1991

Radio World

Vol 15, No 4 Section B | Radio's Best Read Newspaper | February 20, 1991

Hottest Stories for 1991

Complete Industry Sourcebook

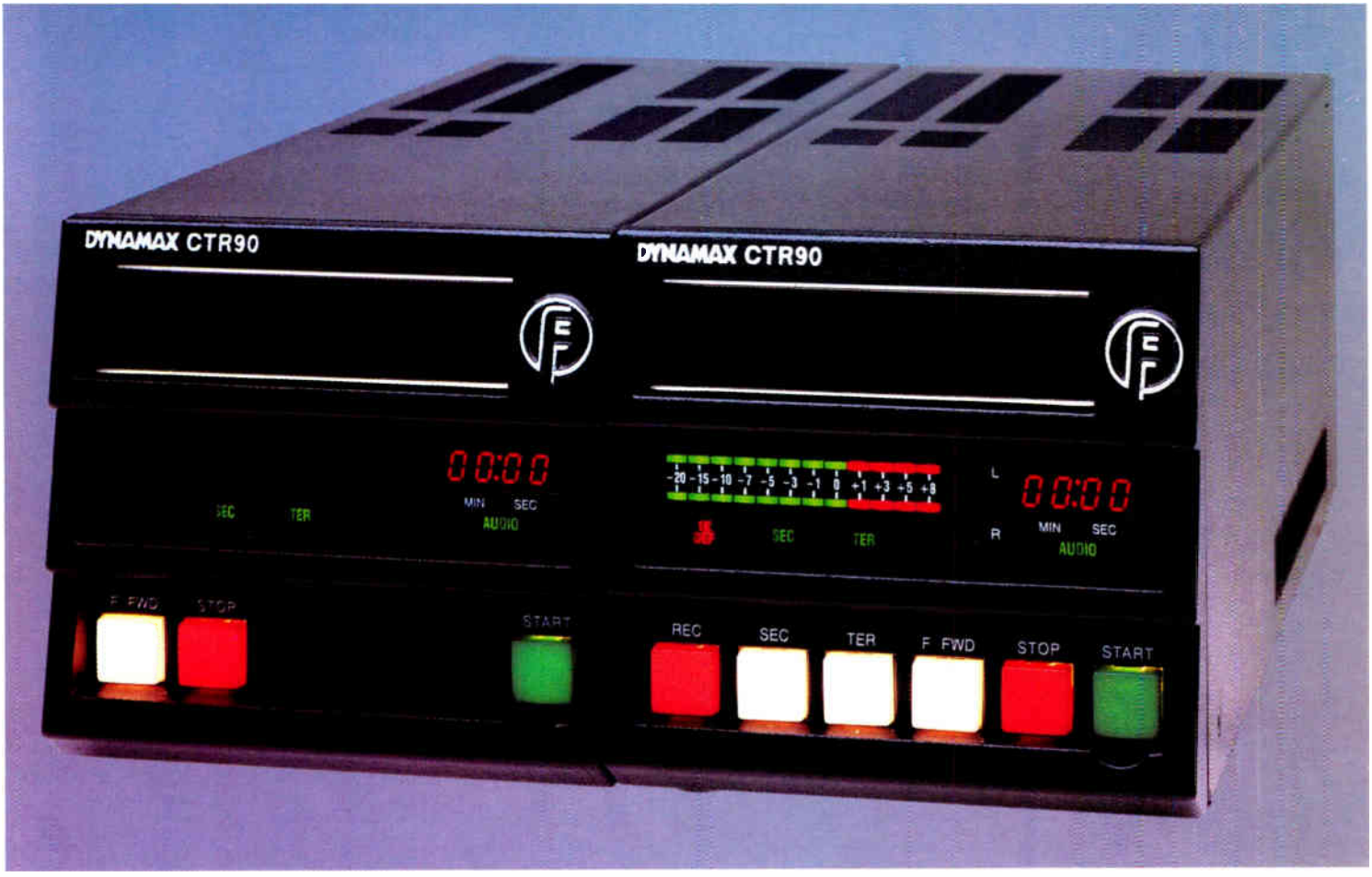
JG's Earwaves Predicts . . .

Bucking Murphy's Law

Special DAB Section: *What, Who & How*

Top RF & Audio Tips

Supplement to *Radio World* February 20, 1991



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RADIO WORLD 1991

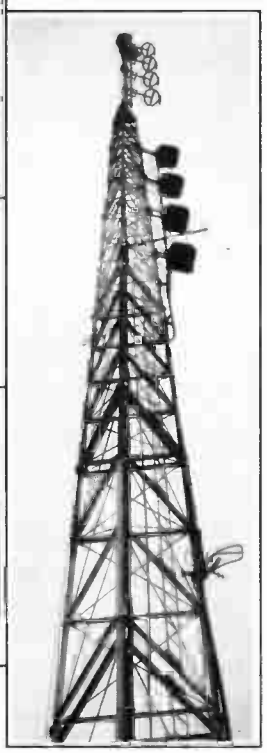
On the cover: *Wheatstone goes to Germany. See page 50.*

Radio World (ISSN: 0274-8541) is published semimonthly by Industrial Marketing Advisory Services, Inc., 5827 Columbia Pike, Falls Church, VA 22041. Phone: 703-998-7600, FAX: 703-998-2966. Second class postage rates are paid at Falls Church VA 22041 and additional mailing offices.

Postmaster: Send 3579 forms and address changes to Radio World, P.O. Box 1214, Falls Church, VA 22041.

FM stations are still seeking solutions to **multipath** and studies of the persistent problem (left) are still inconclusive. Other concerns plague FM as well. There is still confusion over **directional antennas for FM** and engineers will be keeping an eye on **tower radiation** (below, right) in the wake of ambiguous policy from the FCC. FM engineers are also interested in finding a digital system compatible with current spectrum.

Technical concerns will continue to be influenced by the state of the economy and the marketplace (above) in general. But there is reason for optimism as all signs point to a slowly rising trend toward mid-year.



While 1989-90 saw the opening of the Iron Curtain, 1991 is the year when a **greater exchange** of information flows from the west. The NAB has already played host to delegates from the Soviet Union (above right) at industry conventions.

Another sign that the US radio market is moving from a **national to a global** arena is evident in plans being formulated for the NAB's first radio-only convention in June, 1992 in **Montreux, Switzerland**. The announcement by NAB and Montreux city officials came at the NAB's Radio show in Boston (above) and meetings are ongoing to formulate the convention's agenda and establish international memebership policies for NAB.

Back at home, FM stations have another hurdle to struggle over, this one involving battles between the **FAA and the FCC**. Late in 1990 the FAA opened a rulemaking on restrictions for FM tower construction and even minor modifications (left). The NPRM from the FAA came about after a failure at compromise with broadcasters. Now FM stations are worried that **restrictive rules** will hamper a station's ability to find the best site for its tower. The crisis came to a head as 1991 drew to a close. If enough broadcast interests have made their fears known, the proposed ruling may be reworked.

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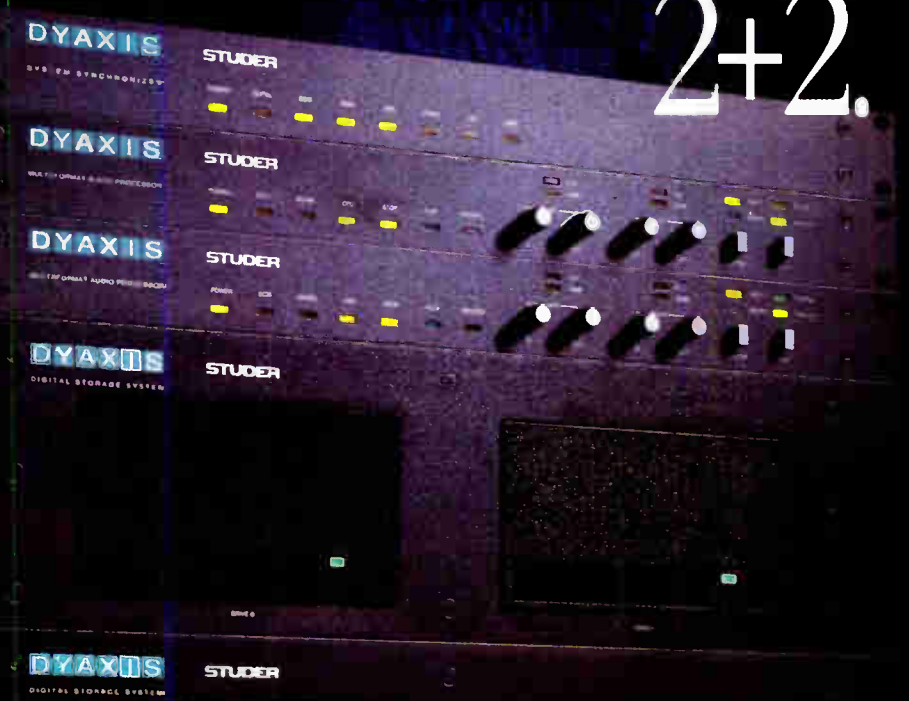

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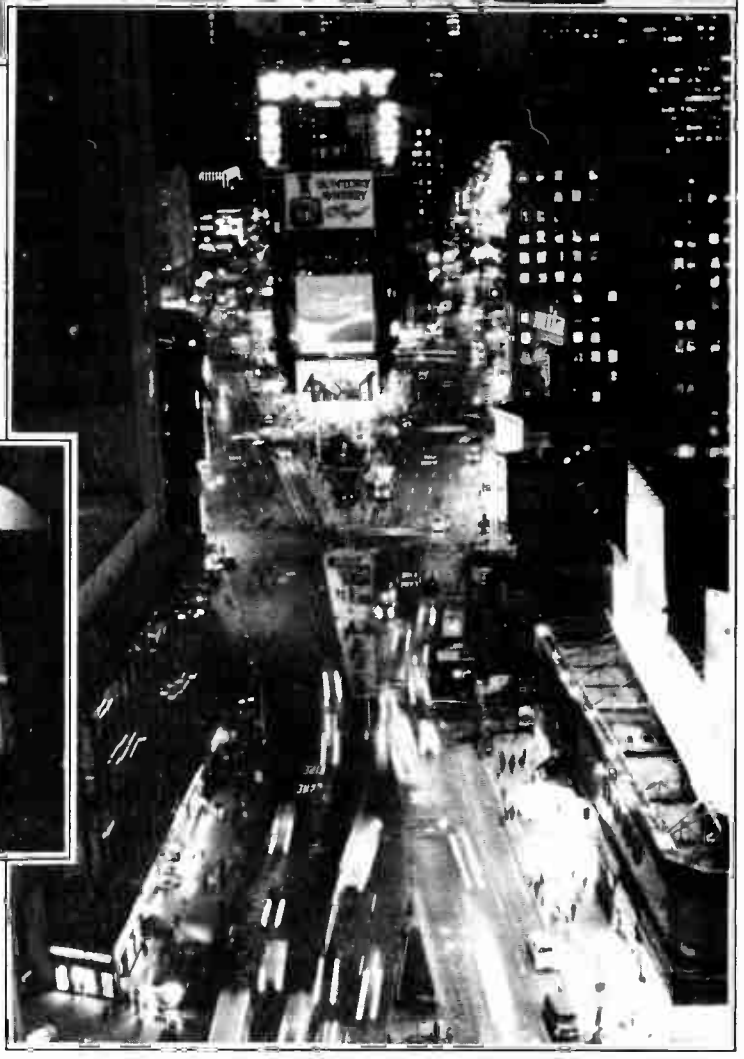
This year brings with it its usual quota of conventions. The big event, the **NAB's spring convention** (right) has already sold out its exhibit space. Some companies are faced with an overloaded convention schedule.

AES boasts two shows in two trend-setting cities. First, in February, the **European AES** moves back to Paris (left) for four chilly days in February.

Later in the year, in October, the **US AES** moves back to its East Coast venue in the Big Apple (right) where the show enjoys a robust attendance.

In between, in mid-September is the NAB's radio show, to be held this year in San Francisco (not shown).



The youngest of the trade shows is the **Society of Broadcast Engineers** national convention. This will be the show's fifth year, and the venue moves from a center-of-the-country site to Houston, Texas (above). Years when the SBE has been held in St. Louis have seen the best attendance, however.

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The NAB spring show moves back to Las Vegas. The familiar **Las Vegas** convention center is still undergoing renovation.

The **NAB 1991** show begins on April 15th and runs through the 18th, the first time it is being held exclusively on weekdays. The switch to weekdays came about after protests from Las Vegas casinos and hotels who do their best non-convention business on weekends. The **Engineering Conference**, however, will begin on Sunday, **April 14th**.

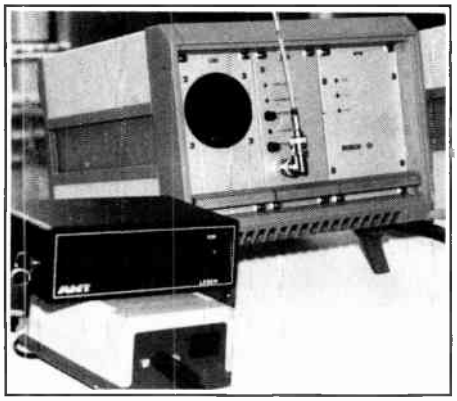
This year the show will focus heavily on new technologies such as **DAB**. An actual demonstration of the European Eureka 147 system, including mobile reception, is slated to show how the system performs terrestrially. It will be the first time the system is tested in this country.

Another new technology which will have a booth at the show is **RDS** (see next page).

Also on tap for the Las Vegas extravaganza is a repeat of last year's **HDTV expo**, while something new is slated for this year. **Japan's NHK** will bring its technology open house outside of its home country for the first time ever with a special exhibit at the show. Much of the new tech highlighted will be for TV, but expect some radio advances as well.

Some radio exhibitors and attendees complain because the spring show has become so much a television show. But the return to Las Vegas should bring enough of a crowd to please the booth-watchers.

The **Radio Data System**, RDS, was introduced at the NAB show last year (left) and is of interest on both the receiver and transmission end. For 1991, RDS, along with AM and the certification mark, FM and the **loudness wars** and the possibility of the **NAB super-tuner**, radio broadcasters find themselves looking to the receiver industry to help determine the success or failure of new ideas. This interdependence began when stations realized that decisions were being made without broadcaster input. The problem was brought home in the controversy over **AM stereo**, and efforts continue to keep a receiver manufacturer-broadcaster dialogue going.



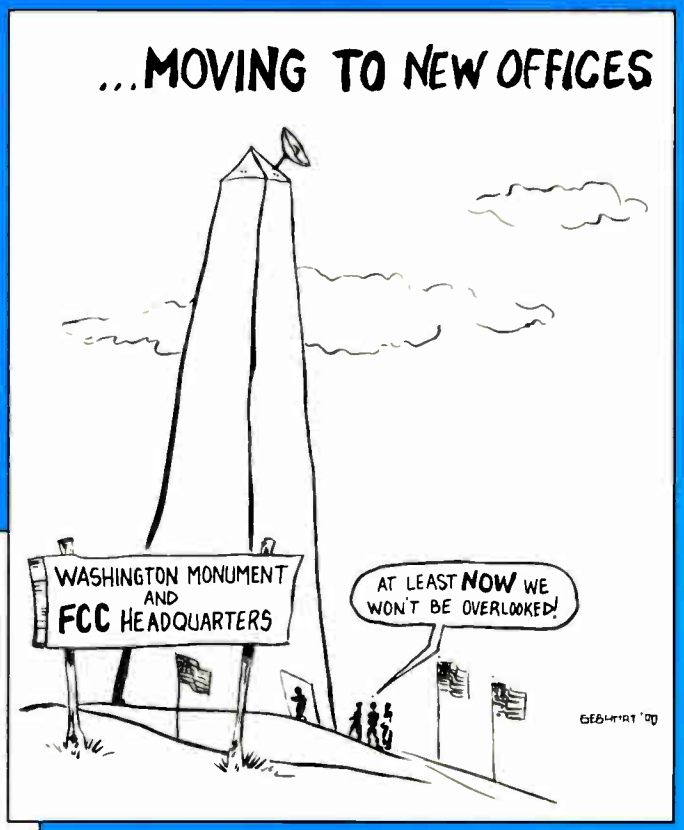
RDS, with some equipment already available, looks to be one of the fastest developing digital technologies for radio. The system has already been established in Europe, and is in the midst of adaption to US broadcasting with technical standards-setting underway by the **NRSC**.

The system uses the FM subcarrier at 57 kHz to provide station identification on special RDS receivers. Stations can be identified by call letter and by program format, so a listener can tune to "country" and have the radio automatically switch to the nearest country station. Some stations are already broadcasting RDS, and **Delco** has made a commitment to including it as a feature on car radios.

Currently the NRSC is working to define codes and formats for RDS with a draft standard expected early this year. In addition, there are other uses for the technology. **Emergency alerting** is one that is already under investigation in Jefferson County, Texas, where petrochemical spills are a threat. **Traffic alerting** is another possibility, with an RDS system that will interrupt a cassette or turn a radio on to warn motorists of traffic jams or accidents. As a technology in development, RDS has all the benefits of a digital system without any of the politics that plague DAB.

The Lighter Side

by Brad Gebhart



Prognosticating the Next Century

by Judith Gross

Did you ever try to imagine what radio will be like in the next century? If someone had asked **Marconi** that question, oh say 100 years ago, wonder what he would have said?

"Everybody will be wearing **headsets** all the time and turning **little knobs** and sending personal messages to each other like '**Mario**, don't forget to bring home the spaghetti' all because of my latest invention."

Bet he wouldn't have counted on **loudness wars**, or **boom boxes**, or **Arbitrons**. Or digital storage and PCM transmitters, either.

Looking back is a heck of a lot easier than **looking ahead**, but not as much fun. So it wouldn't be the **RW** annual without *JG's* predictions for the future. (Jean Dixon, where are you when I need you?)

We'll get the **serious** ones out of the way first, then I'll polish up the **crystal ball** and see what really looms before us.

First off, **DAB**. 1991 brings more jockeying for position, **more politics** and a few more systems to try, many of them compatible with FM. There'll be some **over-the-air** testing of real systems, too, and some moving toward about three different consensuses (consensi?) for WARC **spectrum requests**.

WARC is in early **1992**, then watch the fun begin after that.

For **AM**, the FCC is going to finally approve some kind of **rule-making** on improvements, and some of them will actually **be** an improvement. Then, perhaps as soon as late 1991, the **expanded band** allocations should make the limelight. The receivers are already here.

AM stereo? Well the receivers are still hitting the market but the promotion and other benefits have about passed their **window of opportunity**. I don't see it—sorry, not this year, either.

For **FM?** The modulation hassles simmer down but the whole brouhaha over **processing** too much will continue to do a slow burn and may erupt in **mild arguments** (although not any you haven't heard before) in the latter half of the year.

Industry conventions? Everywhere you turn there'll be some sort of seminar or session on **DAB**. Everyone will want to know everything about it, pie in the sky or not. Those folks who wished it to go away in 1990 will become **experts** in 1991. Watch and see.

How about **products?** Look for digital processors, digital stereo generators for FM and maybe even a **digital console**.

Look for some companies which have been keeping almost **a little too mum** to be out front with some digital **R&D**, even companies that claimed longly and loudly to be inseparable from analog.

And the big one . . . **the economy**. Traditionally a slowdown turns around after **18 months** at the most. In radio, I'm already hearing some **optimistic** things. Yeah, the junk bond folks and overleveraged companies will go on paying the piper for awhile.

But the **good news** is that as the powers that be will stop trying to put the best face on it and come to terms with the "R" word, **remedies** will be put in place to stem the tide and if you bet we'll see a turn-around by **third quarter** I wouldn't bet against you.

And now for a look **far beyond**, to the wonderful world of radio's future as seen through the eyes of the **amazing JG**:

• Scientists will discover new **electromagnetic spectrum** from a long-ago supernova on super, ultra, very high frequency (SUVHF); 120 applicants will instantly **file for CPs** to construct stations which will broadcast over it.

• A receiver manufacturer will begin selling **digital audio implants** for the ear.

• Equipment vendors will sell **processors** to be **implanted** in the cheek to improve the sound of digital audio implants in the ear.

• The **AM stereo wars** will finally end. The technology finally succeeds when there are only **two AM stations** left and they agree to simulcast.

• NAB will appoint a **subcommittee** of a **task force** that will agree to meet for no apparent reason at all.

• **Scott Shannon** will don a space suit to power-program the first station on **Mars**. Modulation from Power-Mars will be found to destroy vegetation on **Venus**.

• **Z-100** and **Power-95** in New York and **Pirate Radio** and **K-Power** from LA will meet in a joint Geneva conference and sign a treaty to end the **loudness wars**. Two competing equipment manufacturers then market "**softness monitors.**" Boom-box listeners will complain about the addition of **dynamic range**.

The endless meeting . . .

• The **DAB task force** will appoint an **advisory group** which will have a **subgroup** which will name an **engineering** task force which will appoint an **advisory group** which will agree to sit down and decide on the appropriate parameters for a report to decide **what questions** must be answered and the report will suggest **a survey** to determine a study to see if they need to do a report.

• NRSC meetings will be declared **open to the press** the fifth time not one person shows up for the meeting. A reporter will attend and die of **boredom**, but write a deathbed story on it anyway.

• The FCC will announce its **110th** Notice of Inquiry on **DAB**.

• An FCC advisory group will meet for its **106th consecutive weekly** meeting but will have forgotten why.

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The Experts' Tips to Better Audio

RW went straight to the audio gurus and sought their advice for station engineers.

The question was: If you could give station engineers just one or two tips to improve their overall audio, what would they be?

Frank Foti, of Cutting Edge Technologies is not only a manufacturer of processing equipment and a consultant to stations. He also has spent many years as a CE himself, including a stint at New York's Z-100 working with demanding programmer Scott Shannon.

Using square waves

For audio testing, Foti advocates "the square wave response test." He notes that a radio engineer needs to deal with a myriad of electronic circuits, from a mic preamp to a complex modulator. "In having the ability to test any of these circuits for square wave response, a good deal can be learned," says Foti.

Foti explains that data gathered from a square wave response test can provide the engineer with information pertaining to several things, including: group delay, linearity, amplifier "sag", filter response overshoot and much more. This information can be useful especially for troubleshooting; square wave response will usually uncover problems that would normally go unnoticed when only static frequency response testing is employed.

"All you basically need to perform a test like this is a square wave or function generator and an oscilloscope. This just may lead to that "hidden" improvement in the sound on your station.

"Try running square wave response sometime through a tape or cart machine. Better yet, try doing this through your STL or the cross-over network in your audio processor. If the observed output from a square wave response test does not give you a square wave, or something that closely resembles one, than you have a problem somewhere.

"If your STL system cannot pass a good square wave in the region of 50Hz to 15 kHz, then you are robbing yourself of either processing power, stereo separation, frequency response, or worse yet ... all three! In a cross-over network, if the recombined audio at the output of the cross-over does not produce a good square wave, then harmonics and transients are being "lost" because of the time "misalignment" of the cross-over filters."

Conscientous test, measurement and use of devices such as these processors and telephone hybrids can greatly enhance a station's audio signal.

As Foti explained, in an AM transmitter, square waves will be able to verify the performance of the modulator stage, as well as indicate the strength of the modulator power supply.

Audio gremlins

Another one of his tips, resembling the square wave test, is harmonic distortion nulling. Foti notes that in almost every radio station there is equipment that employs amplifiers that have harmonic distortion adjustments.

"These are provided for a few reasons," Foti says. "If a component is replaced, the distortion can be trimmed, also over prolonged periods of time as components age the distortion will drift. This can be reset with these adjustments."

Foti advised taking the time to look around the station and see if you have any equipment that fits the above scen- ►

Out of Service.

In Service.

Unfortunately, our Porsche Targa Carerra is in for a pit stop. Seems there's an annoying noise in the front end. *Pity.*

Meanwhile, the incredible Schmid SIAT is still going strong. In fact, this fully automated marvel is fast enough to conduct complete audio tests in under 5 seconds. Which means you can now measure audio network quality *in-service*. Without the noise and intrusion of lengthy tone tests. Without interrupting programming. And without annoying your audience. *Amazing.*

Even more amazing, SIAT lets you measure noise, distortion and crosstalk during peak broadcast periods, when quality is critical and the transmission environment is noisiest.

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ario. Most devices that employ a VCA will probably have distortion null pots installed. Some equipment examples would be audio consoles, compressors/limiters, audio processing chains, stereo generators and FM and AM exciters.

"I personally found from my experiences that aligning the console, audio processing and FM Exciter at least once a year really helped in keeping the audio as clean as it could be," says Foti.

Sound Tips

- Use square waves to test overall audio performance.
- Adjust studio equipment for ideal harmonic distortion nulling.
- Use filtering and equalization on high and low ends of phone lines; also invest in a quality hybrid for on-air phone use.
- Simple and routine maintenance of studio gear is a must.
- Balance console amp and line amp levels.
- Dedication to detail and meticulous attention to problems keep audio quality high.
- Go digital where you can.

Steve Church, of Telos Systems is another engineer-turned manufacturer. Now he specializes in telephone hybrids, and in getting the best on-air sound from telephones, which have built in audio limitations.

"Distorted, noisy, or unintelligible phones can really destroy the mood you are trying to go for in those popular late night love song shows, for example. A little bit of filtering and EQ can really make a difference," says Church.

How best to do this? "You want to remove hum and high-frequency noise, so high and low end roll-off make sense. On most phone calls, there is an excess of energy in the boom area, around 400-500 Hz, so this should be reduced with a parametric EQ. Often, a little boost at the phone high and low extremes will add clarity and warmth."

Church notes that selection of quality hybrid equipment is a must for stations which rely heavily on callers. "A poor hybrid can make the air talent sound bad when there's not enough cancellation and the leakage audio combines in-and-out-of-phase with the clean mic audio. On the other extreme, speakerphone switching is especially annoying to listen to when "morning zoo" jocks laugh and duck out the caller at a critical moment in a phoned-in joke!

"Fortunately, the cost for a decent full duplex hybrid interface has come down recently, so there's no longer any excuse for these sorts of blemishes on the audio of otherwise well-engineered stations," Church says.

Maintenance important

Radio World's production columnist, Ty Ford, is a producer and audio consultant in his own right. He gives some simple maintenance tips that will pay off in better sound quality and fewer repairs.

Ford advises increased vigilance in cart machine maintenance; clean heads, aligned heads, properly adjusted electronics and scrupulous observance of cart tape and pad quality will make a major difference in the sound of a station. Although he notes "it's a pain in the butt to do, it will really pay off."

Ford also suggests balancing preamp and line amp levels to the console so that the faders or pots on a console hit the average operating level at about the same point. "This makes it easier for the operators to run more consistent levels. No brain surgery required here, but sometimes we forget the simplest solutions are the best," says Ford.

Bob Orban, of Orban Associates is considered by many to be "the father of audio processing" and is a well-respected industry expert. He sums up the best of his advice simply. "Audio quality is not achieved by following one or two tips; it is achieved by dedicated attention to detail; slogging through the trenches and cleaning up whatever problems you find."

While that's hard advice to argue with, Orban also suggests referring to the appendix in the Optimod operating manual called "Audio Quality in the (FM or AM) Plant."

From Bruce Bartlett of Crown International, who also writes a regular audio column for **RW**, the advice is even simpler—and more timely. "Go digital, compact discs, DAT machines and midi workstations," he says.

Which is an optimistic way of saying that audio is getting better and better, even without an engineer's tweaking.

Improving Your RF Performance

Wouldn't it be great if you could sit down with the recognized experts on RF technology in the industry and get their own personal favorite tips?

Well, how about the next best thing?

We asked several RF experts to share their advice with **RW** and tell us: if an engineer could do just one thing to improve the RF performance of a station, what would that be?

Experts from Harris-Allied, Continental, Broadcast Electronics, Nautel and QEI were happy to come up with RF tips for engineers, and as you'll see, they were more than generous with their advice.

Hot Tips for RF

- Tuning an FM transmitter for minimum synchronous AM is a good starting point but doesn't go far enough. Finish tuning at the symmetrical group delay point.
- Fine tuning the input and output for minimum even-order harmonic distortion will optimize the group delay response.
- Measure stereo IMD or stereo to SCA crosstalk as a quick way of determining transmitter performance. If minor re-tweaking can repeat the original (excellent) proof numbers, there should be no need to re-run the entire proof.
- Cool your power transistors for long life and manage those factors that determine efficiency and cooling for prolonged semi-conductor life.
- Reduce transmitter tube costs by maintaining filament voltage.
- A regular, rigorous maintenance schedule can save untold amounts of repair time and engineering headaches. Don't wait for a breakdown to invest time and energy.
- Installation and maintenance manuals—along with a company's technical and sales staff—may be an engineer's best friend.

Using synchronous AM noise

According to Vice President of Engineering for Broadcast Electronics, Geoff Mendenhall, synchronous AM (ICAM, incidental amplitude modulation) measurements are an indirect way of evaluating and optimizing FM performance.

He says that even though synchronous AM measurements are a helpful aid to begin tuning an FM transmitter, these measurements tell only (the amplitude response) half of the total story. Transmitter tuning also affects the group delay (time) response which in turn affects the relative time delays of the higher order FM sidebands.

"Recent research using computer simulations as well as empirical measurements made on FM transmitters showed that group delay asymmetry results in much more distortion than asymmetrical amplitude response," he said. "As long as the group delay response is symmetrical, the amount of synchronous AM has little effect on the FM modulation performance and distortion."

Mendenhall further explains that FM broadcast transmitter RF power amplifiers are typically adjusted for minimum synchronous AM which results in a symmetrical amplitude response and centers the transmitter's amplitude passband on the FM channel.

He notes the upper and lower sidebands will be attenuated equally or symmetrically which is *assumed* to result in optimum FM modulation performance. This would be true if the RF power amplifier circuit topology resulted in simultaneous symmetry of amplitude and group delay responses.

Instead, Mendenhall points out that the tuning points for symmetrical amplitude response and symmetrical group delay response usually do *not* coincide, depending on the circuit topology. Therefore, he suggests, simply tuning for minimum synchronous AM (symmetrical amplitude response) does not necessarily result in best FM modulation performance.

"Tuning for minimum synchronous AM is a good starting point," he said, "but it is more desireable to finish tuning at the symmetrical group delay point.

"Fine tuning the input and output for minimum even-order harmonic distortion will optimize the group delay (time) response. The symmetrical group delay tuning point usually does not coincide exactly with the symmetrical amplitude tuning point and falls between the point of minimum synchronous AM and the point of maximum efficiency. Most FM transmitters will exhibit a group delay response even though this results in best FM modulation performance."

Quick tips from Harris

Bob Weirather of Harris Corporation's Broadcast Division says that engineers need to use one or two key parameters to quickly assess that their transmitter is really tuned to optimum performance.

"If the last transmitter proof showed excellent numbers, then without re-running all the proof numbers, a measurement of stereo IMD or stereo to SCA crosstalk will indicate the overall performance of the transmitter. If minor re-tweaking can repeat the original proof numbers for stereo IMD or stereo to SCA crosstalk, then leave good enough alone."

Weirather elaborated to say that RF transistor designs for reliability are dependant on the transistor used and surrounding circuitry. But all transistors share one common enemy: heat. This threat is shown to be true by Black's Law: for every 10° C rise in transistor chip temperature, the lifetime of a transmitter is halved.

"Take care to cool your power transistors and they'll reward you with longer lifetimes," he said.

Weirather also discussed the importance of monitoring chip temperature, however he notes that without sophisticated instruments it is impossible to measure.

"Chip temperature is dependent on many things but transistor efficiency and air handling are the keys. This means watching tuning, drive, supply voltage and current, VSWR, air flow and air temperature in your solid state stages. Manage these factors that determine efficiency and cooling and you'll give your power semi-conductors a chance for prolonged life," he said.

Reduce tube costs

Dave Chenoweth, supervisor for field services at Continental shows that by maintaining filament voltage, a station engineer ►

can reduce transmitter tube costs, which can be a major maintenance expense, and one that is easily avoided.

"Filament temperature has more control of tube life, in an otherwise properly operating transmitter, than any other single factor," Chenoweth notes. He says the filament voltage should be as low as possible without affecting some operating parameter.

"In an FM transmitter, the power output and plate current should not be affected by filament voltage. In an AM transmitter, reduction of positive modulation peaks will be the first indication of filament emission limiting in the RF tubes and an increase in distortion when the modulator tubes are emission limited," says Chenoweth.

Specifically, he explains how an engineer should accomplish this. "The procedure should be to slowly lower the filament voltage until some parameter is affected and then increase the filament voltage about two-tenths of a volt above that point. The reason for increasing the voltage slightly is to allow for line voltage variations. You will never want to operate the tube with the filament voltage so low that it is limiting tube emission," he says.

Ounce of prevention

Phil Bean of Nautel Inc., stressed the relevance of equipment maintenance as the most significant aspect of broadcast engineering.

"As any automobile owner knows, the most efficient and reliable vehicle is a well-maintained one. We have all been exposed to the cliche describing a "well oiled machine;" a transmitting site is not unlike any other well-oiled machine. The more attention paid to detail in keeping a clean, fine-tuned plant, the more efficient and reliable the station. And the attention paid to it is an investment, with generous dividends in reduced downtime and top notch performance.

Waiting until free time taps you on the shoulder, Bean asserts, is not good enough. Nor is that short time when the transmitter is off the air and there will not be even enough time to clean the unit, let alone be thorough.

"What I am suggesting is a premeditated scheme to sneak up on the transmitter when it least expects it, and clean its guts out. Time and time again I have seen stations trade optimum performance because "unnecessary" maintenance was inconvenient.

"Hats off to the guys who insist their plant will be clean, organized and trouble free. They will *not* pay for it later!"

Make full use of resources

Not unlike his colleagues, Jeff Detweiler of QEI Corporation insists the most critical aspects affecting the performance of RF systems are proper design and maintenance.

"If the station engineers make an effort to review the specific requirements for the antenna, line, and transmitter, providing the proper installation and environment, the maximum performance of each component can be realized," he says.

"If the care and feeding schedules are adhered to, the life of each section of the RF chain will be maximized and the mean time between failures reduced. Take the time to read everything before installing the components, and then set up routine maintenance to provide the best care for your system," he says.

Radio Engineers Forecast the Future

RW asked two of the industry's most well-known and respected engineering managers—one from public radio and one from commercial radio—to reflect and project on some trends which will be emerging in this year and the remainder of the '90s.

National Public Radio's Donald Lockett and Group W's Glynn Walden have both been active in participating in industry standards setting committees and in bringing their stations to the forefront of the technological frontier.

In addition to their views of coming trends, Lockett and Walden have each included their personal "Wish List" for equipment in the next year, the next five years, and the decade.

Focus on digital

Digital will play an important role at NPR as Lockett anticipates purchasing digital audio tape recorders with timecode and computers. He also put remote recording consoles, custom line amps for remote feeds (Loudmouths), compressor/limiters, near-field monitor speakers, audio precision test gear, audio phase scopes into the coming year's budget.

"I see 1991 identified as a belt tightening year with purchases being closely scrutinized..."

At NPR, he said, the budget is planned ahead one year for the short-term view and five years for the long-term outlook. He predicts a belt-tightening year ahead and says fiscal '92 is expected to be bleak.

"Analog will still be around... but digital will be the goal of the '90s."

But the economic slowdown does not seem to put a damper on NPR's long term plans to be at the forefront of digital technology, according to Lockett.

"For the next five to ten years," he said,"we envision a gradual shift to full digitization of our audio chain. Analog will still be around (like black and white TV), but digital will be the goal of the '90s.

"The potential to overcome the artifacts of analog RF transmission is most exciting," he says but adds "The political, economic, and regulatory reality of it really happening is a major concern."

Facility rebuilds at Group W

Walden says 1991 will be a busy year for him in new studio planning. "We are moving two of our facilities in 1991, rebuilding the studios at one location and making significant improvements to the studios at another location. We plan a pilot digital audio storage project at a yet undecided station."

The pilot project has the potential to see the all-digital newsroom become a reality, Walden notes. But all of this takes money. He says the company plans a detailed capital budget, for the upcoming year, in June, with a forecasted spending for the next two years.

Like other engineers, Walden is aware of the current economic situation. "I see 1991 identified as a belt tightening year, with purchases being closely scrutinized as to their productivity benefit," he says. All the more reason for DEs to generate good rationales for any purchases they do make.

However, Walden has his own "Wish List" which names digital and audio storage. He believes it will take five years to have a fully installed digital storage base at all of the facilities.

An added benefit of digital, according to Walden, is its built-in ability to make a station more efficient, which also translates into more "bang for the buck."

"In the past, technology tended to replace the lowest paid persons on the staff while delivering marginal product improvements," he says. "Many cost reductions were not realized due to the additional technical requirements required to support this technology. Digital technology promises an improved product, improved efficiencies, and better utilization of our technical departments."

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Circle 152 On Reader Service Card

Beating the "New-Build" Blues

by Dee McVicker

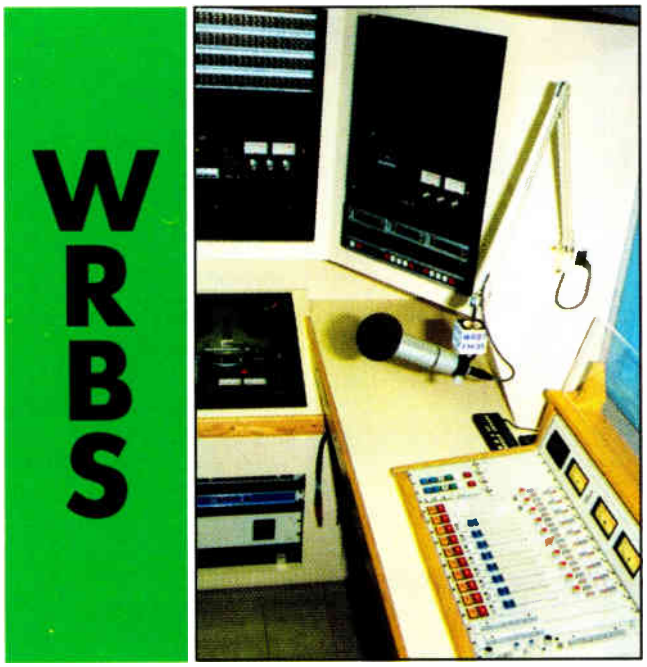
Every year, engineers by the hundreds set out to build new studios. And every year the same thing happens: Murphy's Law. Whatever can go wrong will and whatever can't go wrong will anyway.

Last year, for instance, DE Tom Knauss of Chicago's WLUP-AM/FM found himself in almost an acre of asbestos and CE Stan Gold of San Diego's KYXY-FM battled with off-the-wall studios that needed to be elbowed into a trapezoid-shaped building.

Meanwhile, CE Pete Allen with Baltimore's WRBS-FM lost an entire studio. His trailer of equipment and custom furniture was stolen and not one wire has shown up since.

But eventually studios do get built and Murphy's Law does move on to narf someone else's one-of-a-kind gear or to re-wire another console. In the end engineers have only a hazy memory of the sleepless nights, the endless days and the new cart machine that airs for the first time with a blurrrp.

WLUP



WRBS

Here, then, are the hazy memories and end results of three engineers who braved Murphy's Law for radio's sake.

WLUP adds 6000 more

Judging by the numbers, WLUP-AM/FM's renovated facility was one of last year's largest projects. Starting out at an already impressive 9000 square feet, WLUP's facility in Chicago's Hancock building swelled to a staggering 15,000 square feet in less than three months time, thanks to Pacific Recorders & Engineering, Allied Broadcasting and engineer Tom Knauss.

The studio complex alone stretched from 1,000 square feet to 5,000 square feet, making room for:

- 4 on-air studios
- 2 8-track production studios with a shared voice room in between
- 1 master control room with 13 full racks of equipment
- 1 newsroom with edit station, including tape and cart machines
- 1 sportsroom with edit station, including tape and cart machines
- 1 music dub center
- 2 producer rooms
- 1 large jock lounge for WLUP's radio stars

Studios are roughly 25×20 feet and Knauss spared no expense to equip them with the best. He went with PR&E BMX consoles in the on-air studios and ABX consoles in the 8-tracks, fitting them around solid walnut furniture. The Sony PCM2500 DAT machine, Studer A727 compact disc player and ITC cart machines are used in the air and production studios, and most of these can be found in the stations' sportsroom and newsroom as well.

Otari MX5050 reel-to-reel recorders are used in all studios, with the exception of the 8-tracks, which use the Studer A807 tape recorders and the remote-controlled A827 8-track recorders.

Knauss is especially partial to the new A827 recorders, primarily because these production giants were his toughest equipment decision. Previously, he says, "they (Studer) offered it in a version (the A820) that had auto-alignment and a lot of features that were for recording studios."

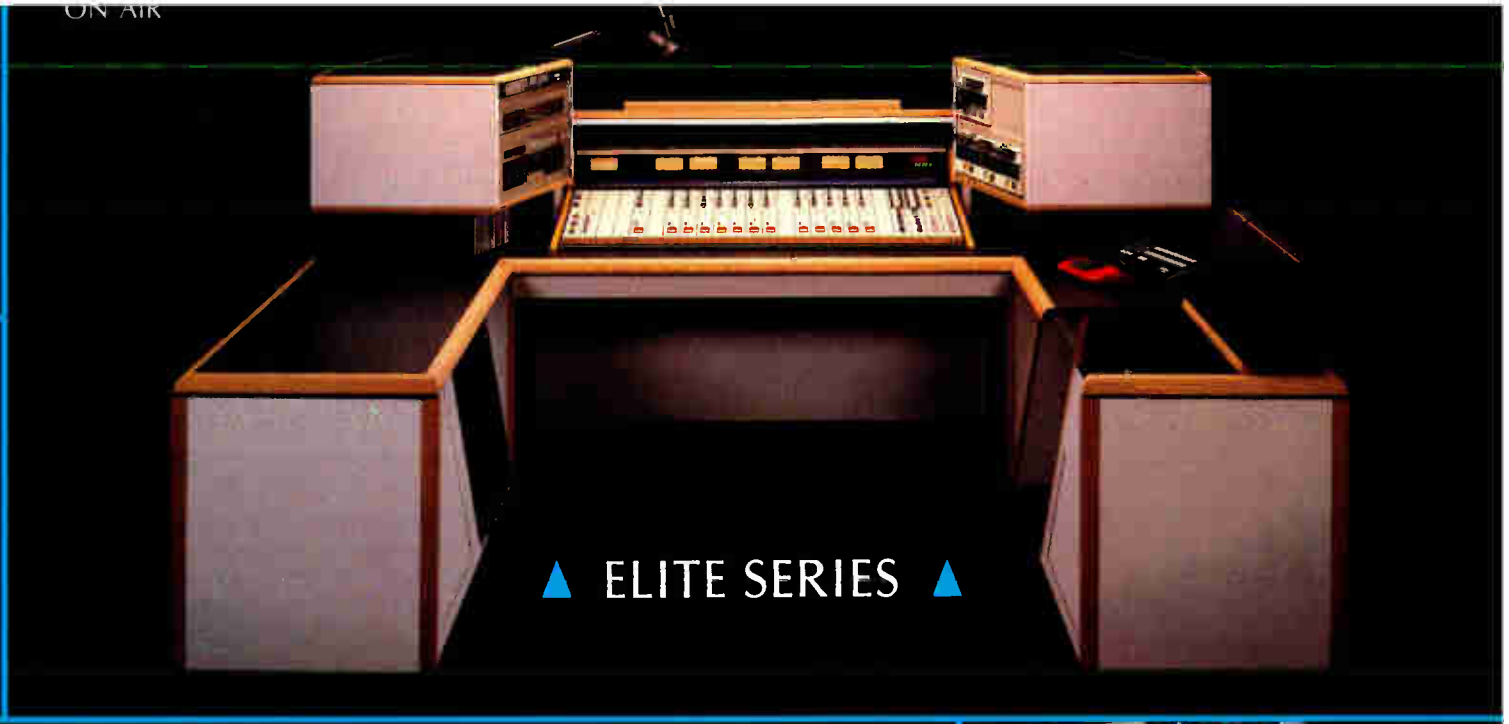
When Studer introduced the new A827 early last year, at $11,000 less than predecessor model A820, the radio production recorder started to look more and more at home in the studios. Today, the A827s do look at home in WLUP's spacious new facility, which has been cleared of asbestos - no thanks to Murphy's Law!

Space, a new frontier

San Diego's KYXY FM also has a relatively spacious new facility, although CE Stan Gold will be the first to acknowledge its interesting use of space.

The station's trapezoid-shaped building, at only three stories tall and looking much like an odd slice of pie,, required a whole new angle on studio design. The station's two production studios, for example, share a common wall angled at roughly 20° which terminates

(continued on page 66)



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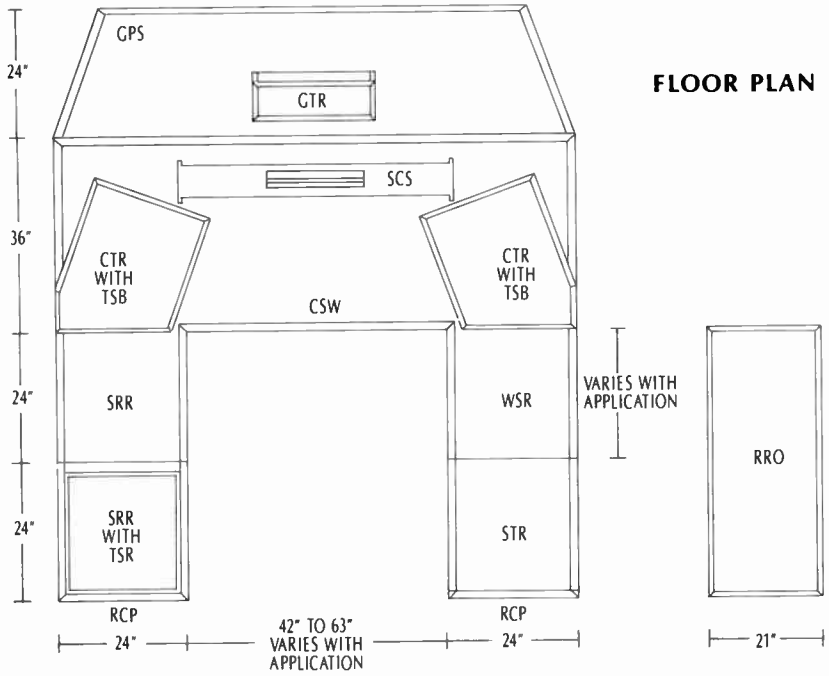

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SYSTEM COMPONENTS

CSW — CONSOLE SUPPORTS AND WIRE TROUGH — Each console support has a field relocatable, hidden 14 inch rack, covered with a removable smoked plexiglass panel. The panel protects the rack mounted equipment from the operator's feet while allowing a view to the panel lights. Drawers can be added to supports. The center counter and wire trough can be expanded to accommodate larger consoles.

CTR — CORNER TOWER RACK — Sitting on top of the CSW and CTR positions equipment such as cart machines at a 20 degree angle to operator. Standard rack opening is 14 inches. The rack height can be expanded as much as needed.

TSB — TOWER STORAGE BASE — The TSB raises up the CTR to provide storage for 10 hot carts or 15 CD's. This also allows the CTR to cantilever over the control console thereby saving the addition of width to center when using an 18 input console.

SRR — SLOPED RACK RETURN — This return comes standard with a 21 inch rack. This space can be easily converted to media storage or pencil and file drawers.

STR — SINGLE TURNTABLE RETURN — Featuring an easy to see over bifold dust cover this return houses turntables, reel to reel machines and CD players. It comes standard with a 10½ inch rack. An optional sand loaded isolator base can be ordered.

WSR — WORK SURFACE RETURN — Used as a work surface for computers, keyboards and guest positions. This module can be built to custom widths. There is a built in wire pass and it can be ordered with a pencil drawer.

RCP — RETURN COMPLETION PANEL — Used to cover the unfinished end of a return. One panel needed for each return.

GPS — GUEST POSITION SHELF — Used to provide multiple talent positions. This shelf can be mounted anywhere and can be free standing.

SCS — SLIDING COPY STAND — This is a copy holder that features a stick on note surface.

RRO — RAISED RACK OVERBRIDGE — This versatile module use is to provide rack space above the return modules or above transport mounted reel to reel machines. Rack heights and the number of rack bays vary according to your exact needs.

TSR — TOP SLOPED RACK — Used mainly to house reel to reel machines. This rack can be used for patch bays and any other gear that needs to be kept at a low profile on the countertop.

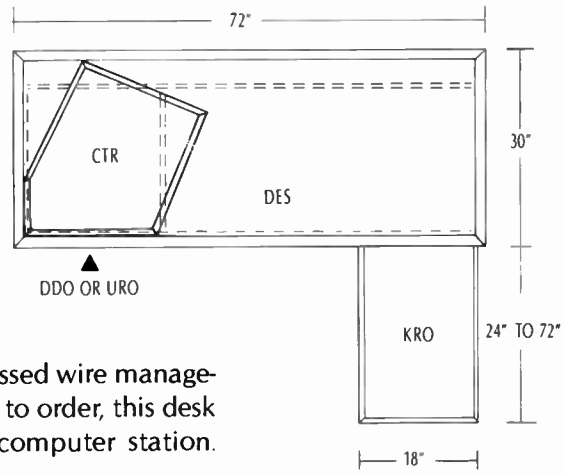
GTR — GUEST TURRET RACK — This panel rack attaches to the top of the Guest Position Shelf. Timers, cough buttons and headphone controls can be mounted in panel face.

RPC — RACK PANEL COVER — These panels cover empty rack space and should be ordered after equipment installation.

▲ DUB/EDIT STATION ▲

SYSTEM COMPONENTS

DES — DUB/EDIT STATION
KRO — KEYBOARD RETURN OPTION
DDO — DOUBLE DRAWER OPTION
URO — UNDERCOUNTER RACK OPTION



This electronic desk system offers a recessed wire management area and flexibility of layout. Built to order, this desk can be used for a dub, edit, CAD or computer station.

SPECIAL DAB SECTION

by Judith Gross

DAB.

These three letters, which were an ordinary part of the alphabet little more than a year ago, may have just changed the course of radio's future.

Digital radio proposals first burst on the scene in the US at the 1990 NAB spring convention. But in truth, European engineers had been working on systems long before that.

The term "DAB" was originally meant to be a brand name of the Eureka 147 project. But the radio industry got hold of it and it quickly became the generic buzzword for the digital changes looming on the horizon.

Now the political questions are bubbling to the surface. Shall it be satellite or terrestrial? Require new spectrum or be compatible with existing FM? And if new spectrum is needed, where will it be found?

Some of these answers will come about as a result of domestic debates and decisions. Some will be decided in a global arena at the World Administrative Radio Conference in Spain in early 1992.

Right now there are three proponents of DAB systems which have petitioned the FCC for authorization to "let the games begin."

Ron Strother's SCI wants to test a terrestrial system. He was first interested in testing the Eureka system on UHF-TV channels, but says now he would like to test all systems.

Satellite CD Radio has proposed a satellite DAB system for 66 satellite and 34 terrestrial channels; the satellite channels would be national. Stanford Telecom, which owns part of Sat CD, has modified that plan to address multipath problems. The modifications resemble the Eureka system's answers to the same questions.

Radio Sat Corp. also favors satellite channels, but wants to combine a DAB service with other types of services in the mobile satellite band.

Others are surfacing, including several hoping to be compatible with FM and one even with AM stations.

The policies are being formulated, the sides are being drawn, and what follows in this section is an attempt to shed some light on DAB and keep the discussions going.

Consulting engineer Steve Crowley of du Treil, Lundin and Rackley has written an explanation of the Eureka 147 system. The company he works for has Strother as a client but his explanation is technical, not political.

Debating the possibility of a global satellite DAB service to replace shortwave broadcasting for services such as the VOA are Tom Rogers of the Sophron Foundation, which supports the concept, and Michael Rau, VP of Science & Technology for the NAB. The NAB is opposed to all satellite implementation of DAB.

There is also an in-depth question and answer session with the chairman of the NAB's task force on DAB: Alan Box of EZ Communications.

The stage is set for a very political and somewhat technical battle of policies and systems. The NAB, the FCC and broadcasters themselves will all play a crucial role in the outcome.

As Strother likes to say, "it's going to be interesting." So let the games begin.

Going One on One with Alan Box

The Chairman of NAB's Task Force on Digital Audio Considers Goals and New Directions

In June the NAB board appointed a task force of board members to deal with the fast-breaking issues arising from discussion of DAB. The Task Force on Digital Audio Broadcasting and Satellite Sound, chaired by Alan Box, president of EZ Communications, has to date visited Canada for in-person listening tests of the Eureka 147 DAB system; appointed an engineering advisory group and commissioned and completed a study of DAB spectrum requirements.

As 1990 drew to a close, **Radio World** *talked with Alan Box on the goals of the task force and the work that lies ahead.*

RW: *What is the main work of the DAB task force; what is its goal?*
Box: The task force was formed in June and we've made public our goals in a mission statement. We're here to protect the NAB members and broadcast interests in DAB. We'll be around until DAB is finalized and for some time after.

RW: *What role does the engineering advisory group play in the task force's work?*
Box: The task force is made up of NAB board members; none of us are engineers. The engineering advisory group is here to help us with technical issues; they played a role in the request for proposal and the designating of firms for the spectrum studies and will meet to discuss the studies' results.

RW: *There are many "DAB" groups springing up, most of them ad hoc. There's the Committee for Digital Radio Broadcasting, for instance, which seems determined to involve as many people as possible. How does the work of the NAB task force fit into all the discussions that are taking place?*
Box: Our doors are open to those who want to participate through the process, although it's true that we don't have an "open" membership; it would not be practical to have everyone who wants to come at every meeting. But we have included members of the CDRB—Paul Donahue for instance—on our engineering advisory group.

We try to look at what the other groups are doing and we certainly encourage NAB staff to become involved in the activities of these other groups to keep us informed.

Box and DAB equipment in Montreal.

RW: *The task force has as part of its title "satellite sound," yet the NAB board has stated its opposition to digital systems based on satellite technology. Where do satellites fit into the future of digital broadcasting—or do they?*
Box: We included the satellite sound part of the title primarily for international reasons; DAB is truly an international issue and other countries are considering satellites. We need to be recognized in the international DAB arena; thus the name of the task force.

We don't see that satellites fit into the DAB picture in our country at all; not just because of the localism issues the NAB board has taken a position ►

on, but also because from the information that's out there terrestrial is technically better and more spectrum efficient than satellite systems.

RW: *The ad hoc group, CDRB, also wants to investigate technologies that will fit into the current FM spectrum. Will the task force be looking in that area as well?*
Box: We're very interested in compatible technologies, but the other systems being discussed are only for FM improvement and we're concerned about AM stations. Our goal is to improve the technical operations for all stations, which means AM as well.

RW: *Can you discuss the reasons behind the spectrum study? Why was the Eureka 147 system used as its model?*
Box: From this study we hoped to get a clear understanding as to how much spectrum is needed for DAB, and what part of the spectrum is best suited to it. The study looked at the spectrum considerations for a DAB system which would give each station equal coverage and one in which there is tiered coverage based on a station's current coverage area.

We used the Eureka system, not because we wanted to exclude the others but because that's what's out there to work with. Currently there isn't an American system which has gotten the amount of study as Eureka 147. Engineers seem to like the Eureka system.

RW: *Now that the spectrum study is done, what's the next step?*
Box: We hope to come up with a detailed plan involving the role of the NAB board and what to bring to the Commission as well as implementation in the industry. We're also working on the DAB demonstration to be held at the spring convention in Las Vegas.

RW: *Will the task force try to play a role in developing a technical standard for a DAB system?*
Box: It's too early to tell exactly what role we'll play; we will get involved in standards. I agree that it has to be clear-cut from the start, so broadcasters and manufacturers are working toward the same goal. No doubt the technical advisory group will get involved in any standards work undertaken.

RW: *What was your own reaction to the DAB listening tests in Canada?*

►

Box: I was very impressed; there's no doubt the signal was improved, it was interference-free. It was especially dramatic for AM stations, but in FM the frequency response was better and the interference goes away.

I would like to hear it demonstrated with digital source material; this was not always the case in the Canadian tests and I don't think some of the other broadcasters were as impressed with analog source material through the digital system. With digital to digital we would hear more enthusiasm.

RW: *Now that some information has been disseminated to the industry on DAB, what are some the myths and misunderstandings you are encountering? How will the task force try to dispel these misunderstandings?*
Box: There haven't been myths and misunderstandings as much as concerns, and we've got to address those concerns. Clearly the industry is going to change, whether we go to a digital over-the-air transmission medium or digital cable radio comes along. If the (broadcast) industry doesn't take a leadership role it's going to be satellites.

One concern is: will everybody be equal? We may have to face the fact that some stations may need to give up coverage; high power regional AMs may go away. How do we license DAB? Should it involve an improved service or new? The filings on the NOI have begun to address this.

Is it possible to please everybody? Probably, if it is an evolutionary process. Logical evolutions serve everybody's needs. Some broadcasters don't want to see it happen at all: NAB can help educate those who are opposed so we can come up with a plan that generates industry support.

... we thought everyone could have an equal allocation; now we know it has to be more complex to serve today's broadcaster.

RW: *You must get feedback from other broadcasters, what are they saying about DAB?*
Box: All kinds of things. Some say delay it; others say we're moving too fast on it. I've heard: Why can't we use FM spectrum, why don't we have a US system?

The feelings of the task force have evolved as we've heard these things. At first we thought everyone could have an equal allocation; now we know it has to be more complex to serve today's broadcasters. We have to look at regional, local and suburban allocations. But remember what we're really talking about is a new transmission medium.

RW: *The question everybody always asks about DAB is "when?" What do you see as the timetable for DAB and how will it roll out?*
Box: I first thought it would be here in five to seven years, but now I believe it's going to 10-12 years before we see the first stations. We have to decide the spectrum issues: where and how much; the WARC meeting will play a role. Although we don't have to make all our decisions based on what happens there we'll certainly want to see what happens. Then the Commission will tackle DAB and that could take years.

Alan Box (2nd left) participated in the well-attended "DAB: Friend or Foe" session at Radio 1991

My best guess is that we'll see the first stations in the year 2000 with a real transition to DAB a few years later. I don't see a long transition, because it won't take long to make the receivers. The biggest chunk of time until then will be ironing out the policy issues.

RW: *Is the US broadcasting industry moving ahead fast enough on DAB? There are fears that other countries interests, even our own international broadcast interests, may pull us along in directions we don't necessarily want to go.*
Box: The industry is moving pretty fast. Other countries, such as Canada and in Europe, may be testing systems faster, but they are no further along than we are in implementation. There are other forces, such as government interests and satellite interests moving rapidly. That's why we're staying on top of the issues and discussions, taking a leadership role with the spectrum study and coverage concerns and making sure the industry stays informed about DAB.

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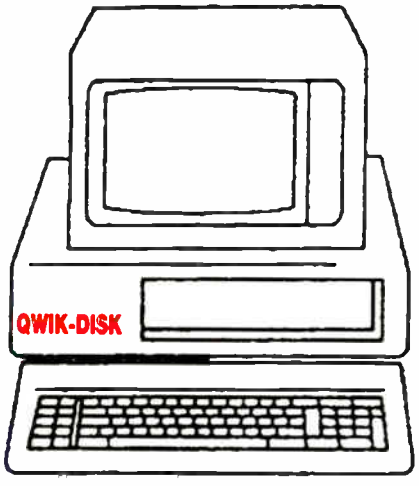
THE FUTURE OF RADIO

QWIK DISK



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Circle 101 On Reader Service Card

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TWO → COMPLETE COMMERCIAL CLUSTERS: DECK NUMBER AND "CART" NUMBER. BOXES AUTO-MATICALLY SIZE TO HOLD A CLUSTER

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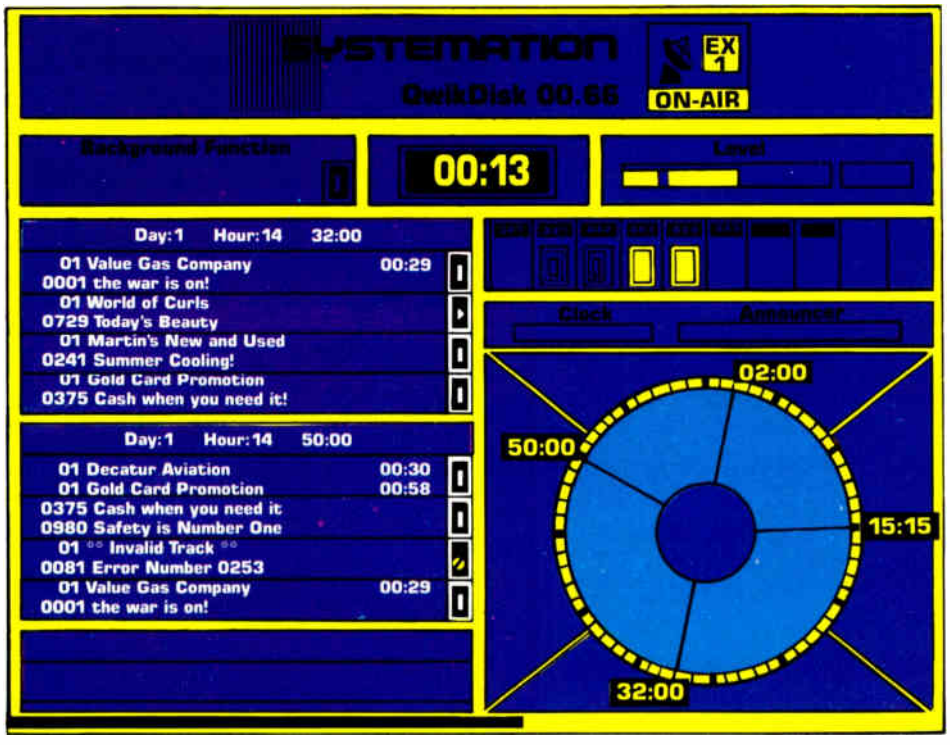

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← THIS IS THE ACTUAL CLOCK HOUR. IN LIVE ASSIST MODE THESE BOXES AUTOMATICALLY FLASH FOR TWO MINUTES TO REMIND THE LIVE ANNOUNCER TO PLAY SPOTS... AFTER TWO MINUTES THE SPOTS THEM-SELVES FLASH

STOP/ CUE

PLAY

ERROR

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Circle 111 On Reader Service Card

An In-Depth Look at Eureka 147

by Steve Crowley

Compact discs—the ubiquitous CD—outselling vinyl records since 1987, offer the consumer the finest in recorded audio quality. They're also a hit at radio stations, where they're less of a maintenance hassle than tapes or records. But all the brightness and definition don't come across on the air. And while you're driving or jogging, the best receivers can be interrupted by noise or distortion.

The problem is that both AM and FM radio are now comparatively low-tech methods of broadcasting. They serve us well, but can't match compact-disc digital quality due to inherent limitations in their analog transmission schemes.

In Europe, they've started from scratch and combined the latest in signal processing hardware with research on the psychology of hearing to develop a new type of digital radio that offers the sound quality of compact discs. Some day it might allow US broadcasters to get highest-caliber audio to the listener.

The idea of digital audio broadcasting (DAB)—transmitting a digital representation of audio—has been around for some time. Experiments have produced outstanding audio quality, but at the price of bandwidth so wide, it hasn't been practical for general use.

The bandwidth obstacle has been overcome by a consortium of European research institutes and consumer electronics companies in the Eureka 147 digital audio broadcasting project. Originally created for satellite audio transmission, the developers also see it operating terrestrially in the VHF or UHF band to offer CD quality sound and make possible a complete digital program chain.

Eureka defined

Among the system's features are frequency response to 20 kHz, low transmitter power, no multipath distortion and more efficient spectrum utilization than FM—12 to 16 stereo channels can be placed within a single 4 MHz block. Also, on-frequency boosters may be implemented to fill coverage gaps without interference between the main and booster signals.

A key to the reduced bandwidth requirement is digital compression of the program material before transmission. This begins with analog to digital conversion of the left and right audio channels. Using a 16 bit word and sampling at a 48 kHz rate, a combined data stream of $2 \times 16 \times 48{,}000 = 1{,}536{,}000$ bits per second is generated. The compression process then cuts this by a factor of six to 256,000 bits per second.

The CAB's Michael McCabe hosted Eureka listening tests this summer in four Canadian cities.

The lower bit rate allows for narrower transmitted bandwidth, but isn't audio information lost? Yes, but remember, the Eureka 147 system is said to produce CD quality sound; it can't physically reproduce the CD waveform because of the lost data. In digital audio systems, (this one included) fewer bits mean more noise and distortion. The idea here, however, is to keep artifacts imperceptible to the listener.

Sounds are concealed by others all the time. A TV can't be heard over a vacuum cleaner. Similarly, a piece of music drowns out parts of itself. Louder notes mask softer ones. We don't hear a lot of what's going on. The property of masking is well known to psychologists who study human responses to sound, or psychoacoustics.

While engineers measure a sound's frequency and intensity, psychologists are concerned with their perception as pitch and loudness. In masking, the closer two tones are in frequency the greater the likelihood that the louder will

(continued on page 39)

POINT-COUNTERPOINT:

GLOBAL SATELLITE DAB?

Radio As Diplomacy

by T.F. Rogers

For millennia individual countries have advanced their international interests through the establishment of remote embassies and the exchange of diplomats to facilitate government-to-government communications.

As the people of the world have become better educated, have wider access to communications media and are increasingly influential in the conduct of their government's activities, an additional form of international political discourse has come into being: that between governments and the populations of other countries. This government-direct-to-people communications is called "public diplomacy."

One important way by which public diplomacy is now conducted, worldwide, is by means of shortwave broadcasting.

But shortwave broadcasting, which depends upon the earth's ionosphere to see radio waves propagated to great distances, is of inherently poor reliability and quality, cannot focus well on specific listening areas, is not easily received and is very expensive. Therefore, radio scientists and engineers have studied the possibility of using transmitters in orbit, digital modulation, and UHF radiowaves to broadcast directly to low cost home radios.

Improvements by satellite

The last few years have seen satellite technology advances, and the invention of new operating methods and means, so that a fine and economical space-based international direct audio service can be confidently foreseen. Studies by our National Research Council have reached this conclusion, NASA and the VOA have related activities underway, and our National Security Council has concluded that it would be to our country's benefit if such a service became available.

Thus, listeners here and around the world can look forward to the day when they will be able to tune in, easily and directly, to audio programs originating in most of the countries of the world, and learn, thereby, of their interests, values, activities, and government policies. And our country will be able to do a much better job of providing the rest of the world's peoples with broad and current information about our own interests, values, activities, and policies—and at a lower cost to our taxpayers.

Localism Is the Issue

by Michael C. Rau

The National Association of Broadcasters strongly opposes the efforts of the US government, in particular VOA, to provide a means for foreign governments to digitally broadcast news, opinion and propaganda direct to the radio listeners of the United States.

Under such a view, each local AM or FM radio station could find itself competing against the satellite-delivered broadcasts of other countries such as Radio France, BBC, and Radio Moscow. These broadcasts also could contain commercial, advertiser-supported programs as well. At stake is the future of US local commercial radio stations.

Whether our government broadcasting agencies should be involved in establishment of a new digital satellite system is not a simple question. Government involvement in digital satellite sound broadcasting raises serious policy considerations that go to the very foundation of why these agencies exist in the first place.

The world has changed; the cold war is over. Private broadcasting stations and networks, once absent from the airwaves in many countries, now are being actively developed and promoted. As a consequence of these factors, the role of the VOA in our changing world needs very careful examination. We may find serious questions as to whether continued government expenditures are justified in an age with a burgeoning budget deficit.

"Localism" is not just a slogan NAB bandies about in Washington. It's the philosophy that underlies the development of US AM and FM radio—the world's most successful broadcasting system. Every day in America local radio stations provide music, news and information to communities of all sizes. Local advertising helps steer local buyers to local sellers. In a sense, local radio stations function as a kind of lubrication for local economies and community affairs all across America. If the business of local radio stations is adversely affected, the local economies, jobs and local information services provided by stations also will be adversely affected.

The VOA argues that its "public diplomacy interests" and the US policy on "free flow of information" somehow compel establishment of an international digital satellite service. These arguments are totally without support. No one questions, at least in the US, the right of programmers (whether sovereign countries or private entrepreneurs) to serve foreign markets using whatever transmission facilities are available.

But principles of fair and equitable access, or "free flow of information," do not mandate establishing a new transmission or distribution mode; the VOA has no right to subsidize development of a whole new technology, a new broadcasting platform, for delivery of its programs. Neither the VOA nor any foreign user has the right, directly or indirectly, to force a satellite broadcast delivery system on the US.

How necessary?

Similarly, the "public diplomacy interests" of the VOA do not support establishment of an international satellite sound broadcasting service. While it's hard to find a precise definition of what these interests are, presumably they include telling the world about American free society. Government broadcasts, however, are not the only source for information and news about American society.

Private enterprise, in the form of international newspapers, the nascent private broadcasting and cable industries developing in Europe and elsewhere, and existing shortwave broadcasting stations, provide sources for world news and information for all nations. As a result, there are serious questions raised about whether the US has the same need for the

The United States Code notes in Chapter 18 of Title 22: "The Congress declares (that)... United States Information ... programs should enable the Government of the United States to promote a better understanding of the United States in other countries, and to increase mutual understanding between the people of the United States and the people of other countries (and) that it should utilize, to the maximum extent possible, the services and facilities of private agencies, including ... radio."

Our private sector is now beginning to conceive of ways by which an existing important radio service could be sharply improved and offered to our people and government, thereby providing a broader listening menu, improving our national security and lowering our government's costs.

T.F. Rogers headed the division of the MIT Lincoln Laboratory that did some of the earliest satellite communications research. He is President of the Sophron Foundation, McLean, VA, which studies space matters.

VOA as it has in the past. And, the US government international broadcasting agencies—the VOA, United States Information Agency, Radio Free Europe and Radio Liberty—increasingly, and properly, may be uncertain about their institutional futures.

Moreover, establishing a digital satellite sound broadcasting system could disenfranchise the very audience that is most likely to be receptive to VOA's news and views about America: the Third World, societies that are not free. Where, in these societies, would third world listeners find the money to buy digital satellite receivers? Especially when the same programs are likely to be available on existing shortwave receivers?

Radio's future at stake

I can't stress enough the importance of this issue to the US radio industry. Digital audio broadcasting should be established, if at all, not as an international satellite service, but as a terrestrial radio system, modeled on our current AM and FM allocations. Every AM and FM licensee should be afforded an opportunity to evolve to a new digital delivery system.

Michael Rau is Senior VP of Science and Technology for the National Association of Broadcasters, 1771 N St. NW, Washington, DC 20036. He can be reached at 202-429-5346.

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Circle 139 On Reader Service Card

Examining Eureka 147

(continued from page 35)

mask the softer. Increasing the frequency separation makes the softer tone more apparent.

Masking plays an important role in clinical audiology: When a loud test tone is generated to test an impaired ear, the other ear may detect it and bias the results. This is overcome by introducing a masking noise in the non-test ear that makes the test tone imperceptible.

Eureka masking

The Eureka system uses masking to eliminate the details of audio that can't be heard. After the audio at the radio studio is converted to digital data, the audio is divided into 32 subbands. Because there are so many subbands, little information is carried in each one.

If the audio in a particular subband is below the threshold of perception, the data representing that subband are eliminated. Additionally, the amount of data representing remaining audio is reduced; this increases noise in the audio, but enough data are kept to keep noise below the threshold of perception.

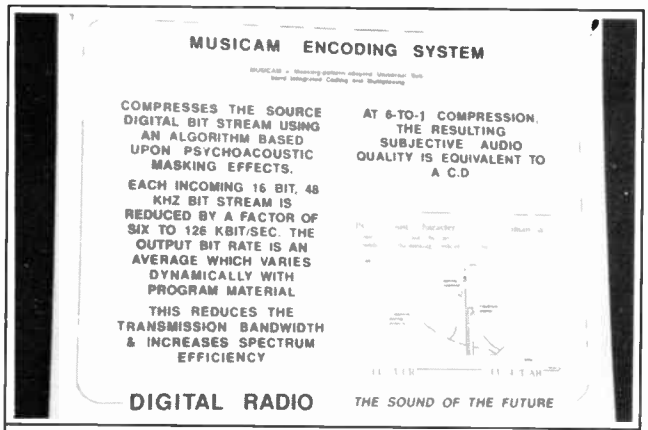
The resulting data rate varies according to the amount of activity in the audio. Rock music requires more information than chamber music, which requires more information than an announcer. The transmission system is designed for the highest data rate required. During slow points in the audio, non-audio data can be transmitted, increasing the utility of the receiver. Data might be used to display song titles, weather warnings, station slogans or still pictures.

Taken together, all these techniques allow the amount of audio data to be reduced by more than 80 percent with no perceptible degradation. The audio reduction process is called MUSICAM (Masking-pattern Universal Sub-band Integrated Coding and Multiplexing).

MUSICAM takes a lot of computing power, but the increasing economies of digital signal processing (DSP) are making it practical for consumer use. DSP has been used for years in areas where complex signals need to be analyzed and processed, such as biomedical engineering, seismic analysis and speech recognition.

DSP of the scope required by the Eureka system used to require prohibitively large computers. Today, the necessary DSP devices are available on integrated circuits. They're similar to microprocessors, but are optimized for signal processing calculations.

The audio compression scheme is not foolproof. Listener adjustment of receiver tone controls can disturb the critical loudness relationship between masking and masked frequencies. Noise might be unmasked.



A chart used to help explain the Eureka 147 DAB system shows the role of psychoacoustic masking in the system.

Also, in the unlikely event that one of these stations was recorded and played back on another station, the audio would be reduced a second time. Noise that was originally just below the threshold of hearing could cascade and become perceptible. To help prevent these impairments, a mask-to-noise margin is built in; the system doesn't reduce audio data to the absolute minimum.

Getting rid of multipath

Reducing the amount of data needed to represent audio helps lower spectrum requirements—but that still leaves the multipath interference problem. A radio signal carrying precise digital data can still be wiped out at certain locations.

The Eureka 147 system takes advantage of the variation of multipath with time and frequency. Variation with time can occur when the receiver is in motion and moving through interference pockets.

Variation with frequency is less intuitive. Multipath interference occurs when signals on paths of varying length arrive at the receiver out of phase. That phase relationship is a function of wavelength which corresponds to frequency. A different frequency will change the phase relationship and thus change the likelihood of interference at any point.

If you're in a market with several stations using the same antenna, listen to one the next time your driving. When it fizzles at a stoplight, punch up the others. They're OK. And so on down the road.

With the Eureka system, the data are split up and portions transmitted on many closely-spaced frequencies. Because of the frequency dependence of multipath, most of the frequencies, and hence most of the data, will usually be available.

Missing information can be reconstructed using error correction techniques. Extra data representing error correction information are added to the audio data stream. These data tell the receiver what patterns of audio data it should be receiving at any instant. If the receiver detects a missing element, it then uses the error-correction information to accurately predict what the missing or incorrect data should have been and adds them in.

With the data divided over so many frequencies, the data rate per frequency is so low that each symbol lasts longer than the spread of propagation delays. Furthermore, the receiver doesn't sample between symbols (that period of uncertainty when phase transitions arrive from multiple reflections). Within limits, these features prevent inter-symbol interference, and enable most multipath signals to add constructively in the receiver.

Another performance enhancement can be achieved by "interleaving" the audio data in time. A cluster of data representing a millisecond of audio can be broken up, spread out and transmitted over several seconds; the parts can then be recombined by the receiver. Thus if all frequencies are lost for a split second—perhaps when driving under a bridge—there doesn't have to be a total loss of audio as with AM or FM; instead, there could be a less noticeable degradation over several seconds.

►

Of course, if you drive too slowly under the bridge, the receiver will run out of data. A big concern of the system is the "brick wall" transition at the edge of the coverage zone.

The system is designed to either work perfectly or not at all, unlike AM and FM where there is generally a graceful degradation. This might be alleviated through the use of punctured error correction codes. This technique simply reduces the amount of error correction so that when a certain amount of data are lost, the receiver starts to generate noise instead of correct all the information.

A key to the reduced bandwidth requirement is digital compression of the program material before transmission.

Lower power needed

The error correction process helps the system use much less power than conventional radio stations. With AM and FM, high power is needed to get a usable signal to most locations most of the time. Instead of brute force, the Eureka system uses the mathematics of error correction to finesse the audio data to the receiver. Excellent coverage has been had with powers of less than 1000 watts.

The transmission process is called COFDM: Coded Orthogonal Frequency Division Multiplexing. "Coded" refers to the error correction and data interleaving process. "Orthogonal" ultimately means that information can be extracted separately from each carrier without interference from adjacent carriers; it allows for modulation and demodulation using digital signal processing techniques. "Frequency Division Multiplexing" simply refers to the distribution of data over many frequencies.

Ideally, system performance will be optimized to the propagation characteristics of allocated spectrum, of which there's none—yet. For terrestrial implementation of the Eureka 147 system, the lower the frequency the better, with a lower limit of approximately 80 MHz to prevent sporadic E interference. The higher the frequency, the more problems there are with building and foliage attenuation.

Also, a characteristic of COFDM is that synchronous transmitters must be placed closer together with increasing frequency. This raises the number of transmitters required to cover a wide area.

Of course, the best spectrum is hardest to get. But since Eureka 147 spectra consists of hundreds of closely-spaced carriers, each having random phase and low power, it looks like wideband noise; it's relatively benign to other communications systems. This feature may enable sharing with other systems.

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The Pendulum of FCC Regulations

by Harry Cole

Federal regulatory policy—especially the FCC's regulatory policy—is occasionally described in terms of a pendulum, periodically swinging in the direction of extensive regulation, then reversing course in the direction of extensive deregulation (or, to use the infamous buzzword of the Fowler Commission, "unregulation").

This metaphor clearly holds a certain validity in the FCC universe, as is apparent from the actions of the Sikes Commission which set it apart from its two predecessors. Recognizing and understanding those distinctions may prove a useful exercise for licensees who intend to stay on as licensees in the 1990s.

First, let's take a look at what happened during the Fowler and Patrick Commissions, a period which covered almost all of the past decade.

FCC Chairman Mark Fowler, at the start of the '80s, helped bring then-President Ronald Reagan's "hands off" approach to the broadcast industry.

Down with the rules

The Commission seemed almost to presume that any rule which appeared on the books was automatically undesirable unless some compelling justification for it could be shown. The result for broadcasters was considerable liberation from various requirements.

But at what cost? First, the Fowler Commission's overall program of "unregulation" led to a substantial increase in competition, as more stations were authorized and as all stations were permitted to gravitate toward central markets without fear of reprimand from the Commission.

This certainly could have been foreseen—after all, the supposed justification for deregulation was the notion that competitive marketplace forces would function adequately in place of governmental regulation.

Thus, it was to be expected that deregulation would be accompanied by efforts to maximize competition. Nevertheless, many broadcasters grumbled at the onset of the increased competition which was the price exacted for deregulation.

Second, the wholesale stripping of regulatory standards in some cases made it difficult for licensees to figure out how best to keep their stations in compliance. After all, the notion of "deregulation" may be nice in the abstract, but as long as you have to get your license renewed, you have to worry about complying with the rules. And in order to comply with the rules, you have to know what standards those rules impose.

Thus, when the Commission, in the name of rampant deregulation, simply throws out well established standards in favor of some amorphous notion that licensees should bear the burden of determining when and if they are in compliance, licensees should think twice before applauding.

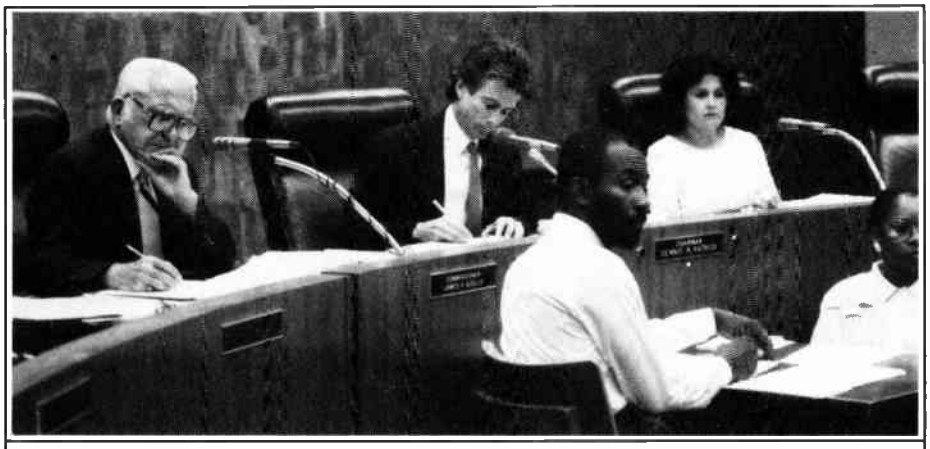
Goal-oriented

Perhaps the most troubling aspect of the Commission's activities in the 1980s was not its substantive policies, but the result-oriented way in which it sought to achieve those policies.

Determined to reach certain particular ends, the Commission often seemed not to care whether or not the analytical path which it charted made sense or enjoyed any reasonable support in fact or law. Instead, the FCC seemed at times willing simply to announce and adopt a position without regard to the practical, legal or political advisability of the position. This did not inspire confidence in the FCC's decision-making processes and it did not provide much guidance to licensees seeking in good faith to comply with the ►

Commission's expectations.

Fortunately, those days appear to be over. Whatever may be said of the Sikes Commission—and a number of very valid complaints may be made—the Commission today seems determined to act in a rational fashion which takes into account not only a particular desired



The Patrick Commission carried out the industry's deregulation in the 1980s.

end, but also a multitude of other factors and considerations which the Fowler and Patrick Commissions seemed inclined simply to ignore.

Retrenchment

Already the Sikes Commission has retrenched substantially in a number of areas where its predecessors' deregulatory forces had made dramatic advances. For example, the Fowler Commission abandoned virtually all consideration of character questions as part of the licensing process; no longer did it make any difference that an applicant may have been convicted of serious felonies involving its character qualifications.

The Sikes Commission, by contrast, has recognized that that deregulatory approach doesn't necessarily work. Instead, the FCC now reviews such matters on a case-by-case basis, with appropriate consideration given to the facts and circumstances surrounding any past illegal conduct.

In a similar way, the Sikes Commission has recently reconsidered one of the Patrick Commission's last actions. The Patrick Commission adopted a new policy concerning changes in the cities of license of FM and TV stations. The new policy made it very easy to move such stations away from smaller, rural communities and in toward larger metropolitan areas.

Obviously, this was a boon for those stations on the fringe of an urban area that were able to move in and become, in effect, part of the urban market. However, the flip side of this was the likely abandonment of those smaller communities—a danger which Commissioner Quello wisely noted in his dissent to the policy.

Now the Sikes Commission has cut back on the Patrick Commission's policy substantially. While FM and TV licensees can still change cities of license, the Commission has made it clear that such changes should not be permitted unless they can be justified not only in terms of the applicant's private interest, but in the *public* interest as well.

A familiar phrase

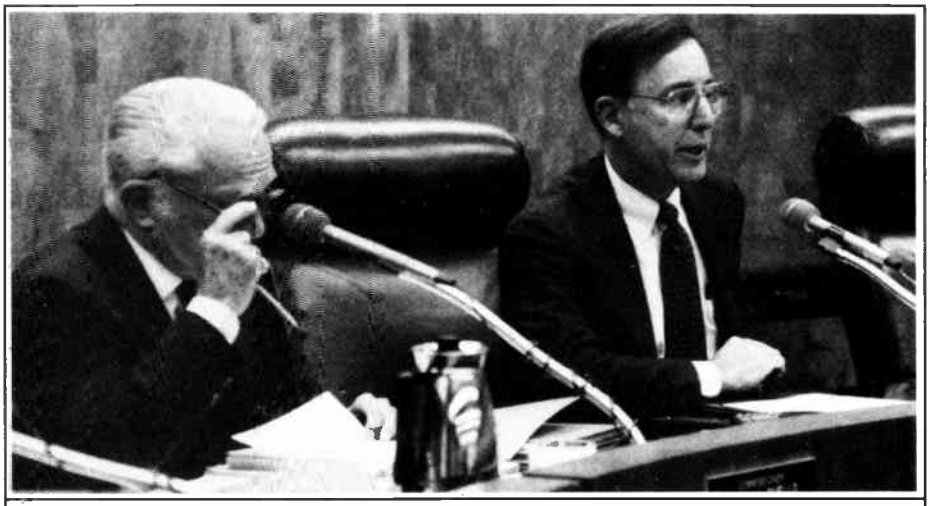
It is probably not unreasonable to extrapolate from these examples that we are likely to witness, over the next few years, a restoration of the notion of "the public interest."

That term, of course, has always been a fundamental linchpin of the Communications Act and, therefore, of the Commission's regulatory mission. But in the heyday of unregulation, it seemed that the Commission all too frequently equated that which was deregulatory with that which was in the public interest; too seldom did the Commission consider whether the public interest itself brought any additional considerations to bear.

Underscoring the return of the concept of "public interest" is the Supreme Court's decision last summer in *Metro Broadcasting Inc. V. FCC.* There, as you may recall, the Court affirmed the FCC's minority ownership policies. But in so doing, the Court's majority went out of its way to reaffirm traditional notions of the public interest, the broadcast licensee's role as a public trustee, and the overriding public importance of the broadcast medium.

Those deregulators anxious to see the demise of the "scarcity rationale" (which was used to justify, among other things, the Fairness Doctrine) were disappointed to see that rationale at least conceptually bolstered, if not expressly reaffirmed. Clearly, it appears that the highwater mark of deregulation has been reached and passed.

Of course, this is not a bad development by any means. To the contrary, the well-reasoned approach which seems characteristic of the Sikes Commission thus far will probably work to the advantage of broadcasters and the broadcast industry as a whole far more than did much of the reflexive, result-oriented deregulation of the 1980s. We should welcome the change.



Under Chairman Al Sikes (right) the FCC of the 1990s is reinstituting some regulatory policies.

Harry Cole is a partner in the Washington, DC-based law firm of Bechtel & Cole, Chartered. He can be reached at 202-833-4190.

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Communications Act: Friend or Foe?

An Examination of Whether This Cornerstone of FCC Regulatory Policy Should Be Reconsidered

by Lex Felker

There never seems to be any shortage of Communications Act critics. Almost every Congress some member calls for major surgery on the Communications Act of 1934. Of course, as is true for most legislative initiatives, these rarely get past the idea stage. But it seems to me that, increasingly, the governed (that's you and me) are becoming more vocal in suggesting big changes in communications law.

All of this activity has encouraged me to contemplate the possibility of creating a wholly new communications statute: one that would better facilitate technological advance and the introduction of innovative services.

Technology

Technology has surely changed over the past 60 years. When the Comm Act (and its predecessor the Radio Act) was created, AM radio was cutting edge stuff. Since then, advancing technology has brought big changes, both in the scope of radio-based services and equipment and in the numbers of communications service providers.

On the other hand, the Act was conceived in the midst of a technological revolution. As terrific as the new communications systems are, from a societal perspective, I don't believe they compare with the quantum leap Guglielmo Marconi brought the world in 1895.

The framers of the Act seemed to anticipate that the nature of communications technology was bound to change, and they vested substantial flexibility in the new Federal Communications Commission to adapt regulations to that change. It's hard to argue that the FCC has been reasonably successful in adapting to technological change.

There may be some *structural* deficiencies in the system Congress created, however. Most notable is the apparent barrier new licensees, services and technologies face. Some of this hindrance was built in to the arrangement consciously by the statute's framers, as an informal *quid pro quo* to broadcasters for the statute's content controls.

But, much of the potential incumbency bias impediment could simply be a byproduct of an administrative resource allocation scheme. Although many policy analysts have argued that most of the inherent barrier to entry could be erased by instituting a more market-based resource allocation plan, I see virtually no chance of Congress making this type of statutory change.

Economics

When the Act was created, the communications field was merely a pimple on the face of US commerce. Today, of course, communications companies are ►

among the largest and most productive in our economy. Some observers have suggested that the fact that broadcasting is now "big business" conflicts with the Act's public interest standard and that a new law could reconcile this tension.

There is little question that the potential economic value of at least broadcast communications was appreciated by the statute's framers, however. In fact, there is evidence that the framers sought to limit the number of broadcasters to ensure profits that could be funneled to support "public interest" programming which many believed would not be broadcast otherwise.

Whether licensees' business interests would actually conflict with the public interest was an issue debated when the Act was created and it rages on to this day. What does seem clear, however, is that so long as government seeks to influence the types of programs aired by broadcasters, a tension will exist with the business aspects of communications.

Regulatory philosophy

At first glance, it might seem that one area in which some difference might be detected between the 1920s and the 1990s, at least insofar as communications law is concerned, is regulatory philosophy.

In the '20s, there was little dispute that some form of government control of radio was inevitable. In fact, in convening the first of four radio conferences, Herbert Hoover—then Commerce Secretary and instrumental in crafting the 1927 Radio Act—announced that the field of radio communications was "one of the few instances that I know of in this country where the public—all of the people interested—are unanimously for an extension of regulatory powers on the part of the Government."

In contrast, the past ten years have seen a roll-back in government regulation of, and involvement in, the electronic media.

But these differences in regulatory philosophy might not be reflected where it would count the most—changes in statutory oversight. With the exception of some legislation enacted during Reagan's first term as President, most of the 1980's deregulative activity has occurred at the FCC, not in Congress. And most recent Congressional activity has been devoted to restoring some of the constraints the Commission has removed.

Has the Act outlived its usefulness?

There have been undeniable changes in technology during the past 60 years, and the world is a much different place than it was in the Roaring '20s. There are undoubtedly statutory changes which could be made to the Communications Act that could help attract capital to communications endeavors, further encourage innovation in communications and facilitate the development of new services.

For all the technical and social changes which have occurred worldwide over the past 60 years, however, the legal considerations and choices facing legislators crafting a communications statute have remained essentially constant.

Legislators must still strike a balance between reliance on market forces and individual/corporate freedoms on the one hand, and consumer protection and government control on the other. Frankly, I don't see much difference between the concerns expressed by today's legislators and those of the Comm Act's framers.

In many ways, I view the '34 Act as an old friend: there are some things I'd change if I could, but the current arrangement is familiar. Despite the difficulties inherent in the present system, the US enjoys a highly diverse and technically sophisticated communications structure.

The Communications Act of 1934 created the FCC. Is it time for a change?

At this point, I can't see any good reason to spend the time and energy needed to create a new communications statute that does not look much different than the Act it would replace. As we have for the past 60 years, I suggest we continue to rely on the FCC to refine its regulations to adapt to the never-ending changes that affect the world of communications.

I can't see any good reason to spend the time and energy needed to create a new communications statute that does not look much different than the Act it would replace.

Lex Felker is a Technology/Engineering Consultant with the law firm of Wiley, Rein & Fielding, Washington, DC.

The Manufacturers' Crystal Ball

Some of Radio's Best Known Equipment Makers Predict Product Trends for the Coming Years

by Debra Green

What will 1991, and the rest of the decade bring in the way of new equipment manufacturing and marketing trends? Will new players change the shape of industry economics? What about mergers? And of course, there's the all-important new technology—read: digital—to consider.

Lacking a crystal ball, RW decided the best way to answer these questions was to go right to the source and ask those most closely involved.

We selected the top players in the business and asked them five questions concerning new trends in equipment development with respect to the economy and increasing interest in digital possibilities.

While opinions vary on everything from the current economic situation to developing technologies, all answers give a fascinating insight into what's ahead for the equipment side of radio.

Analog replacements

Dave Veldsma of the Audio Broadcast Group, Inc. says he sees new equipment trends developing into a recordable CD or equivalent that will replace tape cartridge machines. It will incorporate digital technology, permitting storage medium to have one single piece of information, ready for instant playback, preserving the element stations like best about the ubiquitous cart machine.

"As I visit with broadcasters around the country, I find resistance to any computer-type device that has everything stored on a couple of disks. Should there be a "glitch" and all is gone, so is their library," Veldsma notes.

Digital technology will abound, he says, bringing new opportunities in broadcasting, all the way from a new generation of consoles with touch screens to transmitters that are smaller and more efficient.

"Digital will be a major factor in the '90s and as an equipment/system supplier it will become a major factor in our business," Veldsma explains. "We are actively looking at equipment that will fulfill the broadcasters' requirements in both performance and operation."

And let's not forget the all-important "people aspect." "The coming year will provide opportunities to organizations that provide good customer service. Personal contact with knowledgeable people will excel," he asserts. "As more and more managers will be making engineering decisions, the organization that can solve their problems will have opportunities for exceptional growth."

What will 1991, and the rest of the decade bring in the way of new equipment manufacturing and marketing trends?

Recession immunity

But what about the sluggish economic picture? Veldsma says business will be good for his company, despite a slowing down in other areas. "Our company will not be affected by the recession, just as we weren't in previous last ones. With a commitment to outstanding customer service, we look forward to a great year," he maintains. "Low price is soon forgotten, but outstanding service is long remembered."

Russell Gentner of Gentner Electronics Corporation, however, does see an overall effect of the state of the market. He believes the recession in the radio broadcast market will spill over and slow manufacturers' research and development efforts.

However, he notes, it is likely that we will continue to see the ongoing development of the digital workstation, and the ongoing discussion regarding standardization for digital compression.

"Digital audio processing using DSP's will become a reality as Gentner brings to market its line of digital audio processors. Products such as the Audisk and other digital storage devices will continue to be refined and enhanced. I predict that DAB will be a reality in the United States within five years."

►

"Also, I believe that within the next five to ten years a standardized digital audio compression method will be adopted. Storage of audio on hard discs, warm drives, etc., will be commonplace," Gentner says.

Gentner believes that although the use of cart machines will become less and less, they will never be replaced. However, storage transmission and digital manipulation of audio, according to Gentner, will become commonplace. He says this is the most significant change that has occurred in the industry. And he believes it will be a factor in economic survival.

"I don't believe we will be out of this recession for the next 18 months. The companies that survive will be those that cut their expenses, continue to do limited amounts of marketing and some research and development. The international marketplace is a key to the possibility of any growth through these tough economic times. Companies that continue to develop products through the recession will have an advantage once the recession is over," Gentner says.

And he adds his own tactics for slow-market survival. "Our strategy to cope with the economic downturn in the market is to diversify into teleconferencing. We are now devoting a significant amount of our resources to that end, and we will be introducing new products soon. Additionally, we have significantly reduced our overhead."

Predictions

- Continued digital replacement of analog gear, slower for some products, faster for others.
- Increasing interest in DAB but timetable predictions vary and skepticism abounds.
- Working through an economic downturn, but radio somewhat "recession-proof."
- Some slowdown in R&D due to a tight economy.
- More cost effective products and more antenna site-sharing.
- Customer service becomes increasingly important.
- Continuing influence of and emphasis on computer technology.

"As more and more managers will be making engineering decisions, the organization that can solve their problems will have opportunities for exceptional growth."

How soon digital?

"I doubt that anyone would argue that the future for broadcast audio is digital," says Larry Lamoray, director of marketing for International Tapetronics Corporation.

"But when, in what format, and at what cost are the obvious questions. While we foresee additional hard-disk based systems being introduced in the next year, with more innovations and commonality of functions, we cannot see typical radio stations fully embracing the technology as of yet."

Lamoray believes the older, tried and true technologies will remain in place at the majority of facilities. Then, in the longer term, a reasonably priced digital recording and retrieval system with removable media will evolve.

"We, among others, are actively pursuing this. In the meantime, our strategy is to continue providing reliable products and support, permitting customers to weather the current economic downturn, while closely monitoring the state of the industry and new technologies," he concludes.

Ron Frillman of Harris Broadcast Corporation also predicts continued focus on digital for radio transmission and studio products in the coming year. There already is a strong interest among US radio broadcasters in digital products. He believes it will escalate. Frillman says Harris-Allied will continue to focus heavily on digital technologies in both transmission and studio products.

Equipment, he points out, must offer real value to customers in terms of performance, reliability and efficiency. With increased demands on radio station engineers, equipment must also be user-friendly for non-technical operators. Customer support has always been important, but it is becoming even more so.

"Economically, the coming year will be tight. The US radio industry's already seeing that," says Frillman. "Factors playing a role include overall US economic conditions being down, impacting station advertising revenues with carryover to all industry suppliers.

"There is no reason for either optimism or pessimism. Obviously, economic conditions are not ideal, but pessimism has the unfortunate habit of becoming a self-fulfilling prophecy which can paralyze a station or supplier's ability to deal with challenges in a responsive, constructive manner."

Harris Allied's strategies as outlined by Frillman, include expanded customer field capabilities with trained representatives who will be able to work even more closely with radio broadcasters; central radio telemarketing; and continued emphasis on technical training and support of customers.

"Overall, we know we must stay close to our customers, understanding their needs then quickly responding to them," Frillman notes.

More cost-effective gear

Jonathan Clark, marketing manager of Shively Labs, sees the challenge on manufacturers to help stations meet their bottom lines.

"Due primarily to the economic woes in our industry, we expect to see a trend towards products that can either reduce costs without significantly reducing quality; or increasing value without significantly increasing costs," asserts Clark.

Clark outlines specific developments in his company's field of expertise to help that process along. Among them are proven antenna designs in "no-frills" configurations; increased reliance on pattern studies to assure maximum coverage; custom antenna configurations, such as half-wave spacing, to provide the best possible signal; and a move towards more bays to reduce transmitter costs and operating expenses.

Clark sees the long term developmental trends in the FM industry tied into the development of DAB. Maybe in anticipation of this, or as a lucky coincidence, over the next five years he sees a continuing effort on the part of broadcasters towards establishing and expanding multi-user sites.

"The technical sophistication of DAB is real, and its eventual implementation is inevitable; however, the short term question is more difficult. DAB implementation and growth seems to depend, primarily, on one thing: bandwidth allocation. Without it, DAB is like a technologically marvelous train, with no tracks to take it anywhere. When the bandwidth allocation question is resolved, and there is a real spectrum home for DAB, then its true potential can ►

be better analyzed," says Clark.

DAB will not be a displacing technology, according to Clark, but rather another radio broadcast approach supplementing AM & FM.

"FM did not eliminate AM, CDs did not eliminate tapes and albums, and DAB will not eliminate AM and FM. If DAB allocation is allotted to present stations, then the impact should be tolerable to broadcasters. However if the DAB allocation expands radio licenses then suddenly the ad revenue "pie" is divided again, and broadcasters will be fighting for a smaller piece," he says.

With a healthy amount of skepticism, Clark cautions against jumping to conclusions about the acceptance of DAB. "Our industry is fraught with a certain amount of cynicism. For how many years have we heard about HDTV? AM Stereo? Having the technology is not everything." He notes that since no receivers are currently being built, it may take a phase-in period even once the spectrum issues are decided.

"I foresee a continuing trend of radio stations turning to digital workstations for use in the production room in '91."

Other economic influences

But there are other factors, besides DAB, playing a major role in the market, Clark says. The real-estate market is becoming more and more difficult to deal with, site costs are escalating, and the growing pressures from the FAA and environmental groups against new towers are all contributing to encourage broadcasters in a market to band together and establish a common site, which ultimately benefits all involved.

"Theoretically," Clark notes, "broadcasting is a local business service and therefore should be able to operate somewhat independently of nationwide economic trends. However, nationwide trends are just that—nationwide, and the effects of a recession would undoubtedly be felt, both in reduced advertising and in increased operating costs." He notes that the situation is worsened by the current problems in the banking industry and previously the unhealthy amount, and influence, of "speculative and investment broadcasters."

Neil Glassman of Bradley Broadcast Sales takes a more general approach to the question of digital's affect on the future. He says that to see the whole picture, it is necessary to look at the economic and social effects it may have on society.

"In the sixties," says Glassman, "the FM band, ignored by most of the broadcast community, provided bandwith for stations that played the sound track for social and political changes that still reverberate in America.

"It was predicted that cable TV would change our daily lives," he continues. "Unfortunately, the only changes that occurred in the US were decreased profits for network television and the accessibility of *I Love Lucy* 24 hours a day. On the other hand, in China and Europe, CNN has been credited with serving as a magnifying mirror that fueled the upheaval of recent years."

Citing the effects of over-zealous deregulation in the last decade, Glassman cautions that there are more than just economic or policy issues to think about. "One can only hope that we all remember that the airwaves (AM and digital, terrestrial and satellite) are held as public trust. Once delivered, will these new services be worthy of the task of fulfilling that trust?"

The computer industry, Glassman continues, offers some insight into the changes that lie ahead for radio. "Technological integration will dramatically change radio. Origination, transmission, and control functions become integrated, the audio console, the tape recorder, and most computer based automation control is not new to radio. Now those same computers can record and edit your program material." He points out that even Apple computers offer an ISDN expansion card for developers of software and hardware.

"Bingo! Now it is possible for your STL to be part of that same computer network!" Glassman says.

Rise of digital audio

"I foresee a continuing trend of radio stations turning to digital workstations for use in the production room in '91," says Tim Schwieger of Broadcast Supply West.

Schwieger predicts that although analog recorders represent a comfort in user-awareness, the digital workstation offers more productivity and creativity and will be mandatory to remain competitive in the larger markets. Audio quality is on the forefront of all stations and he says a particular weak link now is the production room.

"In the next 5 to 10 years I see an elimination of analog components throughout the audio chain from studio to the transmitter. Digital consoles and digital processors will be coming on strong. Direct digital remotes via satellite will also be a cost effective advantage over telephone lines," Schweiger says.

As for the economy, Schweiger, also, believes that the core of radio may be somewhat immune. "Should the US enter a recession in 1991, I believe that radio stations will weather the storm well. Radio station advertising is particularly cost-effective especially in a recession. Advertisers will buy radio instead of more expensive TV or newspaper," he notes.

"Broadcasting has truly entered the 'information age.' We've got to be able to respond with products that meet broadcasters' needs."

Dave Burns of Harris Broadcast Sales also predicts that NAB '91 will reflect the industry's growing interest in digital and become "a veritable computer show, more than ever before."

He explains that broadcasters are looking for more efficient and economical methods of operation. Digital and computer based equipment can provide them, he notes, along with excellent performance.

"The trend," says Burns, "toward digital and/or computer-based products is expanding. Broadcasting has truly entered the 'information age.' We've got to be able to respond with products that meet broadcasters' needs."

That last important trend, increased emphasis on the service oriented aspects of manufacturing and marketing, is probably the single most important reason for giving the radio broadcast industry the immunity it needs to weather the storms of 1991.

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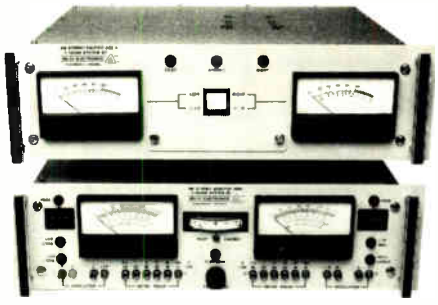
Every day, all over the world, Delta's full line of products make sure the most important broadcasting standard of all is met—your total satisfaction.

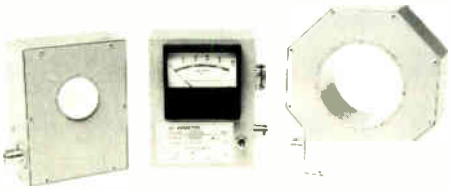
AM Splatter Monitor—Spectrum analyzer performance at a significantly reduced price! An inexpensive means of verifying FCC and NRSC spectral compliance. This frequency agile instrument tunes from 1700 kHz down to 450 kHz, with 9 or 10 kHz channel spacing. The monitor also measures incidental phase modulation (IPM). Designed to be rack-mounted or operated from a vehicle's 12 volt supply using an optional antenna.



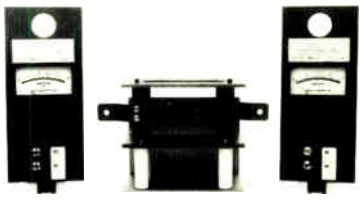
C-QUAM® AM Stereo—The Above Standard Industry Standard is easy to install and maintain with its modular design and construction. Offers standard features other manufacturers charge as options. A sound value, built to last.

High Power Pulse Reflectometer—Strong interfering fields that would destroy time domain reflectometers are virtually ignored by the PRH-1. This instrument can handle up to 1,000 watts of induced power on an intermittent basis as it locates faults on transmission lines. Provides a visual representation of the transmission or sample line, STL coax, or antenna, using your oscilloscope.

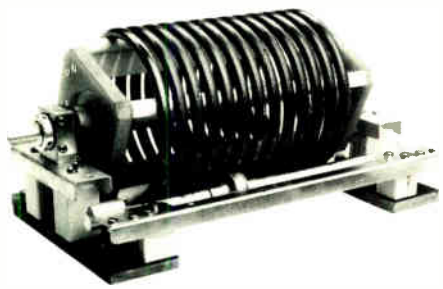
Coaxial Transfer Switches—These 1⅝" and 3⅛" motorized four port switches are designed to switch between antennas, transmitters, or dummy loads both quickly and efficiently. The switches can also be operated manually and are fully interlocked.



RF Ammeters and Sampling Toroids—Precision toroidal current transformers (TCTs) provide stable antenna monitor sampling while eliminating the problems associated with loops. TCTs also work well in supplying additional modulation monitor or test sample RF outputs. The transformer coupled ammeter (TCA) offers stable base or common point current readings, independent of modulation. The dual and single scale meters also provide remote DC outputs.

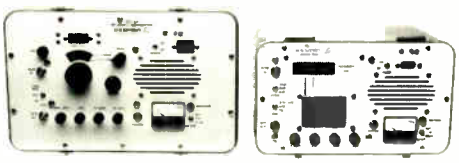


Low Power RF Ammeters—When every milliamp of current counts, depend on the accuracy of the TCA-Jr. This portable RF ammeter is designed to plug into either a Delta MJ-50 Meter Jack (pictured above), or a standard J-plug jack. Two current ranges are available: 0.2 to 1.0 Ampere, or 0.4 to 2.0 Amperes.



Rotary Variable Inductor—Where long life and high reliability are required, specify the RV1. Designed to provide long life, even under continuous rotation, the RV1 is available in either 12 μH or 10 μH versions (maximum inductance). Other values by special order.

Transmitter Power Controller—Your insurance against over- and under-power citations. Continuously monitors transmitter power levels, compensating for AC power line sag by adjusting the transmitter to 100% power.



RF Receiver/Generator—A rugged, high output (2 watts) generator and correlation detector receiver virtually eliminate false nulls caused by interfering signals. The RG-3A operates from 0.5 to 1.65 MHz, and the expanded range of the RG-4 generates signals from 100 kHz to 30 MHz.

Digital Controlled Processor—This inexpensive, stereo tri-band processor boasts user-friendly controls and an aggressive sound. Mono stations can take a step toward AM Stereo, at a price that won't break the budget.

Impedance Bridges—At last, a means of measuring your impedance under full power. Both portable and in-line bridges are available, with a variety of features, for both AM broadcast and HF applications. The in-line Common Point Bridge can be supplied with a TCA RF Ammeter to permit precise current and impedance measurements.

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Circle 114 On Reader Service Card

AM Antenna Monitors—These are true ratio monitors which deliver a ratio reading without the need to continually reset the reference tower to 1.000. This simple operation reduces errors by non-technical personnel and makes tuning an array easier.

Spirit of International Camaraderie

That intriguing studio on the front cover of this year's **Directory** comes to our attention from all the way across the Atlantic Ocean.

It's no secret that Germany is one of the fastest-growing radio markets in the world. Several years ago privatization of broadcasting led to the forming of consortiums interested in obtaining radio licenses.

Some of the parties involved have built showcase studios equipped to handle not only the public's newly aroused taste for Western hit music, but the all-important news and public affairs.

Radio Essen, in NordRheinwestfalen, in what used to be West Germany, is an example of one such facility. Acoustic & Sound Design of Hamburg laid out and installed 11 stations with the same equipment, as part of a network of about 40 stations in the same area.

Wheatstone Corp. brought its equipment, furniture and studio design expertise across the continents and helped build one of the best-equipped stations in the country.

For consoles, Wheatstone provided its A-500, 18-input on-air models. The tape machines are Studer 807 and the CD players and tuner are also Studer's.

The cartridge players and recorders were obtained from Sonifex, and to continue the analog-digital hybrid theme there are also Sony and Aiwa DAT machines. Tascam tape decks were also installed.

The processing is done with a Texar Audioprism and EMT 266x processor. The microphones are Neumann. There are also distribution amps, stereo switchers and compressor/limiters all from Wheatstone, and all the equipment fits nicely into the range of Wheatstone studio furniture.

What better way to look toward the future than to recognize the merging of American technology with Germany's new-found enthusiasm for radio.

Digital Technology for the Phone

by Angela DePascale

CBS was the first commercial radio station to cover the Paris Summit with new digital technology.

ABC and CBS have been covering the Cape Kennedy Space Shuttle Launch via high quality digital audio transmission at 7.5 kHz.

In addition, the remote audio feeds for ABC and CBS have been delivered to the network studios in New York City for the first time via the switched 56 k/bs service from the public telephone companies.

What is this new advance sweeping broadcast phone use? It's the result of advances in digital technology which have recently become affordable for radio station use.

Beyond data transmission

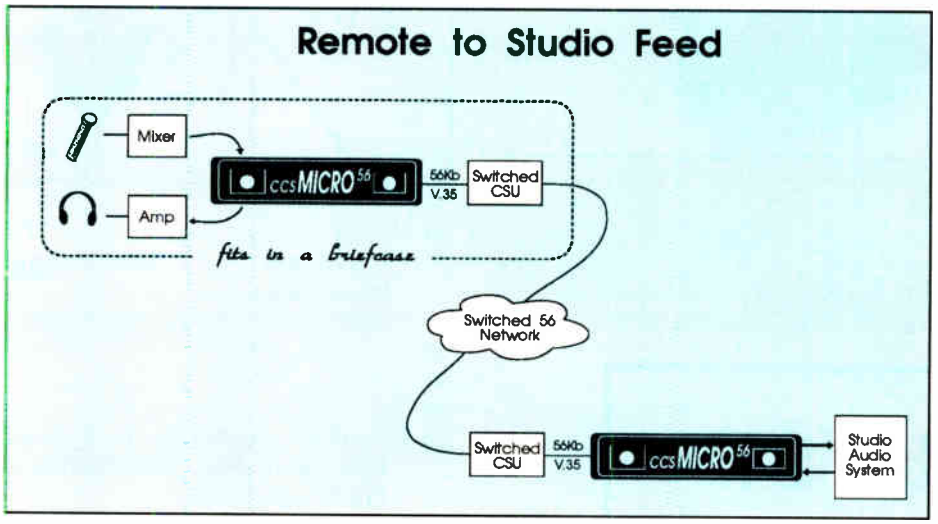
Switched 56 is typically used for data applications. The emergence of cost effective digital signal processing or DSP chips and the growing installation of digital switches in the telephone companies led to digital processing techniques to improve telephone audio quality.

Program analog audio circuits are expensive and are not readily available today from the local phone companies. The Digital Audio Transmission Technology offers the broadcast industry a high quality audio signal for remote feeds without the expense of satellite transmission or 7.5 kHz analog leased lines.

Typically, program analog audio circuits cost between $150-300 per month in New York City while a digital switched 56 k/bs circuit only costs $90 per month.

Switched 56 k/bs service connects to a standard mixer/amp combination and then into the micro 56 codec unit. The Micro 56 unit produces a 56 kilobit digital output to an industry standard V.35 connector.

The digital output directly connects with a high speed data unit (CSU/DSU), which in turn accesses a single switched digital phone line. The configuration is reversed at the other end. The 56 kilobit service terminates at a CSU/DSU which is connected to the Micro 56 Codec unit.



The high quality audio at 7.5 kHz is switched to the AT&T network and carried to New York City via Accunet. In New York City, New York Telephone carries the signal into the network's broadcast studios via a Switched 56 k/bs single digital line.

ISDN

A basic ISDN channel consists of two 64 k/bs data channels and one 16 k/bs control channel. The two, B plus D, 144 k/bs channel is called the ISDN basic rate interface. This is the ISDN "local channel" or local loop between the end user and the telephone company central office digital switch.

There are ISDN terminal adaptors which have developed to allow the telco twisted pairs to carry 144 k/bs. This service is not fully deployed in the US because telephone companies are slow in replacing equipment and upgrading central offices.

In the meantime, there is a "Pre ISDN" service, a switched 56 service. The local telephone companies have been providing switched 56 k/bs service.

I've been intimately involved with the broadcast industry helping provide the future products of the phone companies "Digital Transmission" via ISDN and Switched 56 for a year now. Northern Transdata has brought the different companies together to make this application work.

The cost ranges from $40-100 per month for a local channel and about 13 cents per minute of usage.

Becoming acquainted with and making arrangements to begin using ISDN and switched 56 services are some of the ways engineers can bring the future into their stations right now.

Angela DePascale is Industry Sales Manager at Northern Transdata Networks, Hauppauge, NY and a telecommunications specialist. She can be reached for inquiries about Northern Transdata services at 516-231-7272.

1991 CALENDAR

JANUARY

1 — New Year's Day - 1927 - Rose Bowl game broadcast over first NBC coast-to-coast hook-up
2
3 — 1930 - David Sarnoff becomes Pres. of RCA
4 — 1923 - First network or chain broadcast: WEAF (NYC) WNAC (Boston)
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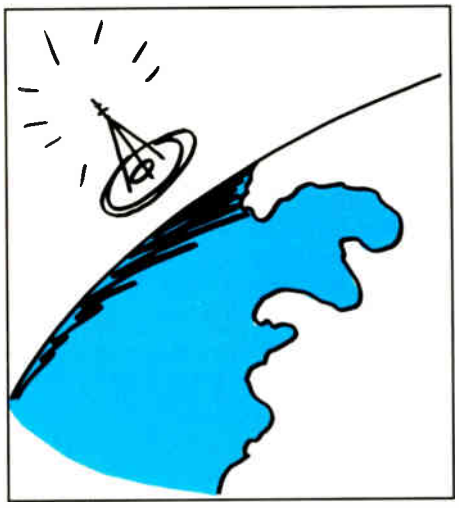
8
9 — 1963 - First full TV program beamed by satellite, from US to Europe
10-14 —1991 Consumer Electronics Winter Show, Las Vegas
11
12
13



14
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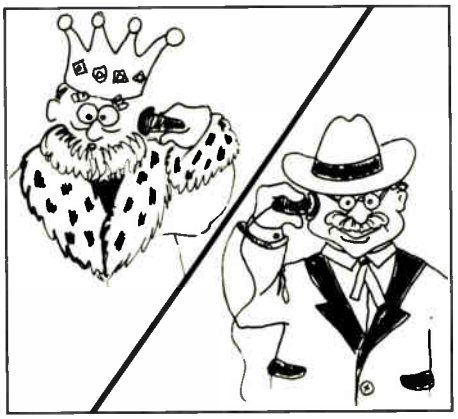
18
19 — 1903 - President Theodore Roosevelt talks with Britain's King Edward VII by wireless



20 — 1953 - First coast-to-coast TV broadcast of Presidential inauguration
21
22
23
24
25-29 —1991 National Religious Broadcasters Convention, Washington DC
26
27
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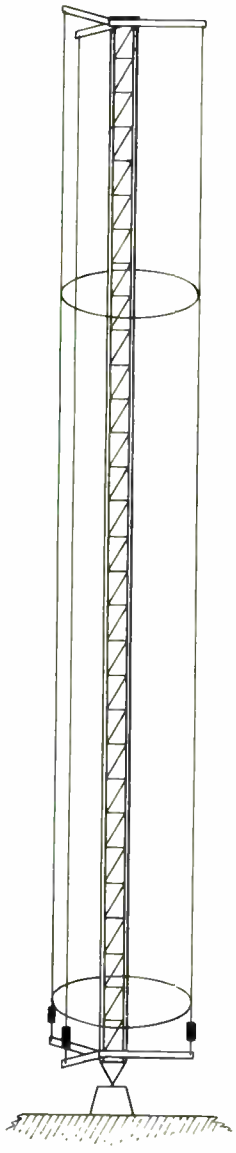
31

FEBRUARY

1
2 — Groundhog Day

THE FOLDED UNIPOLE

THE ULTIMATE ANTENNA FOR AM BROADCAST



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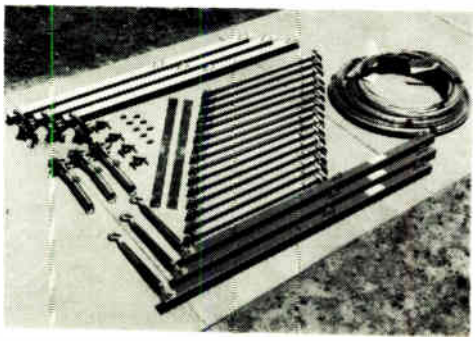

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Broader bandwidth can change a "muddy" or "bassy" sound to a sparkling, penetrating sound that can give you the edge over competitors and actually increase the effective range or coverage area of the station. The construction of the unipole improves the height to diameter ratio by making the tower appear to have a greatly increased diameter. Its not necessary to replace your existing tower with one of large cross section to broadcast in stereo.

A grounded antenna is much less vulnerable to lightning strikes and static discharge. Isocouplers are necessary with the conventional series fed, insulated base antenna if FM, communications or microwave antennas are mounted on it. They introduce a discontinuity in the transmission line, causing a small loss, but primarily they are expensive, lightning vulnerable liabilities in the transmission chain. The unipole, with its grounded tower allows VHF, UHF and microwave antennas to be fed through continuous lengths of coax or waveguide.

The FCC views the unipole as a form of shunt feed, although the unipole is far superior in its omni-directional and broad bandwidth characteristics. Conversion of an antenna to a unipole is considered a minor change and after installation, a form 302 with the new impedance measurements is submitted. The vertical angle of radiation from an antenna is determined primarily by its height and to a minor extent by its diameter. The resultant current distribution, ie, the sum of the currents in the drop wires and the tower, are the same as the current in a tower of the same height and same effective diameter. Otherwise, the FCC would not allow conversion from a conventional series fed to a folded unipole. When a conventional antenna is converted to a folded unipole, the small increase (typically 5% to 10%) in field strength is due primarily to the increase in effective diameter.

The conventional antenna tuner is a device of limited bandwidth. It is normally tuned at station carrier frequency and the sideband response is assumed to be adequate. However, it does roll off above and below the carrier, further narrowing the bandpass of the RF chain. With the unipole, the antenna tuner may be eliminated entirely or a broadband tuner may be employed giving the ultimate in broad bandwidth.

The *NOTT LTD.* folded unipole kit incorporates lightweight construction using high grade aluminum components, power line quality fiberglass insulators and your choice of aluminum conductor, steel reinforced downlead wire, or stranded Copperweld. Windloading and tower loading are minimal. Installation is simple, and can usually be done in a day by a two man crew. Full instructions for installation and tuning are included. Quit overworking your transmitter modulators and get full benefit from your audio processing equipment. Improve your monaural sound now and be ready for AM stereo. *CALL NOTT LTD. FOR DETAILS!*

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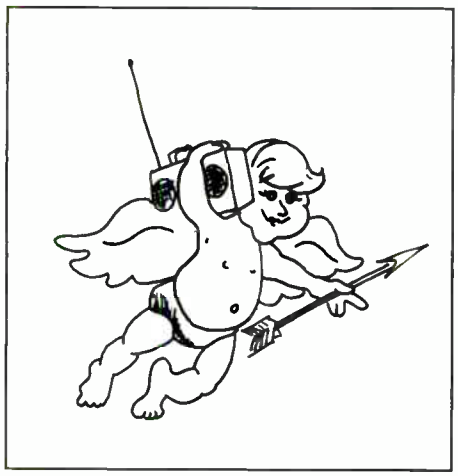
13
14 —Valentine's Day



15
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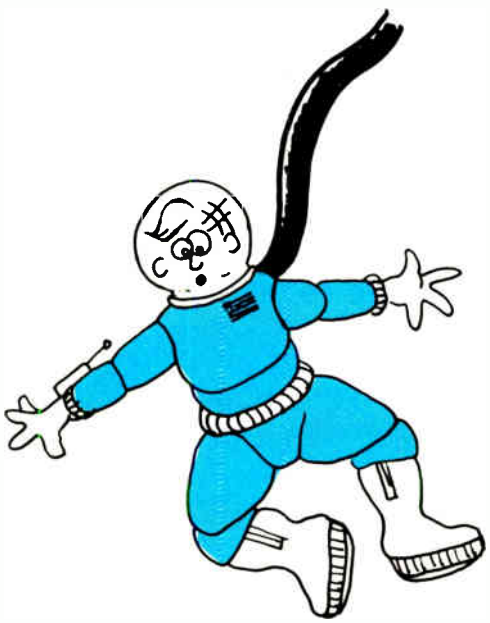
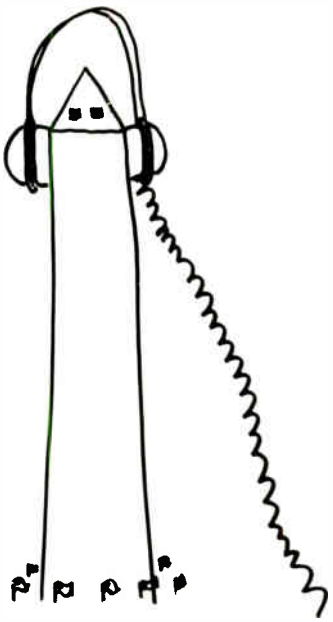
20 —1962 - Col. John Glenn orbits the earth three times



21
22 —1857 - Heinrich Hertz born
23 —1927 - Federal Radio Commission is created
24
25
26
27 —1922 - First annual radio conference held in Washington, DC



28

MARCH

1
2 — 1927 - Federal Radio Commission members named
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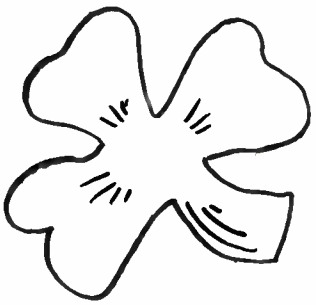
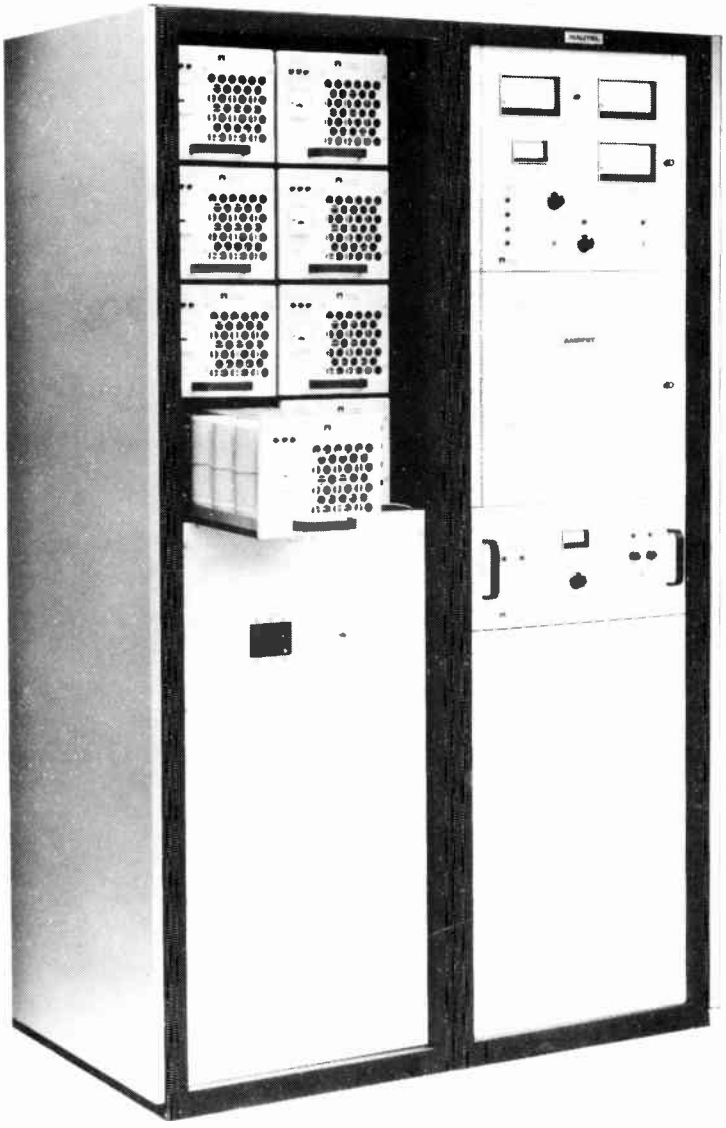
11
12 —1933 - First FDR "fireside chat" by radio
13
14
15 —Ides of March
16 —WEAF (NYC) and WTIC (Hartford); also WJZ (NYC) and WBAL (Baltimore) begin using identical frequencies to overcome the shortage of broadcast channels
17 —St. Patrick's Day



nautel

The World Prefers Nautel Transmitters



All Solid State AMPFET series AM Medium Wave Transmitters. The choice of Broadcasters around the world.

Proven solid state design, modular configuration and On-Air serviceability are reasons why broadcast professionals choose Nautel transmitters.

Other features include
- 75% overall efficiency
- Built in redundancy
- Power Reserve

Power Range up to 100 kw.

ALL SOLID STATE

Contact Jorgen Jensen for more information about the Nautel AMPFET series transmitters:

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Nova Scotia, Canada B0J 3J0

Nautel Maine Inc.
201 Target Industrial Circle
Bangor, Maine 04401 U.S.A.

nautel

Circle 115 On Reader Service Card

18 —1940 - 22 experimental FMs authorized
19
20
21
22
23
24
25 —1940 - US Supreme Court gives FCC the power to license new broadcast stations without regard for economic injury to existing stations
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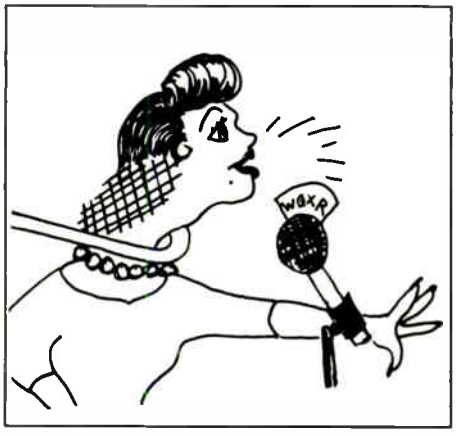
28 —1902 - Cornelius D. Ehret gets first patent for FM - 1944 - Singing commercials banned on WQXR (NYC)



29
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31

APRIL

1 — 1974 - Dial-a-joke begins

2
3
4 — 1928 - NBC receives first TV station CP
5
6 — 1917 - Due to US declaration of war on Germany, all amateur wireless stations are taken over and closed down by the US government
7 — 1927 - Public TV over wire demonstrated between New York City and Washington DC (later that afternoon, TV by radio waves was shown)
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11 —1922 - First cash give-away on a radio station

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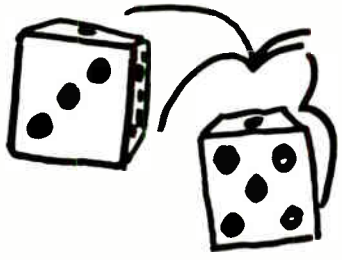
14 —1991 NAB Engineering Conference begins, Las Vegas



15-18 —1991 NAB Spring Convention, Las Vegas
16
17
18 —1923 - Group of broadcasters meet in Chicago to discuss organization of the National Association of Broadcasters
19
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21
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23 —1874 - Guglielmo Marconi born
24
25
26 —1931 - TV station W2XCR, operated by Gimbel Bros. goes on-air in NYC
27
28
29 —1953 - 3-D TV demonstrated by ABC over KECA-TV in Los Angeles

30

MAY

1
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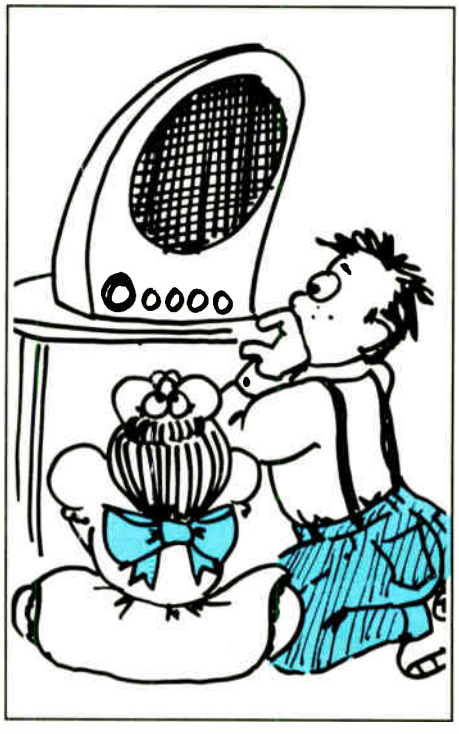
6 — 1943 - Home radio sets reported to reach 91.9% of nation's families, according to Life (4.5% of all sets are out-of-order)



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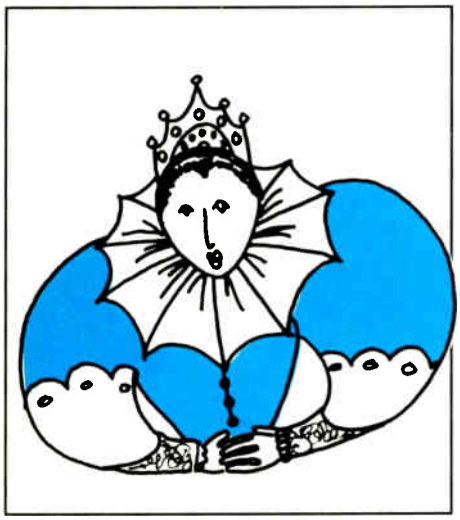
11 — 1897 -First wireless messages sent across water by Marconi
12 — 1937 - Seven-hour broadcast of coronation of King George VI and Queen Elizabeth broadcast



13 — 1912 - Institute of Radio Engineers formed
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20 — 1940 - FCC authorizes full commercial FM broadcasting
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JUNE

1 — 1906 - Cost of local calls at pay phone in NYC: 5 cents

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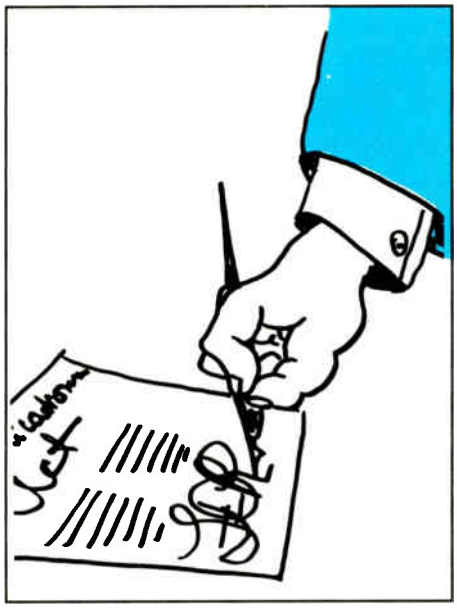
8 — 1937 - Total eclipse of the sun, longest in 1200 years, vividly described on radio from Canton Island and Peru
9 — 1934 - President FDR signed Communications Act, creating the FCC



10 — 1924 - First national political convention broadcast on radio
11
12
13
14 — Flag Day

15
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18

TAKING IT TO THE STREETS

Programming Crossroads- Radio programming is now at a crossroads with stations using sound alike formats to attract target demographics. How your station gets its next advertising dollar may depend on how you handle remote broadcasts. Remotes will give you an edge on the competition, involve your listeners and give you station recognition.

The Premium Vehicle- You need a premium vehicle to broadcast the cleanest sound. Your next remote doesn't have to be an audio compromise. Deliver studio quality sound with the **new Moseley Remote Programming Link 4000.**

Quiet Ride- The **RPL 4010 Transmitter** delivers up to 20 watts in a package that's lightweight, portable and field programmable.

You can drive to your remote with confidence that the **RPL 4020 Receiver** will operate in high RF environments virtually immune from adjacent channel interference.

Cruise Controls- You and your air talent will enjoy the easy set-up of the RPL 4000 featuring a built-in 3-channel audio mixer for mic and line inputs, 2:1 internal noise reduction, two frequency operation, wide/narrow bandwidth and extensive metering and diagnostics. The RPL 4000 is also fully compatible with existing RPUs.

Service and Support- As with all Moseley products, the RPL 4000 carries a 2 year warranty and 24 hour technical support.

The RPL 4000 puts you in the driver's seat. So what are you waiting for. Get your economical **Moseley RPL 4000** and take it to the street!

Destined to be a classic, the RPL 4000 is available NOW from your favorite Moseley dealer!

Moseley

The Trusted Name in Communications

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Santa Barbara, CA USA
93117-3093
a GRC Int'l Company
Phone 805 968 9621
Telex 658448
FAX 805 685 9638

Circle 27 On Reader Service Card

19 — 1945 - First prize fight telecast, NYC to DC, Joe Louis vs Billy Conn
20
21 — 1923 - First radio address by a US President, Warren G. Harding
22
23 — 1891 - Nikola Tesla granted patent on Tesla coil
24
25
26
27 — 1929 - First public demonstration of TV with three colors transmitted simultaneously
28
29
30 — 1930 - First around-the-world radio broadcast, Schenectady—, NY to Holland and back, takes less than one second

JULY

1 — 1934 - Communications Act takes effect
2
3
4 — Independence Day

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6
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11 — 1934 - FCC organized with Eugene O. Sykes as Chairman
12
13 — 1896 - Marconi granted patent on wireless telegraphy
14 — Bastille Day
15
16 — 1945 - First atom bomb experimental test - New Mexico
17
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19
20
21 — 1931 - Experimental TV station W2XAB, owned by CBS, opens atop Chrysler Tower
22
23
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25 — 1922 - WBAY (later WEAF) opens in NYC for "toll broadcasting"—no program origination, just leased facilities and time
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30 — TV station W3XBS started in NYC by NBC
31

AUGUST

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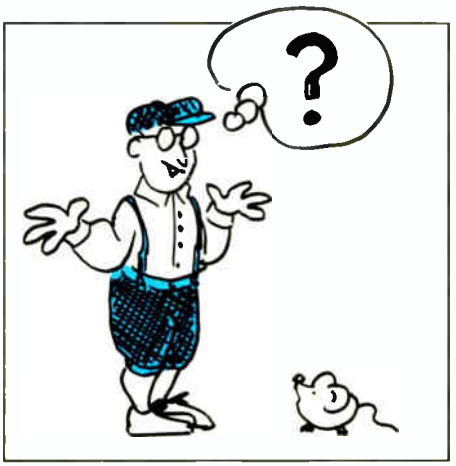
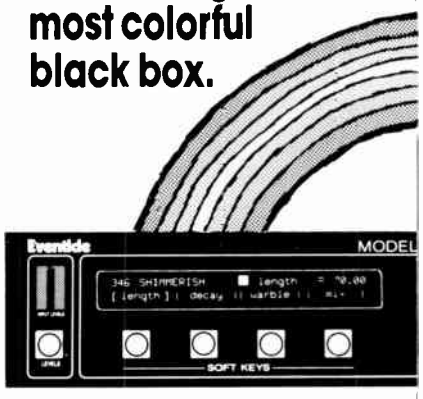
3 — 1923 - Lowly assistant traffic manager at Marconi Wireless Telegraph Co. proposes the concept of a "radio music box"—using wireless to broadcast music. His name was David Sarnoff.



Get the box that makes On-air Magic...

Eventide's H3000B Ultra-Harmonizer.

Introducing radio's most colorful black box.



Shimmerish Swept Reverb program—one of 70+ Eventide Broadcast Ultra-Harmonizer® digital audio effects you can use "right out of the box." Just turn the H3000B on, and it'll turn your listeners on.

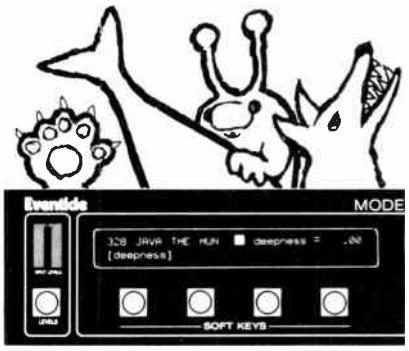
RADIO'S MOST COLORFUL BLACK BOX

EVENTIDE INC
ONE ALSAN WAY
LITTLE FERRY, NJ 07643

Eventide
the next step

TEL 201-641-1200 • TWX 710-991-8715 • FAX 201-641-1640

Morning zoo-in-a-box.



Java The Hun vocal shifter—one of 70+ Broadcast Ultra-Harmonizer® digital effects designed to let you dial up pre-programmed insanity. It's easy to afford the broadcast-engineered H3000B's power and flexibility: ask your Eventide distributor.

RADIO'S MOST COLORFUL BLACK BOX

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the next step

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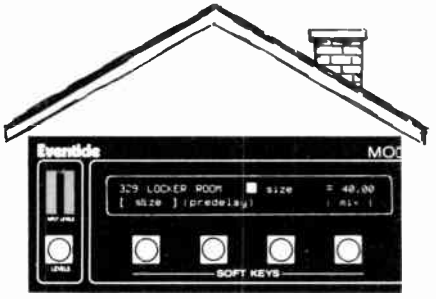
Running out of room? Plenty of rooms in here.



Locker Room reverb/echo—one of 70+ broadcast-engineered H3000B audio effects you can use "right out of the box". The powerful and versatile Broadcast Ultra-Harmonizer® is also amazingly affordable—put it to work for you.

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ONE ALSAN WAY
LITTLE FERRY, NJ 07643

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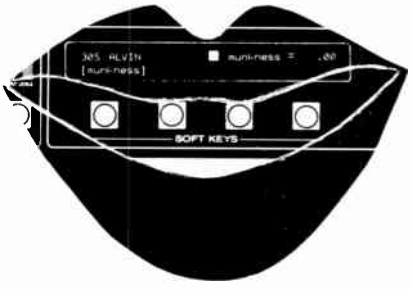
The effects are all digital. The grins are only natural.



Alvin vocal shift program—one of 70+ Eventide Broadcast Ultra-Harmonizer® digital audio effects designed to stretch your imagination (and your smile). And when you have fun, so do your listeners.

RADIO'S MOST COLORFUL BLACK BOX

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LITTLE FERRY, NJ 07643

Eventide
the next step

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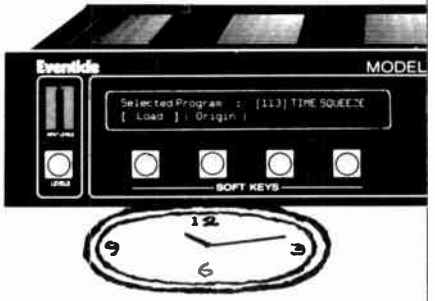
Pressed for time? Press directly below.



TimeSqueeze™ automatic stereo time compression/expansion—one of 70+ Broadcast Ultra-Harmonizer® audio effects designed to make you more effective. The H3000B: never before has so little money done so much for your station's sound.

RADIO'S MOST COLORFUL BLACK BOX

EVENTIDE INC.
ONE ALSAN WAY
LITTLE FERRY, NJ 07643

Eventide
the next step

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Audio effects designed to make your staff more effective.

Traffic Report voice filter with 'copter effect—one of 70+ Broadcast Ultra-Harmonizer® digital audio effects. Put the "special effects department in a box" to work; call your Eventide distributor.

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EVENTIDE INC
ONE ALSAN WAY
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Eventide
the next step

TEL 201-641-1200 • TWX 710-991-8715 • FAX 201-641-1640

Circle 61 On Reader Service Card

4
5 — 1945 - Hiroshima
6 — 1926 - First full-length motion picture with synchronized sound (music) from Warner Brothers: *Don Juan* starring John Barrymore
7
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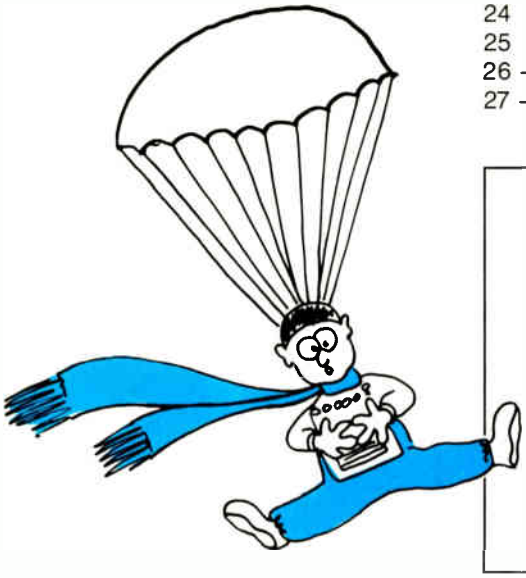
12 — 1929 - Parachute jumper equipped with NBC 2-pound, 2 watt transmitter pack leaps from a plane over Roosevelt field "to test the possibilities"



13 — 1912 - US government approved the licensing of radio operators and transmitting stations
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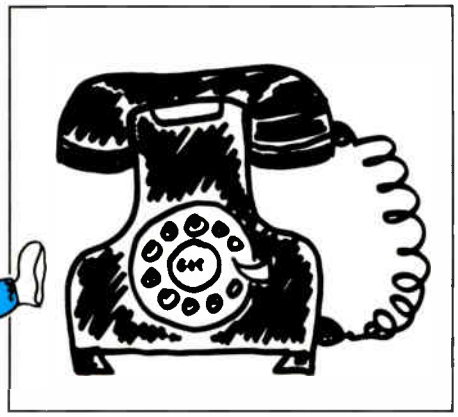
20 — 1920 - Radio station 8MK (later WWJ) started by *Detroit News*
21
22 — 1939 - All broadcasting networks placed on 24-hour basis because of growing crisis in Europe
23
24
25
26 — 1873 - Lee DeForest born
27 — 1896 - First dial telephones come into use



28 — 1922 - First commercial sponsorship of a radio broadcast: $100 for 10 minutes on WEAF (NYC)
29
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SEPTEMBER

1
2 — Labor Day
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9 — 1926 - National Broadcasting Co. organized as a service of RCA, with 24 stations
10
11-14 — Radio 1991 in San Francisco
12
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16
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18 — 1926 - Columbia Broadcasting System goes on the air with 16 stations
19
20
21

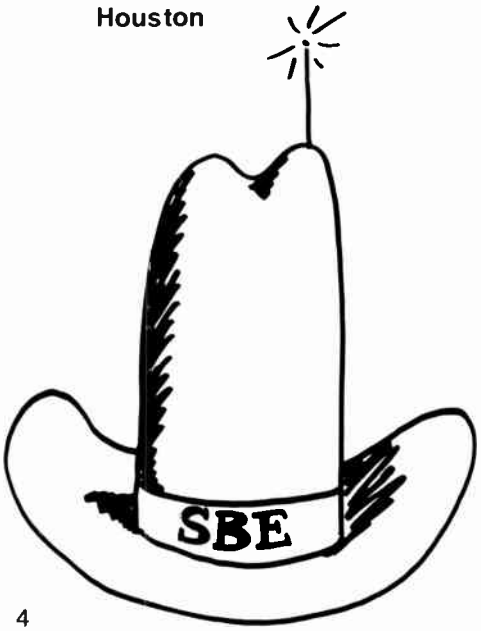
22 — 1791 - Michael Faraday born
23
24
25
26
27 — 1921 - WBZ started at Springfield, MA
28 — 1937 - FCC authorizes radio facsimile tests on regular broadcast channels during early morning hours
29
30 — 1934 - Mutual Broadcasting starts as a cooperative, four-station hook-up

OCTOBER

1 — 1962 - FCC's new Office of Satellite Communications begins operations

2

3-5 —1991 SBE Convention, Houston



4

5 — 1962 - President JFK names the incorporators of ComSat

6 — 1914 - Edwin Armstrong granted patent on regenerative circuit known as self-heterodyne

7

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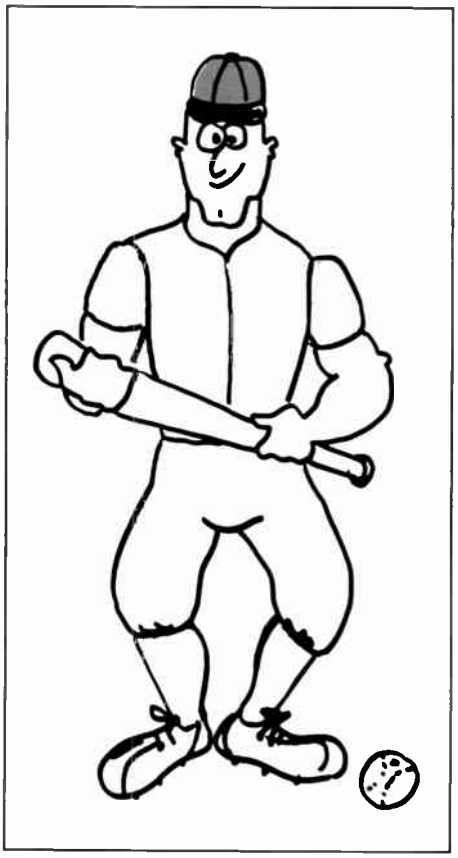
9

10 — 1923 - First radio broadcast of the World Series: Yankees vs Giants



11 — 1923 - First meeting of NAB

12-18 —1991 AES Convention, NYC
1961 - Ad hoc committee reports to FCC, calling for creation of corporation to establish and run a satellite system of communications

13

14

15 — 1922 - High power 20 kW vacuum tubes first used by RCA

16

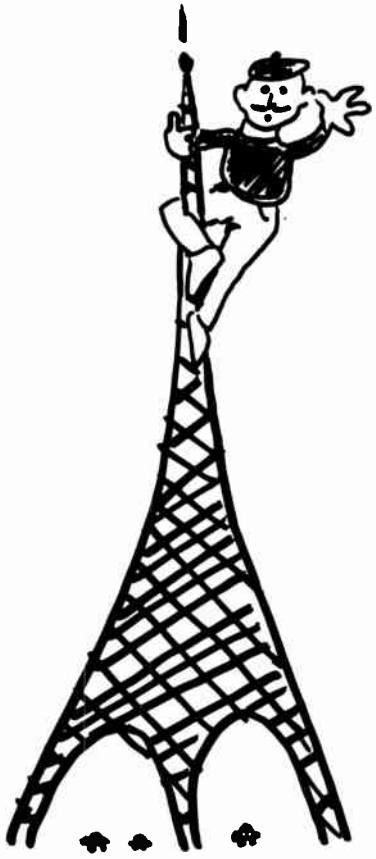
17 — 1919 - Radio Corporation of America is formed

18

19

20 —Dr. Lee DeForest presents a paper on the audion—first of the vacuum tubes—to the AIEE

21 — 1915 - First transatlantic radiotelephone transaction: B.B. Webb from Arlington, VA to H.R. Shreeve at the Eiffel Tower; "and now, Shreeve, good night."



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30 — 1938 - Orson Welles broadcast of *War of the Worlds* starts a panic as terror-stricken listeners flee their homes

31 — 1927 - NAB is incorporated

NOVEMBER

1
2 — 1920 - Radio broadcasting of programs begins from KDKA, Pittsburgh
3
4 — 1924 - First broadcast of presidential election returns over radio
5 — 1955 - First stereophonic sound program broadcast over radio
6 — 1935 - FM system on 2½ meter wave demonstrated by Major Armstrong
7 — 1916 - DeForest experimental radio station started
8
9
10
11 — 1933 - NBC studios dedicated in Radio City (NYC)
12 — 1938 - FCC Chairman declares censorship of radio "impracticable and definitely objectionable"
13
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20 — 1919 - RCA takes over Marconi Wireless of America
21
22
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24
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26

27
28 — Thanksgiving
29
30

DECEMBER

1
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6 — 1937 - US Court of Appeals for DC upholds that broadcast stations are not public utilities
7 — 1941 - Pearl Harbor
8 — 1941 - All radio stations carry broadcast of declaration of war speech by FDR
9
10
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12
13
14
15
16
17
18 — 1890 - Edwin Armstrong born
19
20
21 — 1902 - Marconi sent wireless telegraph from Glace Bay, Nova Scotia to England
22
23 — 1928 - NBC establishes a permanent coast-to-coast network
24

25 — Christmas
26
27
28
29 — 1923 - First transatlantic broadcast on 1600 meter wave: dance music from the Hotel Savoy in London
30
31

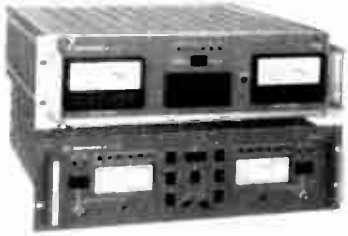
With the whole world turning to Stereo . . .

Why in the world broadcast in AM Mono?

Modernize with C-QUAM® AM Stereo!

Face it. We live in a stereo world. And you join a amily of winners when you choose C-QUAM AM Ste-eo. You'll find . . .

- Over 800 C-QUAM AM stations around the globe
- Over 20 Million C-QUAM decoder IC's shipped to receiver manufacturers
- 4 countries to date with a C-QUAM AM Stereo standard
- IC technology, broadcast equipment, receiver design, international seminars and technical/marketing support . . . from studio to listener, Motorola is totally committed to AM Stereo!



Model 1400 Exciter

Model 1410 Monitor

For details on the Motorola C-QUAM Stereo system, **all Don Wilson collect at 708/576-0554.**
'ax 708/576-5479.

MOTOROLA
C-QUAM® SETTING THE INDUSTRY STANDARD

C-QUAM® IS A REGISTERED TRADEMARK OF MOTOROLA INC.

Circle 16 On Reader Service Card

Beating Murphy's Law

(continued from page 26)

at the studio's shared sound booth.

The control room, newsroom, and network studio—not yet complete as of this writing—all have similar layouts, with equally unique placement of furniture and equipment. With the exception of Eventide H3000-B Ultra Harmonizers, Orban 642B equalizers and Lexicon LXP-5 audio effects units in the two production studios, all studios will be equipped with similar gear, including:

- Otari MX5050 recorders
- BE Phase Trak 90 cart machines
- Technics SP-15 turntables
- Denon DN-950FA compact disc players

In addition, Gold lined the ceilings with 2" soffet lighting to give a warm "mood glow" throughout and 500 watt track lighting is also provided in each studio for normal operation of equipment.

Gold's prize purchase is the AKG DSE 7000 digital editor. Other than being the station's first formal introduction to digital, the 8-track DSE 7000 has proven to be a practical solution to 8-track production.

"We were trying to decide whether to go with a 2-track console or an 8-track console in the production studios," says Gold. "And the more I thought about it, the less I felt I needed an 8-track console. Everything can really be done on the AKG."

KYXY's DSE 7000 workstation, married to a new 2-track PR&E ABX console in one of the two production studios, mixes eight tracks from compact discs or tape sources and lays the mix down into two tracks for playback. The DSE 7000 also has the look, feel and even sound effects of analog production, which has stretched a long way in making KYXY's staff comfortable with digital production.

This almost unbelievable event set Allen back eight weeks, timing that was nonetheless a monumental feat by Audio Broadcast Group considering new equipment needed to be delivered and all new custom furniture needed to be built and wired.

But the results were well worth it, heist and all. WRBS-FM, one of this country's few commercial religious stations, was able

Every year, engineers by the hundreds set out to build new studios. And every year the same thing happens: Murphy's Law.

Meanwhile CE Pete Allen had been hard at work renovating WRBS-FM's facility in Baltimore since 1988, and having completed a production studio and an on-air studio, was about to finish the facility when a thief took off with his latest project: the news center.

As the story goes, Audio Broadcast Group had pulled into a nearby hotel with Allen's news center in tow after the long drive from Grand Rapids, Michigan. In the morning, says Allen, Dave Spoelhof woke up early, walked out and saw that their vehicle was gone. Assuming that Audio Broadcast Group's Bob Bont had used it to make a run to the drug store for eye medication, he was surprised when minutes later Bob showed up at his door.

Burglar-proof burglary

Police officials surmised that the vehicle and WRBS's trailer of studio wares were stolen at approximately 3:30 that morning. Surprisingly, thieves were able to jimmy the lock on what was billed as one of the most advanced burglary-proof systems ever built.

to complete a studio complex that had once been occupied by '60s vintage equipment.

Allen equipped the on-air and 2-track production studios with:

- Auditronics 200 Series Consoles
- Fidelipac CTR10 cart machines
- Otari MX5050B recorders
- Technics SP-15 turntables
- Tascam 501 compact disc players

Since WRBS has a "vision for the news," as Allen's general manager likes to describe the station's commitment to timely news reporting, the new news center is lacking very little in the way of state-of-the-art. Comprising a full news complex with an isolated news booth, the news center is also equipped with a 386 Compaq computer that taps into an AP line for news stories.

In addition, a Panasonic SV-3500 DAT recorder was added to the news center's equipment list. Although Allen hasn't put the recorder on line yet, he speculates it will be used to record events from the dozen or so satellite feeds coming into the news center and to archive out-of-print vinyl cuts, a continuing problem with the station's esoteric library.

This year, thieves allowing of course, Allen will most likely bring in several DAT recorders for the on-air and production studios.

In the coming year, as Pete Allen's studio heist, as Tom Knauss' acre of asbestos and as Stan Gold's frustrations with off-the-wall studios become far-away memories, there will be hundreds of engineers just starting their new studios.

And there will be Murphy's Law. You can bet on it.

Dee McVicker is a freelance writer and regular contributor to **RW**. *To Inquire about her writing service, call 602-899-8916.*

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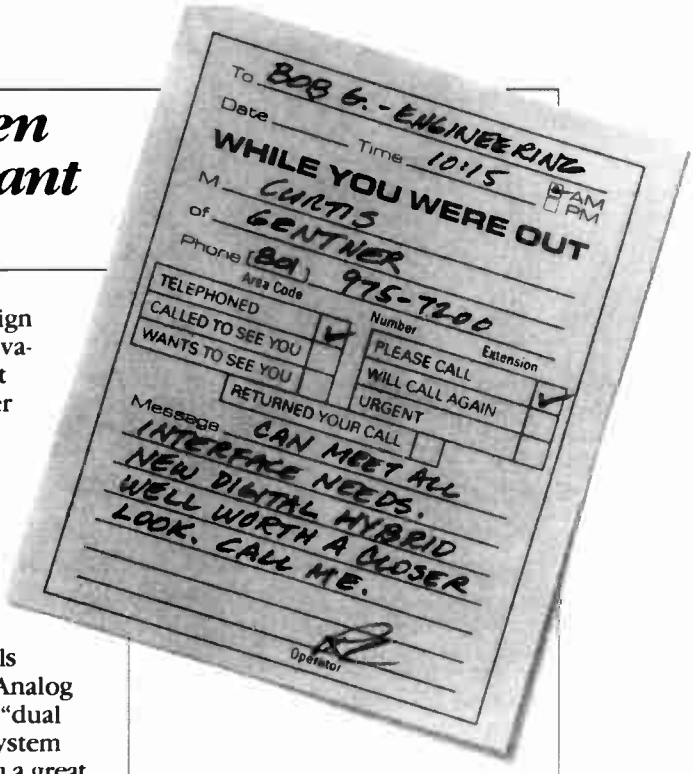


Have you been playing telephone tag trying to solve your telephone interfacing problems? Well, have we got an important message for you. Every telephone interface you could possibly need is available with a single call.

Only Gentner Has A Hybrid For Every Application.

Rapidly growing needs for sophisticated special purpose telephone interfaces have driven our engineers to develop quite a range of products. Here are just a few for you to consider.

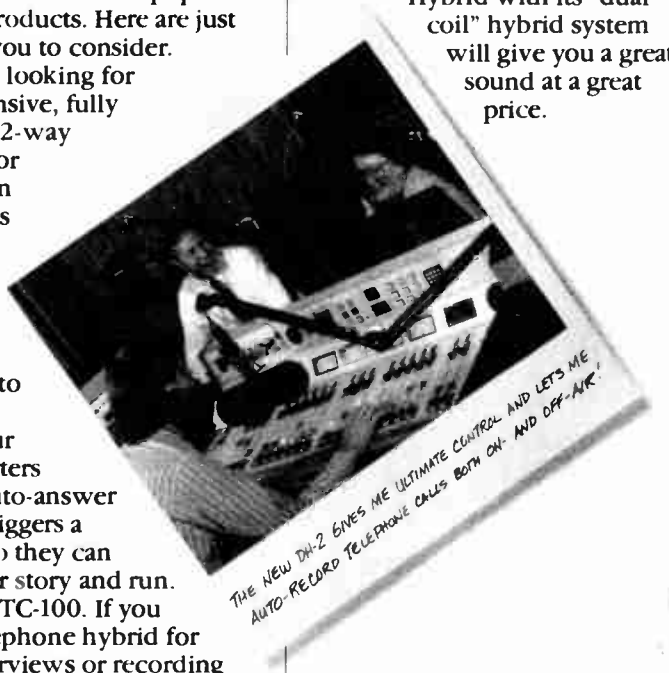
If you're looking for an inexpensive, fully automatic 2-way interface for your "listen line," sports line or weather phone, you're looking for our Auto Coupler. Maybe your field reporters need an auto-answer line that triggers a recorder so they can dump their story and run. That's our TC-100. If you need a telephone hybrid for on-air interviews or recording calls in the production studio and newsroom, you can rely on our SPH-3. It's a full blown hybrid that's been the workhorse of many stations for years.

Gentner telephone interfaces give you the on-air presence you need to dominate your market. That's because they're designed to make callers sound like they're right in the studio with you.

New Solutions To Old Problems.

The latest additions to our growing line of hybrids, the DH-2 and SPH-5, take proven Gentner technology to new heights.

Thanks to some real design and manufacturing innovations, we've packed a lot more features into higher performing packages. With 16 bit processing and 2X oversampling, the DH-2 Digital Hybrid gives you auto-nulling, full digital separation of "send" and "receive" signals and a sound quality that rivals analog. The new SPH-5 Analog Hybrid with its "dual coil" hybrid system will give you a great sound at a great price.



Both the DH-2 and SPH-5 give you a CUE button to toggle send audio between the console and the announcer's mic. This allows your announcer to easily use the hybrid like a speakerphone before putting a caller on-air. And a RECORD button lets you automatically record calls, both on- and off-air, for later playback. Finally, telephone hybrids designed to work the way you work.

Get The Message?

Your single source, for every telephone interface you could possibly need, is Gentner. Give us a call for the name of your authorized dealer. Our operators are standing by. Hello, you're on the air...

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1825 Research Way
Salt Lake City, UT 84119
(801) 975-7200
Fax: (801) 977-0087

Circle 48 On Reader Service Card

DIRECTORIES & PROFILES

In the following pages, you will find three tools for keeping track of vendors and their products.

PRODUCT SOURCE BOOK

A

ACOUSTIC MATERIALS
ASC - Tube Traps
AVC Systems
Acoustic Systems
Allied Broadcast Canada
Allied International
Alpha Audio
Audio Broadcast Group, Inc.
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Services Co.
Broadcasters General Store
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Hy James, Inc.
Martin Audio/Video Corp
New World Music & Sound
Oakwood Audio Labs Ltd.
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Pro Media
RF Specialties of Missouri
RPG Diffusor Systems Inc
Research Associates Inc
Ritz Audio-Visual Associates, Inc
Suministros Gonzalez
UAR Professional Systems

AMPLIFIERS — Audio
ATI (Audio Technologies Inc)
AVC Systems
AVR Communications, Ltd.
Dan Alexander Audio
Allied Broadcast Canada
Allied International
Ashly Audio, Inc.
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Audiotechniques
Audisar
Auditronics
BGW Systems, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Benchmark Media Systems Inc
Best Audio
Bogen Communications, Inc.
Bradley Broadcast Sales
Broadcast Devices, Inc.
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Bryston/Bryston Vermont Ltd.
CaVox/Tape-athon Corporation
Clear-Com Systems
Control Technology Inc.
D.N. Latus & Co., Inc.
Datatek Corp
Delta Electronics Inc.
ESE
Electro-Voice Inc.
Electronic Industries, Inc.
Erko Technologies
Excalibur Electronics
Fostex Corp
Full Compass Systems, Ltd.
Furman Sound, Inc.
Fusion Electronics, Inc.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Henry Engineering
Holzberg Inc.
Hy James, Inc.
ICB Audio
JBL Professional
J.N.S. Electronics, Inc.
Jensen Transformers Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Logitek Electronic Systems Inc.
Martin Audio/Video Corp
McCurdy Radio Industries
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
PARCOM
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
QSC Audio Products
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
ROH
RTS Systems
Radio Design Labs
Ram Broadcast Systems
Ramko Research
Rane Corporation
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Roscom General
Russco Electronics Mfg. Inc.
Sescom Inc.
Spectra Sonics
Suministros Gonzalez
Symetrix Inc.
TOA Electronics Inc
Tape-athon/Cavox
Telo Technology
That Corporation
Urei
Valley International
Ward-Beck Systems Ltd.
Wide Range Electronics Corp
Wohler Technologies
Yamaha Music Corp. of America
Zercom Corporation

RF
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Broadcast Supply West
Barrett Associates, Inc.
Belar Electronics Laboratory, Inc.
Bext Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broacast Services
Broadcasters General Store
Cancomm
Comad Communications Limited
Continental Electronics
Control Technology Inc.
Elcom Bauer
Full Compass Systems, Ltd.
Fusion Electronics, Inc.
Giesler Broadcasting Supply, Inc.
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Imperial Transmitter Worldwide
J.N.S. Electronics, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Litronix Corporation
Nady Systems
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Ron Radio Communications
Roscom General
Spectra Sonics
Suministros Gonzalez
Tepco Corporation
Tobias & Company Ltd
Vector Technology Inc

Audio Distribution
ATI (Audio Technologies Inc)
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Aphex Systems, Ltd.
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Audisar
Auditronics
BGW Systems, Inc.
BSM Systems
Broadcast Supply West
Barrett Associates, Inc.
Benchmark Media Systems Inc
Best Audio
Bogen Communications, Inc.
Bradley Broadcast Sales
Broadcast Audio Corp
Broadcast Devices, Inc.
Broadcast Electronics
Broadcast Equipment Sales
Broadcast Services Co.
Broadcasters General Store
Bryston/Bryston Vermont Ltd.
CaVox/Tape-athon Corporation
Conex Electro-Systems, Inc.
Control Technology Inc.
Datatek Corp
Di-Tech Inc.
ESE
Electronic Industries, Inc.
Excalibur Electronics
Full Compass Systems, Ltd.
Funke & Associates
Fusion Electronics, Inc.
Gaines Audio
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Grass Valley Group Inc
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Henry Engineering
Holzberg Inc.
Hy James, Inc.
J.N.S. Electronics, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Logitek Electronic Systems Inc.
McCurdy Radio Industries
Milam Audio Co.
Modulation Sciences, Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RTS Systems
Radio Design Labs
Radio Systems
Ram Broadcast Systems
Ramko Research
Rane Corporation
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Ron Radio Communications

Roscom General
Russco Electronics Mfg. Inc.
Sequoia Electronics
Sescom Inc.
Sine Systems, Inc.
Spectra Sonics
Suministros Gonzalez
TOA Electronics Inc
Tobias & Company Ltd
UAR Professional Systems
Versatech Industries, Inc.
Ward-Beck Systems Ltd.
Wheatstone Corporation
Wide Range Electronics Corp

ANTENNAS — FM
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broacast Services
Broadcasters General Store
Cablewave Systems, Div of RFS Cancomm
Capital Electronics Inc
Comad Communications Limited
Comark Communications
Continental Electronics
Control Technology Inc.
D.N. Latus & Co., Inc.
Dielectric Communications
Electronic Industries, Inc.
Electronics Research, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Mart Haller Co.-Exporters
Harmon's Tower Service
Harris Corp
Holzberg Inc.
Hy James, Inc.
IBSS
Imperial Transmitter Worldwide
Jampro Antennas
LDL Communications
Landy Associates, Inc.
Lita Broadcasting Distributors
Litronix Corporation
Micro Communications Inc
John Nix
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Paramount Communications Systems
Parcom
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Ron Radio Communications
Roscom General
Scala Electronic Corporation
Shively Labs
Suministros Gonzalez
Tennaplex Systems, Ltd.
Tobias & Company Ltd
Transcom Corporation
U.S. Tower Services

AUTOMATION

Station Business
Barrett Associates, Inc.
Columbine Systems Inc
Custom Business Systems, Inc.
IBSS
The Management
Master Software Systems
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
Summit Software Systems

Newsroom
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Broadcasters General Store
Columbine Systems Inc.
Compromptер Inc
Control Technology Inc
DHK Group
IBSS
The Management
Media Computing, Inc.
RF Specialties of California
RF Specialties of Missouri
Sine Systems, Inc.

Radio Program
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Absolute Broadcast Automation
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Broadcast Automation, Inc.
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Century 21 Programming, Inc.
Concept Productions
Control Technology Inc.
DHK Group
Drake-Chenault
Giesler Broadcasting Supply, Inc.
Guarantee Radio Supply Corporation
Harris Corp
Holzberg Inc.
Hy James, Inc.
IBSS
Innovative Automation
Kingdom Technology
The Management
McCurdy Radio Industries
Media Touch
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
PARCOM
Pristine Systems, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Schafer Digital
Schafer International
Sentry Systems
Sono-Mag Corporation
Tennaplex Systems Ltd
Versatech Industries, Inc.

B

BATTERIES
AVC Systems
AVR Communications, Ltd.
American Media Services
Audio Services Corporation
BJM Electronics Ltd.
Broadcast Services Co.
Capital Electronics Inc
D.N. Latus & Co., Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Fusion Electronics, Inc.
Guarantee Radio Supply Corporation
Holzberg Inc.
Landy Associates, Inc.
Professional Audio Supply
PARCOM
Periphex, Inc.
Pierce-Phelps, Inc.
Ritz Audio-Visual Associates, Inc

BUILDING — Prefabricated
Andrew Corporation
Fort Worth Tower Inc
Harris Allied Broadcast Equipment
Holzberg Inc.
LDL Communications
RF Specialties of Missouri
RF Specialties of Washington
UNR ROHN Inc
Skyline Antenna Management
Tower Structures, Inc

C

CABINETS, CASES & RACKS
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
Amco Engineering Co.
American Media Services
Anvil Cases
Arrakis Systems
Atlas/Soundolier
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
BJM Electronics Ltd.
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Bud Industries, Inc.
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
The Express Group
Fiberbilt Cases Inc.
Fidelipac Corporation
Full Compass Systems, Ltd.
GKM Mfg. Corp.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
J.N.S. Electronics, Inc.
Kintronic Laboratories Inc
LPB, Inc.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
Murphy Studio Furniture
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
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RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
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Ritz Audio-Visual Associates, Inc
Roscom General
Ruslang Corp
Sono-Mag Corporation
Spectra Sonics
J Storeel Corp.
Suministros Gonzalez
Thermodyne Intl Ltd
Tobias & Company Ltd
Wide Range Electronics Corp

CART MACHINES — Play Only
A/V Technology International, Inc.
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
AudioLine, Inc.
Audiomedia
Auditronics
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Continental Electronics Corporation
Control Technology Inc.
Downeast Engineering
BARCO-EMT GmbH
Electronic Industries, Inc.
Fidelipac Corporation
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
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Hy James, Inc.
International Tapetronics
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Lita Broadcasting Distributors
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Otari Corporation
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Pierce-Phelps, Inc.

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Pro Media
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RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
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Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sequoia Electronics
Sono-Mag Corporation
Suministros Gonzalez
Transcom Corporation

Record/Play
A/V Technology International, Inc.
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audi-Cord Corp.
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Auditronics
Broadcast Supply West
BARCO-EMT GmbH
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Continental Electronics Corporation
Control Technology Inc.
Downeast Engineering
Electronic Industries, Inc.
Fidelipac Corporation
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Hy James, Inc.
International Tapetronics
Jim Walters Co.
Landy Associates, Inc.
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Lauderdale Electronic Labs
Lita Broadcasting Distributors
The Management
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Otari Corporation
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Pierce-Phelps, Inc.
PMA Marketing
Pro Media
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RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
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Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sequoia Electronics
Sono-Mag Corporation
Suministros Gonzalez
360 Systems
Tobias & Company Ltd
Transcom Corporation

Multi-deck
AVC Systems
AVR Communications, Ltd.
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Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Broadcast Supply West
BARCO-EMT GmbH
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Continental Electronics Corporation
Control Technology Inc.
Downeast Engineering
Electronic Industries, Inc.
Fidelipac Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Hy James, Inc.
International Tapetronics
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
The Management
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sequoia Electronics
Sono-Mag Corporation
Tobias & Company Ltd
Transcom Corporation

CASSETTE RECORDERS
AVC Systems
AVR Communications, Ltd.
Accurate Sound Corporation
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
CaVox/Tape-athon Corporation
Continental Electronics Corporation
Control Technology Inc.
Electronic Industries, Inc.
Fostex Corp. of America
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
ICB Audio
International Music Co
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
Nakamichi America Corp
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
PARCOM
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Roscom General
Sony Business & Professional Group
Studer Revox
Suministros Gonzalez
TASCAM
Tape-athon/Cavox
Telectro Systems Corporation
Tobias & Company Ltd
UAR Professional Systems
Uher of America
Wide Range Electronics Corp
Yamaha Music Corp. of America

COMPACT DISC (CD) PLAYERS
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Century 21 Programming, Inc.
Continental Electronics Corporation
Control Technology Inc.
DENON America Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
ICB Audio
Jim Walters Co.
LPB Inc
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
PARCOM
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Roscom General
Sono-Mag Corporation
Sony Business & Professional Group
Studer Revox
Suministros Gonzalez
TASCAM
Tobias & Company Ltd
Transcom Corporation
UAR Professional Systems

COMPONENTS
Transistors
Allied Broadcast Equip Canada
Audiotechniques
BJM Electronics Ltd.
Barrett Associates, Inc.
Broadcast Services Co.
Capital Electronics Inc
D.N. Latus & Co., Inc.
Electronic Industries, Inc.
Fusion Electronics, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Martin Audio/Video Corp
Parcom
Richardson Electronics/RF Gain
RF Specialties of Missouri
Richardson Electronics Ltd.
Riggins Electronic Sales
Suministros Gonzalez
Thor Electronics Corp.
Wide Range Electronics Corp

Capacitors
Allied Broadcast Equip Canada
American Media Services
BJM Electronics Ltd.

Barrett Associates, Inc.
Broadcast Services Co.
Capital Electronics Inc
Commercial Radio Company
D.N. Latus & Co., Inc.
Downeast Engineering
Electronic Industries, Inc.
Fusion Electronics, Inc.
Hall Electronics
LSI Jennings
Lita Broadcasting Distributors
Martin Audio/Video Corp
Parcom
Richardson Electronics/RF Gain
RF Specialties of Missouri
Richardson Electronics Ltd.
Riggins Electronic Sales
Suministros Gonzalez
Surcom Associates, Inc.
Wide Range Electronics Corporation

Resistors
Allied Broadcast Equip Canada
Altronic Research
BJM Electronics Ltd.
Barrett Associates, Inc.
Broadcast Services Co.
Capital Electronics Inc
Commercial Radio Company
D.N. Latus & Co., Inc.
Electronic Industries, Inc.
Guarantee Radio Supply Corporation
Lita Broadcasting Distributors
Martin Audio/Video Corp
Parcom
Power Film Systems, Inc.
RF Specialties of Missouri
Riggins Electronic Sales
Shallco
Suministros Gonzalez
Tech Laboratories, Inc.
Wide Range Electronics Corporation

COMPUTER — Hardware
AVR Communications, Ltd.
Allied Broadcast Equip Canada
Alpha Products
BJM Electronics Ltd
Century, Inc
Columbine Systems Inc.
Computer Concepts Corporation
Concept Productions
Custom Business Systems, Inc.
DigiDesign Inc
Guarantee Radio Supply Corporation
Lasalle Music and Pro Audio
The Management
Media Computing, Inc.
Nordic Software, Inc.
PARCOM
Parsons Audio
Radio Computing Services, Inc.
Register Data Systems
Tennaplex Systems Ltd
Time & Temperature Company of S.D.
Turtle Beach Systems

Software and Peripherals
AVR Communications Limited
Allied Broadcast Equip Canada
Alpha Products
BJM Electronics Ltd
Century, Inc
Columbine Systems Inc.
Computer Concepts Corporation
Concept Productions
Custom Business Systems, Inc.
Datel Corporation
DigiDesign Inc
Downeast Engineering
Fostex Corp. of America
Jensen Transformers Inc.
Lasalle Music and Pro Audio
Litronix Corporation
The Management
Master Software Systems
Media Computing, Inc.
Nordic Software, Inc.
Parcom
Parsons Audio
Plastic Reel Corp. of America
Pristine Systems, Inc.
Pyramid Audio, Inc.
Radio Computing Services, Inc.
Ramko Research
Register Data Systems
Tennaplex Systems Ltd
Text Technologies, Inc.
Time & Temperature Company of S.D.
Turtle Beach Systems
Doug Vernier Broadcast Consulting

CONSOLES — On-Air
A/V Technology International, Inc.
ATI (Audio Technologies Inc)
AVR Communications Limited
Allen & Heath
Allied Broadcast Canada
Allied International
Amco Engineering Co.
AMEK/TAC U.S. Operations
Arrakis Systems
Audio Broadcast Group, Inc.
AudioLine, Inc.
Audiomedia
Auditronics
Autogram Corp
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Audio Corp
Broadcast Automation Inc
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Continental Electronics
Control Technology Inc.
Dorrough Electronics
Downeast Engineering
BARCO-EMT GmbH
Electronic Industries, Inc.
Full Compass Systems, Ltd.
GLW Enterprises, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Hallikainen & Friends, Inc.
Harris Corp
Harrison by GLW
Holzberg Inc.
Howe Technologies Corporation
Hy James, Inc.
Jim Walters Co.
LPB, Inc.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Logitek Electronic Systems Inc.
Martin Audio/Video Corp
McCurdy Radio Industries
McMartin Industries
Media Touch
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Pierce-Phelps, Inc.
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Systems
Ram Broadcast Systems
Ramko Research
Register Data Systems
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Russco Electronics Mfg. Inc.
Sequoia Electronics
Sony Business & Professional Group
Soundcraft
Studer Revox
Suministros Gonzalez
Telo Technology
Tobias & Company Ltd
Transcom Corporation
UAR Professional Systems
Ward-Beck Systems Ltd.
Wheatstone Corporation
Yamaha Music Corp. of America

Production
A/V Technology International, Inc.
AVC Systems
AVR Communications, Ltd.
Dan Alexander Audio
Allen & Heath
Allen and Heath
Allied Broadcast Canada
Allied International
Amco Engineering Co.
AMEK/TAC U.S. Operations
Arrakis Systems
Audio Broadcast Group, Inc.
Audiologic
Audio Services Corporation
AudioLine, Inc.
Audiotechniques
Auditronics
Autogram Corp
Broadcast Supply West
Barrett Associates, Inc.
BARCO-EMT GmbH
Bradley Broadcast Sales
Broadcast Audio Corp
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Continental Electronics
Control Technology Inc.
DDA
Downeast Engineering
Electronic Industries, Inc.
Full Compass Systems, Ltd.
GLW Enterprises, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Grass Valley Group Inc
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Harrison by GLW
Holzberg Inc.
Howe Technologies Corporation
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Logitek Electronic Systems Inc.
Martin Audio/Video Corp
McCurdy Radio Industries
Milam Audio Co.
Neotek
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Douglas Ordon & Company, Inc.
Otari Corporation
Professional Audio Supply
Pacific Recorders & Engineering
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Systems
Ram Broadcast Systems
Ramko Research
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Russco Electronics Mfg. Inc.
SECK
Sequoia Electronics
Sony Business & Professional Group
Soundcraft
Spectra Sonics
Studer Revox
Suministros Gonzalez
TASCAM
Telo Technology
Tobias & Company Ltd
Transcom Corporation
UAR Professional Systems
Ward-Beck Systems Ltd.
Wheatstone Corporation
Yamaha Music Corp. of America

Remote
AVR Communications, Ltd.
Dan Alexander Audio
Allen & Heath
Allied Broadcast Canada
Allied International
AMEK/TAC U.S. Operations
Audio Broadcast Group, Inc.
Audiologic
AudioLine, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Audio Corp
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Comrex Corporation
Conex Electro-Systems, Inc.
Control Technology Inc.

D D A
Electronic Industries, Inc.
Excalibur Electronics
Full Compass Systems, Ltd.
Furman Sound, Inc.
GLW Enterprises, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Grass Valley Group Inc
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Hallikainen & Friends, Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Logitek Electronic Systems Inc.
Martin Audio/Video Corp
Media Touch
Milam Audio Co.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
RP Communications
Russco Electronics Mfg. Inc.
SECK
Sequoia Electronics
Shure Bros.
Soundcraft
Spectra Sonics
Studer Revox
Studio Technologies
Suministros Gonzalez
Telfax Communications
Tobias & Company Ltd
Tri-Tech, Inc.
UAR Professional Systems
Ward-Beck Systems Ltd.
Yamaha Music Corp. of America
Zercom Corporation

CONSULTING
Engineering and Design Services
A/S Vibration, Inc.
ASC - Tube Traps
AVC Systems
AVR Communications Limited
Allied Broadcast Systems
Audio Concepts and Engineering Services
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Audisar
Barrett Associates, Inc.
Broadcast Equipment Sales & Engineering
CTI Installations, Inc.
Carl T. Jones Corporation
Central Tower, Inc.
Jules Chen & Assoc
Circuit Doctors Inc
Cliff Gill Enterprises, Inc
Cohen, Dippell and Everist, P.C.
Commercial Radio Company
Communications Technologies, Inc
Control Technology Inc
D.N. Latus & Co., Inc.
Dataworld
Datel Corporation
Digital Recorders Inc
Diversified Communications Systems
Downeast Engineering
Electronics Research, Inc.
First Atlantic Group, Inc.
Full Compass Systems, Ltd.
GKM Mfg. Corp.
Ronald J. Grandmaison, P.E. Consultant
Hammett & Edison Inc
Hatfield & Dawson Consult Engr
Holzberg Inc.
Hy James, Inc.
IBSS
IDB Communications Group, Inc
Innovative Automation
Intraplex, Inc.
John Furr and Associates
Kenneth R Meades
Kintronic Laboratories Inc
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lawrence Behr Associates Inc
Lawrence L. Morton Associates
Litronix Corporation
Magrill Engineering
Micro Communications Inc
Milam Audio Co.
Moffet, Larson & Johnson, Inc.
Mullaney Engineering, Inc.
Multiphase Consulting
National Supervisory Network
Northeast Broadcast Lab, Inc.
Nott Ltd.
Fred A. Nudd Corporation
Rick Nudd, Ltd.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Owl Engineering, Inc.
Pacific Recorders & Engineering
Parsons Audio
Paul Dean Ford, P.E.
Pierce-Phelps, Inc.
PMA Marketing
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RPG Diffusor Systems Inc
Radio Systems Engineering
Radiotechniques Engineering Corp
Raines Electromagnetics
Research Associates, Inc.
Ron Radio Communications
RP Communications
RRADCO Group
SG Communications
Sine Systems, Inc.
W Lee Simmons & Associates Inc
Skyline Antenna Management
Spectra Sonics
Spencer Broadcast
Steven L DeLay Co
Steve Vanni Associates
Target Tuning, Inc.
Tennaplex Systems Ltd
Transtector Systems Inc.
UAR Professional Systems
U.S. Tower Services
Doug Vernier Broadcast Consulting
Walter Wulff & Associates
Warren Electronic Systems
Wide Range Electronics Corporation

CONTRACT ENGINEERING SERVICES
AVC Systems
Allied Broadcast Systems
Audio Concepts and Engineering Services
Broadcast Automation Inc
Broadcast Equipment Sales & Engineering
Circuit Doctors Inc
Downeast Engineering
Electronic Research
Full Compass Systems, Ltd.
Funke & Associates
Holzberg Inc.
Imperial Transmitter Worldwide
Innovative Automation
Lasalle Music and Pro Audio
Magrill Engineering
Multiphase Consulting
National Supervisory Network
John Nix
Old Dominion Broadcast Eng. Serv.
Parsons Audio
PMA Marketing
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
Radio Systems Engineering
Research Associates, Inc.
Ron Radio Communications
SG Communications
Skyline Antenna Management
Steven L DeLay Co
Target Tuning, Inc.
U.S. Tower Services
Versatech Industries, Inc.
Warren Electronic Systems

D

DIGITAL AUDIO TAPE (DAT) MACHINES
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Equipment Sales
Broadcast Services Co.
Broadcasters General Store
Concept Productions
Control Technology Inc.
Electronic Industries, Inc.
Fostex Corp. of America
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Corp
Holzberg Inc.
Hy James, Inc.
ICB Audio
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
The Music Director Programming
Nakamichi America Corp
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Radio Systems
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc
Roscom General
Sono-Mag Corporation
Sony Business & Professional Group
Suministros Gonzalez
TASCAM
Tobias & Company Ltd
UAR Professional Systems

DIGITAL AUDIO WORK STATIONS
AKG Acoustics
AVC Systems
AVR Communications, Ltd.
Allied International
Alpha Audio
AudioLine, Inc.
Bradley Broadcast Sales
Broadcast Services Co.
Broadcasters General Store
Century, Inc
Control Technology Inc.
DigiDesign Inc
Full Compass Systems, Ltd.
Harris Allied Broadcast Equipment
Hy James, Inc.
IBSS
International Music Co
Intraplex, Inc.
Kingdom Technology
Lasalle Music and Pro Audio
Lexicon Inc.
The Management
Martin Audio/Video Corp
Media Touch
Milam Audio Co.
New England Digital
New World Music & Sound
Oakwood Audio Labs Ltd.
Orban Associates, Div of AKG
Douglas Ordon & Company, Inc.
Otari Corp
Parsons Audio
Pristine Systems, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
Research Associates Inc
Schafer Digital
Studer Revox
Symetrix Inc.
Turtle Beach Systems
UAR Professional Systems
Waveframe Corporation

DISTRIBUTOR — Regional
AVC Systems
Audiomedia
Bradley Broadcast Sales
Broadcast Equipment Sales &

Engineering
Broadcast Services Co.
Burlington Audio/Video Tapes
Burlington Audio/Video Tapes
Cancomm
Capital Electronics Inc
Clements Company
Crouse-Kimzey
Electrex Company
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Guarantee Radio Supply Corporation
Hall Electronics
Holzberg Inc.
Jim Walters Co.
Lake Systems
Martin Audio/Video Corp
Northeast Broadcast Lab, Inc.
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
RF Specialties of California
RF Specialties of Texas
RF Specialties of Washington, Inc.
Riggins Electronic Sales
Roscom General
Tobias & Company Ltd
UAR Professional Systems
Wide Range Electronics Corp

National
A/V Technology International, Inc.
AVR Communications, Ltd.
Harris Allied Satellite Equipment
American Loop Systems
Audio Broadcast Group, Inc.
Audiotechniques
BJM Electronics Ltd.
Bradley Broadcast Sales
Broadcast Cartridge Service Inc.
Broadcast Services Co.
Broadcasters General Store
Burlington Audio/Video Tapes
Burlington AudiLita Broadcasting Distributors
Litronix Corporation
Martin Audio/Video Corp
Micro Controls, Inc.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sequoia Electronics
Suministros Gonzalez
TTC Wilkinson
Tepco Corporation
Tobias & Company Ltd
Transcom Corporation
Vector Technology Inc

F

FIBER-OPTIC PRODUCTS
ADC Telecommunications, Inc.
Artel Communications Corp
Barrett Associates, Inc.
Cooper Industries/Belden Division
Broadcast Services Co.
Broadcasters General Store
Electronic Systems Laboratories, Inc.
Grass Valley Group Inc
Harris Allied Broadcast Equipment
Holzberg Inc.
IDB Communications Group, Inc
Intraplex, Inc.
Martin Audio/Video Corp
PARCOM
Parsons Audio
Rockwell International
Selco Products
Sony Business & Professional Group

H

HEADPHONES, HEADSETS
AKG Acoustics
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Audio Services Corporation
Audio-Technica U.S., Inc.
AudioLine, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Beyer Dynamic Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
Fostex Corp. of America
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
Nady Systems
Nakamichi America Corp
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Orban associates, Div of AKG
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
R-Columbia Productions
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RTS Systems
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sennheiser Electronic Corporation
Sony Business & Professional Group
Stanton Magnetics Inc.
Suministros Gonzalez
Systems Wireless Ltd.
TASCAM
TOA Electronics Inc
Telex Communications Inc
TV Equipment Assoc Inc
UAR Professional Systems
Yamaha Music Corp. of America

HEADS AND REFURBISHING SERVICES
AVR Communications, Ltd.
American Media Services
Amp Services
R.B. Annis Co Inc.
Barrett Associates, Inc.
Electronic Industries, Inc.
Giesler Broadcasting Supply, Inc.
Hall Electronics
JRF Magnetic Sciences
JRF Magnetic Sciences Inc
Milam Audio Co.
Nortronics Company, Inc.
Parcom
Parsons Audio
Research Associates Inc
Riggins Electronic Sales
Saki Magnetics Inc.
Sequoia Electronics
Sprague Magnetics
VIF International

I

INTERCOMS
AVC Systems
AVR Communications, Ltd.
Aiphone Intercom Systems
Allied Broadcast Canada
Allied International
Atlas/Soundolier
Audio Services Corporation
Auditronics
Best Audio
Beyer Dynamic Inc.
Bogen Communications, Inc.
Broadcast Services
Broadcasters General Store
Clear-Com Systems
D.N. Latus & Co., Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Gentner Electronics Corporation
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
New World Music & Sound
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
R-Columbia Productions
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
ROH
RTS Systems
Ram Broadcast Systems
Roscom General
Studio Technologies
Swintek Enterprises, Inc.
Systems Wireless Ltd.
TOA Electronics Inc
Telectro Systems Corporation
Telex Communications Inc
Vega, Wireless
Ward-Beck Systems Ltd.

L

LIGHTNING PROTECTION AND POWER CONDITIONING
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Barrett Associates, Inc.
Best Power Technology, Inc.
Broadcast Equipment Sales & Engineering
Broadcasters General Store
Cancomm
Capital Electronics Inc
Columbine Systems Inc.
Comad Communications Limited
Commercial Radio Company
Continental Electronics
Cortana Corporation
Current Technology, Inc.
Peter W. Dahl Co., Inc.
Electronic Industries, Inc.
Energy Control Systems
Full Compass Systems, Ltd.
Furman Sound, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Kintronic Laboratories Inc
Lightning Eliminators
Lita Broadcasting Distributors
Litronix Corporation
MCG Electronics Inc.
John Nix
Northeast Broadcast Lab, Inc.
Professional Audio Supply
Paramount Communications Systems
Parcom
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Roscom General
Suministros Gonzalez
Transtector Systems Inc.

M

MACHINE SYNCHRONIZERS FOR ATRS
AVC Systems
Audio Broadcast Group, Inc.
AudioLine, Inc.
Audiotechniques
Bradley Broadcast Sales
Broadcast Services Co.
Control Technology Inc.
Harris Allied Broadcast Equipment
Hy James, Inc.

Jim Walters Co.
Lasalle Music and Pro Audio
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
UAR Professional Systems

MICROPHONES AND ACCESSORIES
AKG Acoustics
AVC Systems
AVR Communications, Ltd.
Accurate Sound Corporation
Dan Alexander Audio
Allied Broadcast Canada
Allied International
American Media Services
Atlas/Soundolier
Audio Broadcast Group, Inc.
Audio Services Corporation
Audio-Technica U.S., Inc.
AudioLine, Inc.
Audiomedia
Audiotechniques
Audix Corp
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Best Audio
Beyer Dynamic Inc.
Bogen Communications, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Bruel & Kjaer Instruments, Inc.
Capital Electronics Inc
Continental Electronics
Control Technology Inc.
Electro-Voice Inc
Electronic Industries, Inc.
Fostex Corp. of America
Full Compass Systems, Ltd.
Fusion Electronics, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milab
Milam Audio Co.
Nady Systems
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Old Dominion Broadcast Eng. Serv.
Orban associates, Div of AKG
Douglas Ordon & Company, Inc.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
PMA Marketing
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
R-Columbia Productions
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Design Labs
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Roscom General
Sennheiser Electronic Corporation
Shure Bros.
Sony Business & Professional Group
Studio Technologies
Suministros Gonzalez
Swintek Enterprises, Inc.
Systems Wireless Ltd.
TASCAM
TOA Electronics Inc
Telex Communications Inc
Milab
Tobias & Company Ltd
Vega, Wireless
Yamaha Music Corp. of America

MICROWAVE EQUIPMENT
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Services Co.
Broadcasters General Store
Cablewave Systems, Div of RFS
Cancomm
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
Environmental Technology, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
IBSS
J.N.S. Electronics Inc
Radiation Systems, Inc.
Marti Electronics, Inc.
Micro Controls, Inc.
Narda Microwave Corp
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Parcom
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Rockwell International
Ron Radio Communications
TFT Inc.
Tobias & Company Ltd
Verda Corp
Will-Burt Co.

MIDI EQUIPMENT
ART, Applied Research & Tech
AVC Systems
Aphex Systems, Ltd.
Audiologic
Audio Services Corporation
Audiotechniques
Barrett Associates, Inc.
Bradley Broadcast Sales
Broacast Services
Broadcasters General Store
Full Compass Systems, Ltd.
Harris Allied Broadcast Equipment
International Music Co
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Professional Audio Supply
Parsons Audio
Peavey Electronics Corporation
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
Rane Corporation
Sony Business & Professional Group
TASCAM
360 Systems
Turtle Beach Systems
UAR Professional Systems
Yamaha Music Corp. of America

MOBILE PRODUCTION VANS
Audio Broadcast Group, Inc.
Broadcast Services Co.
Harris Allied Broadcast Equipment
IDB Communications Group, Inc
Pierce-Phelps, Inc.
Pyramid Audio, Inc.
RF Specialties of Missouri
RRADCO Group

MONITORS — AM
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Belar Electronics Laboratory, Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Commercial Radio Company
Continental Electronics
Control Technology Inc.
Delta Electronics Inc.
Downeast Engineering
Electronic Industries, Inc.
Funke & Associates
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
Inovonics, Inc
J.N.S. Electronics, Inc.
J-Squared Technical Serivce
Jim Walters Co.
Motorola Inc./AM Stereo
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
TFT Inc.
Tobias & Company Ltd
Transcom Corporation

FM
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Belar Electronics Laboratory, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Continental Electronics
Control Technology Inc.
Downeast Engineering
Electronic Industries, Inc.
Funke & Associates
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
Inovonics, Inc
J.N.S. Electronics, Inc.
J-Squared Technical Serivce
Jim Walters Co.
Modulation Sciences, Inc.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
Pro Media
QEI Corporation
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Design Labs
Research Associates, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
TFT Inc.
Tobias & Company Ltd
Transcom Corporation

MUSIC LIBRARIES
AVR Communications, Ltd.
Airforce Broadcast Services Inc.
Allied Broadcast Canada
Allied International
AudioLine, Inc.
Barrett Associates, Inc.
Broadcast Programming
CaVox/Tape-athon Corporation

Century 21 Programming, Inc.
Classical Music Syndication
Control Technology Inc.
Creative Support Services
Drake-Chenault
Hy James, Inc.
Jay Mitchell Assoc
The Music Director Programming
PMA Marketing
Promusic, Inc.
Pyramid Audio, Inc.
Schafer Digital
Sopersound Music Library
Sound Ideas
Suministros Gonzalez
Summit Software Systems Inc
Tape-athon/Cavox
UAR Professional Systems
Valentino Production Music & Sound

N

NRSC EQUIPMENT
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Broadcast Supply West
BARCO-EMT GmbH
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Circuit Research Labs
Cancomm
Continental Electronics Corporation
Control Technology Inc
Delta Electronics Inc.
Electronic Industries, Inc.
Funke & Associates
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hnat Hindes
Holzberg Inc.
IBSS
Inovonics
Jim Walters Co.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Orban a Division of AKG Acoustics
Professional Audio Supply
Parcom
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Design Labs
Research Associates Inc
Ron Radio Communications
Suministros Gonzalez
Tobias & Company Ltd

NOISE REDUCTION EQUIPMENT
ART, Applied Research & Tech
AVC Systems
AVR Communications, Ltd.
Dan Alexander Audio
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiotechniques
Auditronics
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Control Technology Inc.
DBX Professional Products
Dolby Laboratories Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Lasalle Music and Pro Audio
Marti Electronics, Inc.
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Douglas Ordon & Co Inc
Professional Audio Supply
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Research Associates, Inc.
Roscom General
A/S Vibration, Inc.
Suministros Gonzalez
Symetrix, Inc
Tectan Inc
That Corporation
UAR Professional Systems
Valley International

P

PATCH PANELS, JACKS, PLUGS, CONNECTORS
ADC Telecommunications, Inc.
AVC Systems
AVR Communications, Ltd.
Acoustilog, Inc.
Allied Broadcast Canada
Allied International
American Media Services
Audio Accessories
AudioLine, Inc.
Audiotechniques
Auditronics
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Canare Cable Inc.
Commercial Radio Company
Connectronics Corporation
Continental Electronics Corporation
Control Technology Inc.
Dielectric Communications
Downeast Engineering
Electronic Industries, Inc.
Fostex Corp
Full Compass Systems, Ltd.
Furman Sound, Inc.
Fusion Electronics, Inc.
Gaines Audio
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
IBSS
Jim Walters Co.
Kings Electronics Co., Inc.
Kintronic Laboratories Inc
Landy Associates, Inc.
Lasalle Music and Pro Audio
Major Custom Cable
Martin Audio/Video Corp
McCurdy Radio Industries
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Penny & Giles
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Shively Labs
Suministros Gonzalez
Switchcraft, Inc.
TASCAM
Tennaplex Systems Ltd
Trimm Inc.
Trompeter Electronics
UAR Professional Systems
Wireworks Corp
Zercom Corporation

PHASORS
AVR Communications, Ltd.
Dan Alexander Audio
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Barrett Associates, Inc.
Broadcast Equipment Sales & Engineering
Broadcasters General Store
Commercial Radio Company
Continental Electronics
Delta Electronics Inc.
Elcom Bauer
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Kintronic Labs
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RF Systems
Ron Radio Communications
Roscom General
Suministros Gonzalez
Tobias & Company Ltd
Vector Technology Inc

PHONO — Cartridges
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Audio-Technica U.S., Inc.
AudioLine, Inc.
Audiotechniques
BARCO-EMT GmbH
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Capital Electronics Inc
Control Technology Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Stanton Magnetics Inc.
Suministros Gonzalez
UAR Professional Systems

Turntables and Tone Arms
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International

American Media Services
Audio Broadcast Group, Inc.
AudioLine, Inc.
Audiotechniques
BARCO-EMT GmbH
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Henry Engineering
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Russco Electronics Mfg. Inc.
Sequoia Electronics
Suministros Gonzalez
UAR Professional Systems

POWER SUPPLIES AND GENERATORS
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Services Corporation
Barrett Associates, Inc.
Beckman Industrial Corporation
Best Power Technology, Inc.
Broadcasters General Store
Current Technology, Inc.
Full Compass Systems, Ltd.
Guarantee Radio Supply Corporation
Hall Electronics
Holzberg Inc.
J.N.S. Electronics, Inc.
Jim Walters Co.
Lasalle Music and Pro Audio
Norac Industrial Services Inc.
OPAMP Inc.
Professional Audio Supply
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Washington
RTS Systems
Solar SignAge, Inc.
Spectra Sonics
Transtector Systems Inc.
Wide Range Electronics Corporation

PROCESSING
Audio EQ and Limiting
ART, Applied Research & Tech
ATI (Audio Technologies Inc)
AVC Systems
AVR Communications, Ltd.
Dan Alexander Audio
Allied Broadcast Canada
Allied International
Aphex Systems, Ltd.
Ashly Audio, Inc.
Audio Animation
Audio Broadcast Group, Inc.
Audio Concepts and Engineering Services
Audiologic
AudioLine, Inc.
Audiomedia
Audiotechniques
BARCO-EMT GmbH
Auditronics
BSS
Broadcast Supply West
BEE Sound, Inc.
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Circuit Research Labs
Continental Electronics Corporation
Control Technology Inc.
Cutting Edge Technologies
DBX Professional Products
Delta Electronics Inc.
Dorrough Electronics
Downeast Engineering
Electro-Voice Inc.
Electronic Industries, Inc.
Eventide Clockworks
Full Compass Systems, Ltd.
Furman Sound, Inc.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Hnat Hindes
Holzberg Inc.
Hy James, Inc.
IBSS
Inovonics
JBL Professional
J.N.S. Electronics, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Logitek
Martin Audio/Video Corp
Milam Audio Co.
Modulation Sciences, Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Orban a Division of AKG Acoustics
Douglas Ordon & Co Inc
Professional Audio Supply
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
PMA Marketing
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Rane Corporation
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Roscom General
Klark Teknik Electronics Inc.
Sequoia Electronics
Sescom Inc.
Somich Engineering
Sony Business & Professional Group
Suministros Gonzalez
Symetrix Inc.
That Corporation
TOA Electronics Inc
Tobias & Company Ltd
UAR Professional Systems
Urei
Valley International
Ward-Beck Systems Ltd.
Yamaha Music Corp. of America

Studio Effects
AKG Acoustics
ART, Applied Research & Tech
AVC Systems
AVR Communications, Ltd.
Dan Alexander Audio
Allied International
Aphex Systems, Ltd.
Ashly Audio, Inc.
Audio Broadcast Group, Inc.
Audio Concepts and Engineering Services
Audiologic
Audio/Digital, Inc.
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
BEE Sound, Inc.
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Circuit Research Labs
Control Technology Inc.
DBX Professional Products
BARCO-EMT GmbH
Electronic Industries, Inc.
Eventide Clockworks
Full Compass Systems, Ltd.
Furman Sound, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Klark-Teknik
Lasalle Music and Pro Audio
Lexicon Inc.
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Orban a Division of AKG Acoustics
Douglas Ordon & Company, Inc.
Professional Audio Supply
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pyramid Audio, Inc.
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Research Associates, Inc.
Roscom General
Klark Teknik Electronics Inc.
Spectra Sonics
Studio Technologies
Suministros Gonzalez
Titus Technologies Lab
Tobias & Company Ltd
UAR Professional Systems
Valley International
Yamaha Music Corp. of America

PROGRAM DISTRIBUTORS AND SERVICES
Broadcast Programming
CaVox/Tape-athon Corporation
Classical Music Syndication
Concept Productions
Drake-Chenault
IDB Communications Group, Inc
Jay Mitchell Assoc
The Music Director Programming
Zephyr Weather Information Service

PUBLIC ADDRESS (PA) SYSTEMS
AVC Systems
AVR Communications, Ltd.
American Loop Systems
Ashly Audio, Inc.
Atlas/Soundolier
Audio Services Corporation
Audisar
BEE Sound, Inc.
Best Audio
Bogen Communications, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Capital Electronics Inc
Control Technology Inc.
Electro-Voice Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Furman Sound, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Hy James, Inc.
JBL Professional
Lasalle Music and Pro Audio
Milam Audio Co.
New World Music & Sound
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
RF Specialties of Texas
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc

TOA Electronics Inc
Telectro Systems Corporation

R

RF FILTERS
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Barrett Associates, Inc.
Bird Electronics Corporation
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Cancomm
Coaxial Dynamics Inc
Comark Communications
Commercial Radio Company
Dielectric Communications
Electronic Industries, Inc.
Electronics Research, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
LDL Communications
Lasalle Music and Prc Audio
Micro Communications Inc
Microwave Filter
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RF Systems
Roscom General
Spectra Sonics
Tennaplex Systems Ltd
Tepco Corporation
Tobias & Company Ltd
Vector Technology Inc

RECEIVERS — Radio
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Services Corporation
Broadcast Supply West
Barrett Associates, Inc.
Bext Inc.
Bogen Communications, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Control Technology Inc.
Electronic Industries
Erko Technologies
Full Compass Systems, Ltd.
Gorman Redlich Mfg. Co.
Grant Becker Enterprises
Hall Electronics
Hamtronics Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
J.N.S. Electronics, Inc.
Jim Walters Co.
Lasalle Music and Pro Audio
Marti Electronics, Inc.
Motorola Inc./AM Stereo
Nady Systems
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Washington, Inc.
Research Associates, Inc.
Roscom General
Target Tuning, Inc.

Satellite
AVCOM of Virginia, Inc.
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
Antenna Technology Corporation
Broadcast Services Co.
ComStream Corp
Control Technology Inc.
Downeast Engineering
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
IDB Communications Group, Inc
Intraplex, Inc.
Satellite Systems Corp
PARCOM
RF Specialties of Pennsylvania, Inc.
Tennaplex Systems Ltd
Wegener Communications, Inc.

SCA
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Antenna Technology Corporation
Applied Micro Technology, Inc.
Avocet Instruments
Broadcast Supply West
Barrett Associates, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Cancomm
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
Erko Technologies
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
J.N.S. Electronics Inc
Lita Broadcasting Distributors
Marti Electronics, Inc.
Micro Controls, Inc.
Modulation Sciences, Inc.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Target Tuning, Inc.
Tennaplex Systems Ltd

REEL-TO-REEL RECORDERS
AVC Systems
AVR Communications, Ltd.
Accurate Sound Corporation
Dan Alexander Audio
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Automation, Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
CaVox/Tape-athon Corporation
Continental Electronics
Control Technology Inc.
Downeast Engineering
Electronic Industries, Inc.
Fostex Corp. of America
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Otari Corporation
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Sequoia Electronics
Sono-Mag Corporation
Studer Revox
Suministros Gonzalez
TASCAM
Tape-athon/Cavox
Telectro Systems Corporation
Tobias & Company Ltd
UAR Professional Systems
Uher of America
VIF International
Wide Range Electronics Corporation

REMOTE CONTROL AND TELEMETRY
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burk Technology, Inc.
Cancomm
Commercial Radio Company
Continental Electronics
Control Technology Inc.
Delta Electronics Inc.
Downeast Engineering
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Hallikainen & Friends, Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
J-Squared Technical Serivce
Marti Electronics, Inc.
Micro Controls, Inc.
Monroe Electronics, Inc.
Moseley Associates
National Supervisory Network
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Schmid Telecomm. America Inc
Sine Systems, Inc.
Solar SignAge, Inc.
Sony Business & Professional Group
Suministros Gonzalez
TFT Inc.
Telo Technology
Telular, Inc.
Tobias & Company Ltd
Versatech Industries, Inc.
Warren Electronic Systems

S

SCA EQUIPMENT
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Applied Micro Technology, Inc.
Audio Broadcast Group, Inc.
Avocet Instruments
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burk Technology, Inc.
CaVox/Tape-athon Corporation
Cancomm
Continental Electronics
Control Technology Inc.
Cutting Edge Technologies
Electronic Industries, Inc.
Erko Technologies
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.

Hy James, Inc.
J.N.S. Electronics Inc
J-Squared Technical Serivce
Marti Electronics, Inc.
McMartin Industries
Micro Controls, Inc.
Modulation Sciences, Inc.
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Orban a Division of AKG Acoustics
Professional Audio Supply
Parcom
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Suministros Gonzalez
TFT Inc.
TOA Electronics Inc
Tape-athon/Cavox
Tennaplex Systems Ltd
That Corporation
Tobias & Company Ltd

SATELLITE EQUIPMENT

Antennas

AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
Andrew Corporation
Antenna Technology Corporation
Antennas for Communications, Inc.
Bradley Broadcast Sales
Broadcast Services Co.
Comex Worldwide Corporation
ComStream Corp
Comtech Antenna Systems, Inc.
Downeast Engineering
Environmental Technology, Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
IDB Communications Group, Inc
Satellite Systems Corp
John Nix
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
RF Specialties of Pennsylvania, Inc.
Scientific Atlanta
Tennaplex Systems Ltd

Electronics

AVC Systems
AVCOM of Virginia, Inc.
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
Antenna Technology Corporation
Bradley Broadcast Sales
Broadcast Automation Inc
Broadcast Services Co.
Comex Worldwide Corporation
ComStream Corp
Dolby Laboratories Inc.
Downeast Engineering
Guarantee Radio Supply Corporation
Hall Electronics
Hallikainen & Friends, Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
IDB Communications Group, Inc
Intraplex, Inc.
Kingdom Technology
Satellite Systems Corp
Narda Microwave Corp
PMA Marketing
RF Specialties of Pennsylvania, Inc.
Schafer Digital
Scientific Atlanta
Sine Systems, Inc.
Tectan Inc
Tennaplex Systems Ltd
Wegener Communications, Inc.

SPEAKERS AND ENCLOSURES

AVC Systems
AVR Communications, Ltd.
Aiphone Intercom Systems
Allied Broadcast Canada
Allied International
American Media Services
Atlas/Soundolier
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiomedia
Audisar
Audix Corp
Auernheimer Labs and Co.
Auratone Corporation
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Bogen Communications, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Continental Electronics Corporation
Control Technology Inc.
Electro-Voice Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
JBL Professional
Jim Walters Co.
Klark-Teknik
Landy Associates, Inc.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Numark Electronics Corp.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Roscom General
Spectra Sonics
Suministros Gonzalez
TASCAM
TOA Electronics Inc
Tannoy North America
Telectro Systems Corporation
Urei
Wohler Technologies
Yamaha Music Corp. of America

STL EQUIPMENT

AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Artel Communications Corp
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Bext Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cancomm
Continental Electronics
Control Technology Inc.
Electronic Industries, Inc.
Funke & Associates
Giesler Broadcasting Supply, Inc.
Graham-Patten Systems
Grant Becker Enterprises
Hall Electronics
Hamtronics Inc.
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
Intraplex, Inc.
J.N.S. Electronics Inc
J-Squared Technical Serivce
Leaming Industries
Lita Broadcasting Distributors
Litronix Corporation
Marti Electronics, Inc.
Micro Controls, Inc.
Moseley Associates
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RF Systems (Div of Audio Electronics)
Ron Radio Communications
Roscom General
Suministros Gonzalez
Systems Wireless Ltd.
TFT Inc.
Tectan Inc
Telular, Inc.
Tobias & Company Ltd
Transcom Corporation
Wegener Communications, Inc.

SWITCHERS, AUDIO ROUTING

AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Harris Allied Satellite Equipment
BARCO-EMT GmbH
BJM Electronics Ltd.
BSM Systems
Broadcast Supply West
Barrett Associates, Inc.
Best Audio
Bradley Broadcast Sales
Broadcast Services Co.
Broadcasters General Store
Chrontrol Corporation
Conex Electro-Systems, Inc.
Control Technology Inc.
DHK Group
Di-Tech Inc.
ESE
Electronic Industries, Inc.
Full Compass Systems, Ltd.
GLW Enterprises, Inc.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Grass Valley Group Inc
Hall Electronics
Harris Allied Broadcast Equipment
Harrison by GLW
Holzberg Inc.
Hy James, Inc.
International Tapetronics
J.N.S. Electronics, Inc.
Jim Walters Co.
Landy Associates, Inc.
Logitek Electronic Systems Inc.
Martin Audio/Video Corp
McCurdy Radio Industries
Micro Controls, Inc.
Milam Audio Co.
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Pyramid Audio, Inc.
RE Instruments Corp
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ram Broadcast Systems
Ramko Research
Research Associates, Inc.
Roscom General
Sine Systems, Inc.
Sony Business & Professional Group
Telfax Communications
360 Systems
Titus Technological Laboratories
Versatech Industries, Inc.
Wheatstone Corporation
Wide Range Electronics Corporation
Yamaha Music Corp. of America

T

TAPE — Cartridge

A/V Technology International, Inc.
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Audiodyne Bdct Cartridge

AudioLine, Inc.
Audiomedia
Audiopak, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Cartridge Service Inc.
Broadcast Cart Rewinding Service
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burlington Audio/Video Tapes
Continental Electronics Corporation
Control Technology Inc.
Electronic Industries, Inc.
Fidelipac Corporation
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
International Tapetronics
J & I Audio/Video
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Marathon Products
Martin Audio/Video Corp
Milam Audio Co.
National Audio Co. Inc.
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
PMA Marketing
Pro Media
Pyramid Audio, Inc.
R & A Broadcast Services
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Sequoia Electronics
Sony Business & Professional Group
Suministros Gonzalez
Tapex Corp
UAR Professional Systems
Western International

Cassette
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Ampex Recording Media Corporation
Audio Broadcast Group, Inc.
Audio Services Corporation
Audiodyne Bdct Cartridge
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Cartridge Service Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burlington Audio/Video Tapes
Drake-Chenault
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
J & I Audio/Video
Jim Walters Co.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
Music Director Programming
Nakamichi America Corp
National Audio Co. Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Raks Corporation of America, Inc.
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc
Ron Radio Communications
Sony Business & Professional Group
Suministros Gonzalez
UAR Professional Systems

DAT
A/V Technology International, Inc.
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Ampex Recording Media Corporation
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Cartridge Service Inc.
Broadcast Equipment Sales & Engineering
Broacast Services
Broadcasters General Store
Burlington Audio/Video Tapes
Concept Productions
Dic Digital
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
J & I Audio/Video
Jim Walters Co.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
The Music Director Programming
Nakamichi America Corp
National Audio Co. Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Professional Audio Supply
Panasonic/Ramsa
Panasonic/Prof Audio Systems
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Radio Systems
Raks Corporation of America, Inc.
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc
Sony Business & Professional Group
Suministros Gonzalez
UAR Professional Systems

Reel-to-Reel
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Ampex Recording Media Corporation
Audio Broadcast Group, Inc.
Audio Services Corporation
AudioLine, Inc.
Audiopak, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Cartridge Service Inc.
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burlington Audio/Video Tapes
Drake-Chenault
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
J & I Audio/Video
Jim Walters Co.
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Martin Audio/Video Corp
Milam Audio Co.
The Music Director Programming
National Audio Co. Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Sony Business & Professional Group
Suministros Gonzalez
UAR Professional Systems
VIF International

Cleaners, Erasers, and Evaluators
AVC Systems
AVR Communications Limited
Accurate Sound Corporation
Allied Broadcast Canada
Allied International
American Media Services
R. B. Annis Co, Inc.
Audio Broadcast Group, Inc.
Audio Concepts and Engineering Services
Audiolab Electronics, Inc.
AudioLine, Inc.
Audiotechniques
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Burlington Audio/Video Tapes
Comad Communications Limited
Electronic Industries, Inc.
Fidelipac Corporation
Full Compass Systems, Ltd.
Garner Industries
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Hall Electronics
Holzberg Inc.
Hy James, Inc.
International Tapetronics
Lasalle Music and Pro Audio
Lauderdale Electronic Labs
Magnefax International, Inc.
Marathon Products
Martin Audio/Video Corp
Microtran Company
Milam Audio Co.
National Audio Co. Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
RTI (Research Tech Intl)
Research Associates Inc
Research Technology International
Riggins Electronic Sales
Suministros Gonzalez
TASCAM
UAR Professional Systems
VIF International
Wide Range Electronics Corporation

Duplicators
AVC Systems

AVR Communications, Ltd.
Accurate Sound Corporation
Allied Broadcast Canada
Audio Broadcast Group, Inc.
AudioLine, Inc.
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales
Broadcast Services Co.
Control Technology Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Magnefax International, Inc.
Milam Audio Co.
The Music Director Programming
Nakamichi America Corp
National Audio Co. Inc.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Otari Corporation
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Raks Corporation of America, Inc.
Research Associates, Inc.
Ritz Audio-Visual Associates, Inc
Sony Business & Professional Group
Suministros Gonzalez
TASCAM
Telectro Systems Corporation
Telex Communications Inc
UAR Professional Systems
Valentino Production Music & Sound
Wide Range Electronics Corp

TELEPHONE EQUIPMENT

Hybrids

AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Broadcast Group, Inc.
Audio/Digital, Inc.
AudioLine, Inc.
Audiomedia
BJM Electronics Ltd
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Comrex Corporation
Control Technology Inc.
ESE
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Graham-Patten Systems
Grant Becker Enterprises
H & E Micro-trak Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Henry Engineering
Holzberg Inc.
Hy James, Inc.
IBSS
Intraplex, Inc.
Jim Walters Co.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Martin Audio/Video Corp
Microtran Company
Milam Audio Co.
Monroe Electronics, Inc.
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Sound America Corporation
Suministros Gonzalez
Symetrix Inc.
Tape A Thon/Cavox Corp
Telos Systems
Telfax Communications
Time & Temperature Company of S.D.
Tri-Tech, Inc.
Zercom Corporation

Bandwidth Extenders

AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
AudioLine, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales
Broadcast Services Co.
Broadcasters General Store
Comrex Corporation
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Gentner Electronics Corporation
Giesler Broadcasting Supply, Inc.
Graham-Patten Systems
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
IBSS
Jim Walters Co.
Lasalle Music and Pro Audio
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pro Media
Pyramid Audio, Inc.
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington
Ron Radio Communications
Suministros Gonzalez
Telfax Communications
Telular, Inc.
Titus Technologies Lab

TEST EQUIPMENT

Distortion Analyzers

AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Amber Electro Design Inc.
Audio Precision
BARCO-EMT GmbH
Broadcast Supply West
Barrett Associates, Inc.
Broadcast Services Co.
Bruel & Kjaer Instruments, Inc.
Commercial Radio Company
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Funke & Associates
Guarantee Radio Supply Corporation
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Hy James, Inc.
Jampro Antennas Inc
Landy Associates, Inc.
Northeast Broadcast Lab, Inc.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Potomac Instruments, Inc.
RE Instruments Corp
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Sound Technology
Suministros Gonzalez
TFT Inc.
Tektronix Inc

Oscilloscopes

A/V Technology International, Inc.
AVC Systems
AVR Communications, Ltd.
A. W. Sperry Instruments
Allied Broadcast Canada
Allied International
BJM Electronics Ltd.
Barrett Associates, Inc.
Beckman Industrial Corporation
Broadcast Services Co.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
Northeast Broadcast Lab, Inc.
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
RF Specialties of Missouri
Ram Broadcast Systems
Suministros Gonzalez
Tektronix Inc

RF Radiation Test Gear

AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Anritsu America Inc
Barrett Associates, Inc.
Bird Electronics Corporation
Commercial Radio Company
Holaday Industries Inc.
Jampro Antennas Inc
Narda Microwave Corp
Professional Audio Supply
RF Specialties of Missouri
Verda Corp

Spectrum Analyzers

AVC Systems
AVCOM of Virginia, Inc.
Allied Broadcast Canada
Allied International
Amber Electro Design Inc.
Anritsu America Inc
Antenna Technology Corporation
AudioControl Industrial
Audio Precision
Audiotechniques
Barrett Associates, Inc.
Broadcast Services Co.
Broadcasters General Store
Bruel & Kjaer Instruments, Inc.
Delta Electronics Inc.
BARCO-EMT GmbH
Full Compass Systems, Ltd.
Funke & Associates
Harris Allied Broadcast Equipment
Hartmann Associates
IFR Systems Inc.
IVIE
Jampro Antennas Inc
Klark-Teknik
Landy Associates, Inc.
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Numark Electronics Corp.
Douglas Ordon & Co Inc
Professional Audio Supply
Parsons Audio
Pierce-Phelps, Inc.
Posthorn Recordings
Pyramid Audio, Inc.
RF Specialties of Missouri
Sound Technology
Tektronix Inc
White Instruments

Test Systems

ADC Telecommunications, Inc.
AVC Systems
AVR Communications, Ltd.
Allied International
Amber Electro Design Inc.
R. B. Annis Co, Inc.
Audio Precision
Audisar
Beckman Industrial Corporation
Belar Electronics Laboratory, Inc.
Bird Electronics Corporation
Broacast Services
Bruel & Kjaer Instruments, Inc.
Commercial Radio Company
Delta Electronics Inc.
Dorrough Electronics
Full Compass Systems, Ltd.
Funke & Associates
Gaines Audio
Hall Electronics
Harris Allied Broadcast Equipment
Hartmann Associates
Holzberg Inc.
J.N.S. Electronics, Inc.
Landy Associates, Inc.
Magnetic reference Lab
Northeast Broadcast Lab, Inc.
Douglas Ordon & Company, Inc.
Professional Audio Supply
Parcom

Parsons Audio
Potomac Instruments, Inc.
RE Instruments Corp
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
Radio Design Labs
Schmid Telecomm. America Inc
Selco Products
Sescom Inc.
Sound Technology
TFT Inc.
Tennaplex Systems Ltd
Tentel Corporation
Wohler Technologies

TIME CODE EQUIPMENT
AVC Systems
AVR Communications, Ltd.
Allied International
Audio Broadcast Group, Inc.
Audio Services Corporation
Audiotechniques
Bradley Broadcast Sales
Broadcast Services Co.
Broadcasters General Store
Control Technology Inc.
ESE
Fostex Corp. of America
Full Compass Systems, Ltd.
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
JRF Magnetic Sciences Inc
Jim Walters Co.
Landy Associates, Inc.
Lasalle Music and Pro Audio
Martin Audio/Video Corp
Milam Audio Co.
Northeast Broadcast Lab, Inc.
Douglas Ordon & Company, Inc.
Otari Corporation
Professional Audio Supply
Parcom
Parsons Audio
Peavey Electronics Corporation
Posthorn Recordings
Pyramid Audio, Inc.
RF Specialties of Missouri
Research Associates, Inc.
Sony Business & Professional Group
Turtle Beach Systems
UAR Professional Systems
Wide Range Electronics Corporation

TIMERS AND CLOCKS
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
American Media Services
Audio Broadcast Group, Inc.
Auditronics
Autogram Corp
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Chrontrol Corporation
Conex Electro-Systems, Inc.
Continental Electronics Corporation
Control Technology Inc.
ESE
Electronic Industries, Inc.
GLW Enterprises, Inc.
Grant Becker Enterprises
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
Jim Walters Co.
Landy Associates, Inc.
Martin Audio/Video Corp
Monroe Electronics, Inc.
Northeast Broadcast Lab, Inc.
Oakwood Audio Labs Ltd.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Pacific Recorders & Engineering
Parcom
Parsons Audio
Pierce-Phelps, Inc.
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Radio Systems
Research Associates, Inc.
Roscom General
Sequoia Electronics
Sine Systems, Inc.
Sony Business & Professional Group
Suministros Gonzalez
Time & Temperature Company of S.D.

TOOLS AND GAUGES
Audiotechniques
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Broadcast Services Co.
Canare Cable Inc.
Capital Electronics Inc
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Guarantee Radio Supply Corporation
Martin Audio/Video Corp
Professional Audio Supply
Paladin Corporation
Suministros Gonzalez
Vertigo
Brian R. White Co., Inc.

TOWERS
Aluma Tower Company, Inc.
American Media Services
Andrew Corporation
Barrett Associates, Inc.
Broadcast Comm Systems Inc
CTI Installations, Inc.
Capital Electronics Inc
Central Tower, Inc.
Continental Electronics
ERI Installations
Electronic Industries, Inc.
Electronic Research
Express Tower Co. Inc.
Fort Worth Tower Inc
Guarantee Radio Supply Corporation
Hall Electronics
Mart Haller Co.-Exporters
Harmon's Tower Service
Harris Allied Broadcast Equipment
Holzberg Inc.
LDL Communications
Lita Broadcasting Distributors
Magnum Towers, Inc.
John Nix
Fred A. Nudd Corporation
Professional Audio Supply
Paramount Communications Systems
Parcom
Pirod Inc
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Ron Radio Communications
Roscom General
SG Communications
Skyhawk Communications
Skyline Antenna Management
Southern Tower Service Co., Inc.
Suministros Gonzalez
Telex Communications Inc
Tower Structures, Inc
Transmission Structures Ltd.
UNR ROHN Inc
U.S. Tower Services
Utility Tower Company

Guys & Lights
AVR Communications Limited
Aluma Tower Company, Inc.
American Media Services
Andrew Corporation
Barrett Associates, Inc.
Broadcast Comm Systems Inc
Central Tower, Inc.
Continental Electronics
Cortland Cable Company
ERI Installations
Electronic Industries
Express Tower Co. Inc.
Flash Technology
Fort Worth Tower Inc
Guarantee Radio Supply Corporation
Mart Haller Co.-Exporters
Harmon's Tower Service
Holzberg Inc.
LDL Communications
Lauderdale Electronic Labs
Lita Broadcasting Distributors
Magnum Towers, Inc.
John Nix
Fred A. Nudd Corporation
Rick Nudd, Ltd.
Professional Audio Supply
Paramount Communications Systems
Pirod Inc
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates, Inc.
Ron Radio Communications
Roscom General
Skyhawk Communications
Southern Tower Service Co., Inc.
Suministros Gonzalez
Transmission Structures Ltd.
UNR ROHN Inc
U.S. Tower Services
United Ropeworks
Utility Tower Company

Tower Services
Andrew Corporation
Broadcast Communications Systems
CTI Installations, Inc.
Central Tower, Inc.
ERI Installations
Express Tower Co. Inc.
Fort Worth Tower Inc
Guarantee Radio Supply Corporation
Harmon's Tower Service
LDL Communications
John Nix
Fred A. Nudd Corporation
Old Dominion Broadcast Eng. Serv.
Paramount Communications Systems
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates Inc
SG Communications
Sky Tower Service
Skyhawk Communications
Southern Tower Service Co., Inc.
Tenco Tower Company
Transmission Structures Ltd.
U.S. Tower Services
Utility Tower Company

TRAFFIC
Columbine Systems Inc.
Custom Business Systems, Inc.
The Management
Master Software Systems
Summit Software Systems Inc

TRANSFORMERS — Audio
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Audio Services Corporation
Audisar
BJM Electronics Ltd.
Barrett Associates, Inc.
Bogen Communications, Inc.
Broadcasters General Store
Commercial Radio Company
Control Technology Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Fusion Electronics, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Jensen Transformers Inc.
Major Custom Cable
Microtran Company
Milam Audio Co.
Old Dominion Broadcast Eng. Serv.
OPAMP Inc.
Professional Audio Supply
Parcom
Peavey Electronics Corporation
Pierce-Phelps, Inc.
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
Radio Design Labs
Research Associates, Inc.
Riggins Electronic Sales
Ron Radio Communications
Russco Electronics Mfg. Inc.
Sescom Inc.
Spectra Sonics
Suministros Gonzalez

RF
AVR Communications, Ltd.
Allied Broadcast Canada
Allied International
Barrett Associates, Inc.
Broadcasters General Store
Commercial Radio Company
Control Technology Inc.
Delta Electronics Inc.
Electronics Research, Inc.
Fusion Electronics, Inc.
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Hy James, Inc.
Kintronic Laboratories Inc

Lita Broadcasting Distributors
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Systems
Vector Technology Inc

TRANSMISSION LINE
Flexible Cable, Waveguide
AVR Communications, Ltd.
Allied Broadcast Canada
Harris Allied Satellite Equipment
American Media Services
Andrew Corporation
Antennas for Communications, Inc.
Broadcast Supply West
Barrett Associates, Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cablewave Systems, Div of RFS
Cancomm
Comark Communications
Commercial Radio Company
Continental Electronics
Control Technology Inc
Dielectric Communications
Electronic Industries, Inc.
Electronics Research, Inc.
Giesler Broadcasting Supply, Inc.
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
LDL Communications
Lita Broadcasting Distributors
Micro Communications Inc
Myat, Inc.
Narda Microwave Corp
John Nix
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Research Associates Inc
Ron Radio Communications
Roscom General
Scala Electronic Corporation
Shively Labs
Suministros Gonzalez
Tennaplex Systems Ltd
Transcom Corporation

TRANSMITTERS
AM, 0-100 watts
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Besco International
Continental Electronics
Control Technology Inc.
Digital Recorders Inc
Energy-Onix Broadcast Equipment
Guarantee Radio Supply Corporation
Harris Corp
Holzberg Inc.
IBSS
Imperial Transmitter Worldwide
LPB, Inc.
McMartin Industries
Nautel Electronic Laboratories
Nautel Maine Inc
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Washington, Inc.
Radio Systems
Ron Radio Communications
Roscom General
Tobias & Company Ltd
Transcom Corporation

AM, 100-1kW
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Barrett Associates, Inc.
Besco International
Comex Worldwide Corporation
Commercial Radio Company
Continental Electronics
Control Technology Inc.
Elcom Bauer
Energy-Onix Broadcast Equipment
Guarantee Radio Supply Corporation
Harris Corp
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
McMartin Industries
Nautel Electronic Laboratories
Nautel Maine Inc
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Omnitronix, Inc.
Professional Audio Supply
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
Tobias & Company Ltd
Transcom Corporation

AM, 1kW-50kW
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Barrett Associates, Inc.
Besco International
CCA Electronics
Commercial Radio Company
Continental Electronics
Control Technology Inc.
Elcom Bauer
Energy-Onix Broadcast Equipment
Fusion Electronics, Inc.
Fusion Electronics, Inc.
Guarantee Radio Supply Corporation
Hall Electronics
Harris Corp
Holzberg Inc.
Hy James, Inc.
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Litronix Corporation
McMartin Industries
Nautel Electronic Laboratories
Nautel Maine Inc
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Omnitronix, Inc.
Professional Audio Supply
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
Tobias & Company Ltd
Transcom Corporation

AM, 50kW +
AVR Communications, Ltd.
Allied Broadcast Canada
Audiomedia
Barrett Associates, Inc.
Besco International
CCA Electronics
Continental Electronics
Control Technology Inc.
Energy-Onix Broadcast Equipment
Fusion Electronics, Inc.
Guarantee Radio Supply Corporation
Harris Corp
Holzberg Inc.
Imperial Transmitter Worldwide
McMartin Industries
Nautel Electronic Laboratories
Nautel Maine Inc
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
PMA Marketing
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Suministros Gonzalez
Tobias & Company Ltd
Transcom Corporation

FM, 0-100 watts
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Besco International
Bext Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
CCA Electronics
Cancomm
Comad Communications Limited
Continental Electronics
Control Technology Inc.
Digital Recorders Inc
Downeast Engineering
Elcom Bauer
Energy-Onix Broadcast Equipment
Fusion Electronics, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Corp
Holzberg Inc.
IBSS
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Litronix Corporation
McMartin Industries
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
QEI Corporation
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Suministros Gonzalez
TTC Wilkinson
Tobias & Company Ltd
Transcom Corporation
Vector Technology Inc

FM, 100-1kW
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Besco International
Bext Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcasters General Store
CCA Electronics
Cancomm
Comad Communications Limited
Continental Electronics
Control Technology Inc.
Downeast Engineering
Elcom Bauer
Energy-Onix Broadcast Equipment
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Corp
Holzberg Inc.
Imperial Transmitter Worldwide
Landy Associates, Inc.
Lita Broadcasting Distributors
Litronix Corporation
McMartin Industries
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
QEI Corporation
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Riggins Electronic Sales
Ron Radio Communications
Roscom General
Suministros Gonzalez
TTC Wilkinson
Tobias & Company Ltd
Transcom Corporation
Vector Technology Inc

FM, 1kW-10kW
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Besco International
Bext Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcasters General Store
CCA Electronics
Cancomm
Comad Communications Limited
Continental Electronics
Control Technology Inc.
Downeast Engineering
Elcom Bauer
Energy-Onix Broadcast Equipment
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Corp
Holzberg Inc.
Imperial Transmitter Worldwide
Landy Associates, Inc.
Lita Broadcasting Distributors
Litronix Corporation
McMartin Industries
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
QEI Corporation
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
TTC Wilkinson
Telo Technology
Tobias & Company Ltd
Transcom Corporation
Vector Technology Inc

FM, 10kW +
AVR Communications, Ltd.
Allied Broadcast Canada
Audio Broadcast Group, Inc.
Audiomedia
Broadcast Supply West
Barrett Associates, Inc.
Besco International
Bext Inc.
Bradley Broadcast Sales
Broadcast Electronics
Broadcast Equipment Sales & Engineering
Broadcasters General Store
CCA Electronics
Cancomm
Continental Electronics
Control Technology Inc.
Elcom Bauer
Energy-Onix Broadcast Equipment
Fusion Electronics, Inc.
Fusion Electronics, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Corp
Holzberg Inc.
Imperial Transmitter Worldwide
Landy Associates, Inc.
Lita Broadcasting Distributors
Litronix Corporation
McMartin Industries
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
PMA Marketing
QEI Corporation
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Ron Radio Communications
Roscom General
Suministros Gonzalez
TTC Wilkinson
Telo Technology
Tobias & Company Ltd
Transcom Corporation
Vector Technology Inc

Shortwave, 0-1kW
Besco International
Continental Electronics
Elcom Bauer
Energy-Onix Broadcast Equipment
Guarantee Radio Supply Corporation
Harris Corp
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Old Dominion Broadcast Eng. Serv.
PMA Marketing
TTC Wilkinson
Tobias & Company Ltd
Transcom Corporation

Shortwave, 1kW-50kW
Besco International
CCA Electronics
Continental Electronics
Elcom Bauer
Energy-Onix Broadcast Equipment
Harris Corp
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Old Dominion Broadcast Eng. Serv.
PMA Marketing
Tobias & Company Ltd
Transcom Corporation

Shortwave, 50kW +
Besco International
CCA Electronics
Continental Electronics
Energy-Onix Broadcast Equipment
Harris Corp
Imperial Transmitter Worldwide
Old Dominion Broadcast Eng. Serv.
PMA Marketing
Tobias & Company Ltd
Transcom Corporation

TUBES — Transmitting
AVR Communications, Ltd.
American Media Services
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Commercial Radio Company
Continental Electronics
Control Technology Inc.
Econco
Electronic Industries, Inc.
Freeland Products, Inc.
Giesler Broadcasting Supply, Inc.
Guarantee Radio Supply Corporation
Hall Electronics
Mart Haller Co.-Exporters
Holzberg Inc.
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Litronix Corporation
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
PARCOM
PMA Marketing
Richardson Electronics/RF Gain
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Richardson Electronics Ltd.
Suministros Gonzalez
Thor Electronics Corp.
Vacuum Tube Industries, Inc.

Receiving
AVR Communications, Ltd.
American Media Services
BJM Electronics Ltd.
Barrett Associates, Inc.
Capital Electronics Inc
Commercial Radio Company
D.N. Latus & Co., Inc.
Electronic Industries, Inc.
Guarantee Radio Supply Corporation
Mart Haller Co.-Exporters
Imperial Transmitter Worldwide
Lita Broadcasting Distributors
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Richardson Electronics/RF Gain
RF Specialties of Missouri
RF Specialties of Texas
Richardson Electronics Ltd.
Thor Electronics Corp.
Vacuum Tube Industries, Inc.

W

WIRE — Audio
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Canada
American Media Services
AudioLine, Inc.
Audiotechniques
BARCO-EMT GmbH
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Cooper Industries/Belden Division
Beyer Dynamic Inc.
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Canare Cable Inc.
Capital Electronics Inc
Commercial Radio Company
Connectronics Corporation
Continental Electronics Corporation
Control Technology Inc.
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
IBSS
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Major Custom Cable
Martin Audio/Video Corp
Milam Audio Co.
New World Music & Sound
Northeast Broadcast Lab, Inc.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Peavey Electronics Corporation
Pierce-Phelps, Inc.
Posthorn Recordings
Pro Media
Pyramid Audio, Inc.
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Riggins Electronic Sales
Ritz Audio-Visual Associates, Inc
Roscom General
Spectra Sonics
Suministros Gonzalez
Thor Electronics Corp.
Wireworks Corp

Coax
AVC Systems
AVR Communications, Ltd.
Allied Broadcast Equip Canada
American Media Services
BJM Electronics Ltd.
Broadcast Supply West
Barrett Associates, Inc.
Cooper Industries/Belden Division
Bradley Broadcast Sales
Broadcast Equipment Sales & Engineering
Broadcast Services Co.
Broadcasters General Store
Cablewave Systems, Div of RFS
Canare Cable Inc.
Capital Electronics Inc
Commercial Radio Company
Connectronics Corporation
Continental Electronics Corporation
Downeast Engineering
Electronic Industries, Inc.
Full Compass Systems, Ltd.
Fusion Electronics, Inc.
Giesler Broadcasting Supply, Inc.
Grant Becker Enterprises
Guarantee Radio Supply Corporation
Hall Electronics
Harris Allied Broadcast Equipment
Holzberg Inc.
Hy James, Inc.
IBSS
Landy Associates, Inc.
Lasalle Music and Pro Audio
Lita Broadcasting Distributors
Major Custom Cable
Martin Audio/Video Corp
Milam Audio Co.
Old Dominion Broadcast Eng. Serv.
Professional Audio Supply
Parcom
Parsons Audio
Pierce-Phelps, Inc.
PMA Marketing
Pro Media
RF Specialties of California
RF Specialties of Missouri
RF Specialties of Pennsylvania, Inc.
RF Specialties of Texas
RF Specialties of Washington, Inc.
Riggins Electronic Sales
Roscom General
Scala Electronic Corporation
Suministros Gonzalez
Thor Electronics Corp.
Trompeter Electronics
Wireworks Corp

SUPPLIER SOURCE BOOK

A

A/V Technology Intl
PO Box 275
Newton Centre, MA 02159
Contact: Gerard Abeles, Pres
617-965-5656 FAX: 617-965-1865

A & D Cartridge Rebuilding
3380 Blakey Avenue
Eau Claire, WI 54701
Contact: Amy Casey

ADC Telecommunications
4900 W 78th St
Minneapolis, MN 55435
Contact: Lynne High, PR Manager
612-835-6800 FAX: 612-893-3292

ACP-ABACUS
7402 Setting Sun Way
Columbia, MD 21046
Contact: Gene Bidun, President

AEG Bayly Inc
167 Hunt St
Ajax, Ontario, L1S 1P6 Canada
Contact: Allan P Proctor
416-683-8200 FAX: 416-683-8186

AHB USA Ltd
5 Connair Road
Orange, CT 06477

Air System Technologies, Inc.
14232 Marsh Lane, Suite 339
Dallas, TX 75234
Contact: Tom Becker, Pres.
214-402-9660

AKAI
1316 E Lancaster
Fort Worth, TX 76102
Contact: Woody Moran, VP AKAI Division
817-336-5114 FAX: 817-870-1271

AKG Acoustics
1525 Alvarado Street
San Leandro, CA 94577
Contact: David Roudebush, Marketing Manager
415-351-3500 FAX: 415-351-0500

ANT Telecommunications Inc
211 Perry Pkwy, Ste 4
Gaithersburg, MD 20677
Contact: Natalie Hutson
301-670-9777

ART, Applied Research & Tech
215 Tremont St
Rochester, NY 14608
Contact: Philip Betette, President
716-436-2720 FAX: 716-436-3942

ASC - Tube Traps
P.O. Box 1189
Eugene, OR 97440
Contact: Art Noxon, President
503-343-9727 FAX: 503-343-9245

ATI (Audio Technologies Inc)
328 W Maple Ave
Horsham, PA 19044
Contact: Sam Wenzel/Ed Mullin
215-443-0330 FAX: 215-443-0394

AVAB America Inc
967 Howard St
San Francisco, CA 94103
415-421-3562

AVC Systems Division of Vaughn
7901 Computer Ave So
Minneapolis, MN 55435
Contact: Jack Dailey
612-832-3232 FAX: 612-831-0791

AVCOM of Virginia Inc
500 Southlake Blvd
Richmond, VA 23236
804-794-2500 FAX: 804-794-8284

AVR Communications, Ltd.
595 Middlefield Road, Unit 8
Scarborough, ON M1V 3S2 Canada
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416-297-9377 FAX: 416-297-4757

AVR Communications, Ltd.
2615 126 Ave., S.W.
Calgary, AB T2W 3V5 Canada
Contact: Wilf Rice, Sales Manager
403-251-0707 FAX: 403-281-2695

AVR Grp/Audio Video Research
5 Walnut Terr
Newton, MA 02160

A Steeple Jack Co
3722 Roma
Houston, TX 77080
Contact: Don Highley, President

A W Sperry Instruments
245 Marcus Blvd
Hauppauge, NY 11788
Contact: Dennis Carroll, VP Sales
516-231-7050 FAX: 516-434-3128

A.W. Hollar
2832 Riverview Blvd West
Bradenton, FL 34205
Contact: Allan Hollar, President

Absolute Broadcast Automation
82 Main St
Westernport, MD 21562
Contact: Jack Mullen, Jr
301-786-4661

Access Communications
208 Mohawk Trail
Deforest, WI 53532
Contact: Jim Miller, President

Accu-Weather Inc
619 W College Ave
State College, PA 16801
Contact: Sheldon Levine, Director of Sales
814-237-0309 FAX: 814-238-1339

Accurate Sound Corp
3515 Edison Way
Menlo Park, CA 94062
Contact: Ronald M. Newdoll, President
415-365-2843 FAX: 415-365-3057

Acoustic Systems
415 East St Elmo Rd
Austin, TX 78745
Contact: Tim Jarvis, Sales Mgr
800-531-5412 FAX: 512-444-2282

Acoustilog, Inc.
19 Mercer St
New York, NY 10013
Contact: Alan Fierstein, Pres
212-925-1365

Acoustionics Sound/Shelex
PO Box 3752
Hollywood, CA 90078
Contact: Shelly A Herman, Owner

Adams-Smith
34 Tower St
Hudson, MA 01749
617-562-3801

Adelphon
PO Box 7256
Ft Worth, TX 76111
Contact: Henry Mcginnis, Pres
817-335-8666

Adcom Inc
3408 Tullmore Road
Cleveland Heights, OH 44118
Contact: John Bancroft

Advanced Receiver Research
P.O. Box 1242
Burlington, CT 06013
Contact: Jay Rusgrove, Owner

Agfa-Gevaert Inc Magnetic Tape
275 North St
Teterboro, NJ 07608
201-288-4100

Aiphone Corporation
1700 130th Ave NE
Bellevue, WA 98005
Contact: Robin Anderson, Marketing Coordinator
206-455-0510 FAX: 206-455-0071

Airforce Broadcast Services
216 Carlton Street
Toronto, ON M5A 2L1 Canada
Contact: Richard Loth, Director of Mktg & Sales
416-961-2541 FAX: 416-961-7754

Air System Technologies
828 SW 16th St
Ft Lauderdale, FL 39315
Contact: Ralph Chambers

Alactronics
192 Worcester St
Wellesley, MA 02181
Contact: Bob Alach, President

Alamar USA
471 Division Street
Campbell, CA 95008
Contact: Jesside Blount, Marketing Manager

Alden Electronics Inc
40 Washington St
Westboro, MA 01581
617-366-8851

Alderfer & Associates
298 Town Mountain Road
Asheville, NC 28804
Contact: G.M. Alderfer, President

Alesis Corporation
3630 Holdrege Avenue
Los Angeles, CA 91006
Contact: Allen Wald

Dan Alexander Audio
5935 Market Street
Oakland, CA 94608
Contact: Dan Alexander
415-601-1146 FAX: 415-652-4022

Allen & Heath
5 Connair Road
Orange, CT 06477
Contact: Charles Augustowski, VP Marketing
203-795-3594 FAX: 203-795-6814

Allied Broadcast Equipment
See: Harris Allied Broadcast Equipment

Allied Broadcast Equip Canada
See: Harris Allied Worldwide Sales

Allied Broadcast Systems
See: Harris Allied Systems

Allied Bulletin Board
See: Harris Allied Bulletin Board

Allied International
See: Harris Allied Worldwide Sales

Allied Equipment Exchange
See: Harris Allied Equipment Exchange

Allied Emergency Service
See: Harris Allied Customer Service

Alpha Audio
2049 W Broad St
Richmond, VA 23220
Contact: Terri Murphy, Pdct Mgr
804-358-3852 FAX: 804-358-9496

Alpha Electronics
1365 39th Street
Brooklyn, NY 11218
Contact: S Popiol

Alpha Products
242 West Avenue
Darien, CT 06820
Contact: Robert Maffei, Director of Marketing Research
203-656-1806 FAX: 203-656-0756

Alpha Recording Corp
2049 W Broad Street
Richmond, VA 23220-2075
Contact: C Nicholas Colleran Jr, President

Alpine Marketing Comm Ltd
3300 Edinbourough Way, Suite 306
Edina, MN 55435
Contact: James Preste, Pres

Altec Lansing Corp
PO Box 26105
Oklahoma City, OK 73126-0105
405-324-5311

Altronic Research Inc
PO Box 249
Yellville, AR 72687
Contact: Doug Starkey, Marketing Director
800-482-5623 FAX: 501-449-6000

Aluma Tower Co Inc
PO Box 2806
Vero Beach, FL 32961-2806
Contact: T.E. Gottry, VP/GM
407-567-3423 FAX: 407-567-3432

Amber Electro Design
3391 Griffith St
St Laurent PQ, H4T 1W5 Canada
Contact: Wayne Jones
514-735-4105 FAX: 514-340-1468

Amco Engineering
3801 N Rose St
Schiller Park, IL 60176
Contact: Jim Walenda, Mktg Manager
708-671-6670 FAX: 708-671-9469

Amek/Tac US Operations
10815 Burbank Blvd
N Hollywood, CA 91601
Contact: Sue Jones, Oper Mgr
818-508-9788 FAX: 818-508-8619

American Loop Systems
43 Davis Road, Suite 2
Belmont, MA 02178
Contact: Robert Gilmore, President
617-489-6100

American Media Services
P.O. Box 1953, 4817 Panola Drive
Ft. Worth, TX 76101
Contact: Genie Sims, Owner
817-535-1953 FAX: 817-536-1953

Amp Services
224 Datura St
W Palm Beach, FL 33401
Contact: Chris Rappolt, Mktg Mgr
407-659-4805

Amperex Electronics Corp Klyst
230 Duffy Ave
Hicksville, NY 11802
516-931-6200

Amperex Electronics Corp
Providence Pike
Slatersville, RI 02876
Contact: Greg J Murphy
401-762-3800

Ampex Recording Media Corp
401 Broadway M/S 22-02
Redwood City, CA 94063
Contact: Richard A. Antonio, VP US Sales & Customer Service
415-367-3809 FAX: 415-367-4132

Amtel Systems Inc
33 Main St
Nashua, NH 03060
603-880-9011

Analog Digital Synergy, Inc.
120 S.W. 21 Terrace, C-104
Fort Lauderdale, VL 33312
Contact: Lutz Meyer, President
305-791-1501 FAX: 305-791-8986

Andrew Corp
10500 W 153rd St
Orland Park, IL 60462
Contact: Jerry Tuttle, Mktg Mgr
708-349-3300 FAX: 708-349-5943

Anixter Brothers, Inc
4711 Golf Road
Skokie, IL 60076
Contact: Vince Buckman

R B Annis Co
1101 N Delaware St
Indianapolis, IN 46202
Contact: R.B. Annis, President
317-637-9282 FAX: 317-637-9282

Anritsu America Inc
15 Thornton Rd
Oakland, NJ 07436
Contact: Hugh Felger, Marketing Mgr
201-337-1111 FAX: 201-337-1033

Antenna Technology
1140 East Greenway St.
Mesa, AZ 85203
Contact: Gary Hatch, Dir of Intl Sales
602-264-7275 FAX: 602-898-7667

Antennas For Communications
334 Cypress Rd
Ocala, FL 32672-3198
904-687-4121 FAX: 904-687-1203

Anvil Cases
15650 Salt Lake Avenue
City of Industry, CA 91745
Contact: Gabe Nakash, Marketing Manager
818-968-4100 FAX: 818-968-1703

Anything Audio
63 Melcher St
Boston, MA 02210
Contact: Dave Malekpour, President

Aphex Systems Ltd
11068 Randall St
Sun Valley, CA 91352
Contact: Paula Lintz, Dir of Sales/Marketing
818-767-2929 FAX: 818-767-2641

Applied Micro Technology
3116 Merriam Lane
Kansas City, KS 66106
Contact: Steve Hathaway, Engineer
913-362-9422 FAX: 913-362-9477

Arben Design
600 W Roosevelt Rd
W Chicago, IL 60185
312-231-5077

Armstrong Transmitters
5046 Smoral Road
Camillus, NY 13031
Contact: Bob White, President

Arrakis Systems Inc
2619 Midpoint Dr
Ft Collins, CO 80525
Contact: Michael Palmer
303-224-2248 FAX: 303-493-1076

The Art Studio
1300 Timberline Office Park
Austin, TX 78746
Contact: Jack Wilson

Artel Communications Corp
22 Kane Industrial Dr
Hudson, MA 01749
Contact: Judith Flynn, Marketing/Communication Manager
508-562-2100 FAX: 508-562-6942

Asaca/Shibasoku Corp
12509 Beatrice St
Los Angeles, CA 90066
Contact: Bruce Cope, VP Mktg/Engr
213-827-7144

Ashly Audio, Inc
100 Fernwood Ave
Rochester, NY 14621
Contact: Robert French, Sr VP Mktg
716-544-5191 FAX: 716-266-4589

Atlantic Research Corp
5390 Cherokee Ave
Alexandria, VA 22312
703-642-4000

Atlas/Soundolier
10 Pomeroy Raod
Parsippany, NJ 07054
Contact: Herbert M Jaffee, VP
314-349-3110 FAX: 314-349-1251

Audi-Cord Corp
A1845 West Hovey Ave
Normal, IL 61761
Contact: Carol A Williams
309-452-9461 FAX: 309-452-0893

Audient Marketing Services
POB 7217
Mission Hills, CA 91346
Contact: Erika Lopez

Audio & Design
PO Box 786
Bremerton, WA 98310
206-275-5010

Audio Accessories Inc
Mill St
Marlow, NH 03456
Contact: M.B. Hall, Pres.
603-446-3335 FAX: 603-446-7543

Audio Animation
6632 Central Avenue Pike
Knoxville, TN 37912
Contact: James M. Ruse, Product Development & Mkting Mgr
615-689-2500 FAX: 615-689-7815

Audio Broadcast Group Inc
2342 S Division Ave
Grand Rapids, MI 49507
Contact: David E Veldsma, President
616-452-1596 FAX: 616-452-1652

AudioControl Industrial
22313 70th Avenue West
Mountlake Terrace, WA 98043
Contact: Rick Chinn, Sales & Marketing Manager
206-775-8461 FAX: 206-778-3166

Audio Concepts & Engineering
P.O. Box 459
Mechanicsville, VA 23111
Contact: Jeff Loughridge, President
804-550-3337

Audio Digital Inc
1000 S Bertelsen No 4
Eugene, OR 97402-5421
Contact: G Hardesty, President
503-687-8412 FAX: 503-687-0632

Audio Eng Assoc
1029 N Allen Ave
Pasadena, CA 91104
Contact: Wes Dooley, Pres

Audio Innovators
5001 Baum Blvd
Pittsburgh, PA 15213
Contact: Martha Wilson

Audio Labs
9 Roxbury
Keene, NH 03431
Contact: C Keith, Manager

Audio Logic
5639 South Riley Lane
Salt Lake City, UT 84107
Contact: Dean Stubbs
801-268-8400 FAX: 603-672-4246

Audio Precision
PO Box 2209
Beaverton, OR 97075
Contact: Tom Minter, Director of Sales & Marketing
503-627-0832 FAX: 503-641-8906

Audio Service Corp
10639 Riverside Dr
N Hollywood, CA 91602
Contact: Gwen Madrid, Director of Marketing
818-980-9891 FAX: 818-980-9911

Audio-Technica U S, Inc
1221 Commerce Road
Stow, OH 44224
Contact: Garry Elliott, National Sales Manager
216-686-2600 FAX: 216-686-0719

Audio-Video Engineering Co
65 Nancy Blvd
Merrick, NY 11566
516-546-4239

Audio/Digital Inc
1000 S Bertelsen Rd Ste 1
Eugene, OR 97402
Contact: Kathleen Gallagher, Office Manager
503-687-8412 FAX: 503-687-0632

Audiodyne Bdct Cartridge Rebld
725 N Bush Avenue
Fresno, CA 93727
Contact: Allan Tatarian, President
209-252-2787

Audioforce
37 W 20 St
New York, NY 10011
Contact: Sid Zimet, Sales Mgr

Audiolab Electronics Inc
5831 Rosebud Lane, Bldg C
Sacramento, CA 95841
Contact: Ron Stofan, VP Marketing
916-348-0200 FAX: 916-348-1512

Audioline Inc
2323J Bluemound Rd
Waukesha, WI 53186
Contact: Barbara Gutknecht, Mktg Dir
414-785-9166 FAX: 414-785-0789

Evans Sales & Marketing
509 A Ligon Dr
Nashville, TN 37204
Contact: Sales Mgr

Audiomedia Associates
PO Box 29264
New Orleans, LA 70189
Contact: Corey Meyer, Pres
504-586-0140

Audiopak Inc
1680 Tyson Drive, P.O. Box 3100
Winchester, VA 22601
Contact: Gordon Stafford, VP Sales
703-687-8125 FAX: 703-667-6379

Audiotechniques Inc
1619 Broadway
New York, NY 10019
Contact: Robert Berliner, VP/GM
212-586-5989 FAX: 212-489-4936

Audisar Inc
PO Box 1561
Bellevue, WA 98009
Contact: Robert Munger, Owner
206-454-2040

Auditronics Inc
3750 Old Getwell Rd
Memphis, TN 38118
Contact: Murray Shields, Dir of Sales
901-362-1350 FAX: 901-365-8629

Audix Corp
5653 Stoneridge Drive
Pleasanton, CA 94588
Contact: Cliff Castle, VP Sales
415-463-1112 FAX: 415-463-2149

Auernheimer Labs & Co
4561 E Florence Ave
Fresno, CA 93725
Contact: Curly Auernheimer, Owner
209-442-1048

Auratone Corp
PO Box 180698
Coronado, CA 92178-0698
Contact: Jack Wilson, Pres
619-297-2820 FAX: 619-296-8734

Automated Call Processing Corp
220 Jackson St,
San Francisco, CA 94111

Autogram Corp
1500 Capital Ave
Plano, TX 75074
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Elcom Bauer
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Electrex Co
18620 NE 2nd Ave
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Electro Impulse Lab Inc
1805 Corlies Avenue
Neptune, NJ 07754-0278
Contact: Mark Rubin, Pres
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Electro Mavin
2985 East Harcourt St
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Contact: R Averbach, General Mgr

Electro-Voice Inc
600 Cecil St
Buchanan, MI 49107
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Electrodenics
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Comack, NY 11725
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Electronic Equipment Bank
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Electronic Industries
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Electronic Specialty
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Electronics Diversified Inc
1675 Northwest 216th Ave
Hillsboro, OR 97124
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Electrotechnics
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Seattle, WA 98111
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Ellcon
417 S Associated Road, #A-313
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Ellason Weather Radar
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Emcor Products/Crenlo Inc
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Emergency Alert Receiver Inc
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Emphasys Software
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Enberg Electronics
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ECS International
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Enterprise Systems
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Entrack Corp
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FM Technology Assoc Inc
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FMX Stereo/BTP
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Parts Department:
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Distributed Products Technical Service:
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Richmond, IN 47375
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U.S. Television RF Products:
3200 Wismann Lane
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Quincy, IL 62305-4290
Contact: Gaylen C. Evans, MGR
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Satellite Products:
3712 National Road West
Richmond, IN 47375
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317-962-8596 FAX: 317-962-8961

Canada Sales:
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Pueblo, CO 81004
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Henry Engineering
503 Key Vista Dr
Sierra Madre, CA 91024
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Hirschmann Co
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LNR Communications Inc
180 Marcus Blvd
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LPB Inc
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LSI Jennings
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Lahm, Suffa & Cavell, Inc.
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Lake Systems
287 Grove St
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Lamp Technology Inc
1645 Sycamore Avenue
Bohemia, NY 11716
Contact: Janet Lang, Marketing Mgr

Landy Associates Inc
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Lasalle Music & Pro Audio
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Lightning Elimination
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Lightning Eliminators
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Lindco Commercial Audio
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Lineau Assoc Inc
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Columbia, MD 21045-3260
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Charles J Lipow Inc
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Nagra Magnetic Recorders Inc
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Potomac Instruments
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Precision Electromagnetics
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Montebello, CA 90640
Contact: William Stevens, P.R. Mgr
213-726-0303 FAX: 213-727-7656

T & W Tower/Antenna
P.O. Box 898
Hurlock, MD 21643
Contact: Patrick Todd

T.H.E.A.T.A. Digital Co
5330 Darry Avenue
Agoura Hills, CA 91301
Contact: Neal Sinclair

TCI
6050 Backlick Road, Suite 215
Springfield, VA 22150
Contact: J B Straud Sr, Director

TDK Electronics Corp
12 Harbor Park Dr
Port Washington, NY 11050

TEI Electronics
19850 Pheasant Drive
New Berlin, WI 53146
Contact: Tom Winnicki, President

TFT Inc
3090 Oakmead Village Dr
Santa Clara, CA 95052-8088
Contact: Jesse Maxenchs, Dir Mktg
408-727-7272 FAX: 408-727-5942

THC Associates
15 Plum Grove Way
Gaithersburg, MD 20878
Contact: Tom Creighton, Consultant

T.M. Communications Inc
1349 Regal Row
Dallas, TX 75247
Contact: David Tyler

TOA Electronics Inc
601 Gateway Blvd, Suite 300
S San Francisco, CA 94080
Contact: Christine Foran, Marketing Communications Mgr
415-588-2538 FAX: 415-588-3340

Television Technology Corp
650 South Taylor Avenue
Louisville, CO 80027
Contact: Alex Delay, Sales Administrator
303-665-8000 FAX: 303-673-9900

TV Systems
3625 Clare Drive
San Angelo, TX 76904-5284
Contact: Cary Fitch

Taber Manufacturing & Engrg Co
1880 Embarcadero Rd
Palo Alto, CA 94303
Contact: Veldon Leverich
415-493-3811

Tandberg of America Inc
1 Labriola Ct
Armonk, NY 10504
914-273-9150

Tannoy-Ntgi north America Inc
300 Gage Ave Unit, No. 1
Kitchener, Ont, N2M 2C8 Canada
Contact: Bill Calma, Sales & Marketing Manager
519-745-1158 FAX: 519-745-2364

Tape-Athon/Cavox
13633 Crenshaw Blvd
Hawthorn, CA 90250
Contact: Leon E. Tate, President
213-676-6752 FAX: 213-676-9532

Tapex Corp
3608 Davisson Road
Des Moines, IA 50310
Contact: Vic Blacketer, Sales Mgr
515-255-3232 FAX: 515-274-3087

Tapscan
3000 Riverside Galleria, 1111
Birmingham, AL 35244
Contact: J Christian, Pres

Target Head Enterprise
5360 East Raymond St
Indianapolis, IN 46203
Contact: Geo Cecil Frye

Target Tuning
6 Caesar Place
Moonachie, NJ 07074
Contact: Dan Flohr, Pres
201-935-8880 FAX: 201-935-6548

Taube Violante Advert
PO Box 504
Norwalk, CT 06856
Contact: Jean Crawford

Tech Laboratories Inc
500 Tenth Street
Palisades Park, NJ 07650
Contact: Nino M. Vlacich, Vice President
201-944-2221 FAX: 201-944-1653

Technical Services
P.O. Box 57
Rupert, VT 05768
Contact: Peter Morton

Techni-Tool
5 Apollo Rd Box 368
Plymouth Meeting, PA 19462
Contact: Bonnie Burgemeister, Adv Mgr

Technology Plus
6502 Robin Forrest
San Antonio, TX 78239
Contact: Bill Smith, Proj Mgr

Techron
P.O. Box 1000
Elkhart, IN 46515
Contact: Larry Shank, TEF Sales Manager

Tec Pro Technology
306 Madison Hills Blvd, #4
Richmond, KY 40475
Contact: David Humes

Tech/Write Communications
307 Glen Street
Ashland, OR 97520
Contact: Bruce Borgerson, Owner

Tectan Inc
PO Box 271872
Concord, CA 94572
Contact: William D. Leasy, Vice President, Sales
415-798-2222 FAX: 415-798-2224

Tektronix Inc
P.O. Box 500
Beaverton, OR 97077
503-627-7111

Telcom Group Intl
2921 Carlisle Blvd NE, #200
Albuquerque, NM 87110
Contact: David Morgan, President

Telos Systems
1729 Superior Ave
Cleveland, OH 44114
Contact: Trisha Ristagno, General Manager
216-241-7225 FAX: 216-241-4103

Tele-Wire Supply Co
1620 W Crosby Rd
Carrollton, TX 76006

Telectro Systems Corp
96-18 43rd Ave
Corona, NY 11368
Contact: Harry Sussman, President
718-651-8900 FAX: 718-651-4103

Teletech Inc
23400 Mich Ave
Dearborn, MI 48124
Contact: Kenneth Hoehn

Television Engineering
6400 Hollis, Suite #12
Emeryville, CA 94608
Contact: David Dunaway, West Dist Sales Mgr

Telex Communications Inc
9600 Aldrich Ave South
Minneapolis, MN 55420
Contact: John Schofield, Sr VP Marketing
612-884-4051 FAX: 612-884-0043

Telfax Communications
2501 N. Loop Drive, ISIS Center
Ames, IA 50010
Contact: Craig Pringle, Owner
515-296-9911 FAX: 515-296-9910

Telnox Ltd
55 Montpellier Blvd
St Laurent, PQ H4N 2G3 Canada
Contact: Jacques Coutellier, Pres
514-744-1785 FAX: 514-744-2797

Telo Technology
1305 Upland Drive
Stanwood, WA 98292
Contact: Dan Rupe, Owner
206-387-3558

Telos Systems
1729 Superior Avenue
Cleveland, OH 44114
Contact: Steve Church, President

Telular
1215 Washington Ave
Wilmette, IL 60091
Contact: Richard Wasserman, Technical Sales Supervisor
708-256-8000 FAX: 708-256-3555

Temtron Electronics Ltd
15 Main St
E Rockaway, NY 11518
Contact: Sid Sussman
516-599-6400

Tenco Tower Company
9723 Folsom Blvd, Ste A
Sacramento, CA 95827
Contact: Donald Tenns, Owner
916-638-8833

Tennaplex Systems Ltd
21 Concourse Gate
Nepean, ON, K2E 7S4 Canada
Contact: Marvin Crouch, President
613-226-5870 FAX: 613-727-1247

Tentel Corp
4475 Golden Foothill Pkwy
El Dorado Hills, CA 95630
Contact: Wayne Graham, Sales Mgr
916-939-4005 FAX: 916-939-4114

Tepco Corp
PO Box 680
Rapid City, SD 57709-0680
Contact: Jerry Johnson, Sales Mgr
605-343-7200

Texas Electronics Inc
PO Box 7225 B
Dallas, TX 75209
Contact: J R Tozer
214-631-2490

Text Technologies Inc
1475 South Quebec Way, 8, PO Box 2
Denver, CO 80224
Contact: John Clark, Pres
303-751-7619

That Corporation
15 Strathmore Road
Natick, MA 01760
Contact: Gary Hebert, VP Engineering
508-653-6335 FAX: 508-653-5334

Thermodyne Intl Ltd
20850 S Alameda
Long Beach, CA 90810
Contact: Gary Ackerman, Vice President
213-603-1976 FAX: 213-603-1929

3M Magnetic Media Division
Bldg 223-55-01, 3M Center
St Paul, MN 55144-1000
Contact: Richard J Collins
612-733-1082

360 Systems
18740 Oxnard St
Tarzana, CA 91356
Contact: Don Bird, Director of Marketing
818-342-3127 FAX: 818-342-4372

The Capener Company
620 C Street, 6th Floor
San Diego, CA 92101
Contact: R.L. Capener, Chairman

The Media Groupe
657 East Thach Avenue
Auburn, AL 36830
Contact: Michael Shelley, President

The Summit
1227 W McNolia, #500
Fort Worth, TX 76104
Contact: Denise Graham

Thermodyne Intl Ltd
20850 S Alameda
Long Beach, CA 90810
Contact: Walter Wolf

Thor Electronics Corp
321 Pennsylvania Ave
Linden, NJ 07036
Contact: Angelo Crudele, President
800-666-8467 FAX: 201-486-0923

Time & Temperature Co of SD
PO Box 3605
Rapid City, SD 57709-3605
Contact: Don Grant, VP Sales & Mktg
605-787-4805

Tinet Inc
2611 Temple Heights Dr, Ste F
Oceanside, CA 92056
Contact: Paul Scott

Titus Technologies Labs
77 Kreiger Lane, Ste 914
Glastonbury, CT 06033
Contact: Lawrence Titus, Pres
203-633-5472

TK Video
12300 Coppola Drive
Potomac, MD 20854
Contact: Eric Hillman

Tobias & co ltd
4246 Gate Crest
San Antonio, TX 78217
Contact: Gordon Tobias, President
512-599-0789 FAX: 512-599-0799

Tody Arnold & Assoc Inc
3234 Commander Drive
Carrollton, TX 75006
Contact: Lawrence Mangiameli, Vice President

Tower Network Services
P.O. Box 4065
Miami, FL 33269-4065
Contact: Jim Tiner

Tower Structures Inc
1869 Nirvana Avenue
Chula Vista, Ca 92011
Contact: Fred Wells, Director, Marketing/Sales
619-421-1181 FAX: 619-421-0533

Townsend Broadcasting Systems
P.O. Box 2439
Springfield, MA 01101-2439
Contact: Barry R Huntsinger

Transcom Corporation
201 Old York Road, Suite 207
Jenkintown, PA 19046
Contact: Martin Cooper, President
215-884-0888 FAX: 215-884-0738

Transmission Structures Ltd
PO Box 907, 227 South Vann Street
Vinita, OK 74301
Contact: Tom Snow, Vice President
918-256-7883 FAX: 918-256-2558

Transtector Systems Inc
10701 Airport Dr
Hayden Lake, ID 83835
Contact: Tom Wobker, VP Corporate Marketing
208-772-8515 FAX: 208-772-6619

Trimm Inc
PO Box 489
Libertyville, IL 60048-0489
Contact: Harry Lewis, Sales
312-362-3700 FAX: 708-680-3888

Tri-Tech Inc
2415 East Skelly Dr
Tulsa, OK 74105
918-425-5588

Trompeter Electronics Inc
31186 La Baya Dr
Westlake Village, CA 91362
Contact: Dick Coleman, National Sales Manager
818-707-2020 FAX: 818-706-1040

Milab
200 Sea Lane
Farmingdale, NY 11735
Contact: Sam Spennachio, National Sales Mgr
516-249-3660 FAX: 516-420-1863

Turtle Beach Systems
P.O. Box 5074
York, PA 17405
Contact: Jeff Klinedinst, Marketing Director
717-843-6916 FAX: 717-854-8319

Television Equip. Assoc., Inc.
PO Box 393
South Salem, NY 10590
Contact: Steve Tocidlowski, Manager
914-763-8893 FAX: 914-763-9158

TWR Lighting Inc
1630 Elmview
Houston, TX 77080
Contact: Patrick Feller, General Mgr

U

UAR Professional Systems
8535 Fairhaven
San Antonio, TX 78229
Contact: Robert Bruce, Mgr
512-690-8888

US Tape & Label
1561 Fairview Ave
St Louis, MO 63132
Contact: Byron Crecelius, VP Mktg

U.S. Tower Services
5263 Agro Drive
Frederick, MD 21701
Contact: Norman Jeweler, President
301-874-5885 FAX: 301-874-5887

Uher of America
7067 Vineland Ave
N Hollywood, CA 91605
Contact: Patricia Belgiorno, Vice President
818-764-1120 FAX: 818-764-1129

United Communications
3304 N Ocoee Street
Cleveland, TN 37311
Contact: Dave Robinson

United Recording
681 Fifth Ave
New York, NY 10022
Contact: Anita Adams

United Rope Works
151 Commerce Drive
Montgomeryville, PA 18936
Contact: Rosely Stronski, Administration Manager
215-368-6611 FAX: 215-362-7956

UREI
8500 Balboa Blvd
Northridge, CA 91329
Contact: Neil Conley, Sales Manager
818-893-8411 FAX: 818-893-3639

Utility Tower Co
PO Box 12369
Oklahoma City, OK 73157
Contact: Reggie Wright, Eng & Sales
405-946-5551 FAX: 405-947-8466

V

VIF International
PO Box 1555
Mountain View, CA 94042
Contact: Gordon Mackechnie, Advisor International Operations
408-739-9740

Vacuum Tube Ind Inc
506 N Warren Ave, PO Box 2009
Brockton, MA 02403
Contact: Joani Mallett, Mktg Mgr
508-584-4500 FAX: 508-584-0096

Thomas J. Valentino, Inc.
151 West 46th St
New York, NY 10036
Contact: Thomas Valentino, President
212-869-5210 FAX: 212-869-6259

Valley International Inc
PO Box 40306
Nashville, TN 37204
Contact: Norman Baker, Pres
615-383-4737 FAX: 615-269-5441

Vanner Inc
745 Harrison Dr
Columbia, OH 43204
614-272-6263

Vantage Associates
1305 Mesilla NE
Albuquerque, NM 87110
Contact: Rick Harris, President

Varian Continental Electronics
PO Box 270879
Dallas, TX 75227
Contact: W Rice, US Bdct Sales Mgr
214-381-7161 FAX: 214-381-4949

Vaughn Communications
7951 Computer Ave So
Minneapolis, MN 55435
Contact: Beth Evans
612-831-2248 FAX: 612-831-0791

Vector Technology Inc
203 Airport Rd
Doylestown, PA 18901
Contact: Melvyn Lieberman, President
215-348-4100 FAX: 215-348-3167

Vega Wireless
9900 Baldwin Place
El Monte, CA 91731
Contact: James Stoffo, Market Specialist
818-442-0782 FAX: 818-444-1342

Verda Corp
5321 South Kedzie Avenue
Chicago, IL 60632
Contact: Mr. Don Hudalla, President
414-961-2185

Doug Vernier Broadcast Cslt
1600 Picturesque Dr
Cedar Falls, IA 50613
Contact: Doug Vernier, Pres
319-266-8402 FAX: 319-273-6402

Versa Count
553 Lively Blvd
Elk Grove Village, IL 60007
Contact: Charles Piper

Versatech Industries Inc
14750 South Grant St
Bixby, OK 74008
Contact: Gene B. Randall Jr, Pres
918-366-7400 FAX: 918-366-7400

Vertigo Recording
12115 Magnolia Ste 116
N Hollywood, CA 91607
Contact: Charles Bolis
818-907-5161

Vinylweld Inc
2011 W Hastings St
Chicago, IL 60608

VIR James Consulting Engrs
3137 W Kentucky Avenue
Denver, CO 80219
Contact: VIR James

Voyager Mobile
79 Old Palatine Road
Wheeling, IL 60090
Contact: Dave Wertman, Owner

Voyageurs Communications
P.O. Box 282
International Falls, MN 56649
Contact: Leroy Hervey, President

W

Walter Wulff & Associates
P.O. Box 77028
Atlanta, GA 30357
Contact: Walter Wulff, President
404-881-6786

Ward-Beck Systems Ltd
841 Progress Ave
Scarborough, ON M1H 2X4 Canada
Contact: Eugene L. Johnson, Sales Engineer
416-438-6550 FAX: 416-438-3865

Warren Electronic Systems Inc
3720 Greenwich Drive
El Paso, TX 79902
Contact: Pete Warren, III, President
915-533-2911 FAX: 915-533-4703

Washington Professional System
11157 Veirs Mill Road
Wheaton, MD 20902
Contact: Robert Forman, Sales Mgr

Waveframe Corp
2511 55th St
Boulder, CO 80301
Contact: Courtney Spencer
303-447-1572 FAX: 303-447-2351

Waters Manufacturing
Longfellow Ctr
Wayland, MA 01778
Contact: Peggy Angel, Ad Mgr

Weather Central
5725 Tokay Blvd
Madison, WI 53719
Contact: Bob Lindmeier, Bdcst Mgr

Weather Services Corp
131A Great Rd
Bedford, MA 01730
Contact: G Stamos, VP Mktg

Wegener Communications
11350 Technology Cir
Duluth, GA 30136
Contact: Kenneth D Leffingwell
404-623-0096 FAX: 404-623-0698

Weisel Communications
147 Brookfield Avenue
Youngstown, OH 44512
Contact: Charles Weisel

Western Intl Communications
505 Burrard St Ste 1960
Vancouver, Bc, V7X 1M6 Canada
604-526-3214

Westlake Audio Prof Prod Mfg G
2696 Lavery Ct Unit 18
Newbury Park, CA 91320
805-499-3686

Wheatstone Corp
6720 VIP Parkway
Syracuse, NY 13211
Contact: G Snow, P Bagshaw
315-455-7740 FAX: 315-454-8104

White Instruments Inc
Box 90099
Austin, TX 78709
Contact: Emory Straus
512-892-0752 FAX: 512-892-0855

Brian R White Co, Inc
313 Henry Station Rd
Ukiah, CA 95482
Contact: Larry J Richmond, Sales Manager
707-462-9795 FAX: 707-462-4800

Wide Range Electronics Corp
174 Chesterfield Ind Blvd
Chesterfield, MO 63005
Contact: G. Stecker, Sales
314-532-5887 FAX: 314-532-5493

Wilkinson Electronics
PO Box 1385
Broomfield, CO 80020
Contact: Mkt Mgr

Will-Burt
P.O Box 900
Orrville, OH 44667
Contact: Donald S Barlow, Sales Mgr
216-682-7015 FAX: 216-664-1190

Martin Williams
10 So 5th St
Minneapolis, MN 55402
Contact: Marlene Ordof

Wiltronix Inc
16850 Oakmont Ave
Washington Grove, MD 20880
301-258-7676

Winchell Marketing Comm
1315 Cherry St
Philadelphia, PA 19107
Contact: Joan Meagher

Winsted Corp
10901 Hampshire Ave South
Minneapolis, MN 55438
Contact: G R Hoska, Vice Pres
612-944-8556 FAX: 612-944-1546

Wireworks Corp
380 Hillside Ave
Hillside, NJ 07205
Contact: Angela Kelly, Customer Service Representative
201-686-7400 FAX: 201-686-0483

Wohler Technologies
1349 Kansas St
San Francisco, CA 94107
Contact: Will Wohler, Pres
415-285-5462 FAX: 415-821-6414

Wood & Douglas
P.O. Box 1631
Melbourne, FL 32902-1631
Contact: Alan Papworth, Marketing Director

Worldwide Technologies
8 Patrician Drive
E Northport, NY 11731
Contact: Harvey Lunfenfeld, President

World Tower Co
PO Box 405
Mayfield, KY 42066
Contact: Nate Sholar

Worrell Assoc
300 College St
Ft Worth, TX 76104
Contact: Chuck Worrell

X

Xedit Corp
218-31 9th Avenue
Queens Village, NY 11429
Contact: Claude M Karczmer, President

Y

Yamaha International Corp
PO Box 6600
Buena Park, CA 90622
Contact: Bob Shomaker
714-522-9011 FAX: 714-739-2680

Z

Zephyr Weather Info Service
40 Washington St
Westborough, MA 01581
Contact: Jimmie Smith, President
508-898-3511 FAX: 508-898-2427

Zercom Corp
PO Box 84, Zercom Dr
Merrifield, MN 56465
Contact: Jeff Zernov, Pres
218-765-3151 FAX: 218-765-3900

Zimmer Broadcast Co
PO Box 1810
Cape Girardeau, MO 63701
Contact: John Zimmer

THE ATI GUYS

"Sam" "Ed"

Audio Technologies, Inc.
328 W. Maple Avenue
Horsham, PA 19044
Phone: (215) 443-0330
Fax: (215) 443-0394

Co-owners:

SAMUEL B. WENZEL, President, born 1934, married. 1951-55 served U.S. Armed Forces. BSEE 1959 City College of New York. MSEE 1963 Drexel University. 1959 - 1961 - AIL Design Engineer. 1961-1976- Philco Ford, Senior Engineering Specialist Terrestrial and Satellite Communications. 1976 - 1979 - Ampro Scully Co., as Vice-President and General Manager. 1979 - Co-founded ATI.

EDWARD M. MULLIN, Vice-President, born 1938, married. BSEE 1961 Drexel University. 1961 - 1964 - ITA Corp. Audio Design Engineer. 1964 - 1967 - Omnidata Corp - Digital & Electromechanical Design engineer. 1967 - 1979 Ampro Scully Co. successively as Design Engineer, Chief Engineer and President. 1979 Co-founded ATI.

ATI - Audio Technologies Incorporated was incorporated in the state of Pennsylvania in August 1979. We are now in our eleventh year. The company was organized and is co-owned equally by Samuel B. Wenzel and Edward M. Mullin. The initial ATI designs which are still manufactured, are the Micro Amp Series of Mike, Line, Distribution and Turntable Amplifiers. These products have been augmented by a full line of Consoles and "Problem Solver" products directed toward the broadcast and pro-sound industries. ATI's market is worldwide. 80% of sales are domestic, 20% are international.

ATI's manufacturing facility and headquarters occupy 10,000 sq. ft. in beautiful downtown Horsham, Pennsylvania, a suburb of Philadelphia. The principal activity at the plant is the manufacturing of ATI's extensive proprietary product line of audio equipment, along with marketing/sales and engineering offices.

ATI supports the National SBE and local SBE chapter 18 and is an associate member of NAB and NSCA.
The "Micro-Amp Series" - Premium Mike Amplifiers, Turntable Amplifiers, Line Amplifiers, Audio Distribution Amplifiers, Meter and Monitoring systems.
The "Vanguard Series" - Eight and twelve mixer, dual channel stereo broadcast consoles.
The "Encore Series", of Ulti-mike, Line, Turntable Amplifiers, Audio Distribution Amplifiers and Multi-Amplifier arrays.
The "Match-Maker" and "Disc-Patcher" line of bi-directional and uni-directional interface systems for level matching IHF leads to 600 ohms.
The "Emph-a sizer" - A Mike and Line Audio Processor.

Principal Dealers:

Allied Broadcast Equipment, Audio Broadcast Group, Bradley Broadcast Sales, Broadcast Supply West, Crouse - Kimzey Co., Broadcasters General Store, Martin Audio/Video, Northeast Broadcast Labs and other domestic and international dealers.

1991 trade shows where ATI will exhibit:

NAB '91, Radio '91, SBE National '91, Regional SBE Shows, Univ. of Wisconsin Broadcasters Clinic

DEDICATED TO SOUND ENGINEERING

CENTRAL TOWER, INC.

2855 HWY 261
Newburgh, IN 47630-8642

Phone: (812) 853-0595
Fax: (812) 853-6652

President: **Ray R. Ryan**
Director of Engineering: **Len Cook, P.E.**
VP/Marketing: **Terrence A. Becht**

VP/Operations: **Tim Ryan**
Installations Supervisor: **Steve Rhinerson**

Products:
- Guyed towers
  18" to 60" face, all welded
  48" to 120" face, bolt together
  Microwave
  Cellular
- Self-supporting towers
- Antenna poles
- Ice shield & Transmission Bridges
- Grounding systems

Services:
- Engineering structural analysis
- Steel fabrication
- Tower & antenna system installation
- Tower & antenna system maintenance & repairs
- Turn-key project supervision
- Custom rebuilding of FM antennas
- Field tuning of FM antennas

Central Tower offers several advantages when initiating a tower construction or repair project. With over twenty-five years of experience in broadcast equipment manufacturing and repairs, afford the expertise necessary to be a leader in the industry.

Among the other advantages CTI can offer, is the single source option which provides:

- custom, in-house engineering
- complete fabrication facility
- factory installation service

This option insures straight line accountability resulting in project excellence.

Central Tower is located in Newburgh, Indiana. This central location allows economic pricing, expedient response and delivery. Our modern 18,000 square foot facility encloses a state-of-the-art manufacturing operation. Plans for expansion are scheduled for early 1991, which will more than triple CTI's size and production capabilities.

By employing a fulltime engineering staff and five installation crews, CTI is able to provide the best possible product with total control. Central Tower, Inc. is anxious to fulfill your tower needs and with a dedicated staff of professionals, CTI is capable of handling any size project.

Trade Shows: NAB, CTIA, UTC

Circle 97 On Reader Service Card

Henry Engineering

503 Key Vista Drive
Sierra Madre CA 91024
818-355-3656
Fax: 818-355-0077

Henry Engineering was founded in 1982 by current President Hank Landsberg to formally produce products which Landsberg originally "built from scratch" during his career as a Chief Engineer. His first products were retro-fit modules for Autogram broadcast consoles and the well known Matchbox, selling over 8,000 units since its introduction. Henry Engineering specializes in unique, low cost "problem solver"
products.

Henry Engineering products are affordable by every station. Most products are unique and manufactured in a 4000 square-foot facility by six assemblers, a staff which has remained unchanged since 1983. All products recieve 100% testing before shipment; return rate is below one percent.

Major Products:
The Matchbox; Turntable Controller; MixMinus Plus; Superelay; LogiConverter; Telecart II; Synchrostart, and USDA New products indlude the FAST TRAC automatic dubbing system, a unique "one-pot console" for dubbing and editing stations. (See review in this issue.) Also two new audio products: TWINMATCH, MICROMIXER, a compact four-input, two-output stereo mixer. The widely acclaimed "turbo modules" for Autogram and Collins console continue to be available.

Henry Engineering products are distributed through dealers such as Allied Broadcast Equipment, Broadcast Supply West, Bradley Broadcast Sales, Crouse-Kimzey, Broadcasters General Store, Broadcast Services Company, and others. Contact Henry Engineering for the name of your nearest dealer.

Trade Shows: NAB, SBE National. We often supply "give away" items for drawing at various shows.

We Build Solutions

Hank Landsberg

President

Director of Engineering for Drake-Chenault for 15 years. Designed/built multi-studio complex including custom designed audio consoles and tape duplicating system. In broadcast industry since 1972. Hobbies: ham radio, photography, live music recording, antique jukebox collection.

Circle 80 On Reader Service Card

multiphase consulting

Contract Engineering Service

Test Equipment Rental

founded in 1978 by Henry Stewart and John Bisset

5827 Columbia Pike
Suite 310A
Falls Church, VA 22041

(703) 379-1664
answered 24 hours

FAX: (703) 998-2966

Now beginning its 13th year of service to broadcasters, Multiphase Consulting provides affordable contract engineering, emergency, and special project services. Our involvement in projects is customized to the specific need. Whether it's a turnkey system or simply an "extra pair of hands" to complete a project deadline, broadcasters are turning to Multiphase. Our experienced engineers are former Major Market CE's who offer responsible, affordable technical service. With experience in both audio and RF, Multiphase is a logical choice for station assessments and evaluations. For a free FCC Compliance Checklist, **circle 19 on reader service card.**

An example of a studio project involving Multiphase

Multiphase is recognized as an authorized installer for C-QUAM® AM Stereo systems, and also provides system tuneups for existing stereo installations. Multiphase maintains a stock of rental test equipment which includes:

- **Delta's "HEART MONITOR"** PRH-1—tests the condition of all types of transmission lines
- **The AM SPLATTER MONITOR** Verify NRSC and transmitter performance. Also minimize IPM
- **OIB Operating Impedance Bridges** and RG-3/RG-4 Receiver/Generators

"try before you buy"

For test equipment rental application notes, **circle 107 on reader service card.**

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• FULLY FCC LICENSED AND SBE CERTIFIED •

Kintronic Laboratories

144 Pleasant Grove Road
Bluff City, TN 37618

Phone: 615-878-3141
Service Phone: 615-878-3141
FAX: 615-878-4224

President: Thomas F. King
VP/Sales: Gwen B. King
Customer Service Rep: Donald Hastings
Production Manager: Boyd Wright

Founded in 1962 by Louis A. King, Kintronic Laboratories got its start in the fabrication of isolation transformers and custom RF components. The company has since grown in size to encompass a facility of 17,500 square feet and a staff of 25 employees.

Kintronic has also grown in reputation to be the leading independent manufacturer of custom AM antenna systems and components in the US. The firm also has established a reputation for high quality service and products worldwide.

Kintronic Laboratories' President Thomas King holds a Bachelors and a Masters Degree in Electrical Engineering; he also has completed two years of graduate study toward his Doctorate in the field. King has 10 years of experience in defense electronics, and an additional seven years in broadcast engineering.

Major products from Kintronic include directional antenna phasing systems, antenna tuning units, AM multiplexers, dummy loads, equipment racks, shortwave antennas, rigid transmission line and accessories, and RF contactors. Other products from the company include RF fixed and variable inductors, isocouplers, lighting chokes and custom RF components.

Kintronic is also the stocking distributor for Jennings vacuum capacitors and contactors, and maintains Andrew and Cablewave products in stock.

Direct marketing and distributors are employed by Kintronic Laboratories for sales, and the company has distribution agreements with RF Specialties, Allied Broadcast Sales, NE Broadcast Lab, Radio Resources, and Southern Coastal Marketing Services.

Kintronic plans to exhibit in 1991 NRB, NAB and SBE conventions.

J.N.S. Electronics, Inc. founders share over half a century of station and broadcast equipment manufacturing experience. This hands-on experience has lead to the development of products that do jobs as needed by the broadcaster. The 50+ years of founders John E. Leonard, Jr. and John N. Stannard result in products with exceptional performance and reliability.

The firm spans two continents. J.N.S. Electronics, Inc. has corporate and sales offices in San Jose, CA. Manufacturing occurs in both California and in Australia. Products currently include two families of audio routing systems and a rack frame system that provides broadcasters a new method of solving a number of audio, video and RF jobs called **'the FRAME'**.

CD Quality Audio Switchers

8300 Series - From 1 × 10 or 10 × 1, offering flexibility in small space and a variety of controls. All stereo.
9000 Series - From 1 × 15 to 60 × 60, mono or stereo, and unlimited control capability.
All having CD level performance, relay crosspoints, machine control options and more.

'the FRAME'

It can be configured to amplify, switch, match, equalize, demodulate or generate. Two frames are available to house and power from 2 or up to 10 different modules. Jobs being done include:

- Mono or Stereo Audio Distribution
- Audio Monitor Amplifiers
- Video Distribution
- Audio Failure Sensing
- Stereo Presence/Validity Measurement
- Program Changeover, automatic and manual
- RF Demodulation

Trade Shows scheduled for 1991- NAB, SBE, Radio 91 and select state and regional meetings.
Products are marketed through select distributors and by direct sales.

J.N.S. Electronics, Inc.
P.O. Box 32550
San Jose, CA 95152
408 729-3838/FAX 408 926-1003

Circle 83 On Reader Service Card

RPG DIFFUSOR SYSTEMS, INC.

In 1983 Dr. Peter D'Antonio and Dr. John Konnert founded RPG Diffusor Systems to develop new and innovative acoustical materials and architectural acoustic designs for critical listening and performing environments. All products are manufactured in a modern manufacturing facilitiy located at 3803 Ironwood Place, Landover MD 20785. Corporate offices are located at 12003 Wimbleton Street, Largo MD 20772. RPG distributes worldwide through RPG Europe located in London and Ohba Trading in Tokyo.

RPG LAUNCHES AN ACOUSTIC INDUSTRY
The sound diffusor industry was launched in 1984 with the introduction of the first reflection phase-grating (RPG) sound diffusor. A strong dedication to continued research and development has produced the complete architectural acoustic system consisting of the:

- *QRD DIFFUSOR®* -a broad-bandwidth wide-angle 1-D sound diffusor
- *ABFFUSOR®* -a broad-bandwidth abffusive sound absorber
- *TRIFFUSOR®* -a three-sided variable acoustics module consisting of diffusive, absorptive and reflective sides
- *DIVIEWSOR™*-a see-thru diffusor for visibility and lighting effects.
- *ABSORBOR™*-a new graduated density upholstered fiberglass panels with resin-hardened egdes
- *BIFFUSOR™*-a two-sided diffusive/abffussive variable acoustic module
- *OMNIFFUSOR™/TERRACE™*-2-D sound diffusors with omnidirectional coverage
- *FLUTTERFREE™*-an architectural acoustic flutter control moulding
- *DIFFRACTAL™*-a full-spectrum fractal sound diffusor
- *CHORISTER™/ENSEMBLE™*-diffusive choral and orchestral shells
- *RPG DIFFUSOR SYSTEMS™* also has developed complete broadcast studio design packages.

CLIENTS
RPG Diffusor Systmes has to its credit the largest installed base of QRD® diffusor systems in the world, for prestigious client such as Carnegie Hall, Cincinnati Music Hall, Houston Grand Opera, Baltimore Symphony Orchestra, Pantages Theatre, Whitney Houston, Peter Gabriel, Miami Sound Machine, INXS, Disney Imagineering, Lucasfilms, Warner Hollywood, HBO, NBC, NPR, BBC, CBC, ABC, CBS Records, Telarc, DMP, Polygram Records, Sony Classical, Cleveland Institute of Music, Berklee College of Music, Duke University and literally hundreds of others.

PERSONNEL
President: Dr. Peter D'Antonio
Sales Manager: Dr. Peter D'Antonio
Customer Service: Ms. Cynthia Bonavito
Advertising: Ms. Veronica Coleman

DR. PETER D'ANTONIO
Peter D'Antonio was born in Brooklyn, New York, in 1941. He received his B.S. degree from St. John's University in 1963 and his Ph.D. from the Polytechnic Institute of Brooklyn, in 1967. Dr. D'Antonio has lectured extensively on architectural acoustics and his designs and diffusor systems have been used in hundreds of recording, broadcast, performing and residential listening applications all over the world.

Trade Shows: AES, NAB, NSCA, CES, USITT, CEDIA, ASA

RPG®

RPG Diffusor Systems, Inc., 12003 Wimbleton St., Largo,MD 20772
Phone 301-249-5647 FAX 301-249-3912

Circle 26 On Reader Service Card

S.C.A.
Data Systems Inc.

225 Arizona Avenue
Santa Monica, CA 90401
(213) 576-0655
FAX: (213) 576-0566

Steven Davis
Mr. Davis has been President of SCA Data Systems since its conception in 1984. He is responsible for the marketing, product development, and system engineering. Steve holds several patents in the communications field.

Lawrence J. Karr
Mr. Karr is the Chairman and co-founder of SCA Data Systems. He is responsible for advanced product design and development, and shares overall management responsibility with Mr. Davis. Larry is the holder of seven issued U.S. patents.

Company History
SCA Data Systems, Inc. was founded in October 1984 and currently has 8 employees. We are located in Santa Monica, just minutes away from the Los Angeles beaches.

Our principal areas of expertise include digital and analog signal processing, algorithm optimization, and novel methods of hardware/software minimization.

In the radio frequency receiving apparatus area, we have designed and/or manufactured a number of innovative products. These include the most sophisticated and reliable FM subcarrier data systems, which incorporate digital tracking loops, forward acting error correcting codes, and statistical signal quality monitoring. We also manufacture a FM subcarrier music system with 4 times the channel capacity of other systems. The technology for this system is patented. Further, we manufacture to the MBS/EBU standard, 57kHz DSP based paging generators, and related devices, which have been well received by paging system operators.

MUSIC 4 four-channel SCA Generator and Receiver.

In addition, we have developed comprehen sive modelling and simulation software which allows us to evaluate overall system performance prior to fabrication of system components.

Major Products
Paging Generator (PG57-1, PG57-2, PG57-3)
Paging Combiner
19.2 Kbit half channel SCA data system
9600 bit/sec SCA half channel data system
Music 4 (TM) multi-channel SCA music system
Data 4 multi-channel SCA data system

For sales please contact SCA Data Systems direct.

Trade Shows
NAB, NSCA, IBMA

Scientific-Atlanta, Inc.
Broadcast Radio & Data Systems

Scientific-Atlanta (S-A) is the world's leading supplier of satellite communications equipment to the broadcast radio industry. In 1982, four of the leading networks in the United States — ABC, CBS, NBC and United Stations — switched from terrestrial to satellite distribution using the Scientific-Atlanta Digital Audio System. S-A dominates the radio market with more than 6,000 earth stations installed. The company is involved in design, manufacture and support of satellite communications sytems.

Broadcast Radio & Data Systems is headquartered in Melbourne, Florida. Products and services include:

- Analog uplink and downlink systems for audio distribution.
- Digital audio satellite distribution systems (wideband and narrowband)
- Data broadcast uplinks and downlinks for point-to-multipoint data transfer and newswire distribution.

In 1990, Scientific-Atlanta introduced Spectrum Efficient Digital Audio Technology (SEDAT™) to the company's product lines. This technology provides CD quality audio transmitted via bit streams as low as 128 kbps. SEDAT uses an S-A proprietary audio compression technique, including encoding algorithms and special coding for satellite transmission.

Some advantages of SEDAT:

- A *complete* technology with full production and support from S-A . . . incorporating algorithm, hardware design, network control, network transmission and manufacturing expertise into a seamless network architecture. The architecture is "system" level.
- Developed in the U.S.
- The only algorithm compatible with the North American broadcast standard for satellite-delivered digital audio (DATS).
- Complete flexibility in bit rate and bandwidth selection; requires no filter band redesign. Provides 20 khz vs. 15 khz.
- Bit allocation is *fully* adaptive. Exploits noise masking properties of the human auditory system.

This Fortune 500 company was founded in 1951, initially offering products in the antenna instrumentation area. S-A developed the earth station used in the first public demo of satellite-delivered commercial cable programming. The company has been the major supplier to the cable industry. Today, with almost 4,000 employees nationally and internationally, the company's core business is communications. Contributions to technology and specific markets have ranged from the areas of telephony and television to encrypted and digital transmission systems, including both domestic and international satellite networks.

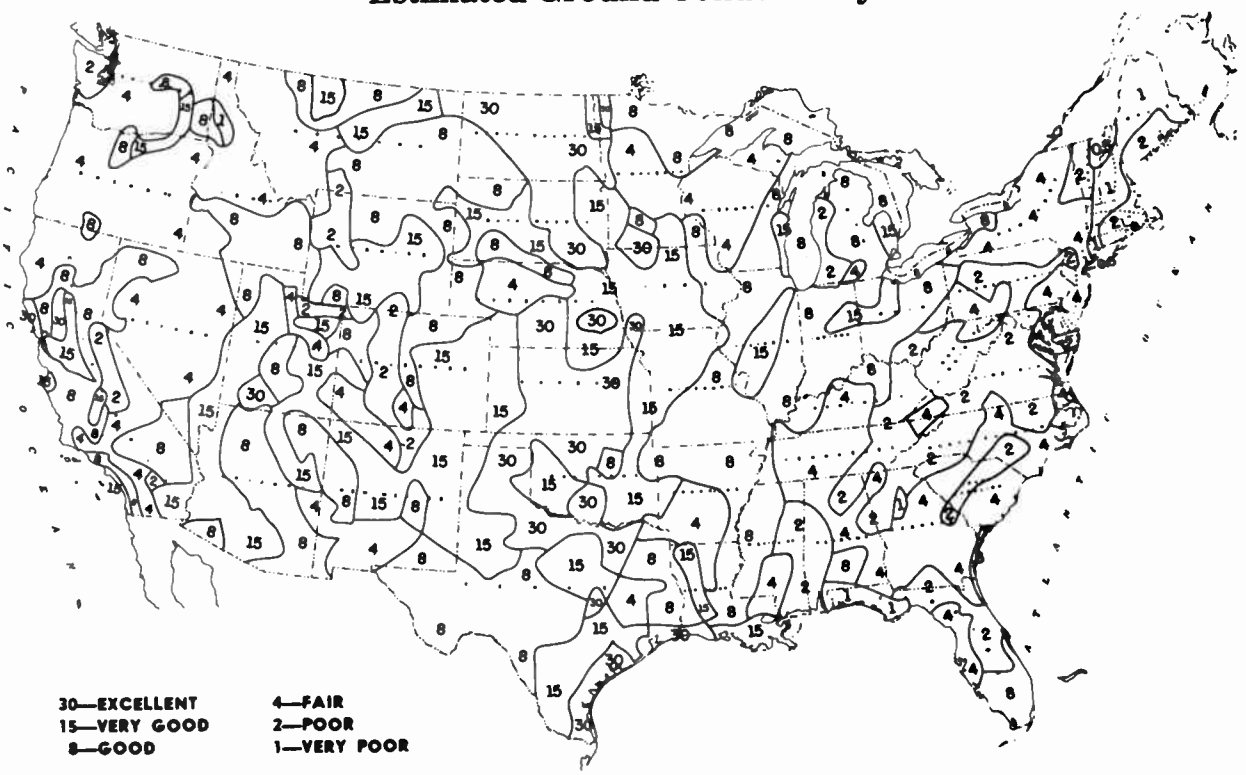
Scientific-Atlanta, Inc. (NYSE:SFA) with headquarters in Atlanta, Georgia is a leader in cable TV, radio electronics and satellite communications networks. The company is a key supplier of electronic instrumentation for industrial, telecommunications and government applications worldwide.

Scientific-Atlanta
Private Networks Business Division

Steven P. Nowick, President
Joined Scientific-Atlanta in 1988.
Prior to that, he was a lead partner with Booze, Allen & Hamilton, specializing in business and marketing strategy development for Fortune 500 companies involved in communications services and communications products.
His previous experience includes the Proctor & Gamble Company and the manufacturing division of Air Products and Chemicals as an industrial engineer.
Education: B.S., M.S. with honors; Industrial Engineering; Lehigh University.

Circle 91 On Reader Service Card

Estimated Ground Conductivity



Courtesy of Continental Electronics

INDICES & REPRINTS

Each index uses a numerical system to denote issue date and page number–the month and day are separated by a slash, while the day and page are separated by a colon. Thus, an entry of 2/22:6, for example, refers to a story in the 22 February 1990 issue, on page 6.

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BUYERS GUIDE

ASC Introduces Tape Handler

by Ronald Newdoll, President
Accurate Sound Corporation

Menlo Park CA Accurate Sound Corporation introduced at the September AES show the AS-100, a new tape handler patterned after the popular Ampex ATR-100 design.

The AS-100, with its up-to-date microprocessor control design, has numerous added features and has eliminated many of the cumbersome manual load requirements and service difficulties encountered with the ATR-100.

TECHNOLOGY UPDATE

Previously, in order to tension the servos, it was necessary to push the stop button while holding and then jerking the supply reel. Now, with just a push of the load button, the reels slowly take up the slack in the tape until the servo arms are correctly positioned and the tape is automatically tensioned.

The fully microprocessor controlled transport electronics will include an IEEE 488 computer interface buss as well as an RS-232 buss.

The AS-100 user interface will be identical to the ATR-100 so that timecode synchronization can be achieved using the capstan reference frequency.

The microprocessor design will allow software control of all parameters of the transport, including tape tensioning. This will allow tailoring the reel tensions from start of reel to end of reel for special tape tensioning curves. Programmable tension is especially important for long term storage or archiving of master tapes. Also, software can be written to interface the transport to any computer.

You will notice that no mention as yet has been made regarding the signal electronics. Considerable thought, however, has gone into the proposed audio electronic design to ensure that the original sonic qualities of the ATR-100 are not lost, and are, in fact, improved.

This new AS-100 transport has been designed for use in a variety of applications. In addition to a studio master recording system, the transport will also be used in the pancake evaluator and as a high speed slave transport for cassette and reel-to-reel duplication. Because of its superior tape handling qualities, a cassette slave is planned that will duplicate at a speed of 300 IPS.

David Manley with Vacuum Tube Logic has indicated an interest in using the new AS-100 transport with a new vacuum tube record electronics design. This combination of the microprocessor controlled transport with David's new vacuum tube record electronics will produce a studio mastering recorder of unique design.

Editor's note: For more information on the AS-100 tape handler, contact Ron Newdoll at Accurate Sound Corporation: 415-365-2843, FAX: 415-365-3057, or circle Reader Service 44.

Reprinted from **Radio World** *September 26, 1990.*

Altronic Load Used in Testing

by Richard Garrett, Spvsr Bcast Test
Continental Electronics

Dallas TX Dummy loads are used daily in the test facility at Continental Electronics Corp. in the testing of AM, FM and SW transmitters. Our requirements for loads depend on the output power of the transmitters being tested. We were excited, therefore, to try the 35 kW air-cooled load from Altronic Research.

The air-cooled load, Model 6735, is designed to operate from DC to 240 MHz with a VSWR of 1.15:1 maximum; it is perfect for the application of testing broadcast transmitters in the 10 to 35 kW power level.

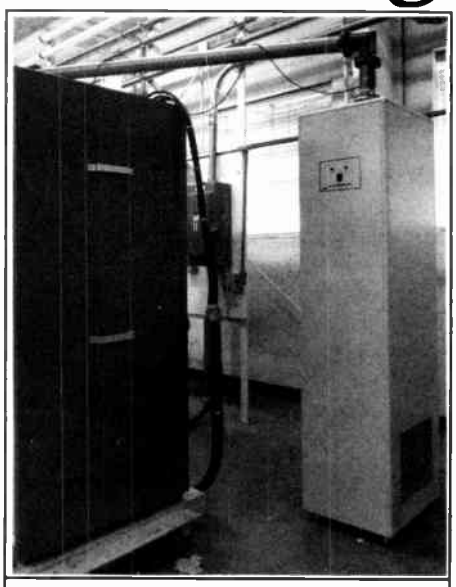
The load, available in 115 V or 230 V models, is designed using 24 nonreactive resistors (300 ohms each) and is cooled by a centrifugal blower. The blower pulls air from floor level up through a plenum that encloses the resistor assembly. Air is then channeled down through the resistor assembly and out a discharge vent.

USER REPORT

This arrangement results in extremely quiet operation. In fact, some transmitters may create more blower noise than does this load.

The output vent has a removable grill so that a duct may be installed to allow moving the hot air outside. This allows efficient mixing of load and transmitter air exhaust.

The outside of the load has a main power switch, an overheat light, a blower "on" light, AC input connector, ►



The Altronic Research dummy load, at right, in a typical Continental test installation.

a ground terminal, and an interlock terminal strip. As the instruction book indicates, these can be grouped into two categories or control circuits. Both circuits are supplied power via a 15 A circuit breaker.

In the blower control circuit, power is supplied to a blower relay through the front panel power "on" switch or through one of three thermal switches in parallel with the power on switch. The thermal switches activate at approximately 120° F. Upon activation, the blower relay supplies power to the motor and blower on lamp.

The second circuit provides interlock contacts for the user. This circuit consist of two thermal switches in series with the interlock relay. These thermal switches open at approximately 260° F. Because the blower on thermal switches will cycle the blower on when required, the interlock provides a closed pair of contacts whenever power is applied to the load.

During the more than twelve months we have had the load, service requirements have been zero. Maintenance of the load as recommended by Altronic Research consists of periodic cleaning of the blower and motor assembly with a vacuum cleaner. Also, periodic lubrication of the motor is recommended depending on the amount of service it provides.

Replacement of the resistors in the RF circuit is an easy task. All panels are removable via Torx head screws. Once the outside panel is removed, the inside panel must be removed to expose the resistor bank.

We have used the Altronic load for over a year and have experienced no failures. The load operated flawlessly even when temperatures were over 100° F in our test facility.

The most enjoyable parts of using this load are its extremely quiet operation and its stable VSWR under power. In addition, the load is completely enclosed with solid panels that provide important safety protection from RF.

If it ever becomes necessary to replace any resistors, the easy access to the resistor bank will be a big plus. We have found the Altronic Model 6735 RF load to be a positive addition to our test facility.

Editor's note: For more information on the Model 6735, or other Altronic dummy loads, contact Doug Starkey at Altronic Research: 501-449-4093, FAX: 501-449-6000, or circle Reader Service 56.

Reprinted from **Radio World** *November 21, 1990.*

ATI's Vanguard Puts An End to RF Problems

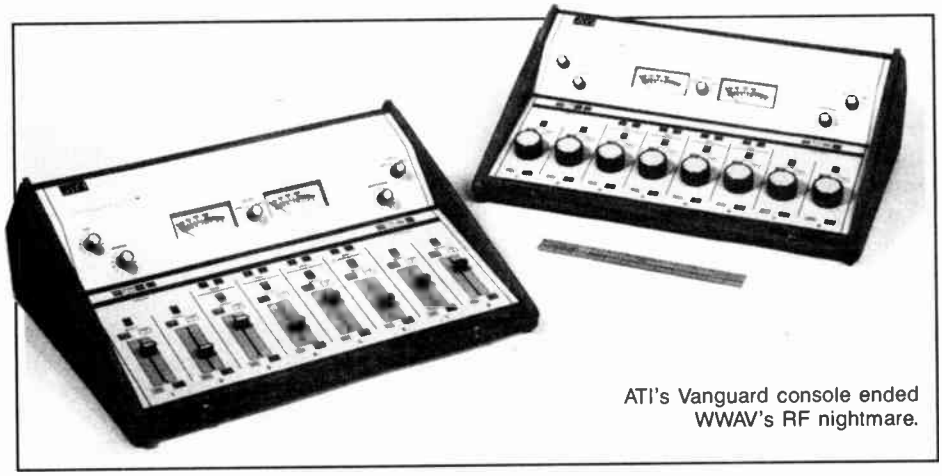
by Charles T. Wooten
Broadcast Consultant

Panama City FL As a consultant for a large number of smaller market radio stations in the South, I could fill a novel with "war stories" about engineering problems that I have run into.

USER REPORT

One of the most severe RFI problems I have ever encountered was at a small class A station, WWAV-FM in Santa Rosa Beach, FL.

I had a relatively easy task—install a small console to mix liners and commercial cart machines in conjunction with a Transtar audio switcher for "Format 41."



ATI's Vanguard console ended WWAV's RF nightmare.

A four-channel stereo console was ordered and installed. The console, manufactured by a prominent US manufacturer, featured FET switching on the input to each mixing channel.

When the equipment was turned on, the VU meters pinned with RF. All kinds of beads, transformers, chokes, aluminum foil and capacitors were tried in all kinds of combinations to no avail.

Formidable RF

A phone call to the manufacturer resulted in another console being shipped, as it was thought that the original was defective. Four days later the replacement console arrived. There was no change in the RF condition.

The station owner and I were about to pull our hair out as we listened to the RFI coming through the monitor speakers.

We talked with Bill Turney, an equipment rep that had not sold us the console, who suggested that we try an ATI Vanguard console.

Eager to please

He spoke to the people at ATI about our problem and they were eager to supply us with a console to try out. They were confident that their console would operate without any problems.

I reserved judgment because I had experienced the RFI firsthand and had tried everything that I knew to rectify the problem.

A few days later the ATI Vanguard eight-channel console arrived. I eagerly drove the 50 miles from my office to the station to see how it would fare. I was ready to have this "simple installation" out of the way.

Installation was a snap—literally. All connections are made with plastic snap-on connectors that fit over Molex-type PC board connectors.

A programmable plug on each input channel that sets the input level at either −20 dB, −10 dB, or +4 dB made for a speedy installation.

A quick trip to Radio Shack was needed for an amplifier (the console ►

requires a separate monitor amp) which I like since different applications may require various monitor amp requirements.

Beats "Brand X"

The console was powered up and behold, no RF! The station owner and I sighed in relief. ATI really knew what they were talking about when they told me that we wouldn't be returning their console.

The "Brand X" console was packed up and returned. I have to admit that they did return our money in a timely manner.

Since that day, the console has operated flawlessly with the exception of one instance when lightning took out the program amp in the board.

Since the console has two stereo program channels and the program amps are separate but adjacent, a simple plug and unplug operation was done to put it back on the air immediately. All ICs are socketed and repair was quick and easy.

I think you will find the ATI Vanguard series will live up to everything that ATI says it will and more.

Even if you are not having RFI problems with your installations, I think you will find the ATI Vanguard series will live up to everything that ATI says it will and more. I know WWAV plans to purchase another console for its production room later this year.

Editor's note: Charles Wooten is a broadcast engineering consultant serving radio and TV stations in Florida, Georgia, Alabama, Tennessee and Louisiana.

For more information on ATI consoles, contact Ed Mullin at 215-443-0330. The author may be reached at 904-234-0060, or circle Reader Service 17.

Reprinted from **Radio World** *August 15, 1987.*

Belar Keeps EZ-101 Neighborly

by Russ Mundschenk, CE
WEAZ-FM

USER REPORT

Philadelphia PA RF real estate has become a very valuable commodity due to changes in frequency allocation procedures and deregulation. As more and more stations avail themselves of new power upgrade opportunities, the "people next door" will be that much closer to our doorstep.

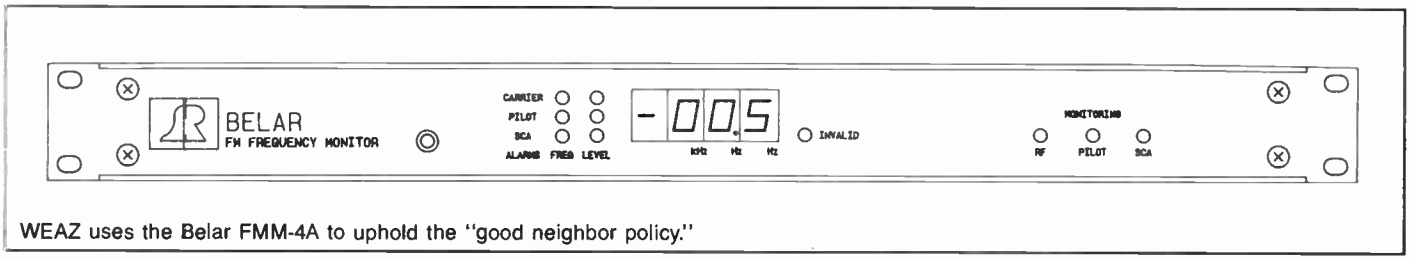
WEAZ-FM has been continually committed to close maintenance of modulation and center frequency to uphold the "good neighbor policy."

Since we are short spaced, with co-channel stations in New York City and Washington, DC, we have a significant area of signal overlap midway between Philadelphia and these cities. Tests have shown that minimization of the amplitude beat frequency (and subsequent multipath reduction) in these areas can be achieved by keeping as close as possible to our center frequency.

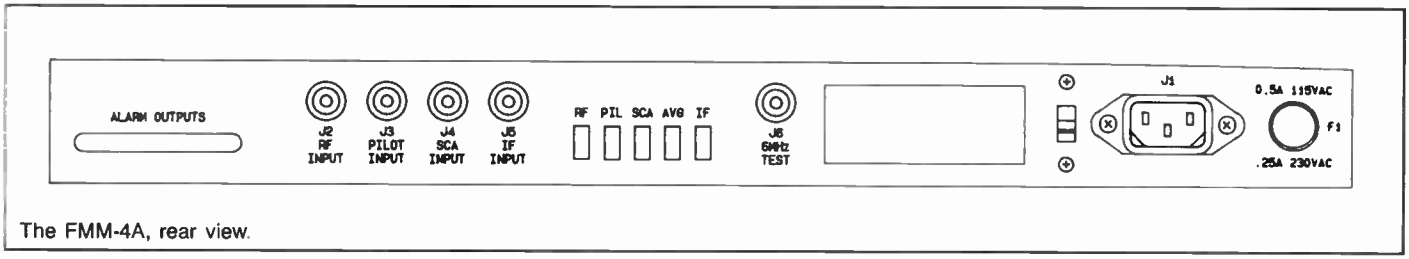
EZ-101 has always been impressed with the quality, accuracy and cost effectiveness of Belar monitors, having purchased two FMM-1/FMS-1 monitors (one of them serial number 1) and one FMM-2/FMS-2 monitor. All three units are still in continuous use and none (not even the old guy) have given us a bit of trouble.

When Belar told us they would be producing a digital monitor, the FMM-4A, that would continuously monitor our main carrier, pilot and subcarrier frequencies, we requested one of the first units.

We installed the monitor at the studio and bridged the on frequency output of the RF amplifier to the unit's RF input. We then connected the pilot output of our Belar FMS-2 stereo monitor to the frequency monitor's pilot input. In this configuration, the FMM-4A can be programmed to automatically alternate between the carrier and pilot frequencies.



WEAZ uses the Belar FMM-4A to uphold the "good neighbor policy."



The FMM-4A, rear view.

The unit also will measure the frequency shift of any subcarrier when connected to the output of a Belar SCM-2 subcarrier monitor. The FMM-4A is frequency agile, and will measure the deviation from any 100 kHz center frequency in ►

the FM band. When coupled to the LO and IF outputs of Belar's RFA-4 frequency selective RF amp, the frequency of any station in the market can be observed.

A digital averaging function can be enabled to perform successive averages on each two-second reading. The approximation then becomes the average of the average, and so on.

We performed a number of tests on the unit to determine the effectiveness of this averaging function in reducing errors caused by modulation. A stable count with no modulation could vary as much as ±50 Hz with modulation and no averaging. After turning on the averaging function, we observed a maximum 10 Hz change.

One of the unit's features I particularly like is its ability to poll the three frequencies in sequence and display each on a 3.5-digit LED readout while performing out-of-tolerance tests. A two-color LED on the monitor is set to alarm if three center carrier counts exceed ±1 kHz (yellow) or ±2 kHz (red).

Similarly, two other LEDs give visual alarm status for a 2 Hz pilot or 500 Hz subcarrier variation. A failsafe circuit in the unit prevents invalid counts and low input levels from producing erroneous readings. When the optional relay interface board is installed, the FMM-4A can be used in a variety of ATS applications.

The monitor uses a temperature-compensated 6 MHz time base that has a frequency drift specification of better than 5 parts in 10^7 per year. That translates to better than 50 Hz per year at 100 MHz. Since we receive an independent frequency measurement each month, the unit's accuracy is easy to spot check.

Where you are and what space you take up are two prime criteria in today's highly deregulated FM band. Monthly frequency measurements by an independent service are good as a check, but without continuous monitoring your station could be operating off frequency for up to 30 days.

An automatic monitor such as the Belar FMM-4A will let you know immediately if something causes your exciter, stereo or subcarrier generator to stray out of frequency tolerance.

Editor's note: Russ Mundschenk can be reached at 215-667-8400.

For more information on the Belar FMM-4A, contact Arno Meyer at Belar: 215-687-5550, or circle Reader Service 85.

Reprinted from **Radio World** *January 24, 1990.*

WMXR Selects Bext

by Rob Wolf, GM
WMXR

Woodstock VT Our station was pieced together in the spring of 1989 with a mix of both new and used equipment. We anticipated replacing much of the original equipment in phases after the first three years, so we felt we had an ability to compromise with used equipment.

USER REPORT

The transmitter facility required greater attention than the studios due to its remote access. The half-mile hike to a ridge overlooking the Connecticut River required as maintenance-free a facility as possible while remaining fiscally conservative.

The internal base frequency in the frequency synthesizer can be tapped and fed to another Bext exciter for synchronous operation.

The transmitter, an old ITA model refitted with solid state power supplies, uses composite STLs, a new remote control and 2-bay Jampro antenna coupled with an over-built tower to withstand additional services. The exciter is a Bext PTX 20.

Impressive performance

The performance of the Bext exciter has been impressive. In a technical and financial environment that promotes new and expensive, the quality and cost-effectiveness of Bext deserves attention.

With the anticipated replacement of the entire system with "new" sometime in the future, the Bext will likely be replaced—with another Bext unit. Not just because it is significantly less expensive than other units on the market, but mainly due to its proven reliability and the way it sounds.

Everything should operate right out of the box, right? Wrong. We had a series of malfunctioning new equipment and the Bext was the exception. However, perhaps more than any other factor, the Bext exciter sounds good—better, in my judgment, than other "famous brand" exciters used by the other stations in the market.

The model we currently have on the air is an older unit no longer in production and we understand the current models offer better specifications. Check with Bext for the subtle details. Even intermod specs are very good.

Our PTX 20 accepts one composite, two mono and three SCA inputs easily, with internally adjustable gains for each as well as an overall deviation adjustment on the front panel. Setup was a breeze.

Front panel metering

Perhaps the most helpful detail of the PTX 20 is the front panel metering with three frequently used functions: output power, VSWR and modulation. There's even an accurate peak indicator lamp that helps verify our entire system. Both the meter and peak indicator were proven accurate during our initial setup and proof.

The PTX model uses front panel thumbwheel switches to set up the frequency. Just set it and go. A harmonic filter on the output has helped our ancient transmitter operate cleanly and in a pinch the exciter works well as a 30 W backup transmitter. Our unit feeds a grid excited 250B IPA and the front panel metering makes it easy to tune the tank circuit for minimum VSWR.

The internal base frequency in the frequency synthesizer can be tapped and fed to another Bext exciter for synchronous operation. Our model was not initially designed with this feature in mind and will require more extensive modification than I would care to make in the field. However, the newer models have been developed with this feature ►

and make it easier for synchronous booster operation. At least the frequency will match, if not the overall deviation.

Simple and reliable

The internal workings of the Bext exciter are simple. Since our unit has required no servicing and has been the most reliable piece of equipment we bought, our only internal exploration was for curiosity. The unit has never failed, and worked right out of the box. Even the physical construction lends credibility: It's solid, rugged, looks good, fits into the rack well, etc.

My only criticism is about the front panel meter. Ours "sticks" somewhat in colder weather; and if only it were slightly larger ...

Why do I recommend Bext? With so much pressure on a broadcaster today, I won't waste time and money. I'd buy a Bext again without hesitation.

Editor's note: Since this writing, the PTX-20 has been renamed the PTX-30. For more information, contact Anne De Fazio at Bext: 619-239-8462, FAX: 619-239-8474, or circle Reader Service 100.

Reprinted from **Radio World** *November 21, 1990.*

BE's M/A Minimizes Downtime

by Bill Harland, Mgr Dom Sls, and Russ Erickson, Mgr RF Products Broadcast Electronics

TECHNOLOGY UPDATE

Quincy IL As FM radio stations become more profitable, lost revenue from any time off the air has become unacceptable. The solution of building new FM transmitter installations featuring completely redundant transmitters with automatic standby activation is becoming more common. The problem is that the time needed to design and build such a system is generally more than a typical station engineering staff has available.

To provide a solution to this problem, Broadcast Electronics designed Main/Alternate Main (M/A) FM transmitter systems as "standard" products.

Complete dual-combined FM transmitter systems have been common for many years in situations where 10 kW or more transmitter output power was required, but a factory delivered system that provides 100% full power standby capability has not been available except as an expensive custom alteration.

Broadcast Electronics has standard M/A FM transmitters available at all power levels from 100 W to 38.5 kW. These systems include two transmitters of the same model, a motorized coax switch, a center control cabinet housing the transmitter/switch controller, and all required RF plumbing and control wiring.

BE can also add to the standard system options such as: manual RF bypass patching, switching for two antennas, in-line RF wattmeters, system RF loads, probes, couplers, etc.

If failure of the transmitter on the air occurs, automatic change-over is controlled by a Broadcast Electronics FA-2 transmitter/output switch controller. This unit is designed for direct connection to (and control of) Broadcast Electronics FM transmitters and all popular motorized coax switches.

The FA-2 provides automatic activation of the standby transmitter if the on-air transmitter's power output falls below a user adjustable threshold for a designated period of time. It includes an alarm closure to inform the operator that the transmitter change-over has occurred.

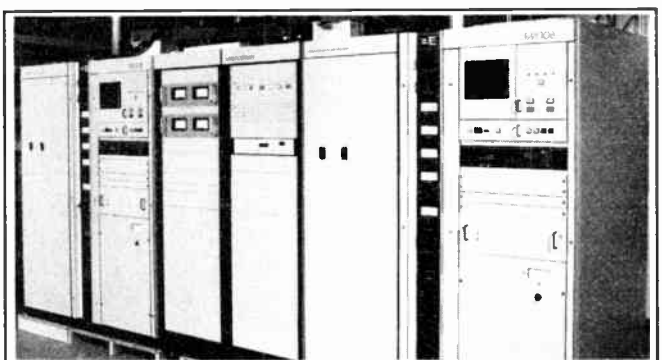
The FA-2 is equipped with latching relays to provide "memory" of which of the transmitters was on the air, in the event of an AC power failure. If the transmitter site loses AC power, the transmitter that was on the air at the time the power failed automatically returns to air when AC power is restored.

The most significant advantage of Broadcast Electronics' M/A transmitter system is installation time once the system has been delivered to the customer's location. This is because the entire system RF plumbing and control wiring is laid out and pre-cut as a part of the final assembly, prior to final test.

When the system is received at the customer's transmitter site, there is no measuring or cutting of transmission line or installation of connectors or spade lugs on control wires required. The user simply puts the transmitters and control racks in place, installs the pre-cut rigid line and connects the pre-cut control wiring.

Since the M/A was tested as a system, not only have the transmitters had a complete final test, but so have all the control wiring, motorized coax switches and the automatic change-over controller.

Because the system has been assembled at our factory, it includes all the needed rigid transmission line. The customer receives not only the benefit of saving installation time, but also the time spent planning, specifying and purchasing the smaller components required for the new transmitter system.



A BE FM-10B M/A, recently delivered to WYNY, includes an optional second center cabinet, Bird RF Wattmeters and a Burk Technology ARC-16 remote control.

Editor's note: For more information on Main/Alternate Main FM transmitters, contact Russ Erickson or Bill Harland at Broadcast Electronics: 217-224-9600, FAX: 217-224-9607, or circle Reader Service 53.

Reprinted from **Radio World** *November 21, 1990.*

SMI-5A Offers Intercom Solution

by Chris Ostrander, CE
KUDL/WHB

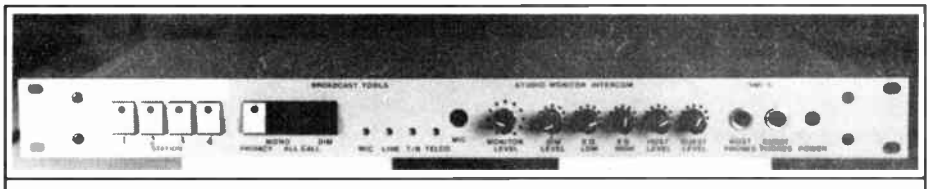
Kansas City MO Each year, our engineering staff gets together with the air staff to discuss projects that would make their on-air and production jobs easier. An overwhelming number of them named a studio intercom system as their highest priority. The existing telephone intercom was cumbersome for communication between studios.

We wanted this intercom to exceed the talent's expectations and looked at several possibilities. On the low end was the FM wireless intercom and the more sophisticated "talk-a-phone" style intercoms.

On the other end of the scale was the type of intercom used in TV studios, but these were not cost effective. None of these systems was suitable for use in a radio station environment such as ours.

To make them work properly would have required extensive modifications. That's when we learned of the Broadcast Tools, Inc. SMI-5A. For us, it was a dream come true.

One of the strongest features of the SMI-5A is that it is inserted into both the monitor and headphone paths in each studio. The monitors don't cut out with each call, but dim to a preset level. The on-air program can be monitored while having a conversation.



The SMI-5, from Broadcast Tools, Inc., exceeded the expectations of KUDL for a studio intercom.

Each SMI-5A intercom can handle up to four other studios (five total). But if you want to separate some systems such as production rooms and voice booths, by selectively interfacing certain ones with each other, you could have a larger combination of studios.

The best way to describe it is that each SMI-5A is like a 1A2 5 button phone set. You can have certain lines in all rooms and selective lines in one or two places, making the system very versatile.

The SMI-5As are connected with 25-pair phone cable like the 1A2 systems use. This cable is relatively easy to find at distributors like Graybar.

All you do is plug each unit in. There are no messy terminal strips on the back of these units and the 19" rackmount chassis at 1¾" makes them easy to install.

Each SMI-5A has a connector on the back which brings out all the switches and indicators for remote control. You can use either the internal electret condenser mic or feed it with a DA output from your console mic or any other line level source.

It uses a nice limiter circuit to squeeze up the voice when talking off mic. Because of the way the SMI-5A is designed, you have full Duplex talk paths. One person does not have to wait for the other to finish before pressing his talkback button.

Other nice features include an All Call button that helps in those "panic" situations and a mono switch that easily sums L and R channels together in the monitor speakers and headphones for checking phase.

It also includes a Privacy feature. When Privacy is set to *on*, the SMI-5A does not allow talkback into the headphone circuit while the mic is on. This prevents someone doing an "All Call" or flustering someone on the air.

When Privacy is *off*, communication is not interrupted, which could be useful for voice cueing on the fly.

The SMI-5A has two headphone amps, one for Host and the other Guest. Both have ample gain to drive any low impedance headphones or feed an external amp.

One welcome addition is that the SMI-5A has bass and treble controls for the headphones. Jocks love to adjust these to their preference and particular set of headphones.

Another feature is the Telco Interface input. This takes any output from an external telephone hybrid and inserts it into the headphone circuit. If you are currently using a speakerphone for hands-free communication, this would be a great improvement.

You have the choice of setting up the Host headphones "split," with Talkback in one ear and Program in the other, or Talkback in both ears.

USER REPORT

Both Host and Guest headphone circuits receive the Telco input when selected. This enables two people to take off-air calls easily.

Here at KUDL-FM and WHB-AM we had five studios that needed intercoms. Two on-air, two news and a traffic studio are used by both stations. In the Air Studios, we mounted the SMI-5As out of the way in a rack and outboarded the controls into our PR&E BMX consoles.

The lighted switches we used indicate which studio is calling them as well as to initiate talkback. In the other studios we mounted the SMI-5As into countertop racks at eye level.

In each of the studios we feed the audio input from the existing microphone by use of a DA output. By using our own mics, we hear a full, warm voice through the monitor speakers and headphones on the other end.

This is something we could never have accomplished with other intercom systems. There are trim pots for all inputs and outputs, as well as a nice setup sheet for logging settings for future reference.

As a result of our decision to purchase the Broadcast Tools, Inc. SMI-5A system, our air staff was overjoyed. They use it all the time and because it's so easy to use we have had few problems.

If you are looking for an intercom that is designed to integrate with broadcast equipment and has all the bells and whistles you'll ever need, you should consider the SMI-5A system.

Chris Ostrander is the Chief Engineer at KUDL/WHB. He can be reached at 913-722-2866.

For more information on the SMI-5A intercom, contact Don Winget at Broadcast Tools, Inc: 206-938-4089; FAX: 206-286-4433, or circle Reader Service 79.

Reprinted from **Radio World** *March 28, 1990.*

CCA F Series Updates Shortwave

by John Binsfeld, Director of Sales CCA

Fairburn GA The newly developed CCA F series shortwave transmitters were specifically designed to lead medium power plate modulated AM into the 21st century.

TECHNOLOGY UPDATE

This proven technology has gained the respect of shortwave broadcasters worldwide. The F series transmitters are available in power levels from 1 to 50 kW in either single or multiple frequency configurations.

Some of the design features include: solid state low level RF and AF stages, solid state control logic, automatic power control and VSWR protection.

The AM10000F-HF single frequency model is self contained in two 38"×34" cabinets. High quality modulation iron assures reliability in harsh tropical environments as well as high altitude applications.

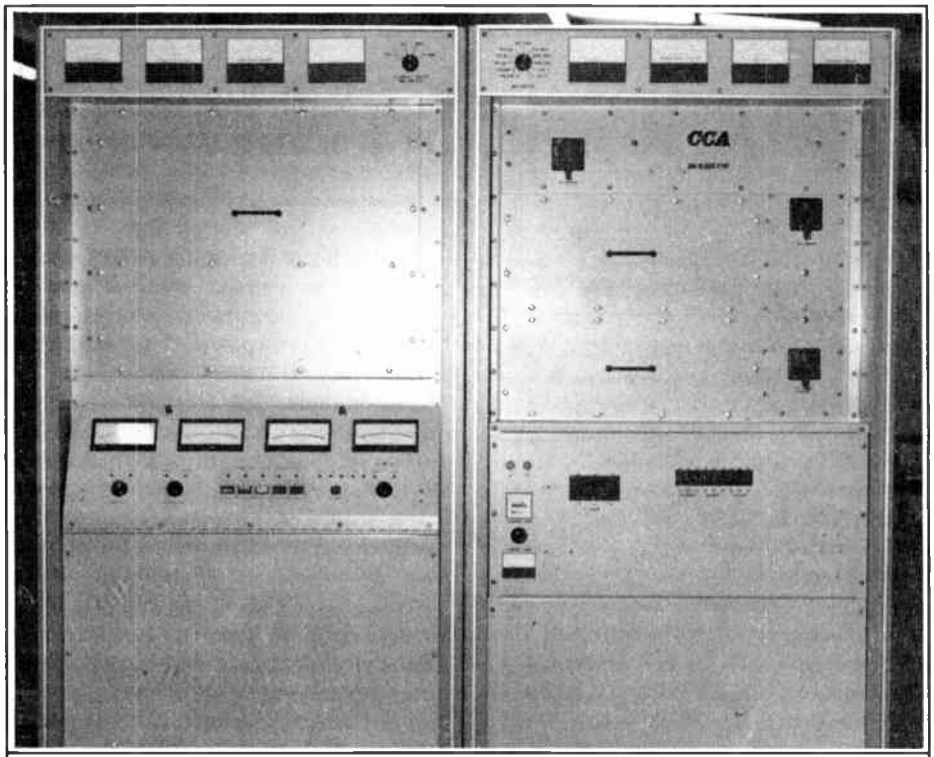
A total of three beam power tetrodes are employed in the conventional single-ended Class C PA stage and Class B push-pull modulators. Modulator bias is provided and regulated by the solid state modulator driver stages.

Conservatively rated, quality components were selected to withstand continuous high modulation levels with 125% positive peaks.

The low Q "PI-L" output matching network delivers the high frequency sideband response demanded by shortwave broadcasters. Sideband symmetry and low ICPM reduce the distortion effects of selective fading common to skywave signals.

CCA was awarded contracts to deliver three of the AM10000F-HF transmitters to the National Institute of Standards and Technology (at the time, the National Bureau of Standards) at Boulder, CO. These new CCA transmitters will be the source of the WWV time and frequency standard transmissions at 5 MHz, 10 MHz, and 15 MHz from now until well into the next century.

The F series AM transmitters will also be available in medium wave standard broadcast (540-1600 kHz) versions at 25 kW and 50 kW.



Three AM10000F-HF transmitters were commissioned from CCA for use at NIST, Boulder CO.

These models will replace the AM25000D and AM50000D transmitters. CCA, committed to the simplicity and reliability of this established technology, believes these new transmitters will maintain the company's position as a major supplier to "powerhouse" AM broadcasters worldwide.

Editor's note: For additional information on the AM10000F HF transmitter, contact John Binsfeld at CCA: 404-964-3530, or circle Reader Service 24.

Reprinted from **Radio World** *April 25, 1990.*

CCA 5 kW Tapped For WQLC Start-Up

by Mark Schmucker, CE WQHL

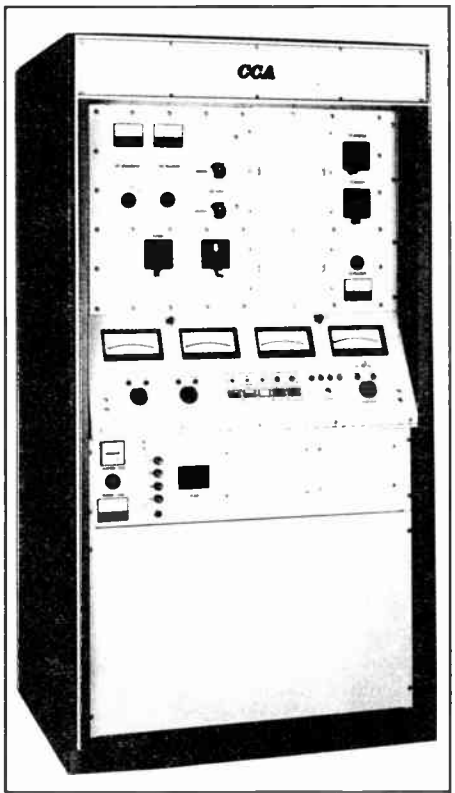
Lake City FL Broadcast engineers dream about the opportunity I've had: building a station from the ground up, from the control room to the transmitter plant. Included with that thrill, however, are doubts and questions about picking the equipment for the project.

The single most expensive equipment purchase will be the transmitter. Of course, the cost involved with the purchase and the operating expense are very important. The bottom line: Get the most and best for the least. We chose the CCA 5000G, 5 kW FM transmitter with the CCA 20G 20 W exciter for WQLC, our start-up FM.

CCA has been in business many years and has many transmitters throughout the country. Within a 60 mile radius, I can find several CCA transmitters either on the air full time or on standby. In fact, WQHL, the station where I am employed full time as the chief engineer, uses a CCA 10 ►

kW FM transmitter; it has been on the air since 1973 and has had very little down time.

The CCA 5000G is packaged in a single nice-looking cabinet. The power



A CCA transmitter was selected by WQLC.

supply as well as the PA box are built with enough room for easy maintenance and repair.

Tube technology

CCA still uses tubes in both the IPA and PA. The IPA is a 3CX800A7 tube, which supplies more than enough drive for the PA. The PA uses the reliable 3CX3000A7 tube in a grounded grid design, eliminating the need to maintain screen voltages and currents.

Tuning of the transmitter is both easy and straightforward. The exciter is rack-mounted in your associated equipment rack. The exciter control circuits can be easily connected to the transmitter so that the output is muted when the transmitter plates are turned off—to protect the IPA tube.

Metering of the transmitter consists of not only the required parameters, but also voltage and grid currents of the IPA tube as well as PA grid current. The transmitter also has metering for filaments of the IPA and PA tubes and the AC line voltage. The filaments are adjustable for both tubes.

Located behind the meter panel is the auto power control, plate control and overload circuits. The overload circuit monitors all the important points of the transmitter as well as VSWR. The auto power control monitors the output from the directional coupler and will maintain the output to the set levels.

The transmitter has ample status lights to tell you what is off, as well as when and where an overload has been detected.

The transmitter has ample status lights to tell you what is off, as well as when and where an overload has been detected. It will attempt to recycle itself in the event of an overload, but the overload status will remain lit until it is manually reset.

Going right to the top

The evening the transmitter was first turned on we were, unfortunately, faced with a bad plate transformer. After a call from the station manager to the president of CCA (how many other companies let you speak directly to the president?), we had a new transformer delivered within the day and were able to get on the air by the target date.

The transmitter is operated by remote and is controlled by a Gentner VRC 2000. Interconnection between the transmitter and the remote control was easily accessible from behind the meter panel.

The only things I do not like about this transmitter are that the upside-down IPA tube is difficult to install and CCA no longer provides a tube puller for the PA tube.

USER REPORT

I have had good luck in the past with CCA transmitters and expect it to continue with this one. I will have no problem in leaving CCA on my transmitter consideration list when I am faced with recommending a transmitter for future purchases.

Editor's note: Mark Schmucker is CE for WQHL-AM/FM, Live Oak, FL. He is the contract engineer for WQLC-FM, Lake City. Contact him at 904-362-5810.

For more information on CCA transmitters, contact Ron Baker at CCA: 404-964-3530, FAX: 404-964-2222, or circle Reader Service 67.

Reprinted from **Radio World** *November 21, 1990.*

KZAP Chooses Denon

by Kent Randles, CE
KZAP

Sacremento, CA The moment I saw a prototype of the Denon DN-970FA CD cart player, I knew it was what we needed at KZAP.

USER REPORT

We already had two DN-950FA CD cart machines on the air and one in the production room. But those machines were designed to be jock-proof on-air and lacked production features like a search/cue knob and programmable segment play.

Also, having invested in several hundred of the cartridges that the Denons use, I thought the 970 would be appropriate, flexible and easy to use. This definitely has proven true.

Easy to read

At 16"×8½"×5¼", the 970 player is two inches deeper and almost two inches wider than the 950. The front panel is slanted back and easy to read even when on top of a desk. It includes a big knob for search and cue, and smaller knobs for vari-speed and headphone level.

Buttons control play/pause, standby/cue and the mode features. There is a display for vari-speed percentage. You can go up or down 10 percent and program it to de- ►

fault to +2 percent.

On the back panel is the AC connector, power switch, fan opening and connectors for remote control, serial remote control and "tally" (end of message, etc.), BNC connectors for external sync in and external sync out, and XLRs for digital out and balanced left and right audio out.

When you slide a loaded cartridge in and it drops into place, depending on the presets, the unit automatically cues either to the beginning of track 01 or to the first audio that exceeds one of seven programmable thresholds.

At 16″×8½″×5¼″, the 970 player is two inches deeper and almost two inches wider than the 950.

Cueing at will

If you click the search knob to choose other track or index numbers while the machine is cueing, it will cue up to what you have selected instead. You also can use the search knob to scrub forward or backward, frame by frame.

In the fast search mode, more clicks bring one-quarter speed, real time, or four or eight times regular speed. If you push the play button and then use the search knob to find the spot from which to start, pushing the cue button will make that place the starting point.

Some consumer CD machines will let you program a segment to repeat. The 970 will let you pick the segment and then allow you to move the start and end times around with the search knob even if they are in different tracks. Next, you can loop that segment or use the Play button to start it when you need it. Finally, you can store three start/stop points from anywhere on the disc.

You may have heard some horror stories about Denon's earlier DN-950F. Notice that there was no DN-970F.

Since, cartridge handling mechanics have been beefed up, circuitry has been changed and the way the machines deal with a problem is much better. The "F" machines would sit there skipping or jump back and forth. The "FAs" are much more civilized. Generally, they either play correctly or stop. They no longer have to be aligned periodically. Lens cleaning is no as critical.

So now KZAP has four DN-950FAs and one DN-970FA. Even if a DN-970FA ends up being your only CD player, its ease of operation and numerous features make it an ideal machine for production and occasional on-air use.

Editor's note: For information on the DN-970FA, contact Laura Tyson at Denon: 201-575-7810, FAX: 201-808-1608, or circle Reader Service 103.

Reprinted from **Radio World** *December 26, 1990.*

The Denon 970FA CD cart machine is ideal for KZAP's production needs and occasional on-air use.

Having Tubes Rebuilt

by John Sullivan, Co-owner
Econco

Woodland CA Often Econco engineers are asked by customers, "What do you do to rebuild a tube?"

At Econco, tubes sent for rebuilding are first routed to Incoming Test, where an analysis is made of the condition. Over the years, testing of incoming tubes has allowed Econco to develop a detailed picture of what constitutes normal modes of failure for each tube type.

SPECIAL REPORT

Incoming tubes that do not fit the normal pattern may result in a call from Econco's engineers to the customer to inquire about any abnormal circumstances associated with the sending of the tube to Econco.

After incoming testing, the tubes are routed to the Internals Department, where they are opened and broken down into their basic elements. Filaments are replaced, grid assemblies are repaired or replaced, and cleaning of internal surfaces is completed.

Filaments are carburized, a process which causes the filament to emit sufficient electrons at the proper operating temperature. During normal operation, the carbon burns out of the filament, resulting in reduction of the electron emission to the point where normal output can no longer be achieved. Grids, on certain types, require surface processing to reduce "grid emission."

After reassembly, alignment and sealing of the vacuum envelope, the tubes are vacuum processed. The vacuum pumping process can require from six to 30 or more hours, depending on tube size and the degree of gas evolution from interior elements.

Cleanup, plating and testing to new tube or greater specifications then leave the tube ready for return to a customer.

Econco has produced a booklet, *Tube Topics*, describing in more detail power tubes and their operation. We will be happy to send *Tube Topics* at no charge to any interested tube user.

Editor's note: For more information on Econco's services, contact John Sullivan at Econco: 916-662-7553, FAX: 916-666-7760, or circle Reader Service 109.

Reprinted form **Radio World** *November 21, 1990.*

CTR90 Boasts Sonic Superiority

by Bill Franklin, DE
Fidelipac

Moorestown, NJ One of the most significant improvements broadcasters can offer to listeners is better clarity and signal to noise ratio of the on-air signal. The new Dynamax CTR90 series cartridge machine draws upon advanced electronic design to help broadcasters bring such improved audio to their audience.

Audio signal path designs with solid state circuitry are straightforward in the CTR90, and typical circuit topologies are easily recognizable. The CTR90 audio signal paths are all DC coupled—the idea was to eliminate coupling capacitors which add adverse distortions to signals passing through them.

TECHNOLOGY UPDATE

There is only one capacitor in the play amp signal path, and it is a specially selected audio grade electrolytic. It connects the reproduce head to the low noise, low impedance transistor preamp stage. The reproduce head is of a humbucking, noise cancelling design with additional shields to minimize hum and noise pickup.

Polystyrene capacitors are used in the feedback loops for their audio quality. Tantalum capacitors are chosen to bypass critical power supply rails; their low impedance at high frequencies and their fast response maintain a very clean and stable power supply to all devices.

The OP37 op amp is specially situated at the head input stage for nearly Class A operation, slew rate of 17V/μS and low noise (MI110 dB CMR). Low amounts of negative feedback in the various amplifier stages maintain transient intramodulation (TIM) distortion to a minimum at the cost of a few additional stages.

There are many good tape recorder noise reduction units available to the aftermarket. It has always been Fidelipac's policy to allow the end user to make the selection on his own. Our CTR100 Series machine addresses the interchangeability of switching NR carts with non-NR carts by using the Cart Scan feature.

In the CTR90 design, we introduced a transparent, easily adjustable, single-ended noise reduction circuit which would benefit the end user without any interchangeability problems with older libraries of carts.

The DNR (Dynamic Noise Reduction) system from National Semiconductor cleans up the sound of noisy tape transfers and noisy source material in general. The professional version of the DNR I.C. offers more than 10 dB of noise reduction by means of a variable lowpass filter that controls high frequency cutoffs.

The instantaneous attack time and natural decay time make the DNR circuit's side effects inaudible and, based on our test results, constant over a wide variety of music productions. When other noise reduction systems are employed externally, or simply if the user dislikes the system, the entire DNR circuit can be removed easily from circuit by jumpers.

In the record circuits, the only capacitors in the signal path are at the input to guard against any DC present from the outside world, again using an audio grade capacitor.

A DC control voltage is fed from the front panel to an Aphex VCA as a way of controlling the record input sensitivity. This keeps the input signal on the board where it belongs, rather than running the audio signal cables all around the machine to be exposed to stray EMI fields from motors and solenoids. The VCA operates in Class A mode and can be used in a DC coupled circuit design.

The opportunity to design a new cart machine from ground up made it easy to take advantage of newer technologies, such as the Dolby HX Pro™ headroom extension system. The advantages that HX Pro offers can be a significant improvement to 7 1/2 IPS cart reproduction. The nature of the wide dynamics and high frequency content of the newer digital sound sources make the HX Pro function a natural solution for carting music and productions.

The Dolby HX Pro circuit controls the effects of tape saturation and the self-biasing that high frequency signals can cause to tapes during the recording process. By minimizing distortion and improving dynamic range, the HX Pro system guarantees high quality recordings on both older and newer tape formulas without any compatibility problems.

The Dynamax CTR90 from Fidelipac offers DC coupled audio signal paths.

The analog cart machine works effectively and reliably every day while maintaining current music libraries. New technologies and advanced design criteria can elevate the performance of the cart machine to keep pace with newer sound sources. The superior sonic qualities of the Dynamax CTR90 series meet these criteria yet preserve the familiar rugged features and economy of the endless loop cartridge medium.

Editor's note: For more information on the CTR90 series cart machine, contact Bill Franklin at Fidelipac: 609-235-3900, FAX: 609-235-7779, or circle Reader Service 28.

Reprinted from **Radio World** *December 26, 1990.*

KODJ-FM Gets on the Fast Trac

by Jim Garrett, CE
KODJ-FM

Los Angeles CA A few months ago, KODJ, an all-oldies FM station in LA, made the decision to re-cart most of its music library. Existing titles would be re-dubbed from the best sources we could find and many new titles would be added.

The existing production studios couldn't be used; they were busy enough and this project would take several months. The solution was a dedicated dubbing studio using the Fast Trac dubbing system from Henry Engineering.

USER REPORT

The Fast Trac has inputs for three sources and I use all three: one for a Technics turntable, one for an Otari reel-to-reel deck and the third for a Studer CD player. There are internal gain adjustments for each source, so a −10 dBv output from a turntable preamp can be made to match the level of a +4 dBm CD player.

The unit's record output is connected to an ITC 99B cart recorder, and the monitoring outputs feed a Crown amplifier, which drives a pair of Tannoy near-field monitor speakers. The Fast Trac's "scope" output is connected to an X-Y audio monitor scope to check for phase error.

The most unique feature of the Fast Trac is its automatic machine control system, which is what makes dubbing carts a snap.

I first select one of the three source machines with a pushbutton. While auditioning the tune, I set the recording level by adjusting the "Line Gain" knob. I then cue the source, put a cart in the recorder and hit the "Start" button on the Fast Trac.

If I'm dubbing a record the turntable starts first—with the audio muted. A bit later the cart recorder starts. Just as modulation reaches the stylus, the audio is smoothly unmuted and recording begins. If I am dubbing a CD, the cart machine will start just slightly before the CD player. This prevents the intro from being "clipped," since most CD players will start more quickly than a cart machine.

I especially liked the ability to select different recording modes on the Fast Trac. I can record in stereo but I can also take just the left or right channel and feed it to both L and R outputs. This is useful when the source is "re-channeled stereo" and only one channel is usable. The L and R inputs can also be summed to mono.

Being able to switch among these recording modes is an absolute necessity when dealing with "oldies" material from numerous sources. A "Balance" control lets me fix those "off center" vocals and there's a "Process In/Out" button that inserts external devices (like an equalizer or filter) into the recording chain for quick A/B comparison.

I always monitor the actual cart playback when dubbing. The PB output of the cart recorder is connected to the tape monitor input of the Fast Trac. A button allows me to switch between "Line" and "Tape" to instantly check recording quality.

A "Mono" button puts the monitor system in mono to check for phase error, without affecting the actual stereo recording. The X-Y scope displays the monitor signal and provides a visual indication of cart phase performance.

I've used the Fast Trac for about six months now, and it's done a fine job. The automatic start-timing makes the dubbing process a one-button operation and the carts are consistently tight. Having to re-dub a cart because the cue isn't quite right is a thing of the past. And it's great to be able to dub music carts without tying up a production studio.

What would I change about the unit? I'd put some kind of numerical scale around the "Line Gain" knob so I could easily return to a certain gain setting.

When you add up the quality, convenience and utility of this little unit, the Fast Trac dubbing system is hard to beat.

Editor's note: For more information on the Fast Trac, contact Hank Landsberg at Henry Engineering: 818-355-3656; FAX: 818-355-0077, or circle Reader Service 14.

Reprinted from **Radio World** *July 25, 1990.*

ITC Switches VOA Delano Audio

by Perry Gene Pitts, Maint. Mgr.
VOA

Delano CA In early 1989, the VOA Delano Relay Station installed an ITC audio routing switcher to handle six program audio feeds for Delano, delivered via satellite from our studios in Washington, DC.

In addition to the primary duty of routing the correct program feed to one or more transmitters for transmission, the ITC switcher also routes CD players used for local sign-on and sign-off and other announcements. Backup telephone patch audio is also brought through the switcher for use in the event of a satellite failure.

One shortcoming with the ITC switcher for our application is its limited number of programmable events. With six program lines feeding twelve transmitter inputs, the number of daily

USER REPORT

scheduled switching events significantly exceeds the memory capacity of the switcher.

This problem was solved by driving the switcher from a PC type computer using in-house software written in Turbo Basic. The switcher has an RS-232 port for this purpose.

The software provides a graphic display of the status of audio routing and allows both automatic and manual operation. An entire seasonal daily schedule is stored on files in the PC. It provides virtually hands-off switching of the audio for the entire relay station, including monitoring.

An optional feature available with the ITC switcher is the machine control unit. This device provides a choice of 16 relay contacts or opto-isolated open collector outputs. Each output can be programmed for either momentary or ►

latched closures.

Installation is made over the RS-485 remote controller bus. The machine controller can be configured to follow input selection to provide a contact closure whenever that input is connected to any of the outputs.

We use the machine control unit to start CD players for various station announcement inserts and fill music. A reel-to-reel tape and cassette machines are also controlled by this unit.

Another option is a desktop remote control unit that can be programmed to control up to four output channels on the ITC switcher.

We use these units in various locations throughout the transmitter plant to switch audio to monitor speakers. The selected audio is routed from the ITC to voltage controlled attenuators through Crown D-75 monitor amplifiers to speakers near the desk control units.

Control wiring for the desk control units is through the switcher's balanced 2-wire RS-485 bus. The ITC switcher provides a serial printer port and a printer. The printer functions as a dumb terminal during switcher configuration and is available to print out each switching event on a real-time basis.

The ITC switcher provides a serial printer port and a printer.

There is provision for connecting a parallel BCD encoded clock into the ITC switcher. The master clock at Delano is an EROS satellite receiver locked to NIST time. This time is fed into the switcher to guarantee the switcher is locked to station time.

The ITC switcher is supplied with dual power supplies and has a one farad capacitor across its RAM DC supply. According to ITC, it will power the RAM for up to two weeks without AC power.

There is also a configuration backup RAM module that consists of a self contained, plug-in memory block (Dallas Chip) with its own battery backup. In the event of power failure or other catastrophe, the system configuration may be reloaded from this plug-in memory block.

Our only significant complaint with the switcher is related to the RS-485 remote bus. A momentary short or glitch on the bus line will totally lock up the switcher.

The only recovery from this locked-up condition is a cold reboot. This requires both power supplies to be switched off and the RAM supply voltage drained (with a clip lead) before power is switched back on.

Another inconvenience is the liquid crystal display. It is difficult to see without being in the proper position. A better readout screen on the control unit would help.

Despite these minor points, since the initial installation and shakedown of the ITC switcher at the Delano Relay Station, the VOA has purchased and installed the ITC audio switcher at other installations in the US, Germany and Liberia.

Editor's note: For more information on the ITC audio routing switcher, contact Bruce Helling at ITC: 309-828-1381; FAX: 309-828-1386, or circle Reader Service 11.

Reprinted from **Radio World** *July 25, 1990.*

ITC's Series 1 Is the One at WJNO/WRMF

by Richard R. Lucas, CE
WJNO/WRMF

West Palm Beach, FL With four cramped workstations where all the editing is done and news voices and actualities flying fast and furious, the newsroom at WJNO/WRMF can be an awfully busy place.

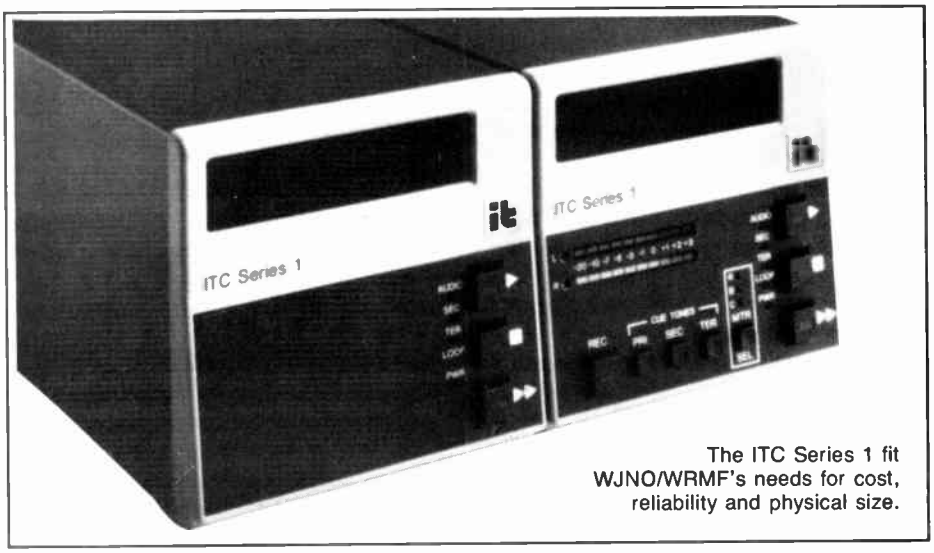
USER REPORT

Within the setting, our 20-plus year old cart machines were becoming unreliable, not to mention antiquated. So in searching for replacement machines I not only was concerned with cost and reliability, but also physical size and the inclusion of all the bells and whistles needed to make our air product flow.

These requirements made the choice of ITC's Series 1 obvious to me. This seemingly mundane-looking machine is packed with some goodies we engineers could only dream about just a few years ago, not all of which are immediately apparent.

Cool running

The first thing I noticed about the machine is how cool it runs, when compared with other cart machines. The power supply is a switching type, thereby eliminating a bulky, heavy power transformer, along with its magnetic field.



The ITC Series 1 fit WJNO/WRMF's needs for cost, reliability and physical size.

This makes the machine very flexible in that any AC line voltage between 94 V and 240 V will work fine with no jumper changing—great for our Florida brownouts. Another reason for its cool running is the new, dual-winding ►

solenoid. One winding provides the initial torque to engage the pinch roller, the other takes over to hold it in at considerably less power. Thus, the machine runs cool, even after hours of heavy or continuous use.

Other, less apparent features include a hard-surface nickel-plated, die-cast aluminum base plate with cast head brackets and cart guides. The hold-down springs are of a unique roller bearing type, and all active components are included on four plug-in boards—the mother board contains only traces, no active components.

The motor is a DC servo-type, the same Papst motor as used in ITC's 99B series. Heads and pinch rollers are also interchangeable with the rest of the ITC line.

Our programmers are pleased with the machine's full line of features. All three standard cue tones are accessible from the front panel for special editing, along with switchable LED VUs that include bias and cue tracks. High-speed cue, excellent audio quality—all the goodies you'd expect in a top-of-the-line machine—all are included in this, their least expensive model.

Stereo-mono sensing

Another unique feature of the Series 1 is the sensing capability between stereo and mono modes. With a simple jumper change, you can enable the machine to playback left channel-only audio to both the left and right output amps. It's ITC's answer to an on-going problem we deal with daily: how to make stereo and mono carts compatible for use on both AM and FM.

This engineer is impressed. In fact, I wouldn't be at all reluctant to use these machines for FM stereo playback where we're presently using the ITC Deltas. To me, the Series 1 is a better buy at $800 less.

Having no provisions for auto-azimuth control, I wouldn't use them for critical applications, such as recording stereo music or spots, but for a good utility cart machine, the Series 1 will be a tough one to beat. Add to this the now-legendary ITC factory support and their two-year full warranty, and you've got a winner.

Editor's note: For more information on the Series 1 cart machine, call Bruce Helling at ITC: 800-447-0414; FAX: 309-828-1386, or circle Reader Service 4.

Reprinted from **Radio World** *December 26, 1990.*

LPB Provides "Sleep Insurance" for WLSH

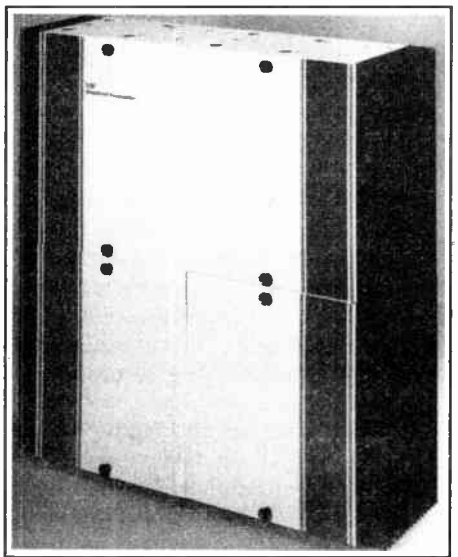
by William Lakatas, Jr., CE
HGF Media Group

USER REPORT

Allentown PA "That breadbox on the wall is our new transmitter?" With that comment from a staff member, I threw the switch that turned on our new LPB low power transmitter and instituted 24-hour service on our most recently acquired AM station.

When we purchased WLSH in Lansford, PA, it was a daytime-only operation. It had an overnight authorization of 59 W, but the former owner did not use it. I talked to Dick Crompton of LPB in Fraser, PA and he suggested the LPB 100 W low power transmitter for our application.

I now have a transmitter that can economically provide me with my overnight power and can provide an intermediate power level for Post Sunset Authorization. Also, as Dick calls it, I now have "sleep insurance" in the form of a backup for my main transmitter, an old Collins 21E.



LPB earns high marks for reliability at WLSH.

The installation of the LPB transmitter seemed at the outset to be as simple as mounting the unit on the wall, making a few connections and plugging it into the wall outlet.

It *is* that simple—and that is the problem! It took me longer to install the transfer relay in the phasor cabinet, and to plan and install the audio and modulation monitor switch over relays, than it did to install and fire up the new LPB transmitter.

The LPB line of low power transmitters is modular in design. One module is the 30 W transmitter. Two modules connected together form the 60 W transmitter and the 100 W transmitter is composed of four modules.

Internal adjustments select a variable output level and adjust audio input. (I added a relay and a trimpot to select two power output levels.)

The transmitter sounds great on the air and met or exceeded every single spec when I checked it out with our Delta splatter monitor.

As far as quality and reliability are concerned, I have 12 LPB boards among the eight stations in our group. These transmitters are designed and constructed just as well as their boards. If my track record with the LPB boards is any indication, I expect to see many years of reliable and trouble free service from our LPB transmitters.

The only changes I would like to see on future designs are external connections for modulation monitors and a door with an interlock rather than pop-on hatches. I am very pleased and impressed with this fine LPB line of transmitters. They were certainly worth our investment.

For more information on LPB transmitters, contact John Tiedeck at LPB: 215-644-1123, or circle Reader Service 49.

Reprinted from **Radio World** *April 26, 1989.*

Examining Low Power AM Options

by Richard Burden, President
Burden Associates

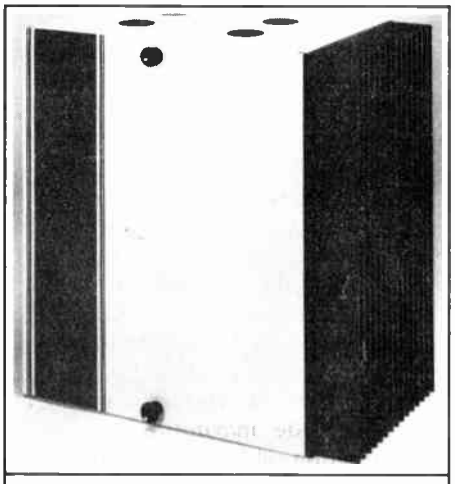
Canoga Park CA One area of broadcasting which makes particular use of the AM receiver is low power AM radio. Applications fall under Part 15 and Part 90 of the Commission's rules.

SPECIAL REPORT

Perhaps the best known low power AM radio application is that of the campus radio station, authorized under Part 15. This application employs carrier current technique, the process by which the RF signal is superimposed upon an existing power line.

The output of the transmitter is interfaced with the power line through a high pass network. This allows the RF energy to enter the power line while preventing the low frequency 60 Hz from backing into the transmitter.

This network also makes the match between transmitter and load. The



The AM-30P, from LPB, can assist in Part 15 and Part 90 applications.

equivalent circuit of the power line is represented by a low resistance (usually in the order of 1 to 50 ohms) in series with an inductance.

Variable transformer

This interface device, therefore, contains a variable transformer to match the resistive element of the load and a variable capacitor to null out the inductive element.

Connection to the power line is at the 220 or 110 volt secondary of the incoming power transformer. The RF signal then follows the route of the electrical wiring throughout the building.

The signal emitted does not radiate as an antenna. Instead, it yields a strong induction field in the vicinity of the conductor with a rapidly diminishing field that varies as the inverse cube of the distance.

This physical principle allows for a strong signal to be received in the close proximity of the conducting cable. The rapid attenuation of this same signal keeps the signal confined to the area of interest. (LPB has a publication on this subject, titled "Tech Note 1A." It can be ►

LPB's Signature Makes Its Mark

by Dave Schmidt, CE
WAMS-AM

Wilmington DE Searching for the words that best describe LPB Signature consoles, those that come to mind are: "No problems!"

We have been involved with LPB Signature consoles for many years. Our company has always made them our first choice for any station that asked for a good, dependable console.

USER REPORT

Its selectable inputs for each of the channels make source selection easy, and gives the operator the pleasure of smooth operation. If a change has to be made, it can generally be done in a matter of minutes.

How well do the Signature consoles hold up under tough operating conditions? We have installed them in private schools and universities, which we feel really puts any piece of equipment to its maximum test of durability. The results? No problems after years of hard use.

The layout inside the consoles is an engineering dream. The large barrier strip terminals, clearly marked, make for a smooth hook-up (unlike the very tough wedge-in-the-small-hole-and-screw-down terminals).

After you have done a few installations of the Signature consoles, you can generally do 75% of the hook-up without even looking at the detailed instruction book.

In the event of a problem, LPB has always given us full support with needed parts and has always answered our technical questions (as few as need to be asked).

If a pot needs to be changed or a switch needs servicing, there is plenty of room in which to work and the problem can usually be corrected in a few minutes.

Construction of the console makes it look like it is built to last—we have not been let down in that department.

And in high RF fields we have found the console to be RF-free (even in the immediate area of a 10,000 W AM transmitter, RF is not present).

The movie guy gives "thumbs up" for a good movie review; we can do the same with the Signature consoles.

For more information on Signature Series consoles, contact John Tiedeck at LPB: 215-644-1123, or circle Reader Service 47.

Reprinted from **Radio World** *August 23, 1989.*

obtained by writing the company at 28 Bacton Hill Rd., Frazer, PA 19355.)

Drive-ins and leaky cables

Another common carrier current technique is used at numerous drive-in theaters. Here the RF signal is superimposed upon the existing field loudspeaker wiring and the sound from the picture is received on the standard AM automobile receiver.

Although originally intended to circumvent speaker theft, this technique has been widely accepted as an improvement in audio for the theatre patron.

A variation of the carrier current technique is "leaky cable technology." Here, the technique is employed as the vehicle for routing an RF induction signal.

Leaky cable is terminated in its characteristic impedance. At AM broadcast frequencies, it intentionally leaks a linear induction field along its length.

There has been much misconception on the subject of the radiated field. Some argue that this constitutes an antenna. Actually, its representation is that of a transmission line terminated in its characteristic impedance and is more properly defined as a "Terminated Transmission Line."

It is the dummy load, or termination, that is the actual antenna member in this system. The resultant field, linear along its length, yields a propagation characteristic which attenuates as the inverse cube of the lateral distance from the conductor.

Wide range of supporters

Measured data supports the physics of this approach. Leaky cable has found favor in those applications where a linear field was required over longer distances.

Users of this technology include the Los Angeles Lakers and Los Angeles Kings at the Forum. The sports teams employ this method to receive game broadcasts inside the arena. Santa Anita Racetrack uses the technique to enhance the enjoyment of racing.

Other uses have served the church community. The Crystal Cathedral in Garden Grove, CA utilizes leaky cable routed through the parking area to provide reception of services held in the sanctuary to those choosing to remain in their vehicles.

Others who use leaky coax techniques for language translation and aid to the hearing impaired attest to this simple but effective use of induction principles and standard AM broadcast receivers.

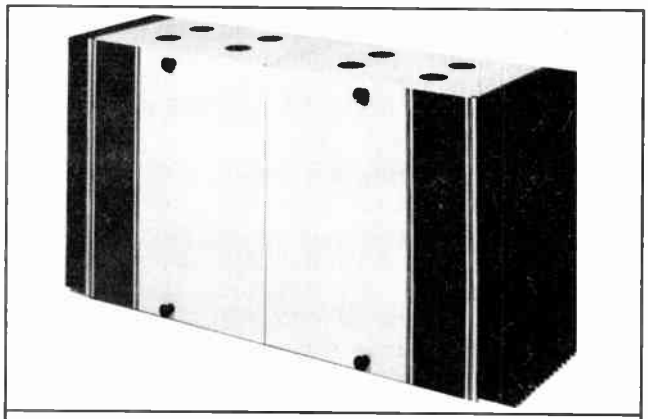
Longer lengths of induction cable can be found on the approach roads to such attractions as Walt Disney, Epcot Center and the Grand Ole Opry. These attractions make use of induction techniques to provide information to incoming motorists. As commercial establishments, they operate under Part 15 of the rules.

In the late '60s, Cliff Moore, GM of the Los Angeles Department of Airports, used leaky cable technology to solve a congestion problem at LAX, which has the distinction of being the busiest vehicular traffic airport in the world.

Moore felt the congestion at LAX could be relieved if motorists were provided with traffic, parking and airline location information as they entered the airport area. This was the beginning of what is now known as the Traveler's Information Service.

The Commission issued rulemaking on the TIS service in 1977. This is a licensed service limited to local government use, for the expressed purpose of providing information to the traveler.

Authorization includes both leaky coax technology and short vertical antennas. Power limitations for this service are a maximum of 50 W into a leaky cable or 10 W into an antenna system.



LBP's AM-60P low power AM transmitter.

The maximum field at 1.5 km from the site of an antenna system is not to exceed 2.0 mV/m regardless of power, which limits coverage to the specific area of interest.

Conversations with receiver manufacturers would seem to indicate that the public has abandoned interest in AM radio. But the continuing effort on behalf of AM improvement is helping AM to compete in today's world.

The multifaceted uses of low power AM radio only add to the value and versatility of the AM broadcast spectrum.

Editor's note: Richard Burden is president of Burden Associates, a broadcast engineering service.

For information on low power transmitters, contact John Tiedeck at LPB: 215-644-1123, or circle Reader Service 122.

Reprinted from **Radio World** *April 25, 1990.*

Radiating Cable Uses

by Richard Crompton, App. Eng. LPB Inc.

St. Michaels MD Radiating cable can be described as a unique form of "antenna." Why? Read on.

SPECIAL REPORT

The term "antenna" is actually a misnomer. A radiating or leaky cable is actually operated as a terminated transmission line. The characteristic impedance load termination at the end of the cable is the actual antenna, but terminations do not radiate usefully.

Like all current-carrying transmission lines, there is a field surrounding the cable. It is this field that we utilize, hence we incorrectly call the radiating cable an "antenna." This surrounding field is the induction field; it is highly localized to the immediate vicinity of the cable.

While most other types of antennas strive to provide maximum coverage area, a radiating cable system is used to provide coverage of a small and specific geographic area. Practical reception range from the cable, in the AM broadcast band, will be limited to approximately one hundred feet.

Cable forms and applications

To produce a controlled amount of radiation from a coaxial cable, the cable is manufactured with some form of openings in the outer shield.

Andrew "Radiax," originally designed for VHF use in subways, resembles a ►

semi-rigid transmission line with a solid slotted outer shield. Other radiating cables manufactured for specific AM broadcast band use employ a sparse copper braid for the outer jacket.

LPB produces the NF-1D cable for transmission zones of no more than 1000 feet. The NF-2D cable, also made by LPB, is a lower loss, heavy duty cable, which may be used for a linear transmission zone of up to 5000 feet. The cable is coaxial, with drain wire and a polyvinylchloride jacket.

Almost all applications of radiating cable have been in the AM broadcast band, where a standard AM radio is the receiver.

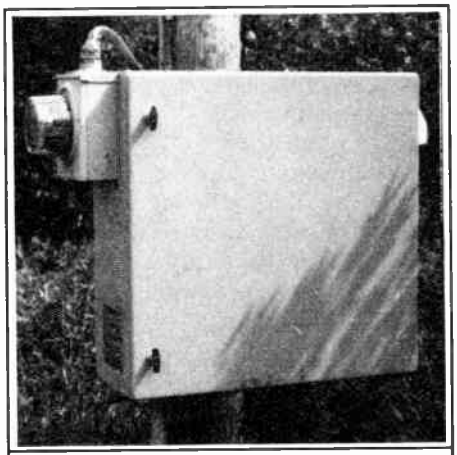
Travelers' information services (TIS), authorized in Part 90.242 of the Commission's Rules, may use either a radiating cable or a short vertical antenna. The first TIS installation, at the Los Angeles International Airport in 1972, employed two buried cable transmission zones.

A more recent installation is the system on the approach road to the Dulles International Airport near Washington, DC. This system utilizes a single length of approximately 11,000 feet of cable.

Unlicensed applications

Part 15 of the Rules allows unlicensed operation in the AM broadcast band under certain conditions which can be met by a radiating cable system operating at low power input.

A wide variety of applications have utilized this approach. Perhaps the best known are those on the entrance and exit roads to Disney's Magic Kingdom and EPCOT Center. A timely repeating message prepares visitors with information about daily features, hours of operation, ticket prices, etc., before they even get to the parking area.



A typical equipment cabinet for a buried cable system along a road.

In New Jersey, a visitor listening on 530 kHz while driving through the Animal Safari at Six Flags Great Adventure hears a series of informational tapes as he progresses from one animal area to another. Clarity is excellent and there is no interference between the 17 adjacent message zones.

Drive-in theaters and churches have long been users of radiating cable systems buried in the parking lot, to provide patrons a system that does not annoy the neighbors and is less expensive to maintain.

Typical radiating cable systems

A length of approximately 7000 feet of type NF-2D radiating cable, a product found in most buried cable systems, can be driven by a small AM transmitter operating at about 20 watts.

These systems may be placed end-to-end to provide a sequence of messages as in the Great Adventure Animal Safari, or the system may be extended almost indefinitely using linear RF amplifiers and additional cable lengths.

The highly confined radiation pattern of a radiating cable system is advantageous for many specialized applications. In addition to the several examples above, the "smart road" of the future may prove to be based upon the induction field from a buried radiating cable.

Editor's note: For additional information on radiating cable and its applications, contact John Tiedeck at LPB: 215-644-1123, or circle Reader Service 10.

Reprinted from **Radio World** *May 23, 1990.*

Moseley RPL 4000 A Winner at KFMZ

by Eric Hoehn, CE
KFMZ

Columbia MO It seems that most stations are doing more remote broadcasting; KFMZ is no exception. From revenue-producing broadcasts from clients' stores to promotion of the station to charity events, the live remote is becoming increasingly popular.

USER REPORT

Unfortunately, with the spectrum being a fixed commodity, remotes are not as easy to do as they once were. We found that our old VHF equipment just wasn't up to the job anymore.

After deciding that the UHF RPU channels had promise, we started searching for equipment. Having seen the Moseley RPL 4000 system at the SBE convention last year, we decided to purchase one even though the unit was not available immediately.

The system began to impress us as soon as it arrived. The transmitter weighs only 12.5 lbs. and boasts features and performance that make setup and use a simple matter.

Three microphone inputs, one of which can be switched for line level, mean that remotes for our morning show don't require a mixer. For engineering, the transmitter is fully metered and comes equipped for two-frequency operation. The frequency selector automatically sets the deviation as well.

A wideband and a narrowband channel can be used without any more work than flipping the frequency switch. And, since the carrier frequency is synthesized, changing to any frequency can be done in the shop in a few minutes by setting DIP switches for frequency and deviation.

Twenty watts of output make simple work of everything we have tried. On battery power the transmitter draws only 5 amps at 13.6 V, so any vehicle can handle a remote ... simply build a power cable for the cigarette lighter. Moseley even supplied the connector for the transmitter battery power input!

The transmitter has companding built in, but you can add any kind of noise reduction you like because the audio is routed to a rear panel connection. Just switch the front panel "NR" switch to "EXT" ... it is supplied with a jumper installed, so you can switch off the companding if desired.

Also included is a test oscillator, a 27 Hz oscillator for repeater control, and dual color LEDs for channel selected, deviation selected, AFC locked, radiate, and VSWR higher than 3:1. The front panel also has a headphone jack with a volume control.

The receiver is also synthesized with DIP switch programming ►

for the two front panel selected frequencies. The deviation is set automatically when the channel is selected, but it can be switched manually to wide or narrow, bypassing the internal programming if desired.

The choice of companding or external noise reduction is carried through from the transmitter, as is the dual color LED scheme. The LEDs indicate signal presence and AFC lock, as well as channel selected and bandwidth selected. The squelch and output level can be adjusted with a small screwdriver from the front panel.

Performance has been excellent. The audio quality is outstanding even in the narrowband channels. The receiver, based on technology used in Moseley's STLs, is remarkably selective and sensitive—it allows us to set up indoors fairly often.

Probably the highest praise we can give the system is that we no longer send an engineer to most remote broadcasts . . . the talent sets up the equipment, and we can count on a good received signal.

The only criticism we have is that the power cord on the transmitter shouldn't be detachable . . . we had worries of misplacing the cord on a distant remote, but we just tie-wrapped the power cord to the back of the transmitter.

The Moseley RPL 4000 system has solved the problems that remote location broadcasts traditionally have given us.

Editor's note: For more information on the RPL 4000, contact Dave Chancey at Moseley: 805-968-9621, FAX: 805-685-9638, or circle Reader Service 63.

Reprinted from **Radio World** *October 24, 1990.*

Myat Rigid Line Put to the Test

by Don Aves, VP Engineering Myat, Inc.

Norwood NJ It's long been known that FM broadcasters in urban centers can realize substantial cost savings by sharing antenna towers.

Until recently, however, many RF engineers were concerned about the possible penalties in transmitter performance and signal quality involved in a multistation antenna installation.

The 603' antenna recently erected for KGON-FM in Portland, OR meets those concerns by combining four FM stations on a single run of 9 3/16" 50 Ohm rigid line.

The signals will be combined at the transmitter building and then sent via the Myat rigid line to a circularly polarized antenna at the top of the tower. This solution has allowed KGON-FM to meet its new Class C height requirement, while simultaneously satisfying strict local and federal ordinances regulating RF exposure at ground level.

KGON-FM had two principal reasons for choosing 9 3/16" 50 Ohm line—maximum peak voltage fault protection and mechanical ruggedness.

The high peak voltage capacity greatly enhances system survivability in the event of lightning or antenna problems involving high standing waves from the many frequencies carried by the transmission line. The mechanical ruggedness should help reduce maintenance costs and ensure a reliable system.

There are other reasons why 9 3/16" transmission line is suited to this type of multistation installation. Its 580 MHz cutoff frequency is high above the FM band—in fact, it will accommodate UHF stations up to Channel 31.

With a peak power rating (at unity VSWR) of 5800 kW and an average power rating at 108 MHz of 430 kW, 9 3/16" line has ample capacity for several FM channels.

Power loss per 100 feet of line at 108 MHz is only 0.032 dB, giving a transmission line efficiency of 95.67% at 600'.

Unique and innovative project

KGON-FM chose Myat to supply the 9 3/16" rigid line for its new tower after evaluating competitive bids from several potential suppliers. This multiple FM installation represents a unique use of 9 3/16" line, so we were excited to be the supplier for this innovative project.

TECHNOLOGY UPDATE

Like all Myat copper transmission line, our 9 3/16" line sections are formed from high-purity selected conductivity mill run copper tubing.

Buying the mill's entire run ensures us the consistency and quality needed for RF line. In addition, we can control dimensions precisely for optimum RF performance.

To further minimize VSWR, four-port dielectric tuners are available. It is anticipated that when KGON's tower goes on the air later this year, it will have a VSWR of 1.05 or less over the entire FM band from 88 to 108 MHz.

We also made use of advanced construction techniques to enhance the reliability of Myat 9 3/16" RF line. All flanges are joined to the line sections and elbows with a technique known as MIG-welding, which reduces heat transfer into the welded materials, for a stronger joint.

In any transmission line installation, elbows are subjected to the greatest stress. To prevent deformation as the line expands and contracts, the copper tubing used for our 9 3/16" elbows has walls that are twice as thick as those of the line sections.

Elbows are reinforced with heavy-duty brass box gussets. Each elbow is pressure-tested twice—once after the two legs have been welded together and again after the gusset has been attached.

Watchband contacts

To ensure clean friction surfaces and maximize thermal conductivity in the line anchors, four "watchband" spring contacts made of silver plated beryllium-copper alloy are used.

The design of the KGON tower includes a below-grade tunnel leading from the transmitter building to the tower, and a 6' diameter central tube that houses the vertical portion of the run.

Despite this protection from exposure to the weather, we elected to use stainless steel for all the hangers. To further enhance the reliability of the installation, all vertical line hangers have dual springs.

As ground-level RF limits become lower and FCC height requirements higher, it's likely that more and more FM stations will be looking at the merits of shared towers.

If an installation of this type is in your future, we urge you to consider the benefits of 9 3/16" 50 Ohm transmission line.

Editor's note: For additional information, contact Don Aves at Myat: 201-767-5380, or circle Reader Service 37.

Reprinted from **Radio World** *May 23, 1990.*

AMX Rates High at WDFX

by Jeff Breitner, CE
WDFX

Detroit MI Pacific Recorders & Engineering describes its AMX console as a "broadcast operations console"—one that can handle the rugged life of an on-air board and one flexible enough to be of use in a production studio.

Yet how many times have "one-size fits all" products fallen short of even the most conservative expectations? The AMX will meet the challenge of a variety of broadcast applications.

USER REPORT

The AMX, like all of PR&E's consoles, is modular. For wiring ease, all wiring connections are made in the rear of the console. Mainframe sizes are 10-, 14-, 18-, 22-, 26-, 30- and 34-input positions. The mainframe comes standard with the mixing bus metering and meter switchers, line output/DA modules, control room monitor and a send/return foldback module.

Return to sender

The send function is a useful concept: It allows audio from any input module to be routed to one of the two send busses. Send audio can be strapped as a left-right sum of the input module or discrete left and right channels.

The return buss routes audio into any or all of the three mix busses and is controlled with its own fader. The advantage of being able to easily punch audio to another location is readily apparent. There's no patching involved in sending various workparts to effects equipment.

And getting it back to the console for the final mix is just as easy with the return controls. Additional versatility is gained with the "pre-send" controls on each module. Pre-send routes audio ahead of the module fader to the send busses.

The AMX has been designed to allow each input module to be independently processed. This is accomplished with an extra row of slots above the input modules. Optional accessories for these slots are stereo and mono equalizers and a voice processor module.

PR&E's AMX console stands up to daily use in WDFX's production studio.

Even though the PR&E equalizer and voice processor modules do a good job, for some people it may not accomplish the desired amount of equalization or voice compression. It may be a good idea to provide additional mic processing via patch send and return points and put any existing equalizers in the effects rack.

A very useful optional module is the line output switcher. Its function is simply what the name implies—it selects the source for another set of line outputs. Any of the three mix busses can be selected (although not simultaneously) and sent to a set of outputs independent of the normal line outputs. This can be a handy device if distribution amplifiers are used in a production studio.

Telephone mix-minus

Almost all studios have a need to record telephone conversations. Whether it be with state of the art digital hybrids or less lofty methods, the AMX is quite at ease in making mix-minus for telephone use.

A very simple method of supplying mix minus is by using two mix busses and a mono-output module. The mono output module will sum the left and right channels of the selected buss. If more than one buss is selected, it too is part of the output.

If the user requires a bit more extravagance, the telco mix module will sum the channels of the selected mix bus and give additional control over the incoming telephone audio. Control panels for the Telos brand of telephone hybrids are also available and make a nice complement to the console.

There are also a host of other option modules and accessories suited for different needs. Items such as remote control panels, studio monitor modules, slate/talkback monitors, remote input selectors and extra control turrets make the AMX very well suited for either a specific or wide range of tasks.

In the real world of radio, how does the AMX perform? The one in use at WDFX has withstood the incessant use dealt to it every day.

In the real world of radio, how does the AMX perform? The one in use at WDFX has withstood the incessant use dealt to it every day. It's turned out to be a great two-track production console. Very little coaching of the production staff was required to get them off and working when the console was first installed. And there's never been a problem which resulted in studio downtime.

PR&E has a reputation of being not for the budget-minded. However, once consideration is given to the features and quality of the AMX, the money is found to be well spent.

Editor's note: For additional information on the AMX consoles, contact Anders Madsen at PR&E: 619-438-3911, FAX: 619-438-9722, or circle Reader Service 88.

Reprinted from **Radio World** *August 22, 1990.*

QEI Offers Power Supply Option

With FMQ-20000B/30000B, Broadcasters Can Choose Between Single and Three Phase Supply Design

by Jeff Detweiler, Dom Sls Mgr QEI Corp.

Williamstown NJ "If we don't have it . . . you don't need it!" That's how most transmitter manufacturers used to treat the idea of a high power single phase transmitter. They overlooked the possibility that Class "A" facilities might someday upgrade their plant and be confronted with the cost or inability of the power utility to provide three phase power.

Such stations often installed rotary phase converters to generate three phase for the new transmitter. But this rotary converter approach added complexity and another piece of equipment to maintain. There had to be a better solution to the problem.

Many transmitter companies had single phase designs. But because the tetrode designs of many manufacturers were prone to having the plate voltage soar when exciter drive was lost, many a rectifier stack was sacrificed in a plume of smoke and fire.

TECHNOLOGY UPDATE

It was this inherent problem of mixing tetrodes and single phase that led QEI to design its high power transmitters around a triode in a grounded grid configuration.

If you measure power in and RF power output, the overall efficiency between a tetrode and a triode transmitter are within 1% to 2% of each other. Triodes typically are less expensive, and rarely foul up catastrophically like their tetrode counterparts. Add in the inherent stability, elimination of tube neutralization, and greater internal component spacing, and you have a rugged tube with a predictable characteristic.

For those concerned with synchronous AM noise, the grounded grid triode is the only design to get numbers approaching −60 dB!

Triode advantage

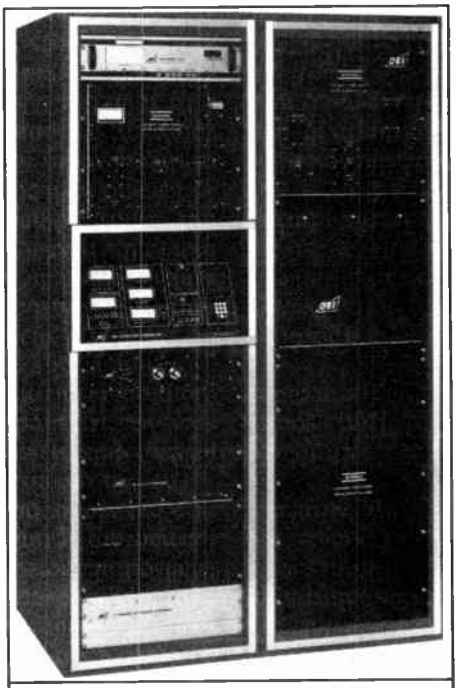
What makes the triode so conducive to single phase operation? Obviously, the tube doesn't care how it gets the DC voltage. The problem is filtering the DC to the degree required for transmitter operation. It requires the use of a two-section choke input filter.

However, to keep the inductance of the input choke to a realistic value, a relatively large minimum current must be maintained. Should the current drop below the critical value, the filter will act as a capacitor input filter and the DC voltage will rise to the peak value of the applied AC (approximately 150% of normal). With a tetrode design this happens when RF drive is removed, as could happen with a momentary power glitch or an exciter or IPA fault.

The use of a bleeder resistor to maintain this current would waste large amounts of power. Switching the bleeder in and out with RF drive would save power, but is complex and expensive to accomplish.

Fortunately, the zero bias triode accomplishes the switched bleeder trick automatically. With no RF drive, the idling current is sufficient to allow an input choke of practical size, and as RF drive is applied, the plate current makes RF power instead of heat.

In addition to modular IPAs, the FMQ-20000B/30000B have redundant modular power supplies.



QEI's FMQ-20000B/30000B transmitters employ modular solid state IPA design.

A breed apart

This design concept resulted in the QEI FMQ-20000B/30000B, the first high power FM transmitters to offer a single phase and a three phase design. Beside having a power supply that sets the FMQ-20000B/30000B above the others, QEI has incorporated our proven "lump constant" PA circuit around the grounded grid triode. It has no trouble-prone sliding contacts, and no conventional plate blocker.

Driving the PA are QEI's own 600 W solid state IPA modules. In addition to modular IPAs, the FMQ-20000B/30000B have redundant modular power supplies. This design gives each module its own supply, adding to the ease of maintenance.

The entire package including power supply is housed in two 24"×76"×34" cabinets. Through the use of hinged front panels and full rear doors, every component is easily and safely accessible.

With a free spares kit, free on-site check out, a 15,000 hour tube warranty, and the option of having the single or three phase supply you want at no extra cost, FMQ-20000B/30000B really make QEI stand for Quality, Engineering and Innovation.

Editor's note: For more information contact Jeff Detweiler, at QEI Corp.: 609-728-2020, FAX: 609-629-1751, or circle Reader Service 52.

Reprinted from **Radio World** *November 21, 1990.*

RPG Key to WQXR Acoustics

by Alfred W. D'Alessio, President Northeastern Communications Concepts, Inc.

New York NY In radio the concept of the studio has become virtually extinct ... or to be more precise, its functions have become incorporated into the control room itself.

Relying on traditional materials for designing a live performance studio at classical format WQXR in New York City would have been difficult. The gross space available for the studio would yield a useful acoustical volume of less than 5000 cubic feet.

To complicate matters, every weekday afternoon a live show is broadcast which includes an informal mix of chamber music and roundtable discussions with the musicians themselves.

Combining talk and music functions in this manner leaves no available time to make adjustments between the music and speech portions of the program.

The properties of absorption, reflection and diffusion make up the acoustician's entire palette. Tuning a given room for a specific purpose is a matter of selecting the appropriate materials to keep these properties in proper proportion relative to the listener or the microphone.

But just as capacitors and inductors can each exhibit the characteristics of the other as a function of frequency, so can acoustical absorbers and reflectors. Traditionally, using these two classes of materials, reverberation time could be tailored by balancing the proportion of absorptive to reflective materials, relative to the incident angle and frequency of any sound to be controlled.

In order to maintain that balance throughout a room, the reflective materials were usually contoured to disperse the sound they reflected over a large area. This is the property of diffusion.

However, in small rooms such as the WQXR studio, no practical diffusion was available until the advent of the RPG Diffusor.

The RPG Diffusor lends WQXR's studio its most obvious acoustic characteristic. Mounted in the ceiling, a field of over 100 square feet of modified QRD 1911s opposes a specularly reflective wood parquet floor.

The result is that sound originating in any location in the room is distributed with clarity and intelligibility throughout the entire studio, without significantly increasing the sound's reverberation decay time.

Such characteristics permit intimate miking of musical ensembles with a distant pair of coincident stereophonic microphones. The placement of the microphones is not critical.

Once seated at the interview table, up to five guests and one host can be individually miked, with no disturbing room artifacts, thanks to the short reverberation decay the RPG Diffusors help maintain.

To understand how the RPG Diffusor differs from a reflector, consider your bathroom mirror as a simple reflector and a white painted wall as a diffuser. If you hold a lamp in front of the mirror, its reflection will be harsh and blinding. This is known as a specular reflection.

Place two specular reflectors opposite each other and like barber shop mirrors they will support numerous reflections of each other, an analogy of the "twang" you hear when you clap your hands between two brick buildings. Known as slap echo, this makes listening uncomfortable and miking impossible.

SPECIAL REPORT

Holding that same lamp in front of a white painted wall will illuminate the entire room, just as an acoustical diffuser disperses sound.

The RPG Diffusor products work on a principle similar to diffraction gratings in the field of optics. The acoustical "grating" is actually composed of a series of wells separated by thin dividers.

For WQXR, NCC chose the RPG Diffusor with the highest number of wells per unit length, the model with the highest frequency at which diffusion outranks specular reflection.

The RPG Diffusor disperses sound at multiple angles to the incident sound source in one plane, while exhibiting a specular reflection of the sound source at 90° to that plane.

The RPG Diffusor also has the advantage of diffusing any incident source over a full 180° within its diffusing plane. In order to provide dispersion in two planes and to diminish the chance of supporting any slap echoes from the specularly reflective floor, the WQXR diffusers were modified to form a checkerboard pattern in the ceiling.

The acoustic quality of the new WQXR live performance studio is appreciated enthusiastically by the musicians who have played there, as well as the WQXR engineers and on-air talent.

As an essential ingredient to the studio's success, the RPG Diffusor remains the only field-proven commercial product to provide efficient acoustical diffusion for the broadcast and recording industries, wherever uniform sound dispersion is desired within a limited space.

Editor's note: For additional information on RPG Diffusors, contact Peter D'Antonio at RPG Diffusor Systems: 301-249-5647; FAX: 301-249-3912, or circle Reader Service 94.

Reprinted from **Radio World** *July 25, 1990*

Shively Tames the Tiger

by Clay Freinwald, CE KBSG-AM/FM

Seattle WA When it became clear that KBSG (known as K-Best) was going to be successful in its bid to move its FM transmitter site to West Tiger Mountain, it was time to begin the process of selecting equipment for the new location.

There were some problems to keep in mind, however. Some years ago, our station had moved to the site of another station whose coverage was superior. After dutifully installing an antenna on the same tower and expecting the same results, guess what? Great coverage in all directions—except Seattle, the major city in the region!

The station fell victim to a severe case of pattern distortion. I vowed to not get caught in that trap again.

The new transmitter site had never ►

been used by broadcasters before; it was about 3150' above sea level, 16 miles east of Seattle.

At 47° north, this meant harsh winters with lots of ice. I knew that, with the snows that fall over West Tiger Mountain in the winter, we needed a rugged antenna.

Frank Kramer, Viacom's corporate radio DE, suggested a Shively—after all, Shively had supplied the system on Mt. Washington, NH. Surely West Tiger could not be any worse than that place!

At Shively's invitation, I visited the company's facilities in Bridgeton, ME. The high point was my tour of the company's antenna range. Shively determines the actual coverage of its antennas with scale models of towers and antennas and frequencies four times the actual.

On the way back to Seattle, I was convinced that the fellows in Maine could do the job.

Now it was on to the project and another consideration. The powers that be determined that our new tower should be able to hold a TV antenna on top.

This meant I was going to have to side mount our FM antenna on a tower big enough to support the multi-ton monster. At the same time, the antenna should neither distort KBSG's coverage pattern nor give me nulls over territory that must be served.

I had nightmares about the GM being able to see the tower on the mountain top, but not being able to hear the station on his radio, just like at the old site.

After we had determined the minimum size for the tower, it was back to Maine and the test range. Shively's old standby, the 6810, provided us good patterns, with minimal nulls in the vital directions.

USER REPORT

Also, due to the site's elevation, we needed to address beam tilt. At the projected 60 dBu contour, the angle was about one degree. Because of the minimal number of bays—four—I chose two degrees of downtilt; the array is center fed.

With other stations at the site, it became clear that we would have to be alert not only to interference to the 100-plus land mobile installations from the K-Best transmitter, but also the cumulative effect of all the stations, intermodulation products, etc.

Shively came up with just the ticket. Borrowing from the company's successful multistation combiner technology, we installed a four-section band pass filter at the output of the transmitter combiner.

This filter turned out great. With something under 20 ns of group delay, degradation to the K-Best signal would be minimal. In conjunction with the band-pad combiner system, IMD products would be addressed.

The antenna from the old main site was dissected and installed on the Tiger Mountain tower as a standby. A new Shively 6810 four-bay directional was installed in its place (to keep the standby site's 1 mV/m contour from overlapping that of the new site).

The proof of the pudding is in the eating and turning the new site on proved to be sweetness. The station played great, all over the place! A number of other stations in the market agreed, and shortly we were on our way toward a multiple FM station facility.

Keep in mind that almost any side mounted antenna will produce a pattern that could do your station considerable harm. Spend the extra money and have your pattern checked before you put up that FM antenna.

Call Shively. You'll be as happy as I am.

Editor's note: For more information on the 6810 antenna, contact Jonathan Clark at Shively: 207-647-3327, or circle Reader Service 33.

Reprinted from **Radio World** *May 23, 1990.*

Shure Automates WTMX Mics

by Scott Fenstermaker, Asst. CE WTMX

Skokie IL Some things never change. Just minutes before the scheduled taping of one of several public affairs programs aired on WTMX, we were running around trying to figure out where all the talk studio microphones had gone.

USER REPORT

As a station that produces much of its own PA material as well as other interview programming, WTMX needed to find a better way of maintaining a basic interview studio without having microphones, mic stands and headphones disappear between taping sessions.

We tested several different systems before discovering the Shure AMS-4000 automatic microphone mixer. Used with a compressor/limiter to ride gain, it seems to be the answer to our prayers.

Dedicated mics

The AMS-4000 is a four-channel mixer (an eight-channel version is also available) which automatically gates each mic on and off as needed. It is important to note that the mics used with the AMS-4000 are specially designed for use *only* with this system and are connected using supplied cable.

The AMS mics are available in either a "probe" type with a cardioid pattern or low-profile surface-mount style with a hemi-cardioid pattern. Again, both types of microphones can only be used with the Shure AMS system, but this fits our needs perfectly . . . these mics can't get up and walk into another studio between uses.

The AMS mics are available in either a "probe" type with a cardioid pattern or low-profile surface-mount style with a hemi-cardioid pattern.

Using the AMS-4000 is simple. Set the input gain and master gain controls as you would with any microphone mixer, except that you don't need to keep unused mics turned off—the mixer does it for you.

When sufficient audio level is detected within the pickup ►

zone of the mic, the mixer gates that mic on, leaving the unused mics off. This minimizes background conversation, air vent noise, paper shuffling, etc., from being picked up.

Straightforward layout

Layout of the controls on the AMS-4000 is straightforward. Individual channel input gain controls and a master gain control make up the front panel along with an aux input control to adjust gain of the 1/4" unbalanced aux input and output jacks located on both front and back panels.

...this mixer has improved the quality of our news and public affairs programming at WTMX.

The microphones plug into rear panel XLR jacks. Front panel LEDs indicate which microphones are gated on. Each channel module also provides an unbalanced direct output that can be internally jumpered to feed pre- or post-fader mic audio independent of the balanced Line/Mic program output.

For even more versatility, Shure provides logic control for each channel. From these rear panel barrier strip connections, it's possible to control the gating, muting, remote indications, etc., of each individual input channel.

Other rear panel controls include an adjustable (.5 to 2 seconds) "time to off" delay to keep the mic gated on after audio is no longer present, as well as an adjustment (−8 dB to minus infinity) to determine how "off" you want the mics to be. Also available are audio patching jacks that allow the linking of up to 25 AMS-4000s, for a total of 200 microphone inputs.

All in all, the AMS-4000 is an extraordinary piece of equipment. It does exactly what Shure says it will do, and it has a very detailed user's manual that explains how and why. There is no question this mixer has improved the quality of our news and public affairs programming at WTMX.

Editor's note: For more information on the AMS-4000, contact Michael Pettersen at Shure: 708-866-2512; FAX: 708-866-2279, or circle Reader Service 41.

Reprinted from **Radio World** *July 25, 1990.*

Symetrix SX-206 Gives KXRX's Audio Punch

by Don Winget, CE
KXRX

Seattle WA At KXRX it seems like our production rooms get more important—and more complex—every day. Rising expectations are forcing us to upgrade, with new effects and signal processors added almost weekly.

USER REPORT

What first got my attention about the Symetrix SX-206 was how compact and complete it is. In just one half-rack size box you get a compressor, a limiter, a downward expander, a gate or a ducker. A pair gives you true stereo in any mode, all in a single rack space!

The SX-206 front panel is very clear and easy to use. LEDs show which mode you're in and how much gain reduction you're getting.

A push switch on the front panel sets the operating mode to comp/limit, expand, gate, duck or slave. Each push of the button steps the unit to the next mode. On the back are DIP switches that set the "wake up" mode—the mode the unit comes up in when you turn on the power.

When you want to run stereo, slave mode allows one set of front panel controls to operate two SX-206s. With one control panel running two units, you don't have to go back and forth between channels to get them to sound the same. And they always track perfectly so the stereo image doesn't shift.

The SX-206 from Symetrix puts a compressor, limiter, downward expander, gate and ducker in a half-rack size unit.

That means that in a single rack space you can have two mono units for laying down tracks and later you can use them as a tracking stereo pair for making your final mix.

To record tracks, you must step through to the operating mode you want. At KXRX, when we want the finished spot to have more presence without sounding too squashed, we fatten up voice tracks with about 4 dB of compression, at a 2:1 ratio.

For real kickers we'll hard jam the voice around 9 dB, at a ratio of about 5:1. That really punches 'em up. But, it also brings up all the noise in the room.

We get rid of the noise run-up by going from the SX-206 that's in compress mode, to the other SX-206 running in expand mode. Expand means downward expander, which works like a gate, only it's easier to use. For this kind of noise control the attack and release are turned almost as fast as they go and the ratio is set at maximum.

A lot of the sound effects we get were digitally recorded with no limiting at all. They're pretty hard to handle recording to tape, and especially difficult when we put them into the sampler.

We use high ratio peak limiting to get more level into the sampler without running out of headroom. With limiting we get a better signal to noise ratio all the way ►

through and higher levels on the master tape without worrying about overmodulation and distortion.

Reading the manual that came with the Symetrix unit, we discovered a couple of clever tricks we've used to really blow the competition away. The manual explains how to use the ducker and the gate with the key input, something we hadn't heard of before.

Symetrix showed us how to "jam fit" a voice-over into a music bed. We use the two units as a stereo ducker for final mixing—one set for slave, the other for duck mode.

The stereo music bed goes through the regular inputs and outputs on the SX-206s. The voice track goes through the console and into the key input on the master SX-206.

With the attack and release controls set maximum fast, and the range set for 3 to 6 dB, the voice-over automatically pulls down the music bed—exactly the right amount—at exactly the right time.

The other secret weapon we get from the SX-206 is triggered sounds. Think what you could do if any one sound could be used to turn on and turn off any other sound. Can you hear a squealing tire that laughs?

With the SX-206 in gate mode you can use one signal at the key input to turn on and off another signal that's going through the normal audio path.

With the aforementioned laugh going into the audio input and no signal at the key input, there's no signal at the audio output. But, as soon as that squealing tire sound comes on, the SX-206 opens up and lets the laugh out. Presto! Squealing tires laughing!

This kind of stuff leaves the competition wondering what hit them, keeps the clients coming back and keeps the GM happy to boot.

Editor's note: For more information on the SX-206, contact Doug Schauer at Symetrix: 206-282-2555, or circle Reader Service 89.

Reprinted from **Radio World** *June 27, 1990.*

Symetrix Measures Up to WABS

by Bill Ashley, CE
WABS-AM

TECHNOLOGY UPDATE

Arlington VA From the earliest days, audio levels have been of paramount importance to broadcast and recording engineers. This is because, in the physical world, there are distinct limitations on dynamic range. If levels are too high, overmodulation or tape saturation occurs; too low, and your signal approaches the noise floor.

For many years, our measuring instrument has been the analog VU meter. This is an average responding AC voltmeter, with specific ballistics, calibrated in audio terminology.

One VU (volume unit) is equal to 1 dB. In broadcasting and recording, 0 VU is usually made equal to 0, +4 or +8 dBm. The traditional analog VU meter suffers from limitations including limited range, lack of accuracy and fixed ballistics.

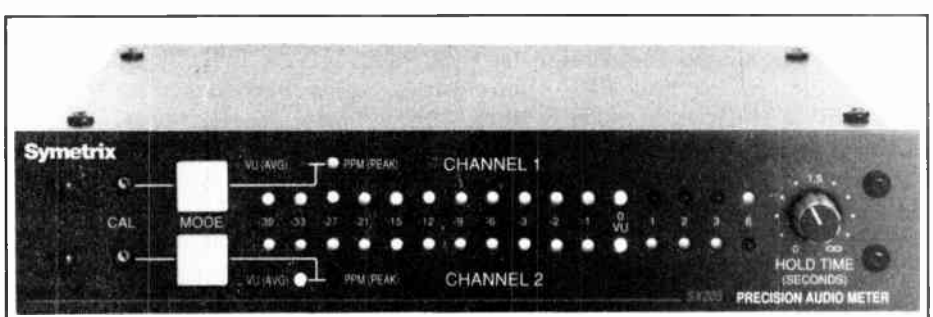
Enter now Symetrix with its SX205 Precision Audio Meter, an LED readout meter that is the newest member of the well known SX family. Like the other members of the family, it occupies very little space—one rack unit in height and one half rack in width.

Installation was simple: four screws hold the SX205 to its rack frame, the power transformer cord plugs into the rear panel and two TRS ¼" phone jacks on the rear panel accept the audio input. The audio inputs are capable of being fed from either a balanced or an unbalanced source; the input impedance is high enough to bridge any source.

One important point regarding the power supply. By using a plug transformer, the SX205 qualifies as a low voltage device, therefore not requiring UL approval. The transformer itself, of course, is UL approved.

Ideal for stereo monitoring

The SX205 works wonderfully! It has two channels, making it ideal for stereo level monitoring. With the channels one atop the other, viewing both simultaneously is easy.



The Symetrix SX205 provides accuracy at reasonable cost.

Both VU (US standard) and PPM (European peak reading standard) scales are available at the touch of a button. Its range is +6 VU to −39 VU. By switching between VU and PPM during a recording session, you're able to quickly determine your peak-to-average ratio, thereby achieving the best level consistent with headroom, dynamic range and signal-to-noise ratio.

My favorite use of the SX205 at WABS (a mono AM) is to parallel the two channels across the audio output of the modulation monitor. Then, with one channel set for average (VU) and the other set for peak (PPM), I'm able to see quite clearly how hard and how well my processing is working.

The smaller the peak-to-average spread, the harder I'm processing. For this use, I have the SX205 set for the bar mode with about one second of hold time.

While I prefer the bar mode, a dot mode is also available; switching from one to the other is accomplished using the front panel mode switches. The hold time, too, is adjustable. One knob controls both displays and is continuously variable from zero to infinity.

The only other controls on the front panel are the screwdriver-adjust calibration pots. These merely set the input level for referencing to your system's operating level; they do not affect the unit's accuracy.

►

Speaking of accuracy, I compared my SX205 to a laboratory grade AC voltmeter; it was right on the money! Obviously, when Symetrix put the word "precision" in the SX205's name, it wasn't just hype.

Key features

Two other features of the Symetrix SX205 should not be overlooked. One is a built-in 1 kHz sine wave oscillator, putting out +4 dBm from a rear panel TS phone jack. This is quite handy in recording and maintenance situations for system level setting.

The other feature, which will probably be of more interest to service technicians than to broadcast and recording engineers, is its ability to measure power amplifier output.

A rear panel barrier strip accepts the input, while two rear panel switches select the power level (100 W or 1 kW) and the impedance (2, 4 or 8 Ohms). A supplied overlay, calibrated in watts, adheres to the front panel display.

Frankly, I would have preferred the PC board and rear panel space occupied by this feature to have been used for an additional range or two for the line level inputs. An extra 40 dB of gain that could be switched into the input circuitry would have permitted the SX205 to measure noise levels, too.

Silkscreening criticism

One other small criticism I have of the SX205 is the PC board silkscreening. Many of the component designators are under the components they designate. For example, try to find R29 when you're in a hurry. It seems the silkscreen artist has never had to service a piece of electronic equipment.

All in all, though, the Symetrix SX205 is a great device for continuous level monitoring, as an aid in setting up your processing or as a piece of test equipment on your bench. It's compact, easy to use, very accurate, quite reasonably priced and I'm crazy about it!

Editor's note: Bill Ashley has been CE at WABS since 1968. Then it was a full time chief's job; now, it's part time. His full time job is now with Bradley Broadcast Sales in Gaithersburg MD, where he can be reached for comments or questions at 800-732-7665.

Or, for more information, circle Reader Service 30.

Reprinted from **Radio World** *January 24, 1990.*

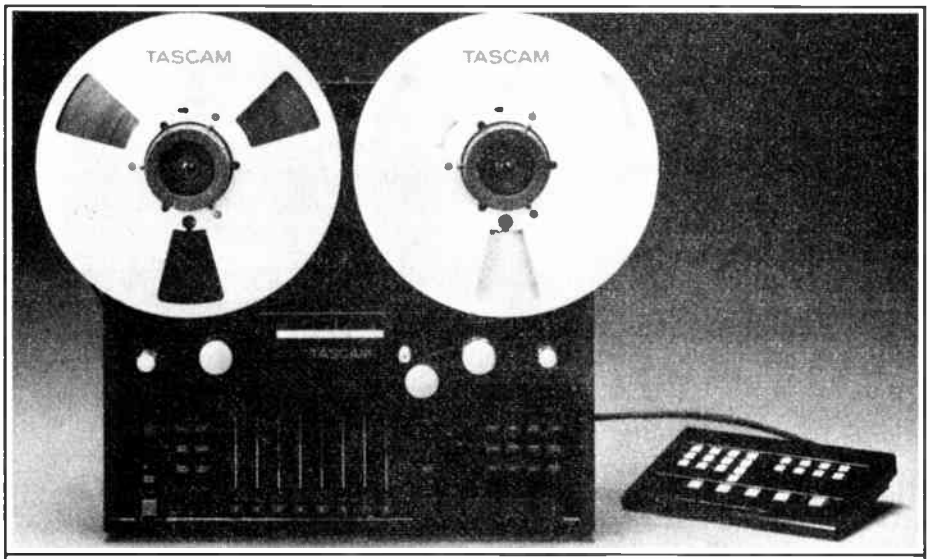
Tascam on the Right Track with the TSR-8

by Dave Holmes, President Holmes Productions

Stockton CA After four years of hard work in an 8'×8' cubical I built in my garage, it was time to move up in the wonderful world of production—I decided to build a new, larger studio.

USER REPORT

The original studio utilized a Tascam 32 and a Tascam 22-2 machine, along with an ancient Sony TC-353-D quarter-track. Although originally I had planned to move up to a 4-track, after careful consideration, I decided that 8-track was my destiny.



The Tascam TSR-8 has paid for itself in time saved and results obtained.

What to do? I needed a new board and I needed an 8-track . . . that I could afford. I'd had my eye on the Tascam model 38, and was ready to buy one, but when I talked to John Reed at PAS, he changed my mind. I'm glad he did.

Impressive choice

John suggested I purchase the new Tascam TSR-8. He told me about all the added extra features and said I would be impressed. Needless to say, I was.

The overall cosmetics on the TSR-8 are completely different from the 38. Rather than using the standard LED meters (like on the 38) the TSR-8 utilizes bargraph LEDs, giving you a much more accurate peak level. Tascam also decided to include on-board dbx Type I noise reduction. This feature alone makes it superior to the 38.

The TSR-8 is controlled by a microcomputer, which makes the punch-ins flawless. Along with 12%± pitch control, rehearsal function and repeat programs and other various "trick" goodies, the TSR-8, in my book, is without a doubt the best machine on the market in this price range.

Currently, I am using the Tascam M-512 console, which adapts perfectly to the TSR-8. I recently did a number of spots for a local air show, which had numerous voice changes, sound effects and music changes. After sweating for years mixing spots like this "live," with four cart machines, two turntables and three hands, the world of multitracking was a welcome relief.

Clean-sounding production

Since I've built my new studio, and started using the TSR-8, many of my peers have commented how clean the production sounds. I must give credit to ►

the dbx noise reduction.

Tascam has really made a big move with the birth of the TSR-8. I have always liked their gear, but this product exceeded my expectations. Taking advantage of the real-time counter versus the standard reference counter saves time, and with the two memory location functions, finding strategic points on the tape is a breeze.

I also went for the RC-408 remote control, which makes it possible to have the TSR-8 located out of arm's reach and gives me more room for equipment that needs to be close to me. Every function that's needed is on the remote control, so there's never a need to touch the machine.

There are many other attractive features on the TSR-8. For instance, the input for SMPTE/EBU devices makes it possible to "chase" video and provides a connection to interface with computers and MIDI.

I'm not sure whether Tascam originally designed the TSR-8 for the musician, or for use primarily in radio and television audio production. All I know is that it will easily work well in either application, at a price that really gives the competition something to think about.

Paid for itself

If you've always wanted a multitrack machine and thought you could never afford it, think again. I figure I have saved so much time with the TSR-8, and have reached such a level of quality production that the TSR-8 has paid for itself.

Commercials that in the past would have taken me hours to produce, or some that were not possible to do in the first place, are now actually fun, and I make good money doing them.

If there was one thing I would change on the TSR-8, it would be to see maybe three or four more memory location functions, in addition to the existing two already on the machine.

You'll also find the little things make the unit attractive: a complete schematic and maintenance manual with every machine, and a price that can't be beat.

Editor's note: For more information on the TSR-8 multitrack recorder, contact Ken Hirata at Tascam: 213-726-0303, FAX: 213-727-7656, or circle Reader Service 8.

Reprinted from **Radio World** *September 26, 1990.*

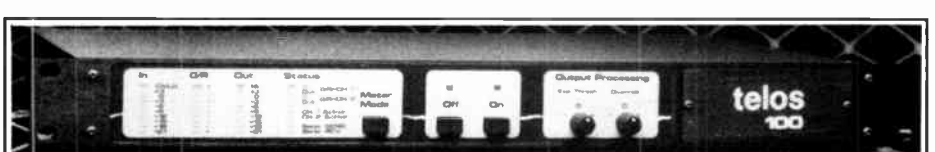
WSYR Goes with the Telos 100

Digital Hybrid Used Throughout Recently Renovated Facilities at News/Talk Outlet

by Conrad Trautmann, CE WSYR

Syracuse NY When we decided to rebuild our studios at WSYR and WYTY, we had to decide what phone systems to standardize on and how to best accommodate all of the requirements for our news/talk AM. Pacific Recorders & Engineering recommended Telos Systems.

The Telos 100 digital hybrid is what we chose to use throughout the facility. The hybrid can be used as a single line unit. With the Telos 1A2 interface module and external switch console, it can be used as a multiline system.



The Telos 100 digital hybrid is used throughout WSYR's news/talk facility.

What really excited us was that Telos and PR&E, in a joint venture, have designed a switch console that fits into the PR&E console alongside the fader modules. This puts the phone right in front of the DJ.

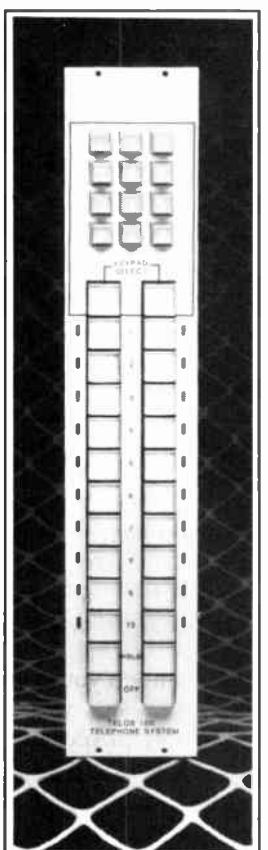
For ease of interfacing, it was decided that a standard 1A2 key system would be installed for the studio area. The Telos 1A2 interface module connects to the key system the same as a 10 button set would, with the same type of connector.

USER REPORT

The Telos 100 is entirely software driven; you can update yours by changing the memory ICs. Typical sidetone noise is virtually eliminated with a digital high-pass filter. Another filter attenuates the high frequency noise above the telephone frequency range. The null provided by the hybrid between caller and announcer is great.

The 1A2 interface module, used with the switch console, takes the place of having to use a multiline set to select which lines go on the air.

The switch console has the ability to dial out, with a built-in keypad, and you can put a call on hold the same as a standard key set. The Telos equipment also enables you to lock a call on. By locking the line on (pressing the button twice), you can now take other calls without hanging up the first.



Telos 100's PR&E switch console.

The interface module also provides a port for a single line set to take calls off the air. By picking up the single line set, the hybrid will not be activated and the operator can select the desired line by using the switch console.

We installed a dual hybrid system in the WSYR air studio. The system consists of two hybrids, a single 1A2 interface module and the Telos/PR&E switch console built into the audio mixer.

The switch console has two banks of switches, which we have configured to duplicate the line appearances on both ►

banks. The first bank corresponds to the first hybrid and the second bank to the second hybrid.

Each bank comes up on its own fader on the board. This allows us to have a guest caller on a private line on the first bank "locked" on so the line cannot be disconnected accidentally.

The second bank is used to take calls on our listener lines. Fader levels can be set up independently of the guest to compensate for different line levels.

At the news reporter desks, we need to record sound off the phone for news stories, which the Telos 100 does beautifully. We use a 10 button multiline set as the switch console.

The only disadvantage I could find with the Telos equipment was that the DJs had a difficult time getting used to the new configuration. Now that we have been using the equipment for a few months, however, this problem has been solved.

The Telos 100 telephone hybrid, the Telos 1A2 interface module and the Telos/PR&E switch console have worked out beautifully in all of our applications. We are extremely pleased with ease of operation and the excellent performance of the Telos Systems equipment.

Editor's note: For more information on the Telos telco systems described here, contact Steve Church at Telos Systems: 216-241-7225, FAX: 216-241-4103, or circle Reader Service 59.

Reprinted from **Radio World** *October 24, 1990.*

Tennaplex Fits the Bill at WCKW

by Sidney Levet, III, CE
WCKW-FM

La Place LA In January 1988, WCKW, 92.3 MHz and KHOM, 104.1 MHz began operation on a Tennaplex/Kathrein combiner with a crossed dipole (Twisted Sister) panel antenna system.

USER REPORT

The antenna was chosen because it provided the bandwidth required to radiate both the 92.3 MHz and 104.1 MHz signals equally and the radiation pattern for both stations was truly omni-directional. Both stations are now operating at the maximum limits allowed for Class C FM stations and provide reliable signals out to about 110 miles.

A 12-bay model antenna was chosen because in the flat Bayou country of south Louisiana it afforded the energy savings of lower transmitter power and provided the coverage required.

Configuration

Each of the 12 bays has three panel elements that are mounted on the face of a 6' wide tower. This tower is 125' long and is mounted atop a 1875' Stainless G-10.

The antenna was constructed on site. Using stainless steel fittings, the side skirts were bolted to the back panel or grid. Then, the radiating elements were bolted to the back panel. Since this was a new tower, the various power dividers were installed in the tower on the ground.

Next, feed cables were hoisted up and connected. Each cable has a weather proof ID tag, since each cable has a certain place to go for proper operation of the antenna. There are 12 1 5/8" and 72 3/8" Flexwell cables.

After installation, every fitting on the lines was wrapped with a special tape for protection from the weather. All coax lines are pressurized from the output of the combiner right up to the input jack at the panels.

Serious business

This is a serious antenna, one that is built to withstand the rigors of riggers and the elements over the years. It's really heavy metal.

WCKW and KHOM each use a BE Model FM-30 FM transmitter. Using unflanged 3 1/8" line, each transmitter is connected through its own Dielectric coax motorized transfer switch, to its separate input port on the combiner.

There is no forced air cooling required. The bandwidth of the combiner at each station's input frequency is in excess of 1.0 MHz, while the return loss is in excess of −35 dB. The isolation between stations is in excess of −77 dB.

WCKW and KHOM have great stereo separation. WCKW does not have an SCA; however, KHOM uses two with no apparent problems. Both stations operate with a forward of power of about 25 kW. The reflected power of each station is less than 20 W and there are no hot spots on any of the transmission lines.

The antenna radiation elements look like the head of an arrow made of four galvanized 2" pipes in an 8 o'clock, 2 o'clock, 10 o'clock, 4 o'clock arrangement, mounted on a 32" long shaft. This assembly is centered on a 6' square panel. All exposed metal parts are at DC ground for lightning protection.

The cross dipole Twisted Sister panel system design has bays 2, 4, 6, 8, 10 and 12 physically rotated 90° with respect to bays 1, 3, 5, 7, 9 and 11. This 90° phasing system alows for automatic VSWR compensation.

Have the vendor send an experienced rigger who knows how the antenna should be installed to supervise the tower crew.

Have the vendor supply an engineer with a network analyzer to check the tuning of the combiner. The tuning of this unit is critical and easily knocked out of line by the shipping companies.

On arrival of our unit, the KHOM side of the combiner was found to be right on the factory setting; however, the WCKW setting of one of the coupling devices was slightly out. Marvin Crouch of Tennaplex, with the aid of the network analyzer, quickly got the combiner retuned to factory specs.

This is a serious antenna, one that is built to withstand the rigors of riggers and the elements over the years.

The bottom line is that since this system was installed, both WCKW and KHOM have seen their ratings and revenues soar. The management of both WCKW and KHOM are very pleased with the operation and performance of the Tennaplex/Kathrein combiner and the Twisted Sister panel antenna and would highly recommend this system to other broadcasters.

Editor's note: Sidney J. Levet, III was named the 1990 Broadcaster of the Year by the Louisiana Association of Broadcasters. He can be reached at 504-535-2424.

For more information on the combiner and Twisted Sister antenna, contact Marvin Crouch at Tennaplex: 613-226-5870, or circle Reader Service 54.

Reprinted from **Radio World** *May 23, 1990.*

360's Alternative to Analog

by Don Bird, Dir. Mktg.
360 Systems

Tarzana, CA 360 Systems is generally known in the audio industry as the originator of the first digital storage and playback systems for industrial applications. Recently, this experience with digital audio systems has been focused on the problem of creating a viable digital cart machine for broadcast use.

360 Systems' DigiCart is the result of two years of research and development.

A two-year research and development project at 360 Systems has resulted in the DigiCart, scheduled for release in January. To provide an acceptable alternative to analog tape carts and automation systems, it was essential that the DigiCart emulate certain cart-like features and functions. Another design criteria was that the DigiCart should easily interface with current analog equipment, to minimize studio re-design and user education.

Resembles cart deck

Outwardly, the DigiCart looks and operates much the same as analog carts. It has large illuminated stop, play and record buttons, secondary and tertiary cue indicators, and a drive for removable cartridges. The rear panel carries balanced XLR connectors for audio; EIA-232/485 serial ports for automation, logging and remote control; a remote connector for transport controls and their lamps; and contact closures for the cue outputs.

The DigiCart's front panel includes a Cue Select knob to "dial up" cues for playback, and a 40-character fluorescent display that indicates titles, running time, and other useful information in plain English. As an alternative to the front panel controls, a rear panel keyboard port allows connection of a standard "AT" style keyboard for titling.

Audio is recorded with 16-bit linear resolution using the latest oversampling technology and linear-phase filters. Recording may be done in mono or stereo, at selectable bandwidths of 10, 15, or 20 kHz, with sample rates up to 48K. The digitally encoded audio is stored on rugged, removable Digital Audio Disks.

The disks are enclosed in a hard plastic shell about the size of a CD "jewel box" and possess a much longer life-span than tape carts. A single Digital Audio Disk will hold up to 10 minutes of 15 kHz stereo (20 minutes mono), and different formats can be contained on the same disk.

Besides the removable cartridge drive, the DigiCart's SCSI buss accommodates an additional internal hard disk, and as many as five external hard disks. Total combined storage time, including all optional drives, is upward of 25 hours.

Error correction

An extensive error correction scheme is used to maintain perfect audio reproduction. Bandwidth and format information are stored on a header for each cue, which the DigiCart reads to correctly configure itself for playback. Frequency response is 10 Hz-20 kHz, with 18-bit playback resolution; dynamic range is 92 dB, and interchannel phase error is less than 0.5 degree.

TECHNOLOGY UPDATE

In addition to excellent audio quality, one of the most powerful features the DigiCart offers to broadcasters is random access of every audio file on a disk. Any cue may be selected for immediate playback and, since the beginning of each cue is buffered in RAM, start time is instantaneous.

Additionally, cues may be selected for playback while another cue is playing. The DigiCart's "stack mode" is a natural extension of this: Lists of cues can be created, stored as a playlist in memory, and recalled for continuous back-to-back playback from a single start command.

DigiCart's various software functions are divided into three menus. A Utility Menu provides file management: naming, copying, deleting and moving cues. A Setup Menu selects options such as replay lockout, pause, repeat, scan files, and auto-play modes. An Edit Menu includes non-destructive editing features: head and tail trim, fade in, fade out, and output level adjust for individual cues.

The DigiCart has been revised prior to its scheduled release in January. Following the DigiCart's first showing at the 1990 NAB convention, new features have been incorporated into the design. A BCD automation port is now included as a standard item, and internal RAM expansion is available for greater buffering capability. Spot rotation and several other software features have also been incorporated in the final design.

...one of the most powerful features the DigiCart offers to broadcasters is random access of every audio file on a disk.

Editor's note: For more detailed information on the DigiCart and other 360 Systems broadcast products, contact Don Bird at 360 Systems: 818-342-3127, FAX: 818-342-4372, or circle Reader Service 45.

Reprinted from **Radio World** *December 26, 1990.*

PMRL-030 Phone Cures

British Manufacturer Provides an Answer To Telephone Remote Woes in One Box

by Lawrence Frayne CE
Midland Community Radio PLC

Birmingham, UK "And now over to the stadium where our roving reporter is ready to give us a first hand account ... Hmm, we don't seem to be receiving him at the moment ... no, he is hearing us ... we apologize for the small technical problem and will return later ... "

How often have you heard it? How often have you suffered it? The small technical problem that might as well be a deceased reporter for all the good it does your professional image. In reality it was probably a deceased battery or an intermittent contact, local interference ... the list is endless.

The problem is today's reporter needs to be an ambidextrous Sherpa with four ears. He must be able to talk to the studio, listen to the studio and also hear off-air for added confidence.

...today's reporter needs to be an ambidextrous Sherpa with four ears. He must be able to talk to the studio, listen to the studio and also hear off-air for added confidence.

The Wood & Douglas PMRL-030 solves telephone remote troubles.

USER REPORT

Overburdened

Picture if you can this humble specimen festooned with his reliable Walkman™, his off-shore manufactured walkie-talkie and his oversize remote pickup transmitter. This will bedeck his torso on bandoleers, belts and—if he is willing—perhaps a backpack frame.

Oh, and let's not forget his two sets of headphones. Ingenuity strikes again that if he uses Walkman inserts he can overwear enclosed headphones for his cue feed ...

Does this sound familiar? Yes, and it works! But should we do this to these conscientious souls?

To date there has been little option. The market for studio equipment is immense, for remote vehicles equally so, but for the reporter on the scene it has been bad news while trying to make live news. Let us review on a more serious note the needs.

Needs to be filled

Commentator link. This will be a VHF or more likely UHF extended audio transmitter, perhaps 30 Hz to 10 kHz bandwidth. It must be capable of line level and microphone level operation. It may have a companding facility to improve link signal to noise.

It must be frequency economical using the minimum RF spectrum in today's polluted RF environment. The power output should be tailored to use and battery economy. It should be easy to operate and easy to service.

Cue link. This is the lifeline to base; without it, the reporter is an aimless nomad. It will be VHF or UHF communications-quality equipment, probably to land mobile specifications. It must maintain communication to control the commentary. It must dominate the reporting scene vicinity.

Off-air receiver. This must provide fill-in coverage before and during pieces to give confidence and a sense of belonging to the reporter. It must not be affected by the local commenator link or incoming cue transmissions.

Auxiliary equipment. For every transmitter there must be a receiver and vice versa. The remote van or studio therefore must always carry the compliment. Land mobile equipment is never suitable, will need modification, and will almost certainly be the wrong size and rarely line level compatible.

What is needed is a box that does everything.

It has arrived.

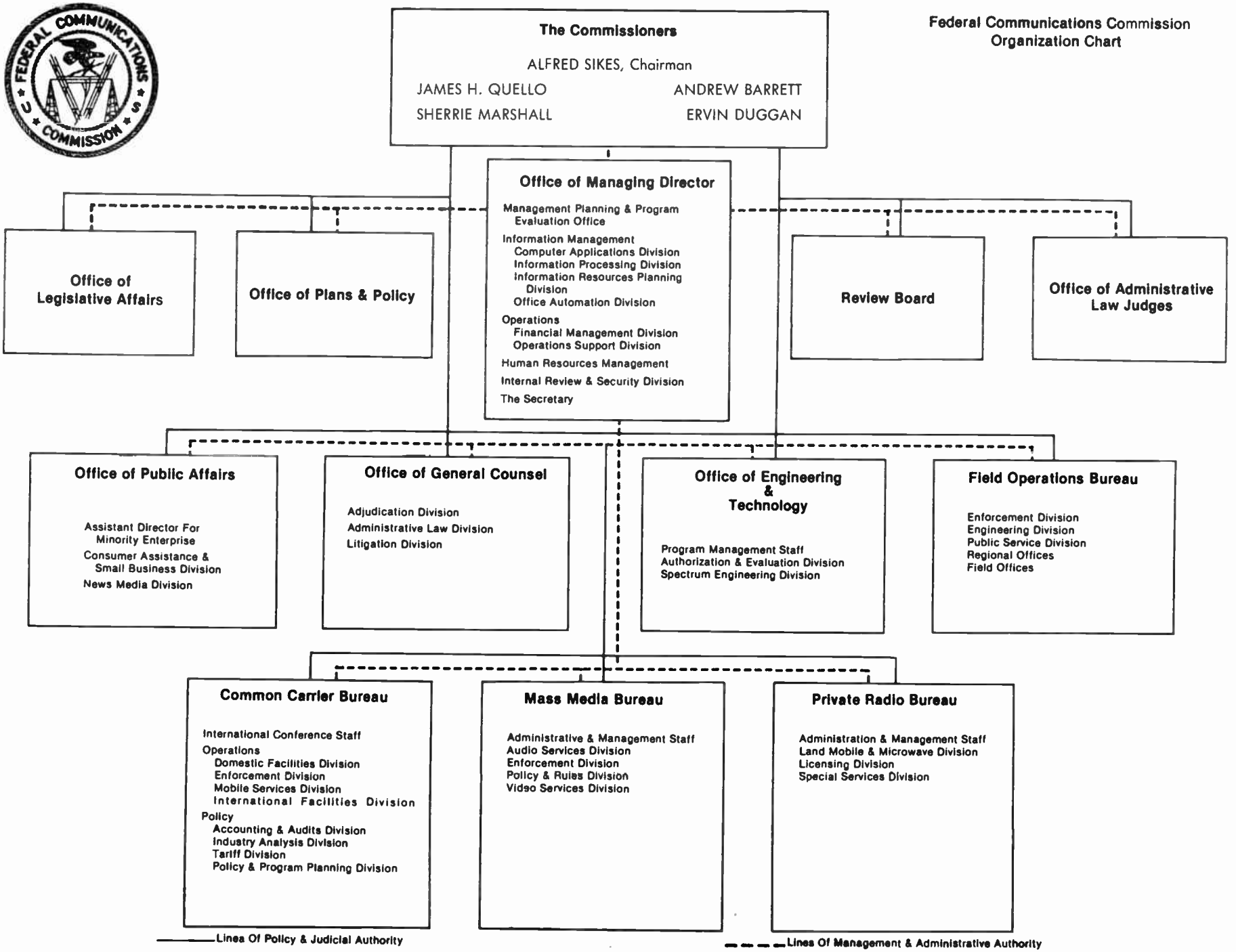
At the request of a number of the UK's major local radio stations, Wood & Douglas, a small British company with expertise in specialist radio communications was contacted to design such a product.

The result is the PMRL-030 which incorporates all of these features giving a reporter an "all in one" complete radio link.

The unit has been very successfully used by the stations in our group and by many other in UK & Europe. It allows quick, inexpensive live inserts into any radio program.

Editor's note: For more information on the PMRL-030, contact Allan Papworth at Wood & Douglas: 011-44-734-811444, FAX: 011-44-734-811567, or circle Reader Service 35.

Reprinted from **Radio World International** *December 26, 1990.*



National Association of Broadcasters

1771 N Street, NW, Washington, DC 20036

Unless otherwise indicated all numbers should be preceeded by 202-429

(202) 429-5300

Advanced Television Systems Committee (ATSC) 5345
Broadcast Capital Fund (BROADCAP) 5393
Broadcast Ind. Council. to Improve American Productivity (BICIAP) 5330
Broadcast Education Association (BEA) 5355
Broadcast Pioneers Library Catherine Heinz 223-0088

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Radio Membership 5400
Research & Planning 5380
Science & Technology 5346
Station Services 5373
Television 5362
Television Membership 5363
Tarpac 5318

Federal Communications Commission

Broadcast Related Phone Listing

**Unless noted, all numbers are in Area Code 202, Washington, D.C. Area Code 717 refers to the Gettysburg, PA office, Area Code 301 refers to the laboratory in Laurel, MD.*

Subject	Telephone Number
Access Charge (CCB)	
• Rules and Policies	632-9342
• Tariff	632-6387
Accounting systems (CC)	634-1861
Advisory Committees	
• Radio Broadcasting	632-6485
• Emergency Broadcast System	632-3906
• National Public Safety	632-7060
Alien Restricted Permits (FOB)	632-7240
Allocation	
• Broadcast	634-6530
• Call Signs	634-1923
• Call Sign Block	653-8126
• Call Sign Policy	653-8126
Charts and Tables (OET)	653-8108
• Government (OET)	653-8141
• Non-Government (OET)	653-8108
• International (OET)	632-8126
Amateur Licenses (PRB)	(717) 337-1212
Annual Report Form (CC)	632-7084
Annual Employment Report (CCB)	632-0745
Antennas & Towers (FOB)	632-7521
Application Status	
• Amateur (PRB)	(717) 337-1212
• Aviation (PRB)	
• Aircraft	(717) 337-1212
• Aviation Ground	(717) 337-1511
• Business (PRB)	(717) 337-1511
• Cellular	632-6400
• Commercial Operator (FOB)	632-7240
• Common Carrier	634-1800
• Domestic Satellite	634-1624
• Mobile Services (CCB)	254-6810
• Microwave (CCB)	634-1706
• Multichannel Service (CCB)	634-1706
• International (CCB)	632-7265
• Experiment (OET)	653-8146
• General Mobile (PRB)	(717) 337-1511
• Industrial (PRB)	(717) 337-1511
• Land Transportation (PRB)	(717) 337-1511
• Equipment Authorization RF Devices only:	
• 24 Hour computer access	(301) 725-1072
• Non-computer access	(301) 725-1585
• Offshore Radio Service (CCB)	653-5560
• Rural Radio Service (CCB)	653-5560
• Microwave (Industrial) (PRB)	(717) 337-1421
• Public Safety (PRB)	(717) 337-1511
• Radio, TV, & Aux. Serv. (MM)	634-6307
Assignment of Microwave Common Carrier Licenses (CCB)	634-1706
Auctions (OPP)	653-5940
Automobile Emergency (PRB)	(717) 337-1212
Bills (Legislative) (OLA)	632-6405
Broadcast, Inspection of Stations (FOB)	632-7014
Broadcast Services—(MMB)	
• *AM Service*	
• Engineering Rules:	
• Existing Stations	632-7010
• Minor Changes Applications	254-9570
• New stations and major changes Applications	254-9570
• STLs; RPUs, Intercity Relays	634-6307
• Non-Engineering Rules:	
• Advertising Questions/Comments	632-7551
• Application Forms	632-7272
• Assignment/Transfer Applications	254-9470
• Construction Permit Applications	254-9570
• Emergency Broadcast System	632-3906
• Political Broadcasting	632-7586
• Programming Questions	632-7048
• Renewal Applications	254-9572
• Equal Employment Opportunity	632-7069
• Reports	
• Employment (Form 395B)	632-7069
• Ownership (Form 323)	632-7258
• *FM Services*	
• Engineering Rules	
• Existing Stations	632-6908
• Minor Changes Applications	632-6908
• New Stations/Major Changes	632-6908
• SCA	632-7186
• STLs; RPUs; Intercity Relays	634-6307
• Translators/Boosters	634-6307
• Advertising Questions	632-7551
• Application Forms	632-7272
• Construction Permits	632-6908
• Educational FM	632-6908
• Emergency Broadcast System	632-3906
• Political Broadcasting	632-7586
• Programming Questions	632-7551/632-7048
• Renewal Applications	632-3954
• Equal Employment Opportunity	632-7069
• Employment (Form 395B)	632-7069
• Ownership (Form 323)	632-7258
• SCA's Stereo-Multiplex	632-7166
Bulletins, Request for (OPA)	632-7000
Business Radio (PRB)	(717) 337-1212
Registration (MMB)	632-7076
• Complaints (Subscribers)	632-7048
• Franchising	632-7076
• General Radio and TV	632-7048
• Microwave	
• Legal	632-7480
• Engineering	254-3420
• Pole Attachments (CCB)	632-4890
• Policy	
• Access	632-7480
• Public Reference Room	632-7076
• Special Relief	632-7480
• Technical Standards & Rules	254-3420
Cablegrams (CCB)	632-7265
Call Letters (Signs—)	
• Private Radio Services	(717) 337-1212
• Broadcast	634-1923
Campus Radio Stations (OET)	653-6288
Carrier Equipment (CCB)	634-1800
Cases in Court (OGC)	632-7112
Cellular Mobile Radio	632-6400
Cellular (Recorded Message)	653-5858
Certification of RF Gear (OET)	653-8288
Civil Air Patrol (PRB)	
• Applications/Licenses	(717) 337-1212
• Rules	632-7175
Coast Stations (PRB)	
• Applications/Licenses	(717) 337-1212
• Rules/Hearings	632-7175
Commercial Operators—(FOB)	
• Examinations (D.C. Area)	(301) 962-2729
• Examinations (Other Areas)	632-7240
• All other matters	632-7240
Commission Proceedings	632-7000
Common Carrier Radio (CCB)	
• International & Satellite	632-7265
• Mobile Services	632-6400
• Microwave Services	634-1706
Complaints—	
• Broadcast (TV & Radio)	632-7048
• Advertising Questions	632-7551
• Political Broadcasting	632-7586
• Programming	Questions/Religious
• Common Carrier—	
• Informal Complaints & Inquiries	632-7553
• Telephone	632-7553
• Telegraph/Telegram	632-7553
• Pole Attachments (CCB)	632-4887
• Rates	632-7553
• Interference to Radio & TV	
• Washington, DC Area	(301) 962-2727
• All Other Areas—Refer to local field installations	
Compliance—	
• Registration (MMB)	254-3407
• Common Carrier Accounting (CCB)	634-1861
• Experimental (OET)	653-8141
• Incidental Radiation (OET)	653-6288
• Land Mobile (PRB)	632-7125
• Aviation & Marine (PRB)	632-7197
• Personal & Amateur (PRB)	632-7197
Conferences	
International—CCIR, WARC (OET)	653-8126
CCITT (CCB)	632-3214
Conflict of Interest (OGC)	632-6990
Congressional Liaison (OLA)	632-6366
Consumer Assistance/Small Business	632-7000
Control Devices (non-licensed) (OET)	653-6288
Copy Contractor	857-3800
Cordless Telephone (Pt. 15) (OET)	653-6288
Court Cases (OGC)	632-7112
Customer Owned Equipment—	
• Attach to Telephone (CCB)	634-1833
Customer Toll Dialing (CCB)	632-7553
Depreciation Rules (CCB)	632-7500
Development Stations	
• Aviation or Marine (PRB)	(717) 337-1431
• Common Carrier (CCB)	634-1706
• Experimental (OET)	653-6288
• Dial-a-Porn Complaints	632-7553
Diathermy Approval (OET)	(301) 725-1585
Digital Terminations Systems (DTS)	634-1706
Digital Electronic Message Svc	634-1706
Direct Broadcasting Satellites	632-9356
Direct Distance Dialing (CCB)	632-5550
Domestic Public (CCB)	
• Auxiliary Test and Repeater Stations	653-5560
• Cellular Radio	632-6400
• Land Mobile Radio Service	653-5560
• Microwave	634-1706
• Rural Radio	653-5560
Duplication Contractor (ITS)—	
• Washington, DC	9-857-3800

Subject	Telephone
• Gettysburg, PA	(717) 337-1433
Eavesdropping (Electronic) (OGC)	632-6990
Electronic Switching (Telephone) (CCB)	634-1800
Emergency Broadcasting System (EBS)	632-3906
Employment Verification	**632-6234**
Enforcement—Common Carrier Bureau	632-4887
Enforcement—Private Radio Bureau Forfeitures Show Cause Orders Revocations, Suspensions	632-7197
• Land Mobile (PRB)	632-7125
• Aviation & Marine	632-7197
• Personal & Amateur	632-7197
Requests for Enforcements	
• Washington, DC Area (FOB)	(301) 962-2727
• All other areas—Refer to local field office (FOB)	
Engineering Surveys (OET)	632-7080
Environmental Law (NEPA)(OGC)	632-6990
Equipment Measurement (OET)	(301) 725-1585
Examinations—(FOB)	
• Washington, DC Area	(301) 926-2727
• Outside Washington, DC	632-7240
Ex Parte Rules (OGC)	632-6990
Facsimile—Wire (CCB)	634-1800
Fairness Doctrine	632-7586
FCC Rules (Interpretations) (OGC)	632-6990
Fee Information	632-FEES
Field Disturbance (Pt.15)	653-8285
Field Offices	
• Common Carrier (CCB)	634-1861
• Field Public Service Staff	634-1940
Fire (PRB)	(717) 337-1212
Foreign Attachments—	
• Telephone (CCB)	634-1833
• Interconnection (CCB)	634-1800
Forfeitures/Fines	
• Mobile Services (Includes CB)	632-7197
• Collection of (OGC)	632-6444
Forms Distribution—	
By form number only	632-7272
General form request	632-7000
Freedom of Information (OGC)	632-6990
Frequencies Allocations—	
• Government (OET)	653-8147
• Non-Government (OET)	653-8108
• Allocation Treaties (OET)	653-8144
• International (OET)	653-8126
• Lists	
• Government (OET)	653-8147
• Non-Government (OET)	653-8108
• Notification and Registration (OET)	653-8126
• Usage Data & Utilization (OET)	653-8108
General Counsel (OGC)	632-7020
General Mobile Radio (PRB)	(717) 337-1212
Harrassing Telephone Calls (CCB)	632-7553
Hearing Calendar (OLJ)	632-7680
Incidental Radiation (Rules) (OET)	653-6288
Information—General (OPA)	**632-7000**
Infraction Reports—International (OET)	653-8138
Injunctions (OGC)	632-7112
Inspections (FOB)	632-7014
Interception of Radio Comms (OGC)	632-6990
Interference Complaints	
• Washington, DC Area (FOB)	(301) 962-2727
• All Other Areas (Refer to Local Field Office)	
• Requests for Monitoring (FOB)	632-6975
International Conferences (Future)	653-8126
Conference (past)	632-7025
WARC (OET)	632-7025
• Conferences and Meetings (OET)	632-7025
• Frequency Allocations (OET)	632-7025
• Frequency Allocation Tables (OET)	632-7025
• Frequency Coordination (OET)	653-8126
• Frequency Lists (OET)	653-8126
• Interference (OET)	653-8126
Interlocking Directors (CCB)	632-4887
• Permits to Operate in Canada	653-8126
• Radio Publications (OET)	653-8126
• Satellites Systems Coordination	653-8153
• Telecommunications Union (OET)	653-8126
• Telegraph & Telephone Rates (CCB)	632-5550
• Treaties & Agreements (OET)	653-8144
Investigations—	
• Unlicensed Operations	
• Washington, DC Area (FOB)	(301) 962-2727
• All other areas refer to local field office (FOB)	
• Interference	

Subject	Telephone
• Washington, DC Area (FOB)	(301) 962-2727
• All other areas refer to local field office (FOB)	
Ionosphere (OET)	653-8166
IRAC (Interdepartment RAC) (OET)	632-7025
Land Mobile—	
• Common Carrier (CCB)	653-5560
• Other than CC (PRB)	(717) 337-1212
• Public Safety	(717) 337-1212
• Special Emergency	(717) 337-1212
• Business	(717) 337-1212
• Other Industrial	(717) 337-1212
• Land Transportation	(717) 337-1212
Land Transportation (PRB)	(717) 337-1212
Law Suits Litigation (OGC)	632-7112
Law, General (OGC)	632-6990
Leased Facilities (CCB)	632-7553
Library (FCC) (OMD)	**632-7100**
License	
• Amateur (PRB)	(717) 337-1212
• Business (PRB)	(717) 337-1212
• Commercial Operator (FOB)	632-7240
• Domestic Satellite	634-1624
• Mobile Services (CCB)	632-6400
• Cellular	632-6400
• Microwave (CCB)	634-1706
• Wire or Cables (Auth. or Cert.) (CCB)	634-1800
Internat'l & Satellite (CCB)	632-7265
• Experimental (OET)	653-8146
• General Mobile (PRB)	(717) 337-1212
• Industrial (PRB)	(717) 337-1212
• Land Transportation (PRB)	(717) 337-1212
• Marine (PRB)	(717) 337-1212
• Microwave (Industrial) (PRB)	(717) 337-1421
• Operators Licenses (FOB)	632-7240
• Public Safety (PRB)	(717) 337-1212
• Radio (See Broadcast Services)	
Lighting devices (RF) (Pt. 18) (OET)	653-6288
Local Government Radio (PRB)	(717) 337-1212
Manufacturing (PRB)	(717) 337-1212
Marine Services (PRB)	
• Applications/Licenses	(717) 337-1212
• Rules/Hearings	632-7175
MD's Licensing	634-1706
Measurement for	
• Type Acceptance	(301) 725-1585
• Type Approval	(301) 725-1585
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• Notification	(301) 725-1585
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Useful Engineering Formulas

REACTANCE FORMULAS

$$C = \frac{1}{2\pi f X_C} \qquad X_C = \frac{1}{2\pi f C}$$

$$L = \frac{X_L}{2\pi f} \qquad X_L = 2\pi f L$$

RESONANT FREQUENCY FORMULAS

$$F = \frac{1}{2\pi\sqrt{LC}} \qquad f_{kHz} = \frac{159.2}{\sqrt{LC}}$$

$$L = \frac{1}{4\pi^2 f^2 C} \qquad L_{\mu HY} = \frac{25{,}330}{f^2 C}$$

$$C = \frac{1}{4\pi^2 f^2 L} \qquad C_{\mu FD} = \frac{25{,}330}{f^2 L}$$

Where f is in kHz
L is in microhenries
C is in microfarads

CONVERSION FACTORS

$\pi = 3.14$ $\qquad 2\pi = 6.28$

$\pi^2 = 9.87$ $\qquad \log\pi = 0.497$

1 meter = 3.28 feet
1 inch = 2.54 centimeters
1 radian = 57.3°

FREQUENCY AND WAVELENGTH FORMULAS

$$f_{kHz} = \frac{3 \times 10^5}{\lambda_{METERS}} \qquad \lambda_{METERS} = \frac{3 \times 10^5}{f_{kHz}}$$

$$f_{MHz} = \frac{984}{\lambda_{FEET}} \qquad \lambda_{FEET} = \frac{984}{f_{MHz}}$$

$0.625\lambda = 225° = {}^5/_8$ WAVE
$0.5\lambda = 180° =$ HALF WAVE
$0.311\lambda = 112°$
$0.25\lambda = 90° =$ QUARTER WAVE

RESISTORS IN SERIES

$$R_{TOTAL} = R_1 + R_2 + R_3 + \cdots$$

RESISTORS IN PARALLEL

EQUAL RESISTORS

$$R_{TOTAL} = \frac{R}{n}$$

Where n is the total number of resistors

UNEQUAL RESISTORS

$$R_{TOTAL} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots}$$

$$R_{TOTAL} = \frac{R_1 R_2}{R_1 + R_2} \qquad R_1 = \frac{R_T R_2}{R_2 - R_T}$$

If the current through a resistor doubles, the power dissipated quadruples

BINARY TO BASE 10 CONVERSION

$1\ (2^3) = 8$
$0\ (2^2) = 0$
$1\ (2^1) = 2$
$1\ (2^0) = +\ 1$
11

DIRECT POWER FORMULA

$$P = I^2R$$

Where I is the common point or base current in amperes, and R is the common point or base resistance in ohms

INDIRECT POWER FORMULA

$$P = IE(effy)$$

Where I is the final P.A. current in amperes, E is the final P.A. voltage in volts, and effy is the transmitter efficiency expressed in decimal form (79% = 0.79)

Courtesy of Delta Electronics

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THE LAST WORD

A Decade by Any Other Name

'20s

Here's a scary thought to ponder: It isn't bad enough that we've embarked on a decade which will close out the century.

The '90s also mark the end of the entire *millennium*.

One thousand years ago anybody who would have predicted that we'd be communicating through the air in sound and even pictures; that eventually we'd even be transporting ourselves in some airborne fashion, would probably have been burned at the stake.

'30s

But those were hard times. Today investment analysts and marketing gurus fight over the direction of the next technological breakthrough. We can help them out a little with that one. The direction is definitely *smaller*. Read: superconducting microchips.

Our move into the '90s has the listmakers and social trendsetters wringing out their brains to come up with a way to characterize this curtain-closing decade.

If the **'60s** was the **Psychedelic** decade, the **'70s** the **Me** decade, the **'80s** the decade of **Greed**, what will the '90s be? Remember that decades don't always get named until late in their histories.

We've heard the **Humble** decade, the **Thrift** decade and the **New Value** decade tossed about.

'40s

Radio's history, a blend of technology and social direction, has always somewhat paralleled the naming of decades by the masses.

The first wireless communications services bellowed to life in the *Roaring '20s*, became practical during the lean years of the *Depression '30s* and were pressed into patriotic service during *World War II* in the early '40s.

Later, radio celebrated the sound of a nation turning prosperous to the big bands and Sinatra, Fitzgerald and other pop vocalists in the *Baby Boom '40s*. A quick glance to the ads of the times, of families smiling and bopping to higher-fidelity cabinet floor models, confirms that.

'50s

Then came radio's biggest threat: television. While mainstream America tuned in to reassure themselves that *Father Knows Best*, radio responded with a sleek, rebellious threat of its own. The '50s gave birth to *Rock 'n Roll* and radio claimed a feisty identity it keeps even now.

'60s

With the *Love and Peace '60s* the fledgling FM service took up the banner and turned rock psychedelic, with a long stretch out to do some serious consciousness raising in protest music.

After its love affair with changing the world for the better, the bottomline sensibilities of the '70s saw AM respond to FM's threat with no-nonsense, talk, advice, sports and of course, business news.

'70s

The bottomline bubbled over in '80s excesses everywhere, even in radio as the ranks of existing stations became swelled to problematic proportions in a deregulatory free-for-all. But that couldn't last forever.

Now radio broadcasters are echoing a return to more traditional values; shifting to more financially conservative sands as over-gorged station prices level off at more realistic levels. And formats are opting for more and more of what works best.

'80s

The '90s entered radio's history with an explosion of new technology. *Digitalspeak* has captured the industry and radio prepares to evolve once again.

No one is sure exactly how the digital game will play out as the millennium draws to a close. Since the planning is already underway, it's a safe bet that in the next 10 to 20 years we'll find our old friend has learned a few new tricks, and we'll be toting along the best of digital radio to jog to, or keep us company on long drives.

'90s

By then the '90s, radio's **Digital Decade**, will be just a fond memory and industry experts will be clamoring to see what radio's future holds in store for its second hundred years as a social mainstay.

Not bad for a technology that began as an engineer's idea one century ago.

Judith Gross

RADIOMIXER®
For everyone who thought a PR&E console was out of reach.

You've tried, but your console budget just can't accommodate a Pacific Recorders BMX—not this time. So you're probably thinking about settling for a copy, even though it won't have the standard-setting features, performance and long-term reliability that have made our BMX consoles so successful.

Fortunately, you don't have to settle. Radiomixer is genuine PR&E. All the way from its high quality components to its efficient BMX-style layout, comprehensive telephone mix system and unique Off Line Mix Matrix. Yet its manufacturer-direct price is no higher than the "clones."

How did the PR&E engineering team build a less expensive console without lowering our standards? Let's start with what we didn't do:

We didn't compromise on quality. Radiomixer uses the highest caliber components throughout, including our standard professional-spec meters, faders, and switches. Plus the best-sounding VCA technology in the industry. To keep Radiomixer's cost down, we've limited the number of different module types and mainframe sizes, and simplified the construction of the card frame, mainframe and modules.

The final result? In less than a year, Radiomixer has quietly become one of our most popular consoles. In fact, it's now one of the best-selling boards in broadcasting. Our color brochure will tell you more of the reasons why, and help you configure a Radiomixer for your particular application. To get your copy, call PR&E direct at 619-438-3911.

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Give Your Production People Some POWER!

THE SP-6 IS LOADED WITH FEATURES! Like a powerful equalizer section that gives your talent greater creative freedom: four auxiliary sends that can be used for special effects, headphone feeds, or IFB mixes; both 8-track and stereo bus assigns for multi-track and dubbing work; plus a choice of mono mic/line or stereo input channels. And, to keep things fast and productive, it even includes full machine control logic, control room and studio mutes, plus tally systems—just like you'd expect on an on-air console. The SP-6 provides independent headphone, control room and multiple studio monitors, and (of course) an automatic stereo cue/solo system. Our unique track monitor section will speed your production pace, allowing simultaneous stereo mixdown during the multi-track bed session.

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SP-6

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