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How Will the AM Rules Affect You?
Find Out in Feed Line, p. 16

Radio World®

Vol 15, No 23

Radio's Best Read Newspaper

December 11, 1991

In-Band Tests Eyed

WASHINGTON The NAB's DAB Task Force Technical Advisory Group is set to tackle tests of in-band first adjacent DAB systems. The TAG, which is composed entirely of station engineers, was to meet in the latter part of November to begin defining in-band tests.

The criteria will be designed to determine protection ratios for adjacent channels DAB systems. So far several such systems have been proposed. Strother Communications Inc. recently demonstrated the LinCom system.

Mercury Digital also has developed a first adjacent DAB system and the NAB has asked the Eureka 147 consortium to develop a narrowband DAB system which would operate on first adjacent FM channels.

First adjacent DAB systems would place a digital signal on an FM station's first adjacent channel. Because each station has two first adjacents, system proponents have suggested that AM stations might be able to broadcast digital signals on an FM station's other first adjacent.

Opponents to allocation of "new" spectrum to a DAB service say an in-band first adjacent DAB system raises all the same spectrum allocation problems that any DAB system seeking new spectrum does. Nevertheless, Eureka 147 and other engineers say an on-channel DAB system is not technically possible.

NAB Senior VP of Science & Technology Michael Rau said that the first adjacent protection ratio tests are needed to determine "to what extent the FM band can support an adjacent channel DAB system."

FCC Pushes S-Band for DAB

by Judith Gross

WASHINGTON L-band (1500 MHz) spectrum for digital audio broadcasting (DAB) in the U.S. is considered a "dead issue," despite some hinting by the FCC that a future domestic hearing on spectrum could resurrect it as an option.

Bowing to military interests and opposition from the Executive Branch and the National Telecommunications and Information Administration (NTIA), the FCC released what will become the U.S. delegation's position at the World Administrative Radio Conference (WARC), slated for February, 1992 in Spain.

The FCC said at the end of October that an agreement with the Executive Branch will direct the U.S. delegation to seek an allocation for satellite and complementary terrestrial DAB at 2300 MHz (the S-band). Specifically, the U.S. is asking for 2310-2360 MHz.

At press time, the NTIA had not yet announced its official position on the DAB issue, but insiders suspected it would be largely identical to the the FCC's position.

The higher frequencies of S-band can accommodate satellite DAB, but at a greater cost than placing a service at L-band. S-band is considered unsuitable for terrestrial DAB, putting an end to arguments over using new-spectrum for domestic land-based DAB.

The NAB had been the bearer of the L-band torch ever since a spectrum study determined that some 57 MHz of new spectrum would be needed to accommodate every existing AM and FM licensee under a terrestrial implementation of the Eureka 147 system.

NAB President and CEO Edward Fritts expressed disappointment at the WARC position. "This decision unfortunately appears to pave the way for satellite DAB which broadcasters have strongly opposed," Fritts said.

NAB DAB Task Force Chairman Alan Box said that in-band DAB may provide



The FCC's WARC recommendation has dashed the hopes of L-band DAB proponents.

the solution.

"I think that's clearly where our intentions have to go. As long as in-band works as well as we think it will, it won't be a problem," Box said.

But NAB has not given up on implementing the Eureka 147 system in the U.S. It has asked the European consortium to develop a narrow-band or in-band DAB system for the FM band.

While there has been no formal answer from Eureka researchers, NAB Senior VP of Science & Technology Michael Rau said that a Eureka spokesman, whom he declined to name, has said Eureka is interested in developing a system for NAB.

Rau also said that the NAB is continuing its negotiations with Eureka on a possible licensing/royalty agreement and that such an agreement "is not contingent upon procuring L-band spectrum."

"The intent of the agreement is to implement Eureka technology in the U.S." Rau said, pointing out that Eureka technology consists of a number of individual patents.

In addition to its own unsuccessful campaign to obtain L-band for terrestrial DAB, the NAB also had successfully lobbied for an L-band WARC position from other Region II countries. Canada and

(continued on page 10)

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On the Air
In the Air

Sky Radio
Takes Flight, p. 3



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NEWS BRIEFS

DAB Offers Opportunity For U.S. Technology Resurgence

WASHINGTON Digital audio broadcasting (DAB) presents a unique opportunity for the U.S. to regain technical leadership in communications technologies—but quick, decisive leadership is needed to bring that about.

That's the conclusion of a DAB report from the Mitre Corp., a technological think-

tank based in the Washington, D.C. area.

Observing that most audio engineering research has moved overseas, the report noted that "DAB is an opportunity for U.S. resurgence in both development and production."

Summarizing the DAB race to date, the report said the European Eureka 147 project is in the lead while U.S. DAB R&D is "undercapitalized, diffuse and confronted by politi-

cal and regulatory hurdles."

In attempting to suggest ways to overcome those hurdles, the report pointed to the Bush Administration's national technical policy, which calls for private sector initiation and only "regulatory streamlining."

It implies that if the U.S. can't get ahead by new technology development, it could "play catch-up" by new product production.

The report said that if the U.S. loses its technical leadership in DAB it will be more than just a loss of prestige. It will leave "U.S. station, transmitter and receiver owners paying royalties in perpetuity

to engineers abroad" and notes that we can't afford to fund enhancements abroad in that manner.

Task Force Recommends DAB Systems Parameters

WASHINGTON The NAB's DAB Task Force has pressed its Technical Advisory Group (TAG) into service to help define parameters of a digital audio broadcasting (DAB) system for the U.S.

The task force was going to develop a list of technical parameters for an in-band DAB system, but the TAG took a broad enough approach so that

both in-band and new-band systems can be judged against the parameters with no "intention of excluding any particular system," according to the task force's chairman, Alan Box.

The TAG defined 11 criteria for DAB systems to meet. The first is CD quality sound, which they defined as 20 Hz-20 kHz frequency response for FM and 20 Hz-15 kHz for AM. It added that a data compression algorithm should meet the requirements of MPEG Layer II.

The group also said that a DAB system should replicate or improve reception within existing coverage areas, accommodate all existing AM and FM broadcasters, provide immunity to multipath—including "stoplight fades"—and provide no interference to existing AM and FM.

Other objectives are for a DAB system to be immune to other types of interference, minimize transmission costs, be able to support affordable and portable receivers in a "box no larger than existing radio technology," provide data capacity and use a more graceful degradation than the sharp drop-off generally associated with digital signals.

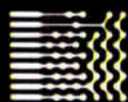
Commission Looks at FM

Licensing Process

WASHINGTON The FCC's FM Branch is conducting an informal review of the FM licensing process and is seeking suggestions on what can be done to reduce application discrepancies, which reportedly occur on 60 percent of the submitted forms.

The FCC said the most frequently occurring discrepancies include: miscalculation of (continued on page 8)

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USA Today Launches Sky Radio

by Frank Beacham

NEW YORK In-Flight Phone Corp. and USA Today have announced plans to deliver live broadcast audio programming to passengers traveling in commercial airliners.

A 12-channel ground-to-air audio system that will offer live sports, news and entertainment 24 hours a day has been proposed by In-Flight Phone Corp. of Oak Brook, Ill. The company has filed an application with the FCC for an experimental license to use modified single sideband emission from a network of land-based antennas for the service.

Sports programming will include professional football, baseball, basketball, hockey and select college games, In-Flight announced. Passengers will be charged a fee on a per-game basis for sporting events, while news and entertainment specials will be provided free as sponsored programming.

USA Today—publishers of the daily satellite-delivered national newspaper—announced the formation of USA Today Sky Radio, a single channel satellite-to-aircraft service delivering advertising-supported news and sports to passengers through the existing audio systems on commercial aircraft.

The Arlington, Va.-based newspaper said a constant wheel of live news,

financial reports, sports scores and weather reports will be offered to passengers during the day from a programming center in the Washington, D.C. area. On weekends and evenings, Sky Radio plans to offer live professional and college sporting events.

Sky Radio will begin broadcasts in 1992 and is awaiting approval of its plan by the FAA, according to USA Today spokesman Steven Anderson. He said Delta Airlines is already committed to carry the Sky Radio program service.

While Sky Radio will use existing airline sound systems, In-Flight plans to market its service with a new digital air-to-ground telephone service, according to In-Flight Director of Communications Darren S. Leno.

He said passengers will be able to plug their Walkman-type headsets into a jack in the armrest and choose programs from an LED menu display on the rear of the forward seat. This same menu can be used for a variety of other services including telephone, fax, passenger paging, flight schedules, weather service, car and hotel check-in, aircraft position, stock quotes, catalog shopping and electronic games.

"Most people who fly want to stay in touch with the events taking place on the ground," In-Flight Board Chairman and CEO Jack Goeken said. "This new service will let passengers listen

to the play-by-play action of their favorite sports team."

USA Today views its new radio service as an extension of the newspaper.

"USA Today has become the news source for travelers who want to know what happened in the past 24 hours and what will happen in the next 24 hours. Sky Radio is the perfect fit for airline passengers who want a quick update on the news as it happens," USA Today spokesman Thomas Farrell said.

USA Today will provide the service through a partnership with Washington, D.C.-based FliteCom Systems, Inc.

FliteCom spent more than a year developing the Sky Radio technology and service.

FliteCom was formed by Richard S. Cooperman, I. Don Brown and Richard M. Neustadt in 1990. All three will hold positions with USA Today Sky Radio.

In-Flight's Goeken, a telecommunications pioneer, is also founder of MCI, the FTD Mercury Network and Airfone. He has applied for a patent on a system enabling aircraft traveling at jet speeds to stay in contact continuously with stations on the ground.

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A New Frame for the Big Picture

by Alex Zavistovich

WASHINGTON Fall and winter traditionally are thought of as seasons of change. It's nature's planning time, filled with expectations for the year to come. And while it's only coincidental, long-time readers of *RW* may notice some changes in our pages through the season, as well.

Take this column, for instance. I know many of you opened this issue fully expecting to read another installment of *JG's Earwaves*. Surprise! Instead, you've got *Pilot Tone ... Radio A to Z* (I had to find a way to get my initials in there somehow).



In *Pilot Tone*, you can expect a take on the news you won't find anywhere else in the paper—one that's filtered through my view of the Big Picture.

There'll be more surprises in store for *RW* in the issues ahead. Nothing drastic, mind you; we're just putting into operation a few things we've been kicking around for some time.

One thing in particular you won't want to miss is *RW's* year-end issue, winging its way to you in the next couple weeks. In it, we'll recap the Top Ten News Stories of 1991, an idea we borrowed from our own annual *Radio World Directory*. Those stories are bound to include some of the developments in digital audio broadcasting (DAB)—in particular, the whole NAB-Eureka-IBOC-IBAC song and dance.

★★★

Speaking of DAB, it was interesting

to learn that the FCC has recommended 2.3 GHz (the S-band) for DAB as the U.S. position to take to WARC next year.

That effectively makes the NAB's plan for Eureka 147 at L-band a moot point—there won't be L-band spectrum available for DAB in the U.S. It's dead in the water. And because most people with an opinion don't think terrestrial DAB will work at S-band, an in-band solution seems to be the way to go. Even the DAB Task Force now seems to agree (although they won't let go of Eureka as a system with promise).

All this doesn't mean that DAB at L-band won't be happening anywhere in the world, though. The Canadians are convinced of the workability of the concept, and they're taking their recommendations for the spectrum to WARC next year.

They won't be alone, either. A number of other nations also are interested in L-band DAB (thanks in large part to the NAB, which lobbied for some solidarity among U.S. allies back when it thought it could steamroll the concept by everyone earlier this year).

Still, I guess anyone with an interest in DAB in the U.S. pretty much owes in-band proponents—particularly Randy Odeneal of Sconnix—a debt of gratitude. If he hadn't been rattling the NAB's cage back when the association was kowtowing to the Eureka system, broadcasters might have found themselves without a DAB pot to transmit in. Now, at least there's some basic agreement about where the technology ought to be headed. Look for Judith Gross' front-page story in this issue for the latest on the DAB front.

★★★

Well, on to more concrete matters. The FCC finally got around to issuing the text on Docket 87-267, the keystone to its campaign for AM improvement (as reported in *RW*, Oct. 23, 1991). The voluminous text—four years in the

making—is, as expected, far from being widely endorsed.

A common complaint heard in the industry is that the FCC's action primarily offers *disincentives* to improvement. After all, stations creating the most interference on the existing band get first dibs on the expanded 1605 kHz to 1705 kHz allocations, and in many cases a station looking to upgrade its facility would have to ratchet down in power in order to make any changes.

... broadcasters might have found themselves without a DAB pot to transmit in.

The FCC is trying to improve interference conditions on the dial, all right, but at the expense of a good number of existing broadcasters. In fact, with this action the FCC is even planning to lift its freeze on new AM facilities in the new year.

You know, Commissioner Andrew Barrett raised a good question in regard to this when the plan first was approved: How can we talk about reducing interference and lift a freeze on AM stations in the same breath? I guess some things are beyond the abilities of us mere mortals (or even some commissioners) to comprehend.

Still, the rules are upon us, and the sooner broadcasters come to grips with their applications, the sooner we'll understand the rules' true impact on the industry. That's why Cris Alexander's latest installment of *Feed Line* is of such great interest. Cris looks at what the regulations really mean to a station planning a facility change. His first-hand encounter with the new rules is a must-read for any AM broadcaster.

Being a board operator can be a thankless job. In fact, often the only time anyone ever hears anything about board operators is when there's been some kind of mix-up on the air. That's an operator's worst nightmare, and it's the topic of Bruce Bartlett's latest installment of *Line Out*.

In this issue, Bruce looks at one DJ's dead air nightmare switching between AM, FM and news, and recalls a time when a board operator became a bored

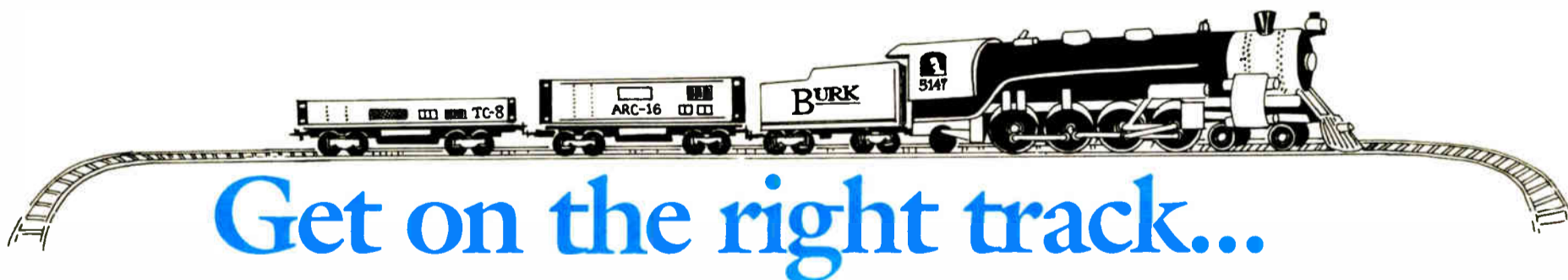
operator (and the solution that got him chewed out).

And finally, a happy 50th to Harold Hallikainen. No, it's not his 50th birthday—it's the 50th installment of his *Insight on Rules* column. That's more than four years and going strong. In his latest installment, Harold delves deeper into the FCC Self-Inspection Report, which was tried out on West Coast radio stations earlier this year. Those of you interested in a copy of the report (at this time an AM-only inspection) may want to turn to Harold's column for more information.

Well, that's it for this time. Drop me a line if you have something you think would be of interest to *RW's* readers.

You can write to me at 5827 Columbia Pike, Suite 310, Falls Church, Va., 22041, phone: 703-998-7600, or fax: 703-998-2966.

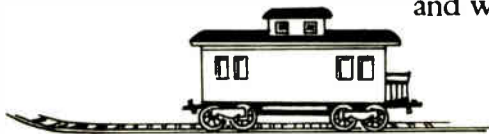
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Accepting composite inputs

Dear RW,
In the Oct. 23, 1991 issue of RW there appeared an article by Jeff Detweiler of QEI Corporation describing the CAT-LINK studio-to-transmitter link.

I found the article informative, but noticed a glaring error that I feel compelled to correct for the benefit of your readers and Mr. Detweiler.

In the first paragraph of his article, Mr. Detweiler states, "... it is the only digital STL that will accept a composite input." This is not only incorrect, but leads to a wrong conclusion, since the T-TECH model FOA-1T/FOA-1R fiber optic STL we manufacture does indeed support wideband composite inputs, but in fact has more bandwidth than QEI's CAT-LINK system. The T-TECH STL can also handle SCA and several higher subcarrier frequencies riding on the same channel as composite stereo.

In addition, the T-TECH link has adjustable compensation for channel frequency response tilt and group delay variation, so that stereo separation can be unimpaired or even improved. This is crucial, because any digital audio system will have anti-alias and anti-image filters

whose flatness must be corrected to 0.01 dB for 60 dB stereo separation, and whose group delay must be constant to within 0.1 degrees of linear phase.

I realize that both the CAT-LINK and the T-TECH link perform valuable service in the appropriated application, but I must set the record straight concerning marketing claims.

Dan Talbot, President
T-TECH Corporation
Hudson, Mass.

The facts about triodes

Dear RW,

It is unfortunate that my article on tetrode tubes versus triode tubes, after having undergone the editing process, misconstrues factual data as opinion. (RW Buyers Guide, Nov. 20, page 45). My original submission is based on fact, operational theory and data gathered from both transmitter and tube manufacturers' literature and information. I appreciate this opportunity to set the record straight and allow readers to get the entire story.

Energy-Onix is pleased to provide a free copy of the complete original unedited transcript of my Nov. 20 Buyers Guide article. To obtain your free copy, circle Reader Service 53 on the enclosed response card supplied with this issue, telephone me at 518-828-1690, or fax me at 518-828-8467.

Ernie Belanger, VP Marketing
Energy-Onix
Hudson, N.Y.

Discrete versus composite

Dear RW,

This letter is in response to the Oct. 23, 1991 RW article entitled "Choosing a Digital Telco Link." While we believe the majority of the article written by Intraplex is correct, we'd like to correct some of the information and expand on some points raised by Intraplex.

QEI introduced CAT-LINK in 1989, and we manufacture both a composite and a discrete digital STL. We have long recognized the need for a discussion of digital composite transmission. Now that we have received U.S. Patent No. 5,054,070 on the method of sampling, transmission and reconstruction involved in the CAT-LINK, we are finally able to offer our side of this discussion.

To begin, since CAT-LINK is the only real-time T1 compatible composite system available, we take issue with the statement "14-bit linear coding is possible if no other channels are required." CAT-LINK offers 14-bit and 15-bit linear composite systems, with the STL side of the system configurable with up to four additional channels of audio. Typically, only two channels are used so as not to decrease the dynamic range of the composite channel.

One of the channels is typically 10 kHz with 11- or 12-bit resolution for SCA or backup program material; the other is 3 kHz with 8-bit resolution for the remote control. This all fits into a single T1 chan-

The FCC's decision on AM improvement is finally out, and while the new rules may indeed lead to reduced interference in the band, it's not without some cost.

When the Commission decided to revamp the old technical standards under which AM stations had been operating, its goal was clear: to clean up interference on the dial.

The result was a three-pronged attack on interference, incorporating technical improvements, migration to the expanded band and consolidation of the existing band. Special consideration was given to AM stereo stations, as well—throwing a bone to a technology many believed the FCC had chosen to abandon.

Complaints already have arisen about how the FCC has set about reducing interference, however.

Revised calculations for determining nighttime interference levels and rules regarding voluntary facility modifications mean that many stations will have to accept a power

cutback at some time. The FCC also is taking a somewhat cool tone toward marginally profitable AM stations, offering owners tax certificates to cease operations.

By reducing power levels, getting rid of some stations and spreading the others to the 1605-1705 kHz expanded band, the result will be more room for the remaining stations, and—at least theoretically—reduced interference. The Commission thus has accomplished its goal.

It's important to note that the goal was *not* to reduce interference while keeping everything else at status quo. Nor could it be. In large measure, interference on the band can be attributed to the condition of the band in general; therefore, anything less than an overhaul might not yield any improvement at all.

To paraphrase Commissioner Ervin Duggan, the greater good often cannot be served without some pain and sacrifice on the part of those most affected by the problem. In this case, the sacrifices will undoubtedly result in extended life for the AM band and greater profitability for the remaining stations.

All of which is cold comfort for the stations who will have to suffer so that greater good can be achieved. And yet, the FCC has taken steps toward doing what AM broadcasters themselves asked them to do.

In the end, the industry is healthier if the band is healthier. And that's what matters most.

—RW

No Pain, No Gain?

nel because of our patented method of sampling and reconstructing the fully-processed composite stereo signal.

Intraplex raised the comparison between 16-bit discrete audio and 14-bit composite stereo. This is really a case of comparing two different types of signal. "CD quality" audio is 16 bits of *dynamic range*, not 16 bits of quality for the entire message signal. A typical CD is mastered with three or four bits of "headroom" for peak handling without clipping and the inherent distortion. This leaves an average program level of 12 or 13 bits—between 72 dB and 78 dB signal to noise!

In comparison, FM composite stereo is processed differently. If 18 dB of headroom were left, the average modulation would be below 20 percent. This is not modern FM audio practice. The broadcaster needs a "louder" sound to capture the listener in the automobile or to achieve that station's "presence" on the dial. This creates an entirely different class of signal.

CAT-LINK's composite structure was designed with the requirements of the broadcaster in mind. The design did not come in the form of data reduction or compression methods, which would alter and possibly negatively affect the station's "sound." Instead, we looked to the FM composite signal itself. Nyquist's theorem states that the sample frequency must be twice the bandwidth, rather than twice the highest frequency. With some thought and experimentation, this led to a sample rate of 76 kHz! With this we could also send the auxiliary channel data without affecting the composite signal in any way.

One of the major benefits of transmitting composite with QEI's patented method is that no input filters are required. This eliminates the problems associated with passband ripple and phase anomalies that affect separation and crosstalk performance.

In the case of a discrete system, input

filtering must be used, requiring the left and right channel program material to be processed once before entering the STL to maximize the response of the system and adjust to the requirements of the channel, and a second time before the stereo generator to achieve the desired result of an FM composite signal. This effectively brings the broadcaster back to the pre-Optimod™ days, requiring control of the peaks and overshoots of low-pass filtering, which today's stereo generators and audio processing systems perform.

The best FM transmission systems typically have specifications in the mid to upper 70 dB range for signal to noise and 0.01 percent distortion. The dynamic range of the CAT-LINK composite input is structured so that the operating level of the input is just 30 percent below the clipping level. This creates a headroom requirement of about 2.5 dB, or less than half a bit.

This means your program level is actually transmitted from 13 1/2 bits to 14 1/2 bits for a 14-bit or 15-bit composite system. This is actually better than that of "CD quality" audio! If a 16-bit linear system is used, either the material must be heavily limited to control the peaks of the signal, to avoid digital clip, or enough headroom must be left for the peak excursions, effectively reducing the channel from 16-bit resolution to 13- or 14-bit! This lowers signal to noise from the 90 dB range of signal to noise to the mid 70s!

Eric A. Eckstein, Bill Hoelzel
QEI Corporation
Williamstown, N.J.

Correction

In RW's Nov. 6, 1991 SBE convention wrap-up issue, the price of Delta Electronics' ASE-2 AM stereo exciter was incorrectly listed as \$4,000. The correct price is \$3,155.

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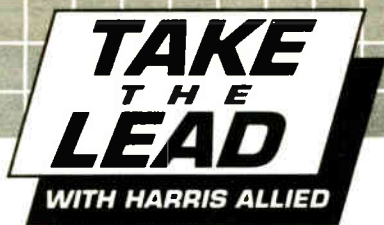
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Radio World
December 25, 1991



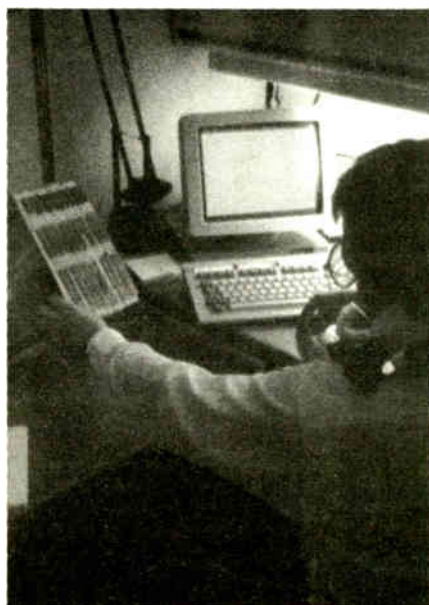
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Costas Remotes Beat the Odds

by Frank Beacham

NEW YORK Each week, within earshot of an audience of millions of radio listeners, Steve Kirsch plays a game of broadcast Russian Roulette. Using skills honed by years as a foot soldier in the "remote" trenches, he keeps turning up a winner.

Kirsch is manager of remote broadcasts for Bob Costas' "Coast-to-Coast" radio show, a weekly sports talk program produced by the Olympia Broadcasting Network and heard on more than 200 affiliate stations.

One of the unique things about the show is its location: sports bars in towns

But what is fun for the audience can be a nightmare for a broadcast engineer.

Hitting sports bars in more than 20 cities a year plus another 20 or so broadcasts from the show's home base,

Mixer Products Michael Petersen and asked if he could use a prototype.

"It's like they made this thing just for me," Kirsch said.

Introduced earlier this year as the

Costas show, four microphones might be open when only one person is talking.

When the number of open microphones is doubled (one to two, two to four, four to eight, etc.), the mixed audio output level increases by three decibels.

Speech clarity and intelligibility always suffer as ambient noise and reverberation increase. The remedy is to keep the minimum number of microphones open that will handle the program audio. This is where the FP410 comes in handy, Kirsch said. Within four milliseconds of the moment a new talker begins, the

(continued on page 8)

Sports bar remotes may be fun for audiences, but they can be a nightmare for a broadcast engineer.

Runyon's in New York, Kirsch navigates a mine field of potential pitfalls each week.

"The biggest problem on the road is the house PA system," he said. "It's been a nightmare."

Kirsch travels to each city a day in advance. This is to prevent the airlines from sending his gear to the wrong town on the day of a broadcast. He has trimmed his travel package to three shipping cases.

Since the entire show originates from the location and is fed directly to IDB's satellite uplink facility on Staten Island, Kirsch must roll in his own spots. This necessitates a complete broadcast facility—including cart machines—for each setup.

Kirsch has picked his road tools carefully. He works only with field-tested gear from companies such as Shure, Sennheiser, Sony, Comrex and ITC. But a new product he began using this year literally revolutionized his job.

"I had been using Shure M267 mixers . . . twisting a lot of knobs, trying to keep things under control," Kirsch said. But, he added, with four open microphones, a house PA feed and a lot of rowdy bar customers, consistently good results were elusive.

Then Kirsch heard that Shure was developing a new portable automatic mixer that would work with any type of microphone. He called Shure's Director of

FP410 Shure IntelliMix, the unit combined three functions which helped Kirsch tame his remote problems.

Noise Adaptive Threshold, a circuit which distinguishes constant background sound from rapidly changing sound, ensures only the voice of a guest will activate a microphone. With MaxBus, one voice will activate only one mixer channel even if multiple microphones are hearing that voice. And Last Mic Lock-On maintains seamless background ambience by keeping the most recently activated microphone open until a newly activated microphone takes its place.

By using the automatic mixer, Kirsch avoids the comb filtering and ambient noise and reverberation build-up problems common to multi-microphone radio production.

Comb filtering occurs when open microphones at different distances from a sound source are mixed together. Because sound travels at a finite speed, sound waves from the source arrive at the microphones at different times. As a result, the outputs of the microphones are out-of-phase with each other. When combined in a mixer, these out-of-phase signals produce a combined frequency response very different from the frequency response of a single microphone.

Another effect of multiple open microphones is the build-up of ambient noise and reverberation. In the case of the



Photo by Jon W. Tatooles

Remote engineer Steve Kirsch (seated) confers with Bob Costas before a live airing of Costas' Coast-to-Coast sports talk program.

throughout America. Since the subject is always sports, Costas likes to broadcast from places where sports buffs can witness a free-form discussion while sipping a favorite brew.

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FCC Denies Gammon City-of-License Move

by Charles Taylor

WASHINGTON Taking nearly two years to make its decision, the FCC has spurned Tom Gammon's plan to move WHMA-FM 90 miles from Anniston, Ala. to an Atlanta suburb.

In its 18-page Report and Order, the FCC concluded that the change in Crown Broadcasting's city of license would not serve the public interest because it would remove service from Anniston and add unnecessary service to the already well-served Atlanta market.

The Commission also said the plan could increase interference to as many as 27,399 listeners of WHMA's first adjacent channel in northern Georgia. "This is, we believe, a significant negative factor weighing strongly against the grant of a waiver," the FCC said.

Gammon said that after more than a \$13 million investment in the plan, he and his investor are "disgusted" with the edict.

"The FCC made the rules and we followed them," he said. "I think they didn't make their decision based on the merits of the case. I invite anyone to read the merits of the case and tell me whether it was a fair decision."

According to Gammon, the reason

his case drew such criticism—while 24 similar city of license changes have been approved by the Commission without controversy—is because people thought it would prompt an avalanche of relocations. But to date, he said, there have been only eight in the top 100 markets.

Gammon did not elaborate on whether or not the decision will be appealed. "What we need right now is a fair decision on what's good for the public," he said.

The NAB said in a brief statement that "the Commission made the right decision because it followed its own rules."

Gammon purchased WHMA in mid-1989, following passage of a new FCC rule that allowed stations to apply for different cities of license. In the February 1990 proposal, Gammon said the configuration would offer two new first local services—to Sandy Springs, Ga., a community of more than 77,000, and Lineville, Ala.—while not depriving Anniston of local service.

The plan was met with fierce opposition from a number of Atlanta broadcasters and the NAB, which claimed that the move represented "nothing more than a thinly veiled effort to subvert Communications Act requirements and relocate a radio station to a much larger market."

Remotes Beat Odds

(continued from page 7)

mixer selects and silently activates the most appropriate microphone.

When the talker stops, the mixer keeps that microphone on until a new one is activated. Only then is the unused microphone turned down.

Kirsch uses his M267 now to buffer his pair of FP410s from the house system and to get an upper hand over house DJs who try to raise the PA level for the customers.

Normally, "Coast-to-Coast" is broadcast live. From home base in New York, Kirsch has a permanent 8 kHz broadcast line installed from Runyon's to the IDB teleport. From remote locations, he orders three voice-grade telephone lines and uses a two-

line Comrex frequency extender. The third line is for program coordination.

One of the most difficult remote situations for Kirsch is not live, but tape-delayed programs made aboard cruise ships. Several times a year the Costas show is taped during sports cruises aboard ships of Norwegian Cruise Lines.

"The cruises are the worst. They have PA speakers everywhere . . . in the floors and the ceilings," Kirsch said. "There's a perpetual low frequency rumble from the motors which you can't get rid of. That's coupled with extraneous ship noises."

As a master of radio remotes, Kirsch said "less is more" sums up his professional philosophy.

"I don't travel with every piece of equipment I own," Kirsch said. "But on the other hand, everything doubles up everything else. I never want to get on the road and get caught with my pants down."

NEWS BRIEFS

Short Space Rules Reaffirmed

(continued from page 2)

transmitter power output, towers constructed to the wrong height, incorrect listing of antenna and transmission line types, and expiration of the construction permit before license filing. Often, stations also are out of compliance with special operating conditions.

Such discrepancies increase license processing time and are a drain on the FCC engineering staff's time, the Commission noted.

The deadline for responses to this informal inquiry is Dec. 16, 1991. Responses should be mailed, dropped off, or sent by fax to: FM Licensing Comments, Mass Media Bureau, Room 310, 1919 M St. NW, Washington, D.C. 20552; fax: 202-632-0158.

WASHINGTON The FCC recently reaffirmed the short spacing rules it adopted in 1989, allowing stations to use directional antennas, facilities reduction or to take advantage of terrain elevation to offer short space protection to adjacent stations.

Following the FCC's 1989 decision, several parties, including the NAB, challenged the rules on several points, including whether such special rules regarding short spacing were even necessary.

In upholding the short space rules, the Commission said they offer greater flexibility in site selection, but do not allow a station to cause interference to other stations.

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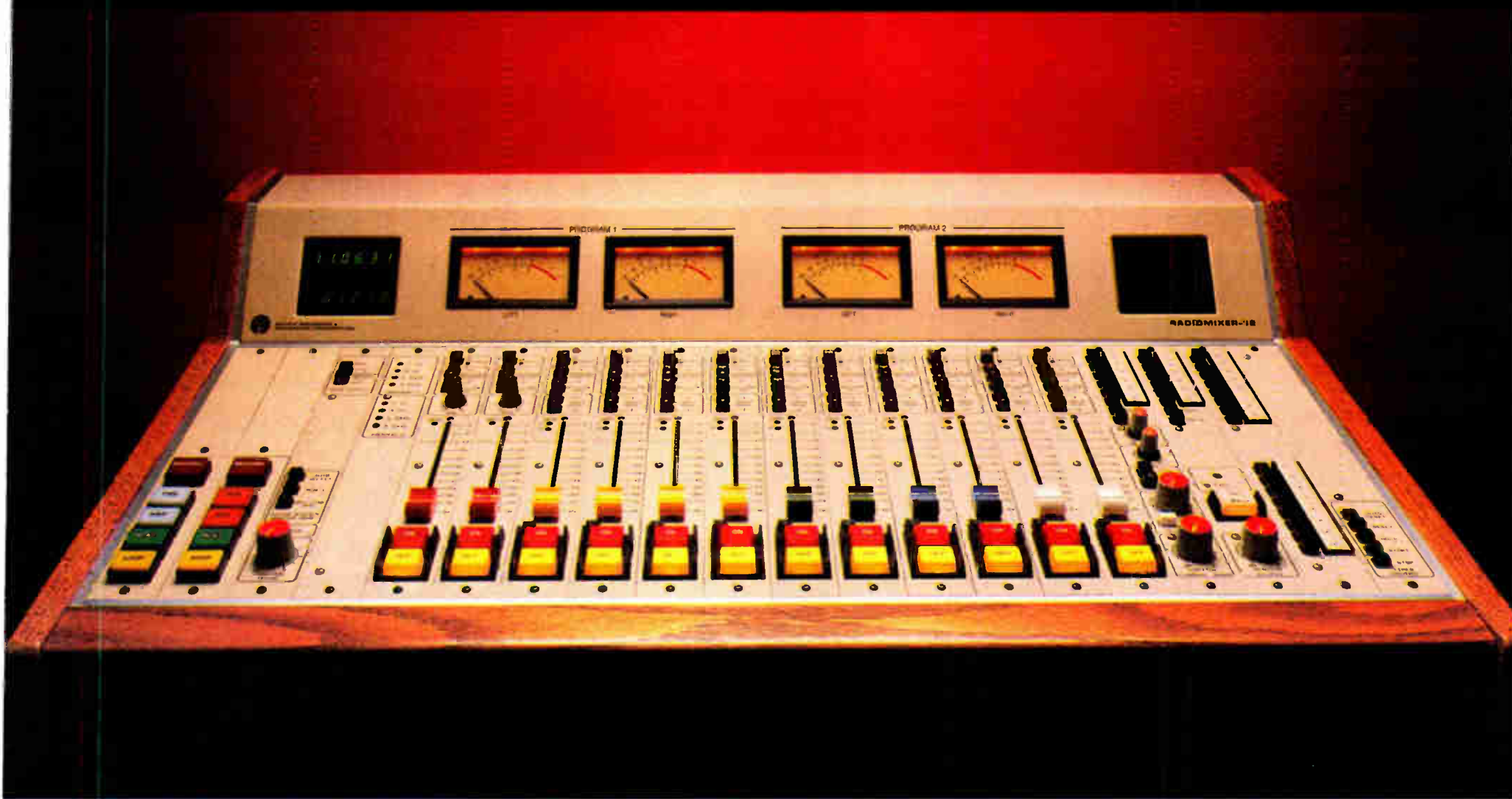
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DESIGNS THAT MAKE THE DIFFERENCE

Hill Inquiry Targets DAB

by Judith Gross

WASHINGTON The NAB came under some heavy grilling for its alliance with Eureka, and a Congressional committee showed an unexpected grasp of issues surrounding digital audio broadcasting (DAB) in a Capitol Hill hearing on emerging radio technologies.

Except for the NAB, there were no DAB systems proponents invited to testify at the hearing of the House subcommittee on Telecommunications

and Finance, held in early November.

NAB Executive VP John Abel and DAB Task Force Chairman Alan Box testified, along with John Holmes, director of the audio systems business unit for Delco Electronics; Gary Shapiro, group VP for the Electronic Industries Association (EIA); and Douglas Bennet, president of National Public Radio (NPR).

Box took the opportunity to reiterate NAB's stand against satellite DAB and to call for the

protection of services which cater to local markets. He predicted a dire future for broadcasters if satellite services were to begin operations first.

"As listeners, already desirous of digital sound, move to satellite DAB, the ability of local radio stations to hold their audience and advertisers who seek those listeners is lost," Box said. He also said that a satellite DAB service could worsen an already harmful recession.

But Shapiro spoke on behalf of the consumer electronics in-

dustry, which he said supports the prospect of satellite-delivered audio. "The potential consumer benefits and unifying effects of national radio service are too large to be ignored," Shapiro said.

Bennet said NPR also favors satellite delivery, especially for areas not adequately served by public or commercial interests today. He noted that services such as English-as-a-second-language—which would not be economically provided by commercial stations, or even a single public station in a small market—could be feasible via satellite.

"Direct satellite broadcasts, available everywhere in the

country, have the potential to solve this problem because taken together small groups of isolated people add up to very large audiences," Bennet said.

In addition to subcommittee chairman Ed Markey, the five witnesses were questioned extensively by Representatives Matthew Rinaldo and Don Ritter, each of whom has been active in radio legislation.

On the question of whether DAB should be a new service or an enhancement of existing service, Markey said, "I'm not sure we should always protect the incumbents in these situations."

Rinaldo and Ritter questioned Box on the would-be NAB-Eureka alliance, with Ritter at first under the impression that the agreement had been completed.

"Doesn't such an arrangement constitute a conflict?" Ritter asked, and Box pointed out that an agreement was still pending but that it would not be a conflict.

"But can you see how such a situation might appear to be a conflict to others?" Ritter pressed. Box conceded that he could see how it might be seen that way. At one point Box was asked if an in-band or narrow-band Eureka system worked as well as the Eureka 147 system demonstrated up until now.

Box said that it did, although Eureka has yet to develop fully or test such a system.

FCC Says S-Band

(continued from page 1)

Brazil have supported L-band, and Mexico was moving in that direction.

The U.S. WARC position now apparently puts the U.S. delegation in the position of opposing other Region II DAB spectrum requests. But Ambassador Jan Baran, who will head the U.S. WARC delegation, said meetings in the next few weeks will attempt to work out a more united front.

"Historically, we have had a unified position, and it's better to have one than not," Baran said. He also said that he foresaw "no flexibility" in the U.S. WARC position opposing L-band and favoring S-band and could not envision a shift.

The FCC, however, left the door to other bands slightly ajar when it said the U.S. would "seek the addition of terrestrial DAB allocation issues to the agenda of the post 1992 ITU WARC, at which time all bands will be considered."

Industry insiders say the possibility of other portions of the spectrum being considered for even a domestic DAB allocation are "remote at best."

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Tape Recipe: Heat and Serve

by Dee McVicker

CHAPEL HILL, N.C. Sound archivists at the University of North Carolina at Chapel Hill (UNC-CH) recently cooked up a scheme to save valuable recordings.

Faced with rapidly deteriorating sound recordings of some of North Carolina's most distinguished folk musicians and storytellers, they baked 50 tapes for four hours at 122° Fahrenheit.

The oven technique was used on 1970s' and 1980s' vintage reel-to-reel tapes, enabling the archivists to preserve one-of-a-kind recordings documenting historical vocalists and the rich African-American traditions of Coastal and Piedmont North Carolina.

Among the recordings preserved were those by popular singers Shirley Ceasar and Elizabeth Cotten. Field recordings of

OFFBEAT RADIO

Southern folklore, in particular the rhymed stories passed on through generations of African-Americans, also were preserved by the baking technique.

Advanced deterioration

"We realized that we had a body of important material, including some really fine performances, that was showing advanced forms of deterioration," said Mike Casey, sound and image librarian at UNC-CH library's Manuscripts Department. "We had to find some way of saving it for future generations."

Funded by a grant, the University's manuscript department, which archives more than 40,000 recordings and some 10 million manuscripts, began seeking methods to restore the recordings long enough to rerecord them onto long-term storage media.

Challenging the group's efforts was a problem common of mastering-quality tapes made in the 1970s and 1980s. As Casey explained, "The binding system breaks down. When you try to play the tapes, the lubricant material migrates to the surface. And sometimes, the binder material comes to the surface."

This shedding of binding material—the chemical agents that "glue" layers of tape material together—significantly hinders tape performance.

Says Casey, "Tape-to-head contact becomes very poor and the recording you make is not going to be very good. Sometimes the tape doesn't even play because it is shedding so bad." Or worse, he adds, "they squeal."

Several remedies were tried to get the tapes to at least make one pass through for rerecording, including coating them with a silicone lubricant. Unfortunately, Casey noted, "We could never get (the silicone) to hold onto a tape for a full pass."

The archivists also tried re-recording cuts onto various tape machines, finding some success with those that had fewer tape guides and parts in contact with the tape. "That helped some," Casey said, "but it wasn't a foolproof method and we didn't exactly have a whole run of machines to work with."

After repeated attempts at these more conventional methods, the archivists

decided to try the unorthodox approach of baking the tapes. The technique promised success by melting the tapes' bindings slowly at a low temperature so that, when cooled, tape bindings would reformulate.

We were aware . . .

"We were aware that the technique was used by some tape manufacturers. I had heard talk of it at various conferences," Casey said.

Gathering as much information as possible on the technique, the archivists constructed a small baking "oven" made out

of cardboard. For the heating element, they purchased a hair dryer from a professional salon "with the largest number of settings as possible because we didn't know what we would need."

Initial experiments were carried out on throwaway tapes in the same binding condition, which were donated by WUNC, the University's FM station.

With these tapes, the group quickly discovered an effective temperature range. "If you get into the 130 degrees and above range, then there's the danger of melting the (tape) plastic. Lower temperatures won't do it," Casey said.

In the final experiment, archivists spaced tapes in individual hubs to circulate heat uniformly on all sides. With the exception of two tapes that had to be recooked for an as-yet unexplained reason, the baking technique proved to be effective for all 50 one-of-a-kind tapes. "We were 100 percent effective," Casey said.

He is not sure how long the technique can preserve tapes for replay, however. Experiments on the tapes donated by WUNC-FM show that transfer should occur within a month. Taking no chances, the group rerecorded the 50 tapes onto current-generation mastering tape for long-term storage.

■ ■ ■

Dee McVicker is a free-lance writer and regular contributor to RW. She can be reached at 602-899-8916.

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World Radio History

Be Aware of Personal Safety

by Barry Mishkind

TUCSON, Ariz. It might be late evening by the time an engineer gets to the top of the mountain where his station's FM transmitter is located. Perhaps it takes a snowmobile or a walk up the side of the hill to reach the transmitter building.

The trouble is not particularly complex. It turns out to be a blown fuse from the storm that had moved through late that afternoon. A few minutes and the station is back up on the air.

Upon opening the door, the light illuminates the snowmobile. But it's not de-

serted. Standing there, nosing around for a late-night snack, is a rather large bear. Now what?

Surprise visitor

Fortunately, I've never been forced to come up with a quick answer. While I've hiked my share of terrain, the dangers have been other than four-legged. That's true in most cases. Bears, moose, etc., are usually a lesser worry for the lone engineer.

The reason is that transmitter sites are strange places. They're usually out of the way, down little-used roads, "two hours

from civilization and across the street from a bar." FM sites, of course, are usually up high, overlooking the city. Just the sort of thing for young lovers. Or sightseers. Or thieves.

The engineer must be concerned about personal safety from such surprise visitors, as well as the security of the site in general. While these two concerns have some common solutions, a tight budget or management insensitivity are not excuses for minimal security measures.

Tom McGinley of WPGC in Washington, recounted an incident while he was out taking field intensity measurements,

to which many of us can relate. A man walked up and pulled a gun on him.

McGinley solved his particular problem by listing that site as "inaccessible" in station records. The FCC understands that this can happen. However, that can't be done with every poor location.

Monitor points

If your station has monitor points that are in dangerous areas, a minimum step would be to have two people in the vehicle. They ought to have a radio or cellular phone to call for help if necessary.

In some areas, it's possible for a couple of engineers to have an informal arrangement to accompany each other to remote sites. I've done this several times.

Jim Bender of Bozeman, Mont., is one of many engineers that have been driven to carrying a gun with them on the job. According to Bender, this "helps me to accept the risks of my profession. It has also helped ease the fears of my family."

It is a sad day when our profession requires us to take "risks" in order to do our jobs. Many law enforcement officers will even suggest that carrying a weapon may increase risks rather than help, especially if the user has no self-defense training. And some station liability insurance policies forbid firearms.

Come to grips

So far, the professional societies haven't really come to grips with this sort of danger. Better respect and better wages are fine goals. But if you can't do your job—or worse, are attacked—they become less important. Perhaps we'll soon hear some recognition of the dangers the lone engineer faces in this area.

ECLECTIC ENGINEER

Perhaps hiring a private guard when someone is put at risk would be a better solution. When several stations share a site, it's often not overly expensive to share the costs of a guard. Getting management on board can be another story though, and some arrangements have fallen apart due to the refusal of one station to pay its share.

Another good solution is a fence with an electric gate. While it has a higher initial cost, it allows the engineer to enter easily without having to get out of the vehicle and fumble with keys. Matched with motion sensors and lights, real security can be achieved.

You might also check out one of the newer remote control units that feature built-in audio links, so that the studio can maintain contact with the transmitter site. In fact, by communicating with the studio, the remote control can be used to turn on lights, open gates, etc., to reduce the exposure of the engineer.

As we mentioned before, radios or cellular phones are real fine tools, especially where there isn't a telephone line out to the transmitter. Otherwise, if a problem occurs, the engineer has to drive some distance to seek help.

Overall, though, perhaps one of the best pieces of advice for staying safe is the one from the old cop show: "Hey! Let's be careful out there."

Barry Mishkind, aka RW's "Eclectic Engineer," is a consultant in Tucson. He can be reached at 602-296-3797, or 325-9883 on MCI Mail, or barry@coyote.datalog.com on Internet.

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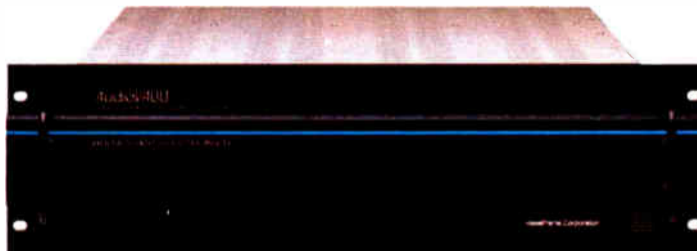
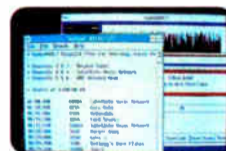
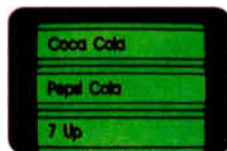


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FCC Self-Inspection

by Harold Hallikainen

SAN LUIS OBISPO, Calif. For the past few months, we've been reviewing the "Self-Inspection Report" the FCC is testing. Again, this looks like an excellent way for the FCC to determine compliance. I hope the "mail order inspection" is put into practice.

INSIGHT ON RULES

So far, the Commission has tested the system on nine AM stations. This month, we'll continue to work our way through the form. If you'd like a copy, send a self-addressed stamped 8.5x11 envelope (\$.98 postage), along with \$2 for copying to H&F, 141 Suburban Road, Building E4, San Luis Obispo, Calif. 93401-7590.

So far, I've sent out about 100 copies. The existing form is aimed at AM stations, especially directional AMs. Many questions, however, are applicable to all radio stations.

Several questions ask what the day, night, PSRA and PSSA power are. When power changes are required, it asks what procedures are used to ensure the power changes occur at the required times.

These times are, of course, listed on the station license, which is to be posted at the control point, so the information is available to the operator. Most stations, however, post another sign in front of the operator advising her or him of the month's power change times, taking into account daylight savings time (the times listed on the license are standard time).

I'd suggest the power change times also be put on the "program log" (which doesn't exist as far as the FCC is concerned, so let's call it the "program schedule"). Since the operator is closely following this schedule, it would be difficult to miss a required power/pattern change.

Power/pattern changes

To further ensure that the power/pattern changes occur, the operator should log transmitter parameters after the power/pattern change (73.1820 is unclear as to whether this is required, and no

parameters are specified). Stations utilizing automatic control systems (whether calling them ATS or not) should have the operator verify that the required power/pattern change did indeed occur.

The current rules do not specify a tolerance on power/pattern change times. The old ATS rules (73.142(d)(5)) specified an ATS clock had to be accurate within one minute. The current ATS rules seem to tolerate an interference-causing condition for three minutes (73.1500(e)).

Reviewing my 1988 violations database, I find one station fined \$1,000 for operating with 1,000 W day power until midnight, when 79 W was authorized at night. Another station was cited for changing to night pattern 15 minutes late. Another was cited for operating at day power for 15 minutes prior to sunrise, when 4.1 W were authorized prior to sunrise.

Under the current forfeiture schedule, late pattern change could be considered "exceeding power limits," subjecting the station to a \$12,500 fine.

Note that stations running very low power for pre-sunrise or post-sunset must have an antenna ammeter sufficient to determine the power correctly (73.99(k)). Such stations that use a directional antenna are required to take antenna monitor readings at full power immediately prior to starting low power operation, if the antenna monitor does not operate at low power.

Public inspection file

The FCC Self-Inspection Report asks for the dates of several items that are required to be in the Public Inspection File. These include the most recent renewal application, the most recent ownership report, the last Annual Employment Report filed with the Commission after the date the station's license was last renewed, and the most recent EEO Model Program.

The form also asks if various items are present in the file. These include "The Public and Broadcasting—A Procedural Manual," letters from the public and requests for air time by candidates for public office. The rather detailed list of public file requirements is listed in 73.3526.

The form goes on to ask where the public inspection file is located. 73.3526(d)

(continued on page 28)

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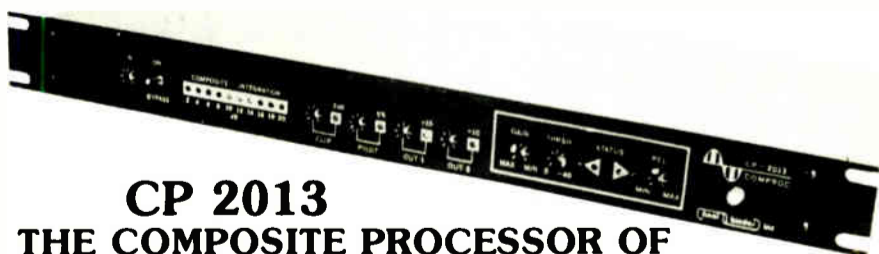
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A Guide to Understanding Watt's Law

This is the fourth in a 10-part series called DC Fundamentals. Northern Virginia Community College will offer 1.2 CEUs (Continuing Education Units) to registered students who successfully complete the course and an examination mailed at its conclusion.

To register, contact the Director of Continuing Education, Annandale Campus, 8333 Little River Turnpike, Annandale, Va. 22003, or call 703-323-3159. The fee for the course is \$30.

by Ed Montgomery

Part IV

ANNANDALE, Va. Power is the measurement of the amount of work that is performed in a specified amount of time. In physics, work is defined as a force multiplied by the distance moved in the same direction of the applied force. Work is

measured in foot-pounds.

In most instances, time is the most important consideration when determining the amount of work being done.

For example, a termite may take years to bore a hole through a log, while an electric drill can perform the same task in a matter of seconds. Both the termite and the drill are doing the same amount of work, but the time to complete the task is

the differentiating factor.

Often, work is expressed in horsepower, a term that dates back to the time of King George III in England. At that time, James Watt had developed the steam engine and was trying to sell this new invention to the operators of coal mines in England.

Up to that time, horses were used to pump water from the mines. James Watt wanted to replace the horse with the steam engine. The obvious question for Mr. Watt was: "How many horses will the engine replace?"

After some experimenting, Watt found that the average work a horse could do over several hours was equal to 550 foot-pounds per second. He used this figure to compare the output of the steam engine to that of the horse.

In electricity, it is important to relate the amount of work performed to voltage, current and resistance. Power is the end result of voltage, current and resistance related to performing a task.

As current flows through a wire, a magnetic field is developed. This makes electric motors turn and is fundamental to producing radio signals. The force developing the magnetic field is considered power. Power also is generated in the form of heat in light bulbs, toasters, heaters, vacuum tubes, etc.

In electronics, power is defined by the term "watt." One watt is the force developed to move one joule (0.7376 foot-pound) in one second. (746 watts equal 1 horsepower). Figure 1 illustrates the numerous formulas available for calculating power.

Ohm's Law states that $V=(I)(R)$. Watt's Law states that $P=(I)(V)$. Therefore $P=(I)(I)(R)$ or $P=I^2R$, multiplied by R. This is the direct method the FCC uses to calculate power going into an antenna.

Ohm's Law states also that $I=(V)/(R)$. $P=(I)(V)$ or power can be calculated by dividing the square of the voltage by the resistance.

There are several ways to calculate power and they are illustrated in Figure 1.

Power is the rate of doing work. When the utility company bills you for the use of energy, it is measuring the amount of energy that has been delivered to your home or workplace over a period of time.

A watt-hour meter measures both voltage and current flow to give an accurate reading of the energy used over a specific period of time. This measurement then is related to the cost of buying fuel to generate power and maintenance to the distribution system.

Figure 1.

$$P = (I)(E)$$

$$I = \frac{P}{E} \quad P = I^2R$$

$$E = \frac{P}{I} \quad P = \frac{E^2}{R}$$

Watt's Law

Here are some problems to check your knowledge of Watt's Law:

$$I=4 \text{ Amperes}$$

$$V=600 \text{ Volts}$$

$$P=$$

$$R=335 \text{ Ohms}$$

$$I=2 \text{ milliAmps}$$

$$P=$$

$$I=500 \text{ mA}$$

$$R=1K$$

$$P=$$

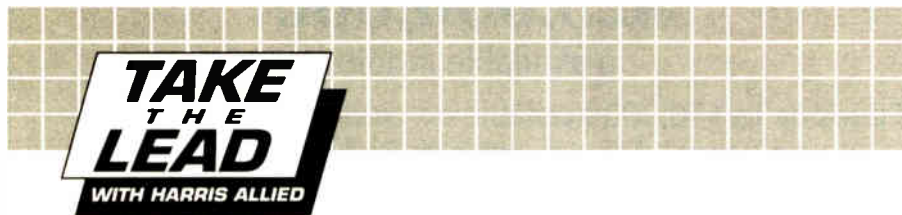
$$V=16 \text{ Volts}$$

$$R=4K$$

$$P=$$

Answers to last lesson's problems are:
 $(120V)/(40,000)=.003 \text{ Ampere or } 3 \text{ mA}$
 $(28.8V)/(.006A)=4,800 \text{ Ohms or } 4.8K$
 $(.002A)(335 \text{ Ohms})=.67 \text{ Volts or } 670 \text{ mV}$

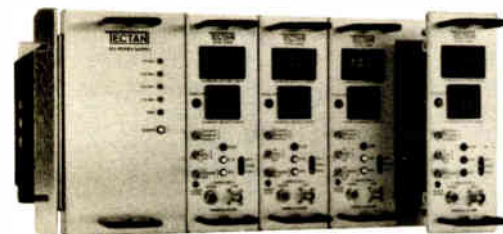
Ed Montgomery is a communications teacher at Thomas Jefferson High School for Science and Technology. He has taught broadcast engineering at Northern Virginia Community College and worked as a broadcast engineer for several radio stations. He can be reached at 703-750-5090.



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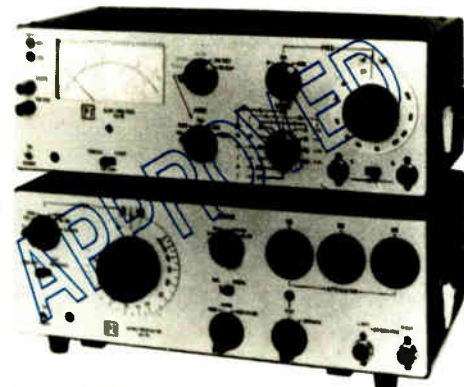
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Airing Radio Horror Stories

by Bruce Bartlett
with Jenny Bartlett

Part II

ELKHART, Ind. This installment of *Line Out* looks at more horror tales from the dark side of our craft, this time from reader Robert Mugg.

Here's his story: "My goof-up took place my first day ever on the air at a

news mixer pot, which took a feed from the news mixer. Any of the three mixers could be patched to the AM or FM transmitter.

"I was running the AM mixer. I was to begin my show after a five-minute simulcast news show. I was told to turn up my news mixer pot to monitor the news show. I was also told that the FM mixer op would patch me over, so after the newscast I would be live on the air."

he switched the patch feeding the AM transmitter to the news mixer instead of the AM mixer. The news mixer was then

LINE OUT

feeding the AM transmitter, not my mixer.

"When the news was finished, the newscaster turned down his mic, and we had dead air until I switched the patch to my mixer."

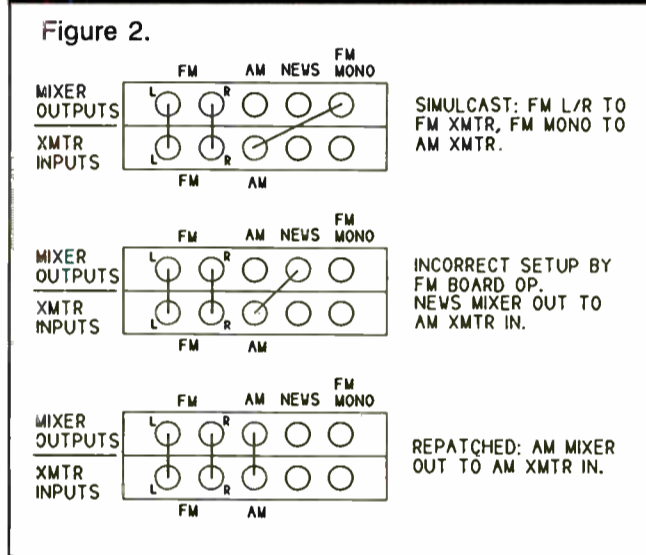
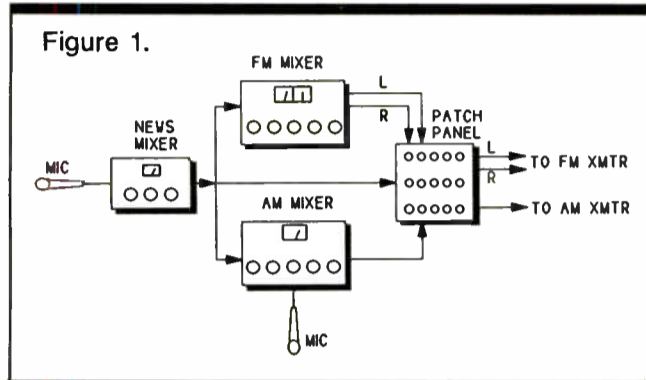
Thanks for the story, Robert. Mugg presented a paper about broadcast audio at the AES convention in October.

Cracked up

Then there was the time I was engineering a newscast. During the program, the CE ran into the control room and mooned the newscaster through the studio window. The newscaster cracked up on the air and couldn't finish, so I quickly put on whatever record was cued up—Led Zeppelin.

No moral here, except: Don't have too much fun on the air. See you next time.

Bruce Bartlett is a microphone engineer and technical writer for Crown International. Jenny Bartlett is a technical writer. Reach them at 219-294-8388.



Biggest nightmare

"Instead, the FM mixer op patched the news mixer on the air, not my mixer. So when the news ended, all that was on the AM was dead air—my biggest nightmare. I had to scramble to the transmitter room, find the patch bay and patch my mixer on the air.

"The moral: Don't trust anyone before you go on, and do everything yourself.

"After thinking over what happened, I found out that I was fooled. I thought I was feeding the transmitter because my news mixer pot was up, and I was hearing the news over the air on AM. But the transmitted news I heard was coming not from my mixer, but from the FM mixer, where their news mixer pot was turned up. It was being simulcast on

1000 W AM/FM station. The station had an AM mixer, an FM mixer and a news mixer that fed the AM and FM mixers (Figure 1).

"Both the AM and FM mixers had a

AM.

"To simulcast the news show, the FM mixer op had patched his FM mixer mono output to the AM transmitter (Figure 2). When it came time for my show,

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How Will the AM Rules Affect You?

by W.C. "Cris" Alexander

DALLAS The FCC has made some fundamental changes in the AM technical rules as the main thrust of its AM improvement program. These changes will, directly or indirectly, affect just about every AM station in the country.

Let's take a look first at the new rules themselves and then examine how they will affect a typical station.

Until now, the first adjacent channel groundwave protection ratio has been 0 dB. The 0.5 mV/m contour of one station could not overlap the 0.5 mV/m contour of a first adjacent channel station.

The new rules provide for 6 dB of first adjacent channel groundwave protection to be applied at the normally protected contour (0.5 mV/m). This would mean that the 0.25 mV/m groundwave contour of one station could not overlap the 0.5 mV/m groundwave contour of a first adjacent channel station.

Another new rule provides for 6 dB of first adjacent channel skywave protection at night. Until now, there have been no adjacent channel skywave protection requirements.

Finally, the second adjacent channel 2 mV/m-to-25 mV/m prohibited overlap has been changed to a 5 mV/m-to-5 mV/m pro-

hibited overlap. This is a spacing rule and not a protection ratio.

The really big rule changes are in the area of nighttime interference calculations and protection requirements.

Until now, interference has been calculated using a root sum square (RSS) method incorporating 50 percent exclusion. This RSS method is really just a way of adding the power from all the other stations together. Only co-channel stations were considered in the calculation. The new rules specify that no exclusion will be incorporated in calculating a station's RSS night limit, and that first adjacent channel stations must be considered in the process.

For existing station protection calculation, the new rules set up a three-tiered standard. I have classified this standard into three cases below:

- Case 1: If an existing co- or adjacent-channel station is a contributor to another station's RSS(50 percent exclusion), the existing station must reduce its contribution to the other station's RSS by 10 percent at the time of any voluntary facility change.
- Case 2: If the existing station is a contributor to the other station's RSS(25 percent exclusion) but not its RSS(50 percent exclusion), a facility change will be permitted in which no increase in radiation toward the other station is involved.
- Case 3: If an existing station is not a contributor to another station's RSS(25 percent exclusion), a facility change will be permitted to increase radiation as long as the RSS(25 percent exclusion) is not equaled or exceeded. New stations will be permitted as long as they do not equal or exceed this same threshold.

There was a statement in the FCC's Report and Order that said in the case of involuntary facility changes (i.e., loss of site, antenna maintenance difficulties, etc.), requests for waiver would be considered. Presumably, this would only apply in "Case 1" situations.

Finally, a new skywave model has been adopted. This new model takes into account the geomagnetic midpoint latitude in computing the skywave field.

There were many other rule changes, including increased latitude in nighttime antenna configuration for low power nighttime operations, split day/night oper-

ations, and tax breaks for those that submit their licenses for cancellation. Also in the new rules are the expanded band migration criteria and technical standards, but I will save these for another column.

How will these new rules affect your station?

Let's say, for example, that a certain AM station has some compelling, voluntary reason to move its site. A new site is selected a few miles away, and the engineering study to determine the new operating parameters begins.

At the old site, the station operated with 5 kW both day and night, directional at night. The RSS(50 percent exclusion) night limit was 4.65 mV/m, which provided a nice, big calculated interference-free coverage area at night.

A daytime allocation study for the new site shows us that everything would be the same were it not for the new 6 dB first adjacent channel protection ratio. A station

FEED LINE

on the next channel is located 60 or so miles away. Using our old site, our station's 0.25 mV/m contour overlaps the other station's 0.5 mV/m contour by about 13 kilometers at the closest point. This "existing overlap" was created by the new 6 dB adjacent protection ratio.

Section 73.37 (f), "Note 1" will allow this "existing overlap" to remain as long as the overlap area is not increased. The trouble is, the new site is about 3 km closer to the adjacent channel station.

To keep from increasing the size of the overlap area, it will be necessary to reduce radiation in the direction of the other station from 687 to 622 mV/m at 1 km. We can do this either by going to a directional antenna daytime or by reducing power.

Because a directional antenna is an expensive and troublesome proposition, the power cut is the best way to go. Instead of being 5 kW day, our station will be 4.1 kW day at the new site, with a resulting loss of coverage all around.

Under the old rules, there was enough space between the two stations' 0.5 mV/m contours to allow the site change with no power reduction.

A night limits study is run using the new site coordinates. In the past, we

(continued on page 28)



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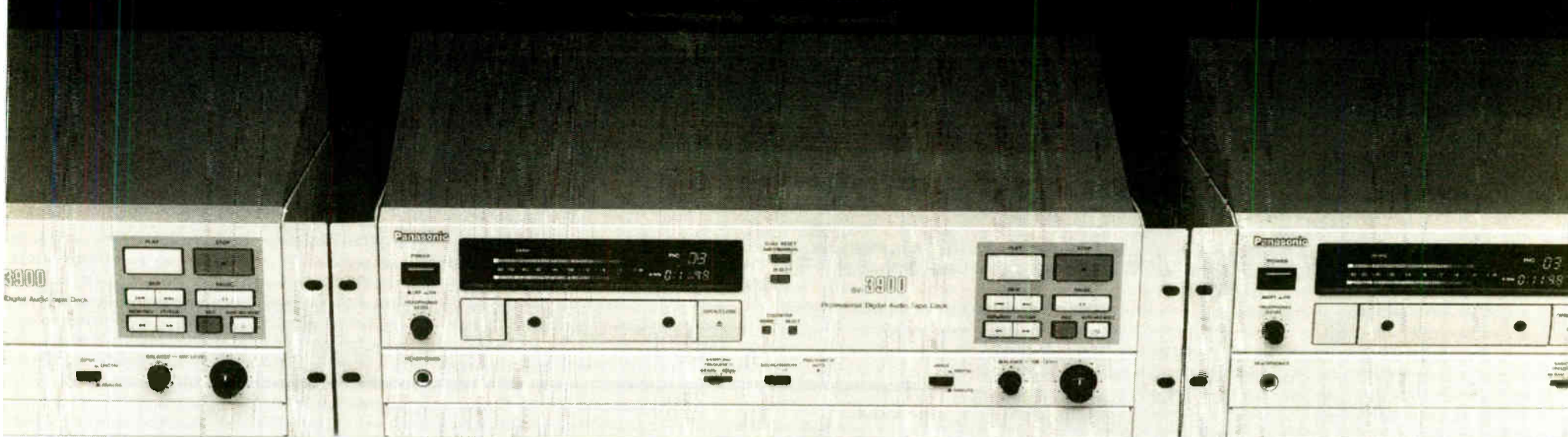
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World Radio History

WORKBENCH

Spraying Away Static

by John Bisset

FALLS CHURCH, Va. The PD proudly showed me his new "remote start" for his reel-to-reel machine. He shuffled his feet across the studio carpet and touched the equipment rack. As his finger drew the arc, the machine switched into Play mode.

Ah, winter is upon us—and with it, static electricity. If you find your studios suffering from static, put a little bounce in your life by picking up a can of spray fabric softener. True, your studios will now smell "April fresh," but the static will be gone.

You'll find a can of fabric softener lasts quite a while—and it beats the \$100 for "anti-static carpet treatments" that some cleaning companies charge. I picked up this tip from a trade show veteran, who was tired of paying the trade show management big bucks to reduce static in his booth. I tried it in the Delta booth, and later in studios that suffered from the problem. It works.

★★★

Since we're on the subject of sprays, listen to this cost-saving tip from Joe Schloss, CE of KICD-AM/FM in Spencer, Iowa. Joe has a Harris 25-K1 FM trans-

mitter that uses those reusable metal filters in its high voltage power supply.

Every so often, you pull the filter out and wash it. Before reinstalling the filter, it needs to be sprayed with a pretty expensive spray that attracts dirt and dust. A low cost alternative, which Joe says works just as well, is Pam™ cooking spray. A light spritz on the outside of the filter works great.

Remember, you don't have to soak the filter—a light spray will do. Joe Schloss can be reached at 712-262-1240.

★★★

Why is it that studios never have enough space? If you suffer from cramped quarters, you understand the need to use space wisely. With that in mind, let's take a look at a new offering from Mid Atlantic.

Owners of Studer CD players may wonder for what purpose that silver blank panel was intended. Well, the secret's out—to be replaced by Mid Atlantic's CD Jewel Case Shelf (see photo, p. 19).

panel into a holder for the jewel case.

The folks at Bradley Broadcast Sales in Gaithersburg, Md. (800-732-7665) put Jon in touch with Mid Atlantic, and a new product was born. The shelves

Figure 1.

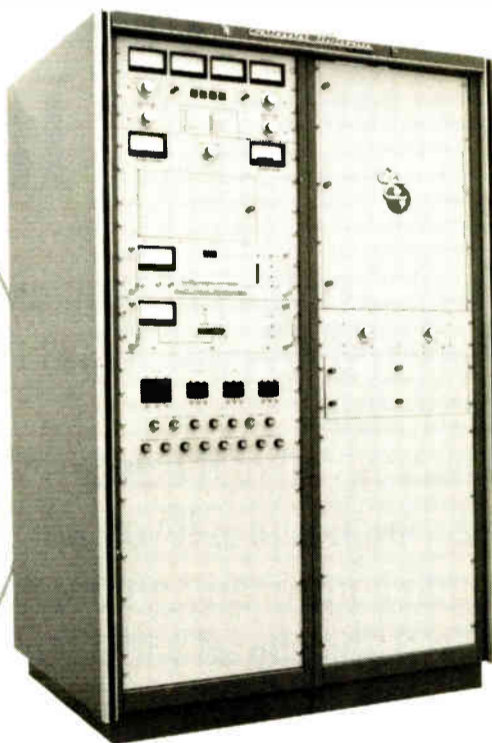
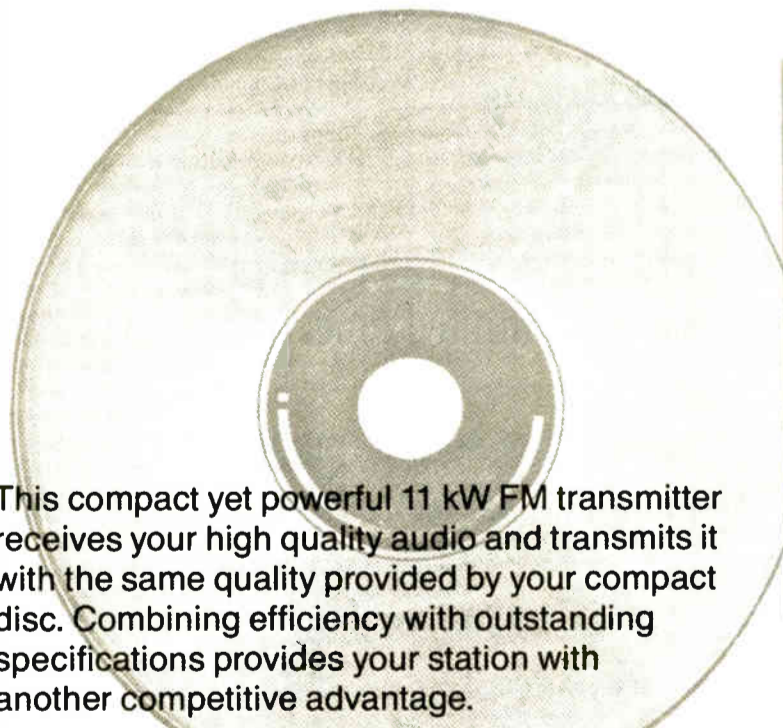
	Symptom	Possible Causes	Good Reading	Location
1	None of the 3 Boards in the EBS is receiving the proper power (+15Vdc, 10.5Vdc, +5Vdc) from the power supply.	a. The Rectifier of Transformer is faulty. b. R-24 or foil traces have burned out. c. Q8 or Q9 are faulty.	1. ≈ +15Vdc 1. ≈ 15Vdc 1. ≈ +10.5Vdc 2. ≈ +5Vdc	Input of R-42 Junction of R-41 and R-42 Emitter of Q8 Emitter of Q9
2	With a good audio input from the Receiver Board, and the LISTEN OPERATE switch in "listen," nothing (or a bad signal) plays over the speaker.	a. Z2 or the speakers are faulty (or surrounding circuitry).	1. Audio 1.2Vp-p 2. Audio 1.2Vp-p	Z2 Pin 6 Z2 Pin 8

TFT's new maintenance manual for the 760 Series of EBS equipment includes detailed troubleshooting charts, as well as problem flow charts.

We have to give Mid Atlantic high points for responding to customer input on this one. WLTT-FM CE Jon Banks was redoing his air studio, and being short on counter space, came up with the idea of turning this blank

are really handy for air talent who need to refer to the jewel case or simply keep track of which CD is in which machine. They're reasonably priced as well. If you'd like information on the jewel (continued on next page)

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All Continental transmitters come standard with a 2 year limited parts warranty and 24 hour technical service via phone. Leasing packages are available upon request.

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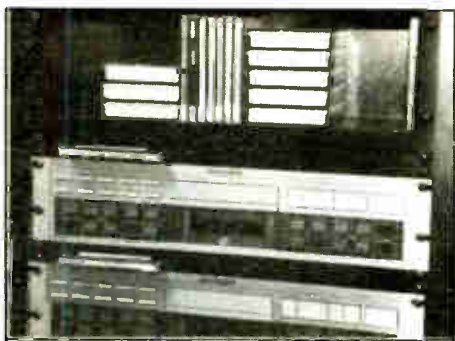
Continental Electronics Corporation

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(continued from previous page)
 case shelf, circle Reader Service Number 34.

★★★

Judging the number of EBS systems I've seen, I wonder if TFT was the only



The blank "spacer panel" used in Studer CD players can be replaced with this Mid Atlantic CD Jewel Case shelf.

company making the two-tone versions when the FCC changed the EBS rules. Although less expensive systems now are available, the TFT Model 760 certainly has proven itself a good value.

The unit is susceptible to drying out of the electrolytic coupling caps and subsequent loss of "received" EBS tests, a condition known by most veteran engineers. Based on the long-lived reputation of the Model 760, TFT recently has assembled several upgrades, including the capacitor replacement, and offers both a trouble-shooting manual and upgrade kit.

If your Model 760 was manufactured before 1985, in addition to upgrading your unit, the modifications will ensure continued good performance. The

upgrade kit, which includes tantalum coupling caps, a new chassis-mounted power resistor and bridge rectifier, sells for \$114. The manual cost is \$25.

In addition to providing trouble-shooting flow charts, the manual also offers trouble locator charts (see Figure 1). These charts list symptoms and offer several solutions for each. If you maintain TFT EBS systems, this manual is invaluable. It saves time.

You can order your manual and upgrade by contacting TFT at 408-727-7272, or by calling your TFT dealer.

★★★

Now that code is not a requirement for the Amateur Technician class license—or "Tech Light," to many Hams—taking the exam is all that stands in the way of the broadcast engineer who would like to explore ham radio, but never had the time to learn the code.

The National Amateur Radio Association has just introduced MacHAM. No, it's not the latest offering from the "Golden Arches"; rather, it's a test generator program that operates on a Macintosh computer.

MacHAM coaches the user, as well as generates FCC-style exams. MacHAM was patterned after The Ham Radio Handbook, published by NARA. For more information, circle Reader Service Number 121.

■■■

John Bisset is a principal with Multiphase Consulting, a contract engineering and projects company. He can be reached at 703-379-1665.

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World Radio History

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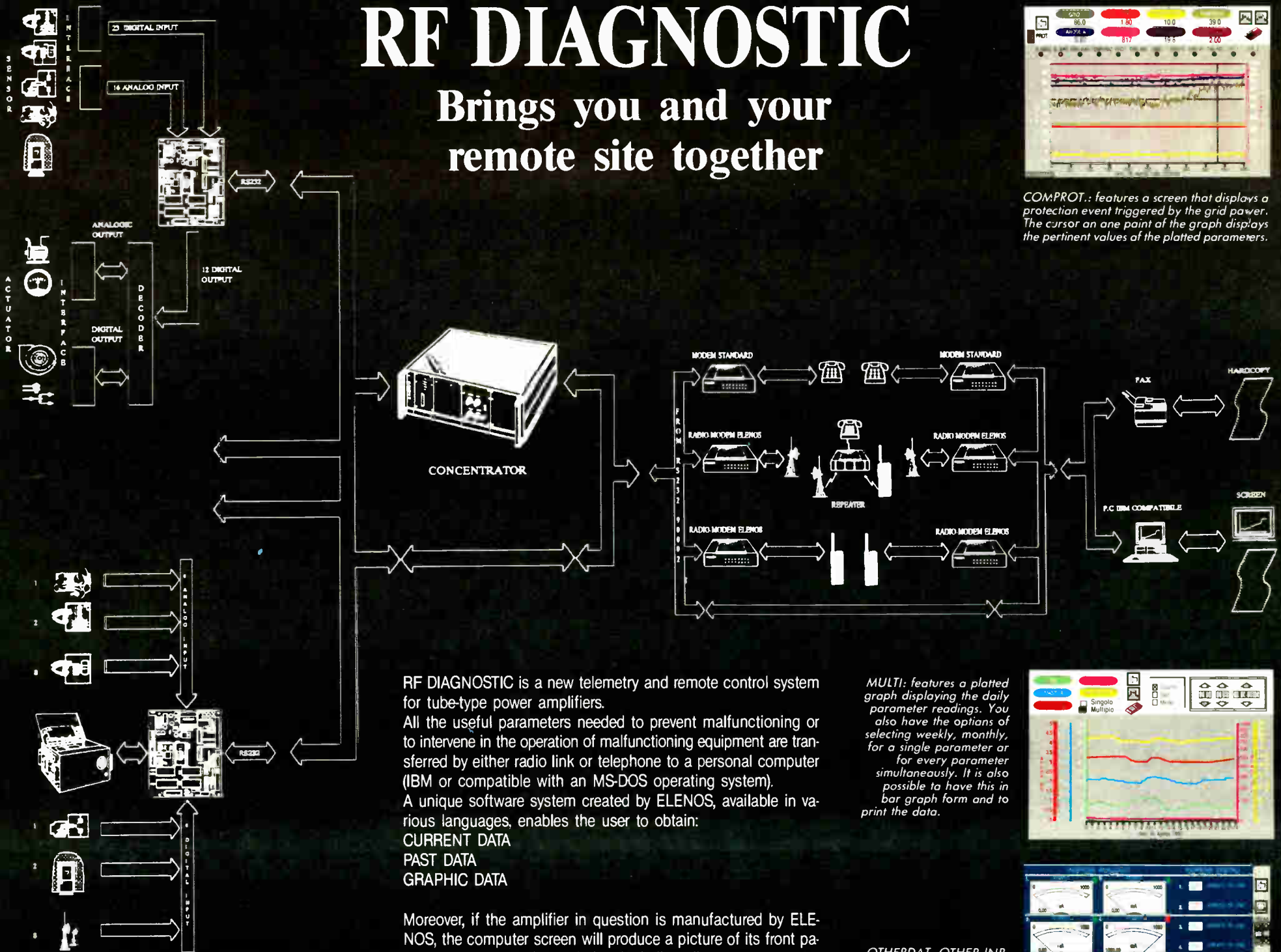
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World Radio History

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RF DIAGNOSTIC is a new telemetry and remote control system for tube-type power amplifiers. All the useful parameters needed to prevent malfunctioning or to intervene in the operation of malfunctioning equipment are transferred by either radio link or telephone to a personal computer (IBM or compatible with an MS-DOS operating system). A unique software system created by ELENOS, available in various languages, enables the user to obtain:

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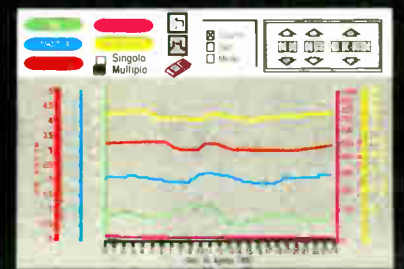
Moreover, if the amplifier in question is manufactured by ELENOS, the computer screen will produce a picture of its front panel (with high graphic resolution) including all current meter readings. Of particular interest to the engineer are:

- ◆ a ZOOM function which allows enlargement of any detail for easier reading.
- ◆ the HELP function: an online troubleshooting manual that guides the user to assess the causes of malfunctions, and in some cases comes up with solutions.
- ◆ the use of a MOUSE and icon representation which allows even inexperienced computer users to be able to work with the PC.

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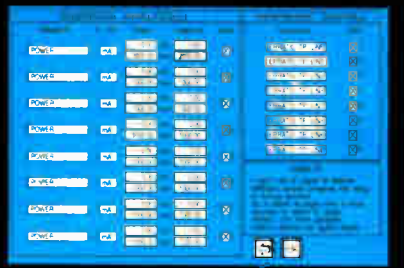
MULTI: features a platted graph displaying the daily parameter readings. You also have the options of selecting weekly, monthly, for a single parameter or for every parameter simultaneously. It is also possible to have this in bar graph form and to print the data.



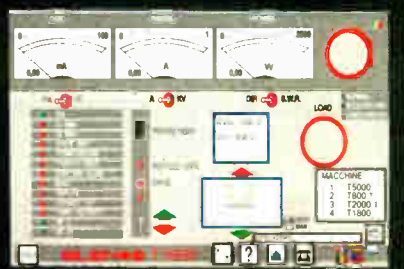
OTHERDAT, OTHER INP: with this feature you can display preset values. The green led shows that the values are within the set threshold limits. It is possible to redefine the scale and the alarm thresholds for maximum and minimum presettings on every analog instrument. It is also possible to define the description and the enabling and to disable the measurements.



RFSETUP: this feature allows a transmitting site with more than one transmitter to work on the same communication line.



T1800: if the transmitter controlled is made by Elenos, the monitor displays the front panel with the meters exactly as they are. In addition to the information displayed on the front panel, it is possible to have other functions displayed at the test points inside the transmitter. Some functions are remote controllable.



ALL THE LOGOS: this feature provides the possibility of adding your station's logo on installation of the software.



OEM INQUIRIES INVITED



Diverting Lightning From the Transmitter

by John 'Q' Shepler

Part VI

ROCKFORD, Ill. So far, we've talked about protecting the power lines, the tower and, most importantly, yourself from the ravages of lightning. This month, we'll look at what to do about those jolts that make it into the transmitters.

the antenna tuning units under the tower and within the transmitter room, inside the phasor cabinet. Make sure the ATU, phasor chassis and transmitter cabinet all are grounded with four-inch copper strap. Components should be spaced far enough so that lightning voltages cannot jump from one to another.

Arc gaps

Some ATUs or phasors also may have arc gaps, much like the ball gap on the antenna. These help set a limit on how high the transient voltage can get. The gaps protect the high voltage tuning capacitors and transmitter RF components.

Despite static protection, grounding and arc gaps, some lightning strike energy may get back into the transmitter. The overload relays may automatically clear the fault if they are working and set properly. This is because the lightning stroke has a very short duration and can be dissipated by the time the overload relays cycle off and on.

Another scheme looks at forward and reverse power and if the VSWR goes too high, it activates the overloads or electronically shuts off the IPA or final amplifier for the milliseconds of the stroke. If you are persistently losing transmitter parts during storms, contact the manufacturer to see what accessories might be available.

The best protection for FM transmitters is a well-grounded tower, transmission line and transmitter. You also need power line protection, because most FM transmitter failures are due to blown high voltage stacks and other power supply components. Cover this path first.

There is a simple device available that will protect the final amplifier and also help you avoid FCC fines. It is called the quarter wave stub harmonic filter. Sounds complicated, but it's not.

The stub itself looks like a long pipe hanging off the top of your transmitter. It is made of rigid transmission line and set to precise dimensions. The reason it

(continued on page 31)

Bring your station into the 90's with CAT-LINK—the digital STL/TSL.

"It's a dream system—we get specs like the microwave wasn't even there. CAT-LINK has completely eliminated the STL delay."

Jeff Andrew, WGCI-FM, Chicago

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Mike Callaghan, KIIS-FM, Los Angeles CA

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Dick Byrd, WZGC-FM, Atlanta GA

Two-way multi-channel communications

CAT-LINK digitizes the entire composite signal with no data compression, so you can run the stereo generator and processing at the studio, where they really belong. At the same time, CAT-LINK sends and receives up to four customized auxiliary channels with no crosstalk—SCAs, control channels, voice communications, RS232 data, AM audio, transmitter readings and satellite or remote program feeds. What's more, CAT-LINK gives you extra capabilities like transmitter building surveillance via closed circuit TV and an analog telemetry channel.

Transparent digital transmission

CAT-LINK encodes the fully processed composite signal, then decodes it at the transmitter. You always get full stereo separation, without the phase or amplitude variations that plague two-channel STLs. Dynamic range is up to 84 dB, and your processed composite signal can use virtually all of it. You hear clear, clean, undistorted audio—all the time.

No audible delays

CAT-LINK's real-time digital encode/decode process doesn't introduce audible delays as data compression can. Jocks can monitor on-air without problems.

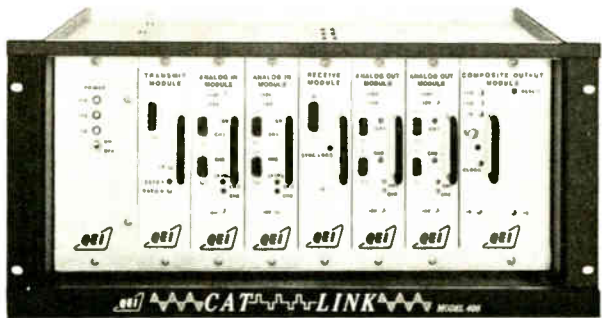
Flexible signal path options

• **23 GHz**
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Q-TIPS

We've mentioned the importance of having a large enough AM transmission line. If the line is too small, lightning will jump between the shield and center conductor. This creates an arc that the transmitter feeds. It burns out the bullet connectors or even the line itself. The heavy load may also stress other transmitter parts.

The transmission line and other components should be sized to take whatever transients get past the tower protection. RF capacitors, coils and switches all are vulnerable. The coils usually are less of a problem because they often are formed from good-sized tubing. If you're losing capacitors, you may need a higher voltage rating.

These components are found in both

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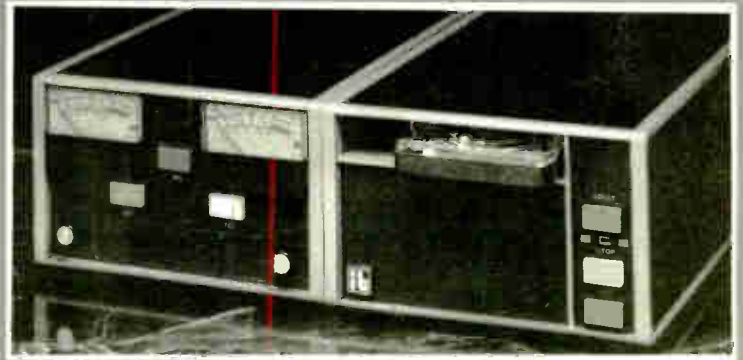
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- 013 035 057 079 101 123 145
- 014 036 058 080 102 124 146
- 015 037 059 081 103 125 147
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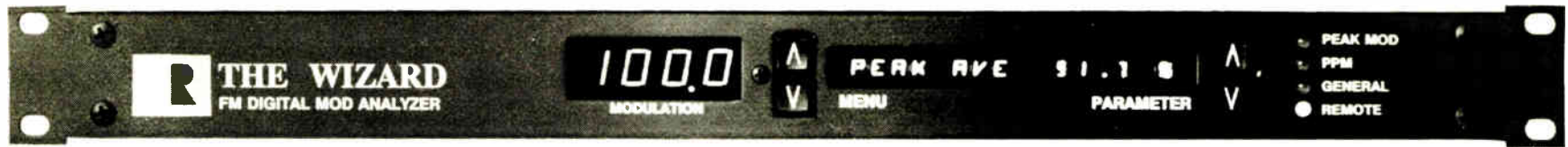
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The Wizard even includes a loss-of-program alarm—just set the minimum modulation (anywhere from 0 - 100%) and the maximum time you can fall below this modulation (0 sec - 60 sec, in 1/2-second increments) from the front panel (or remotely), and the alarm will be triggered when the parameters are exceeded.

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Exploring the History of FM

by George Riggins

LONG BEACH, Calif. Continuing our discussion on the development of FM transmitting and receiving circuits, it is interesting to note the early negative comments of the Bell Engineering Group's John E. Carson in 1922.



Carson wrote a paper that discussed the mathematics of RF modulation. In it, he mathematically demonstrated that FM could not reduce the bandwidth necessary for radio broadcasting to less than twice the frequency range of the audio. As such, FM was basically discarded.

One of Carson's assumptions was that only narrowband FM would distort. Radio innovator Major Edwin H. Armstrong took the opposite assumption and expanded the bandwidth to 200 kHz, achieving promising results. The problem: hundreds of broadcast stations in a 1,000 kHz band that already was too crowded to allow the additional bandwidth necessary for FM. Armstrong's solution was to move his experiments to the 41 MHz band.

The proposal hoped to put the desired information on the RF signal as frequency variations. Natural and man-made interference caused amplitude variations and so was prone to interference. He reasoned that by stripping the amplitude variations and then demodulating the frequency variations, he could faithfully reproduce the original audio. Thus was born our current "hi-fi" method of radiating, via RF, static-free music and speech.

The first model FM system was built in a basement lab at Columbia University. The new system was first shown to David Sarnoff of RCA in 1933. Why Sarnoff? Ma-

lor Armstrong had agreed to give RCA first rights of use.

In reality, 1933 was the end of one era and the start of another. Field testing began with the transmitter and antenna mounted on the Empire State Building in New York City. Good, static-free reception was reported at distances of 80 miles.

Major Armstrong continued to improve his equipment, both transmitting and receiving, at the Empire State Building. A technical paper explaining the concepts and experimental results of the FM system was presented to the Institute of Radio Engineers (IRE) in 1935 after the first two years of experiments.

Built his own site

In 1938, RCA decided that the test space was needed for TV development, so Armstrong built his own site on the Hudson Palisades at Alpine, N.J., paying for the tower and other facilities out of his own funds.

The source of program material for the experimental station was WQRX in New York City. The calls used for the New Jersey station were W2XMN and WE2XCC. (Yes, amateur radio call signs of the "X" series were used for experimental stations for many years. Perhaps some of the true Old Timers will furnish more on the subject of experimental calls and early mobile radio calls used on the amateur bands.)

The Palisades station grew into the Yankee Network, which covered much of the New England area before WWII. During this experimental time, RCA was involved with the development of television and stayed at arm's length from the FM experiments.

General Electric, meanwhile, had requested a license in 1938 to produce equipment under the provisions of Armstrong's patents. The GE request for a license was influenced by W.R.G. Baker, head of the electronics department at General Electric.

One other scientist to extol the virtues of FM was Daniel Noble of the University of Connecticut, who was working on po-

lice and mobile radio. It is interesting to note that Noble later went to work for Motorola. We all are aware that Motorola became the dominant manufacturer in commercial communications—or two-way radio as it sometimes is called—for many years.

Bell Laboratories developed a radio altimeter, based on the FM principles of Armstrong, that was used on some aircraft during WWII. The altimeter used the reflected signals for measuring distance

above terrain.

RCA continued to work on TV research using AM for the transmitted audio. In 1940, RCA offered to purchase the FM patents for \$1 million with no further royalty payments. *No soap*, as far as Armstrong was concerned.

Forty channels

Regular FM broadcasting was authorized by the FCC on May 22, 1940. Forty channels in the 42 MHz to 50 MHz band were allocated. One other happening in 1940 that helped move TV sound from AM to FM was the NTSC choice of FM for the audio over the RCA developed AM TV

(continued on page 31)

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The FCC's New AM Rules

(continued from page 16)

would have considered only the RSS(50 percent exclusion) of co-channel stations. Now, we must find the RSS(50 percent exclusion) and RSS(25 percent exclusion) of all co- and adjacent-channel stations.

Weighing options

Then, for each station, we must find whether our station falls under "Case 1," "Case 2" or "Case 3" as outlined above. This determines whether we must reduce radiation, maintain current radiation, or may increase radiation toward that station.

Co-channel, our station does not enter into the RSS(50 percent exclusion) of any

other stations. It does enter into the RSS(25 percent exclusion) of a few other stations, meaning that we may maintain the status quo as far as those stations are concerned.

Adjacent channel, there is big trouble. Because there never have been any sky-wave adjacent channel protection requirements, our station has never provided protection to any adjacent channel stations. Using the new 6 dB ratio, we find that our station enters the RSS(50 percent exclusion) of two adjacent channel stations. Under the new rules, we must reduce our radiation toward these stations by 10 percent.

There are two ways to reduce radiation toward these stations: reduce power or modify our directional pattern. Unfortunately, both these protections lay in our main lobe.

A study of our existing three-tower "dogleg" array indicates that such a change is not easily accommodated. An additional tower will be needed to create another null. The expense of the additional tower, ground system, land and phasing/coupling equipment (in addition to tune-up and proof) must be weighed against the cost of a simple power reduction. In this case, land for an additional tower is simply not available at the new site.

Since no other suitable sites are available nearby, the power cut is our best option. The new nighttime power figures to a little over 4 kW.

Including adjacent channel stations in the calculation, the new RSS(50 percent exclusion) night limit figures to be 8.78 mV/m. This is a big change from the old 4.65 mV/m. While this is purely a "paper" change, it will affect coverage maps and such.

When all is said and done, is this site change worth the trouble? It may be, de-

pending on how good a price the old site brought. The guys with thick glasses will have to weigh the proceeds against the cost of the move and the operating revenues lost as a result of the power cuts over a period of time. Another factor to consider is the value of the station.

Minimal impact?

Some will argue that a 20 percent power reduction will have minimal impact on a station's coverage. It's true that locally the listeners will notice little difference. The fringe area will lose service, though, and any other stations looking to modify their facilities will use the new contour locations in their protection calculations.

The situation examined here may not be indicative of the effects of the new rules on every station's ability to change its facilities. But in most cases, they will make any such change more difficult. It's my guess that a 10 percent reduction in radiation in some direction will be required of most everyone wishing to make a voluntary change.

■ ■ ■

Cris Alexander is director of engineering for Crawford Broadcasting Co. in Dallas.

Self-Inspections Revisited

(continued from page 13)

requires that the file be located in the community the station is licensed to, either at the studio (in the community) or at some other public location in the community, such as a public registry for documents or an attorney's office.

Stations that were granted permission to have the main studio outside the licensed community under the provisions of 73.1125(a) prior to July 16, 1987 (when the current 73.1125 became effective), may continue to keep the public file at the studio. It appears that stations that have the studio outside the licensed community but within the "city grade contour" under the current 73.1125 must maintain the public file in the licensed community (instead of at the studio).

The form goes on to ask what the "public business hours" are at this location.

73.3526(d) requires the public inspection file to be available to the public "during regular business hours."

Available at any time

Since these records also are subject to FCC inspection and the FCC can inspect any time the station is on the air, they should be available to the FCC at any time the station is on the air. One station was cited for not presenting the file at around midnight (it was locked in an office).

Finally, the form asks if reproductions of any document in the public inspection file are available on request. If there is a copying machine in your community, a station must provide copies of documents from the public inspection file that are requested in person (not by mail) (73.3526(f)).

The Public Inspection File is rather complicated. It should be reviewed regularly to ensure it is in compliance. I'd suggest the entire public file be reviewed quarterly when the required programs/issues list is added to the file (73.3526(a)(9)).

Next month, we'll discuss any new information I dig up (call me with yours) and continue the discussion of the FCC Self-Inspection Report. The next section deals with station logs.

This is the 50th "Insight on Rules" column. Thanks to RW and the readers for giving me this opportunity.

■ ■ ■

Harold Hallikainen is president of Hallikainen and Friends, a manufacturer of transmitter control and telemetry systems.

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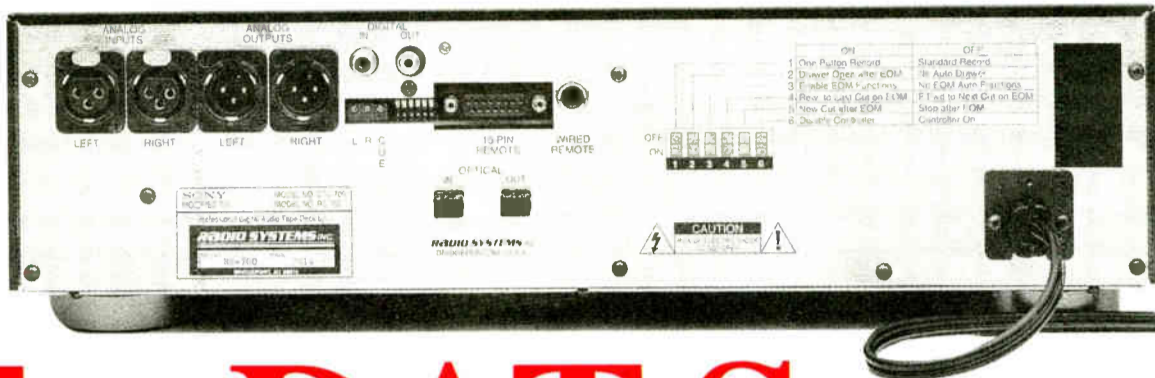
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Common Language

(continued from page 23)

and file structures, so that disk and optical files can be read by "foreign" systems.

Also, an AES Subgroup on Operational Requirements for Disk Recording has been examining the various pros and cons of optical archive and data-exchange formats, including ISO3-format, 650-Mbyte drives and WORM compact disc drives.

Among its various deliberations, the subgroup has proposed adoption of an optimized version of AIFF (Audio Information File Format). The structure is used by a variety of companies, notably Apple Corp., as a standardized format for sampled sound files.

AIFF specifies a number of pre-defined data "chunks," many of which can be incorporated directly into any new data interchange standard; other, currently undefined, chunks will need to be added, including timecode sync plus additional source and destination data.

If digital audio workstations are to live up to their promise of enhanced creativity and user convenience, exchanging data between units of the same or different manufacture should be as simple as possible. Otherwise, as users of early-generation designs are discovering, it can take almost as long to set up a workstation for a session—inload the various voice, music, effects and other files, plus information—as it does to perform the various editing, mixing and processing functions.

■ ■ ■

Mel Lambert is principal of Media&Marketing, a consulting service for the professional audio industry. He can be reached at 818-753-9510.

Divert Lightning from Transmitters

(continued from page 24)

works so simply is because FM wavelengths are only a few feet long.

Short the far end

Remember your antenna theory? A line exactly a quarter wavelength long acts like a transformer. One end is low impedance and the other is high impedance. We'll short the far end and make it the low impedance. The transmitter end then will be high impedance. The transmitter won't even see the high impedance stub in parallel with the

transmission line.

The lightning, however, will see the shorted stub end as a DC-to-high frequency short circuit right across the line. The output of the transmitter is, in effect, being protected by a short circuit at the primary lightning frequencies. Lightning loses a lot of its pep at the VHF frequencies where the stub behaves like a filter rather than a short.

Remember that the quarter wave stub is a high/low impedance transformer at only one frequency—your channel. At twice the frequency, the second har-

monic, the stub looks like a low impedance on both ends. This means that second harmonics and all other even harmonics will be shorted out.

Of course, odd harmonics won't be affected. Even so, it's usually the second harmonic that contains excessive energy.

Don't assume

Don't naturally assume that any harmonic filter on your transmitter is the stub type. There are other filters that are made from coils and capacitors. They help a bit with lightning, but don't offer the hard short circuit to ground for low and high frequencies.

Talk to your transmitter manufacturer or antenna consultant about the possibility of getting a shorted stub filter for your transmitter. Since these are effective for only one frequency, they have to be custom cut to length. Rather than cut the pipe, the filter may have a shorting disc that can be moved in and out to set the exact length for any FM channel.

The key is to have a layered protection approach so that lightning gets diverted many times before it reaches the transmitter circuitry. These layers are grounding, static discharge, grounding, ball gap, inductive loops, secondary arc gaps and shorted stubs or VSWR shutoffs. On the AC power end it's surge protection or a backup generator.

■ ■ ■

John Shepler is an engineering manager, writer and longtime RW columnist.

The History of U.S. FM

(continued from page 27)

caused Armstrong and his wife to separate. TV service was authorized July 1, 1941.

The beginning of WWII brought a halt to most research not directly related to military applications. Armstrong made all his patents available to the U.S. government royalty-free for the duration of the war.

In 1946, RCA tried to get around the Armstrong patents with a "limiter-discriminator" circuit. An evaluation of the RCA circuit suggested that "quality was subordinated to lower cost." Three years later, in 1949, patent infringement litigation began. (The basic Armstrong FM patents were to expire in 1951.)

The litigation was to take five years. There were pre-trial depositions and cross-examinations. Armstrong himself was in the witness chair for one year.

RCA proposed a settlement near the end of 1953. This settlement was rejected. Armstrong's attorneys were of the opinion that a settlement could be reached, but the litigation continued.

By some reports, Armstrong experienced some sort of cerebral problem during the later stages of the litigation. This problem, financial drain caused by the continuing experiments and development work, and the costs of the legal battles

caused Armstrong and his wife to separate.

With all of these pressing issues, Armstrong reportedly jumped fully clothed—with hat, gloves, overcoat and scarf—to his death on the night of Jan. 31, 1954.

At the end of WWII, the Radio Technical Planning Board (RTPB) came out in support of the 1940 band allocation for FM service. The FCC was concerned with possible skywave interference at 41 MHz and recommended that FM service be established at 96 MHz to 106 MHz. The final allocation was as we know it today, 88 MHz to 108 MHz.

■ ■ ■

George Riggins has owned Riggins Electronic Sales for more than 20 years. He can be reached at 213-598-7007.

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Rohn 8R-4R self-standing 100' tower, 1 yr old, new cond; RCA 5BTFD 5 kW tuned to 92.7 MHz, gd cond; Shively Labs 6813 3-bay tuned to 92.7 MHz; 70' 1-5/8" air coax. C Hall, KCDH, POB 165, Nephi UT 84648. 801-623-4010.

Jampro 2-element panel antenna, custom design, up to 10 kW, on 93.9 MHz, (4) cables, never used, BO. B Kingman, KRLL/KOWL, Box 15460, S Lake Tahoe CA 96151. 916-541-6681.

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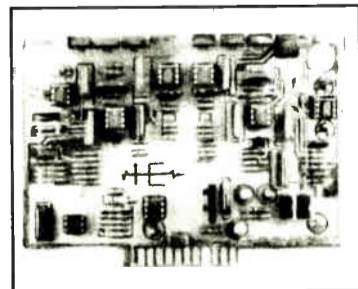
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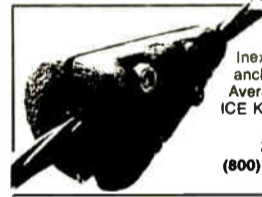
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Jampro JHPC 4-bay tuned to 102.5, wrkng when removed, \$4500. D Miller, KYTE FM, 906 SW Alder, Newport OR 97365. 503-265-2266.

Gates/ERI FMA-8B 8-bay horiz only on 94.5 MHz, complete, gd shape, BO. F Holton, WAHI-FM, Box 195, Augusta IL 62311.

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ERI 04-CPH-10 10-bay circ pol high power FM antenna, tuned to 96.1 MHz, w/500 W functioning Deicers & mounting brackets, makes 100,000 W ERP H&V, w/20 kW xmtr; Dielectric 4-1/16" rigid sections w/spring hangers; 4-1/16" field flanges; some 3" rigid spring hangers. C Murray, Eugene OR, 503-484-9400.

Andrew HJ8-50B 300' 3-1/8" Helix, BO; new Andrew splice kit for 3-1/8" coax, \$300; Andrew EIA connectors, BO. S King, KATP, 7700 I-40 W. Amarillo TX 79160. 806-335-1951.

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ATI emphasize, vgc, \$550. C Crouse, Beech Tree Brdcsng, 48 Cedar St, Dedham MA 02026. 617-461-2699.

Eventide 1745-M w/3DDL & pitch ratio, excel cond, BO. F Virtue, Virtue Rdrng, 1618 N Broad St, Philadelphia PA 19121. 215-763-2825.

Cornell on-air lights (4), for standard duplex outlet box, \$20 ea; Shure Audiomaster M63 EQ, \$75; (2) Technics SL-1200 TT w/bases, \$150 ea; (2) Ramko MA14 spkr amps, \$25 ea; several Ramko TT preamps, \$25 ea. S Sands/S Ludwig, 815-459-7000.

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Burwen DNF 1201A dynamic noise filter, new cond, \$200. D Bailey, Rockshoppe Prod, 3422 Beech St, Rowlett TX 75088. 214-475-9796.

Audio Digital TC4 6.8 sec delay unit (2), 15 kHz, w/stereo couple & catch-up options, \$800 ea/\$1500 pair; CRL AM-4S stereo syst w/SPP-800, (2) SEP-400A, SMP-900, updated to NRSC specs by CRL, avail 1/92, \$3175. J Goode, WCIT/WLSR, 419-228-9248.

Want to Buy

Sony PCM601ESD digital processor, vgc, will pay cash. A LaFay, APC Prod, POB 371, Walnut CA 91788.

CASSETTE . . . WTS

Ampex SP3000 instrumentation recorder in portable case (2), (1) for 1/4" 4-trk & (1) for 1/2" 7-trk, need documentation, \$600 ea; Scully 280-1 FT PB only plug-in head assembly, 1/4" tape, like new, \$95. K deGruchy, WYVW FOX-TV, 205 E 67th St, NY NY 10021. 201-641-3997.

Ampex 350 1/2-trk mono 14" reel transport & Lang SS R/P electronics, \$295+freight. N Mishan, POB 335, Lynbrook NY 11633-0335. 516-582-1338.

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Gates ATC rcrdr, vgc, BO; (3) Gates ATC tape decks, vgc. BO. L Popp, 814-467-7894.

Ampex ATR-102 1/4", gd cond, \$2500; 440 capstan servo w/ps, \$500. M Linett, Yr Place or Mine, 1600 Las Flores, Glendale CA 91207. 818-244-1909.

Scully 280 4-trk in console, excel cond, BO. F Virtue, Virtue Rcrdrng, 1618 N Broad St, Philadelphia PA 19121. 215-763-2825.

Nakamichi 1000 2XL w/NR100, 19" rack w/wood case, \$650/BO; Crown SX824 R-R 1/2-trk, 2-trk R, 4-trk P, w/case, \$500. R English, DJ Entertainment, 882 Old Seneca Tpk, Skaneateles NY 13152. 315-685-3814.

Dictaphone 40-trk 1" loggers, dual decks, mounted in rack w/plexiglass door, gd cond, \$1950; optional time/date generator, \$375; tapes avail. G Wachter, KFYY, 602-258-6161.

Crown SS700 PB, 10-1/2", 15753.75 ips, many features not found on newer machines, gd cond, \$175; Teac Dolby B processor, works grt, \$50. J Deering, 615-264-2886 after 7 PM EST.

Tape Athon R-R (3), bi-directional, 3.65 ips 1/2-trk, auto reverse, (2) portable 7" & 10.5", (1) rack mount 10.5", all working, w/spare parts, \$50/ea. E Davison, 135 N Illinois, Springfield IL 62702. 217-787-0800.

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Studer-Revox B77 2-trk, vgc, \$600. N Hammond, PAS, 320 Ethan Allen Ave, Takoma Park MD 20912. 301-891-3567.

Scully 284B-8 8-trk 1" deck, 3.75-30 ips, vry clean, less than 100 hrs, w/all manuals, \$5500. T Sherry, 415-969-3030.

Revox A-77, 7.5/3.75 ips, 10-1/2" reels, workhorse, gd cond; also, AKAL 4-chnl, 10-1/2" reels, 7.5/3.75 ips, gd cond; \$650/both. J Deering, 615-264-2886 after 7 PM EST.

Otari MX5050 QXD 4-trk, mint cond, heads perfect, w/dbx NR (sep unit), \$1800. B Hanson, Reeltrax, 209 E El Cortez, Columbia MO 65203. 314-449-2433.

Ampex ATR-102 1/4", metal heads, 2 speed, gd cond, \$2400. M Linett, Yr Place or Mine, 1600 Las Flores Dr, Glendale CA 91207. 818-244-1909.

Tascam 48 8-trk w/2) dbx DX-40 NR, excel cond, \$6000. J Maples, WMYU 102, 8419 Kingston Pike, Knoxville TN 37919. 615-693-1020.

MCJ JH-110B 2-trk in Rustang roll-around cabinet, gd cond, \$1500/BO; Sony APR-5000 2-trk on roll-around stand, SMPTE ready, vgc, 2 yrs old, \$3000/BO. T Price, DOCSI Corp, 1140 N LaBrea, Los Angeles CA 90038. 213-462-4966.

Concertone reel hold-downs, pair, excel cond, \$15+shipping. D Dintenfass, Transcription Specialist, 7549-27th Ave NW, Seattle WA 98117. 206-784-4803.

Ampex 3200 serfes R-R duplicator, (3) slaves, brand new cond, BO; Scully 280 8-trk rcrdr, working cond, BO. JaneDan, WBSR, POB 8057, Pensacola FL 32505. 904-438-4982.

Technics RS-1500 2-trk, vgc, \$700. B Watson, KSAK, 714-946-6249.

Nagra 111, NR, NPO, PHO recorder w/carry case in gd cond, \$750 ea. Call Mike Murphy, 619-561-2726 or FAX 619-390-8611.

Want to Buy

Webcor 80 wire rcrdr; Magnecord FT-6 thru PT-63AX; Brush BK-401 Soundmirror rcrdr; Ampex 200 & 300; any Fairchild tape rcrdr. D Igo, KMMX/KCHL, POB 1067, San Antonio TX 78294. 512-359-3167.

MCJ/Ampex 1/2" 4-trk rcrdr, vgc; also, remote PK & dbx; other 4-trks considered. M Carta, KM Prod, Austin TX. 512-218-1610.

Ampex MR-70, gd cond. D deForrest, 7441 Wayne Ave #10-D, Miami Beach FL 33141. 305-866-5401.

Revox B-77, must be 1/2-trk. R Deen, Deen Adv, POB 508, Adel GA 31620.

Ampex AG355/440 P only electronics, stereo/mono, prefer w/optional VU meters. D Dintenfass, Transcription Specialist, 7549-27th Ave NW, Seattle WA 98117. 206-784-4803.

Ampex 601/602 mono FT or 1/2-trk, up to \$75. E Lightman, WEDL, 550 Merchant St, Ambridge PA 15003.

Technics RS-1500, RS-1520, Otari 5050 2 trk only in good condition. J Garvey, 203-744-2476.

MCJ/Sony capstan & reel motors, any cond., rec'd heads, most mfgs, machines, new, used. Relapped then sold. Amp Services, 224 Datura St No 614, W Palm Beach FL 33401. 800-826-0601, in FL 305-659-4805.

Ampex ATR100 taperecorders for parts. Circuit cards, heads, motors, machine parts, or electronic parts. Call 818-907-5161.

Scully '100' recorders, record/play amplifiers, 8, 16, 24 track heads. Sequoia Electronics, 1131 Virginia Ave, Campbell CA 95008. 408-866-8434.

CD's

Want to Sell

Denon 950FA CD cartridge player, working when removed, \$700/BO. R Rogers, KSKG-FM, 1217 S Santa Fe, Salina KS 67401. 913-825-4631.

Technics SL1200 (2), wall orig hardware, manuals & packaging, excel cond, \$1500/both. J Deering, 615-264-2886 after 7 PM EST.

Want to Buy

Radio programs/segments or other misc type material produced on CD format, for brdcast collection. R Strawn, 1900 SW 1st, Fruitland ID 83619. 208-452-3149.

COMPUTERS

Want to Sell

TI Silent 700 electronic data terminal, \$50. Bud, TV-40, 4237 Airline, Norton Shores MI 49442. 616-733-4040.

Wang CPU, (2) terminals, modem, etc, ran Computer Concepts Business System. BO. A McCarthy, KUIIC, 600 E Main, Vacaville CA 95688. 707-446-0200.

Tandy 1000 EX computer & CGA mon, 5-1/4" drive, 258K memory, joystick, new cond, have software to share, \$500. Tim, 315-488-1269/315-673-1624.

Digital Voice Mail software, use for sales communication, station comment line & much more, barter basis. 800-275-7997 X3000.

CONSOLES

Want to Sell

Ramsa WR-8210 10x4 mixing console, 3 band EQ/chnl, effects, sub-mix, solo XLR mic ins, RCA line I/O, like new, \$950/BO; Arrakis mic preamp mixer, (5) I/O, will mix inputs to singl output, requires ±15 VDC, \$75/BO. M Friend, WTJU, Box 711 Newcomb Hall, Charlottesville VA 22904. 804-924-0885.

Shure M67 mixer (2), vgc, rack mount, \$100 ea; (2) Shure M610-2E feedback controller, vgc, rack mount, \$100 ea. D Lundy, POB 408, Heidrick KY 40849. 606-546-6650.

Wheatstone 3224: 32-chnl mainframe, 24 chnlis installed, many spares & xtras, 2.5 yrs old, \$4000. Falk Rcrdrng Studio, 502-239-1044.

Radio Systems S-18, mint cond, very little use, extras w/unit, must sell asap, \$5500/BO. E DeLaHunt, KPRM, POB 49, Park Rapids MN 56470. 218-732-3306.

McCurdy SS8500 custom 10 mixer/dual stereo brdcast console, excel cond, \$4250. D Vernier, KUNI, Univ N IA, Cedar Falls IA 50614. 319-273-6400.

LPB M-8S-03, '85; Shure M63 mixer; Shure M64A stereo mixer; Shure M675 prod mixer; call for info & pricing. M Cooney, Radio 1, 610 N Kiwanis, Sioux Falls SD 57104. 605-336-2706.

McMartin B-501 5-chnl mono mixer, gd cond, \$325. G Wachter, KFYY, 631 N 1st Ave, Phoenix AZ 85003. 602-258-6161.

McCurdy 10-chnl stereo console in desk w/all wiring & termination, BO; McCurdy 6-chnl mono console, BO; CCA Elec Ultimate 10-chnl stereo console, BO; RCA BC-14B 4-chnl stereo mixer, not working, BO. J Socolof, KUII, Dallas. 214-526-2580.

BE 4 pot mixer, \$650/BO. J Phillips, WZOM-FM, 408 Clinton, Defiance OH 43512. 419-784-1059.

Gates 10 pot board, completely rebuilt, also gd for parts, BO. L Popp, 814-467-7894.

Howe Prod 12-chnl stereo console, needs 2 input modules to make almost new, VCA control for cin & noiseless audio, vry reliable, excel cond, \$1500. Tim, 315-488-1269/315-873-1624.

Audio Technica AT4462 stereo field prod mixer, vgc, w/manual, \$600. C Crouse, Beech Tree Brdcastng, 48 Cedar St, Dedham MA 02026. 617-461-2699.

Pacific Records BMX 22, 12 yrs old in gd cond, will incl furniture, \$4800+shipping. K Rider, Unistar Radio Network, 1675 Broadway, NY NY 10019. 212-373-4947.

McMartin B-501, needs work, \$150. E Histed, WWCC/WDNH, POB 1104, Honesdale PA 18431. 717-253-1616.

Quantum Lab QM12-B 12 chnl, stereo mon, 8-chnl tape returns, talk back w/mic, excel cond, \$2000. R Glenn, WJGR, 1718 Shanadoh, Wimauma FL 33598. 813/634-1940.

Cetec 2000 8-chnl stereo, wrking cond, grt for parts, BO. B Sommer, KTEQ, 501 E St Joe, Rapid City SD 57701. 605-394-2231.

Collins 212 F1 console, mint cond, w/manual, \$350; Collins stand alone TT remote system w/PA amp, \$350; Harris circa '75 10-input stereo console w/program, audition & mono busses, full monitoring & manual, cin board, \$600. S Sands/S Ludwig, 815-459-7000.

Bi-Amp 1229 Mixing Console, ASI power amp, Akai GX77 R-R plus much, much more. Call for details. Jack 505-392-1220.

Want to Buy

Sunn mixing board, 8-chnl. S Russell, 60410 Klett Dr, Decatur MI 49045. 616-782-9258.

Collins 212B; Altech 230B. R Osborne, WMOU, POB 667, Ravenswood WV 26164. 304-273-2544.

Pacific Records BMX series mic modules, need (2) in wrking order. B Larson, WUSN, 875 N Michigan Ave, Chicago IL 60611. 312-649-0099.

Tascam/Teac/Yamaha 8-12 chnl stereo console. T Crockett, Hot Tracks, Box 10501, Blacksburg VA 24060. 703-953-0222.

Howe 10,000 parts, any/all, please no 10K series. A McCarthy, KUIIC, 600 E Main, Vacaville CA 95688. 707-446-0200.

Gatesway-II spare modules. Bob, 303-330-1342.

On-air stereo console, 5-10 chnl. HV Madera, WNZN, Carr Vieja del Vigia #83, Ponce PR 00731. FAX 809-840-1588.

Gates Studioette 4-chnl mixer, '61 model, up to \$100. E Lightman, WEDL, 550 Merchant St, Ambridge PA 15003.

Langevin AMA4 w/documents. J Gangwer, 942 32nd St, Richmond CA 94804. 415-644-2363.

DISCO & SOUND EQUIPMENT

Want to Sell

Altec N501-8A 2-way crossover networks, new in orig box, never used, \$60/pair. S Lawson, KAK Prod, 928 Hyland Dr, Santa Rosa CA 95404. 528-4055.

SAE 5000 impulse NR, removes clicks & pops, \$125; JBL 4312-A 12" 3-way studio mns, 035T.1 tweeter, 3 yrs old, grt cond, \$500/BO. R Glenn, WTGR, 1718 Shandoha, Wimauma FL 33598. 813-634-1940.

UREI 529 EQ (2), excel cond, BO. F Virtue, Virtue Studios, 8809-11 Rising Sun Ave, Philadelphia PA 19115. 215-763-2825.

Kerwood system: integrated amp, 90 W RMS/chnl, tuner, tape deck, TT, spkrs, rack, shipping extra, \$300. M Starin, WGTQ TV60, 457 Varney St, Manchester NH 03102. 603-625-1165.

UREI 527A 1/3 octave graphic EQ (2), excel cond, \$250 ea; Eventide H949 Harmonizer, works perfectly, \$1200. G Guarino, Sorcerer Sound, 19 Mercer St, NY NY 10013. 212-925-1365.

Aphex Type C aural exciter, \$75. Falk Rcrdrng Studio, 502-239-1044.

Audio Arts Eng 4200 parametric EQ/preamp, like new, \$225+shipping. C Wagoner, Vision West, 12410 12th Ave S, Seattle WA 98168. 206-242-2042.

JBL 4320R control monitor (2), w/JBL 2235 15" woofer, JBL 15" passive radiator, JBL 2426 1" driver, L91 horn & lens, (2) 2405 slot tweeters, \$1250/pair; also, Ashley XR 2000 24 dB/octave stereo 3-way crossover, \$400. Mark/Jerry, Ligosa Sound Studios, 700 W Pete Rose Way 5th Fl, Cincinnati OH 45203. 513-621-5111.

Want to Buy

SAE 2800 EQ, vgc. R Glenn, WTGR, 1718 Shandoha, Wimauma FL 33598. 813-634-1940.

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Orban 8000A, excel cond, \$1300. Ron, WAWZ FM, Weston Canal Rd, Zarephath NJ 08890. 908-469-0991.

Texar Audio Prism (2), for stereo use, (2) RCF-1 cards, brand new, never used, \$1500/BO. L Marino, 714-889-2651.

Orban 9000-A Optimod, AM stereo compatible. D Lang, 503-774-0459.

dbx 166 dual gated compressor/limiter, like new, \$500. B Dierking, KNDY AM/FM, RR3, Marysville KS 66508. 913-562-2361.

Valley People 610 limiter/expander, call for info & pricing. M Cooney, Radio 1, 610 N Kiwanis, Sioux Falls SD 57104. 605-336-2706.

Optimod 8000A

\$1495 & UP
414-482-2638

Gates Solid Statesman, gd cond but AGC needs new pwr xformer, \$45. M Knight, 339 New Kent Rd, Blacksburg VA 24060. 703-552-5809.

Optimod 8000, clean, J Phillips, WZOM-FM, 408 1/2 Clinton St, Defiance OH 43512. 419-784-1059.

CRL SEP400B, lw hrs, clean, excel cond, w/manual, \$350. P Hess, 134 Derwent Dr, Pittsburgh PA 15237. 412-366-1249.

Orban 111B, \$400; ATI Emph-A-Sizer, \$700; you pay shipping. D Seavy, KROC, 122 SW 4th St, Rochester MN 55902. 507-286-1010.

Optimod 8100A, excel cond, \$2950. E Histed, WWCC/WDNH, POB 1104, Honesdale PA 18431. 717-253-1616.

Inovonics 201 (2), peak & rms, \$500 ea. M Linnett, Yr Place or Mine, 1600 Las Flores, Glendale CA 91207. 818-244-1909.

Optimod 8000A, \$1800; Optimod 8100A, \$2950; UREI 1176LN, black lace, \$500 ea/(2) for \$900; all perfect cond. B Watson, KSAK, 714-946-6249.

Harris MSP 90 (2), w/stereo AGC & limiting modules, \$125 ea. D Greer, WDDZ/WPFD, 1830 Genesee Towers, Flint MI 48504. 313-238-7300.

ADR stereo limiter, gd cond, \$525; Inovonics 201, \$500 ea; API 525, \$375. M Linnett, Yr Place or Mine, 1600 Las Flores Dr, Glendale CA 91207. 818-244-1909.

Optimod 8000A, mint, \$1500/BO. J Phillips, WZOM-FM, 408 Clinton, Defiance OH 43512. 419-784-1059.

Want to Buy

Gregg Labs 2530 tri-band compressor/limiter, check your junk rooms. J Mauk, KMJK/SKS, 1110 E Olive Ave, Fresno CA 93744. 209-266-5800.

Gregg Labs 2530 tri-band compressor/limiter, made in mid-late '70s. J Mauk, KMJK/SKS, POB 70002, Fresno CA 93744. 209-266-5800.

Optimod 8000A, will pay cash, leave message at 703-276-0125.

Optimod 8000A. A Patrick, 405-536-2242.

MICROPHONES

Want to Sell

Electro Voice 666 (2), gd cond, \$40 ea. T Rose, Joiner-Rose Group, 4125 Centurion, Dallas TX 75244. 214-392-7800.

Neumann U-67, excel cond, pwr supply, \$3000; Sony C-35P, excel cond, pwr supply, like new, \$325. F Virtue, Virtue Rcrdrng, 8809-11 Rising Sun Ave, Philadelphia PA 19115. 215-763-2825.

Electro Voice RE-20, gd cond, no stand adaptor, \$175. T Crockett, Hot Tracks, Box 10501, Blacksburg VA 24060. 703-953-0222.

Neumann U-67, excel cond, BO. S Winthrop, Winthrop Prod, 156 W 94th St, NY NY 10025. 212-662-8685.

RCA classic ribbon mics, others, send for list. B Davies, Virgo Prod, 5548 Elmer Ave, N Hollywood CA 91601. 818-761-9831.

EV 635A dynamic mic, fair cond, \$40/BO. M Saady, 1st City Rec, 141-60 84 Rd 3E, Briarwood NY 11435. 718-846-2062.

Sennheiser MD214 lav mic, \$35; Shure 2-way hand mics; call for details. E Davison, 135 N Illinois, Springfield IL 62702. 217-787-0800.

Sennheiser MD-421V w/suspension mount, gd cond, \$225+shipping. R Kerbany, WTNJ, 609 Main, Mt Hope WV 25880.

Neumann U-67, excel cond, pwr supply, \$3000; EV 644 shotgun mic, excel cond, BO. F Virtue, Virtue Rcrdrng, 1618 N Broad St, Philadelphia PA 19121. 215-763-2825.

Shure SM58 dynamic cardioid (4), like new, \$80 ea. N Hammond, PAS, 320 Ethan Allen Ave, Takoma Park MD 20912. 301-891-3567.

Turner S33D chrome dynamic wbase, BO. K Patten, 818-287-7424.

EV 644 Sound Spot, gd cond; vintage RCA, '40s, gd cond. D Morris, WKUN, 204 W Spring St, Monroe GA 30655. 404-267-6558/404-267-2035.

Presto 45 rpm adapter sleeve for 6N disc cutter, new; manuals: Sencore tube conductance analyzer, Sams transistor sub book #8 & #6, RCA tube manual. Mr. Oliver, 2

MONITORS

Want to Sell

Potomac Instruments AM-19 antenna mon. 2 tower, 2 ref, gd cond, \$1000. T Gaiser, KUZZ-FM/KCWR, 3223 Sillect Ave, Bakersfield CA 93308. 805-326-1011.

Want to Buy

Belar FMM-1 & FMS-1 FM mod mon; EBS system; In-line 1-5/8" power meter. HV Madera, WNZN, Carr Vieja del Vigia #83, Ponce PR 00731. FAX 809-840-1588.

Any older McMarrin mod monitors. C Goodrich, 11435 Manderson, Omaha NE 68164. 402-493-1886.

MOVIE PROD EQUIP

Want to Sell

B&H 16mm 202 opt/mag proj, w/sync motor for interlock, M-H 816 hot splicer, Beaulieu R16E camera w/ang 12-120 zoom lens, Holly-wood rebinds, sound readers, split & solid reels, send for more info. B Howard, Academy Film Prod, 3918 W Estes, Lincolnwood IL 60645. 708-674-2122.

Bolex H16 (2), w/400' mag, drive & mag motors, battery packs, 17-85 mm zoom w/r angle VF, voltage regulators, BO. K West, SRSU, Dept Fine Arts/Comm, Alpine TX 79832. 915-837-8219.

Arriflex 16S w/ang motorized zoom, (3) prime lenses, (3) 400' mag w/torq motor, matte box, assorted drive motors, fitted case, \$2200. J Gagliardi, 20 Country Rd, Holliston MA 01746. 617-432-1752/508-429-7846.

RECEIVERS & TRANSCEIVERS

Want to Sell

AM EBS rcvr on 1430 kHz, call for info & pricing. M Cooney, Radio 1, 610 N Kiwanis, Sioux Falls SD 57104. 805-336-2706.

GE Executive (2), w/cables & control heads, (1) lw band, (1) high band, mics incl, \$100. M Storin, WGOT-TV 60, 457 Varney St, Manchester NH 03102. 603-625-1165.

AM STEREO RECEIVERS
Portable, Home/Studio, Auto
RRADCO GROUP
708-513-1386

Elenco LR 2-30 MHz linear amp for 2-way radio communication, 100-300 W, \$50; Hickock 610 TV signal gen, works 0-250 MHz plus markers & sweep, \$30. J Cunningham, KHKC, Rt 2 Box 113B, Stonewall OK 74871. 265-4496.

Kahn Power Side AM stereo system w/signal processing, new, never used, \$7500. J Socolof, KUIL, Dallas. 214-526-2580.

Want to Buy

Zenith Stratosphere AM/SW radio, '36; also, EH Scott/McMurdo silver rcvrs; can pick up. D Hauff, Box 16351, Minneapolis MN 55416.

Motorola HT90/440 dead VHF/UHF rigs, need 2-3. A McCarthy, KUIIC, 600 E Main, Vacaville CA 95688. 707-446-0200.

Three hand helds, (1) base, any freq/make/model, offering \$400. B Freeman, 526 Penn Ave, Pittsburgh PA 15222. 412-263-6800.

Marti equip, used, gd cond. Bob, 303-330-1342.

REMOTE & MICROWAVE EQUIP

Want to Sell

Mark STL dish, 5', \$450+shipping. D Donovan, KCGR, 1620 American Bank Plaza, Corpus Christi TX 78475. 512-888-8555.

Moseley TRC-15AW remote, excel cond, w/manual, \$750/BO. T Bryan, KARO, 503 Old 63 N, Columbia MO 65201. 314-442-3116.

Moseley PCL-SCG-6 135 kHz subcarrier gen; SCD-2 135 kHz subcarrier rcvr; \$250 ea. Ron, WAWZ FM, Weston Canal Rd, Zarephath NJ 08890. 908-469-0991.

Marti R10/STL10 monaural STL system, recently aligned & tuned on 950 MHz, \$2950. A Thompson, KXDD/KUTI, 706 Butterfield, Yakima WA 98901. 509-248-2900.

Stromberg Carlson PABX dial phone system w/(5) 6-line phones, complete, \$1000; (50) GTF LC-4003 phone line cards, wrking, \$10 ea. Bud, TV-40, 4237 Airline, Norton Shores MI 49442. 616-733-4040.

Harris satellite dish, 3 meter delta gain white, solid, durable, set on concrete slab, \$900. 816-359-2261.

Moseley PBR-15AW wire line remote; Micro-Controls RCR-9 & RCT-9; call for info & pricing. M Cooney, Radio 1, 610 N Kiwanis, Sioux Falls SD 57104. 805-336-2706.

Moseley TRC15AR 15-chnl remote, '82, recently aligned by mfr, \$500. K Austin, Austin Brdctng, 1101 Hwy 81 N, Marlow OK 73055. 405-658-9292.

Marti RMC-2AX, gd cond w/manuals, \$400. J Bolton, KKRP, POB 454, Rayville LA 71269. 318-878-9469.

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Silver Lake Audio
(516) 623-6114

Ma-Com MA23CC 23 GHz microwave system w/xmtr, rcvr & antennas, \$4000 complete. C Haynes, WJMI/WOAO, 1850 Lynch St, Jackson MS 39203. 601-948-1515.

Moseley PBR-30 chnl remote system, 110 kHz control, subaudible metering units, needs work, \$350; Potomac extension analog metering panel for AM-19, \$150; Moseley 92 kHz sub-carrier I/O cards for MRC-1600, may be moved to other freq, \$150/ea; Moseley PCL-404 mono STL system, 948.0 MHz, \$450. J Goode, WCIT/WLSR, 419-228-9248.

Marti M-25C/MR-30/150-170 base station. D Morris, WKUN, 204 W Spring St, Monroe LA 70655. 404-267-6558/404-267-2035.

Ampex 351 series remote control, \$50. D Bailey, Rockshoppe Prod, 3422 Beech St, Rowlett TX 75088. 214-475-9796.

Mark 5' STL dish (2), \$900+shipping. D Donovan, KCGR-FM, 1620 American Bank, Corpus Christi TX. 512-888-8555.

Chevy van, '72, complete remote studio, 29,000 miles, all aluminum body, \$8000. R Owen, KJOJ-AM, POB 2368, Conroe TX 77305. 409-756-5501.

Moseley TRC-15 studio/xmtr units w/manuals, Telco operation, grt cond, wrking, in-service now, \$400. J Salov, WHGR/WUPS, 517-740-1165.

Marti RPT-30W450, complete system w/antenna & 175' coax, used 3 times, dual freq, B Carr, WRED, POB 6, Perrysburg OH 43552. 419-837-9696.

TFT digital remote, vgc, \$1500. E Histed, WWCC/WDNH, POB 1104, Honesdale PA 18431. 717-253-1616.

Marti STL 10 monaural on 950 MHz, \$2950. A Thompson, DUTI/KXDD, 706 Butterfield, Yakima WA 98901. 509-248-2900.

Moseley MIU-2, \$250; Moseley SCD-8, \$150; Mod Science CP803, \$300; you pay shipping. D Seavy, KRDC, 122 SW 4th St, Rochester MN 55902. 507-286-1010.

Want to Buy

Gates RDC10 studio & xmtr units, must be in gd wrking order. A Callisti, WBCW, Jeannotte PA 15644. 412-527-5656.

Moseley PCL505C, Marti or TFT 950 MHz STL equip for export, priced right. K Austin, Austin Brdctng, 1101 Hwy 81 N, Marlow OK 73055. 405-658-9292.

Scale MF-960 Miniflector for 950 MHz, reasonable. T English, WEZN, 10 Middle St, Bridgeport CT 06604. 203-366-9321.

SCA generator, 92 kHz/convertible, prefer CRL, Moseley & Sidekick. G Hilliard, 503/226-9791.

Comrex telephone freq xtender, sngl line. L Houck, 512-736-5483.

Composite STL system, late model, pay top dollar. A Patrick, 405-536-2242.

SATELLITE EQUIPMENT

Want to Sell

Dart 384 w/15 kHz, +75 KHz, voice cue card, complete. D Lang, 503-774-0459.

Wegener 1602 & 1601 mainframe w/cards for Unistar country format system, 18 mnths old, like new, \$2800. K Austin, Austin Brdctng, 1101 Hwy 81 N, Marlow OK 73055. 405-658-9292.

Adcomm 7550 satellite rcvr for Unistar ACII & CNN, 2 yrs old, \$3500. B Hearst, WWCH, 725 Wood St, Clarion PA 16214. 814-226-8600.

S/A DAT 15 kHz demod (3), \$400 ea; S/A DAT 75 kHz demod, \$400; you pay shipping. D Seavy, KRDC, 122 SW 4th St, Rochester MN 55902. 507-286-1010.

Equatorial dish/LNB w/radome, receiver/controler & printer, used to receive UPI newswire, BO. G Peterson, KIMM, POB 8205, Rapid City SD 57709. 605-348-1100.

Scientific Atlanta 6600/6601 SSCP rcvr, \$750; SMN Superswitch for unattended satellite operation, \$300. S Sands/S Ludwig, 815-459-7000.

Wegener 1602 series satellite receiver tuned to Unistar AM only format, wall cards & books, excel cond, \$3500. Ray, WDKY, 803-775-2321.

DX Comm DSA-604-1 C & Ku Band satellite rcvrs (5 ea); (3 ea) LNB, pwr dividers, block-down converter; some new cond, some gd cond, w/books, commercial grade quality, \$600 all/BO; Harris 6528 C Band satellite rcvr w/LNA, feed & polar rotor, gd cond, brdct quality, w/book, \$300/BO. S Urbani, Video-Line, 1641 Garden St, San Luis Obispo CA 93401. 805-544-6280.

Want to Buy

Fairchild Dart 384 or Scientific Atlanta equiv rcvr w/15 kHz & SEDAT 21 kHz cards. B Brown, WEQX, Box 102.7, Manchester VT 05254. 802-362-4800.

Scientific Atlanta 6600 satellite rcvr. J Wagner, WMBI AM/FM, 820 N LaSalle Dr, Chicago IL 60610. 312-329-4279.

Harris 6550 receiver for sports & other. Bob, 303-330-1342.

SOFTWARE

Want to Sell

WireReady™ Wire Management Software. . . . Only WireReady™ has the name, the toll-free support and and hundreds of happy users. See us monthly in RW's Product Showcase. WireReady Newswire Systems Inc. 800-833-4459.

FOR SALE: Ron Balonis' Broadcast Engineer's Computer Toolbox for IBM compatible computers. Send \$25.00 for a copy (5-1/4 or 3-1/2 disk), or name and address for details to COMPUTER TOOLBOX, Ronald F. Balonis, 118 Rice Street, Trucksville PA 18708-1628.

STATIONS

Want to Sell

Broadcast facility, complete, set up for talk, news & music, all late/high quality equip, 14'x30' 2-axle mobile studio, less than 5 yrs old, w/air conditioning & restroom. D Lang, 503-774-0459.

AM & FM in stable TX market, owner financing possible, grt opportunity for owner operation, real estate & home incl. 216-331-8012 or 305-296-7575.

1 kW Daytime serving Savannah, Hilton Head market. Have been owner/operator since 1968. Complete facility, antenna on 3.5 acres of prime commercial property. Health/age says sell! NO COLLECT CALLS. Call 912-964-8124 or 912-354-4601.

Non DA daytime, DA night, 50 kW, low dial position, clear chnl, unlimited time, AM in capital city; also, 3 kW FM, can upgrade to 625/50 kW, owner financing. Glenn 501-470-1525.

SCA avail on new 30 kW FM in NE IA, serves NE IA, SE MN & SW WI. D Voss, KRDI, Decorah IA 52101. 319-382-4251.

North Georgia full time AM, upscale resort area, ideal for owner/operator. \$95,000. The Jesse Neal Browder Co., Inc., Rt 2 Box 2197, Lexington GA 30648 or 404-743-8661.

New 50K FM in Southern Missouri Lakes area.
417-273-4308
(evenings & weekends)

Georgia UHF TV, good cash flow, some owner financing. Ready for the Olympics. \$2,500,000. The Jesse Neal Browder Co., Inc., Rt 2, Box 2197, Lexington GA 30648 or 404-928-7906.

Want to Buy

Seeking troubled/dark stations for no money down/debt assumption, all stations/areas considered. J Ballard, POB 1786, Apple Valley CA 92307. 619-261-7787.

Broadcaster w/10 yrs+ seeking to buy AM or FM station in Richmond VA area. Looking for no money down, owner financing. H. Pollard, New Visions Broadcasting, POB 13081, Richmond VA 23225. 804-748-2399.

STEREO GENERATORS

Want to Sell

Moseley SCG-4T 67 kHz subcarrier gen; McMarrin BFM-2001 67 kHz subcarrier gen; Johnson Elec 1C-1 67 kHz tuner; Belar SCM-1 SCA mon. BO. Ron, WAWZ FM, Weston Canal Rd, Zarephath NJ 08890. 908-469-0991.

Motorola C-Quam stereo gen mon & CRL 950 SMP stereo processor, \$6000/BO. B Shannon, WYWR, 401 N Blaine, Youngstown OH 44505. 216-746-1330.

Want to Buy

C-Quam generator & monitor. D Sawyer, 303451-6700.

Optimod 8000A, will pay cash, leave message at 703-276-0125.

TAPES/CARTS & REELS

Want to Sell

Transcription file cabinets (6); (450) standard transcriptions; (170) world transcriptions; (30) various holiday prog transcriptions; BO. B Beattie, 6200 16th St N, St Petersburg FL 33702. 813-526-4275.

Audiopak AA4 & AA3 (1000), 2.0-3.5 min carts, clean, unused rebuilds, loaded w/new tape, gd cond, \$3.50/100, free shipping; (900) Audiopak AA4 & AA3, various lengths w/diff programs, used, gd cond, \$1/100; (20) blank 10" reel tapes, new, in boxes, \$10/reel. D Kincaid, 1445 Parran Rd, St Leonard MD 20685. 301-586-2177.

Adult contemporary library w/2200 songs on CD & cart, incl 93 Goldiscs & 230 misc CDs, add'l 170 songs dubbed on Scotchcart IIs, \$5500; country library w/1500 songs on 66 CD Goldiscs & 500 add'l Scotchcart IIs, \$4500; (380) 3.5 min Scotchcart IIs w/country songs, \$2 ea; all used 6 mnths. B Lord, Lord Brdctsg, 13313 SE 208th St, Kent WA 98042. 206-631-2374.

Contemporary Christian music record library & over 2500 top CCM songs on over 100 Ampex 456 tapes w/25 Hz tones recorded on fade of each song. D Schroeder, WSWL, 904-433-1141.

Fidelipac carts (700), various lengths, gd cond, \$1 ea/\$500 all; approx (400) gospel & country albums from '40s & '50s, all gd cond, BO. D Morris, WKUN, 204 W Spring St, Monroe LA 70655. 404-267-6558/404-267-2035.

EMPLOYMENT

To place ads in this section, use the ActionGram form. To respond to box numbers, write Radio World, PO Box 1214, Falls Church, VA 22041, Attn:_____

POSITIONS WANTED

Radio veteran, 20+ yrs, seeks mgt pos in sm/med SE mrkt, BS degree, exper GM, Ops Mgr, Bus Mgr, all on-air & sales. Bob, 803-536-1491.

Group Chief w/20 yrs+ exper seeks eng mngmt position. SBE Senior cert. FCC license. AM/FM dir exper, const maint FCC compliance. Send responses to: Radio World, POB 1214, Falls Church VA 22041. Box # 91-11-02/RW.

Engineer w/20+ yrs major mrkt exper in all phases of radio. Cecil, 214-544-3799.

Maint eng, CET, FCC gen w/radar, NABER, NARTE certified, CE college station, NBN chief eng & MDS exper, FT/PT, contract work. M Rakoff, 114-41 Queens Blvd #148, Forest Hills NY 11375.

CE w/big prod voice & over 15 yrs hands-on eng exper, seeks CE pos w/prod or air shift in competitive top 100 market. G Morgan, 704-563-8676.

Leading country music TV/radio personality has 50 TV/radio shows of national C&W celebs, looking for TV/radio shows/cable to air them. 908-271-8244.

General Manager, experienced all phases. Sales manager, salesman, trainer, 25 yrs in radio, prefer Florida or Georgia. Write to: Radio World, POB 1214, Falls Church VA 22041. Attn: Box #91-11-01RW.

Blues & jazz host/producer, in depth collection & knowledge, PT OK, San Francisco/North Bay area. S Lawson, 928 Hyland Dr, Santa Rosa CA 95404. 707-528-4055.

If PT eng is needed for older tube-type equip, have tubes & can travel in N New England. Mark, 603-625-1165.

Musical volunteer, college professor for 32 yrs w/15 yrs radio exper looking to help college/commercial station w/music & programming, no pay, Philadelphia/S NJ. 609-784-5782.

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World library 16" radio transcriptions from '43-45: 6079, 6089, 7049, 7059 & 8349, will pay \$50/disk, H Medina, 181 Thomas St, Brentwood NY 11717. 516-273-1832.

Old 45/78 records, prefer large station collections of 50s Rock, R&B, & Country. K Gutzka, Custom Recording, 7134 15th Ave S, Minneapolis MN 55423. 612-866-6183.

TAX DEDUCT EQUIP

Red Cross needs video & audio equip incl video switcher & recorder, will pay shipping & provide tax certificate, call w/avail equip. G Kirby, 614-261-8671.

HELP WANTED

Engineer Wanted
We need a device built capable of generating a "beep tone" every 5-minutes for our nationwide astrology lines. If you can make such a device call (401) 276-3034 or fax (401) 353-0501.

CHIEF ENGINEER
AM-FM combo in New Jersey is looking for roll-up-the-sleeves type. First Class SBE Cert. RF & studio design, engineering & maint. exp. EOE. Send resume & salary history to: Radio World, POB 1214, Falls Church VA 22041. Attn. Box 91-12-03RW.

Program consulting avail to stations, reasonable rates, all stations/areas considered, troubled stations a specialty. J Ballard, 619-261-7787.

Exper friendly adult communicator w/grt prod skills seeks stable opportunity, solid air work, team player, AC/oldies or country. Dave, 712-262-7954.

Can I do play by play? You bet. Sports P-P pos sought in Midwest. Tim, 402-475-3411.

Broadcast eng, young, energetic, resourceful, BSEE, exper in radio, TV, studio & film, FT/contract, will relocate. Todd, 1250 C St NE, Washington DC 20002. 202-547-7008.

EMPLOYMENT SECTION

HELP WANTED: Any company or station can run "Help Wanted" ads for \$1.50/word or buy a display box for \$55/column inch. Payment must accompany insert, use your MasterCard or VISA; there will be no invoicing. Blind box numbers will be provided at an extra charge of \$10. Responses will be forwarded to listee, unopened, upon receipt. Call 800-336-3045 for details.

POSITIONS WANTED: Any individual can run a "Position Wanted" ad, FREE of charge (25 words max), and it will appear in the following 3 issues of Radio World. Contact information will be provided, but if a box number is required, there is a \$10 fee which must be paid with the listing (there will be no invoicing). Responses will be forwarded to the listee, unopened.

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TAX DEDUCTIBLE EQUIP . . .

Educ station seeks tax deduc donation of any brdct equip, computers, carts, etc, will pay shipping. J Violanti, WSJR, 5600 City Ave, Philadelphia PA 19131-1395. 215-660-1082.

Student operated community NP radio station seeking prod & brdct equip of all kinds, tax deductible receipt given. L Copeland, Ivanhoe Civic League, POB 201, Ivanhoe VA 24350. 703-699-1383.

Culturally diverse community radio station needs xmtr & board, will also accept other equip incl cassette decks & CD players. B Rawlins, WAIF FM, 2525 Victory Pkwy, Cincinnati OH 45206. 513-241-4260 X225.

Religious group needs board & TTs to produce well-known Southern Gospel program for world-wide audience, donation is tax deductible, will pay shipping. Dr G Pettyjohn, 615-988-6328.

High school FM going FT, need 1-35 kW xmtr in wrkg cond, will pay shipping. S Harris, WSHR, 212 Smith Rd, Lake Ronkonkoma NY 11779. 516-467-0424 8:30A-1:15P EST.

Youth radio station in public housing seeking tax deductible donations of radio brdctng equip. FrankJuice, ARHA, Alexandria VA. 703-549-7115.

Educ radio/TV needs any equip, esp cart R/P & player, TT, stereo R-R for prod, all wrkg cond, will pay shipping. K West, SRSU, Dept Fine Arts/Comm, Alpine TX 79832. 915-837-8219.

Eng student desiring donation of old brdct equip (anything) in repairable cond, will pay all shipping charges, EE student at Purdue. C Gill, POB 371, Indianapolis IN 46206. 317-923-2800.

Monte Vista Christian School, would appreciate any donations of used TV broadcast equipment. T Quinn, 408-475-0423.

TEST EQUIPMENT

Want to Sell

Knight KG-635 oscilloscope, \$50. Bud, TV-40, 4237 Airline, Norton Shores MI 49442. 616-733-4040.

Leader LPM880 RF wattmeter, 3 scales: 0-5 W, 0-20 W, 0-120 W, \$150. S Lawson, KAK Prod, 928 Hyland Dr, Santa Rosa CA 95404. 528-4055.

HP 8690 B sweep gen mainframe, \$450; HP 8699B 100 MHz-4 GHz YIG tuned plug in, \$500; HP 8696A 19-26.5 GHz plug in, \$400. Gary/Mike, KFYI, Phoenix AZ. 602-258-6161.

Score FC71 freq counter, \$650; HP 239 oscillator, \$385; HP 331A distortion meter, \$500; HP 400E voltmeter, \$200. B McKenney, 501-967-5451.

Fidelipac 390 flutter meter; Heath IM-58 harmonic distortion meter; Heath IG-72 audio gen. P Wahl, WWIB/WOGQ, 5558 Hallie Rd, Chippewa Falls WI 54729. 715-723-1037.

Tektronix 1420 vectorscope, excel cond, \$1100; Tektronix 528A waveform mon, \$1100. G Guarino, Sorcerer Sound, 19 Mercer St, NY NY 10013. 212-925-1365.

Quest Electronics 215 sound level meter & CA-12 permissible sound calibrator, w/case, pristine cond, \$425+shipping. C Wagoner, Vision West, 12410 12th Ave S, Seattle WA 98168. 206-242-2042.

RCA WX2-E field intensity meter, excel cond, \$600; HP 330B audio distortion meter, gd cond, \$100; Heath distortion meter, \$50; General Radio 916A RF impedance bridge, gd cond, \$200. D Messing, KNCY AM/FM, 722 Central Ave #1, Nebraska City NE 68410. 402-873-3348.

Score DVM-32 multimeter, digital, like new cond; Leeds & Northrup resistance decade box, .01 ohm to 20 K ohms precision, 10 switches, \$75/BO. E Davison, 135 N Illinois, Springfield IL 62702. 217-787-0800.

HP 675-A sweep gen, 10 kHz-32 MHz, w/start-stop, MAN center freq sweep & CW, (5) freq markers, 80 dBm output, VAR sweep & width, \$150. J Gagliardi, 20 Country Rd, Holliston MA 01746. 617-432-1752/508-429-7846.

Proof of performance machines: oscillator wide range, distortion meter B&W, Gates Gainset M3625, vgc, BO. L Popp, 814-467-7894.

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Circle 3 On Reader Service Card

Score FC-71, never used, mint cond but battery pack dead, \$600. 303-744-2857.

B&B AM2B phascope, checks headroom, used 6 mnths, \$695. B Lord, Lord Brcstg, 13313 SE 208th St, Kent WA 98042. 206-631-2374.

Patchbays (4), 24 single inputs, also patch cords; Editorial splicing block, 1" tape, audio-head alignment tape for Ampex 7.5-15 ips, 14" tape. Mr. Oliver, 212-674-7660.

Potomac Instruments FIM-71 field intensity meter, \$4995 & Potomac Instruments FIM-41 field intensity meter, \$2595, both with oak carrying cases; Potomac Instruments SD-31/RX-31 synthesizer-receiver, \$2295; Delta OIB-3 RF bridge, \$2195, all in excellent condition. B Bingham, 518-798-4472.

Tektronix 520A NTSC Vectorscope in gd cond, \$1500. Call Mike Murphy, 619-561-2726.

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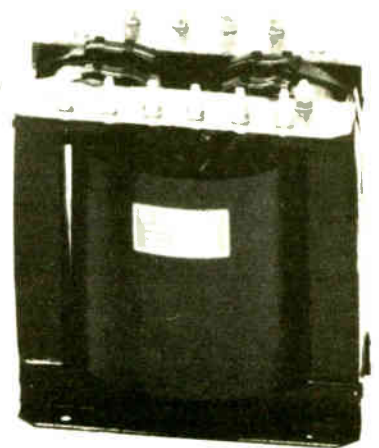
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