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Radio World
ENGINEERING EXTRA

April 16, 2008

PROJECT PROFILE

Helicopters, Barbecue Ribs and the AM Proof

A Story of Conducting Airborne Field Strength Measurements From a Swampy Tx Site Before Cellphones and GPS

by Robert Culver, P.E.

A difficult task requires a bit of innovation; and that's when you learn some things. Over the past several years I have had the occasion to write some letters and short articles for Radio World. This has led the editors to get to know me and ask what other interesting stories I might have.

When I spoke to my partners about writing some more historical stories for RW, the reminiscing really took off. Here, for your enjoyment is one of those stories. I also hope it is informative, as it will point to several critical engineering principals, and life-changing moments that can't be forgotten.

[redacted]ITH IN THE SWAMP

[redacted]hnes and Culver has worked for many broadcasters over the years, large and small, rich and poor.

One of them had a chain of stations with a particularly important one in south Florida. It had a good signal but they were experiencing uneven coverage when Cuba decided to unilaterally "improve" their stations with increased power, changed patterns and hours of operation. More power for the affected U.S. stations was sought and obtained in 1980. The power and the antenna array in south Florida were about to be improved.

Unfortunately the station was located in the Florida Everglades Swamp, at that time outside of the National Park, on a small, improved lot south of the Tamiami Trail (Highway 41) and about 4 miles into what is now the eastern edge of the Everglades National Park.

It was a nice clean installation, recently upgraded to 50 kW power with an eight-tower parallelogram array. It came complete with its own pet alligator; but that, as they say, is another story.

The transmitter site was completely surrounded by swamp and marshland to a distance of at least 5 miles in all directions. With the exception of a few roads and levees that exist in the area, access to measurement locations by foot or wheeled vehicle was virtually impossible. The use of any type of surface access was impossible because of the lack of landmarks and the park land over most of the area. Airborne helicopter measurements were necessary.

BURDEN OF PROOF

The FCC generally likes to receive AM antenna proofs in which the data is accurate.

I say this as a humorous comment because some reports are a bit lax at times. We understood the burden of proof would fall on us to present data that left no doubt as to what measurements were made and where they were taken.

The helicopter chosen was a Hughes 300 series, two-person aircraft (Fig. 1). It was fitted with floats for opera-

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Fig. 1: Helicopter, FI meter and retro reflectors on the access road at the transmitter site.

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FROM THE TECH EDITOR

by Michael LeClair

High-Power Digital Radio: The 10% Solution

It Should Help Reception, But Can We Handle High-Power Digital in FM?

The NAB recently caused a stir in the radio engineering community after word got out that its board had approved the recommendation from its Digital Radio Committee to seek much higher digital power for HD Radio.

Based on experimentation in Los Angeles and other markets, with results analyzed by engineering firm Hammett and Edison, the NAB plans to ask the FCC for permission to operate digital FM radio stations with up to 10 dB more power in the sidebands. It is a bold concept and has attracted plenty of commentary, negative and positive.

We should start off first with some specifics. Some critics already have bemoaned the idea as effectively allowing "drop-in" digital radio stations on first-adjacent channels at up to 10 percent of authorized power. This is close to the truth but not quite.

We need to recall that it is the sum of all digital carriers that adds up to the total digital power. HD Radio creates a duplicate set of carriers on either side of the FM channel so each of these sets of carriers represents half of the digital power. Each set of carriers would be running at a maximum of about 5 percent of the licensed analog power. The individual subcarriers would run substantially below this level, just a bit more than 30 dB below the unmodulated FM analog.

This increase would be on a voluntary basis and stations would have the option of increasing digital power to a lesser amount if they choose.

Additionally, it is important to note the proposal would not change the FM mask characteristics as they are currently accepted by the FCC. Out-of-channel noise generation, such as spectral regrowth, would be limited to the current values expressed as decibels below the unmodulated FM analog carrier.

In effect the proposal says that while you could increase your digital power substantially, you can't increase the currently specified level of interference products caused by the digital transmissions. It is this last point that is at the heart of the idea.

If we can find a way to do this and still meet the current FM mask, there should be no increase in interference between stations beyond what has already been authorized for HD Radio. For that reason it should be a simple matter for the FCC to permit operation at higher digital powers; it won't hurt anyone and it can help digital reception immensely.

As a rule of thumb, increasing the power by 10 dB should increase the coverage radius by about 30 percent. That would help satisfy many HD Radio critics who have complained about the limited coverage compared to analog.

WELL, NOT QUITE

Unfortunately it isn't that simple.

As a recent article ("What Are We Doing to Ourselves Exactly?" Dec. 12) suggests, the existing allocation scheme for FM stations is quite good but not perfect. Doug Vernier gave examples of "grandfathered" stations whose first-adjacent contours cause analog interference that becomes substantially worse when one or both goes digital. The interference between these stations may go ballistic if another 10 dB of digital power were allowed.

Another concern would be with short-spaced stations and pretty much throughout the noncommercial educational (NCE) band. The large majority of commercially licensed stations were allocated with minimum separations that are conservative with regard to first-adjacent separations. However, in the NCE band, allocations are awarded by predicted contour calculations that permit stations to get pretty close to one another. This also is true for short-spaced stations.

Applications are granted where interfering first-adjacent analog contours essentially touch but do not cross. There are probably hundreds of cases in the NCE band where some amount of interference would be caused by digital operation under the current power limits, let alone at higher powers.

I want to be clear that in calling this interference, I am using a layman's usage of this term and not a precise definition.

Technically the FCC does not protect NCE stations past their predicted 60 dBu contour. For the most part, digital interference is well out beyond the protected contour under the current scheme. But it can, and does, already affect some listeners who tune in outside the protected contours.

To a listener, when something degrades their reception of a radio station, it is "interference," no matter what the rules say.

It's pretty easy to see that if some level of interference is happening now, a 10 dB increase in digital power could create much more. Consequently, a larger amount of the unprotected coverage area for a station might no longer be available to those hardy listeners who heretofore have put in the effort or spent the money to have receiving equipment that works in low signal areas, indeed as far out as the 40 dBu.

And it seems likely that there will be cases where a 10 dB increase in digital power will cause interference to protected contours as well.

As of today, I would be very cautious about allowing a blanket increase in digital power without much more analysis done by independent engineers. Right now my gut feeling is that it would cause quite a few problems, but my impression is based on instinct rather than knowledge. Let the studies begin.

It may turn out that this will need to be requested on a case-by-case basis according to standards published by the FCC. Don't hold your breath for those standards to emerge; that kind of process always takes a

SEE SOLUTION, PAGE 8

IN THIS ISSUE

by Cris Alexander

AM Measurements: Equal Parts Art and Science

Creative Engineers Find Ways to Make AM Antennas Match Theory While Working in the Real World

When I started doing AM engineering 30+ years ago, the basic tools of the trade were the General Radio 1606 bridge, an oscillator and a detector.

General Radio made a high-output, buffered, relatively stable oscillator for this purpose, and I had one. The problem was, it weighed 20 pounds. I usually employed a field intensity meter (FIM) as a detector. At least that was relatively portable and had a handle on it.

Hauling all that mess out to a tower base was a real pain, let me tell you. And once you got it out there, there was the issue of a place to set it all up. A small workbench was really needed, but when have you ever seen a workbench in a doghouse?

Then there was the issue of lead length. Just getting the bridge connected into the circuit was a real trick at times. So making measurements and adjustments at a tower base was quite an ordeal.

I think it was in the 1980s that Potomac Instruments came out with the SD-31 synthesizer-detector. This was an FIM-sized device — battery operated, portable and with a handle — that replaced the oscillator and FIM or other detector. Once we had that little jewel, we thought we'd died and gone to heaven.

We didn't need a workbench in the doghouse anymore. Heck, we didn't need AC power out there.

The SD-31 even had a square-wave modulation feature that provided a good deal of immunity from skywave or other on-frequency signals that contaminated the bridge nulling process. So with the GR bridge and SD-31, we were well equipped for making static impedance measurements.

Later, the Hewlett Packard Vector Impedance Meter became affordable on the surplus market. This gave us a much easier, much faster way of measuring static impedances in antenna tuning unit and phasor networks. They weren't much good for measuring antenna impedances, but you couldn't beat one for setting the leg values in a tee- or L-network.

And then AEA came out with a little handheld LCD screen vector impedance analyzer that was nice for the adjusting networks. It just didn't work well in high RF fields, which meant you could use it around the transmitter site only with the transmitter turned off.

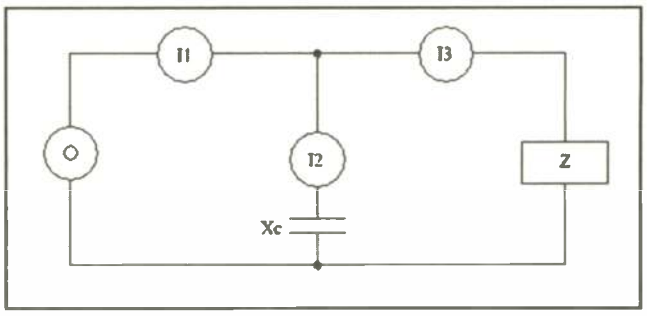


Fig. 1: Before the OIB, operating impedances could be determined using an arrangement of three thermocouple ammeters and a capacitor.

OPERATING IMPEDANCE AND THE THREE-METER METHOD

Making operating impedance measurements was something else altogether. The Delta Operating Impedance Bridge (OIB) was around when I got into the business, but it wasn't as prevalent as it has become today (and they were expensive!).

If you were lucky enough to have one, you were way ahead of the game. For the rest of us, we had to beg, borrow or rent one. I had a good friend who owned one … a friend with an OIB is a friend indeed.

There was another option: the three-meter method. This approach to measuring the operating impedance of a circuit involved using three thermocouple RF ammeters and a capacitor of a known (i.e. "measured") value (see Fig. 1).

Ammeter I3 measures the current in the unknown load Z. Ammeter I2 is in series with a known capacitive reactance Xc, and E = I2 x Xc gives us the voltage across the unknown load Z. From these two meter readings and the value of Xc, the absolute value of Z can be determined from the following formula:

$$Z = \frac{E}{I_3} = \frac{I_2 Xc}{I_3} = \frac{Xc}{I_3/I_2}$$

The third ammeter, I1, is used along with the other two to determine the relationship between R and X. Because I2 is the current through a pure capacitance, its phase angle with respect to the voltage is 90 degrees leading. We use this to determine the phase angle of I3 or I1.

The mathematics of this little exercise are more than the space in these pages allows, but if you want the particulars, drop me an e-mail and I'll clue you in. In fact, a graph was usually used to determine the values of R and X from the current ratios and the value of Xc; that saved a lot of wear and tear on the old slide rule.

The point of all this: Engineers have always found a way to measure unknown values. The three-meter trick was the best we could do in the days before the OIB, and it worked (although the capacitor across the load would affect the system tuning — a high reactance/small capacitance was best — and even the OIB "insertion effect" has to be tuned out). The General Radio 1606 and SD-31 was the best we could do in the days before the vector impedance meter. And the vector impedance meter was the best we could do before … well, read on.

HD RADIO AND THE NETWORK ANALYZER

Several years ago, consulting engineer Ron Rackley presented a paper at the NAB Broadcast Engineering Conference on using a network analyzer for load analysis.

This was timely because we were just edging into AM HD Radio, where the orientation and symmetry of the load were perhaps more important than absolute VSWR values. The network analyzer would tell us in a few seconds what it might take us half an hour to determine with the bridge and synthesizer-detector.

When I heard Ron's presentation, I knew that was what I needed, so we made the investment in a used H-P vector network analyzer, linear power amplifier, directional couplers, attenuators and the cables to connect it all together. This sure made the

SEE DAY IN THE LIFE, PAGE 18

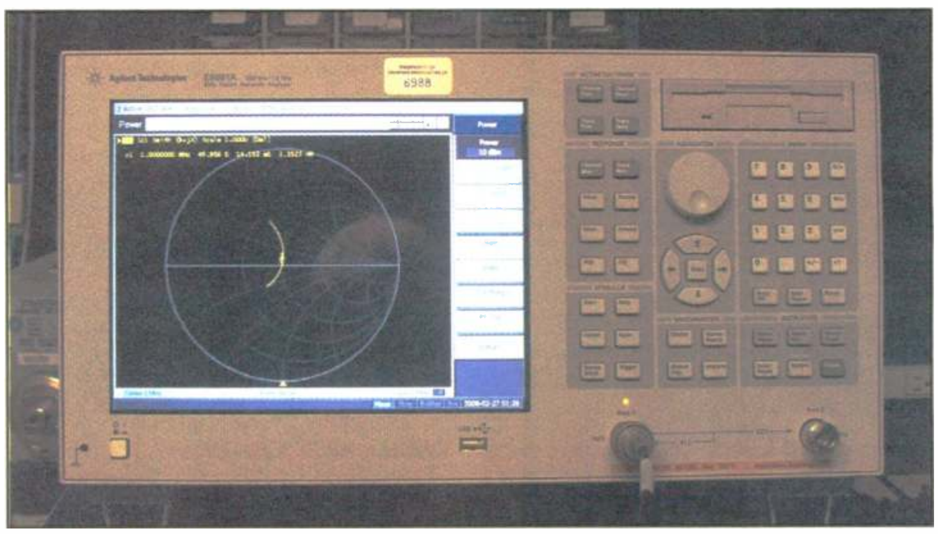
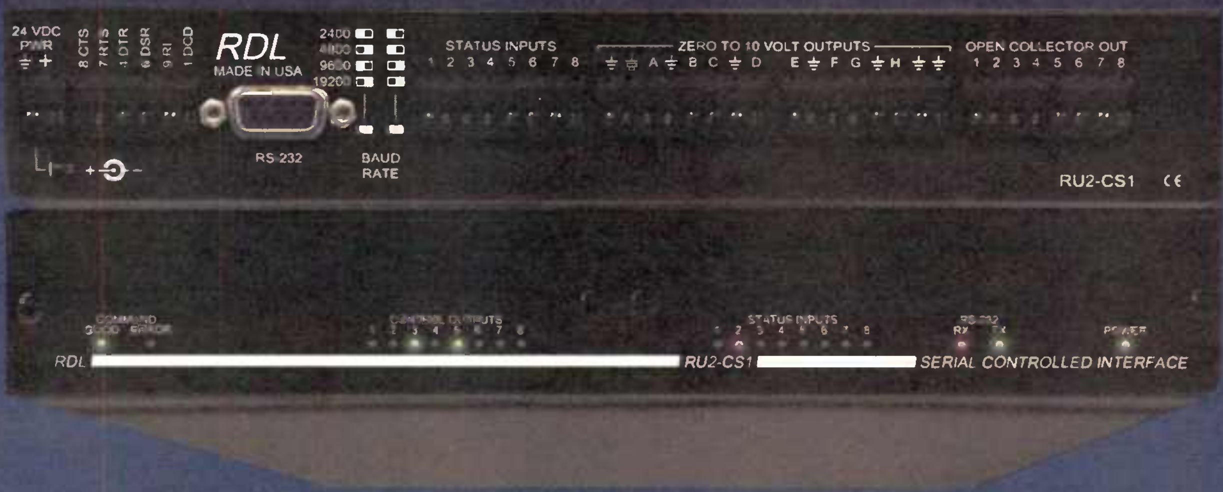


Fig. 2: The Agilent E5061 Network Analyzer makes load measurements and adjustment a snap.

GET EVERYTHING UNDER CONTROL



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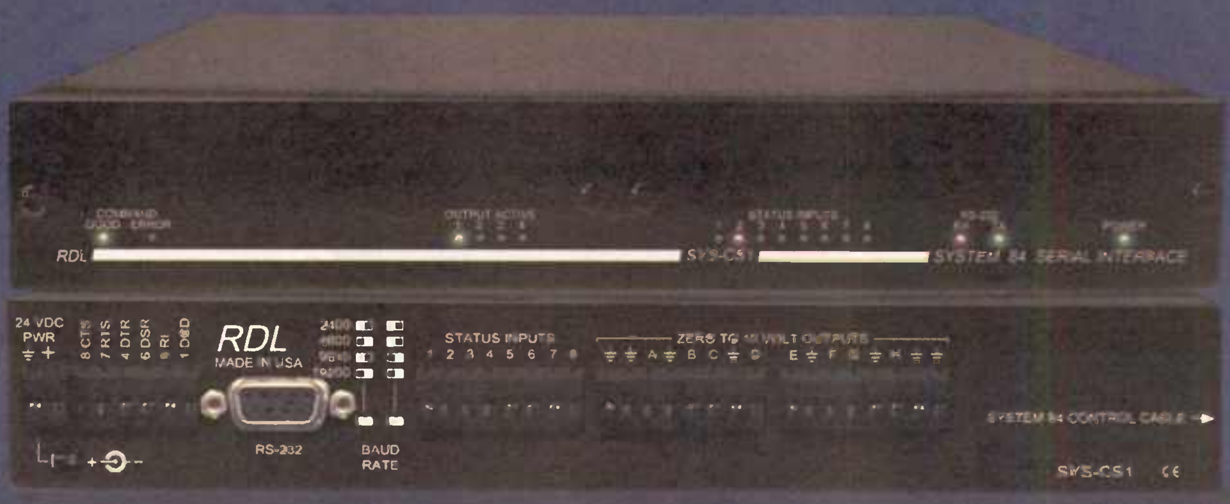
  Examples include sensing contact closures from satellite receivers or from RDL audio or video detection modules.
- Rack mountable using RDL RU-RA3HD



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by Charles S. "Buc" Fitch

Determining Tx Final Stage Efficiency Factors

Last Week's Question

Last time we posed the following question for CBRE-level exam takers: "How are transmitter final stage efficiency factors determined?" The choices are:

a. Directly from the transmitter's reflectometer.
b. From manufacturer's supplied data and/or from measurements taken by a calibrated power measuring device rationalized against input power to the final stage.
c. By multiplying the final stage current, applied voltage and a "K" factor of 40 percent subtracting the drive power
d. From the nameplate ratings.
e. From the final device manufacturer's spec sheet

SBE certification is the emblem of professionalism in broadcast engineering. To help you get in the certification exam frame of mind, Radio World Engineering Extra poses a typical question in every edition. Although similar in style and content to exam questions, these are not from past exams nor will they be on any future exams in this exact form.

The correct answer is B. Final stage efficiency values are most often used in "indirect output power determinations" to validate that the transmitter is producing the correct power output to achieve the licensed radiated power.

The FCC's rules at 47 CFR73.267(c) (for FM) allow that output power to be calculated by multiplying the power consumed in the final stage by an efficiency factor, either supplied by the manufacturer or originally determined by using a calibrated power measuring device.

The power efficiency factor from the manufacturer usually is provided in the original copies of the instruction book and sometimes is an actual measurement for a specific serial number transmitter at the licensed TPO. Occasionally these factors are annotated as graphs, as the efficiency can change somewhat with drive and power level across the legal FM power range of 90 to 105 percent TPO.

If you are using the indirect measurement system for TPO, the source and validity of that number have to be available to the FCC if and when it inspects your station, and should be a permanent part of your station's engineering records. On a more day-to-day level, these numbers are invaluable for troubleshooting transmitter final problems and a validation that tuning, loading, etc., are still at nominal and correct.

The efficiency factor also can be determined on site by using either a calibrated thermo-couple or calorimeter power meters.

In the new universe of digital radio, and especially for HD, the typical peak-reading watt meter (such as the classic, diode sampling through-line type) produces indications that are not fully indicative of the real power in the envelope. Peak-reading meters are only fully accurate with a near-constant CW envelope such as an FM carrier, and do not properly report the varying digital sidebands of HDFM.

In a thermocouple power meter, selected dissimilar metals will produce a current flow at their junction when heated. The increased level of this current flow is proportionate to the heat induced. A thermocouple in a dummy load resistor of characteristic impedance that matches the output of the transmitter can provide us an

See SBE, page 16 ▶

WTMI INDIRECT POWER DETERMINATION CHART
Licensed Power Out: 490 Watts. Use this chart to determine power (incorporates Efficiency Factor of 0.88)

AMPS \ VOLTS	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
7	351	357	363	370	376	382	388	394	400	407	413	419	425	431	437	444	450	456	462
7.1	356	362	369	375	381	387	394	400	406	412	419	425	431	437	444	450	456	462	469
7.2	361	367	374	380	386	393	399	406	412	418	425	431	437	444	450	456	463	469	475
7.3	366	373	379	385	392	398	405	411	418	424	430	437	443	450	456	463	469	475	482
7.4	371	378	384	391	397	404	410	417	423	430	436	443	449	456	462	469	475	482	488
7.5	376	383	389	396	403	409	416	422	429	436	442	449	455	462	469	475	482	488	495
7.6	381	388	395	401	408	415	421	428	435	441	448	455	461	468	475	482	488	495	502
7.7	386	393	400	407	413	420	427	434	440	447	454	461	468	474	481	488	495	501	508
7.8	391	398	405	412	419	426	432	439	446	453	460	467	474	480	487	494	501	508	515
7.9	396	403	410	417	424	431	438	445	452	459	466	473	480	487	494	501	507	514	521
8	401	408	415	422	429	436	444	451	458	465	472	479	486	493	500	507	514	521	528
8.1	406	413	421	428	435	442	449	456	463	470	478	485	492	499	506	513	520	527	535
8.2	411	419	426	433	440	447	455	462	469	476	483	491	498	505	512	520	527	534	541
8.3	416	424	431	438	446	453	460	467	475	482	489	497	504	511	519	526	533	540	548
8.4	421	429	436	444	451	458	466	473	480	488	495	503	510	517	525	532	540	547	554
8.5	426	434	441	449	456	464	471	479	486	494	501	509	516	524	531	539	546	554	561
8.6	431	439	447	454	462	469	477	484	492	499	507	515	522	530	537	545	552	560	568
8.7	436	444	452	459	467	475	482	490	498	505	513	521	528	536	544	551	559	567	574
8.8	441	449	457	465	472	480	488	496	503	511	519	527	534	542	550	558	565	573	581
8.9	446	454	462	470	478	486	493	501	509	517	525	533	540	548	556	564	572	580	587
9	451	459	467	475	483	491	499	507	515	523	531	539	546	554	562	570	578	586	594
9.1	456	464	472	480	488	496	504	513	521	529	537	545	553	561	569	577	585	593	601
9.2	461	470	478	486	494	502	510	518	526	534	542	551	559	567	575	583	591	599	607
9.3	466	475	483	491	499	507	516	524	532	540	548	557	565	573	581	589	597	606	614
9.4	472	480	488	496	505	513	521	529	538	546	554	562	571	579	587	596	604	612	620
9.5	477	485	493	502	510	518	527	535	543	552	560	568	577	585	594	602	610	619	627
9.6	482	490	498	507	515	524	532	541	549	558	566	574	583	591	600	608	617	625	634
9.7	487	495	504	512	521	529	538	546	555	563	572	580	589	598	606	615	623	632	640
9.8	492	495	504	512	521	529	538	546	555	563	572	580	589	598	606	615	623	632	640
9.9	497	505	514	523	531	540	549	558	566	575	584	592	601	610	619	627	636	645	653
10	502	510	519	528	537	546	554	563	572	581	590	598	607	616	625	634	642	651	660
10.1	507	516	524	533	542	551	560	569	578	587	595	604	613	622	631	640	649	658	667
10.2	512	521	530	539	548	557	565	574	583	592	601	610	619	628	637	646	655	664	673

Fig. 1: Efficiency chart for a solid state AM transmitter identifying the voltage and current combination (colored region) where the output will be legal (between 90 and 105 percent TPO) and where a constant efficiency factor is present.

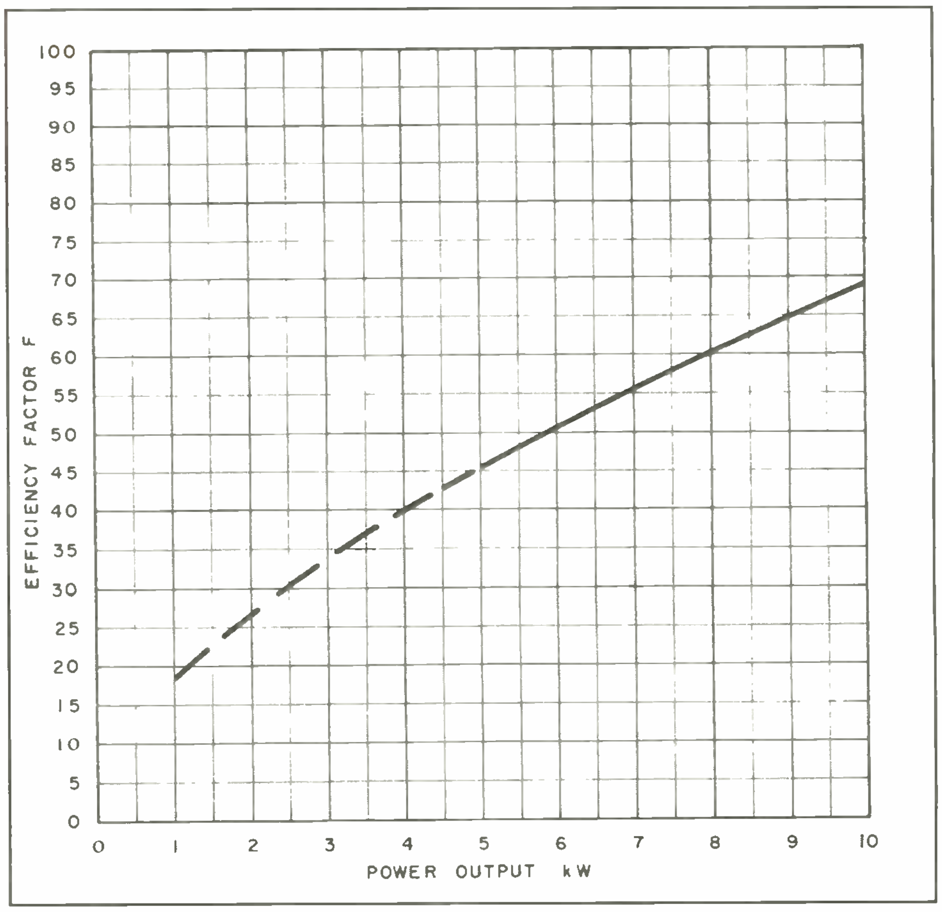

Fig. 2: Final stage efficiency chart from a classic 10 kW RCA FM transmitter with a 4CX10000D output tube. Notice that the efficiency is not quite a linear function for varying power levels.

Above: Rays broadcasters ***Andy Freed*** *(left) and* ***Dave Wills*** *(right) interview Rays' star third base prospect* ***Evan Langoria*** *on the "The Hot Stove Radio Show."*

Top: ***Larry McCabe****, Tampa Bay Rays Senior Director of Broadcasting and* ***Rich Herrera****, broadcaster and Director of Radio Operations are shown on the field during spring training.*

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AM Proof

CONTINUED FROM PAGE 1

tion over water and an external frame on which to mount the Potomac Instruments FIM-41 AM field meter and associated range-finding components. The frame-mounted meter replaced the right side door and thus was able to quickly attach to the usual door hinge and latch points. I was told this configuration was approved "air-worthy" for our use.

Other instruments included a strip chart recorder, battery power supply and radio. This aircraft has a limited flight weight and operational capacity, and we were at that limit.

The helicopter with mounted AM field meter would be used for continuous air-borne measurements, including close-in precision measurements.

CORRECTION FACTOR

It was necessary to confirm the accuracy of the field strength readings with the meter mounted on the aircraft and also with the aircraft flying at expected altitudes and attitudes. Therefore test measurements were made at a ground location approximately 3.5 miles northeast of the antenna site, with the field strength meter mounted in its normal position on the helicopter and then hand-held at the same location. The difference in field strength noted in this test was less than 2 percent.

An altitude calibration test was then conducted above a shallow swamp area, typical of the majority of the terrain around the antenna site, at a distance of 8.0 miles from the site. At this location the helicopter was flown from ground level to an altitude of 300 feet, as straight up as possible, while maintaining meter loop orientation.

The results, which show a maximum difference of 2.7 percent at altitudes of 250 feet and above, are tabulated in Fig. 2.

ALTITUDE ABOVE GROUND LEVEL	MEASURED FIELD STRENGTH	PERCENTAGE OF GROUND LEVEL VALUE
0 Ft.	74 mV/m	100 %
50	73.5	99.3
100	73.5	99.3
150	73.5	99.3
200	73.5	99.3
250	72	97.3
300	72	97.3

Fig. 2: Helicopter Calibration Test Measurements — Altitude Calibration

Meter-mounting relative to flight attitude was simple, as we would always be flying radials toward or away from the transmitter and thus the meter mounting could be fixed.

By the way, everything important (and that meant almost everything in the helicopter) was safety-wired to a nearby secure hard point on the aircraft. Although the meter never came loose from its mount, it was nice to know there was a safety wire lanyard on it. Yes, I have bounced a meter down the road after forgetting it was still on top of a car.

Now it was necessary to confirm the accuracy of airborne measurements as compared to traditional ground measurements along a radial.

The N 179 degree East radial, which had a significant number of ground points, was selected for calibration tests. Field strength measurements were made on the ground at the 12 accessible measuring locations between 4 and 20 miles on the radial, with the station operating at 10 kW in the non-DA mode.

The radial was then re-measured in flight. The field strength was continuously recorded for two runs, one with the helicopter flying inbound and the other out-

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DISTANCE IN MILES	GROUND MEASUREMENT	AIRBORNE OUTBOUND	MEASUREMENTS* INBOUND
4.0	125 mV/m	120 mV/m	115 mV/m
6.63	60	58	56
7.15	55	53.5	50
8.15	47	44	41
9.15	34.5	35	33
9.65	34.5	34	30
11.15	30	26	24
12.65	22	22	20
13.9	19	18.5	17
15.7	12.5	15.1	14.5
17.7	11	12	11
20	6.8	8.5	8.4

*No correction factor applied

Fig. 3: Tabulated FI Radial Data

Solution

CONTINUED FROM PAGE 3

lot of time (and probably should).

FEEL THE POWER?

From an engineering perspective, there also is the very real problem of generating the additional digital power.

Of the approximately 2,000 or so stations that have already converted to HD Radio I doubt more than a handful could use what they have now to generate 10 times the digital power.

Those of us who have been involved in digital conversions are well aware of the four basic choices for digital combining: high-level, low-level, split-level and dual antenna. When we start to talk about digital power at a level that is 10 percent of the analog carrier, it calls into question all of these methods for medium- to high-power stations.

Perhaps the most common of these, high-level injection, would waste enough power to grill steaks using the typical –10 dB injector; approximately the same amount of power as the analog TPO would go to a reject load. It's hard to accept that all that pristine, linear digital power is going to go toward generating heat with only a small fraction actually transmitted for listeners to use.

Early comments from transmitter manufacturers also point out the increased linearity requirements for digital transmitters. While the power goes up by 10 dB, the spectral regrowth has to remain below the mask. This puts pressure on pre-correction systems and Class AB amplifiers, which have been employed to squeeze out as much efficiency as can be produced with a linear amp.

The reduction in efficiency required for 10 percent digital at low-level combining would require an enormous transmitter; for those running at 20 kW TPOs, the transmitter would need to be larger than any single box built today. Manufacturing Class A transmitters of this size may require the use of water cooling to handle the heat loads. Split-level holds some promise but the increased linearization will again make for really large transmitters.

Dual antenna would seem to be the only efficient method at the moment. But the isolation requirement goes up substantially and might not be easy to meet for interleaved designs. On the other hand, many have noted the coverage compromises and even self-interference that have come from using a separate, unmatched auxiliary antenna for digital broadcasting.

There is no clear winner here. Engineers designing new transmission systems will now have to keep the possibility of increased digital power in mind in the planning phase. It will be expensive. Is FM ready for the 10 percent solution? ■

CONTINUED FROM PAGE 8

bound. Identifying marks were made on the chart when the helicopter crossed over the ground measuring locations. This radial test is shown in Fig. 3.

As a side note, the FCC still required that ground measurements be made wherever access to ground locations was possible. In this case there were quite a few to the east. The result was that an overall correction factor was calculated based on all actual air-to-ground comparative measurements. This correction accounted for all external effects.

Herein lies another important engineering point: It is very nice to be able to measure an unknown value by direct comparison to, or substitution of, an accurately known value. It is another problem entirely to attempt to divine an unknown quantity based on only math and physics when there are unknown and uncorrectable outside factors present. I am not sure anyone has yet demonstrated an accurate airborne method to measure VHF or UHF antenna patterns.

The overall correction multiplying factor was calculated to be 1.09 or +9 percent for the airborne measurements over the ground-level measurements, and this factor was applied to all airborne measurements. For comparison, this is very close to the overall FIM-41 meter combined measurement and calibration accuracy.

We now know what is being measured, but as the FCC staff had questioned on the few airborne measurements preceding this, "Do you know where you are?"

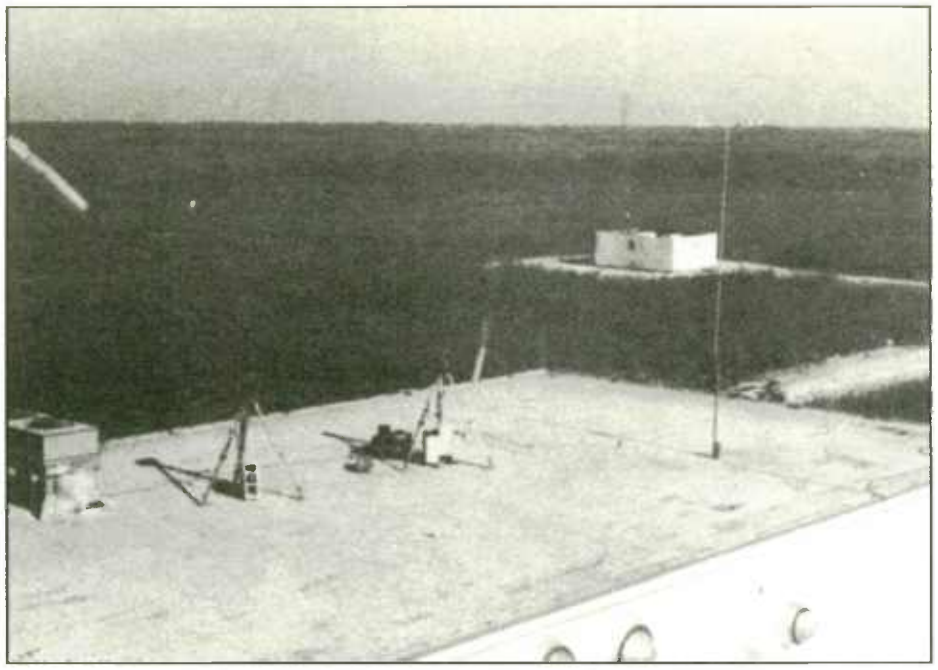

Fig. 4: Roof Top Observation and Control Point (aerial view)

LOCATION FINDER

To overcome this problem an elevated observation post was established on the flat roof of the transmitter building, about 25 feet above swamp level, and located near the center of the antenna array. This post and its equipment is shown in the photographs of Figs. 4 and 5.

From this post the flat Everglades area could be seen for miles. The helicopter in flight was easily seen by eye out to several miles, and with the optical instruments much further.

The radial bearing was monitored by use of a Double Scale Theodolite. The 30-power telescopic sight has cross-hairs with major hash marks at 0.3 degrees and a total field of view of about 1.5 degrees. Each minor protractor scale mark subtended 1 minute of angle. The cross-hairs were zeroed on local objects on the horizon from which the precise horizontal azimuth could be determined. An offset antenna baseline also was created parallel to the line of the towers.

By locking the horizontal angle ring on a known object bearing, or the line of towers, we could make a direct reading of the bearing to any unknown object, such as the helicopter in flight.

Radial distance for close-in points was then measured using a model 3808A Medium-Range Distance Meter laser range finder from Hewlett Packard, the best available for our use at the time. This instrument could track and read the distance to an object while in moderately slow motion, with the range and tracking ability dependant on the reflectivity of the target.

To enhance this reflectivity an array of "Retro Reflectors" was attached to the field meter mounting bracket. This can be seen as

SEE AM PROOF, PAGE 12

Fig. 5: Theodolite in Use Monitoring Bearing to Helicopter

rubicon

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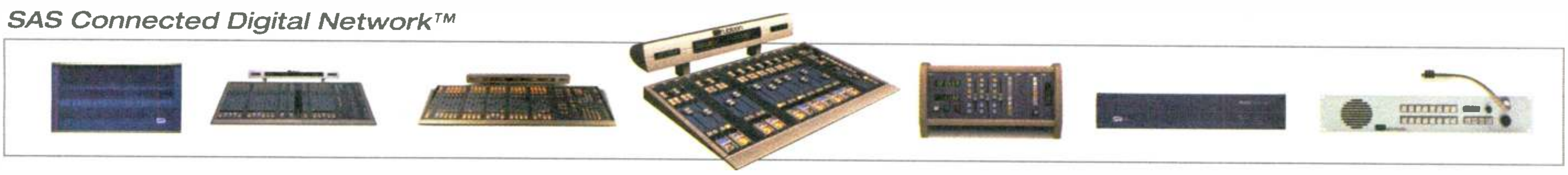

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AM Proof

CONTINUED FROM PAGE 10

the three clusters of three cylindrical mirrors in Fig. 1. Under normal conditions the laser range finder would acquire and lock on to this target at a distance of up to four miles and readings were continuous from there on in.

Distances further out along a radial were measured by direct observation of the few known and visible landmarks from which distances could be measured on topographic maps. Objects such as roads, canals, levees and brush covered island "hammocks" served as these reference points, which were marked on a strip chart recorder as they were flown over. Even a few orange-painted posts with "flags" were set out in the swamp at intermediate points.

The precise distance at these landmarks was known and intermediate distances could be interpolated on the charts, assuming the aircraft velocity was constant between any two landmarks. With moderate effort and skill the pilot could achieve the desired velocity and flight profile for each radial.

TAKING FLIGHT

A typical radial flight would begin at the far end of a radial just beyond the known furthest out landmark. The pilot would orbit or land while the instrument operator would ready the meter and the chart recorder. When all was ready, the pilot would turn onto the radial at a modest cruise speed, crossing over the outermost landmark at about 200 to 300 feet, and proceed to the antenna along the desired radial bearing. Starting at a modest altitude, the helicopter could be seen at well beyond 10 miles depending on optical conditions such as heat mirage. More height was used at the beginning of a radial for both safety and visibility, and was slowly decreased closer in.

When acquired by the Theodolite operator, directions called from that position would guide the pilot onto the final heading.

The Theodolite operator would make radio call course corrections by reporting sighting the helicopter "left" or "right" of the radial in his instrument, which also was the direction the pilot needed to correct his line of flight from his point of view coming inbound on the radial. The speed of flight was not critical but kept constant at about 60 miles per hour. The process was continued until the last of the landmarks were crossed and at a distance at which the close-in process was used.

In the last few miles of a radial (for example from 4 or 5 miles out), the helicopter was over swamp and field intensity data was directly reported and logged without the strip recorder. At this distance the helicopter distance was acquired by the laser range finder. The helicopter could then descend to about 10 to 30 feet altitude over the swamp and slow to about 5 miles per hour, the maximum speed at which laser lock could be maintained.

At this slow flight this particular helicopter needed to be at low altitude in "ground effect" because it did not have enough power to hover for very long at altitude. Now the laser operator joined the Theodolite operator in guiding the aircraft.

At more or less uniform time, and therefore distance, intervals, the laser operator would call out a "mark" over the radio, he would record his distance reading, the field strength meter operator in the helicopter would then call back his meter reading, the laser operator would write down the field reading and return to his laser for the next mark while the Theodolite operator would continue to guide the line of flight.

HOME STRETCH

For the last short distance, a mile or so, the flight would continue low and slow so as to take readings at closer spacing, and the Theodolite operator would release the aircraft pilot to guide himself by eye to the end of the inbound path at the omnidirectional tower or the center of the array, whatever the case may be.

The laser and the Theodolite were both offset a bit from the center of the antenna being measured. Guiding the line of flight from the offset observation post had little effect on the far out points but would introduce an error in the actual radial path close in.

Fortunately it was quite easy for the pilot to maintain a visual flight path to the radial end point when close in. Distances, however, still had to be accurately measured, and these were corrected by simple trigonometry based on the offset angle of the laser site to the measurement end point.

The accuracy of the system was very high. At that time, and perhaps even today, there is probably no way to measure an AM measuring position more accurately. The Theodolite had convenient major hash marks at +/- 0.3 degree marks, and the helicopter could be kept at an even better bearing accuracy depending on the tolerance of the pilot being directed "Left, left, right, left ..."

In the end, the process used the 0.3 degree marks as the must call points, and lesser errors were corrected occasionally depending on the angular velocity heading off of the desired radial.

On some radials no calls were required for long times because of good visual flying, and the pilot would occasionally call to ask how he was doing. A short "on radial" reply was all that was needed and the operators soon learned to give an occasional "on radial" call even when correction was not needed.

When it comes to distance, *nothing* beats the laser. At 3 miles, the laser yields a maximum error of +/- 0.032 feet. The distance reading was 0.01 feet in moving mode, and was rounded to the nearest foot for recording in the data sheets. The distances were corrected for the trigonometric error and then converted to miles to three significant digits for reporting in the FCC Proof Report.

To illustrate the data collected in this project, a copy of one of the chart recordings, as used in the far out measurements, is shown in Fig. 6. This chart covers a distance out to 12.65 miles and shows several interesting things.

First, the distance scale is uniform over its full length. This is a tribute to the ability of the pilot to fly a constant radial speed for the strip chart-recording phase of data collection.

The signal vs. distance characteristic of

SEE AM PROOF, PAGE 14

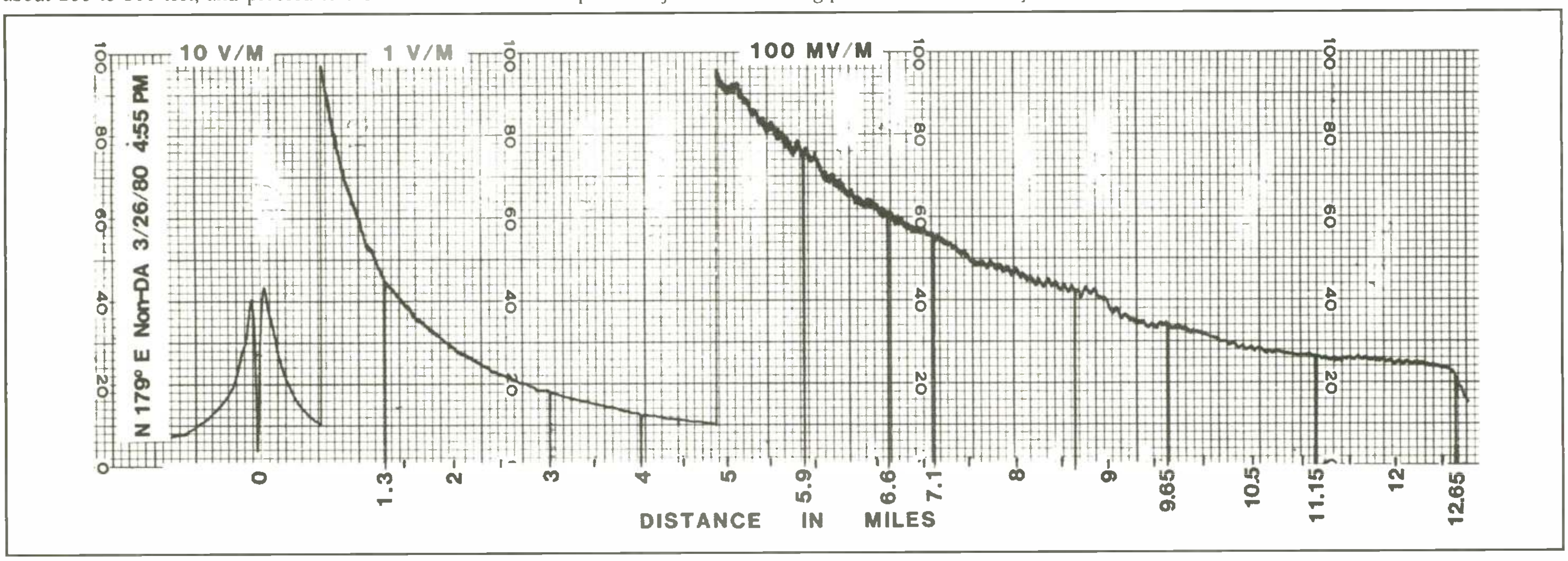

Fig. 6: Sample Radial Strip Chart Recording

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AM Proof

CONTINUED FROM PAGE 12

this chart looks remarkably like the FCC M3 field curves. The remarkably smooth field can be seen, and even the deep null as the omni antenna is flown over clearly shows. There are three attenuator changes on this run, from 100 mV/m to 1.0 V/m to 10.0 V/m full-scale, to accommodate the increasing field.

To further illustrate the data collected, the same radial presented in the strip chart above is presented in the FI Graph (Fig. 7).

To illustrate why airborne measurements were required, a photograph of a monitoring point for this array is seen in Fig. 8. Yes, you still have to measure monitor points for proofs and on other scheduled times, even in the swamp. For those measurements, the helicopter transported the station engineer to the marked location, dropped him off in the swamp and then moved off a few feet so as to not affect the reading.

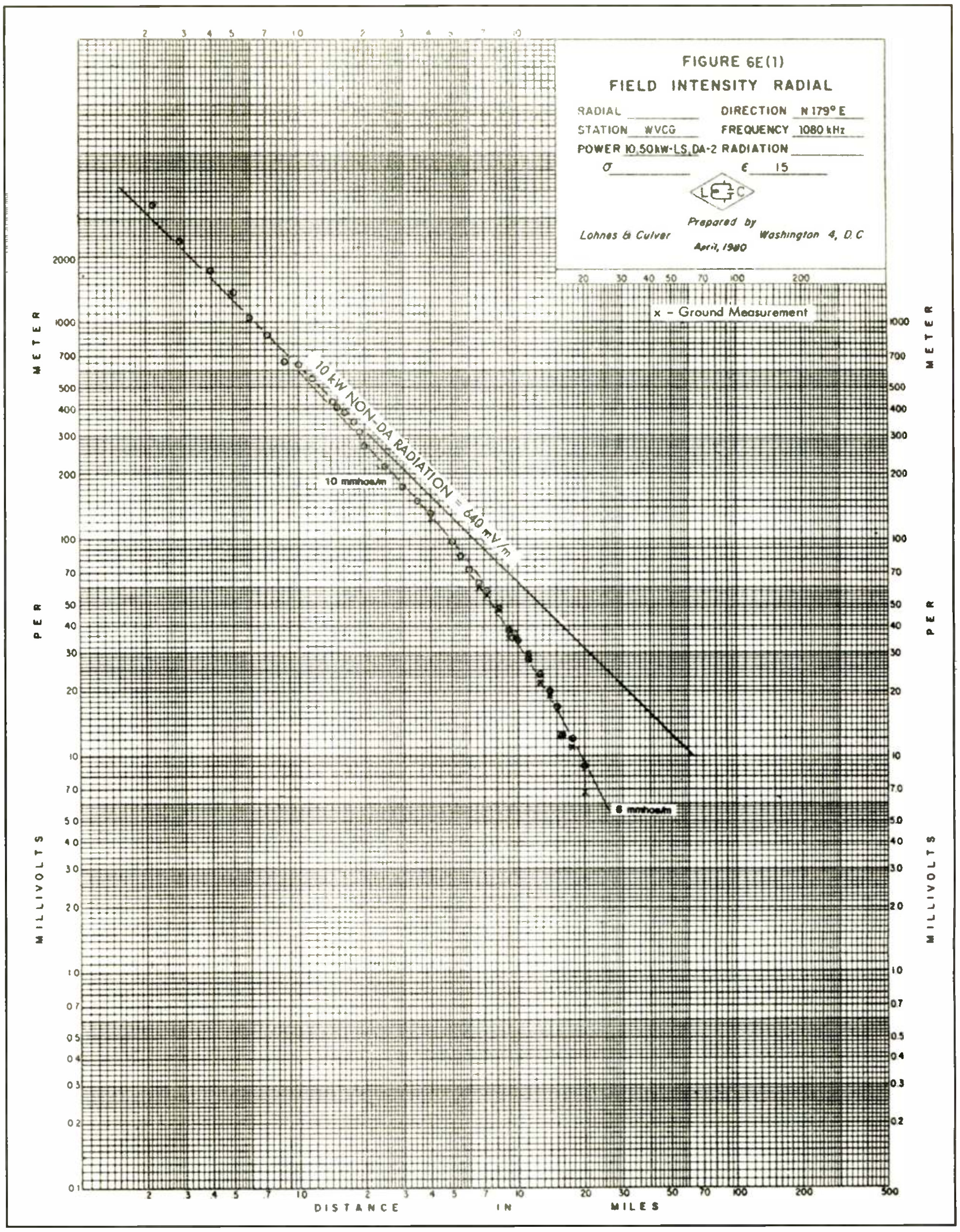

Fig. 7: Sample Radial FI Graph

LESSONS

What was learned in this project? It was expected that planning and preparation for the project would take considerable time, and that the actual data collection should move quickly. Inspecting the dates and times indicated on the many data sheets shows just how quickly.

The non-DA data was collected over about a three-week span encompassing only nine actual days of measurement. The DA data was collected in less than two weeks using only three days of flying. It took longer to set up for the project, collecting equipment and sorting out methods that worked and eliminating those that did not work and then preparing the report, than the actual AM Proof of Performance measurements.

WHAT WOULD BE DIFFERENT TODAY?

The use of GPS and direct data collection by computer immediately comes to mind.

Using a GPS receiver to determine location would not be as fast, but would it be good enough for the far out points at a moderate to slow flying speed? Close in, with the laser and Theodolite after rounding the actual measured distances, we recorded the close in measurement locations within 0.001 miles (three significant figures) and +/- 0.1 degrees of azimuth.

Obtaining this accuracy with a GPS is possible but it would severely constrain data collection speed. High precision requires a relatively long-term GPS average fix, and that precludes measurements with accuracy of a few feet while in motion.

Perhaps a hybrid system could be devised that used a GPS to guide far out flight along a radial and trigger data collection. Closer in, a laser or other methods would determine the range to the helicopter and incorporate those distance readings in the collected data.

Let's take this one step further and speculate that a direct observation system on the aircraft would eliminate any manned instruments at the transmitter.

To keep the aircraft on course, a laser light azimuth beacon attached high up on the tower of interest would work out to many miles. A scanned yellow laser, subtending a few 1/10ths of a degree, would indicate the path flight. Left and right of it, a red and green laser would indicate what direction to move to return to the path. Equipped with a stepper motor rotor the beacon would be oriented in any desired azimuth, easily set by observing the beacon from just one distant known location.

Distance could be determined by a pulsed signal on the signal transmitted from the station of interest, or on a radio beacon attached to the tower. The beacon pulse time of flight would be determined with the aircraft at a known distance and locked to an onboard time reference. When flying, the time differential would yield radial distance. Even the scanned lasers could be used to determine the distance by triangulation, as in a split image optical range finder.

RERADIATORS

We were focused on accurately measuring AM field strength at the time of this proof of performance measurement. Since then, other technical issues like FM and TV directional antennas and digital transmissions have been important topics with important lessons.

Looking at this old data again, with the benefit of those intervening lessons, causes me to see technical artifacts that were overlooked in the past.

For example, take a look at the strip chart recording of Fig. 6, especially in the region from 5 to 12 miles. You will see a pronounced ripple in the Field Intensity value on several portions of that distance. By close examination of the region near 8 miles, I found that the ripple is about 2 percent, sometimes a little more. It is uniform, with the peaks spaced at almost exactly 0.1 miles, or 0.58 wavelengths at the frequency being measured.

What we are seeing is a standing wave interference pattern being caused by some reradiators as we flew along this radial. In the VHF and UHF realm, this is our constant companion multipath, and a serious problem for digital transmissions.

Could we have devised a method to seek out and pinpoint the re-radiators, even back then? Let me speculate that by transmitting the proper signal, we could have. The same basic technique, to apply a known signal and detect it and then decode it for reflected signals, was used for the Digital Audio Radio-VHF Channel Characterization testing in Salt Lake City in the 1990s.

LUNCH ON THE FLY

Having a flight duration limit of about two hours before needing to refuel worked out just right for a midday lunch schedule. While the aircraft and crew were at the local Fixed Base Operator servicing the helicopter, the transmitter site crew phoned in a lunch order "to-go." Just about 8 miles east of the transmitter on the Tamiami Trail was a quite good, if somewhat rustic, Bar-B-Q Rib Shack. "Sandwiches, fries and sodas to go please, and we'll pick them up at 1 p.m."

For several weeks the midday helicopter landing in the rib-shack parking lot was the local sensation. I'm sure it helped business at the shack too. An air show with lunch; how good can it get!

PHONING HOME IN THE B.C. ERA

In the B.C. era — Before Cellphones — the only proper way to say hello to the spouse was still to visit, and we were flying a helicopter so it seemed like a good idea at the time to use it for the pilot to say hello to his Mrs.

We headed downtown to her large office complex, which looked like a school campus with several buildings and courtyards. I was curious as to how the pilot would get the attention of his lady but he just said, "You'll see, we've met up like this before."

We flew down the parkland setting at about fifth-floor altitude, up to within a few dozen feet of the appropriate window. The shades opened so the two romantics could wave at each other for a few seconds.

LOCKED OUT

Finally, it is important to make sure that all the crew knows what is to be done, and pay attention especially when it involves helicopter flying.

SEE AM PROOF, PAGE 16


simple, but god has bigger plans for ... attached a picture in white contact me for more info. big_plans #221542

STEADY SEEKING LADY
I am looking for a male partner (38-50)who is willing to be exclusive with me for a long term relationship. Not asking for marriage. I am of average build, dark hair, brown eyes and am an Indian female. I have a wonderful job and attend some classes a couple of nights a week. I have two kids who stay at home with me. They are very precious to me. And they are not going to be a hindrance to our dating. I have a full and busy life. Therefore, the expectation is to see each other on a steady basis, and at the same time, being flexible. precious_me #331252

I LOVE MUSIC. YOU LOVE ME
I'm an indie/hipster girl who adores music and going to clubs and shows. Some of the bands that I'm into are Interpol, The Arcade Fire, Blonde Redhead, Bauhaus, The Smiths, Morrissey, etc. I'm into indie rock, electronica, punk, pretty much anything. I drink and smoke occasionally. I'm 21, 5'8", light-skin, dark brown hair/eyes. I work, am well-educated, funny, spontaneous, nice. #2215234

299685

HANDSOME RAKE
Out of work leaf raker/bagger seeks whimsical beauty with un-kempt auburn or chestnut hair, cool coarse hands and a penchant for whistling. mellow_mo, 28, #101318

LET'S CONNECT
Radio engineer seeks stable long distance relationship. Need to connect immediately. Everywhere I go, I see broadband internet, but I just never hook-up. I need to meet that special someone that will plug me in so I can be heard. Must be reliable, connect easily, forgive errors and adapt to change. Should come from a good family. easy_going #101352

SIMPLICITY HERE
Simply put, I'm looking for a fun, casual relationship with only one person. That means one person for me and one person for you. :-) Every woman wants to feel safe with a partner, whether it's serious or not. It's key to her feeling comfortable to express her more intimate nature. I don't ask for much other than to hang out, enjoy your time with me and be available to chill.

MR. RIGHT
I'm actually posting this on behalf of a friend. Since she's been single she hasn't found the right guy and I'm doing this in hopes of helping her find Mr.Right. After you and I talk, if you are chosen then you will get to go on a date with her and who knows, it could be the perfect date and start of a new ...

... with hint of red. Sorry busy ... name.... (hee). #166778

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CONTINUED FROM PAGE 6

accurate measurement of power produced on a repeatable basis.

A simplification of the design can be achieved by merely sampling the RF current flow through a "current resistor" in line with the load, which is the standard concept for an AM base current meter.

The calorimeter power meter transfers the heat from a dummy load into a cooling liquid that flows around the resistor. For maximum accuracy, the cooling liquid needs to be inert and have no dielectric properties like distilled water or certain oils and anti-freeze mixtures. The flow rate of the cooling fluid, the specific heat of the fluid and the change in the temperature of that fluid between input and output ports are factors in the final calculation, yielding an exceptional degree of accuracy especially in high-power measurements.

Here are your questions for the next issue: "What is a dB? What is a Neper? Whom is the dB named after?"

C.S. Fitch, P.E., CPBE, AMD, is a frequent contributor to Radio World. ■

Fig. 3: Water-cooled dummy load that can be used in caloric power measurements. Notice the fluid in/out fittings at the bottom, and Benjamin the Cat checking out the 6 inch coax input at the top. This unit, the author's personal high power load, is capable of handling an 80 kW input.

AM Proof

CONTINUED FROM PAGE 14

The usual evening routine was to service the helicopter and return it to the transmitter site, tie it down for the night and then drive to our accommodations. For some reason one evening the crew thought we would not fly back and that we had alternative plans and transportation to the hotel. When we got back to the transmitter site we were locked out of the buildings and no cars were in sight.

Flying out of the transmitter site we headed for the local camp/sports store, a this hunting camp store was at the intersection of about the only two roads on the east side of the Everglades?

As we lifted off a few feet we needed to find a clear way ahead to get up to flying attitude and gain altitude. The only way to gain altitude when fully loaded was to get a running start, and as you might guess that was down the road. We picked the less traveled of the two roads, slid sideways off the parking lot and also off the hosed-down area. The last thing I saw of the on-looking crowd was them rolling up their windows.

As we headed onto the road (now runway) we saw we had lots of room left and right relative to wires and trees and oncom-

Fig. 8: One of several marked monitoring points in the swamp. The engineer is transported via helicopter but must measure away from it in the swamp.

home to hunters, fishers and air-boaters for the area. On final approach to the nearly empty gravel parking lot, the entire area disappeared in a cloud of blown dust. The only way you could see anything was by looking straight down or straight up, and at the time looking straight down was more important.

As the rotor spun down and the pilot and I contemplated our fate, we noticed the lady proprietor of the store rolling up the windows on her dusty green Cadillac. Approaching her somewhat sheepishly, we were relieved when she said, in her thick South Florida drawl, "Oh don't worry about it none, son, them air-boaters do that all the time."

Having made our phone call to get a ride, and relaxing for a few minutes with a soda, we returned to the helicopter to see Ms. Fishing Camp Owner hosing down the parking lot in a nice, neat 30 foot circle all around the helicopter. No dust this time.

With the engine fired and the rotor coming up to speed, we switched on the navigation lights, the anti-collision strobes and the landing light, just as the crowd began to gather on the adjacent roads. Did I tell you

ing traffic about a mile ahead. We did notice a few swerving headlights, but nothing serious.

Heading west into the sunset over the swamp at 300 feet altitude, we could not resist chatting about how much fun the day had been and other trivial matters. But something was not quite right. The horizon was still there, just a light band of sky from north to south and reflecting gently off the swamp, but the reflections were different.

After a quick call to the pilot to "check altitude" he illuminated the landing light and about 30 feet below was the swamp and brush. We had lost track of the evening visual horizon over the swamp and also lost most of our altitude.

We finished that flight to the transmitter in slow motion and puckered in silence, carefully checking and confirming all obstacles, like guy wires. We set down, shut down, tied down and then calmed down.

It took us a full 10 minutes to recover and try something new, like trying to call in the local alligators. But that is another story.

Bob Culver, P.E., is consulting engineer, Lohnes & Culver, Laurel, Md. ■

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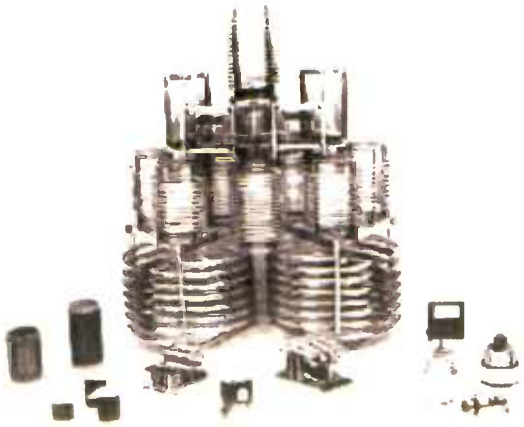

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SINCE 1963

Day in the Life

CONTINUED FROM PAGE 4

process of adjusting an antenna for proper load orientation and symmetry easier and faster, but once again we needed a workbench to hold the analyzer, power amp and all, which probably weighed in at more than 60 pounds. Getting the analyzer out of the shipping case was really a two-person job.

This year, we invested in a new network analyzer, an Agilent E5061A (see Fig. 2). This unit is tiny and featherweight by comparison to the "boat anchor" we had been using. It also has a lot of features that make its use on an AM antenna system fast and easy.

As long as we ensure that the RF level at the measurement point is less than +20 dBm, we can connect the analyzer directly to the common point (or whatever) and leave the amplifier, directional couplers and all in the box.

Even in a relatively polluted RF environment (as you're prone to see in or close to the big city), you can narrow the IF bandwidth down enough to still get a meaningful display.

How did we ever get by without test equipment such as this? Sometimes I wonder. But we managed, and engineers all over the place still manage. In fact, some get very creative in their quest to make load measurements.

ON-AIR IMPEDANCE MEASUREMENTS

Steve Minshall, chief engineer of Clear Channel's Modesto, Calif., cluster came up with an innovative means of making real-time load measurements on an AM directional antenna system, without interrupting program audio or reducing power.

Steve simply bridged the output of an audio oscillator across the transmitter's audio input through a pad and connected a spectrum analyzer to the external detector port on the phasor's common point bridge (CPB). Then he was able to inject very low levels of audio from the oscillator at the frequencies of interest (5 kHz, 10 kHz, 15 kHz, etc.), observing the spectrum analyzer to observe the null of the frequency of interest as he adjusted the R and X dials on the CPB (see Figs. 3 and 4).

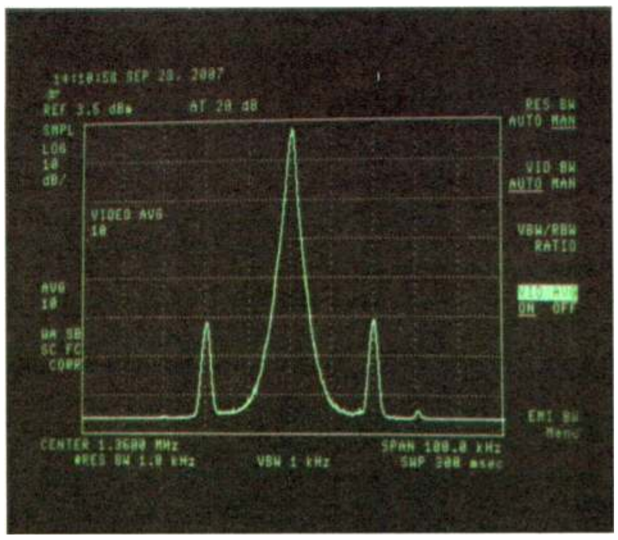

Fig. 3: Spectrum analyzer display showing 20 kHz sidebands at –50 dBc.

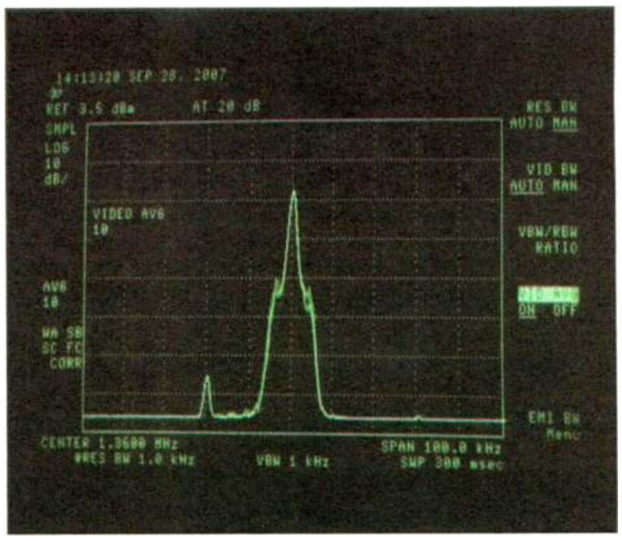

Fig. 4: Display showing upper 20 kHz sideband nulled by CPB.

Notice in Fig. 4 that the upper 20 kHz signal has been nulled out. Once that is done, it's just a matter of reading the R and X dials to get the Z at the frequency of interest.

Last year at the NAB Show, I had some discussions with transmitter design engineers about the need for real-time load analysis on digital (HD-R) transmitters. Load orientation is critical on many antennas, particularly those with high +/- 15 kHz sideband VSWR values. It has been my experience that while such antennas do not meet the load spec for HD-R operation, many can still be made to work provided that the load orientation is right, and I mean dead-on.

But normal adjustments following environmental changes —wet to dry, frozen ground to thawed, etc. — often move the load orientation by a few degrees and wreck HD-R performance. We need a way to check and adjust it on a regular basis without shutting the station down and getting all the test equipment out. Steve's novel idea will work, but it still involves a lot of work just connecting everything up, and you still have to manually plot the data on a Smith chart.

At least one transmitter manufacturer is now claiming that it can do real-time load analysis. I think we'll get a look at this at the spring NAB Show. Once we have that capability, if we also have a hot-adjustable line-stretcher network in or ahead of the phasor, maintaining peak digital transmitter performance will be a snap.

Until then, we have to use the tools and test equipment we have available to keep an eye on the load. Actually rotating the load to a new orientation, even with a cool new Agilent network analyzer, can be a time-consuming process.

RERADIATION

The bane of any AM directional antenna is reradiation. It can come from nearby radio towers, electrical transmission towers, water towers, monopoles, cranes … you name it. If it's metallic, if it has a large aperture or height, and if it's in the high-energy part of the pattern, such a structure can receive and reradiate as a point source of RF energy from the main antenna and thus become, in effect, another array element, one over which we have no control.

Over the years, I've spent a lot of time dealing with reradiation problems. When we think about reradiation, we usually think "cellphone tower," and sometimes this is the case. But the reality is that cellphone licensees have to comply with some fairly specific rules regarding AM directional (and non-directional) sites.

Most such licensees are diligent about compliance with these rules because the liability is so high for non-compliance. It's simply not worth it to cut corners.

But cell tower or not, from time to time we do find ourselves faced with a sudden increase in field strength at one or more monitor points. The FCC rules require us to reduce power to maintain monitor points at or below the licensed maximums and if we can't fix the problem right away to notify the FCC and get a Special Temporary Authorization (STA) to operate with parameters at variance. So when we find one or more high MPs, the pressure is on to figure out what the problem is.

I have run headlong into reradiation issues in a couple of locations of late, and in helping our market chief engineers identify and deal with their specific problems, it occurred to me that I should perhaps share some thoughts in these pages.

Rule #1: If the energy isn't there, the structure can't reradiate.

I learned this early in my career. The "wisdom" that I had been presented with was that a new tower or metallic structure over in a null area would "wreck the pattern." Not so. Reradiation includes by definition the receiving of radiated energy by a metallic structure.

If the incident field is low, the amount of energy available for reradiation also is low. A structure near a monitor point can disturb the field around the point itself and as such should be considered, but seldom do such null-area structures reradiate sufficiently to disturb the far-field pattern.

Rule #2: If a structure contains detuning apparatus (skirt and detuning components), that doesn't mean it's detuned.

SEE DAY IN THE LIFE, PAGE 20

READER'S FORUM

THE LUCK OF THE DRAW

Guy: IBOC is dead. We are still talking about getting radios into cars more than five years into the process. Five years into AM stereo the receivers were showing up as standard equipment for the higher-end models of common cars.

Denigrating the stations protesting AM IBOC interference as shoe-horned rimshots reflects your big-city, big-group biases. There is real interference, inside protected interference free contours of licensed stations.

The WYSL case will probably be another loss for the commission once it goes to federal court. Once Bob Savage has established enough of a record that the FCC is going to stonewall on the interference issue, he'll argue to a federal judge that the commission is deliberately ignoring its own rules. My business partner once worked with him in Pittsburgh; his memory is that he is either an attorney, or his brother is. So they have this planned out.

FM IBOC is not catching fire either. There's little discernible difference between main and digital channel in audio quality. Second channels are of little value to many operators that can't fill the six or seven main channels they already own. And then there are the receivers that don't exist in any significant numbers.

Now to FM translators for AMs: Makes more sense to use 76 to 88 MHz for FM services for AMs (and perhaps new LPFMs) but that is politically impossible and way too creative for this commission to consider. In most areas, there's no place to put new translators for AM stations unless they can displace other translators in use for out-of market signals. Even then, the FM band in most areas is still too crowded.

There are rural and small-market AMs that will be able to find a translator frequency, and these translators will be very useful. It's unlikely that AM stations will be allowed to convert these secondary translators into full-service stations. Here in the east, translators are, for the most part, limited to 250 watts at 200 feet maximum. Often less, as they have a contour limitation based on 12 separately calculated radials. Most AM stations have better daytime coverage than that.

Tom Taggart
Marietta, Ohio

GW replies:

First, let's get my text quoted accurately. I indicated that both unlucky stations and rim-shooters will suffer from adjacent-channel AM IBOC interference. It's the luck of the draw on who will be the unlucky ones. Many are most certainly not rim-shooters but will suffer right along with them. Some are getting hit already. I have very deep small-market station roots, and have great empathy for all of them still trying to serve their communities of license with quality local programming. No bias to the big boys whatsoever.

WYSL(AM) is by all measure a rim-shooter trying to serve nearby Rochester from Avon, a suburban community of license. Even the casual observer can easily see it was shoehorned in to be able to do that with the major lobe of each of their DA-3 patterns aimed due north. It does seem reasonable that WYSL's NIF and critical hours protected contours have been compromised. But I am hearing that some of the measuring techniques and methods used by Bob Savage in his FCC showings of demonstrated interference by WBZ may have been flawed or at least problematic. We shall see what the FCC decides in this case.

FM translators for AM primaries able to establish operations at decent HAATs should cover smaller population areas quite well and be preferred over AM. Those are the ones that will be candidates for eventually turning off the AM channel and converting the translator to a full-time Class D where allocations permit. Admittedly, most of those will not be in congested areas like yours.

Comparing HD to AM stereo and calling HD's acceptance already failed is much too premature. A more appropriate comparison would be the evolution of FM stereo with HD. Five years since the introduction of HD Radios is miniscule compared to how long it took FM stereo to become adopted, implemented and declared successful. Reread the Book of Job and have some patience, my friend.

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Day in the Life

CONTINUED FROM PAGE 18

Tower owners don't detune their towers unless they have to; so that skirt was originally put up for a reason and presumably the detuning network was at that time properly adjusted. But virtually any change on the tower can and will upset the detuning: the addition of antennas/transmission lines, relocation or replacement of antennas or lines, even tower painting.

In this day of copper theft, the removal of the ground lead at the tower base is a likely suspect when a tower that is supposed to be detuned starts reradiating. Such towers should be high on the list of suspects when a reradiation problem crops up.

Rule #3: You can't gauge the effect of a reradiator on the pattern without making radial field strength measurements on the pattern.

One or two high MPs do not a wrecked pattern make. You've got to run at least eight points per monitored radial to get a handle on the effect. In many cases, the MPs, which are usually close to the array, are the only points affected; the ratios at the other points are fine. In such cases, the easiest solution is often to simply move the affected MP to the next point out on the radial.

So assuming that you have one or more high MPs, and radial measurements do indicate that the affected radials are indeed high, how can you tell whether a particular structure is reradiating? That's a question without a simple answer. The sure way to know is to do a set of arc measurements on the tower. See the diagram in Fig. 5.

On paper, the procedure is simple. Lay out a direct line between the ND tower in the directional array (or the center of the array) and the suspected reradiator. Bisect that line and from the mid-point, draw an arc with a radius of half the distance between the sites. Plot an arc beginning at the suspected reradiator and ending at a point perpendicular to the line between the sites.

Measure the field strength at points along that arc from as close to the suspected reradiator as you can get an on-scale indication to the perpendicular point, ensuring that the FIM antenna is always oriented toward the reradiator (and perpendicular to the directional array).

When I do this, I like to put the directional array in the ND mode if possible. That gives a point-source of radiation (as opposed to several sources, one from each tower in the array), making it harder to get a null back toward the array. If the directional array is close-spaced or if the suspected reradiator is some distance from the array, this becomes less of a factor.

The FIM antenna has a tight null exactly perpendicular to its plane, so we can use this property to essentially eliminate the radiated field from the AM antenna while maximizing it from the reradiator. Note in Fig. 5 that each measurement point around the arc is the apex of a 90-degree angle with one side toward the ND antenna and the other toward the reradiator.

One method for ensuring you have the FIM properly oriented is to use the electrostatic break at the top of the loop antenna like a gun sight, and make certain it is pointed directly at the ND radiator. Using a tripod during such measurements takes the "wiggle factor" out of the equation.

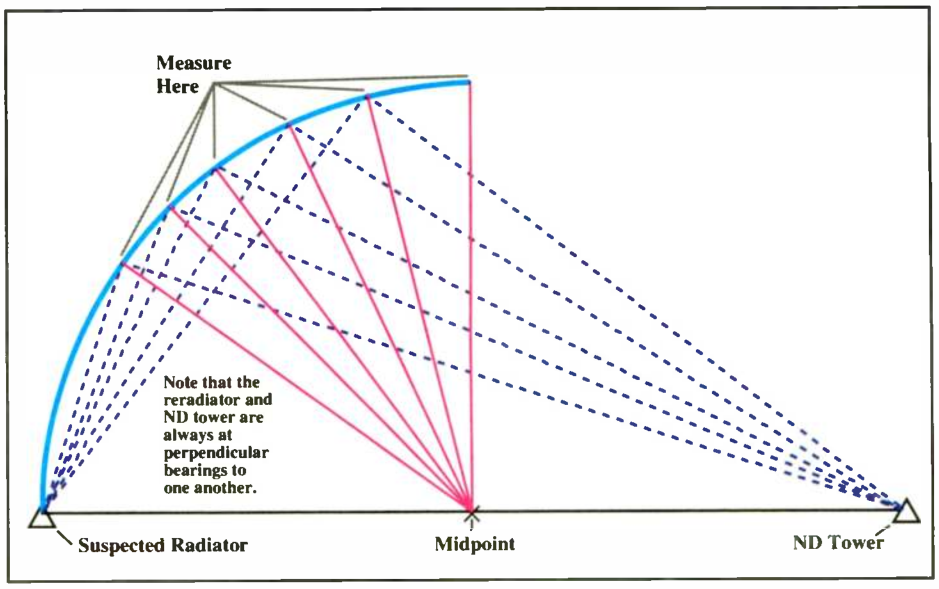

Fig. 5: Arc measurement can be made to determine reradiation.

Use a GPS to note the distance to the reradiator for each measurement. Plot the measurements on a piece of log-log paper and graphically analyze for the inverse distance field (IDF).

Once you have the known IDF of the reradiator, if you made the measurements with the array in the ND mode, ratio the measured IDF up for the directional incident field to determine what the likely reradiation is in the directional mode.

Generally speaking, if it's more than 10 percent of the standard pattern IDF in the deepest null, the potential is there for pattern distortion. That's when you have to go to the tower owner, measurement data in hand, and make your case for detuning.

It's in situations like these that radio engineers earn their stripes. It's really a scientific process: measurement, analysis, hypothesis, applied solution, re-measurement … But in the end, that's what we are, isn't it? Scientists of a sort, applying proper scientific procedures to the problems we are faced with. Think about that the next time you find your monitor points high.

Cris Alexander is director of engineering, Crawford Broadcasting Co., Denver. ■

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by Dave Moulton

Seven Principles of Production Room Design

Let's discuss how loudspeakers work in control rooms. This is where audio meets architecture. It's a confusing place, and there's a lot — an awful lot — of bushwa about this space and its behaviors. Much of said bushwa is an embarrassment.

At the same time, the people who design and build rooms, architects, are generally limited in their acoustical sensibilities. To give you an idea, I have a perfectly serious and respectable college-level acoustics textbook in my library entitled "Deaf Architects and Blind Acousticians." Be very afraid.

ACOUSTICAL ISSUES

Anyway, wearing my "blind acoustician" hat, I figure there are at least seven issues we need to deal with in any respectable control room. Taken individually, they aren't all that hard to deal with if you've got a decent budget, even if in aggregate they make us a little tired (and poor).

They are, in no particular order: noise floor, room symmetry, early sound reflections, decay time in the room, the room's standing waves, loudspeaker placement and loudspeaker behavior. Let me quickly touch on each.

Noise Floor — First off, we've got to get the noise floor down. Our maximum listening levels will peak out, in a calibrated room, at a little more than 100 dBC SPL.

To have a meaningful 60 dB dynamic range, which I have previously suggested is a common-sense and conservative minimum range for any kind of high-definition audio work, we need a control room noise floor of 40 dBA SPL with all equipment and air-handling on. That isn't particularly easy to do. It's a matter of some careful housekeeping, good air-handling, decent doors and windows (and their installation) and careful management of cooling fans.

Room symmetry — Room symmetry is important, though often ignored when adapting spaces to be control rooms. For reasons related to maintenance of the median plane, having a room with lateral symmetry in walls, doors, room treatments, etc., really helps. When we have such a room, of course, we want to install our loudspeakers symmetrically as well, so the room and the loudspeaker median planes are the same plane.

It makes a big difference. Trust me.

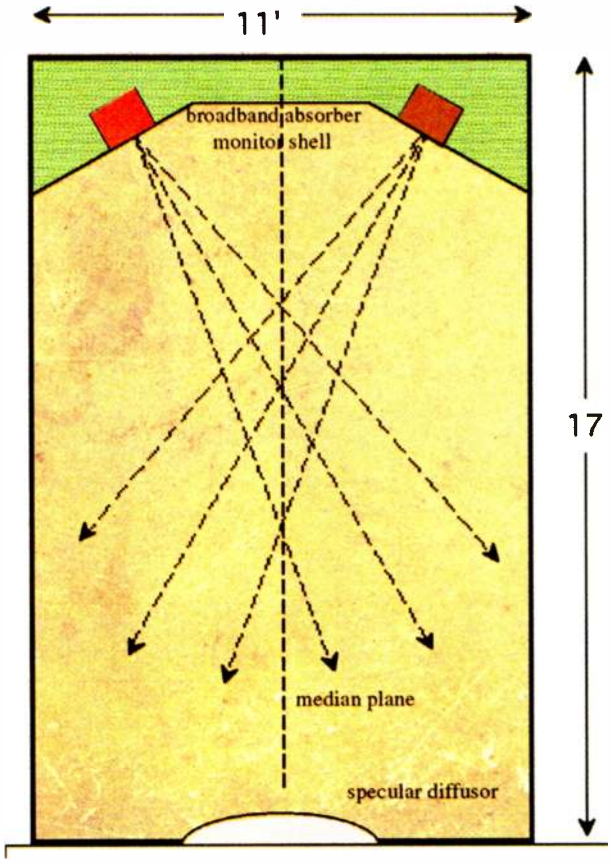


Fig. 1: An idealized Moulton Room. The dimensions assume an 8 foot ceiling. These dimensions are not critical — mainly, we need to avoid dimensions that are multiples of each other.

Early reflections — Early sound reflections are those that emit from the loudspeakers, reflect off walls and reach the listener(s) within 40 ms after the direct sound from loudspeaker to listener.

Their function is not well understood, but after much research, my take is that lateral early reflections need to be maintained and vertical ones suppressed through absorption. To the extent possible, this includes both high and low frequencies (down to at least 100 Hz). To follow, see my infamous Moulton Room.

Decay Time — Decay time refers to the amount of time it takes for sound to die away (by 60 dB, for instance) in a room. This is a function of the amount of absorption in the room, expressed in an arcane unit called "Sabins." We need the decay time to be short (less than 150 ms) and approximately equal at all frequencies. See the Moulton Room.

Standing Waves — All reverberant enclosed spaces have "standing waves," which are resonant frequencies occurring as a function of room dimensions. To the extent possible, they need to be suppressed, as they impose a "tonal sonic signature" on the room at low frequencies that degrades the recorded verisimilitude. Again, see the Moulton Room.

Loudspeaker placement — Let me reiterate: Loudspeakers should, if at all possible, be placed symmetrically (+/- 1 inch) in the room, and should share the same median plane that the room has. In the case of surround sound, the speakers' outputs should arrive at the listening sweet spot at the same time (+/- 0.1 ms).

Loudspeaker performance — Loudspeakers need to each play loud enough to comfortably generate 100 dBC SPL at the listening position, with smooth and reasonably flat frequency response from no higher than 60 Hz (40 Hz is better) to 17 kHz. Wide horizontal dispersion and limited vertical dispersion at high frequencies are good, very good. Subwoofers are a separate topic, worthy of their own column.

THE MOULTON ROOM

Some years ago, when I was describing my approach to control room design, I humorously referred to the design topology as a "Moulton Room."

Curiously, the name has stuck and I both occasionally find the Moulton Room cited in acoustics papers and also receive requests from people to design Moulton Rooms for them.

Happily, the topology is simple and comparatively inexpensive. Why, you can do it yourself, in your own home! You don't even have to hire me (a real blessing).

A reasonably well-done Moulton Room will take care of the room symmetry issues, early reflections, decay times, standing waves and speaker locations. Five out of seven ain't bad. You are still responsible for the loudspeakers (however, I can spec some really glorious ones), and the noise floor.

Take a look at Fig. 1.

The basic principle here is that the front wall should absorb all energy from the loudspeakers after one propagation through the room, which should take about 40 ms. In addition, high-frequency reflections off the floor and ceiling should be suppressed. The monitor shell is more complex than shown, but I can send a more detailed drawing to you if you are curious.

The Moulton Room will work well with 5.1 or 7.1 surround sound. The monitor shell can easily accommodate a video monitor and a center speaker. For surround, just place rear channels symmetrically, toward the back and behind the sweet spot. The specular diffuser at the rear scatters high frequencies laterally to enhance envelopment, and is constructed to absorb low frequencies.

Not shown, the ceiling should be absorbent at high frequencies, and there should be a carpet on the floor.

The point is, construction of such a room is fairly simple and inexpensive — definitely not rocket science. The sonic results are surprisingly good, and productions done in such rooms travel well to most end-user environments.

WHAT DOES IT ALL MEAN?

Humans, and our loudspeakers, live in smallish rooms. That's where we do the bulk of our listening. A simple, straightforward representation of such rooms, with appropriate attention paid to some acoustic and psychoacoustic details, can yield an extremely effective production environment that allows us to listen ahead to end-users' rooms very effectively. Go for it!

And thanks for listening.

Dave Moulton writes for Radio World's sister publication TV Technology. Complain to him about anything at his Web site, www.moultonlabs.com. ■

MARKETPLACE

RME Ships DMC-842 Digital Microphone Controller

RME is shipping its DMC-842 multi-channel digital microphone controller. The unit is both an eight-channel AES42 interface as well as a controller for digital microphones.

One of the best features of the DMC-842, according to the company, is its price. The device makes the use of digital microphones affordable, as its price is within the same range as conventional microphone preamp/converter solutions.

In addition to its role as an interface, the DMC-842 acts as a power supply and control device for digital microphones according to the official AES42 standard.

Mode 1 and Mode 2, as specified in the AES42 standard, are currently supported by Neumann, Sennheiser and Schoeps, among others. Mode 1 permits asynchronous operation. Working with several Mode 1 microphones requires the use of SRCs (sample rate converters), which are built into the DMC-842.

Mode 2 allows microphones to be synchronized. In both modes control data for adjusting gain, polar patterns, hi-pass filter and compression settings can be sent to the microphones. Further functions are specified in the AES42 standard and availability depends on the individual microphone.

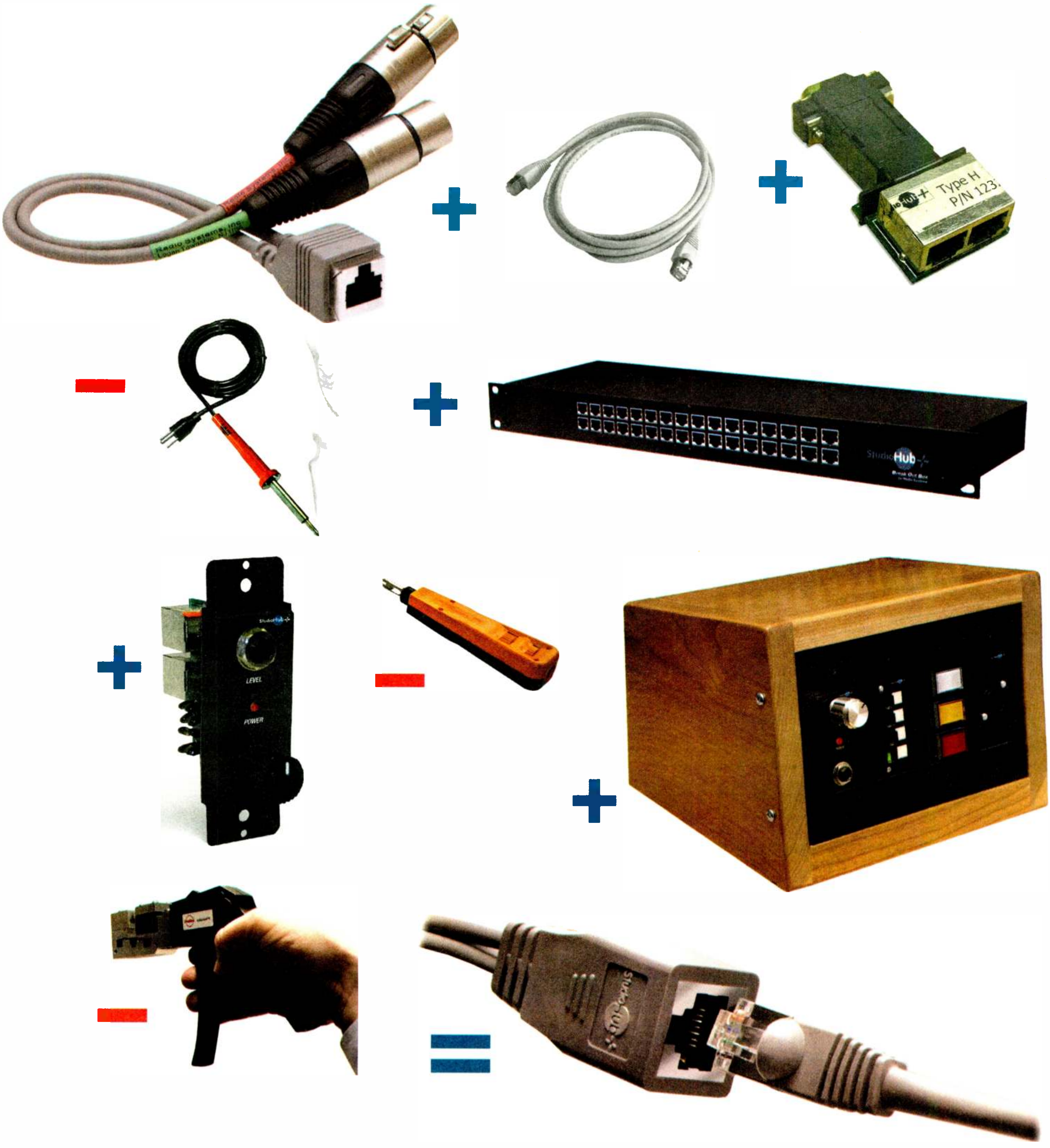
The DMC-842 is a suitable companion to RME's Micstasy. Using the same interface connections as the Micstasy (ADAT, AES/EBU, MADI and other optional formats) it eases assembly of combined systems for both analog and digital microphones. The DMC-842 also offers analog line-level outputs.

The DMC-842 can handle standard AES/EBU signals at the same time as the Digital Phantom Power is switched on or off for individual channels. SRCs allow these signals to be asynchronous as well.

To adjust the various microphone parameters, RME includes a Windows-based software application that communicates with the DMC-842 via MIDI. As with Micstasy, the DMC-842 also supports the transfer of MIDI data over MADI as well as over AES/EBU signals. Main microphone parameters also are accessible on the unit.

The DMC-842 retails for $3,999.

For more information, contact RME's U.S. distributor Synthax at (330) 259-0308 or visit www.rme-audio.com.



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GUY WIRE

Ouch! Radio Hunkers Down

Industry Simultaneously Faces Many Challenges and Declining Revenues

Station employees everywhere know these are tough times for radio. While the Bush administration and many economists have been avoiding discussion of recession in the general economy, it is clear our industry stumbled into it headfirst last December. Shrinking revenues and rapidly falling profits have most radio owners and managers scrambling to shore up their operations.

Many stations have been unable to dodge the falling ax of staff layoffs, contract buy-outs, terminated contracts and restructuring. January and February were especially brutal. Five percent of the entire work force at Emmis and 2 percent of Citadel's were sent packing. Many of our close friends and associates are suddenly gone, expunged from the payroll, the company e-mail and the LAN. Hiring freezes are still in place in many companies while positions that were vacated through attrition remain unfilled.

CHANGING CYCLES

I've been around long enough to see a falling business cycle play out at least four times. Starting in the 1970s we had the Arab oil embargoes and long lines at gas stations. Then in the early '80s we got slammed with high stagflation and 21 percent interest rates. The early 1990s brought the Gulf War and another oil-induced recession. Finally, we all remember the dot-com bust and 9/11.

Dredging up memories of bad times is never much fun. But it can be instructive and enlightening.

Usually station engineers are exempt when recessions hit; it is other staffers who get pink slips. Traditionally, most of us can do a lot of things valuable to a station's well being that others can't. But since consolidation, if you're the new kid on the staff with fewer skills, or an engineer who is perceived by management as "expendable" or "too expensive" for the return on investment, you've found yourself looking for a new gig.

We've seen capable engineers with years of experience and proud contributions to their owners' bottom lines join the ranks of the unemployed. You know who you are.

And we've seen tons of examples in smaller and medium markets where full-time engineers were rolled out in favor of cheaper contractor or part-time engineering support arrangements. Not having to pay benefits unfortunately always saves the employers big money.

EXPAND YOUR SKILL SET

Surviving these downturns has become almost a ritual for many in our industry.

The message for all of us is that diversifying one's professional job skills can help a lot and usually will pay big dividends. Multi-tasking and taking on more responsibility have almost always been invaluable insurance against layoff.

DJs have learned how to sell or become production specialists. Some jocks have acquired computer, Web-support or engineering skills. Account executives learned how to write copy or voice commercials. The better AEs advanced more quickly into management positions.

Traditional radio engineers who embraced the PC revolution became network admins. Others learned HTML, Flash and Java and became station Webmasters. Some pulled board shifts and did production. Some even became part-time AEs.

If you were a hard worker and willing to learn new tricks, you survived and probably even thrived. If you liked working with people and enjoyed the hustle, you may have even become a general manager.

The bottom line for anybody who wants to stay in this business and do well: Think and act like a successful GM. That means keeping the big picture in clear focus, and executing your specific job in a way that best supports the end product.

For radio, the product is content, whether it is entertainment, information or any other fulfilling and engaging personal experience with our medium. I have yet to see any employee who excelled at that get fired or laid off during tough times.

TERRIBLE TIMING

The current cycle of retrenchment couldn't come at a worse time as increased competitive pressure from new digital media alternatives continues to cut into radio's share of the audience and the money pie.

Wall Streeters and new media pundits have been dissing radio for quite a while. It's painful to watch as satellite radio and the Internet get all the attention. For many, the HD rollout seems too little, too late and too flawed.

Everyone who has a stake in our proud industry is beginning to wonder: Is this recession going to be relatively short-lived, and will we spring back to exuberant life as we always have in the past … or, perish the thought, has a big meteor just struck and we've become mass media dinosaurs destined to relatively quick extinction?

Owners and managers have been wringing their hands for some time, wondering how best to "leverage their digital assets" to more effectively compete with the new media. The onset of recession and the need to cut staff and reduce expenses makes this challenge much more difficult than if times were good.

This time around, radio cannot afford to ignore the need to press on and develop new initiatives to bolster and save the business. It's not just about hanging onto our existing audience share, which by all measures is aging. Radio's slow but steady erosion has been most pronounced in the younger demos. The theory is that if the high school and college crowds grow up with little interest or regard for radio, they won't use it as they grow older. Whether that fear will play out in reality is debatable, but it's scaring the hell out of a lot of radio people.

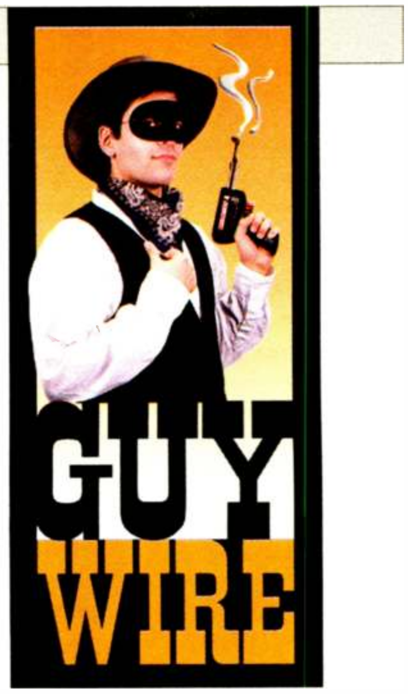
Radio World and industry trade journals that concentrate on the sales and business side of radio are filled with news and stories about the "digital challenge" in every issue. Radio Ink Publisher B. Eric Rhoads is holding seminars for managers and owners on how to "harness the digital engine" to be able to grow, if not save the radio business moving forward. Probably not enough engineers are paying close attention to the ongoing debate and the conundrum radio is facing.

Rhoads is an eternal optimist about radio and sees an even brighter future, if we get our brains and arms around making radio a significant player on the new media platforms.

Take notice, engineers: A big part of doing this successfully involves understanding and implementing the underlying technologies. It's more than obvious to me that this is where the best and most exciting opportunities lie for the next generation of radio engineers.

THE LEARNING NEVER STOPS

We all realize that the radio technology of today and tomorrow is very much integrated with that of personal computing, networking and the Internet.



If you are still working as a station engineer but have not yet fully embraced this reality and are not learning all you can about PCs and IP, your continued employment status could be in jeopardy.

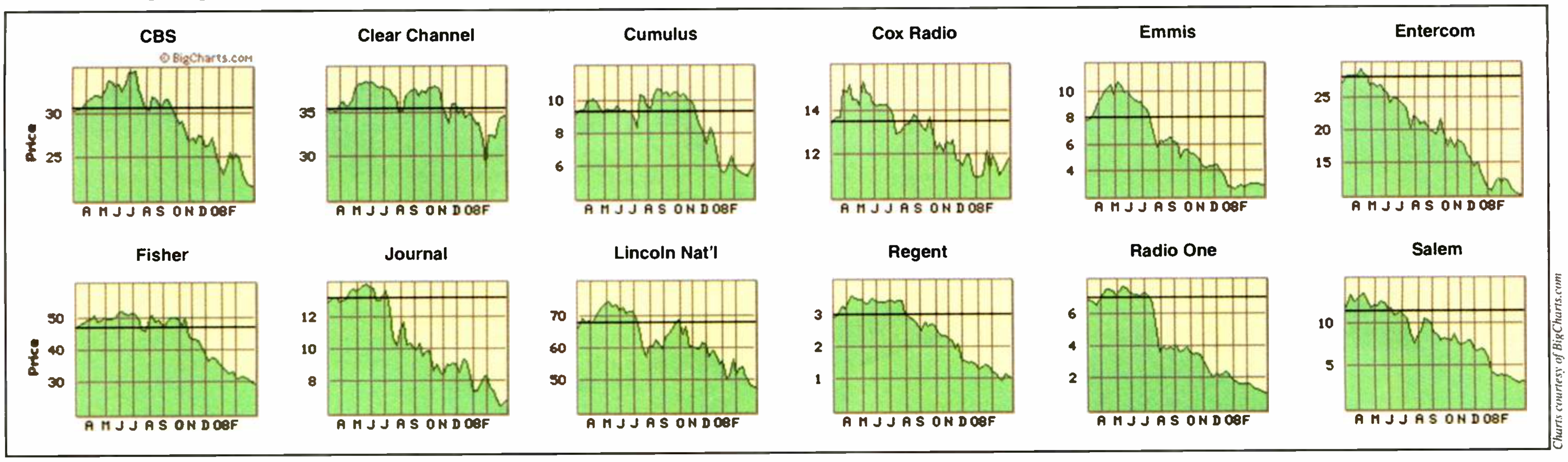
But it won't stop there. Radio's new strategy to survive and stay relevant includes pushing farther into the Internet streaming space. If all you've had to worry about so far is setting up a PC to run your station's program audio stream to hit the Internet, a lot more excitement is on the way.

Special event video podcasts have become regular features on many radio station Web sites. Video cameras, lighting equipment, green screens and editing software are now required tools in most successful radio station promotions and Web departments.

The most significant innovation for radio is video streaming. Fully produced live in-studio video streams of entire shows are now playing on station Web sites in a number of major markets. And it's not just a single cheap Webcam fixed on the host. "Imus in the Morning" on MSNBC has come and gone from WFAN, but more video exposure of popular live radio shows is poised to accelerate the attraction of radio's Internet presence.

Station engineers who ramp themselves up on the new media learning curves to be able to install, maintain and optimize these additions to radio's technology arsenal will be in demand. They will insure themselves a favored place in the structure and the look and feel of radio's evolving future, no matter how or where the listeners and the viewers tap in.

SEE GUY WIRE, PAGE 26



A collection of past one-year stock price performance graphs from publicly traded radio companies.

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by Jeff Detweiler

HD-R Benefits Push IBOC Forward

Jeff Detweiler is director of broadcast business development for Ibiquity Digital Corp.

Enhanced performance, increased reliability, flexibility and cost-effectiveness are the principal motivations for any industry to want to transition from analog to digital technology.

Radio is possibly the last news and entertainment medium that still operates mostly in the analog domain. The music, cellular telephone, television and video recording industries already have begun or have completed their transition to digital technologies.

However, for the radio industry in many countries, sufficient spectrum does not exist to accommodate the transition of radio from analog to digital.

The HD Radio system operates within the existing amplitude modulation (AM) and frequency modulation (FM) bands, and operates at the existing radio frequencies (in-band) while making use of existing broadcaster analog channel assignments (on-channel).

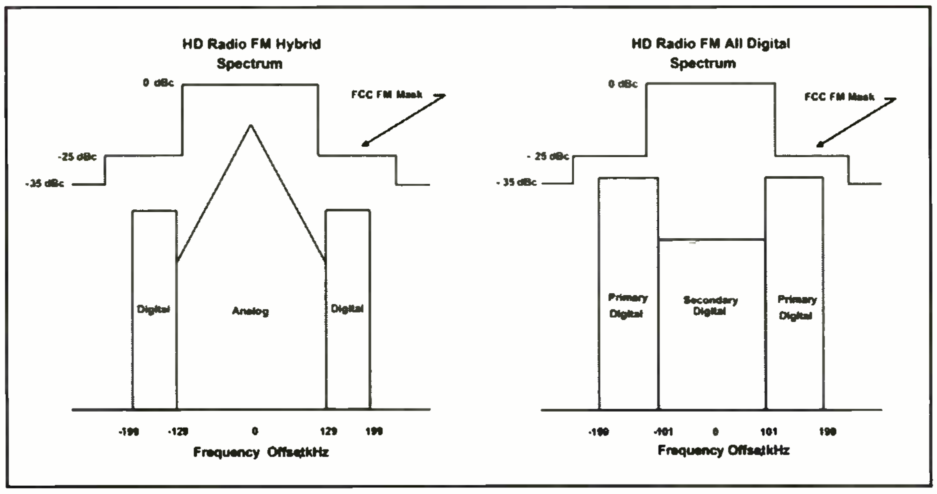

Fig. 1a: HD Radio Hybrid and All-Digital FM Spectrum

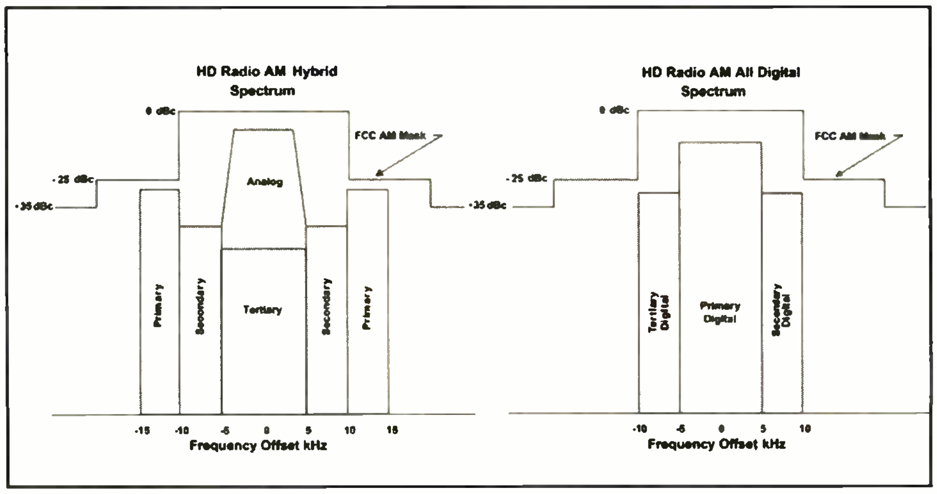

Fig. 1b: HD Radio Hybrid and All-Digital AM Spectrum

TWO MODES

HD Radio technology allows broadcasters to add digital signals to their existing analog broadcasts. Two modes define the transmission of audio and data: "hybrid" and "all digital." The hybrid mode includes both the existing analog and the new digital services. A broadcaster using this transmission mode still permits the continued operation of the billions of existing analog-only radios.

In the future, when the market is fully capable of receiving an HD Radio digital signal, broadcasters can switch to the all-digital mode. Hybrid receivers employing HD Radio technology are backward- and forward-compatible, allowing them to receive current analog broadcasts in addition to digital broadcasts.

HD Radio technology was designed to provide broadcasters and consumers the opportunity to convert from analog to digital broadcasting without service disruption, while maintaining the current receiver dial position.

Additionally, consumers will have the capability to receive new multicast audio channels and wireless data services rendered on the display screens of the radio. Program service data (PSD), such as artist, title, program content, news, sports, local traffic and weather, are available today.

HD Radio technology in conjunction with a new iPod-docking HD Radio receiver will make it easier for consumers to buy songs they hear on the radio from the Apple iTunes download store. Other features planned for HD Radio technology include store and replay, an electronic program guide and conditional access capability.

The FCC has fully adopted HD Radio technology as the only digital standard for both the AM and FM bands in the United States. HD Radio technology is intended for worldwide adoption.

The International Telecommunication Union has adopted Recommendation ITU-R-BS.1514, which endorses Ibiquity AM IBOC technology as a standard for digital broadcasting in the bands below 30 MHz.

The ITU also has developed a preliminary draft recommendation endorsing the Ibiquity FM IBOC system — referred to by the ITU as "Digital System C" — as a standard for digital broadcasting above 30 MHz. A draft revision to Recommendation ITU-R-BS.1114-2 adds Digital System C as an approved digital system.

HD RADIO OVERVIEW

In the hybrid mode, where both the analog and digital signals coexist, upper and lower low-level digital sidebands are added to the analog spectrum. (See Fig. 1a for FM and Fig. 1b for AM.) These carriers are modulated with redundant information to convey digital audio and data. As the analog AM signal is amplitude modulated, a quadrature phase component can carry digital information.

Thus its placement is possible directly beneath or in quadrature to the analog modulation. (See Fig. 2b.) This additional information transmits at a lower power level to avoid increasing noise to the analog signal.

In the FM all-digital mode (Fig. 1a) the analog signal is removed and additional data carriers are added. The main channel stereo audio and its associated data information remain unchanged from the hybrid mode. However, it is possible to increase the power level to provide a more robust service.

HD Radio technology utilizes digital signaling techniques, including quadrature phase-shift keying (QPSK) modulation with orthogonal frequency division multiplexing (OFDM), interleaving, channel coding/error correction, time diversity and frequency diversity.

The audio codec branded HDC is specifically designed to reduce the number of bits required to transmit a given quality audio signal. HDC for FM compresses the audio at a ratio of 15:1 enabling 96 kbps to deliver CD-like quality audio. The AM codec delivers FM-like audio quality with a compression ratio of approximately 40:1.

HD Radio technology employs OFDM to impress the data onto the RF channel (see

SEE HD RADIO, PAGE 28

Guy Wire

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LIVE AND LOCAL RULES

Beyond figuring out the best ways of handling digital assets, the larger question of how radio more effectively manages its traditional over-the-air programming services to stop the slow bleed of lost listeners presents a more urgent challenge.

Whenever I leave a brain-storming session where lots of interesting ideas get tossed around, we are consistently left with only one that really matters: Radio can only survive and thrive if it super-serves the local audience, no matter what the format.

The lion's share of content competition against radio coming from other new media is national or generic, with little or no local focus. The notable exceptions might be cellphone texting plus Internet chat and IMing amongst local friends. And you'd have to include Googling to find the closest movie house or hot new restaurant.

Virtually everything else is homogenized for consumption anywhere. Local communities and their surrounding commerce market areas still matter in America. The sense of attachment and belonging by the local citizens goes much deeper than just wondering about weather and traffic conditions.

Local service is the one basic ingredient of radio's success over its long and storied history that remains its core strength. Those stations that have cut back local service commitments and switched to automated national satellite formats may have saved some operating expense, but in the end they usually lose much more.

The list of call letters falling into that category is too long and is undoubtedly at the root of our industry's malaise. Giving up on "live and local" guarantees most stations a down or out position in the ratings.

Look at stations that have maintained high ratings and success in their respective markets and you will find practically all of them work very hard to maintain a high level of support for matters of local interest.

That's a given for news/talk stations but even for many music formats, this usually includes coverage of local news, local public affairs and politics, local weather and traffic reports, local team sports, local school events, county fairs, local concerts and shows, and almost any significant human interest activity occurring in and around their service area.

It's painful to watch as satellite radio and the Internet get all the attention.

The one arena that radio has traditionally not supported well is local music. Mass appeal formats have never found enough room on their playlists to do this. So it's been left to AAA stations plus various NCE and LPFM outlets to provide at least some exposure for home-grown musical groups.

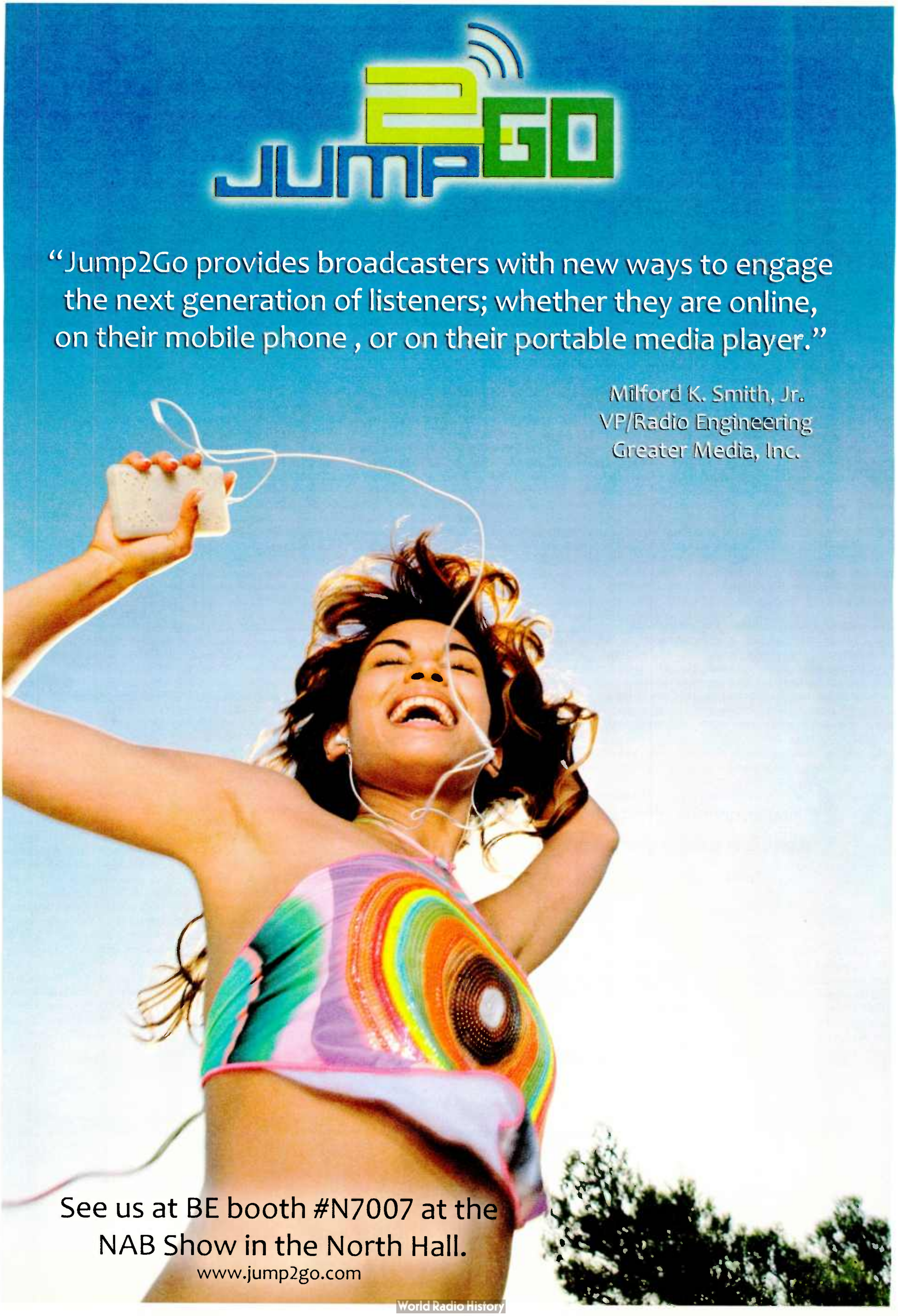
The more forward-thinking stations are already featuring live performance segments by up and coming local groups during regular programming. As HD rolls out more supplemental channels and more unique format offerings appear, we should see more stations showcase local musicians.

We will get through this recession, hopefully sooner rather than later. By the time you read this, around NAB convention time, staff cuts and expense reductions should be mostly behind us. A big contingent of engineers will be MIA at NAB this year, especially my many Clear Channel brothers.

Fewer people are now doing more of the work at most stations, and the workload is only increasing. All of the fat and much of the meat are gone. We're down to bone level. Yet many challenges still remain.

The pressure on radio to hold its legacy as a dominant resource for consumer infotainment will not diminish. Stations that have been successful will continue to succeed if they keep doing the things that have made radio special and have separated us from the other non-local media services.

Guy Wire is the pseudonym for a veteran broadcast engineer. ■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HD Radio

CONTINUED FROM PAGE 26

Fig. 1c). OFDM signaling employs multiple, overlapping, orthogonal subcarriers.

Trade-offs between throughput and robustness are possible with an increasing number of phase states and signal levels, leading to more throughputs with less robustness in fading channels. HD Radio technology for FM modulates its OFDM subcarriers with PSK modulation. OFDM signals modulated with low-complexity PSK are extremely robust in the presence of interference and multi-path fading.

HD Radio technology on AM operates in very narrow

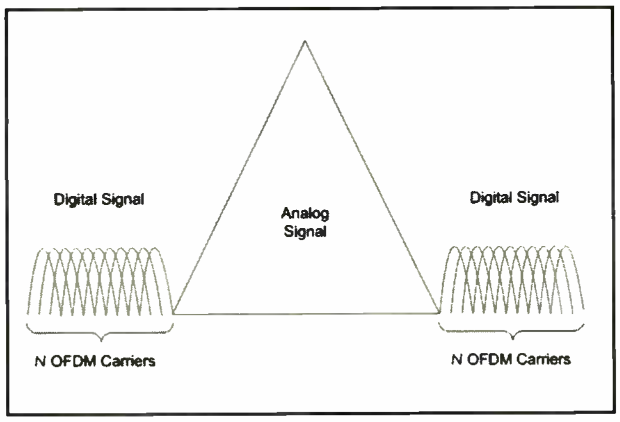

Fig. 1c: Example Depicting Multiple Overlapping OFDM Carriers

channels that are free of multi-path fading. The narrow bandwidth leads to an OFDM modulation technique optimized for higher throughput. HD Radio technology for AM uses quadrature amplitude modulation (QAM) on each subcarrier. In QAM systems, multiple phase and amplitude states are applied to each subcarrier in the OFDM waveform.

ADVANCED PROCESSING TECHNIQUES

HD Radio technology applies Pulse Nyquist root-raised-cosine tapering pulse shaping to its OFDM waveform. Pulse shaping aids in acquisition and relaxes frequency-tracking requirements while reducing spectral side lobes.

The root-raised-cosine function creates a guard band between the symbols, which improves inter-symbol interference by reducing energy in the region where subcarriers overlap.

The reduced side lobes result in less interference to adjacent channels, more robust performance in multipath conditions and less interference to the host analog signal.

Digital error correction techniques are more effective if errors in transmission are spread in a manner that minimizes data loss in successive bits.

Interleaving is a technique that scrambles the bits in a predetermined manner upon transmission and reassembles them in the receiver. Optimization of the length of the interleaver spreads errors over a longer period of time than would exist in a channel fade.

HD Radio technology makes use of convolutional punctured pair codes (CPPCs). CPPC techniques take advantage of the redundancies in the upper and lower sidebands by allowing combination of the error correction in these sidebands so as to create a more powerful error correction algorithm.

TIME DIVERSITY

An effective method for dealing with channel fading in a mobile environment is to provide a second channel conveying the same information. Transmitting the information on the second channel shifted in time can enhance the total system performance when the two channels are recombined at the receiver.

This technique is called "time diversity." HD Radio technology includes a time diverse backup channel in all AM and FM modes.

If the diversity delay is sufficiently large such that the transmission outages are independent, then the probability of an outage after diversity is the square of the probability of an outage without diversity.

For instance, if the probability of an outage in either channel is 1 percent, then the probability of outage after diversity is 0.01 percent, a significant improvement.

HD Radio technology takes advantage of time diversity by delaying backup transmissions by approximately 4 seconds and realigning the digital and analog signals in the receiver.

Transmission systems do not experience uniform fading across the channel bandwidth; frequency selective fading is common in both the AM and FM bands.

If transmission of the information takes place in two different parts of the spectrum and there is sufficient frequency separation between these transmissions, it is possible to mitigate the effects of a fading channel.

Digital error correction techniques are more effective if errors in transmission are spread in a manner that minimizes data loss in successive bits.

SIDEBAND DIVERSITY

HD Radio technology employs sideband diversity as a form of frequency diversity. The system transmits identical digital information on both the upper and lower sidebands.

The data in the upper and lower sidebands is identical. However, the CPPC error correction codes are different.

In the receiver, the sidebands undergo independent detection and decoding. There is additional coding and power gain when both sidebands are combined. HD Radio technology essentially carries the same audio information in two different parts of the spectrum.

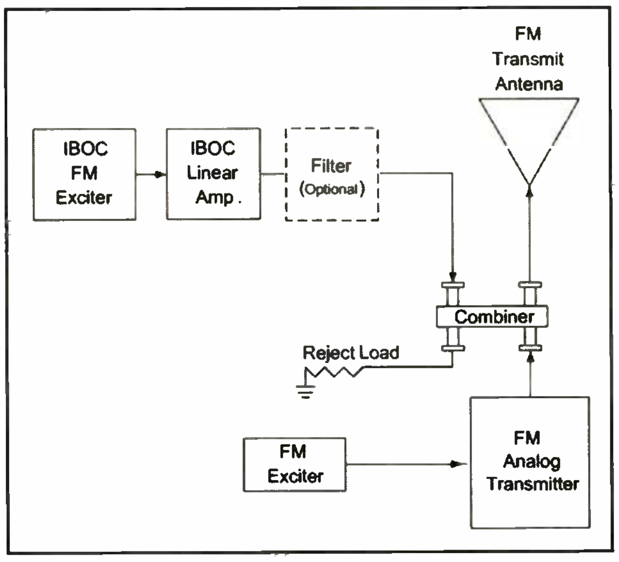

Fig. 2a: FM HD Radio High-Level, Separate Amplification

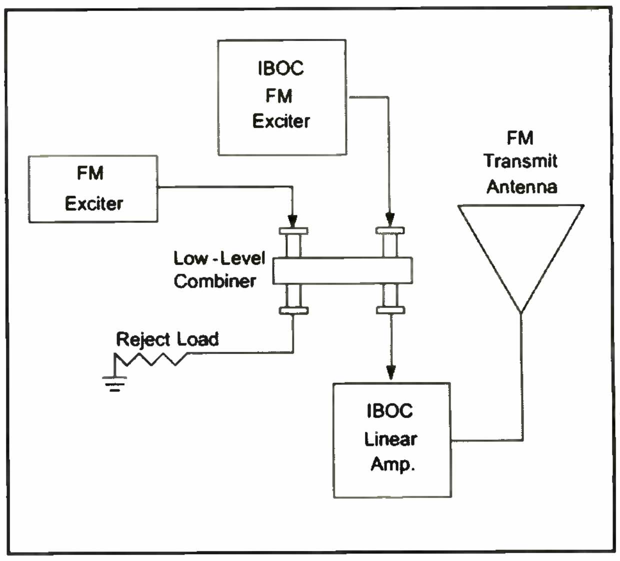

Fig. 2c: FM HD Radio Low-Level, Common Amplification

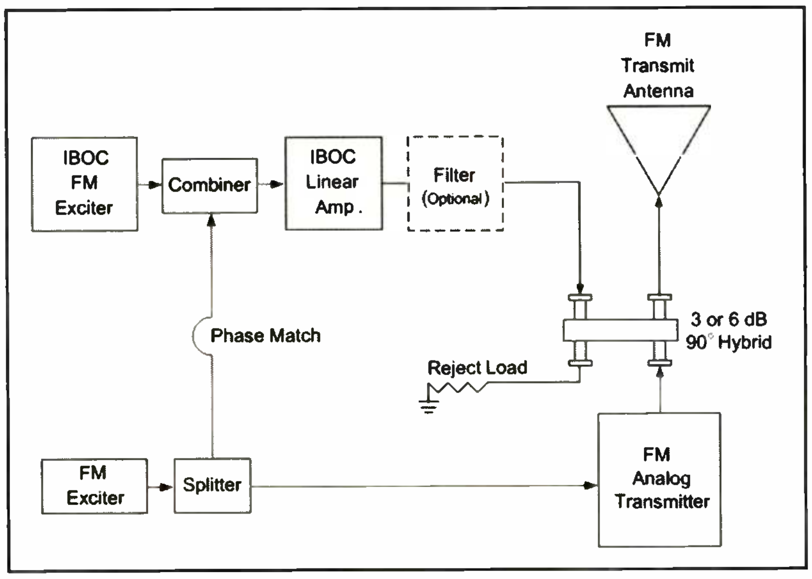

Fig. 2b: FM HD Radio Mid-level, Split Amplification

HD Radio signals operate at much lower power than the analog signals in the FM band. In many instances, the protected contour of an adjacent analog interferer is significantly higher in power than the digital sideband.

HD Radio technology employs a first-adjacent canceller (FAC) to mitigate the effects of first-adjacent channel analog interference. The FAC, which is simultaneously active in the upper and lower digital sidebands, tracks the instantaneous frequency of a first-adjacent channel analog interferer and nulls out its effect on the digital information.

ECONOMICAL IMPLEMENTATION

The cost of conversion to an HD Radio broadcasting system is reasonable and, in the majority of cases, very affordable, especially compared to the initial plant investment. It accomplishes this by minimizing any new infrastructure requirements and maximizing existing broadcaster investment.

Four methods exist for producing the HD Radio hybrid FM signal: high-level combining (separate amplification), mid-level combining (split amplification), low-level combining (common amplification) and a separate or dual-input antenna.

High-Level Combining: Initial station conversions utilized high-level combining or separate amplification. (See Fig. 2a.) With this method, the existing station transmitter had its output combined with the output of a separate digital transmitter compatible with HD Radio technology. The station then fed the resulting hybrid signal to the existing station antenna.

HD Radio FM high-level combining uses two transmitters to produce the transmitted signal. This approach requires the addition of an HD Radio digital transmitter and the associated combiner, filter and digital exciter.

Mid-Level Combining: A derivative of the high-level amplification technique is mid- or split amplification. (See Fig. 2b.) In this design, a traditional FM transmitter and a transmitter adjusted for amplification of both the analog and digital components share the burden of analog signal generation.

Low-Level Combining: Low-level combining or common amplification is depicted in Fig. 2c. This implementation involves the combination of the output of an analog FM exciter with the output of an HD Radio exciter.

The combined signal is fed to a common broadband linear amplifier to raise the power to the desired transmitter output. This method is both power and space efficient and reduces the number of independent elements in the broadcast chain.

Low-level combining utilizes a shared transmitter to amplify the HD Radio digital signal and the host analog signal. This commonality reduces the demand on equipment space and may reduce power demands by increasing overall efficiency.

See HD RADIO, page 35 ▶

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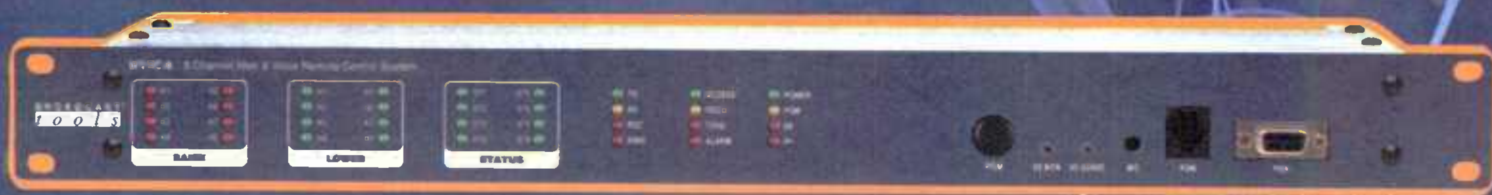

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by Michael LeClair

A Lifetime in Broadcast Equipment

Larry Cervon Talks About His Role in The Growth of the Modern Radio Industry

It was in 1977 that Broadcast Electronics made the decision to move the company to Quincy, Ill., and begin producing a full line of FM transmitters. Since that time BE has grown significantly — it now calls itself the largest radio-only broadcast equipment supplier — offering a line of products headed by AM and FM transmitters and the AudioVault digital storage and automation system.

Larry Cervon, then president of Broadcast Electronics, was the man behind that notable move. Cervon had taken the helm in 1976, at a time when the company's product line consisted of audio consoles and tape cartridge machines.

Cervon was born in 1922 on the island of Brac, seven miles off the Dalmation coast of Croatia, then Yugoslavia; he came to New York with his family at the age of 6. He was attending college at the tuition-free College of the City of New York when World War II began.

During the war, Cervon enlisted in the United States Navy, where he joined the Capt. Eddy Electronic Technician Program, an intensive training course in electronics to support the burgeoning military use of radar. After completing the 10-month course he served on the U.S.S. Amphitrite until the end of the conflict.

In November 1945, Cervon was looking for work, having left the Navy. He joined RCA International as a sales trainee in the Broadcast Equipment section, commencing his long career in the field, and eventually moved into sales for Gates Radio, where he worked for almost three decades before going to BE.

Retired in 1991, Cervon now lives in Florida. That year he received an achievement award from the National Association of Broadcasters "in grateful recognition and appreciation for 45 years of vision and leadership in the development of high-technology broadcasting equipment."

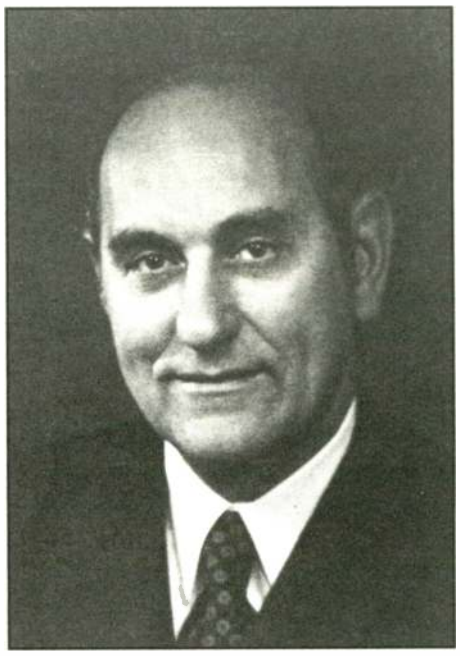
Cervon was honored by BE at a ceremony in Quincy in October 2007, recognizing him for a lifetime of achievement and service in broadcasting. The company dedicated a commemorative plaque for the event, marking the 30th anniversary of the move to Quincy.

We spoke to Cervon after the ceremonies to hear more about his life in the radio industry.

How did you get your start in broadcasting?

It was just kind of an accident that I got involved with RCA. After I left the Navy I was looking for a job where I could use my knowledge of electronics and business. I approached RCA, which at that time was all radio. We were selling medium-wave transmitters in Latin America and worldwide. I then moved to Westinghouse, which also was a radio company.

Gates Radio had approached Westinghouse to sell transmitters made by Gates internationally under the Westinghouse name. That was where I met Parker Gates and Owen McReynolds, the sales manager for the Gates Radio Co. in its New York office.



Larry Cervon

I took over the New York office for Gates Radio when it moved McReynolds to Washington to open a new office right across the street from the FCC.

What was the radio industry like in those years?

In the late 1940s and early 1950s there was a great demand for radio and a tremendous number of applications for new daytime stations. Regional stations also were being constructed during the 1950s and we were very active in selling them medium-wave transmitters.

In the early 1950s, 'You could buy all the equipment you needed for about $25,000 to $30,000, including a tower, the studio equipment and a 1 kW transmitter.'

The FCC would issue new construction permits every Tuesday. We would walk over and get the list of permits and immediately call our salesmen to give them a list of permits they could use to contact the new station owners. We often were the first to call with the information that the owner had received a permit, and we would offer to advise them on equipment purchases.

My job in those days was to sell radio stations by selling the equipment for radio stations. There were many small radio stations being started literally by doctors, dentists and lawyers who knew little to nothing about the technology, and that was where we came in.

You could buy all the equipment you needed for about $25,000 to $30,000, including a tower, the studio equipment and a 1 kW transmitter. Raytheon, Collins and RCA were the main competition.

At that time, Gates Radio was on the bottom of the totem pole in terms of quality in the design and construction of transmitters. Of the other early manufacturers, Westinghouse concentrated on the high-power medium-wave business, and General Electric decided to pursue the brand-new FM technology.

Over time, Gates Radio became one of the most dominant suppliers of medium-wave transmitters at 1, 5 and 10 kW power levels.

In 1952 I moved to Quincy, Ill., to become sales manager for Gates Radio. My wife suggested we stay for a couple of years for the experience and then move back east.

I ended up living there for 46 years.

How did the radio industry evolve in the 1960s?

Over time, some of the other larger radio companies began to get out of the radio business. Raytheon moved on and GE moved into television.

The radio manufacturing business was no longer growing as fast because there were only so many available frequencies for radio stations to use because of the limitations imposed by the FCC. Radio became more of a niche market. You had to know the industry to do well in broadcasting.

In the 1960s at Gates Radio, we moved into FM transmitters and stereo broadcasting. FM had a slow start but stereo gave the listener something he had never had before. Stereo was a whole new dimension for radio. If it had not been for stereo I'm not sure FM would have grown as rapidly as it did.

When did you move on to working for Broadcast Electronics?

I left Gates Radio in 1974, having worked there for 27 years, after it was acquired by Harris Intertype and they made a change in management.

After a short time working for Microwave Associates, I decided that my main career interest was in radio broadcasting equipment, and so in 1976 I became president of Broadcast Electronics in Silver Spring, Md.

I was still living in Quincy at the time and I realized that the cost of manufacturing was much higher on the east coast compared to the midwest. Quincy also had a large number of skilled electronics technicians who had recently been laid off when Motorola closed its Quincy manufacturing plant in the mid-1970s.

I realized I couldn't make the company grow unless I moved it. We relocated to Quincy in 1977.

Why did you decide to develop a full line of FM transmitters?

Hans Bott was vice president of engineering and we knew right away that we were

SEE CERVON, PAGE 35

MARKETPLACE

BC-2000D Inserts, Extracts Linear, Compressed Audio

AEQ's BC-2000D Multiplexer inserts and extracts digital or analog (mono or stereo) audio channels in E1/T1/J1 or Ethernet data transmission flows.

Audio channels can be linear, or compressed for better use of the link. Link capacities not used for audio can be employed for data transport.

The BC-2000D Multiplexer is part of the BC-2000D router digital audio platform that routes, mixes, processes and distributes audio. The system transports audio between stations, and also routes it, within each station, to the required place.

Audio channels are accepted and extracted with flexibility, including analog channels at the mic or line level; AES-3 and S/PDIF digital channels; and AES-10 MADI digital multi-channels.

The unit can be configured, controlled and monitored with computers, which allows setup circuits for monitoring or intercom use through the loudspeakers and microphone installed in each computer, using audio over IP.

Other applications for the BC-2000D Multiplexer are studio-to-transmitter links, and transmission networks for radio with different centers for production and emission.

For more information, contact AEQ in Florida at (954) 581-7999 or visit www.aeqbroadcast.com.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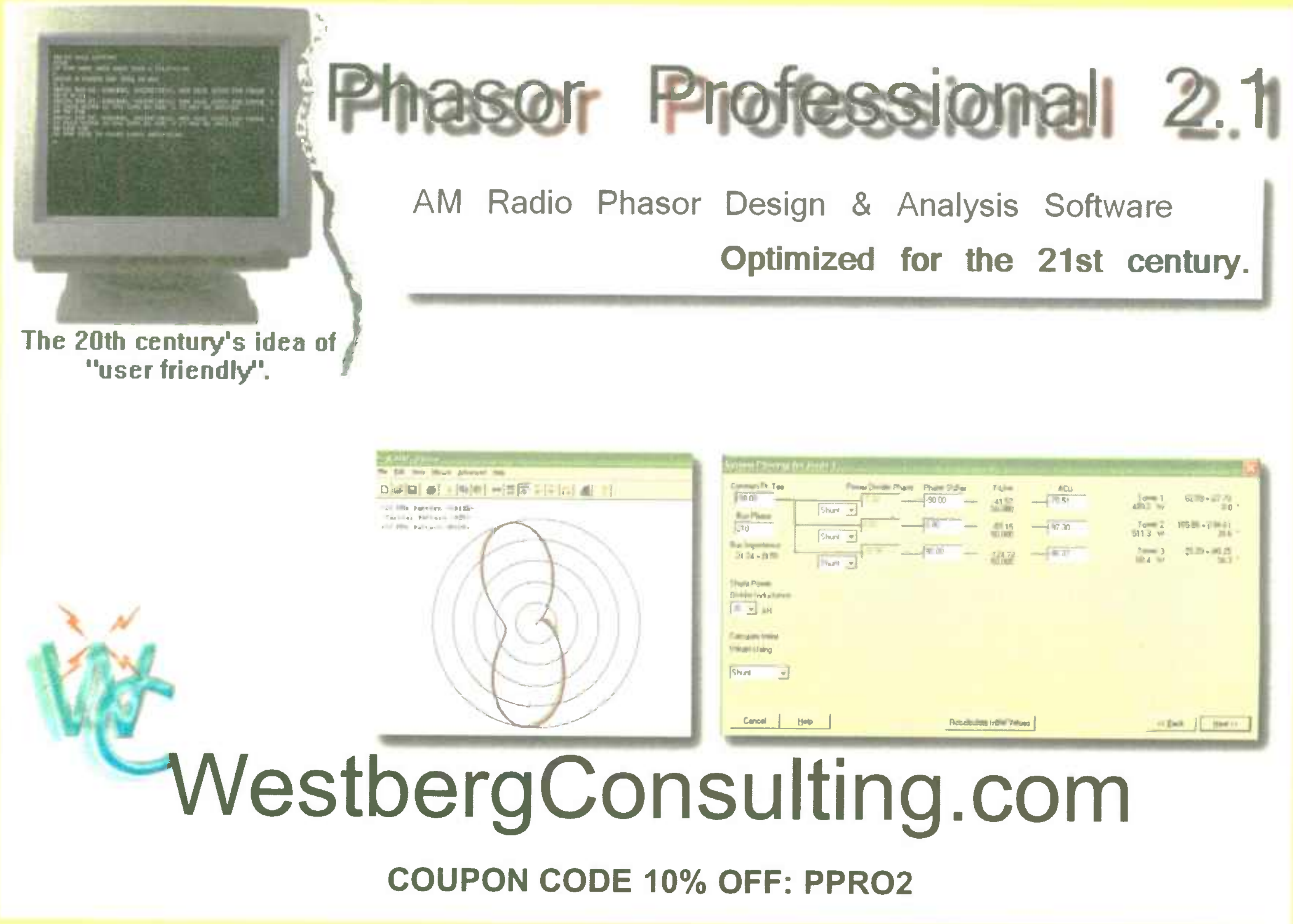
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THE ENGINEERING BLOCK

MARKETPLACE

M-Clock Plus Resamples, Syncs to Precision Clock

The Drawmer M-Clock Plus, a high-stability AES Grade 1 master clock generator, supports clock rates from 44.1 kHz to 192 kHz, and additionally incorporates dual sample rate converters, allowing material to be re-sampled and synchronized to the selected high-precision clock.

M-Clock Plus can synchronize to an external word clock input or retrieve the clock from an AES audio signal via an AES11 input, in addition to its internal word clocks.

The unit offers 10 word clock outputs: eight on the rear connector panel; and two at the front for access when the unit is rack-mounted. The exact frequency of the selected internal or external clock is measured and displayed with an accuracy of 2 ppm.

Access to the two sample rate converters is via selectable AES, S/PDIF or TOSLINK inputs, with simultaneous AES, S/PDIF and TOSLINK outputs, enabling various format conversion and sample rate conversion options. Sample rate converter #1 has a selectable AES, S/PDIF or TOSLINK input on the front panel.

The inclusion of automatic dither generation with user-selectable 16- or 24-bit word length is valuable for 16-bit word lengths at low signal levels, according to the company.

For more information, contact Drawmer distributor TransAudio Group in Las Vegas at (702) 365-5155 or visit www.drawmer.com.

Letters to the Editor

Radio World welcomes your point of view on any topic related to the U.S. radio broadcast industry.

Letters should be 100 to 300 words long; the shorter the letter, the better chance it will be published in full. We reserve the right to edit material for space. Longer commentaries are welcome but may not reach print as quickly. Include your name, address, contact information and permission to print, as well as your job title and company if appropriate.

Send letters via e-mail to *rwee@nbmedia.com*, with "Letter to the Editor" in the subject field; fax to (703) 852-4585; or mail to Reader's Forum, Radio World Engineering Extra, 5285 Shawnee Road, Suite 100, Alexandria, VA 22312-2334.

Products & Services SHOWCASE

Cervon

CONTINUED FROM PAGE 30

going to go into transmitters. We decided we were going to build FM transmitters.

We went with FM because it was growing and AM was starting to die out. All of the stations were moving to high-fidelity radio with stereo and building new stations.

Rather than start with a 1 kW and having a tough time convincing radio stations we could build larger models, we decided we would start out with a full 25 kW model.

Who else was part of the engineering team that developed the broadcast product line?

The folded half-wave cavity was developed and patented by Jim Aurand, who had formerly worked for Harris Corp. This became the FM-30, a single-tube 30 kW transmitter. It was the most powerful one-tube transmitter in the world.

Hans Bott then recruited Geoff Mendenhall to design the exciter. Eventually Hans Bott left to become a consultant and Geoff became the vice president of engineering.

After the FM transmitter line was developed we realized we needed to build AM as well so that we could offer a full line of transmitters to meet the needs of any station.

With AM we started at a low power and built the line up to high-power over time.

Cervon's award ceremony in Quincy, Ill. Presenting the plaque is Joseph Roark, president and CEO of Broadcast Electronics.

Because of the many 1 kW stations around the United States, we wanted to build small, compact and economical models. When I left in 1991 we still had not gone to higher power but subsequently higher power models were developed.

We also developed the AudioVault, which grew out of the Control 16 automation system, first introduced in 1978. Eventually that technology and knowledge was put to use by John Burtle, the driving force on the Control 16 automation and the AudioVault.

The reason we scooped the industry with AudioVault is that we started to use Microsoft Windows as the architecture. That was a big difference between us and other companies because that architecture had more flexibility.

Those three product lines still define the success of the company.

Who influenced you most in your career in radio?

Parker Gates was my mentor.

Gates was really the guy that got Gates Radio Co. moving. He came up with the ideas for many of the products that moved Gates ahead.

His main objective was to match the offerings from RCA. If they came out with an eight-channel console, he would come out with a nine-channel to go them one better.

What do you think about HD Radio and its potential for the U.S. broadcast industry?

I think that it has been adopted pretty quickly by the big stations and in the big markets but the problem is there aren't really enough receivers around. The smallest-market stations are resisting spending the money to go to IBOC because they can't see the advantage for their listeners to get them to go out and buy new radios.

I think it will take many years for it to become a standard throughout the country. In AM, the bigger problem is the interference that it causes.

What new technology developments do you see in the radio transmitter industry?

The radio broadcasting industry has evolved, and there is still a stage of refinement that can continue, but there is nothing in the way of a big breakthrough. The basic limitations are the frequencies allowed by the FCC. Particularly AM is at a disadvantage with respect to FM due to the difference in propagation. ■

HD Radio

CONTINUED FROM PAGE 28

Separate, Dual-Input Antennas: A separate antenna method takes one of two forms: a physically separate antenna (see Fig. 2d) or a dual-input antenna (see Fig. 2e).

The separate antenna implementation routes the signal from independent digital and analog amplifiers to dedicated radiating elements for each signal. The basic form is an independent antenna, often previously installed as an analog backup. The second method, known as an interleaved antenna, places a digital bay at the mid-point of the analog radiating elements. In this design, phase of the digital element is typically inverted — installed upside down — to provide additional isolation.

Digital antennas need a minimum of 40 dB of isolation from the analog antenna in order to keep intermodulation products within required limits. Careful placement and measurement of the antenna elements and RF isolator on one or both transmitters may be necessary to minimize mutual coupling. Replicating radiating element placement with regard to tower leg and crossbar for both the analog and digital transmitting elements will ensure the patterns of the digital and analog signals are congruent.

Dual-input antennas utilize a hybrid to source the two dipoles of the radiating element with independent analog and digital RF signals. In this implementation, the resultant signal has right-hand circular polarization for the analog and left-hand polarization for the digital.

Essentially, the dual-input antenna is a combination of free space signal combining in concert with the use of a 3 dB hybrid. Dual-input antennas have the advantage that the center of radiation is identical for both the analog and digital aperture, resulting in near-identical analog and digital RF coverage.

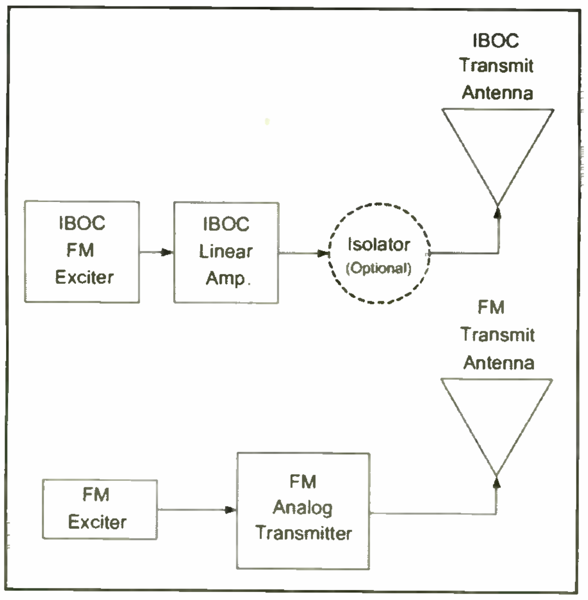

Fig. 2d: FM HD Radio Separate Antenna Implementation

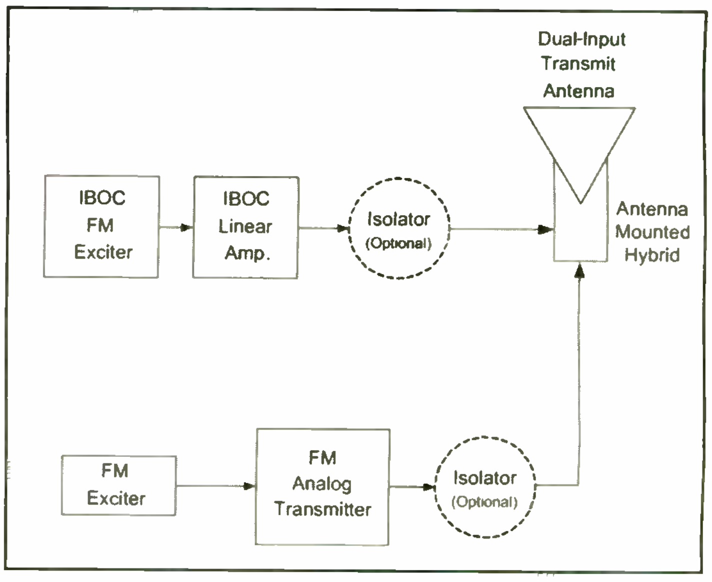

Fig. 2e: FM HD Radio Dual-Input Antenna Implementation

AM HYBRID TRANSMISSION

AM HD Radio transmission requires the amplification of complex modulation. Unlike FM, AM IBOC requires strict phase coherency between the analog and digital signal.

The most straightforward solution is to amplify both the analog and digital signals in a single transmitter. To accomplish this, AM HD Radio transmitters must provide ample bandwidth and minimize phase distortion.

The non-lineal transformation of complex I/Q to phase/magnitude requires infinite bandwidth to perfectly reconstruct the signal within spectral limits. Ideally, the transmission of discrete I/Q data would be desirable over a phase/magnitude transform as it constrains frequency to the bandwidth of modulation.

Transmitter bandwidth is a consideration, as negative modulation peaks reach pinch-off. As these values approach the baseline, infinite bandwidth products are produced.

Though these emissions are infinite, sample rates and filter characteristics employed in HD Radio transmitters constrain the products to acceptable emission limits.

HD Radio transmission requires similar response and phase characteristics from the antenna as did AM stereo. State-of-the-art transmitter designs employ multiple solid-state amplifiers summed to transmit the required power.

For optimal transfer, it is desirable to provide the appropriate match at the summing point of the final amplifiers. Multiphase PDM transmitters with switching frequencies higher than 150 kHz and digitally modulated solid-state AM transmitters are generally compatible with minor input filter modifications. Fig. 2f depicts the key transmission elements of an AM HD Radio implementation.

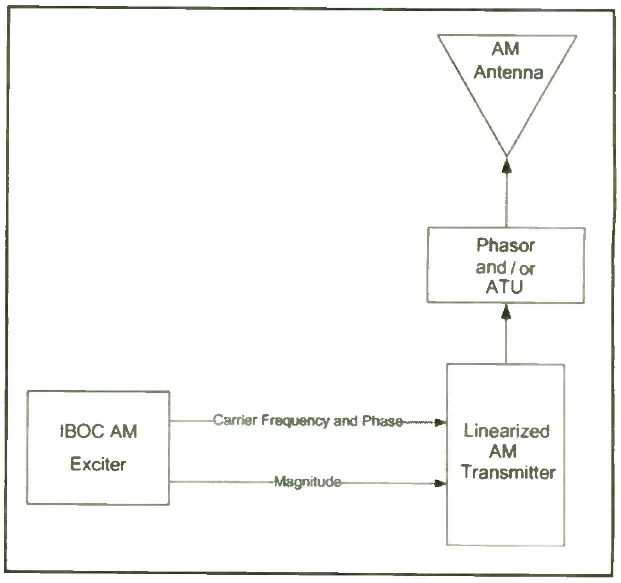

Fig. 2f: AM HD Radio Implementation

CONCLUSION

Inspired by its ability to deliver digital quality sound and services within existing analog spectrum allocations, HD Radio technology has drawn interest from broadcasters around the world. Testing, demonstrations, pilot stations, trials and investigation of HD Radio broadcasting are taking place on every continent.

HD Radio technology offers new and exciting programming streams through HD Radio multicasting capabilities. There are better quality signals and the opportunity to take advantage of non-traditional data applications and services. Low-cost receivers are available and implementation is easy and affordable. ■

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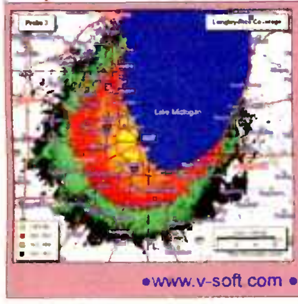

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The Last Word

CONTINUED FROM PAGE 38

They draw in the listener by providing a story with a broad range of emotions, often using vivid soundscapes of images, humanity and dramatic events.

In older cultures with a deep understanding of the senses, the ears were for "seeing life," while vision was simply a means for navigating the environment without colliding with obstacles.

In his book "The Variety of Sensory Experiences," David Howes describes how our concept of the senses is specific to culture rather than being biologically determined. And for most cultures, hearing was the number one sense, while vision was third in terms of importance. The blind seer was honored for his refined ability to "see" the future.

Radio provides the means for listeners to see other worlds and lives.

People vote with their feet; listeners vote with their ears. The greatest success story in broadcast radio during the last 20 years may be NPR and the rise of its affiliate stations. They have been enjoying real growth against a backdrop of shrinking commercial radio numbers.

The executives of commercial radio may well be ignoring the fact that there is a deep hunger for something other than talking heads with loud opinions — "junk food for the ear."

The magnitude of this hunger may finally be quantified with the advent of the PPM measurement system, which could transform a "stealth audience" into hard numbers. Even if some people dismiss public radio for its supposed "leftist and intellectual" bias, it may nevertheless manifest a deep understanding of the power of the imagination and the appeal of a good story.

CONTENT CAPTURES AN AUDIENCE

Broadcast radio is far more than a piece of technology. The news stories on NPR and various other radio shows paint pictures in sound through the use of sound effects, ambience gathered on location and production sensibilities that place the listener in the story.

With National Geographic's radio programs, you float down the Amazon River, hear the water rushing and become aware of birds flying overhead. You hear the distinct sounds of the wooded soundscape in a forest. Listeners enjoy hearing these worlds transported to them by radio.

Lest you think that this argument is too academic for an industry required to make profits, consider the evidence. In 1958, Stan Freberg wrote a six-minute 35-second spot to help Butter-Nut's instant coffee overcome a five-year lag in entering the tough southern California market. The spot, called "Omaha!", was a spoof on the musical "Oklahoma." The product name was not mentioned until the very end of the story. Listeners simply enjoyed the humor and entertainment. As a result of the spot, Butter-Nut sales quadrupled, and the company's product became a featured story in the Los Angeles Times.

At a recent NTS Airchecks Talk Media Conference, Paul Harvey Jr., creator, producer and writer of the longest-running series on radio, "The Rest of the Story," asked the audience, "How many stations here have full-time writers on staff?" One hand went up. Anyone who has ever listened to "The Rest of the Story" will instantly recognize how a master who knows how to write for the audio broadcast medium can turn spoken word into pure storytelling.

Leave the ultra-conservative bureaucrats to sit in the waiting room until there is something of value to be managed.

A TESTED PATH FOR SUCCESS

In the mid-1960s, when radio was dominated by the top 40 AM powerhouses, FM was without any apparent economic value. Radios that could receive FM broadcasts in automobiles would only become standard equipment some 10 years later. Without being able to immediately monetize the new technology, executives and managers allowed a "bunch of kids" to experiment with FM.

Left alone, they reinvented radio content, which then begat a large number of new listeners, thereby creating value that now dwarfs the original golden goose, AM broadcasting.

A half century later, the analogy of FM is HD Radio.

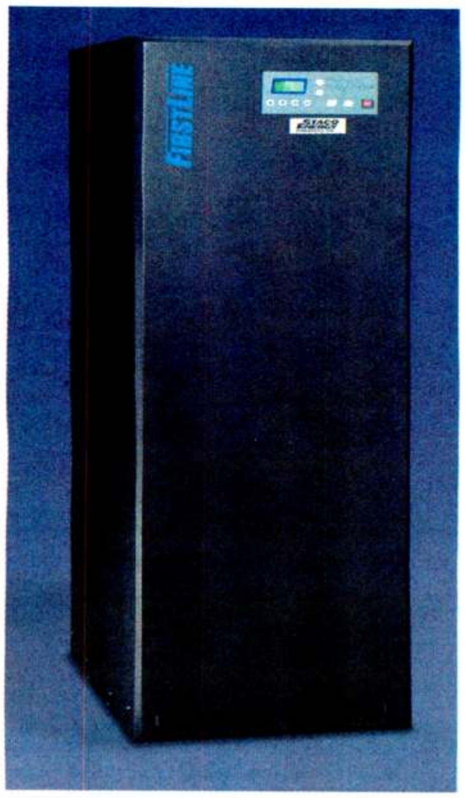
Look at the current value for some other industries that began as play toys: personal computers, video games, search engines and even digital audio. We are confident that HD Radio would attract a new audience if the next generation were given the opportunity to combine their innate understanding of social networking and Web connectivity with the power of our aural medium.

In our view, the industry must enfranchise creative talent, be they writers, comedians, aural artists or enthusiastic kids. Leave the ultra-conservative bureaucrats to sit in the waiting room until there is something of value to be managed. Content is king. Long live the king.

Dr. Barry Blesser is director of engineering for 25-Seven Systems. ■

MARKETPLACE

Staco FirstLine Three-Phase UPS Adds SNMP



Staco FirstLine SNMP

Staco Energy Products added SNMP communications capabilities to its FirstLine three-phase uninterruptible power supply. These models, available for 10, 15 and 20 kVA applications, allow users to network this UPS with their manufacturing and management systems.

SNMP capabilities enable Web-browser based visual readings, alarm notification and a 48-hour system history, as well as client shutdown software for most popular operating systems.

FirstLine is a true online, double-conversion UPS that, despite its small footprint and low weight, has a standard internal battery run-time of up to 30 minutes (with optional batteries for virtually unlimited run time).

Models offer input voltage of 208, 220 and 480 VAC, and a range of +10/-20 percent (166–229 VAC).

Input frequency is 60 Hz +/-5 percent. Full load walk-in from 25 percent to 100 percent of rated load in 10 seconds. Inverter output distortion is ≤5 percent THD for non-linear loads, and ≤ 2 percent THD for linear loads. Output voltage is regulated to +/-1 percent of nominal at full load. Detailed specs are available at *www.staco-news.com*.

Transformer-less power technology provides blackout protection and power conditioning. Front-end harmonic correction eliminates the need for additional filtering. Robust double-conversion technology protects the connected load from sags, swells, noise and voltage imbalances without going to battery operation.

A control panel located on the front of the freestanding NEMA 1 enclosure includes an alarm and remote monitoring through an RS-232 connection.

For more information, contact Staco Energy Products at (937) 253-1191 or visit www.stacoenergy.com.

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by Barry Blesser

Radio Must Enfranchise Creative Talent

Radio Was Once 'The Hot Medium.' What Happened To the Visionaries, Daring Execs Behind That Title?

This article was co-authored by 25-Seven Systems President Geoff Steadman.

In the 1960s, Marshall McLuhan, the famous but oft-forgotten media theorist, communications scholar and social critic, wrote "Understanding Media," where he introduced us to the idea that the medium is the message. Buried inside that five-word phrase is the essence of radio.

McLuhan observed that the means of delivering a message dominates content of the message. Each medium, be it a written novel or a 3D cinema in surround sound, has properties that emphasize one aspect of a message and suppress others.

In analyzing electronic media technology of the 1960s, McLuhan concluded that "radio was hot" and that "television was cold." He further goes on to explain that radio, at least at the time when he was writing, was hot because sound has high information content. An entire world can be created just from a compelling soundscape that contains people, social interactions, physical events and an aural environment of ambience and acoustics.

Perhaps the sad part of radio history is that the industry moved from being a cultural leader to a passive follower. Where are the creative visionaries who understand the power of sound, and where are the network executives who are willing to give those aural visionaries a playground to be creative?

If nothing else, history also teaches us that creative innovation and artistic risk can create fortunes, as the movie empire of Walt Disney and the radio empire of David Sarnoff demonstrate.

DESIRE FOR ESCAPE

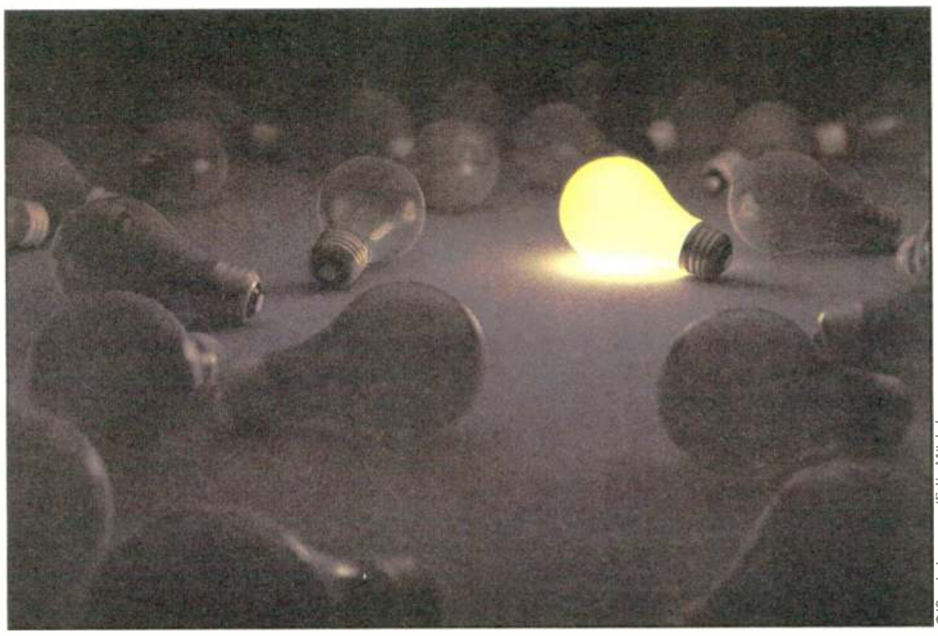
The economic success of the Harry Potter stories proves that people in our modern culture are still hungry for a way to escape into a world of fantasy.

Even though the printed word is the oldest medium, the most recent Harry Potter book sold more than 8 million copies in the first 24 hours. A high-tech medium can still be overpowered by a traditional medium, in this case print.

Similarly, radio need not cede the high road to the techno-wizardry of the Internet and computers.

Claude Lévi-Straus, the French anthropologist, suggested that story telling reflects the fundamental structure of the human mind. We are not computers that store data; rather we retain experience of ourselves and others in the form of a sequence of events and emotions. We empathize and sympathize by building an internal replica of an external world. The mind recreates life.

A good journalist will embed facts into an event that comes alive in the minds of readers or listeners. Facts and life are not mutually exclusive but mutually dependent on each other.



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What's the big idea? Radio is lacking the creative visionaries who dared to be different.

An entire world can be created from a compelling soundscape with people, social interactions and an aural environment of ambience and acoustics.

There is a sad, yet notable, example of how modern media use our imagination: peddling of fear and anxiety.

Doomsday weather forecasts describe massive storms, which usually prove to be nothing more than rain. Sound bites of political figures argue that the world is doomed unless some other agenda is accepted. And there is the old standby of terrorists threatening massive destruction to our way of life, which they have been doing for more than 10 years.

What about all the other forms of imagination that comfort and warm our souls? Where is that hunger being satisfied?

DRIVEWAY MOMENTS

Harry Potter is a rich form of "theater of the mind." So too are the radio dramas of the 1930s, 1940s and 1950s.

Radio of the 21st century also has its "theater of the mind," but it is found mostly on the public radio network in such programs as "Prairie Home Companion" and "All Things Considered." In these examples, good stories with rich soundscapes transport listeners into their imagination.

Attending to these aspects of the aural experience has contributed to the popularity and growth of public radio. It is not radio drama of the 1930s but it is built from the same principles.

Public radio executives refer to the "the driveway moment," when the program is so compelling that people sit for several minutes in their driveway to listen to the end of a story — even when their commute is over and dinner is getting cold. History repeats the dual themes of the Golden Age of radio: transporting the listener to a virtual world, and drawing them in so deeply that they stay.

On commercial radio, there are a few shows that harness this power. Live sports broadcasts, for example, are "theater of the mind."

A baseball game, with the excitement of the announcer, the crack of the bat and roar of the crowd, places you in the "ballpark in your head," all in real time. You are in the story, you are in the grandstands and you have been transported out of stalled traffic.

Even a traffic report broadcast live from a helicopter gives you the feeling of looking down at the roads from on high. The report is more than just information.

THE MOST IMPORTANT SENSE

Radio has more than its share of paradoxes. In public broadcasting, the program content often has wonderful imagery, while the underwriting announcements are as dry as toast. Conversely, on commercial talk shows, most announcers are disembodied voices floating out of automobile dashboards, while the show's commercial spots are often the most creative components in the hour.

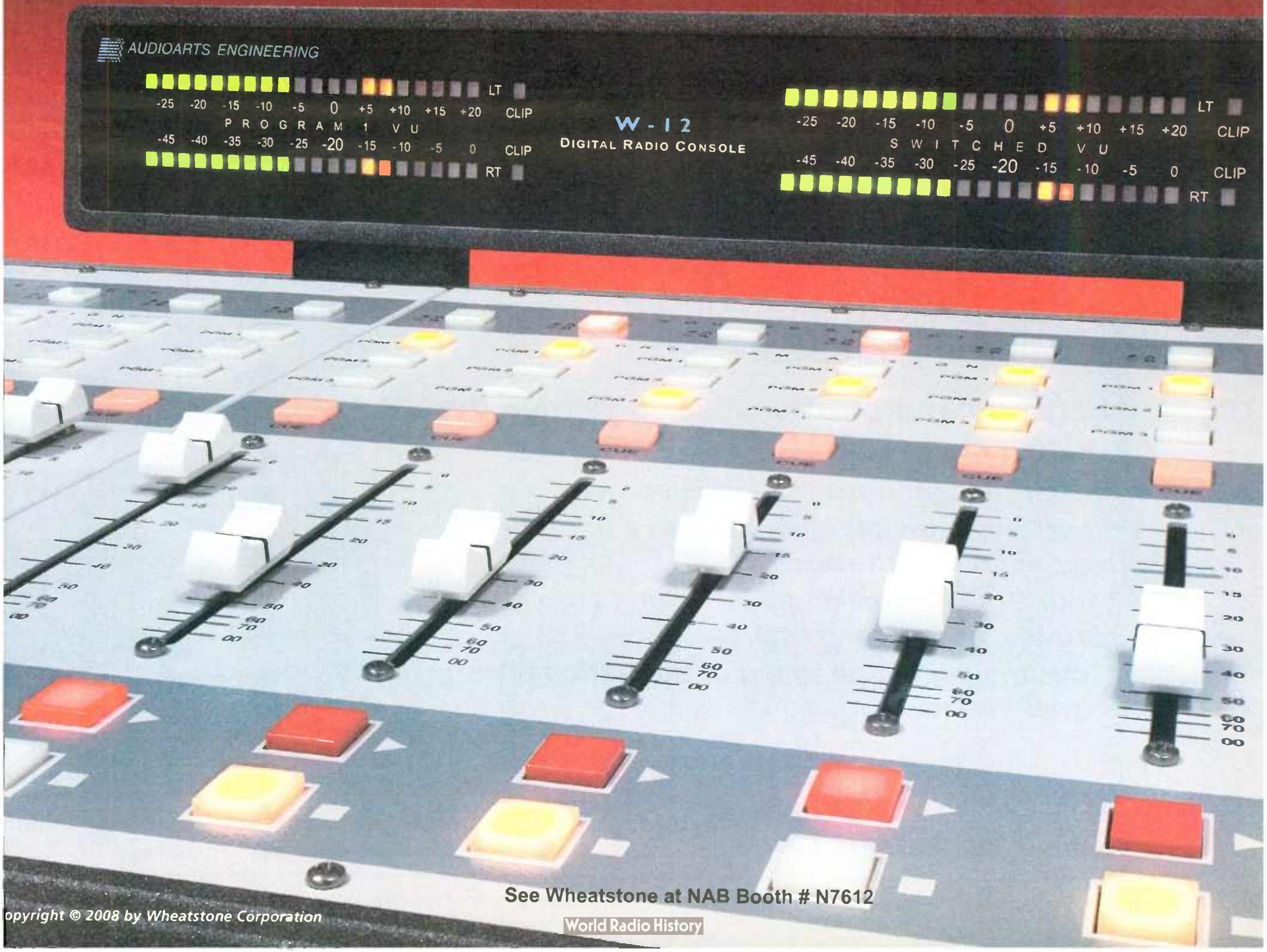
Good commercials can stand alone as miniature stories, dramas or narratives that do not focus just on a product or service.

SEE THE LAST WORD, PAGE 37

LIKE THE GOOD OLD DAYS... ONLY DIGITAL!

AUDIOARTS ENGINEERING W-12 — Like no other digital console, the new W-12 won't require you to use a computer or force you to deal with any cryptic digital baggage. It's SIMPLE: you just wire to your analog or digital inputs (and since it's modular, you choose the combination), set some dip-switches on the back panel (no disassembly required) and you're ready to go. Just like the good old analog days—only now with performance of over 135 dBFS and virtually unmeasurable cross-talk and distortion. ***Get Wheatstone's leading edge technology!***

for more info go to ***www.wheatstone.com/W12.htm***



See Wheatstone at NAB Booth # N7612

Don't Just Bring Your HD Channel Along for the Ride

The VORSIS AP-1000 has a completely separate fine grained processor dedicated just to HD, so you can tweak your HD sound to deal with bit reduced audio while leaving your FM sound uncompromised.

Here's what professionals who've tried the AP-1000 have to say:

"By far the best processor I've ever used."

"It achieved greater loudness with a smoother sound right out of the box."

"Your GUI is so well designed I didn't even need to read the manual to get started."

"Love the box!!! The sound of the station is vastly improved...it's loud, wide and clear."

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REDEFINING Digital Audio Processing

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