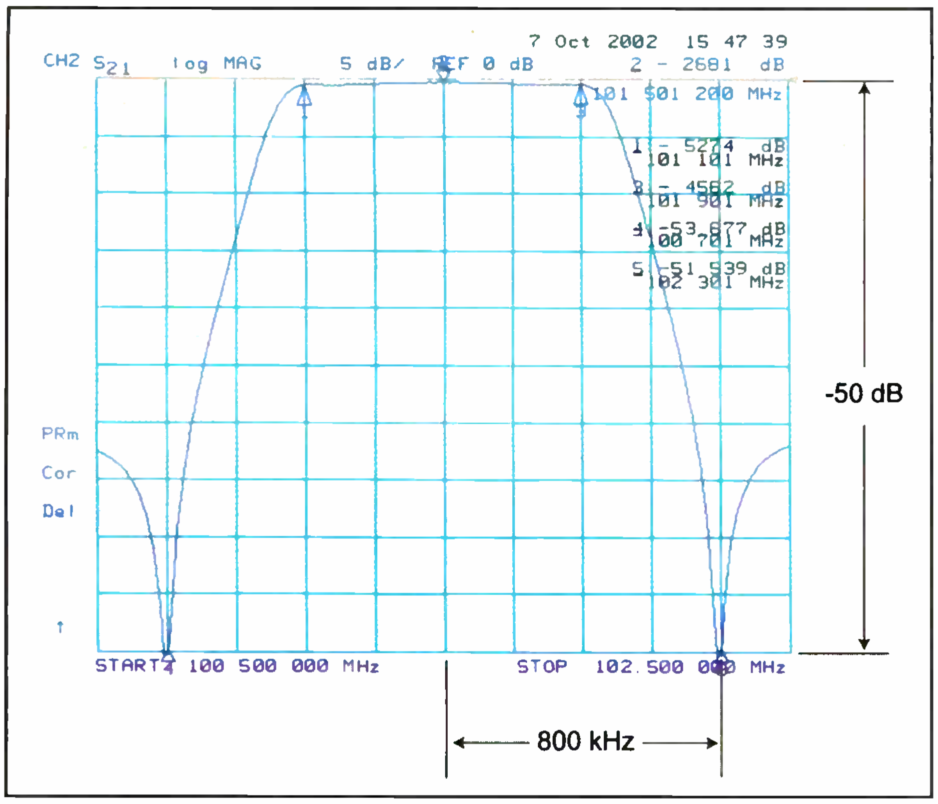

Fig. 12: Response Curve of Digital Mask Filter

MARKETPLACE

Bext X1 Broadcasts Signals On FM Carriers

The X1 FMeXtra radio encoder from Bext allows broadcasting of multiple digital signals on existing FM carriers. It works on HD Radio stations or non-HD Radio stations, and its architecture can use any available SCA carrier space.

The FMeXtra Aruba Radio

The amount of bandwidth each station can make available for the Bext X1 FMeXtra Encoder is up to the individual station's configuration; whether it is broadcasting mono audio or stereo audio; and whether or not there are already existing SCA signals.

The Bext X1 FMeXtra encoder offers an additional independent stream of data that can be put to use for more programming or other data services without sacrificing any bits from the main IBOC data channel, whether or not the station has converted to hybrid mode HD Radio.

The company says the X1 provides an immediate and economical route to having digital broadcast capabilities in addition to the present analog programming for analog FM broadcasters. It also can be used to broadcast 5.1 surround sound, equivalent to Dolby Digital 5.1.

The X1 encoder with FMeXtra technology also can be used to broadcast multiple independent audio streams to provide multichannel programming, for example special-interest audio programs, foreign language broadcasts, full-time traffic and news, additional vocal and music services; or simulcast the station's main program in digital audio.

The X1 delivers telematics, messaging services and other data services with integrated conditional access for individual and group subscription and other controlled-access services.

The company says the X1 can be put on the air immediately, as it works with any good-quality FM transmission equipment, not just Bext transmitters; and there are no fees to pay or STAs to file with the FCC.

For more information, contact Bext in California at (619) 239-8462 or visit www.bext.com.

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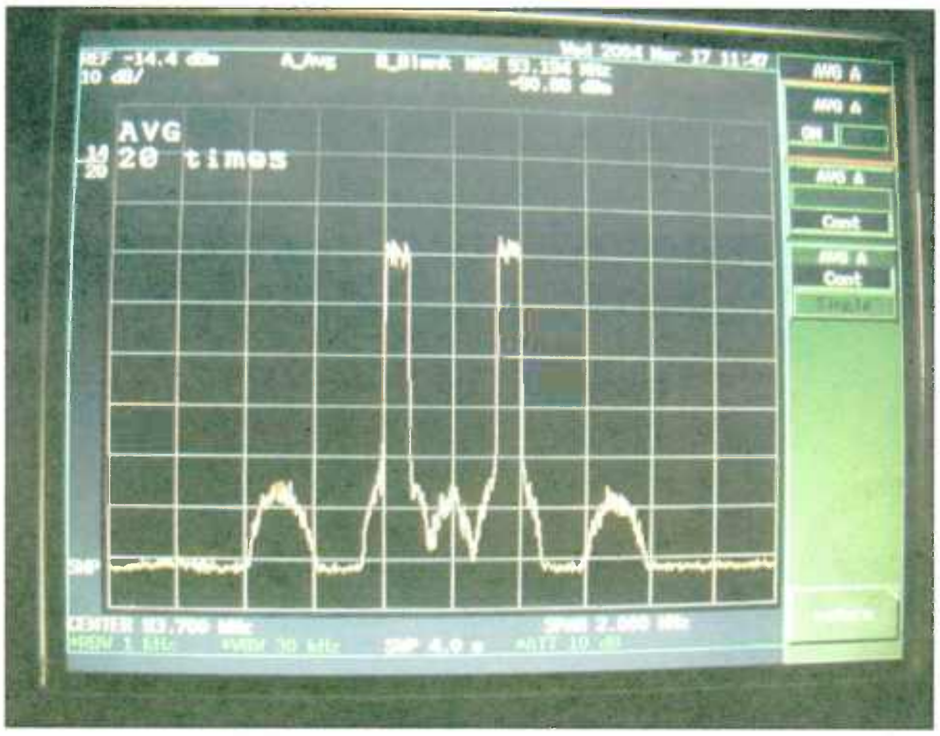

Fig. 13: Uncorrected Digital Transmitter With Filter

Fig. 14: Filtered System Output

Spurs

CONTINUED FROM PAGE 16

of the analyzer.

The spectrum analyzer was then attached to the directional coupler at the combined output of the high-level injector. Fig. 14 shows the suppression of the +/-492 kHz spurs and the elimination of the +/-820 kHz spurs.

The spectrum analyzer was than moved outside of the transmitter building for an off-air measurement. Fig. 15 is a photo of the WMKK channel as the reference. The spurs at +/-492 kHz are not causing interference, and WJMN and WBOS show no interference.

THE WBUR CASE STUDY

The next case study was set up as an experiment to see what could be learned from evaluating a station in compliance with the FCC's digital mask. WBUR is operating with the same style of high-level injection discussed above. At this site there are two SCAs in the analog transmission, which adds another aspect to the analysis of this station's operation.

At the start of our experiment, we disconnected the digital transmitter from the injection system to calibrate the instrumentation to the analog transmitter with no interfering signal. We connected a spectrum analyzer to the forward loop of the directional coupler attached to the output of the analog transmitter, as shown in the highlighted area of Fig. 16.

The analyzer was set up so the peak power level of the transmitter could be determined under conditions of normal modulation but with no digital signal. In order to make this measurement, the analyzer's video bandwidth (VBW) and resolution bandwidth (RBW) were set at 30 and 300 kHz respectively. Fig. 17 shows the result. The FCC's digital mask template, shown by the red line, was placed in the memory of the analyzer and should be

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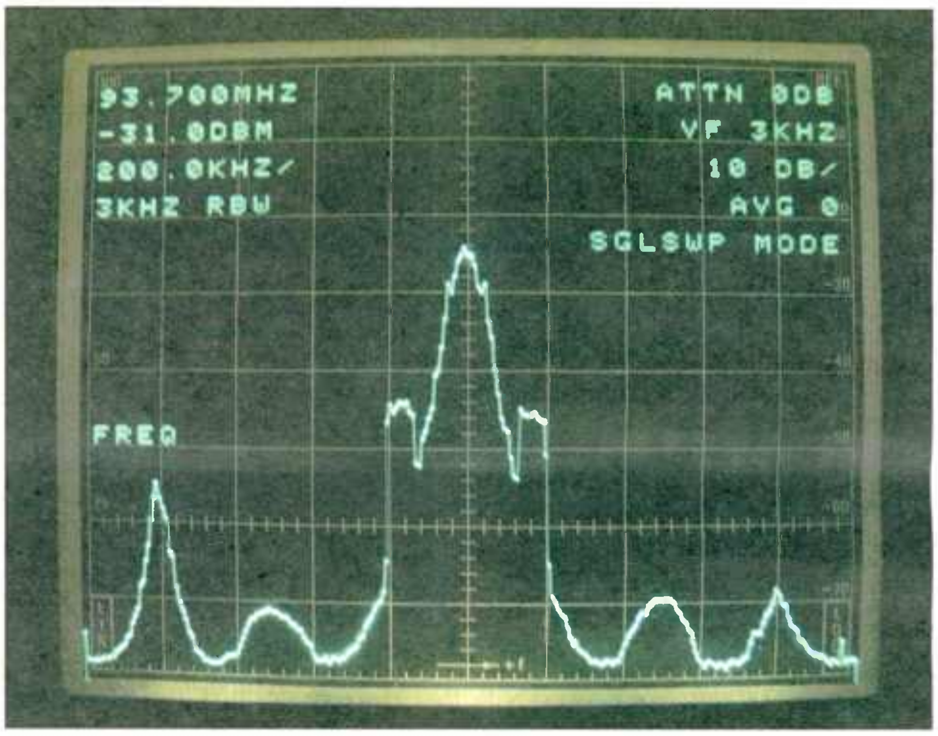

Fig. 15. Off-Air Measurement

V-Soft to Host Broadcast Engineering Seminar in Vegas

V-Soft Communications will hold its fifth annual engineering training seminar April 14-15 at the Excalibur Hotel and Casino in Las Vegas immediately prior to NAB2007. The company says the seminar will focus on specific broadcast engineering projects such as station upgrading, translators, single frequency networks and boosters, interference analysis and move-ins.

Additionally, the seminar will spotlight features in the Probe 3 propagation prediction program, FMCommander frequency search software, AM-Pro 2.0 AM allocation program and others. Breakfast and lunch will be provided for attendees on both days.

For more information, contact V-Soft Communications in Iowa at (319) 266-8402 or visit www.v-soft.com.

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With the addition of the optional MiniSPL measurement microphone, the ML1 also functions as a Sound Pressure Level Meter and 1/3 octave room and system analyzer. Add the optional MiniLINK USB computer interface and Windows-based software and you may store measurements, including sweeps, on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

- Measure Level, Frequency, Polarity
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- VU + PPM meter/monitor
- 1/3 octave spectrum analyzer
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

DL1 Digilyzer
Digital Audio Analyzer

With all the power and digital audio measurement functions of more expensive instruments, the DL1 analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as the embedded audio. In addition, the DL1 functions as a smart monitor and meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you are on an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a sophisticated event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp

AL1 Acoustilyzer
Acoustics & Intelligibility analyzer

The AL1 Acoustilyzer is the newest member of the Minstruments family, featuring extensive acoustical measurement capabilities as well as core analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

- Real Time Analyzer
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The MR2 & MR-PRO are the new standards for portable audio generators - the behind-the-scenes stars of thousands of live performances, recordings and remote feeds. Both pocket-sized analog generators include a new ergonomic instrument package & operation, balanced and unbalanced outputs, and a full set of output signals.

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- Polarity & delay test signals

Plus the MR-PRO adds:

- User-stored custom signals & generator setups
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- Protective jacket

MiniSPL
Measurement Microphone

The precision MiniSPL measurement microphone (required for the AL1 Acoustilyzer and optional for the ML1 Minilyzer) is a precision reference mic for acoustics measurements, allowing dBSPL, spectrum and other acoustical measurements to be made directly.

- 1/2" precision measurement microphone
- Self powered with automatic on/off
- Omni-directional reference microphone for acoustical measurements
- Required for the Acoustilyzer; optional for the Minilyzer

MiniLink USB interface
and PC software

Add the MiniLINK USB interface and Windows software to any ML1 or DL1 analyzer to add both display and storage of measurement results to the PC and control from the PC. Individual measurements and sweeps are captured and stored on the instrument and may be uploaded to the PC. When connected to the PC the analyzer is powered via the USB interface to conserve battery power. Another feature of MiniLINK is instant online firmware updates and feature additions from the NTI web site via the USB interface and your internet-connected PC.

- USB interface fits any ML1 or DL1
- Powers analyzer via USB when connected
- Enables data storage in analyzer for later upload to PC
- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard on AL1 Acoustilyzer

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A node for every need • Someday, all broadcast gear will speak Livewire (so says our Magic 8-Ball). Until then, there are Axia Audio Nodes that turn analog and AES sources into routable 48 kHz / 24-bit audio streams.

Automation station • Wouldn't it be cool to have a **self-monitoring air chain with silence-sense** that can fix problems, then e-mail a status report? To be able to switch your program feed from Studio "A" to Studio "B" with one button? Or build custom switching apps and scheduled scene changes based on Boolean logic and stacking events? PathfinderPC software does all these things and more. But unlike HAL 9000, it doesn't talk back to you.

It's not rude to point • Little kids tell mommy what they want by pointing — a pretty intuitive way of doing things. PathfinderPC software gives talent the same convenience. You can **build custom "button panels"** to execute complex operations with just one click. You can map these panels to controller modules on Element consoles or to turret-mounted controls, place mini-applications on studio computer screens, even run them on touchscreen monitors.

Ether Net • Hardly a month goes by without a story concerning someone getting knocked off the air by STL frequency interference or bandwidth reductions. There's also the headache of trying to add HD Radio™ program streams to already maxed-out transmission links. Luckily, Axia clients have a way around this particular roadblock: they've been using Ethernet radios from well-known manufacturers like Orthogon, Dragonwave and BE to construct a link between the studios and the transmitter that operates *above* the crowded 950 MHz band. Put an Axia AES/EBU Audio Node on both ends of that link and before you can say "Look! Up in the sky!" you've got an Ethernet STL, with room for multiple channels of program audio plus backhaul. And that's **uncompressesd 48 kHz, 24-bit audio** — without nasty compression artifacts that degrade your lovingly-tweaked audio chain. Add a couple of Axia GPIO nodes to the mix, and your new STL link can carry remote control commands for transmitter and processing gear, too.

AES yes • You like your audio to stay digital as much as possible, right? We get that. That's why we have AES/EBU Audio Nodes that let you plug AES3 sources right into the network. Studio-grade sample-rate converters are inside; anything from **32 kHz to 96 kHz** will work. Oh, and there's 8 AES ins + 8 AES outs in each node. Digital distribution amp, anyone?

Brains in the box • The typical radio jock cares for studio equipment about the same as a five year old cares for a puppy: haphazardly, if at all. That's why we **took the CPU out** of our Element modular console and put it in here, with the power supply and GPIO ports. That means a greatly reduced chance of being taken off the air by a Coke spilled into the board. C'mon, don't you have better things to do than trying to dehumidfy circuit boards with a hair dryer?

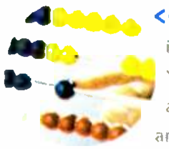
That's cool • Noisy fans in studio equipment? That's a major *faux pas*. You won't find a fan in any Axia Audio Nodes — they're designed to run **cool and silent** (unlike your morning show talent).

Push to play • Axia Router Selector Nodes are pretty cool. Think of them as **really advanced selector and monitor panels;** put one anyplace you need access to audio streams from the IP-Audio Network. Like newsrooms, where a reporter might need access to a satellite feed or a Zephyr connection. Or dubbing stations, where audio is captured and stored for later user. Or in the station's TOC, so you can monitor any of the hundreds - or thousands - of audio streams on your network at a moment's notice. Use the LCD screen to scroll through a list of available streams, or use the eight Fast Access keys on the front panel to store and recall the streams you use most. And Router Selector nodes have something standard X-Y panels don't: an input, for fast connection of an analog or AES device. Sweet.

Let it grow • Growing your business computing network is easy: just add more PCs and hook them to the Ethernet switch. But with broadcast routers, adding more capacity usually means buying another frame, installing more I/O cards, pulling more discrete cable through conduit that's already full to the brim... Hope you've got stock in Grecian Formula! But since IP-Audio networks use standard Ethernet, **adding more capacity to an Axia system is as simple as plugging in an Audio Node** wherever you need inputs. And, should you need to move to new digs, you can just unplug your Axia system and take it with you. Try doing *that* with a big-iron router.

Orc slayer • Hooking up an Axia Audio Node may be the simplest thing you've ever done. All our I/O is presented on RJ-45 and adheres to the StudioHub+ standard, so connecting audio devices is as simple as plugging in an Ethernet patch cable. All of which gives you more time to play World of Warcraft with those guys from IT.

Level headed • These green, bouncing dots built into every Axia Audio Node are confidence meters. One glance and you know whether an audio source is really active — or just playing possum.



<< Thinking about Axia but waiting 'til we're "more established?" You might not know that there are over 400 Axia studios on-air around the world — and counting.

<< An Axia system can expand or shrink as much as you want it to — the Ethernet backbone lets it scale easily, on-demand. Portable too: just take it with you if you move.

<< Axia systems install in as little as half the time of hardwired routers — and without expensive, bulky multi-pair cable. Whatever will you do with all the time you save?

<< Is IP reliable enough for 24/7 audio transport? Millions of VoIP business phone users with systems based on Cisco routers certainly think so. Coincidence?

Nothin' but Net • Did you know you can plug a PC directly into an IP-Audio network and use it to send and receive audio? Can't do that with a mainframe router. Well, you *could* add more input cards to the mainframe, and then buy high-end audio cards for your PCs, and then run more wiring all over the place... but with Axia, you just install the **IP-Audio Driver** on any Windows® PC to send and receive pure digital audio right through the PC's Ethernet port — no sound card required or additional router inputs needed. You get better, cleaner PC audio that's sharable right to the network. The single-stream version is great for audio workstations; the multi-stream version lets you send and record **16 stereo channels simultaneously** – perfect for digital automation systems.

CYA • Sooner or later, someone's going to ask for a hard copy of a specific broadcast. Whether it's a client looking for proof of play, a Group PD that wants airchecks, or a listener claiming your morning show did something naughty, you're going to need a way to prove what was said. Axia makes it easy to keep archives of your programming with iProFiler networked audio logging software. Just install iProFiler on a Windows PC with a NIC and connect it to your Axia network; tell it what audio streams you want to record and it goes to work, sucking audio out of your network like pimientos from Martini olives. iProFiler can record **up to 16 channels of stereo audio simultaneously**, storing them as time-stamped MP3 files you can save to a network drive or FTP server for listening or re-broadcast. And since logic always follows audio in an Axia network, you can tell iProFiler to record only when the jock's mic is open (or vice-versa). And of course you can listen to saved audio from any PC connected to the Axia network.

Put that in your pipe • How many discrete wires can a CAT-6 cable replace? Well, a T-3 data link is pretty speedy with 44.7 Mbps of throughput. But Axia networks use Gigabit Ethernet links, with 1000 Mbps between studios. That's more than 22 times the capacity of a T-3; enough throughput for 250 stereo channels per link — the equivalent of a **500-pair bundle on one skinny piece of CAT-6**. You can even use media converters and optical fiber for higher signal density if you want. Think that might save a little coin in a multi-studio build-out?

Heavyweight champion • This is an Axia StudioEngine. It works with our Element Modular Consoles (the fastest-growing console brand in the world, by the way) to direct multiple simultaneous inputs and outputs, mix audio, apply EQ, process voice dynamics, and generate multiple mix-minuses and monitor feeds on the fly. To make sure it delivers the reliability and ultra-low latency broadcast audio demands, we powered the StudioEngine with a fast, robust version of Linux – so fast that **total input to output latency is just a few hundred microseconds.** How can one little box do so much? There's a blazingly-fast Intel processor inside, with enough CPU muscle to lift a small building. Strong *and* fast: Ali would approve.

Hakuna matata • Axia networks are self monitoring and self healing. Spanning Tree Protocol in the Cisco Ethernet switches we use combines nicely with PathfinderPC's automated program stream monitoring to help ensure that your studio network is **on the air 24/7**. And all Axia gear (like this StudioEngine, that mixes control room audio streams) runs real-time Linux for operation that's as bulletproof as Superman's boxers. Which means 'no worries, mate.'

You got to have friends • Sure we think IP Audio is cool. But it's even cooler that so many *other* folks think so too. Delivery system providers like ENCO, Prophet, BSI, BE, iMediaTouch, DAVID Systems and more all have products that **work directly** with Axia networks. So do hardware makers like AudioScience, International Datacasting, Radio Systems, Telos and Omnia. Check out the whole list at AxiaAudio.com/partners/.

Jammin' on the mic • Radio studios and microphones go together like Homer Simpson and donuts. Unfortunately, so do preamps, mic compressors, EQ boxes, de-essers — let's face it: most studios house more flying saucers than Area 51. Axia helps clean up the clutter by including mic preamps with our Microphone Nodes; not bargain-basement units either, but **studio grade preamps** with headroom enough to handle Chaka Kahn. Phantom power, too. And if you choose to use Axia Element consoles in your studios, you'll find world-class mic processing built right in: vocal dynamics (compression and de-essing) from the audio processing gurus at Omnia, plus three-band parametric EQ with SmartQ, available on every mic input. Rap on, Grandmaster.

Very logical, Captain • Routing logic along with audio used to be almost as hard as performing the Vulcan Mind Meld. But Axia makes it simple, because machine logic can easily be converted to data and paired with Livewire audio streams. So **logic follows audio throughout the facility** on Axia's switched Ethernet backbone. Eight assignable GPI/GPO logic ports, each with five opto-isolated inputs and five opto-isolated outputs, are built into every Element power supply, so you can control on-air lights, monitor mutes, CD players, DAT decks, profanity delays, etc. If you've got more than eight audio devices (and who doesn't), just add a standalone GPIO node like this one wherever you've got gear.

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disregarded for most of this discussion.

The analyzer was then connected to the reverse loop of the same directional coupler and the measurement obtained is an indication (Fig. 18) of the VSWR of the system. As you can see, there is a 30 dB difference between the forward and reflected loops, which represents a VSWR of 1.05:1.

Fig. 19 shows the results of changing the analyzer's video bandwidth and resolution bandwidth to observe the same forward sample of the modulated FM signal. Fig. 20 shows the corresponding reflected FM signal. Here you can clearly see the standard analog signal with the two SCAs in operation. If you compare these two figures with Figs. 17 and 18, you will see that the VSWR is still 1.05:1.

Note that the artifacts of the SCAs at approximately +/-160 kHz from the center of the channel are at a level that does not cause any interference.

Now that we have our reference measurements, we reconnected the digital transmitter as shown in Fig. 21, and attached our analyzer to the forward port of the directional coupler at the digital transmitter's output, expecting to see a nice clean digital spectrum.

Instead, what we found (still ignoring the red digital mask) was a complex presentation (Fig. 22). Not only were there intermodulation products, as discussed earlier, but the analog signal is showing up in the digital output, meaning that a

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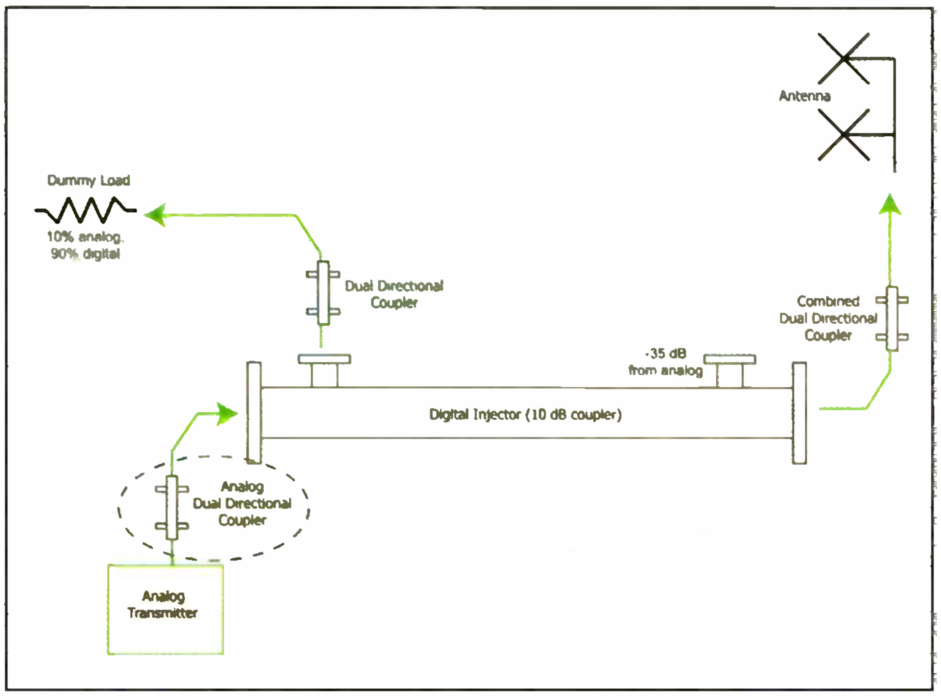

Fig. 16: Analog Transmission System, WBUR

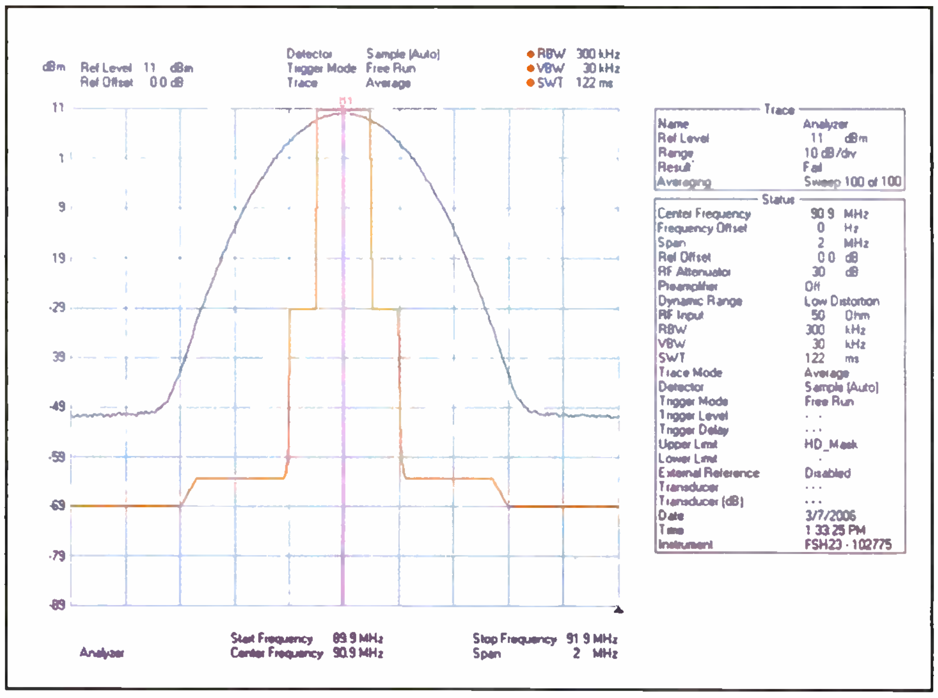

Fig. 17: Forward Peak Power Reference Level, WBUR

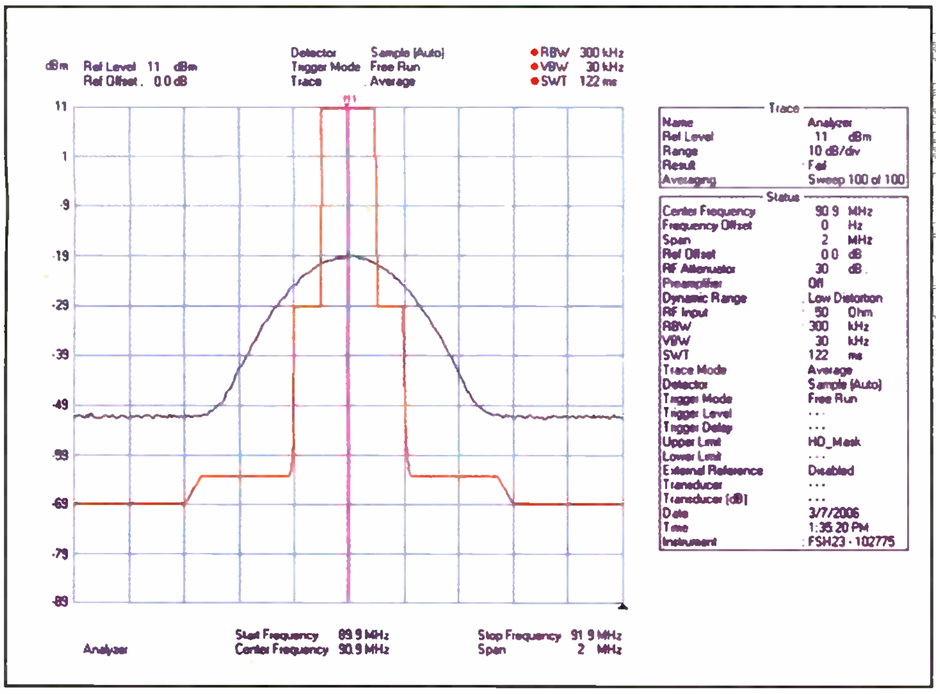

Fig. 18: Reflected Peak Power Reference Level, WBUR

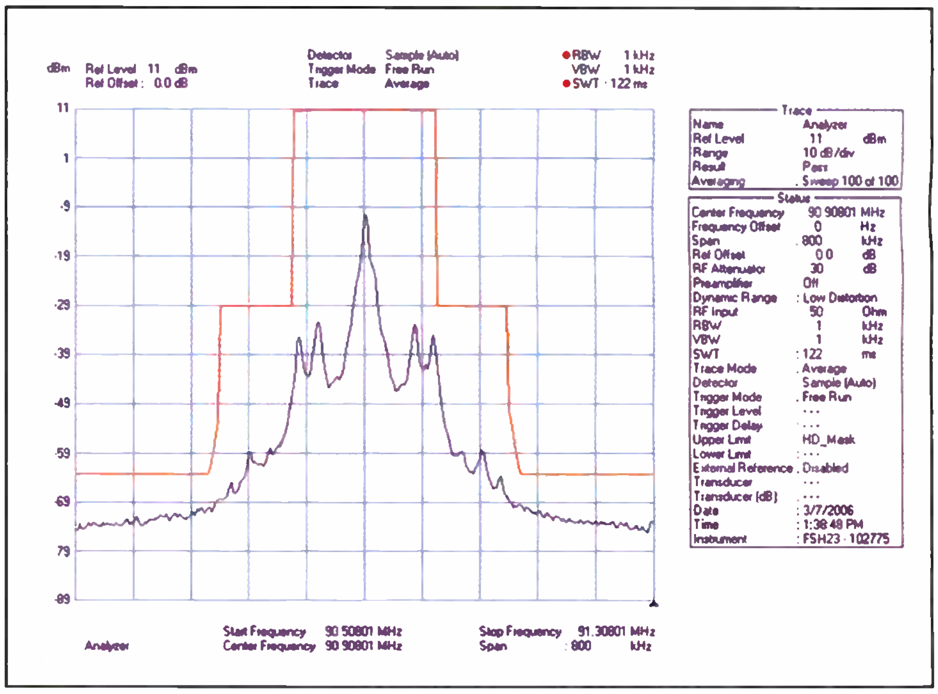

Fig. 19: Forward Sample Modulated FM Signal, WBUR

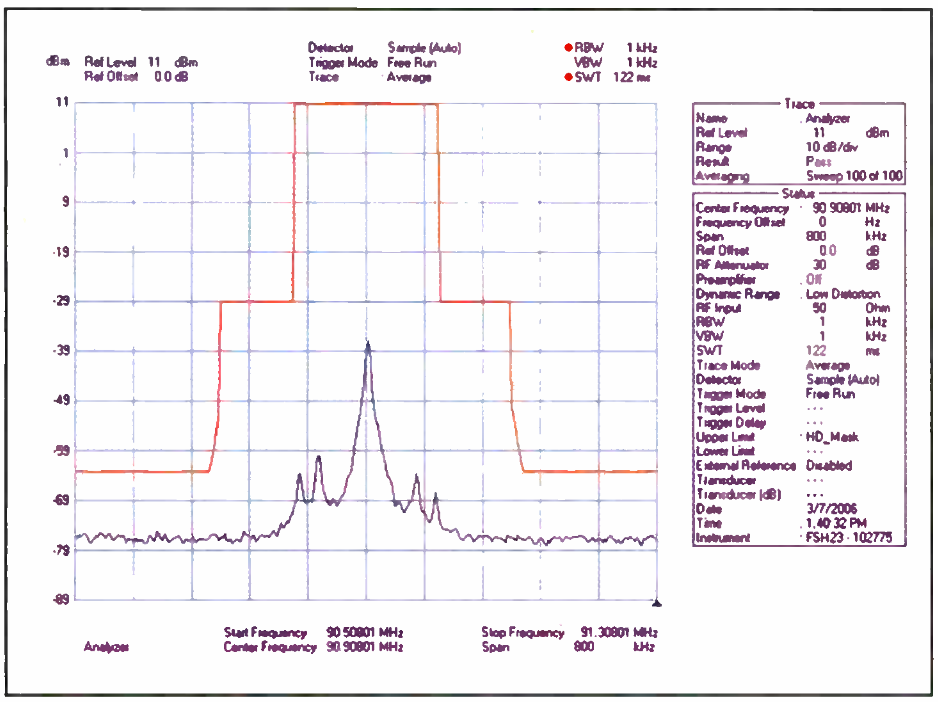

Fig. 20: Reverse Sample Modulated FM Signal, WBUR

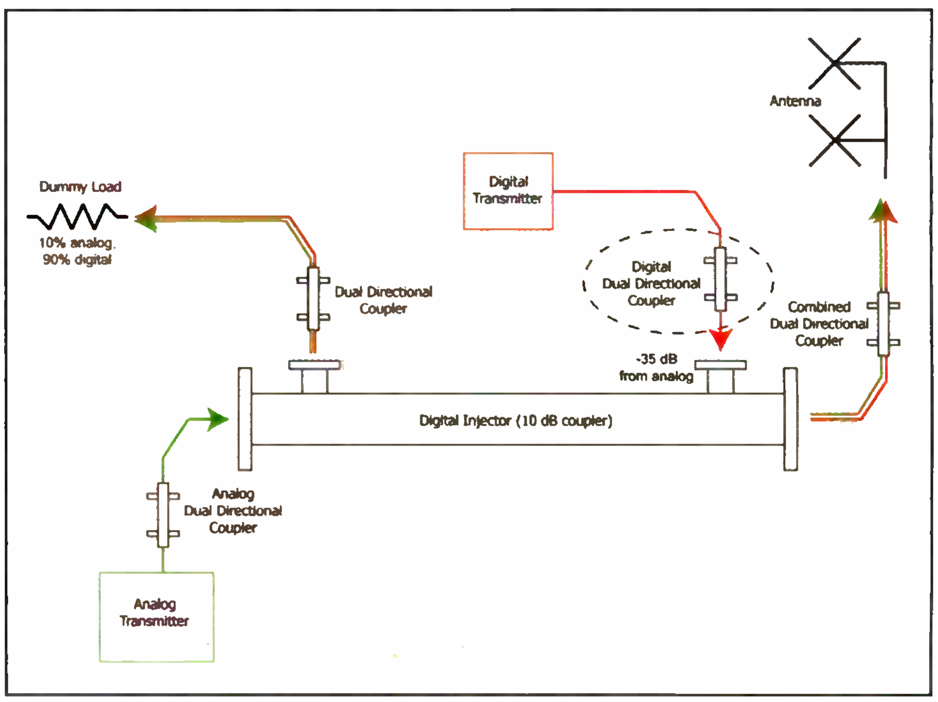

Fig. 21: Digital Input of Combined Transmission System, WBUR

Spurs

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component of the analog signal is coming out of the digital transmitter.

Where is this analog signal coming from? To find out, we attached the analyzer to the reflected port of the same directional coupler (Fig. 23), and we found:

- The presence of the analog signal in the reflected loop of the digital directional coupler indicates the amount of analog power being coupled to the digital port of the injector. This is referred to as the isolation of the injector.
- The analog signal level was higher going into the digital transmitter than coming out of it. This attenuation of the analog signal in the digital transmitter is called the turnaround loss of the digital transmitter, which to our knowledge had never been measured before.
- The digital signal level demonstrates that the VSWR of the system is the same 1.05:1 as the analog. This must be a coincidence and not inherent in the system design, because the analog and digital transmission paths are separate and different. This return loss puts them below the noise floor of the analyzer, and they are no longer visible.

So if the analog signal gets into the digital transmitter, does the digital signal return the favor? We connected the analyzer to the reflected loop of the analog transmitter's output coupler to find out (Fig. 24).

Fig. 25 shows the result. The digital signal does indeed get into the analog transmitter. In order to see what happens to the digital signal in the analog transmitter, we attached the analyzer to the forward loop of the analog transmitter's directional coupler.

Compare the result, Fig. 26, with Fig. 19 above. Note the following:

- The shape and amplitude of the subcarriers have changed.
- The subcarrier artifacts at +/-160 kHz have almost disappeared.
- There is no visible retransmission of the digital signal.

Interestingly, although the subcarriers appear distorted, there are no off-air reports of interference or distortion of the subcarriers.

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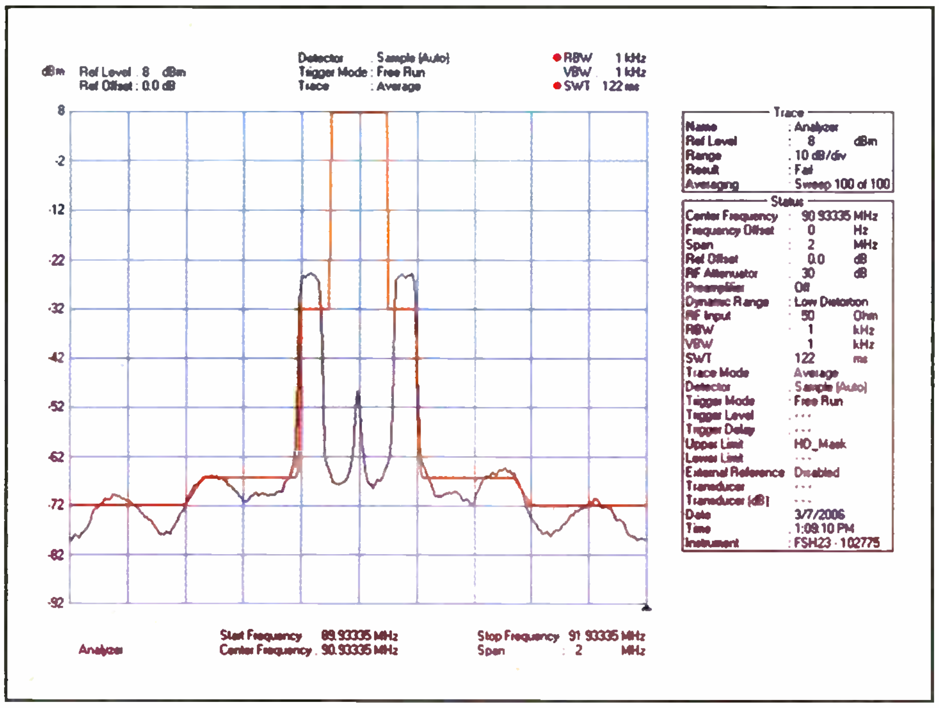

Fig. 22: Combined Digital Forward Power, WBUR

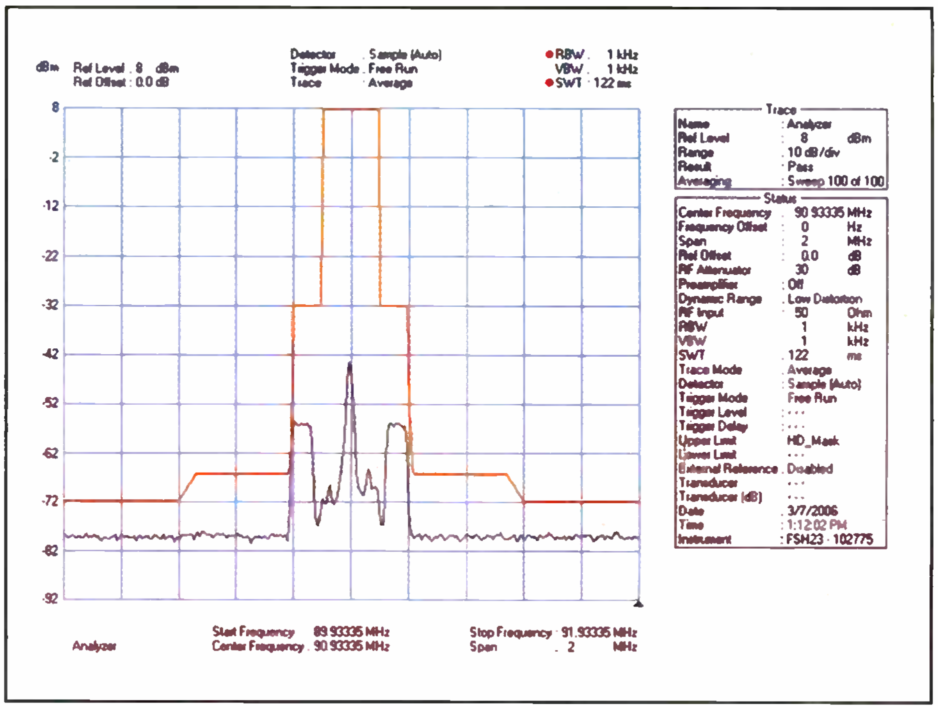

Fig. 23: Combined Digital Reflected Power, WBUR

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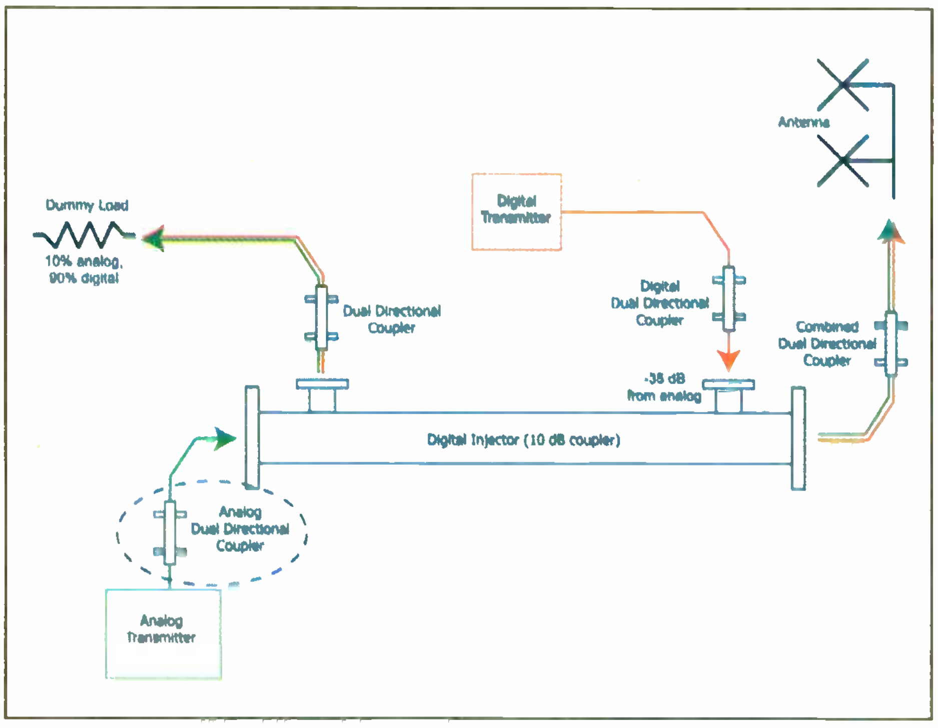

Fig. 24: Analog Input of Combined Transmission System, WBUR

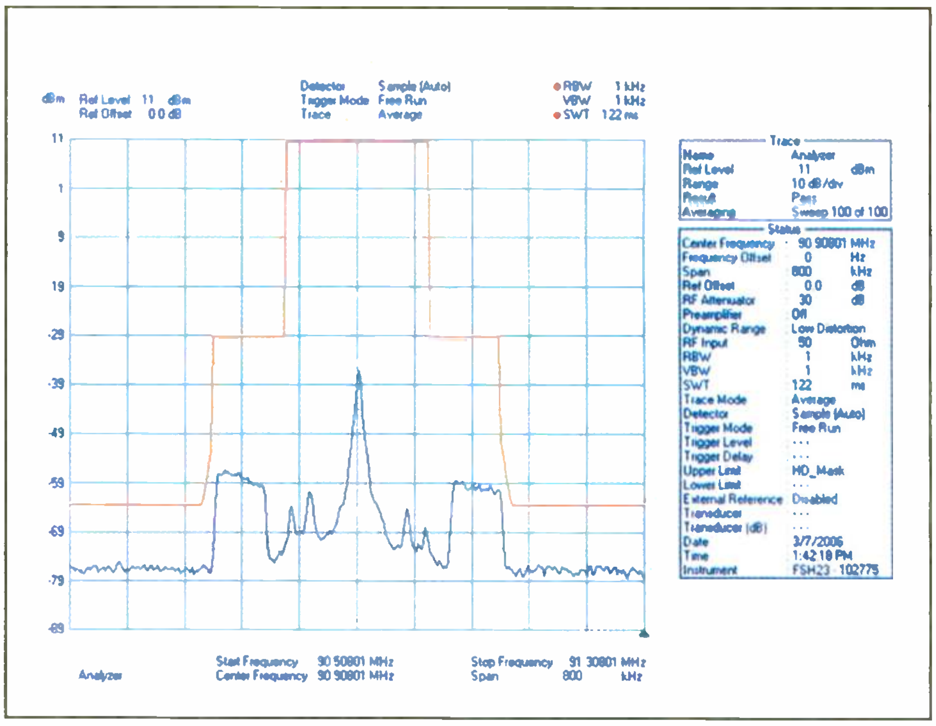

Fig. 25: Combined Analog Reflected Power, WBUR (Note digital sidebands)

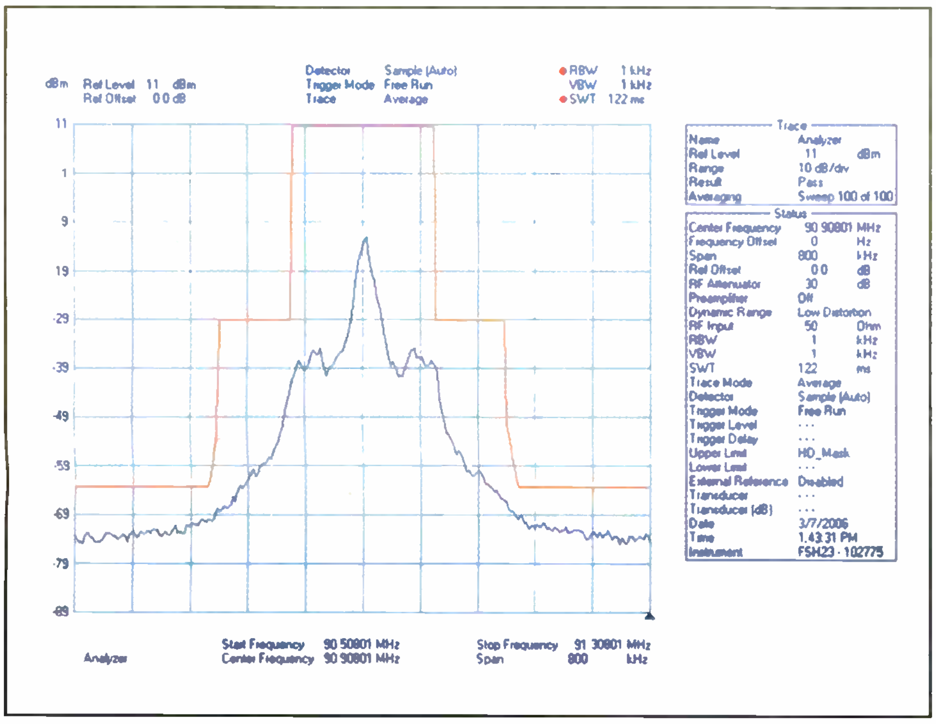

Fig. 26: Combined Analog Forward Power, WBUR

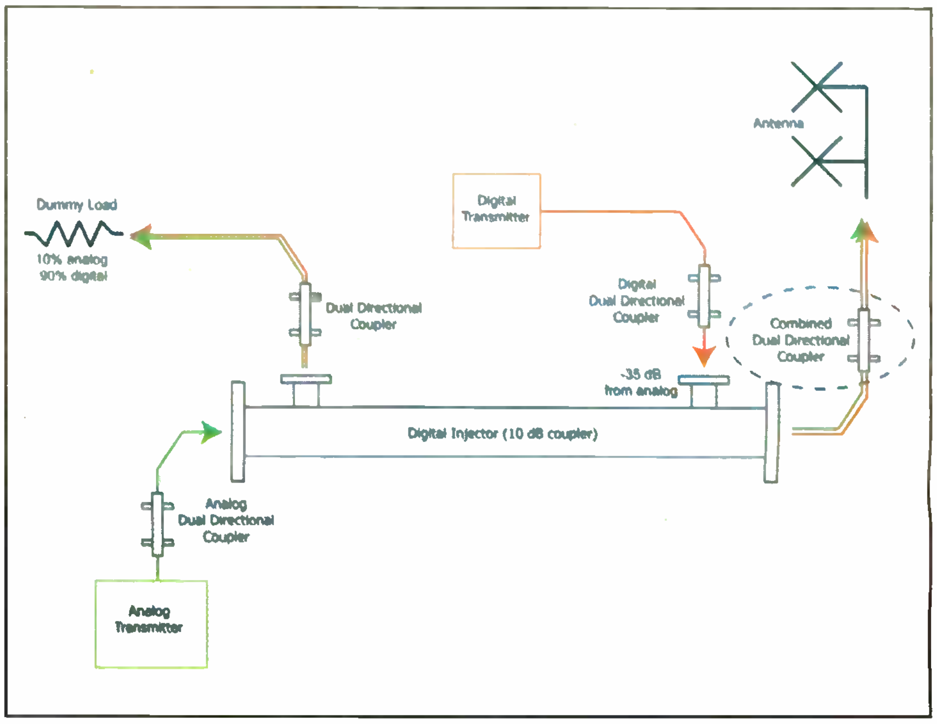

Fig. 27: Output Coupler of Combined Transmission System, WBUR

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Now that we've looked at the analog and digital inputs and outputs, we now analyze the combined system output, as shown in Fig. 27.

The plot in Fig. 28 shows the analog with SCAs, the two digital carriers and intermodulation products, all within the FCC's digital FM mask. The station is operating without interference to other broadcasters.

While monitoring the same directional coupler, we increased the digital transmitter's output power by approximately 1 dB, or about 20 percent. The only change we observed was the increase in the intermodulation products at +/-492 kHz, as shown in Fig. 29.

We did this experiment because in the future, WBUR is going to be allowed to increase its analog ERP. The digital transmitter power also will have to be increased. Because the digital transmitter was adjusted for a specific power level for minimum intermodulation products, in the future it will have to be re-adjusted to minimize the increased intermodulation products shown in Fig. 29.

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OPTIMIZING THE INJECTOR TO REDUCE INTERMODULATION PRODUCTS

As more and more stations have added their digital signals using high-level injection, experience has shown that in some cases, the overall spectral picture is not perfect. Although each transmitter's performance has been optimized, some intermodulation products show up — though they may or may not cause interference to adjacent channels — and the roll-off slope of the digital carriers at +/-225 kHz shows the digital signal slightly exceeding the original Ibiquity mask. Inability to meet the spectral mask in this region is so prevalent that Ibiquity has proposed relaxing the mask requirements out to +/-250 kHz.

Experimentally, it has been found that if you place a tuning slug in the transmission line between the dummy load and the injector, you can optimize the performance of the injector and reduce the above problems. However, a fine-matching transformer (Fig. 30) gives the same result with a lot less effort and can be adjusted under full power.

Fig. 31 is a plot of such an optimized "almost-perfect" system that meets the Ibiquity digital FM mask.

CONCLUSION

Intermodulation products can develop within the analog and digital transmitters in combined systems using high-level injection, resulting in suboptimal signal quality or even causing station-to-station interference.

In the early days of digital implementation, external filtering often was used to eliminate or reduce interference. However, as the technology has evolved and we have achieved a better understanding of high-level injectors, subtle adjustments to the system, such as the addition of a fine-matching transformer to the dummy load, have proven adequate to reduce distortion and interference to meet the Ibiquity digital FM mask.

Comment on this or any article. E-mail *rwee@imaspub.com*. ■

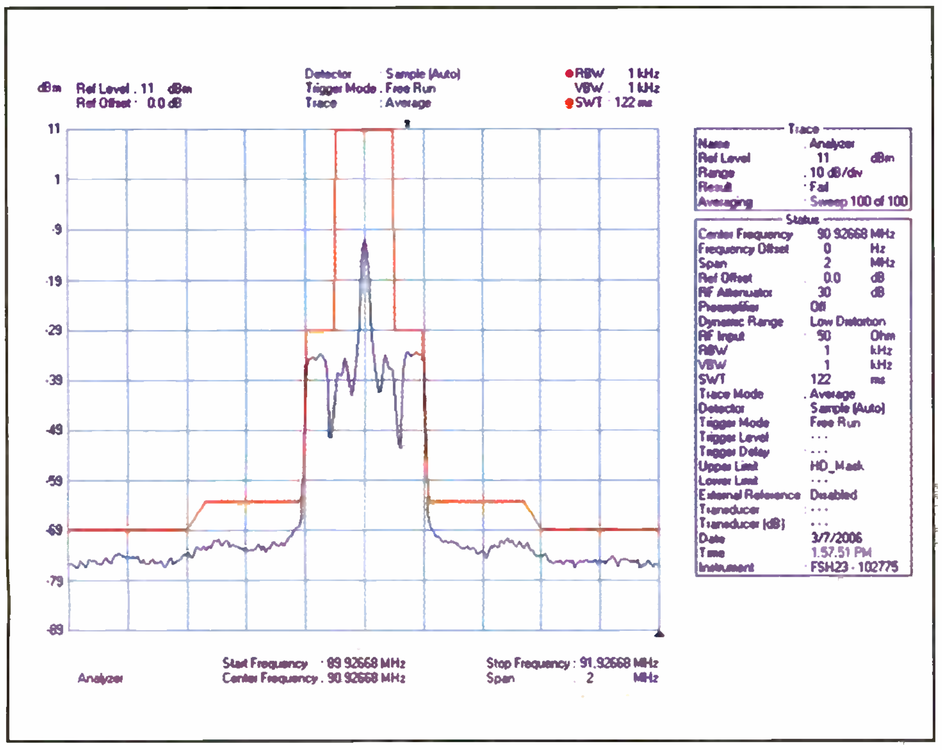

Fig. 28: Combined System Output

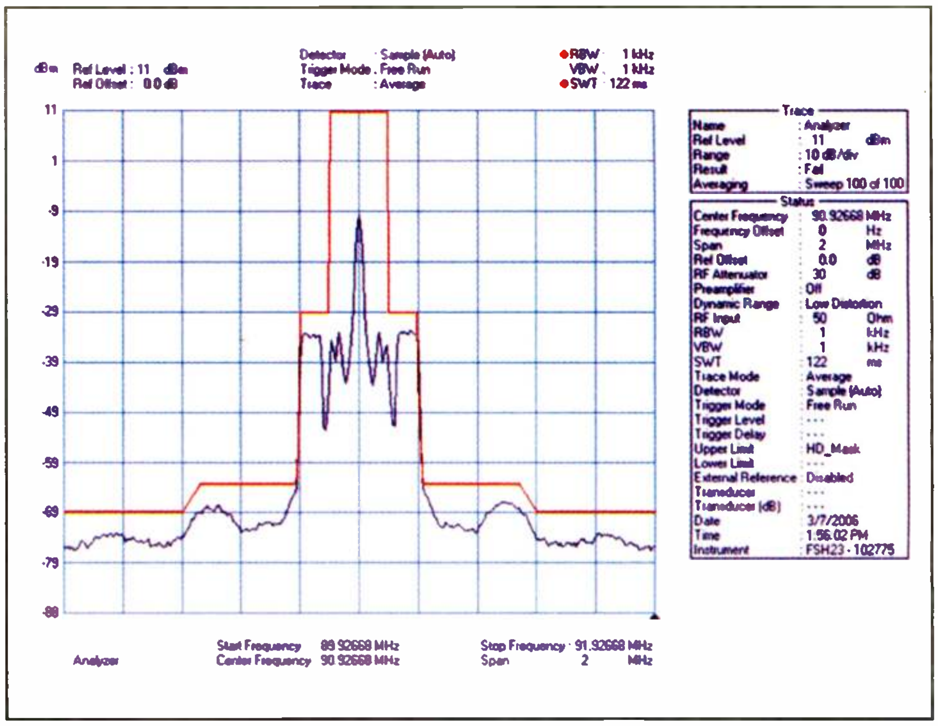

Fig. 29: Combined System Output with Increased Digital ERP

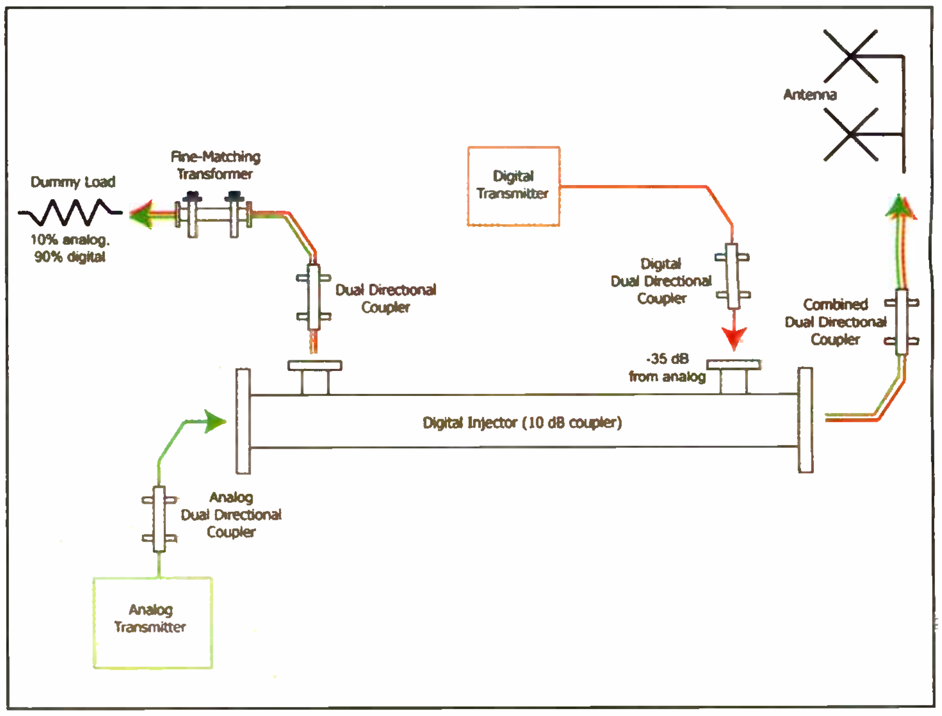

Fig. 30: Optimized Injection System

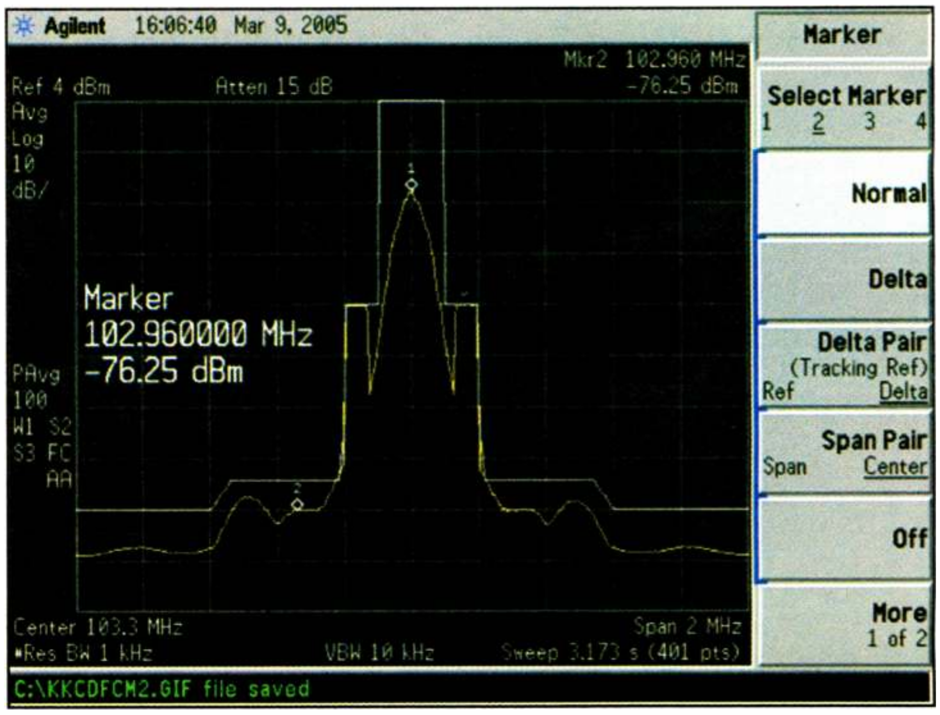

Fig. 31: Almost Perfection

MARKETPLACE

Neutrik Has DLX Series, Improved XXR Rings

Neutrik says its DLX Series is an enhanced version of its DL XLR chassis connectors. Suitable for use with Neutrik's EMC XLR cable connector, the DLX Series features compact metal housing, offering RF protection and electromagnetic shielding. The company says its duplex ground contact provides contact integrity between chassis and cable connector, as well as the option to solder chassis ground to pin1.

The DLX line also offers a male connector designed with a metal retention bar for improved pull-out force. The series is available in 3-, 4-, 5-, 6- and 7-pole configurations with gold- or silver-plated solder contacts and nickel or black metal housing.

Additionally, Neutrik says it improved the design of its XXR colored coding rings. For use with the XX series XLR cable connector, the XXR facilitates connections for audio and instrumentation applications, as the new coding rings expand to fill the void between the rear boot and the front shell/housing for a more secure fit. For optimum efficiency, the insert does not have to be unsoldered to change the color coding.

The XXR colored coding rings also ease identification between XLR cable ends and panel mount receptacles. They are offered in 10 colors.

For more information, contact Neutrik USA in New Jersey at (732) 901-9488 or visit www.neutrikusa.com.

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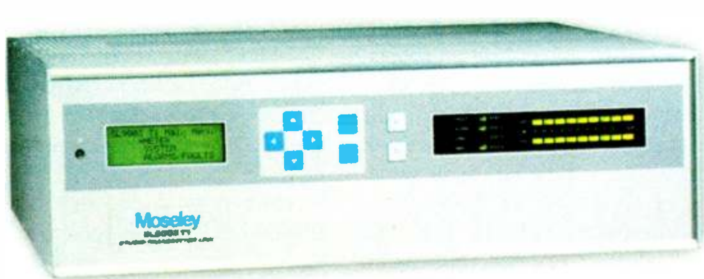

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Today's Technology, Tomorrow's Memory?

As Radio Embraces HD Radio, Streaming and WiFi, What Will Young Engineers Look Back at in 20 Years?

Cris Alexander is director of engineering for Crawford Broadcasting Corp., Denver.

Thirty-*several* years ago, I was an enthusiastic (and young!) amateur radio operator, rapidly moving up in the license classes. In those days, most folks started out with the Novice class (CW privileges only on four HF bands and a 75-watt limit), then worked their way up the ladder to Technician and General. Those with more ambition studied for the Advanced and some went on to Amateur Extra.

One thing these classes had in common was a Morse code proficiency requirement. Novice and Technician required five words per minute; General and Advanced required 13 WPM and Extra required 20 WPM. Morse code proficiency was an off-putting requirement, one many never really got past. A lot of otherwise enthusiastic hams were stuck at the Technician level because they just couldn't get over that 13 WPM hump.

THE 'CODE HUMP'

As I mentioned above, I was young in those days and the code "hump" was no problem for me. I got that General class license at age 14 — I never did hold the Technician class — and before the ink was dry on the General I had tested for the Advanced. With that test behind me, I immediately went to work on the Amateur Extra with its daunting 20 WPM code requirement. By that time I also was studying for my commercial licenses, so the theory portion of the Extra test was no issue.

The code, on the other hand, was something else. So I practiced ... and practiced ... and practiced, on the air and off. Another local ham had a code machine that would generate dits and dahs in random five-character groups at the speed of my choice, so I borrowed it and my proficiency grew. (Before that, I used a code practice LP at 33 RPM for 5 WPM, 45 RPM for seven WPM and 78 RPM for about 12 WPM!)

Within a few months I sat for the test and passed it on the first try. In those days you had to have one minute of solid (perfect) copy. Somehow I managed that and in doing so, joined a rather exclusive club within the amateur radio hobby. It's something I have carried with me, a little proudly I'll admit, all these years.

The no-code camel first put his nose under the tent more than 15 years ago when the FCC authorized the "No-Code Technician" class of license. I wasn't really against that. My wife holds that class of license and I was proud of her for getting it. But that was the beginning. In 1999, the code requirement was dropped to 5 WPM for all license classes.

Now here we are, several years into the 21st century, and the FCC has announced that it is doing away with the Morse code proficiency requirement for all license classes. I saw this coming a long way out, and while I would have a hard time arguing for keeping the Morse code requirement in the digital age, it is still a sad thing for me.

I remember becoming enamored with amateur radio as a teenager, listening to those short and long tones representing dots and dashes as the tubes in the receiver glowed softly. There was something ... well... *mysterious* about it all, the realization that those strange sounds were people far away *talking* with one another. As my proficiency grew, it was like learning a secret language that few others knew.

Morse Key

I miss those days much as I get nostalgic for the cherry glow of modulator tubes in AM broadcast transmitters. It's the end of an era, one that was as inevitable as the end of steam locomotion, but one that I am sorry to see go nevertheless.

Looking ahead, one can't help but wonder what the young radio engineers of today will look back on with fond remembrance. Will it be wired Ethernet networks? Will it be magnetic storage on hard drives? Will it be ... over-the-air *terrestrial radio?*

I get nostalgic for the cherry glow of modulator tubes in AM broadcast transmitters. It's the end of an era, one as inevitable as the end of steam locomotion, but one that I am sorry to see go.

Change is inevitable. It is the one "constant," besides death and taxes, throughout history. Change can be good. It also can be good for some and bad for others. I can't imagine that buggy whip manufacturers were thrilled with the advent of steam power. Nor were boiler manufacturers too happy with the advent of the diesel locomotive. The industries and businesses that adapted, that rolled with the changes, were the ones that survived. Those companies looked ahead, ascertained the needs of their customers and adapted their products to meet those needs.

CHANGE IN THE AIR

The terrestrial broadcast radio industry now stands on the brink of some fairly significant changes. I wonder if we will have the foresight and wisdom to move ahead, ascertaining and meeting the needs of our listeners, or will we hold fast to the way we have long done things, never seeing beyond next month's billing cycle? I'm afraid that if we are myopic at this critical juncture, somewhere not too far down the road we may be looking back on terrestrial broadcast radio the way many of us are looking at Morse code today.

While change is inevitable, it also represents opportunity. I truly hope that we will seize the opportunity before us and make good choices that will ensure the long-term viability of our business.

Back in February, I attended the NRB convention and at the invitation of one of the board members, spoke on HD Radio at the tech conference. I also sat on a panel, answering questions from "skeptics" on HD Radio. The audience was comprised primarily of managers and not engineers. Some were from big markets and some from small. It was interesting to hear the perspectives and address their questions and concerns.

One question that seemed to come up in various forms several times was, "When should I convert my station to HD Radio?" I had to stop and think about that for a bit. The answer is different for various situations. For stations in big markets that are fairly well saturated with digital signals, the answer is likely, "Pretty doggone quick." Such stations could well find themselves as one of the only non-digital stations in the market in short order. That has been my observation in the Denver market, where I live. Non-digital stations on both bands are now in the minority.

But what about stations out there in the heartland, stations in medium and small markets where there is little HD Radio penetration to date? My answer for those folks is to wait. An opportune time to make the change may well be a planned transmitter, tower or antenna replacement, a site move or some other major capital project. I think the important thing for such stations is to not waste capital by investing in non-HD-compatible equipment.

For example, if the main transmitter is scheduled for replacement, consider your HD options and select a transmitter that is either HD-capable or HD-compatible, thus preserving the investment. If replacing a tower, design the new tower to support a dual-input or interleaved antenna for digital operation. If making a site move, design the new facility with HD Radio in mind. Protect the investment and be ready for the future.

Otherwise, my advice for the smaller markets is to let the big markets break trail for you. The big market stations serve the bulk of the population and thus represent the majority of the potential market for receivers. Let those stations create the demand. When receivers become commonplace in new automobiles and readily available on big-box store shelves it will mark the time to move forward with HD Radio conversion.

One thing I did not observe at the NRB tech session was the anti-HD sentiment that seems to be held by a vocal minority in our industry. The only thing I observed that was even close was a gentleman who was a proponent of the subcarrier-based FMeXtra system.

At the end of the day, the consensus was that there are no production FMeXtra receivers, nor are there likely to be en masse, although there is evidently at least one "boutique" manufacturer out there. Knowing what I do about the technology-wary receiver industry, I tend to agree. Time will tell.

STREAMING

I've had a hard time getting interested in Internet streaming of our stations' audio. I can cite a number of reasons for this: poor audio quality, licensing issues and the need to overlay commercial breaks. Perhaps another reason is that I have long viewed Internet streams in the same light as station Web sites — they have been something that we do because it's expected but not a vital part of our business. In recent months, my thinking on this has changed.

Like those buggy whip and boiler manufacturers of the 19th century, terrestrial radio has got to adapt to the world in which it operates. More and more, that world is not only digital but Internet-based. Sooner or later, I think a major portion of "radio" listening will take place over the Internet.

There are available Internet "radios" that communicate directly via an 802.11 wireless network, allowing users to listen sans computer. Is it any great stretch, as 802.16x "Wi-Max" looms on the horizon, to envision automobile, tabletop and portable receivers that can access Internet audio streams directly? Where will terrestrial broadcasters be when that happens?

There is good evidence that the move to IP-based radio listening is happening. Bridge Ratings reported in February that the number of Internet radio listeners has jumped 26 percent in the last year and increased to 72 million monthly listeners from 45 million at the end of 2005. Interestingly, much of this listening is a work-place phenomenon. Three quarters of all online listening takes place between 8 a.m. and 8 p.m. Eastern.

It is an interesting property of Internet audio streams that the height of the FM stick and the ERP don't matter a whit. Likewise, AM audio bandwidth, power and directional pattern also don't matter. When it comes to Internet streams, the stream from a 500-watt AM daytimer can sound every bit as good,

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Products & Services SHOWCASE

by Richard Hinkle and Paul Jackson

Networking Basics in IT

Station Engineers Must Consider the Entire Communication Path to Optimize The Network for HD Radio

Richard Hinkle is vice president of engineering and technical services for Broadcast Electronics Inc. Paul Jackson is marketing editor.

Radio engineers can expect to spend more quality time with their IT networks in the upcoming months and years as they prepare for multicasting, Messagecasting and whatever else comes along as a result of HD Radio technology.

When it comes to managing all that data, whether in the form of audio on the air or text and graphics on the screen, nothing in the station operation is as important as the IT network.

Most radio engineers know their way around a computer, in part because they've been maintaining PC-like components in the air chain for years. In fact, the latest HD equipment is not much more than a PC with HD software.

Fewer radio engineers, however, have a solid understanding of what makes a good IT network for digital radio purposes. An IT network at the most basic level is a series of points or nodes interconnected by communication paths.

To optimize the network for HD, station engineers will need to consider the entire communication path, from the cable and communication protocols to data packet distribution methods. The more engineers understand about addressing and trafficking data, the better they can respond to the new demands of digital radio.

NETWORK HUBS

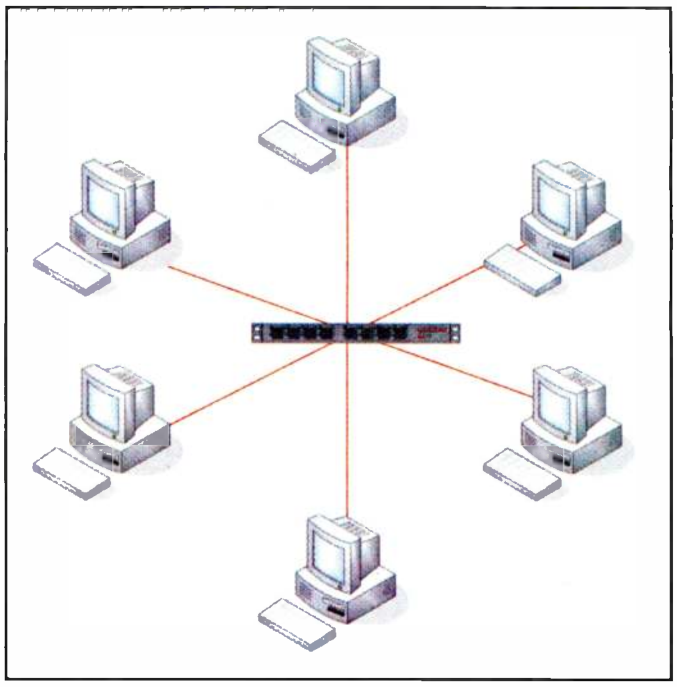
Imagine the computers on your network as a roomful of loud people in a large, unmoderated meeting room. Only one person can talk at a time, because communication consists of standing up and yelling at the top of your lungs. People are allowed to start communicating whenever there is silence in the room.

If two people stand up and start yelling at the same time, they wind up garbling each other's attempt at communication, an event known in the IT world as a collision. In the event of a collision, the two parties sit back down for a semi-random period of time, and then one of them stands up and starts yelling again. As the number of talkers and the amount of talk increases, the likelihood of collisions occurring increases geometrically.

This huge meeting room is like a network hub. In data communications, a hub is a place of convergence where data arrives from one or more directions and is forwarded out in one or more other directions. In an Ethernet network, each workstation or server is located at the end-point of a cable connected to the hub.

The most common forms of Ethernet networks are 10Base-T and 100Base-T, capable of 10 Mbps and 100 Mbps respectively. The faster 1000Base-T, capable of a nominal speed of one Gigabit per second, is becoming more common. For HD Radio purposes, devices capable of at least 100 Mbps are strongly recommended.

All three of these options use shielded or unshielded twisted-pair cable, connecting all nodes through a central point. Category 6 cable is recommended for new installations. Category 6 offers superior transmission performance, and twice the available bandwidth of Category 5e. Shielded cable is preferred in radio stations due to its higher resistance to RF interference.



Networked PCs connected via a hub or switch in a star configuration.

WHAT IS A SWITCH?

Simple network hubs have no traffic managing capabilities. As such, they are unsuitable for HD Radio applications due to the critical nature of our communication. We need a better solution to give us the best chance for successful delivery.

A switch is a network device that separates multiple segments on a network, but is smart enough to know if a particular packet needs to be sent to the other side. Think of our large meeting room. If we split the room in two with a divider that has a single door, the two rooms would be quieter and the chances of talking over the top of someone else's voice would be reduced.

By putting someone in the doorway who could relay information to the other room as needed, communication would be maintained, and each individual room would work better overall.

WHAT IS A ROUTER?

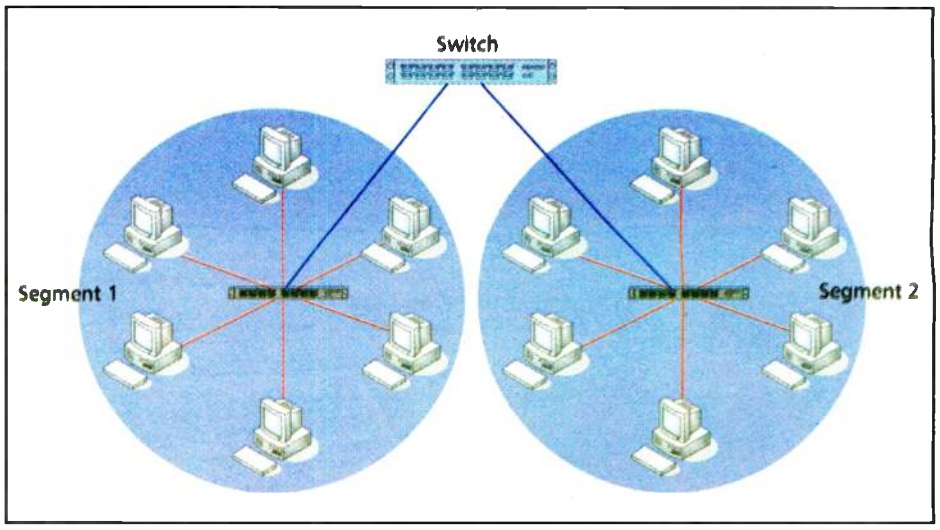
Routers perform the same basic function as switches, separating networks into multiple segments. But while switches automatically learn how to pass data between networks, routers must be configured manually by a network administrator.

An added feature of a router is the ability of the administrator to establish how the data gets from point A to point B, the "route" the data takes between connected segments. While this involves an additional layer of complexity, it also provides additional control as you configure your network.

COMMUNICATING ON THE NETWORK

To communicate over a network, computers send packets or datagrams of information to each other. Each packet contains

SEE NETWORK, PAGE 35



Multiple network segments separated by a switch.

Memory

CONTINUED FROM PAGE 30

and reach the same number of listeners, as a 100 kW Class C FM. The Internet is indeed the great leveler of the playing field in that regard. The viability of a station's stream, then, comes down to three things: content, quality and availability.

Content is indeed king. As the audience moves more and more to IP-based listening in the coming decades, radio stations will become less and less "transmitters" of programming and more and more content providers. If we expect to capture enough listeners to remain financially viable for the long term, our content will have to be better than that of others offering Internet streams — and there will be tens of thousands of other offerings.

One would think that as professionals in the content business, we would know how to do this very well. Maybe. It will certainly be a more competitive world, and some things we take for granted will no longer be in place. Perhaps we should take a hard look at those factors and make adjustments now.

Quality has long been poor on most Internet streams, at least the ones I have periodically tuned into. Poor level control, excessive aliasing and artifacts have defined streams for years. Amazingly, a lot of people put up with the quality issues to get to (you guessed it!) the *content*. There's a lesson in there somewhere.

But recently, in my company we have placed a real emphasis on stream quality. We have focused on three specifics in this regard:

Visitors to my office are surprised when I tell them they are hearing a stream and not a local FM station. That's the kind of reaction I want them to have.

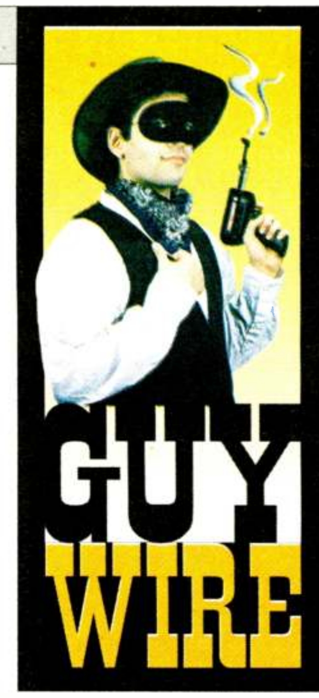
processing, bandwidth and overlay. Audio processing sets the stage for everything downstream, including levels and "sound." Bandwidth of the connection to the streaming service provider is important to prevent dropouts from congestion and packet loss. And the overlay, if used, must be seamless; it can't *sound* like an overlay.

Availability is really a bandwidth issue on the streaming service provider end. If that provider has inadequate bandwidth in its backbone to support the total number of listeners connected, there will be dropouts, buffering and other objectionable products. It's critical that you choose your streaming service provider well, paying attention to its backbone bandwidth.

I am proud of the audio streams we have focused on so far. They are now up to what I would consider "broadcast quality." I feed the sound card from my office desktop PC into a 30-watt amp driving a couple of big speakers, a near "audiophile" setup, and I listen to these streams just as I might a local FM station. The sound of these streams is outstanding. Visitors to my office are surprised when I tell them they are hearing a stream and not a local FM station. That's the kind of reaction I want them to have.

Our streams have got to be different and better to attract and hold listeners. Content is the purview of programmers; *quality* is our responsibility. It's a package deal, one that this increasingly important facet of our product and business must get right. The future of our business, at least to some extent, depends on it.

Comment on this or any article. Write to rwee@imaspub.com. ■



New Options for Pirates and LPFM

Should the Commission Make It Easier to Obtain Community Licenses in Small Towns?

Guy Wire is the pseudonym for a veteran broadcast engineer.

Harry Reid's FCC intervention is provoking new thinking on LPFM licensing and how more pirate stations might become legal.

In January, the Senate majority leader, a Democrat from Nevada, intervened with the FCC to allow an unlicensed pirate broadcaster back on the air. It was a breakthrough victory not only for pirates but for many who dream of owning and running their own radio station.

Radio Goldfield Broadcast Inc. is now fully cleared to serve a small Nevada desert community and parts of nearby Tonopah under special temporary authority, BSTA-20061206AFZ, with call letters KGFN-LP. Owner Rod Moses has moved his pirate operation from 100.3 to 106.3 FM with 100 watts and will use the STA until he can apply for an LPFM license in a future filing window. His mobile home station had been raided and shut down by the FCC last June.

LOUD AND CLEAR

Pressure from an influential politician has forced the FCC's hand to set a new and potentially dangerous precedent here, legitimizing an illegal pirate operation.

FCC licensing rules and due process were completely circumvented to establish a new legal radio station. The action sends a loud signal to all varieties of pirates, including political and social activists as well as radio station owner wannabes everywhere.

Following Radio Goldfield's lead, all they really need to do now is go on the air and contend that their programming is in the public interest — plus of course obtain the backing of local area friends and especially a key politician who can exert pressure on the commission. This could include legendary pirate stations like Radio Free Berkeley that have been battling the FCC for years, but also applicants of previously failed attempts for a legitimate LPFM license.

Radio Goldfield won this round with the government. The precedent paves the way for more up-start pirate operations like it to follow. This is particularly troubling for many, as the rules prevent former convicted pirates from being eligible to apply for LPFM stations. But the Radio Free Brattleboro decision in Vermont seems to have laid that prohibition to rest once and for all.

Other pirates who choose the "Goldfield waiver" route will certainly have to be measured by the same criteria to be eligible for legal conversion, if it stands. So far, there is no indication that it won't.

Licensing a new radio station in an underserved and sparsely populated area like Goldfield, Nev., should not have been that difficult.

If we do see an influx of copycat operators, increased interference will likely occur in more populated areas where open channels do not exist. The FCC is hardly equipped to deal with the extra burden of ramping up enforcement activity against more pirates. Affected stations may have to take it upon themselves to do the legwork of finding and identifying pirates to turn over to authorities. Many in south Florida are doing just that already.

THE GOLDFIELD EXPERIENCE

Licensing a new radio station in an underserved area like Goldfield, Nev., should not have been that difficult. There were numerous frequencies that could have been allocated for a fully licensed station in this sparely populated area about halfway between Reno and Las Vegas. But that path takes more time and money and now requires any new proposed channel to go up for auction. Moses was apparently not willing or prepared to take that risk.

An LPFM station was no doubt more appropriate for Goldfield but that filing opportunity was closed. Instead of waiting for a new LPFM window, Moses took the path of least resistance and established his pirate operation with good intentions while completely ignoring prevailing regulations.

The Goldfield case however is not the usual story of a pirate with a political agenda who breaks the law and defies the feds. Higher-profile pirates usually get busted and then return to the air at another location to keep broadcasting illegally. Some file suit and fight the FCC in court.

Moses apparently is not that kind of operator. His station was put on the air to serve his community with content attractive and important to its residents. His STA would have never been granted had he not co-operated with the FCC inspectors and made a compelling argument for the public service value of his local programming.

The Pahrump Valley Times reported the details of some of his local program offerings that convinced Sen. Reid and the FCC this service was worth fighting for. These are from Reid's letter to the commission: "Radio Goldfield programming brought regular weather reports to this high-desert area of Nevada, where conditions can abruptly change in oftentimes dramatic ways … Radio Goldfield programming also included timely and reliable information on law enforcement, public safety and school activities that helped the residents of Goldfield stay informed and engaged in their community.

"Moreover the station broadcasted Sunday religious services that were listened to faithfully by those living too far from a place of worship or those simply too feeble to make a weekly journey there practicable."

INSIDE THE BELTWAY BIAS

The process by which the commission awards LPFM construction permits and licenses simply does not accommodate the needs of the smaller more isolated communities. FCC rules treat the entire country without regard to population or proximity to large population centers and are written with an inside-the-beltway mentality. They essentially presume there are no populated areas left that deserve a radio station.

Instead, they assume many applicants will fight over scarce channels, probably resulting in MX proceedings. Thus all applicants are faced with very short and infrequent filing windows in all states.

There are literally thousands of small communities throughout this country like Goldfield that have no local service or that are woefully underserved by nearby broadcasters. In areas where LPFM stations can exist without causing interference, the rules should allow a more streamlined and simplified process by which operators like Radio Goldfield can become licensed.

LPFM applicants and operators of all kinds will need to be required to provide public service programming of value to their communities, just like fully licensed stations. Licenses should not be renewed unless licensees document and demonstrate such compliance at renewal time.

UNFULFILLED HIGH HOPES

Since its implementation in 2000, the entire LPFM experience has met with limited success, considering what its chief architect, former FCC Chairman Bill Kennard, had envisioned for it. Part of the LPFM disappointment has been driven by NAB lobby efforts that retain the third-adjacent channel protection rules, plus the delay in opening the LP-10 filing windows for 10 watt stations. Only 100 watt LP-100 licenses have been granted so far.

Some LPFM applications that serve significant population centers have been tied up in MX hearings. A few enterprising operators have licensed an LPFM to a "rim shot" bedroom community and then used clever, but often illegal means to translate the signal

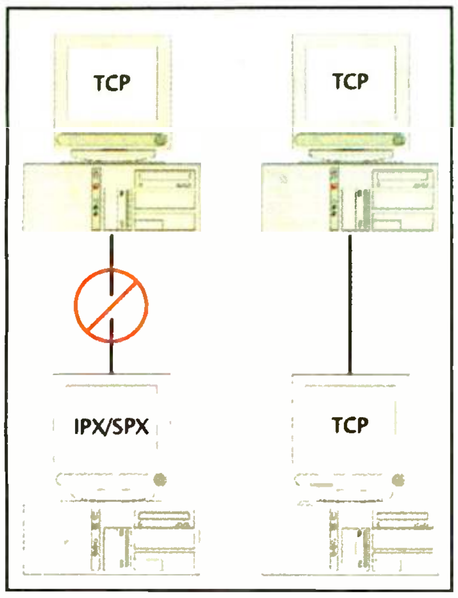
See GUY WIRE, page 37 ▶

Network

CONTINUED FROM PAGE 33

about a thousand bytes of information. To send a message longer than a thousand bytes, the computer breaks it down into packet-sized chunks, puts a sequence number on each chunk, and then transmits one chunk in each packet. The computer on the other end receives one packet at a time and uses the sequence information to put all the chunks back together into a single message.

Just like when you write a letter, both parties must speak the same language to have a meaningful exchange. In network terms, this language is called a protocol. Both computers must be configured to use the same protocol in order to communicate.



Computers must use the same protocol to communicate.

The IP (Internet Protocol) suite is the closest thing the computer world has to a universal language. It is also routable, meaning it's easier to connect multiple segments over a wide area network. The two most common transport protocols, or languages, in the suite are TCP (Transport Control Protocol) and UDP (User Datagram Protocol.)

Using TCP, applications on networked computers create connections with each other to exchange data. TCP guarantees reliable and in-order delivery of data by using receipt acknowledgments and error checking. UDP does not provide the same error checking and ordering guarantees that TCP ensures, but tends to be faster and more efficient.

NETWORK ADDRESSES

Using our letter analogy, when you send information you not only have to use the same language, you need to correctly identify the address of the intended recipient. We're working with transport protocols, so we also need to define some aspects of the route our letter should take. Computers on a network are configured with a unique address to identify senders and receivers. Networked computers also have a subnet mask and a gateway to help determine routing.

An IP address is a 32-bit number that uniquely identifies a host (a computer or other device, such as a printer or router) on an IP network. Reading binary, a computer sees a typical address as:

11000000101010000111101110000100.

Most people don't read binary as well as computers do, so this number would be hard for us to understand and remember. To make it more manageable, we first divide it into four parts of eight binary digits known as octets. Now we see:

11000000.10101000.01111011.10000100

Next, we convert the binary to decimal to give us the address format we're most familiar with:

192.168.123.132

The decimal numbers separated by periods are simply the octets converted from binary to decimal notation.

SUBNET MASK

IP packets can move between hosts on a wide area network, or even between different networks, as long as those networks are connected by switches or routers, devices that pass packets of data between networks.

Switches and routers don't need to know the exact location of a host for which a packet of information is destined. They only need to know what network the host is a member of.

An IP address actually has two parts: the first part of an IP address tells a switch or router which network a computer is on, and the last part is the actual address of the computer. Our example 192.168.123.132 address may describe the 192.168.123 network, and host 132 on that network.

The subnet mask is the bit of required routing information used to determine which network a host is on. The parts of the IP address that are used as the network and host addresses are not fixed, so the network and host addresses cannot be determined unless you have more information. In our example, we don't know if 192.168.123.132 is divided like this:

192.	168.	123.		Network address
			132	Host address

Or like this:

192.	168.			Network address
		123.	132	Host address

The key to this information is supplied in another 32-bit number called a subnet mask. For example, a common subnet mask is 255.255.255.0. Converted into binary, this equals:

11111111.11111111.11111111.00000000

Lining up the IP address and the subnet mask together, the network and host portions of the address can be separated. The subnet mask value of 1 indicates the network portion of the address, and the value of 0 indicates the host portion.

255 .255 .255 .0
11111111.11111111.11111111.00000000
192 .168 .123 .132
11000000.10101000.01111011.10000100

In this case, the first three octets are the network address, and the last octet is the host address. All decimal subnet masks convert to binary numbers that are all ones on the left and all zeros on the right. Using some other common subnet masks:

255 .255 .0 .0
11111111.11111111.00000000.00000000
192 .168 .123 .132
11000000.10101000.01111011.10000100

Or:

255 .255 .224 .0
11111111.11111111.11100000.00000000
192 .168 .123 .132
11000000.10101000.01111011.10000100

This last example specifies the first 19 bits for the network address, and the last 13 bits for the host address.

By specifying different subnet masks for different computers, we are essentially creating new sub networks or VLANs (virtual local area networks). As far as the computer hardware is concerned, different subnet masks indicate separate networks even if everything is physically linked through the same switch or hub. This is an important way to segregate and isolate traffic from different functional networks.

GATEWAYS AND BRIDGING NETWORKS

When a computer tries to communicate with another device, it compares its own address and subnet mask to the address and subnet mask of the destination host to determine whether the destination is a local host or a remote host. The computer resolves and compares the network address of the two subnets; if they match, the destination computer is on the local network. If they are different, the destination computer is on a remote network.

If the result of this process determines the destination to be on the local network, the computer will simply send the packet on the local subnet. If the result of the comparison determines the destination to be on a remote network, then the computer will forward the packet to the switch or router that connects it to other sub networks, called the default gateway. It is then the responsibility of the gateway to forward the packet on to the correct network.

In short, when a device sends a packet using either TCP or UDP, it compares its own address to the address of the destination device. Based on the subnet mask, it can tell whether the destination device is on the local network, or on a remote network. If the destination device is on a remote network, it sends the packet to the router configured as the default gateway, which sends the packet along to the remote network.

Using switches and routers, engineers can isolate network segments by manipulating these IP settings. In this way, radio engineers can build in network expandability for increasing the data load that comes with new multicasting channels and text services.

IT networking will no doubt become easier and more refined in the coming years, but if station engineers keep in mind the basics of addressing and trafficking data over the network now, they'll be ahead of the curve when it comes time for adding new multicasting and Messagecasting services. ■

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Guy Wire

CONTINUED FROM PAGE 34

into the more populated area. The programming has little or nothing to do with the community of license and instead attempts to serve the nearby city, already served by many other stations.

The commission's original intent for establishing LPFM was to provide unserved or underserved local areas with a new community-based, non-commercial public service voice. Local government, civic and educational groups were the obvious candidates.

Unfortunately there are many deserving groups within population centers that could benefit from an LPFM service but there are simply no channels that can be allocated without causing interference to existing licensees. FM subcarriers have been used over the years, mainly by ethnic broadcasters in large cities. But with the promise of more lucrative digital data services still looming, most of those are either unavailable or unaffordable. Leasing supplemental HD channels will likely prove to be no different.

Internet radio has rapidly emerged as the easiest method for such groups to establish their service. The advent of IP-based portable radios should begin to start augmenting the effectiveness of those services within the next few years. But there remain thousands of small communities where open channels are available that could benefit from a traditional LPFM service now.

MAKING ENDS MEET

Running successful, fully licensed community radio stations — both non-commercial and commercial — has long been a challenging endeavor, even in larger markets. Unless they are subsidized by an educational or governmental institution, most struggle to make ends meet every month despite the fact many staff members work as non-paid volunteers.

There are cases where community NCE stations survive by running foreign-language commercial programming in gross violation of the rules. When things run down technically, such stations are often the source of undesired interference to other non-commercial stations. The monthly bills for the usual leased office space, multi-studio facilities, STL and transmitter plant plus tower rental, all drain available finances quickly.

Every few months we hear of another community station raising the white flag, unable to stay alive financially and selling out, usually to a national religious group operator. That's sad, since the losers are the local folks who are forced to look elsewhere for truly local programming of value.

It doesn't take that much infrastructure and staff to build and run a modest but effective radio station nowadays. Pirates figured that out a long time ago.

RE-EVALUATING THE BASICS

Ever-advancing technology has dramatically changed the face of how American enterprise delivers information and entertainment and how it sells products. The Internet is only part of the revolution. Brick-and-mortar businesses everywhere are adapting to survive and prosper. Why not community radio?

The Goldfield story gives a decent example of how one individual put together a 100 watt station in his own home that delivers continuous programming of local interest to his community. It doesn't take that much infrastructure and staff to build and run a modest but effective radio station nowadays. Pirates figured that out a long time ago.

Fully equipped control and production studios with expensive consoles, source equipment, full-featured automation and digital storage systems, processors and audio chains are no longer a necessity or even desirable. Plug a few Heil microphones into a Mackie mixer feeding a PC with Raduga automation software and you have a basic but affordable setup to launch good-quality audio. Even the audio processing can be a piece of inexpensive software. Add a second PC with an Internet connection and Adobe Audition for production needs and put the PCs on a simple LAN.

If you need an STL, use broadband or DSL Internet instead of expensive microwave or T1 circuits. A 100 watt transmitter with a decent-sized tower and a two-bay antenna is little more than a ham radio installation. Of course the exciter and transmitter will need to be FCC type-accepted to ensure occupied spectrum compliance. But you quickly see that such an installation would be easy to assemble and relatively inexpensive.

THE HARD PART

For many of the existing marginal operations to survive, scaling back expenses by downsizing to more modern and affordable, yet easier to manage facilities like I've described seems like a no-brainer. Managing the programming, staff, marketing and finances of a group-controlled operation will continue to be the real challenge.

Community radio with its usual collection of eccentric and demanding personalities often makes that very difficult and frustrating. I'll leave the politics of making modest-sized community radio work and succeed in today's environment to others. But significant relief could be gained by changing the rules to allow granting of LPFM licenses to individuals as well as groups to simplify control and management. That's worked pretty well for all other classes of licenses.

Many LPFM observers and proponents have held that for the service to really prosper, the FCC will have to permit commercials. However, NCE and public radio stations everywhere have succeeded in exploiting and maximizing underwriting opportunities legally to produce revenue. The difference between commercial and non-commercial is not significant enough for LPFM to take on that battle and burden. It would subject the service to many more accounting headaches, including higher fees and taxes as a for-profit business.

The real question here is really not that hard: Why should so many smaller population areas go without local radio service because the bar of entry remains much too high? The old rules that support the old model as the only means of doing broadcasting in these vast United States should be re-evaluated carefully. Other countries have done it and succeeded.

Many areas could benefit from LPFM operations like Radio Goldfield where open frequencies are available. It's time for the commission to seriously consider appropriate and easier methods to establish them legally. Issuing STAs under pressure from politicians is expedient but also bad public policy. ■

Last Word

CONTINUED FROM PAGE 38

AM analog can't hold a candle to AM HD-R. The difference is immediate and astonishing. Every person to whom I've demonstrated it has said the same thing: "Wow!" But what about FM? The differences there aren't quite as obvious, especially not at first. Here, the comparison between the vinyl LP and the CD makes a great analogy: Yes, analog FM can sound great. But it also can sound bad, and often because of things over which we have no control, such as bad spots in the coverage and multipath.

I am convinced the average listener will prefer HD-R, even on FM, once he or she has gotten used to it. I mentioned recently that WDJC(FM) had to do without its HD-R signal for several weeks while our antenna was being repaired. Those were the longest weeks of my life! I had never realized how much I'd miss the HD-R until I was forced to do without. Every time I'd roll down a hill and the signal would blend to mono, and then go fuzzy, I'd mutter, "Boy, I miss my HD!"

PAD data is nice, but let's be honest — we can do the equivalent on analog FM with RDS. I don't think that's the "killer app," though it'll be interesting to see what we can do with PAD data in the future. The "killer app" for FM is going to be more choice and better consistency, assuming we do our jobs properly. That means listening and thinking of new ways to tweak the air chain to give a richer, better stereo sound.

To finish the point, let me put it this way. Don't misunderstand — I'm going to make sure our signals are as "maxed out" as they can be, especially given that we just upgraded all five stations with an all-digital Wheatstone system, and with all-digital signal paths from the consoles to the transmitters. But should I ever be forced to choose between, say, 50 Hz–15 kHz bandwidth with full stereo separation, and 20 Hz–20 kHz bandwidth with limited stereo, I will choose the first option. If I'm forced to choose between full stereo and clicks and pops, I'll choose full stereo. See what I'm saying?

Talk to your listeners. See what they want. If they prefer satellite radio to your station, ask them why. Don't argue with them; you might learn something. If it's something that you can fix or tweak, do it.

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RW welcomes comment on this or any article. Write to rwee@imaspub.com. ■

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by Stephen M. Poole

Quality and Consistency Are Key With HD

Listeners Will Likely Prefer the Richer Sound of HD-R, Even on FM, Once They Have Gotten Used to It

The author at Crawford's WYDE(FM) 101.1 The Source, broadcasting in HD Radio since July 2005.

Stephen M. Poole, CBRE, CBNT, is chief engineer, Crawford Broadcasting Corp., Birmingham, Ala.

Understanding the mind of the listener is a tricky thing, and it's easy to guess wrong about which way they'll apply their zig when you plan your zag.

With that in mind, hearken back with me to the days of the Dymo label maker, which revolutionized the posting of instructions to dimwitted DJs and board operators. "No, to turn the mic on, you use the pot labeled MIC. Get it?" You'd tap on the hideously ugly black or red plastic tag and frown.

"See? M-I-C."

THE LISTENER CALLS THE SHOTS

I grew up when AM was still king in southeastern N.C., a relatively rural area that lived on textiles and agriculture. Until I reached my teens, I'd never even used an FM receiver. None of our family's vehicles had one. Not that it would matter — there were very few FM stations on the air where we lived at that time, in the late '60s and early '70s.

Not long after I got my driver's license — this was in 1972 — I drove out to the local radio station. This was a typical Class IV local AM on 1400 kHz: 1 kW day and 250 W night. They had an old Gates BC-1G transmitter, a Gates Yard console, a Volumax processor (no companion Audimax) and one of those dial-type Gates remote controls with the stepper relays that would clack and clank as you changed channels.

And yes, there were Dymo labels everywhere. My favorite was on the remote control: "NO MORE SPEED SHIFTING BETWEEN POWERS," it said. "PLATES OFF, CHANGE POWER, THEN PLATES BACK ON!" (Having worked on a few BC-1Gs since then, I can assure you that this was excellent advice. But that's an aside.)

Small that AM station was, and unsophisticated it most definitely was. But the station was king; most of the people in my hometown listened to it, and as a result the station was doing reasonably well at the time.

It just so happens that the car that I was driving had an FM radio in it. I had been listening and was impressed with how clear it was. To show you how long ago this was, the station wasn't even in stereo; it was mono FM! I asked the guys at our local AM station, "Do you think this FM thing will catch on? Listen to how much better it sounds!"

I was laughed out of the control room. "Listeners don't care about quality," they chortled. "All they care about is the music!"

Heh. Needless to say, time had a different answer to my question. More to the point and more important, this is a mistake that has been made time and again. "Listeners don't care about quality!" Yes ... and no.

WHAT IS 'BETTER'?

As I've said before, the Industry Gurus (capitalized out of reverence) insisted that it would take the CD many, many years to replace the vinyl LP. In fact, it took about half a decade.

Don't assume listeners will put up with inferior quality once they have been exposed to something better — especially if 'something better' is available at a comparable cost.

By the late 1980s, the record companies had warehouses filled with unsold vinyl, and the CD burners had a backlog of orders. I keep bringing up this example because it's important. In fact, it's absolutely critical, and we must understand it if we're going to compete in an era of Web radio, MP3s and satellite.

It's easy to dismiss the average radio listener as unconcerned about technology. After all, they don't know or care why CDs and FM sound superior to vinyl LPs and AM; they just know that they do. And yes, it's true that the average listener doesn't give a rip about 0.0001 percent vs. 1 percent distortion, or a high end of 20 kHz as opposed to 15 kHz (or even 10 kHz).

But don't make the mistake of assuming that they'll put up with inferior quality once they have been exposed to something better — especially if "something better" is available at a comparable cost.

And never forget: the listener will ultimately define "better" on his or her terms, not ours. They'll consider content, quality and convenience when making their choices, not just "20 Hz–20 kHz at zero distortion"! That is indeed meaningless to most listeners; only the audiophiles get worked up about things like that.

What the average listener wants is a rich, full sound. Listening tests have shown that most people would prefer a lot of stereo separation and a high end of, say, 8 kHz, to mono from 20 Hz–20 kHz. Why? Because the stereo sounds more "real" to them. Most listeners would prefer solid band-limited audio to full-band audio with obvious dropouts and static. Consider that AM talk radio still does quite well, but only in the station's primary coverage area. Once you get out of range and the signal starts fading and popping, most people will change the channel. It's not like they don't have choices.

As further proof, consider that a well-done MP3 will not sound quite as good as a CD. It can't; the MP3 uses lossy compression and the CD doesn't. But many consumers — especially the younger ones — have been flocking to the MP3 because it gives good and acceptable (ah!) performance with greater convenience and at less cost.

LESSONS

How does all of this apply to us? We're making our transition to HD Radio and we're hoping the listeners will catch on. So what lessons should we learn here?

SEE LAST WORD, PAGE 37

Networked / Independent

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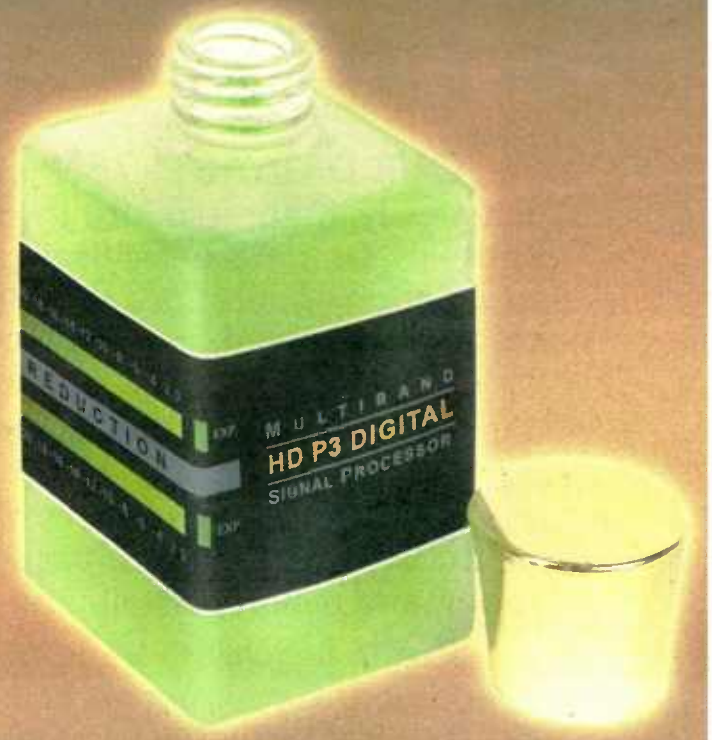

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