ENGINEERING EXTRA

DO YOU KNOW YOUR DECIBELS? Blažo Guzina explains how we measure loudness. Page 4

RADIOWORLD

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NewBay Media

Why a Full 10 dB Increase Is Necessary

Authors Russ Mundschenk and Milford Smith Explore FM HD Radio System Performance At Elevated Carrier Levels

BY RUSS MUNDSCHENK, IBIQUITY DIGITAL CORP., AND MILFORD SMITH, GREATER MEDIA INC.

This paper examines the results of elevated HD Radio carrier power tests performed by Charles River Broadcasting with the assistance of iBiquity Corp. This

WHITEPAPER

information was filed with the FCC by Charles River Broadcasting and iBiquity on July 6. The testing program explored the performance of elevated HD Radio carrier power in comparison to the currently authorized –20 dBc carrier power for both mobile and indoor reception conditions.

MOBILE RECEPTION TESTS BACKGROUND AND OBSERVATIONS

On Dec. 4, 2008 Charles River Broadcasting Co., licensee of WKLB(FM) Waltham, Mass., and a subsidiary of Greater Media Inc., was granted experimental authority by the FCC (file number 20081031ACO) to operate with digital carrier levels up to and including –10 dBc.

This permitted WKLB to operate with digital power levels up to and including 10 dB above that currently permitted by the commission's rules.

WKLB has operated at various elevated digital power levels during the duration of the experimental authority and recently filed an interim report with the commission, coincident with its

(continued on page 8)

Shown:
WKLB @ –20 dBc
(–19.21 dBc in Mode MP3).
This graphic is referred to as Fig. 5 in the text.

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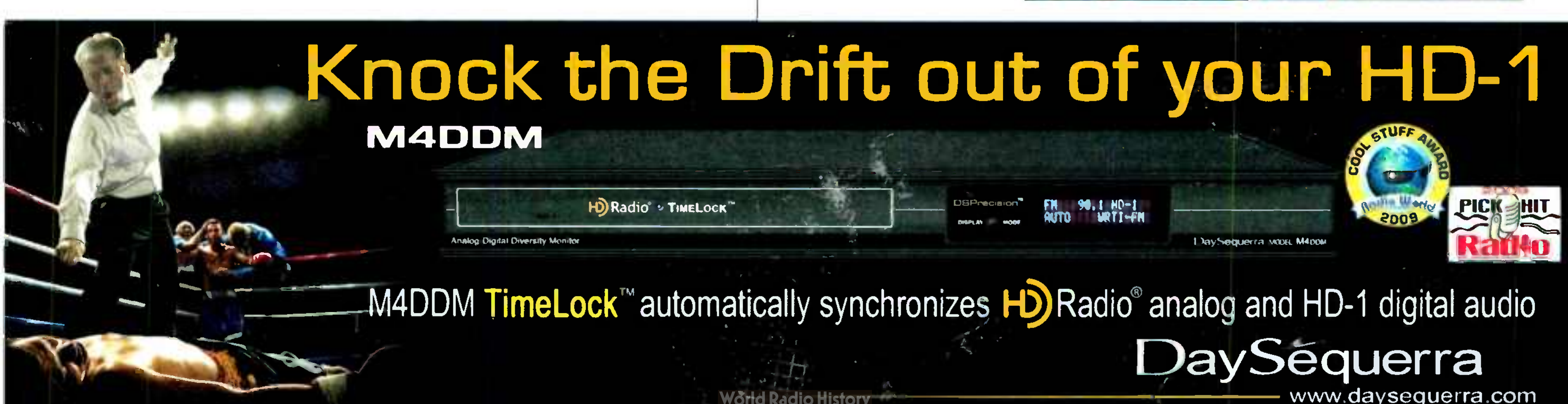

World Radio History

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FROM THE TECH EDITOR

Who Designed This Thing Anyway?

Working Alone Can Make an Easy Job Hard

BY MICHAEL LECLAIR

I found myself in a sticky situation at an AM tower site a few weeks back. I was a couple of hours away from the studio and working alone, trying to make a quick fix to the antenna tuning unit.

I had discovered a problem in the ATU a couple of weeks earlier on a routine inspection. The base current meter had failed with the movement essentially open. A good rap on the side with a screwdriver would cause the meter to show current for a few seconds but then it would drop back to zero. Not good enough for calibration purposes to say the least.

This particular site uses a toroid current transformer, made by Delta Electronics, to measure the base current. The RF power goes through the toroid transformer, which then connects to a meter that is calibrated to show the number of amperes of average current. I like these because they are simple and quite durable. But after a certain amount of time in circuit at a tower base, they expectedly fail, as this is a harsh environment for anything electrical.

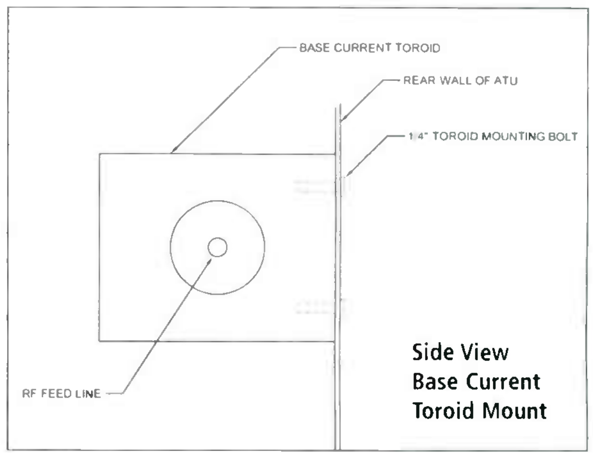
I had made pretty short work of removing the failed meter two weeks earlier. Using my cell phone to shut down the transmitter via the dial-up remote, I put a shorting clip on the transmission line at the point where it entered the ATU (just in case someone tried to turn the transmitter back on while I was working) and quickly pulled the meter, its associated cable and the current transformer. I knew that all three of these components would need to be shipped to Delta in order to properly repair and calibrate the base current metering system. This had taken about 10–15 minutes.

NOT SO FAST

After getting the meter repaired, I planned another short visit to reinstall the current transformer and meter. I figured it would take me about the same amount of time to put everything back together and then I could calibrate the remote control and be on my way. But I had forgotten something crucial from two weeks earlier.

When I originally removed the current transformer I had tied it in place with a pair of wire ties while I removed the 1/4-20 bolts that mount it to the ATU back wall. Although the RF feed line runs through the transformer, it is not designed to support the transformer. After removing the RF feed line, I had unscrewed the bolts, and the toroid, supported by the wire ties, then harmlessly dropped down a couple of inches. Otherwise, the toroid would have tumbled about 18 inches to the base of the ATU, possibly getting dented or damaged.

When I went to reinstall the meter, everything seemed to be going fine. I remounted the meter and then shut down the transmitter to open the feed line and remount the current transformer. That was when I realized my "oops."



Side View Base Current Toroid Mount

The current transformer obviously wouldn't stay in place by itself, 18 inches up on the back wall, in order to let me thread the mounting bolts back into its base. The bolts mount through the rear side of the metal ATU box and into the current transformer base. Unfortunately the ATU was too large for me to reach around the back to start the bolts while holding the transformer in place. I was stuck.

Now the easy solution here was to call up another technician and have them hold the transformer from one side while I ran the bolts through the other. But these days most of us are working alone on these jobs; there really isn't budget for a second technician to assist on a routine repair of this kind. As I mentioned, it was two hours back to the studio so if I chose to get someone else to help me I would have had to make a second trip to get the repair done on a different day and essentially write off the whole day as a waste.

I was feeling a bit stubborn and figured that I could find some way to get the meter back in without having to come back later. In my Engineering SUV I had a fairly complete tool kit, a couple boxes of wire, electrical tape, wire ties and a random assortment of nuts and bolts that had accumulated from various repair jobs over a few years.

I eventually figured out how to get the repair done and get on my way, but it took a few different failed attempts to finally come up with how to accomplish it.

TRIAL AND ERROR

My first thought was to use some wire ties to hold the transformer in place just close enough to get a bolt started through the back. This turned out to be tantalizingly impossible. There were limited tie points available to hold the toroid, and just when I thought I had it right, the slightest pressure of the bolt being fed from the back of the ATU would cause everything to tumble out of place and it was back to square one.

Did I forget to mention that it was about 90 degrees and 90 percent humidity that day? The heat was not doing anything to help my patience, to say the least.

I pretty much learned to forget anything that involves electrical tape, by the way — the toroid is way too heavy for anything like that.

What I eventually came up with worked something like this. I found a smaller bolt, nut and washer combination in my random hardware pile and mounted them snug into one of the mounting holes from the outside. I was then able to use that small bolt as a support for the toroid. I wanted to be able to just push the toroid onto the bolt without having to tightly thread anything. This, in combination with my wire ties, would hold the toroid close to the right height and position on the back ATU wall.

Then I took a piece of wire and used it like a piece of string to pull on the toroid. That allowed me to adjust the position of the transformer from the back

(continued on page 4)

THIS ISSUE

OCTOBER 14, 2009

World Radio History

The Units of Audio Measurement

BY BLAŽO GUZINA

The ear is a subtle yet robust mechanism for measuring audio. While the ear is critical to setting levels in a station or studio, it is important to understand and use less subjective benchmarks when setting and measuring signal levels and when matching equipment levels.

Audio measurement of sound pressure level (SPL), signal level and differences or changes in signal level all are expressed in decibels (dB).

Dynamic range — the difference, expressed in decibels, between the loudest and the quietest sound intensity the ear can normally detect — is the spread between the threshold of hearing and the threshold of feeling (120 dB at 1,000 Hz).

Given that the ear is capable of responding to sound pressures in a ratio of 1,000,000:1, it is apparent that the decibel allows us to reduce large numeric values into smaller, more manageable numbers. Instead of representing such measurements on a linear scale, the data is expressed in accordance with the Weber-Fechner law, which states that the intensity of a sensation is proportional to the logarithm of the stimulus that produces it.

The decibel, one-tenth of a Bel, is the most frequently used unit in acoustics and audio systems, as well as in electrical engineering in general. The reason Bels are seldom used is explained by the capabilities of human hearing. One decibel is generally accepted as the smallest change in level that the average adult can hear, although the just-noticeable threshold varies from 0.1 dB to 5 dB, depending on frequency, sound program material and the individual.

The decibel is the logarithmic expression of the ratio between two linear quantities, for example, sound pressures p_1 and p_2, as follows:

$$N_{[dB]} = 20\log_{10}\left(\frac{p_1}{p_2}\right)$$

The common unit for sound pressure is the pascal, with the old unit microbar (μb) still often seen. Their relation is: 1 Pa = 10 microbars.

The relation of two squared quantities, for example, sound intensities J_1 and J_2, expressed in decibels is:

$$N_{[dB]} = 10\log_{10}\left(\frac{J_1}{J_2}\right)$$

The decibel is always related to some reference value or the zero level. In the case of Sound Pressure Level, it is a pressure of $p_0 = 2 \times 10^{-5}$ Pa $= 2 \times 10^{-4}$ μb, corresponding to the minimum threshold of hearing of a human ear at a frequency of 1,000 Hz.

Sound Pressure Level in decibels, in reference to zero level, is defined as:

$$SPL_{[dB]} = 20\log_{10}\left(\frac{p}{p_0}\right) = 10\log_{10}\left(\frac{J}{J_0}\right)$$

where p is the measured sound pressure.

According to above formulas, doubling (or halving) a voltage, sound pressure or any quantity of first degree (volts or amperes, for instance) produces a 6 dB increase (or decrease). Doubling (or halving) power, energy level, intensity level, energy intensity level or any quantity of second degree produces a 3 dB increase (or decrease). Second degree quantities vary as the square of a first degree quantity.

dB	used alone as reference for level changes
dB_{SPL}	ratio of sound pressures referred to 20 µPa, corresponding to the threshold of human hearing
dBV	ratio of volts referred to 1 V
dBu *or* dBv	ratio of volts referred to 0.7746 V (dBu is preferred)
dBm	ratio of watts referred to 1 mW
dBW	ratio of watts referred to 1 W

Table 2

A further simple calculation illustrates this: If we take two sound intensities, J and J_0, assuming that $J = 2J_0$, the result from the above formula for SPL is approximately 3 dB [$10\log_{10}(2) = 3.01$ rounded to two decimal points].

The logarithm of a value is the number which, when applied to 10 as an exponent, produces that value as a result. For instance, the number 100,000 is 10^5 in exponential form, so its logarithm is 5 (Table 1). Here again, it is apparent how decibels are used to compress large numeric values into smaller, more workable figures.

The amount of power increase required for most people to hear a sound they subjectively describe as twice as loud as the original is 6 dB to 10 dB. The amount of power decrease required for most listeners to hear what is considered to be half as loud is –6 dB to –10 dB. Thus to hear a sound twice as loud as that produced by a 10 watt amplifier would require approximately a 100 watt amplifier (see Table 3).

LOUDNESS, DECIBELS AND PHONS

Our ears do not hear in a linear manner. At the normal threshold of hearing (0 dB_{SPL}) it takes some 10,000 times more acoustic power to enable us to hear a 20 Hz pure tone than it does to hear a 4,000 Hz tone.

As mentioned above, the dynamic range that the ear can detect is spread between the threshold of hearing and the threshold of feeling. Both threshold curves are not linear in the range of audible frequencies. This is a reason another unit, different from the decibel, was introduced for perceived loudness: the phon.

Loudness in phons can be calculated from actual sound volume by using a standard set of curves representing average human hearing.

Since loudness (a subjective quality) and the measurable volume of sound are not the same thing, it was convenient to introduce some kind of a reference, i.e., to regard them as being the same at 1,000 Hz. Therefore, by definition, 1 phon is equal to 1 dB_{SPL} at 1,000 Hz.

Table 2 presents examples of decibel references used in audio systems. Similarly, some basic relationships between watts, dBW and dBm, as well as volts, dBV and dBu, are shown in Tables 3 and 4.

log(100,000) = 5	log(0.000001) = –5
log(10,000) = 4	log(0.00001) = –4
log(1000) = 3	log(0.001) = –3
log(100) = 2	log(0.01) = –2
log(10) = 1	log(0.1) = –1
log(2) = 0.3	
log(1) = 0	

Table 1

OPERATING LEVELS

In audio, the average power levels at which signal-carrying wires operate are usually divided into three categories, as shown in Table 5.

With both analog and digital audio, dBu and decibels full scale (or dBFS) are used to express nominal operating level, headroom and noise floor.

Nominal operating level is the design target signal level of audio circuits. If an analog audio device operates with a 0 dB nominal operating level of +4 dBu and its noise floor is –80 dBu, this means that the nominal operating signal level will be 84 dB higher than the noise. If the maximum system level is +24 dBu, this allows for 20 dB of headroom and a total dynamic range of 104 dB.

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WORKING ALONE

(continued from page 3)

of the ATU until I could get the second mounting hole into the right spot to gently thread in a 1/4-20 mounting bolt. Once I got one 1/4-20 bolt into place, I was able to unscrew the wrong size bolt, dropping the unnecessary washer and nut out of the way, and tighten the one proper bolt firm. It was easy then to place the meter into the right spot to fit the second mounting bolt into place. In all, it took less than five minutes to get this to work once I thought it up. Of course, I had already wasted close to an hour trying other things that didn't work, but I was pretty satisfied at getting the job done alone and saving a lot of extra driving time to bring down an assistant.

ANOTHER WAY?

Since that day I have tried to come up with other ways that I might have used to get myself out of that jam. I'm sure that there are others of you who have been in a similar situation with an ATU or transmitter that required some mechanical ingenuity to get around a similar obstacle.

Share a few with our readers. Please send up your ideas or experiences at *rwee@nbmedia.com*.

The debate over whether to allow increased HD Radio carrier power is perhaps the most important technical issue facing the radio engineering community. In this issue we present a paper by engineers at technology developer iBiquity Digital and broadcaster Greater Media discussing the improvements that increased power offers, with detailed field receiver performance measurements. In December we plan to publish a similar piece exploring possible problems associated with increased HD power. At Radio World Engineering Extra we are making every effort to cover the various sides of this important topic to allow engineers to participate with the best information available.

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RoadWarrior LC is a new full-duplex, two channel (Program & talkback) audio codec. Its new design, robust, compact and with a flat control surface, prevents accidental damage to the controls and makes it easier to use. It is a portable audio codec with all Suprima functionality built in.

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World Radio History

HD Radio Goes Handheld

New Portable HD Radio Turns Out to Be Quite Popular

BY GUY WIRE

Portability in a very small package has finally arrived to the growing selection of HD Radio receivers. Amid a decent amount of pre-release advertising and promotion, the Insignia "Walkman-style" HD portable radio appeared nationwide in Best Buy stores in late July. I was lucky to snag one before all my local area stores sold out in a matter of weeks.

Antagonists of the controversial technology have always been quick to cite HD Radio's inability to deliver receivers that perform well without lots of annoying dropouts. Or provide models that attract more than a yawn from consumers. The Insignia NS-HD01 is one HD Radio that should help put those criticisms to rest.

THE BEST BUY EXPERIENCE

I personally called and visited several stores around my market to check and see if the Insignia pocket HD was in stock, and if the salespeople knew anything about it. Whenever I've done this in the past, I've usually been met with blank stares or suggestions I must be looking for satellite radios. Not this time.

Best Buy appears to have shipped only limited quantities of Insignias to most of their stores nationwide. But at least some stores have made an effort at educating sales staffs about the radio and why it's different than other Walkmans and satellite portables. At the first store I visited, the Insignia radio hanger, with a nice promotion placard and $49.99 price tag, was empty. The sales clerk checked stock and told me they had just sold the last one.

I engaged the 20-ish clerk to find out if she knew what HD Radio was and, to my pleasant surprise, she actually knew about the "secret stations between the stations." She also knew about the Insignia component HD tuner, also being sold at Best Buy for $105. She offered to call a few nearby stores and found only two portables left, so I had them hold one I could pick up on the way home. Since then, many stores have already sold out of their second restocking. Your own Best Buy experiences may vary.

ISO BETTER PERFORMANCE

Anybody who has used HD Radio products knows what the shortcomings have been. Car radios generally perform well on the open road with the advantage of external antennas. Indoor desktop radios and tuners often need external antennas, especially in blocked and compromised venues. Supplemental channels suffer dropouts with no blend to analog. These problems are more pronounced in Class B and terrain-challenged areas of the country. We haven't had a pocket HD Radio receiver with its earbud headphone wire antenna until now.

The usual method I've used to evaluate any kind of new model radio has been to see how well it holds up in various well-known reception areas of high multipath and HD dropouts. My own house is in one of those "black holes" where it's very hard to get clean analog reception, let alone HD. Most desktops, especially early HD models, won't hold most of the local market HD stations without a lot of futzing with their attached wire antennas. Using an outside antenna has been my only solution to get clean analog FM and consistent HD reception.

Walking around my house and yard, the Insignia portable performs surprisingly well. Yes, there are dropouts, but far fewer than I was expecting. What's especially impressive is the initial blend from analog to HD lock. The analog signals are often noticeably contaminated with multipath noise, which totally disappears in HD.

Driving around and listening with the Insignia portable laying on the front seat and one earbud connected also yielded rather impressive results. Comparing the quality of simultaneous reception of the same stations with my after-market JVC HD car radio in the dash, I was quite surprised to find both radios performed very much the same. The brief dropouts encountered seemed to occur in the same locales. Overall, HD reception held up very well, even in areas blocked by hills and the densely packed tall downtown buildings.

Before installing HD in the car about four years ago, I was forced to put up with a lot of noisy multipath and stoplight fades during my daily commute. Since then, I've gotten so used to clean and dependable HD reception, I don't even care to listen to analog any more. HD is simply that much better.

HD ACROSS THE COUNTRY

Selling HD Radio as a worthy successor to analog has been hampered by the widely varying perceptions of how well it performs across different markets. Every market, and the stations that serve it, has unique terrain features, different FCC-imposed transmitter power limits and different transmitter sites, with varying height and proximity to the population centers. These all affect the overall quality of reception.

There certainly are some markets more challenged than others where overall HD performance is poor in the suburban and fringe areas farther away from the primary FM transmitter sites. Most of the pro reviews I've read on HD Radios give their performance very little positive spiff. Many of those you find in trade journals and the Internet are written by folks living in New York City, Chicago, San Francisco and Los Angeles. Those are all Class B markets where most FMs operate with over-height antennas on tall towers or downtown skyscrapers. Except for the California super-power grandfathers, these stations run with reduced ERP. HD powers at 1 percent of analog run less than 70 watts in these markets. No wonder so many complain about frequent blending and HD2/HD3 dropouts.

A lot of these consumer reporters and reviewers need to get out a little more and discover how well HD Radio works in other areas. Out in Class C country, it's often a different experience. But just don't take my word for it. A decent sampling of consumer reviews of the Insignia portable as of this writing confirms that 34 out

(continued on page 8)

MEASUREMENT

(continued from page 4)

In digital audio systems a 0 dBFS level means the maximum permitted amplitude of the signal before clipping. With digital audio, the level of 0 dBFS must never be exceeded, because it would result in excessive and drastically unpleasant distortions. This is different than with analog equipment where there is always a certain amount of acceptable headroom above the reference level of 0 dB.

This is the main reason why monitoring of the signal levels in digital audio is completely different from the usual practice in analog audio. The board operator in a radio station must (to the maximum extent possible) anticipate in advance the amount of headroom, depending on the statistical values of expected program material.

Watts	dBW	dBm
0.0001	–40	–10
0.001	–30	0
0.002	–27	3
0.01	–20	10
0.1	–10	20
1	0	30
10	10	40
100	20	50
1000	30	60

Table 3

Volts	dBV	dBu
0.02449	–32.2	–30
0.03162	–30	–27.8
0.07746	–22.2	–20
0.1	–20	–17.8
0.24495	–12.2	–10
0.31623	–10	–7.8
0.77459	–2.2	0
1	0	2.2
10	20	22.2

Table 4

Microphone level	–90 dBm (1 pW) to –30 dBm (1 μW)
Line level	–30 dBm (1 μW) to +30 dBm (1 W)
Loudspeaker level	Line level or higher, audible from loudspeaker

Table 5

With digital equipment, the operator has to define the reference working level, which might be regarded as a logical equivalent to the 0 dB level for analog audio equipment. It is usual to adopt headroom of about 20 dB, but there is no general rule, as it depends on the circumstances and the type of program.

When the operator sets a facility's headroom to 20 dB this practically means that the signal level pointer has to be at the level 20 dB below the 0 dBFS level (i.e. –20 dBFS). For some types of sound material, for example programming with a smaller dynamic ratio, it is recommended to work with only 18, 16 or even 14 dB headroom, which means –18 dBFS, –16 dBFS and –14 dBFS, respectively.

Blažo Guzina, M.Sc., Dipl.-Ing., is a senior engineer within the Technical Department of Radio-Televizija Srbije. He is the author of the Serbian-language books "Sound Recording Technique" and "Audio Techniques in Radio and Television." Contact him via e-mail at blazo_guzina@yahoo.com.

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World Radio History

POWER

(continued from page 1)

request for an extension of such authority, detailing its observations during this period. It was noted in the interim report that WKLB would shortly be conducting additional testing to better quantify the actual improvements occasioned by operation at the elevated digital power levels.

During the past month, Charles River, with the assistance and cooperation of iBiquity Digital, the developer of the HD Radio system, has conducted extensive field testing in an effort to quantify improvements in the WKLB digital service occasioned by increasing power to several discrete levels. Although a number of studies have been previously submitted detailing coverage improvement over a specific route or routes, it is believed that this is the first to comprehensively quantify such improvements over an entire metropolitan area.

Four heavily traveled radials routes (I-90, I-93, I-95 and State Route 3) and a circular "beltway" (I-495) that encircles much of the Boston metropolitan area were chosen to gain knowledge of digital signal improvements over the entire market. The mobile test platform employed was identical in equipment and configuration to that used for the initial NRSC testing in 2002 and for the more recent testing conducted on Greater Media stations WRAT, WJRZ, WDHA and WCSX as well as several other non-Greater Media owned facilities. Results of these tests have been previously submitted to the commission over the course of the digital radio proceeding.

A JVC Model KDHDR50 receiver was used to determine whether digital reception was possible at any point on a route. This receiver was previously characterized as being "typical" and meeting its published performance specification by iBiquity. Data as to time, location, spectral content and reception mode (analog or digital) was recorded on a micro computer using a proprietary iBiquity data collection program. The receiving antenna was a conventional 31-inch whip mounted in the center of the test vehicle roof (see Fig. 4).

All data on each route, for each power level was recorded with the test vehicle proceeding in the same direction. The data collected represents several thousand miles of vehicle operation.

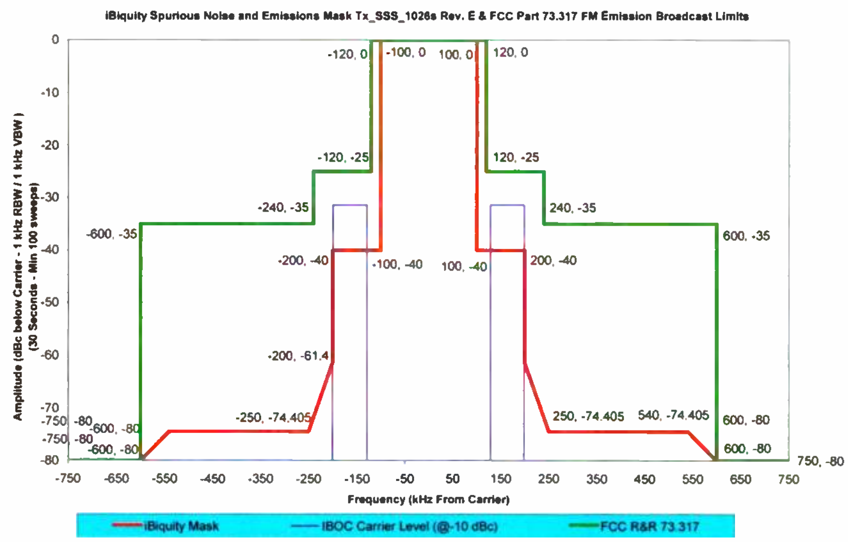

Fig. 1: FM Hybrid IBOC Spectral Test mask @ –10 dBc

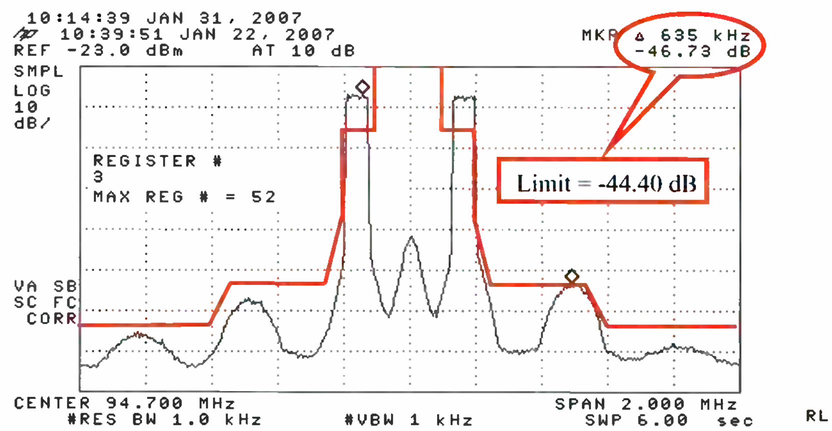

Fig. 2: Typical FM Hybrid IBOC Spectrum @ –10 dB

Test Description

For these tests, the system operated in the hybrid mode, which contains the analog FM signal and service mode MP3 digital carriers.

Fig. 1 shows the digital carriers at 10 dB below analog power levels with both the FCC and iBiquity masks. The digital sidebands will exceed the current iBiquity mask by about 8.5 dB. The digital sidebands comply with the FCC mask.

Fig. 2 shows the RF spectrum from the forward sample port of a dual-input transmitting antenna, and the iBiquity

(continued on page 10)

HANDHELD

(continued from page 6)

buying customers from all over the country give it high marks. Check them out at: *http://tinyurl.com/y9eap5g*.

A few of the reviewers are disappointed the Insignia portable doesn't include the AM band, an MP3 player or iTunes tagging. Others don't like the rechargeable 10-hour battery life and non-replaceable battery. Some say there aren't enough presets or the earbuds are uncomfortable. But for a breakthrough product of this size and impressive performance for under $50, I say it's a slam-dunk winner. I have yet to find a radio fan interested in HD who doesn't want it. Most have either bought one or are still trying to find stock at Best Buy. It'll make a splendid Christmas present.

TURNING UP THE WICK

The single most daunting problem still dogging FM HD is the lack of reception stability. Any consumer who buys an HD radio and has trouble getting their favorite HD stations to stay locked will be disappointed and probably return it for a refund. We've known for a long time that more digital power is really the only viable solution.

The push for up to –10 dBc power increase has shifted into high gear. More stations that can increase HD power have requested and received STAs or experimental temporary licenses. I've had a chance to check in on a few; without exception, every engineer involved in the testing agrees that even a 3 dB increase is noticeable. A 6 dB boost provides very significant improvement and 10 dB is dramatic. Except for a few isolated first-adjacent interference complaints, most notably WRNI vs. WKLB in the Boston area, these increases have proven to be compatible with the existing analog service.

THE REAL VS. THE THEORETICAL

NPR Labs has done the most theoretical evaluation work characterizing the interference impact that an HD power increase would inflict over the entire FM band. With the help of the folks at FCCINFO.com, their quick calculator was devised as a measuring stick for determining what level of HD increase could be employed by any station without causing interference to their first adjacent neighbors. Check it out for your station at *www.nprlabs.org/publications/distribution/interimIBOCpowerallowance/index.php*.

The calculator projects the amount of OFDM sideband power (albeit very small) that occurs inside the first-adjacent channels of an HD station with a –20 dBc injection, using this value as the limit allowed for an interfering contour for first-adjacent analog protection under the present rules. The amount of allowable HD power increase varies all the way from zero to the full 10 dBc, depending on the first-adjacent allocations situation for each station. It's not too surprising the calculator yields rather conservative estimates for theoretically allowed increases.

A number of Clear Channel, Greater Media and CBS stations that are running higher HD powers under STAs have demonstrated that the NPR calculator limits have been too restrictive when power increases are actually deployed and evaluated. My old friend and colleague, Clear Channel engineering exec Jeff Littlejohn, has recently gone on record confirming that conclusion, and is pressing harder for FCC adoption of HD power increases up to –10 dBc.

NPR Labs has also recently performed a number of field studies of existing stations and their first-adjacent neighbors involving experimental HD power increases. A summary report of the results and findings should be published this month. NPR Labs invited various "watchdog" observers from several commercial broadcast groups to participate in these tests and provide input.

The easiest way for the commission to correctly consider the HD power increase proposal and properly write it into law is to focus on the results of actual field tests. Temporary power increases for such testing should be encouraged and quickly granted when requested so that more stations can collect and report more field data. Theoretical expectations lose their importance when they can be replaced by real world measurements. Let's just hope this process doesn't take too long.

Guy Wire is the pseudonym for a veteran radio broadcast engineer.

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World Radio History

POWER

(continued from page 8)

spurious noise and emissions mask. As shown in Fig. 1, the sideband power exceeds the current iBiquity digital mask in the frequency range of ±129 to ±199 kHz. Even at the –10 dB power level, the IBOC transmitter is capable of meeting or exceeding the iBiquity mask thresholds established for the –20 dB power level.

Transmitter Test Site

These tests were conducted using the RF transmission facilities of WKLB, Waltham, Mass. (Boston). WKLB was granted experimental authority under 47CFR 73.1510(d) to operate with digital power levels up to and including 10 dB above currently authorized levels.

Please note that WKLB's total integrated digital power is increased by 0.79 dB over the reference –20 / –14 / –10 dBc levels to accommodate the additional carriers present in transmission Mode MP3.

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Transmission Facility Information

FCC Facility ID: 10542
North Latitude 42° 18′ 37″
West Longitude 71° 14′ 14″
High-Power IBOC authority per 47CFR 73.1510(d) granted 12/4/08

Antenna

ERI Model 1183-4CP-2 Dual-Input Hybrid IBOC (see Fig. 3)

Radiation Parameters

AGL 290 m
G AMSL 30 m
RC AMSL 320 m
HAAT 272.27 m
ERP (Analog) 14.0 kW
ERP (Digital) 167.91 W (–19.21 dBc D/A Ratio – Mode MP3)
ERP (Digital) 670.17 W (–13.21 dBc D/A Ratio – Mode MP3)
ERP (Digital) 1679.1 W (–9.21 dBc D/A Ratio – Mode MP3)

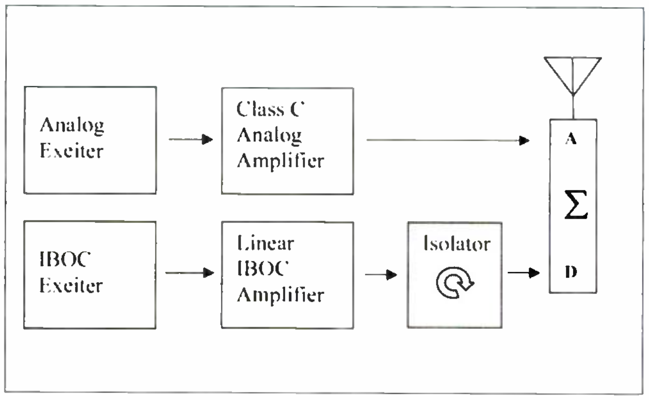

Fig. 3: Dual Input Antenna

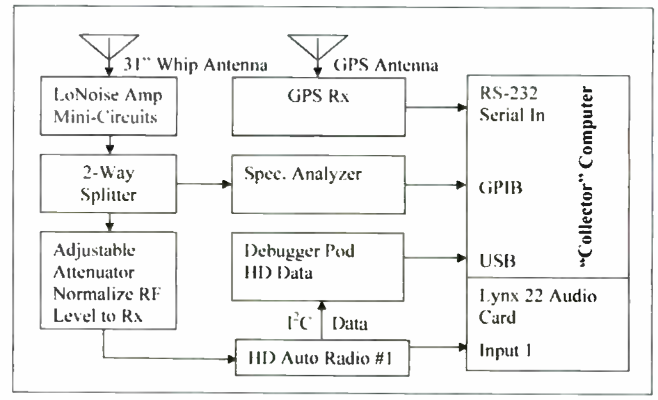

Fig. 4: Mobile Test Platform

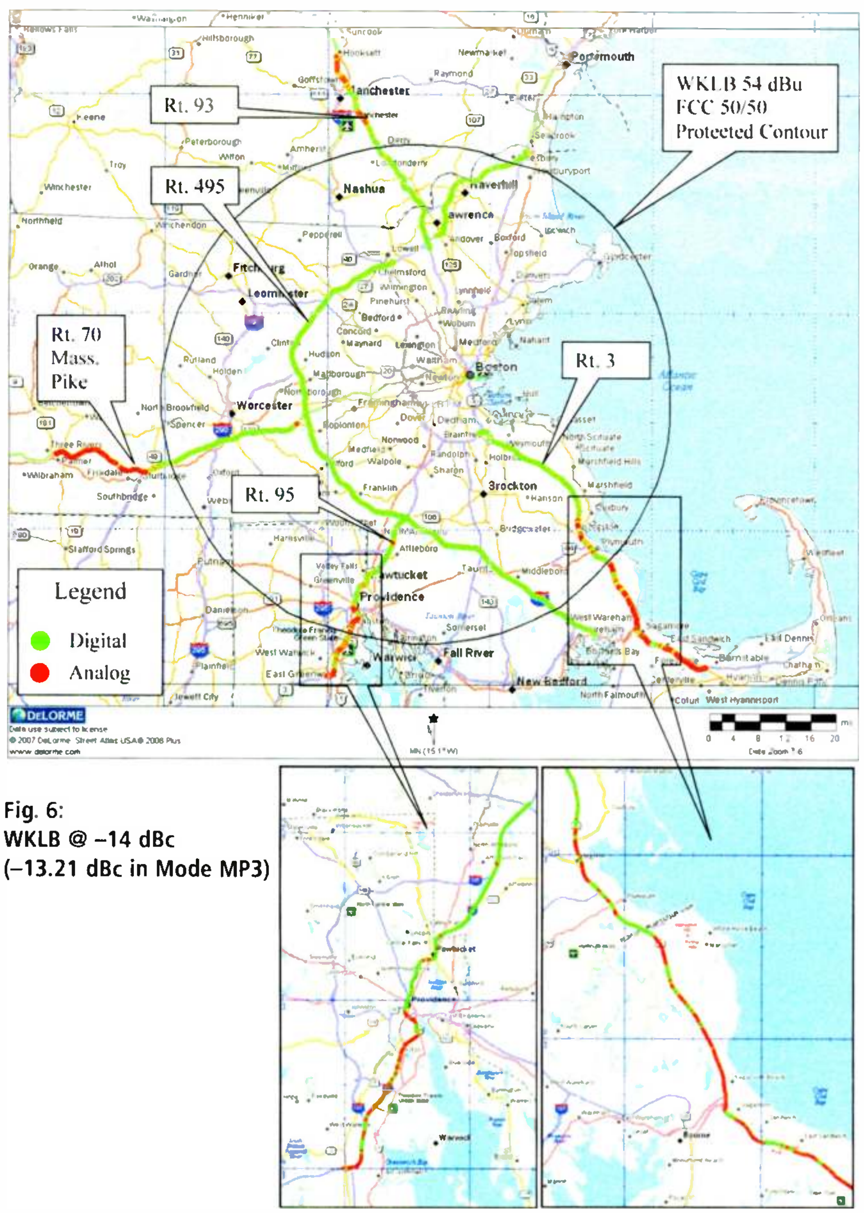

Fig. 6:
WKLB @ –14 dBc
(–13.21 dBc in Mode MP3)

Fig. 7:
WKLB @ –10 dBc
(–9.21 dBc in Mode MP3)

World Radio History

MINSTRUMENT MATRIX

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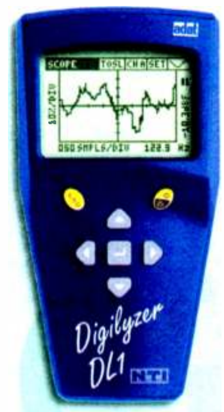
DL1 Digilyzer
Digital Audio Analyzer



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

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

DR2 Digirator
Digital Audio Generator

The DR2 Digirator not only generates digital audio in stereo & surround, it is a channel transparency and delay tester as well, all condensed into a handheld package. Delivering performance & functionality challenging any digital audio generator made today, it produces all common audio test signals with sampling frequencies up to 192 kHz and resolution up to 24 bit. The Digirator features a multi-format sync-input allowing the instrument to be synchronized to video and audio signals. In addition to standard two-channel digital audio, the DR2 can source a comprehensive set of surround signals.

- AES3, SPDIF, TOSLink, ADAT outputs
- 24 bit 2 channel digital audio up to 192 kHz SR
- Sine wave with stepped & continuous sweeps; White & Pink Noise; Polarity & Delay test signals
- Dolby D, D+, E, Pro-Logic II, DTS and DTS-HR surround signals
- Channel Transparency measurement
- I/O Delay Measurement
- Sync to AES3, DARS, word clock & video black burst
- User-generated test signal files

AL1 Acoustilyzer
Acoustics, Audio & Intelligibility Analyzer

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

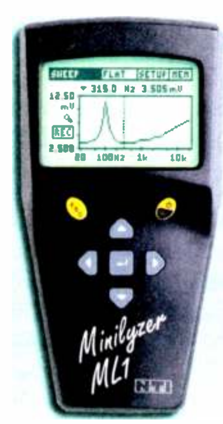
- Real Time Analyzer
- Reverb Time (RT60)
- Delay measurements
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- Automatic Distortion analyzer (THD+N)
- Frequency, RMS Level, Polarity measurements
- Requires optional MiniSPL microphone
- Includes MiniLINK USB interface & Windows PC software for storing tests and PC transfer

MR-PRO Minirator
High performance
Analog Audio Generator +
Impedance/Phantom/Cable measurements

The MR-PRO Minirator is the senior partner to the MR2 below, with added features and higher performance. Both generators feature an ergonomic instrument package & operation, balanced and unbalanced outputs, and a full range of signals.

- High (+18 dBu) output level & <-96 dB residual THD
- Sine waves & programmable swept (chirp) and stepped sweeps
- Pink & white noise
- Polarity & delay test signals
- User-generated custom test signals & generator setups
- Impedance measurement of the connected device
- Phantom power voltage measurement
- Cable tester and signal balance measurement
- Protective shock jacket

ML1 Minilyzer
Analog Audio Analyzer



The ML1 Minilyzer is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand.
The comprehensive feature set includes standard measurements of level, frequency and THD+N, plus VU+PPM meter mode, scope mode, a 1/3 octave analyzer and the ability to acquire, measure and display external response sweeps generated by a Minirator or other external generator.

Add the optional MiniLINK USB computer interface and Windows-based software and you may store all tests on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.


MiniLINK

- Measure Level, Frequency, Polarity
- Automatic THD+N and individual harmonic distortion measurements k2 – k5
- VU + PPM meter/monitor
- 1/3 octave analyzer
- Requires optional MiniSPL microphone for SPL & acoustic RTA measurements
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

MR2 Minirator
Analog Audio Generator

The MR2 pocket-sized analog audio generator is the successor to the legendary MR1 Minirator. It is the behind-the-scenes star of thousands of live performances, recordings and remote feeds.

- Intuitive operation via thumbwheel and "short-cut" buttons
- New higher output level (+8 dBu) & low distortion
- Programmable Swept (chirp) and Stepped sweeps
- Sine waves
- Pink & White noise
- Polarity & Delay test signals
- Illuminated Mute button

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Operating Power

For these tests, WKLB chose to operate each transmitting facility at various total power levels from 20 dB to 10 dB below that of the reference analog carrier. The digital to analog power ratio was verified using digital power meters and transmission system loss/antenna gain calculations supplied by the equipment manufacturers.

Mobile Reception Test Results

Referencing Fig. 5 (page 1), it can be plainly seen that at the currently authorized –20 dBc power level there are significant and serious digital coverage deficiencies within the WKLB 54 dBu protected analog contour on all routes measured.

It should be emphasized that the "cliff edge" propagation characteristics of digital signals, and specifically IBOC digital radio signals, make *any* loss of the digital signal, even momentary, extremely irritating to the listener. The effect is not one to which a listener is accustomed, such as multipath or picket fencing, where the audio is still available, albeit compromised. A listener to an HD-1 channel will sense a fall back to the underlying analog signal, which is likely blended to mono and/or experiencing high-frequency roll-off resultant from circuitry included in virtually every analog auto radio, resulting in the loss of stereo perspective and a significant decrease in fidelity.

The situation with HD-2 and HD-3 channels is worse; the signal is simply gone. More than an extremely occasional instance of any such impairment will cause listeners to seek another audio entertainment option.

A close examination of each route will show multiple and numerous instances of intermittent loss of digital service, even prior to those areas where digital service is largely absent.

Fig. 6, representing service at –14 dBc (6 dB above the currently authorized digital power level), shows significant improvement on all routes but also shows evidence of occasional losses of the digital signal within the underlying analog 54 dBu protected contour, again even prior to those remaining areas where the digital signal is more seriously compromised.

Attention is directed to I-93 (between I-495 and the 54 dBu contour), I-495 (from I-93 to the 54 dBu contour) and even I-90 (immediately west of I-495). All these areas exhibit multiple momentary digital signal dropouts, well within the analog coverage area of WKLB. Clearly, operation at –14 dBc provides significant improvement, but *fails* in terms of replication of analog signal coverage, an absolute requirement if digital radio is to be the successor to that service and the key to listener satisfaction and acceptance.

WKLB High Power Building Penetration Test Locations

Location #1
Greater Media
55 Morrissey Blvd
Boston, MA 02125

N 42° 19' 09.93"
W 71° 03' 00.65"

Location #2
The Caning Shoppe
200 Elm St.
N. Cambridge, MA 02140

N 42° 23' 35.29"
W 71° 07' 14.60"

Location #3
Prudential Tower
800 Boylston St. / 26th Floor
Boston, MA 02140

N 42° 20' 49.78"
W 71° 04' 57.08"

Location #4
Residence
104 Haggetts Pond Rd.
Andover, MA

N 42° 38' 53.02"
W 71° 12' 50.35"

Location #5
Comrex Corporation
19 Pine Rd
Devens, MA 01434

N 42° 32' 35.90"
W 71° 37' 11.40"

Location #6
Residence
641 S. Washington St.
N. Attleboro, MA

N 42° 23' 35.29"
W 71° 07' 14.60"

Map 1: Site Map for Building Interior Reception Tests.

Fig. 7, representing service at –10 dBc (10 dB above the currently authorized digital power level), shows marked improvement in digital service, as compared to Fig. 2. Other than terrain shadowed area in the Providence/Pawtucket and Plymouth areas, digital reception is virtually flawless over the various routes.

It is *extremely* important to observe, other than those areas just noted, there are virtually *no* areas where any momentary digital signal drop outs are evident. This is the level of service a listener anticipates and expects. This is the level of service necessary to ensure the continuing successful roll out of digital radio.

Mobile Reception Conclusions

Clearly, digital radio service at the currently authorized power of level of –20 dBc does not come close to providing the robustness and quality of service anticipated and expected by listeners, based on an analog reference point. This first-of-its-kind survey of an entire metropolitan area proves that fact beyond any reasonable doubt.

Station operation at –14 dBc, a four times digital power increase, substantially improves digital coverage but still does not provide either flawless digital service nor replication of the underlying analog service area, two very basic and critical listener expectations.

Station operation at a –10 dBc level, as proposed by the joint parties, *does* result in largely impairment-free coverage and replication of analog service. It is critical to understand that the failure mode of a multicast digital radio signal is dramatic and unfamiliar to a listener, representing a total loss of service. Such irritants must be absolutely minimized if listener expectations are to be met.

These maps show significant shortfall in coverage for the important suburban Boston communities of Lowell, Andover, Lawrence and Haverhill, Mass. to the north and Plymouth, Mass., Pawtucket and Providence, R.I., to the south. In addition, numerous areas of the heavily traveled Rt. 495 "beltway" experience severe dropouts of the HD Radio signal. It is apparent that WKLB cannot deliver commuters acceptable digital service at a power level of –20 dBc.

Increasing the digital power by 6 dB (to –14 dBc) dramatically improves the HD Radio listener's experience on heavily traveled Rt. 495. Beltway commuters north of Lowell and south of Attleboro can now receive WKLB's multicast programming without interruption. Coverage in Pawtucket and Providence improves, but dropouts of multicast reception here will cause listener tune out. Vacationers stuck in Cape Cod weekend traffic on Rt. 3 will likewise lose the WKLB multicast signal.

A full 10 dB digital power increase (to –10 dBc) appears to be the solution to most WKLB mobile reception issues. The only areas still compromised are low spots in Plymouth, Pawtucket and Providence.

FM HD RADIO SYSTEM PERFORMANCE IN BUILDING INTERIORS AT ELEVATED DIGITAL CARRIER LEVELS

Although at least one previous study (conducted by CBS Radio) has been completed pertaining to the relative ability of digital signals — at various power levels — to achieve penetration of structures, it is believed that the instant report adds appreciably to that body of knowledge and expands the universe of receivers to include the newly released Insignia NS-HD01 battery-operated portable HD Radio Receiver.

Observations were made in a number of varied structures representative of the majority of those in the Greater Boston area and, indeed, the entire United States. Six different locations were selected to be representative of the most common types of building construction.

Location 1, the Greater Media studio building in the Dorchester section of

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World Radio History

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Jessie Walker, Program Director

DMS Broadcasting, San Francisco, CA
" When we started, we were jumping into something we knew nothing about! We called your tech support & within a day they had a solution. It was miraculous. They helped us get wired up & set up. (Tech Support) had a positive & upbeat attitude. They went above & beyond!"
David Trudrung, General Manager & Co-owner

KSMZ, Alexander, AR
" Xtreme has more flexibility, sounds better & has fewer problems then our stations running (other automation systems). It's easier to program & a 9 compared to other programs out there."
Scott Gray

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World Radio History

POWER

(continued from page 12)

Boston, is representative of low-rise (two-story) masonry, steel and glass construction. Location 2, The Caning Shop in the Cambridge section of Boston, is a single-story structure (with an occupied lower level) of wood and masonry construction. Location 3, the Prudential Tower, in the Back Bay section of Boston, is a high-rise skyscraper of steel, aluminum and glass construction. These locations (1–3) are all located within the urban core of Boston, within 8–10 miles of the WKLB transmission facility in Needham, Mass. (see Map 1).

Even though none are farther than 10 miles from the WKLB transmitter site, they all potentially can suffer from the "urban reception dilemma." Since many commercial buildings are metallic construction, shadowing, reflection and parasitic re-radiation of the HD Radio signal can cause it to fail. Excessive urban electrical noise only augments the problem.

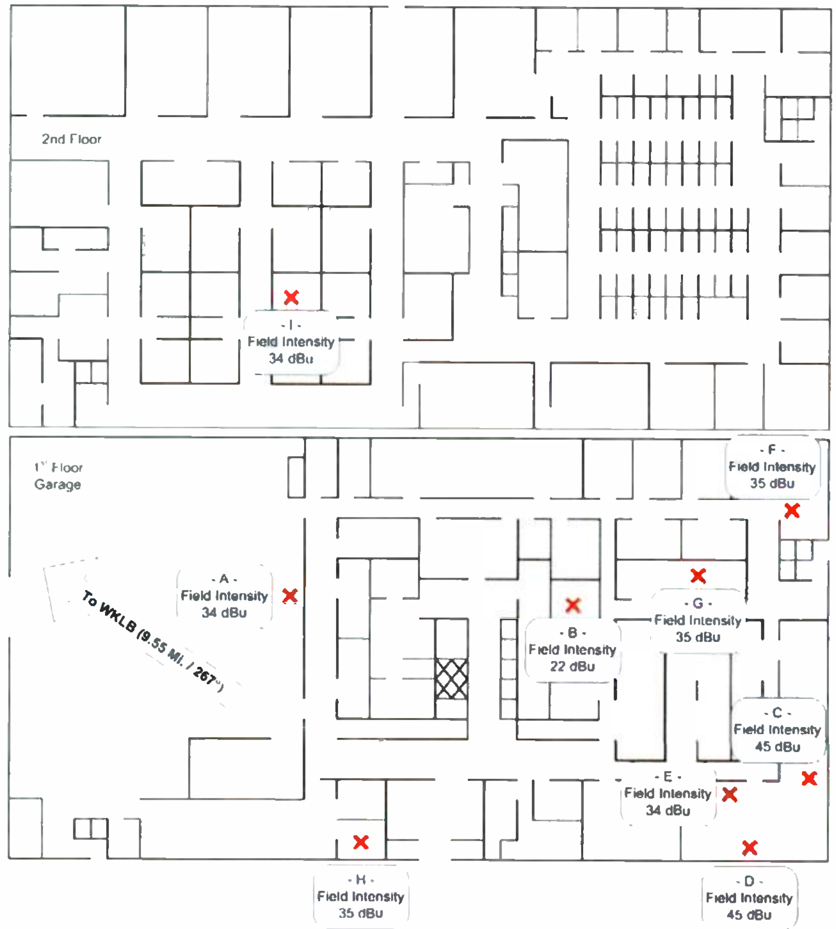
Location 4 is a typical two-story, split-level residence in Andover, Mass., of wood frame construction. Location 5, the headquarters of the Comrex Corp. in Devens, Mass., is a two-story steel-framed, wood building typical of many small- to medium-size commercial structures. Location 6 is a three-story apartment building in North Attleboro, Mass., of poured concrete (with rebar) construction. Locations 4–6 are located at approximately the edge of digital coverage assuming the currently authorized –20 dBc power level.

Receiver Equipment and Test Procedures

Two receiver models were used in the testing. A Sony XDR-S10HDiP table radio, one of the better-performing receivers of this genre, was used for evaluation at numerous fixed locations within each structure. As many as four of these receivers, operated with associated manufacturer supplied antennas, were utilized simultaneously to characterize reception at various locations within each structure.

The radio was connected to the supplied dipole antenna, supported vertically by a custom-made stand of PVC pipe. The manufacturer's antenna uses about 6 feet of unshielded twin-lead feeder cable. This cable not only acts as part of the antenna, but tests in iBiquity's semi-anechoic chamber showed losses of up to 8 dB over a reference dipole fed by coaxial cable. Nevertheless, the manufacturer's antenna was used in an effort to replicate the listener experience.

The second receiver, the Insignia NSHD-01 portable, was operated as it would be by a typical user, being moved about the interior of each structure to ascertain the availability of digital radio reception. All receivers were characterized



D/A Power Ratio (dBc) →		-20	-18	-16	-14	-12	-10
Portable Armband Rx's	FI (dBu)	% Reception on Walking Tour					
Cafeteria (C,D,E)	Varies 45 - 34 dBu	5%	5%	10%	20%	25%	35
Accts Payable (F)		10%	15%	20%	25%	30%	50
Shulins Office (H)		0%	0%	0%	10%	15%	20
2nd Fl WBOS PD (I)		0%	0%	20%	30%	50%	95
1st Floor Tabletops		Front Panel LCD Display					
Loc "A" Sony	34	None	None	None	Flash	100%	100
Loc "B" Sony	22	None	None	None	None	None	None
Loc "C" Sony	45	100%	100%	100%	100%	100%	100
Loc "D" Sony	45	100%	100%	100%	100%	100%	100
Loc "E" Sony	34	None	None	Flash	100%	100%	100
Loc "F" Sony	35	None	Flash	100%	100%	100%	100
Loc "G" Sony	25	None	None	None	None	None	None
Loc "H" Sony	37	None	None	Flash	100%	100%	100
2nd Floor Tabletops		Front Panel LCD Display					
Loc "I" Sony	34	None	None	None	Flash	100%	100
Outside Tabletop		Front Panel LCD Display					
Loc "J" Sony	54	100%	100%	100%	100%	100%	100

Location #1
Greater Media
55 Morrissey Blvd
Boston, MA 02125

N 42° 19' 09.93"
W 71° 03' 00.65"

Two Story / Reinforced Concrete / Steel / Aluminum Construction
Scale: 1/32" = 1'

Location #2

The Caning Shoppe
200 Elm St.
N. Cambridge, MA 02140

N 42° 23' 35.29"
W 71° 07' 14.60"

Single Story
Cinder Block Construction

A - 1st Floor (FI = 52 dBu):
HD Reception on Sony Tabletop and Portable Armband in all locations at -20 dBc

B - Basement (FI = 37 dBu):
Sony Tabletop:
-20 dBc: No HD
-14 dBc: 75% HD
-12 dBc: 100% HD

KRI Armband:
-20 dBc No HD
-12 dBc 75% HD
-10 dBc 100% HD

C - Outside (FI = 52 dBu):
HD Reception on Sony Tabletop and Portable Armband in all locations at -20 dBc

Scale: 1/8" = 1'
Gray Grid is 10' X 10'

World Radio History

in the iBiquity Digital laboratory to verify that each met its published specifications.

Observations were made at each receiver, at each location and at each incremental power level to ascertain the availability of digital reception. In the case of the table (Sony) receiver, reception was characterized as "analog," "flashing," or "100%." "Flashing" indicated illumination of the HD mode indicator but not actual digital reception. "100%" indicated reception of the digital signal. In the case of the portable receiver, the approximate availability of digital reception, as expressed as a percentage, was noted as the receiver was moved about the area of interest.

Actual field strength was documented at each test location as well as at the exterior of each of the six structures evaluated. FM analog field intensity was measured in dBuV with a Z-Technology model R-507 field intensity meter connected to an ETS-Lindgren model 3121C-DB2 calibrated dipole antenna whose elements had been adjusted to the proper length. The antenna was used in vertical polarization only to minimize h-pol directional effects. An average reading was obtained by slowly moving the calibrated antenna of the Z-Technology field intensity meter in a one meter square area around the test location. The test antenna was removed to prevent measurement error due to parasitic coupling of elements.

To determine the point of digital signal acquisition, up to four Sony radio receivers were placed randomly around each of the test areas. The digital power was increased in 2 dB steps from –20 dBc to –10 dBc until the radio solidly locked onto the digital signal. The point of digital signal acquisition was tabulated for each receiver.

Test Results by Location

Referencing Location 1 (see diagram, opposite page), it can be plainly seen that as one moves further into the interior of this building, digital reception becomes increasingly impossible at the – 20 dBc power level. Further, reception by the portable armband receiver is virtually nonexistent at any location within the building at the currently authorized power level. Keep in mind that this location is less than 10 miles from the class B transmission facilities of WKLB(FM).

Increasing the digital power level to –12 dBc results in digital reception by the table radio at most location but –10 dBc is required to achieve any effective reception by the portable receiver.

At Location 2, HD reception is possible at –20 dBc on the first floor level of the structure. However in the occupied basement level there is no HD reception whatsoever. At –14 dBc reception at this location improves to 75 percent but –12 dBc is required to achieve 100 percent reliability on the tabletop receiver and –10 dBc is required for seamless reception on the portable (see Location 2 diagram).

Location 3, on the 26th floor of the Prudential Tower Building, with direct line of sight to the WKLB transmitter site in Needham, exhibited relative high levels of signal within the surveyed space resulting in good reception on the table radio in all areas with direct exposure to the large exterior windows. As one moved further into the building interior, increasingly higher levels of signal were required to maintain digital reception, with –16 dBc being necessary for digital reception at the building core.

Performance of the portable receiver was appreciably worse. At the –20 dBc power level only 50 percent digital coverage was achieved in the space surveyed, with –10 dBc being required to achieve 95 percent coverage.

At the Andover residence, Location 4, reception varied, as would be expected, depending on which floor (and thus which elevation) was surveyed. On the second floor, 100 percent HD reception on the table radio was achieved at –14 dBc while the armband receiver required –10 dBc for 85 percent digital reception. However on the first floor –10 dBc was necessary to achieve seamless reception on both the table and armband radios. At the basement level, –10 dBc was likewise necessary to achieve reliable table radio reception. The armband radio only achieved 20 percent reception at even the –10 dBc power level (see Location 4 diagram, next page).

At the headquarters of Comrex, Location 5, reception was again somewhat dependent on the floor level surveyed. On the second floor, a digital power level of –14 dBc produced acceptable reception at most fixed receiver locations (–10 dBc was required for seamless reception at all locations) while on the first floor only –10 dBc resulted in reception at 50 percent of the locations. Reception by the portable receiver improved from 10 percent to 80 percent on the second floor and from 1 percent to 65 percent on the first floor with a digital power increase of 10 dB.

Location 6, an apartment building in North Attleboro, exhibited no HD reception on any receiver at any location at the –20 dBc digital power level. In every case, –10 dBc was required to achieve digital reception on the table radio and to achieve reception at roughly 50 percent reliability on the portable receiver (see Location 6 diagram).

Structure Type Attenuation Characterization

Review of the data shows that the greatest amount of structural attenuation occurs in metallic buildings, or those using metal in construction. Visible metal such as window mullions as well as hidden building superstructures and concrete reinforcing rods all can potentially reflect or direct the RF signal.

The Greater Media Studio building (Location 1), the 26th floor of the Prudential building (Location 3) and Residence #2 (Location 6) all demonstrate the above. Additionally, concrete and steel apartment buildings (Location 6) easily render the HD Radio signal not receivable in core units. Wood frame

(continued on page 16)

> **Only a full 10 dB** increase will permit reliable service to portable receivers and result in a close approximation of analog coverage, two very basic and critical listener expectations.

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POWER

(continued from page 15)

dwellings and offices (Locations 4 & 5) without metalized vapor barriers or aluminum siding, on the other hand, do little to block the FM signal. Likewise, concrete block structures without metal reinforcement (Location 2) have minimal effect on reception.

Real-World Collateral Effects

If it is true that poured concrete structures present such a barrier to FM HD Radio signals, then the core of daytime in-office listeners will be cut off from their favorite multicast HD Radio programming (and any revenue generating advertising).

It seems reasonable to assume that office workers who are blocked from HD Radio reception at their desk or on their armband radios would drive home listening to their favorite format, only to be barred from reception in their apartment.

Listeners using a portable "armband" type HD Radio receiver can expect dropouts as they walk around the workplace, even in areas characterized by a high outdoor signal level. Armband radio listeners on the 26th floor of the Prudential Tower can only expect solid HD Radio reception if the transmitter is operating at a full –10 dBc digital-to-analog ratio.

Indoor Reception Conclusions

As can be readily ascertained from the test report and these comments, building penetration and thus the ability of listeners to readily receive digital radio signals in their workplaces and their homes is a significant challenge at today's –20 dBc digital power level.

Put more bluntly, in many building types, digital reception is simply impossible on well-performing table model receivers and similarly nonexistent on the new class of portable receivers about to be introduced into the market place.

Although an incremental digital power may serve to partially mitigate the situation for plug-in receivers in some fixed locations, only a full 10 dB increase will permit reliable service to portable receivers and result in a close approximation of analog coverage, two very basic and critical listener expectations.

Russ Mundschenk is field test and implementation manager for iBiquity Digital Corp. Milford Smith is vice president of radio engineering for Greater Media Inc.

Comment on this or any other article at rwee@nbmedia.com.

View diagrams for all six locations at www.radioworld.com.

Location #4

Residence
104 Haggetts Pond Rd.
Andover, MA

N 42° 38' 53.02"
W 71° 12' 50.35"

Split level / Wood Frame
Wood siding Construction

A - Outside (FI = 35 dBu):
Sony Tabletop:

-20 dBc:	50% HD
-14 dBc:	100% HD
-12 dBc:	100% HD
-10 dBc:	100% HD
KRI Armband	
-20 dBc:	75% HD
-14 dBc:	90% HD
-12 dBc:	100% HD
-10 dBc:	100% HD

B - 2nd Floor Kitchen
(FI = 34 dBu):
Sony Tabletop:

-20 dBc:	20% HD
-14 dBc:	100% HD
-12 dBc:	100% HD
-10 dBc:	100% HD
KRI Armband	
-20 dBc:	60% HD
-14 dBc:	70% HD
-12 dBc:	80% HD
-10 dBc:	85% HD

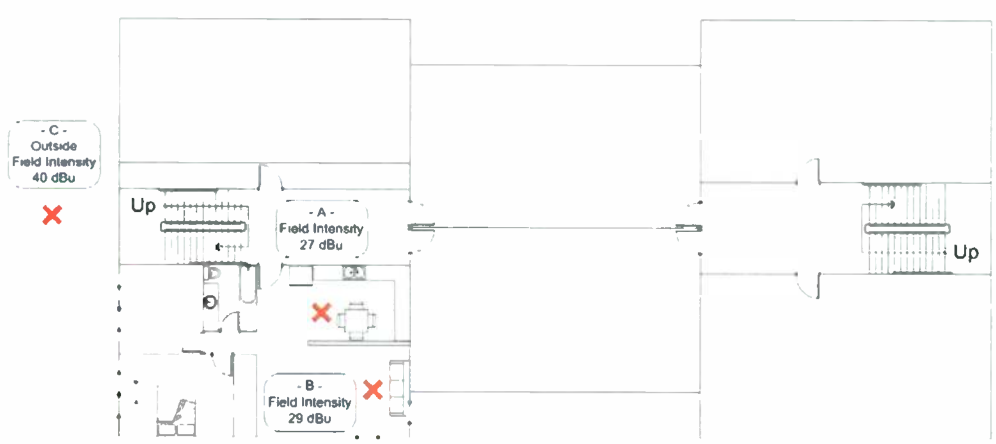
C - First Floor Living Room & First Floor Den
(FI = 32 dBu):
Sony Tabletop:

-20 dBc:	Flashing HD
-14 dBc:	Flashing HD
-12 dBc:	75% HD
-10 dBc:	100% HD
KRI Armband	
-20 dBc:	No HD
-14 dBc:	75% HD
-12 dBc:	100% HD
-10 dBc:	100% HD

D - Basement Room
(FI = 30 dBu) :
Sony Tabletop:

-20 dBc:	No HD
-14 dBc:	Flashing HD
-12 dBc:	75% HD
-10 dBc:	100% HD
KRI Armband	
-20 dBc:	No HD
-14 dBc:	No HD
-12 dBc:	10% HD
-10 dBc:	20% HD

Scale: 1/8" = 1'



To WKLB (24.72 Mi. / 13°)

Location #6

Residence
641 S. Washington St St.
N. Attleboro, MA

N 42° 23' 35.29"
W 71° 07' 14.60"

3 Story Apartment House
2nd Floor (Middle) Apartment
Poured Concrete and Rebar Construction

A - 2nd Floor Kitchen
(FI = 27 dBu):
Sony Tabletop:

-20 dBc:	No HD
-12 dBc:	Flash
-10 dBc:	100% HD
KRI Armband	
-20 dBc:	No HD
-12 dBc:	20% HD
-10 dBc:	45% HD

B - 2nd Floor Living Room
(FI = 29 dBu):
Sony Tabletop:

-20 dBc:	No HD
-14 dBc:	Flash
-12 dBc:	100% HD
KRI Armband	
-20 dBc:	No HD
-12 dBc:	30% HD
-10 dBc:	60% HD

C – Outside @ Front Door
(FI = 40 dBu):
Sony Tabletop:

-20 dBc:	100% HD
KRI Armband	
-20 dBc:	75% HD
-14 dBc:	100% HD

Scale: 1/16" = 1'

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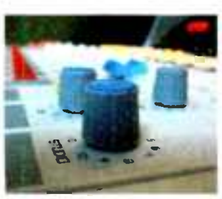

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- 26 slot frame with 20 input modules
- Input channel A/B source select
- Optional dual phone mix-minus module
- Optional line selector and control modules
- Opto-isolated control ports on every input module
- Four stereo output buses: PGM, AUD, AUX, UTIL
- Clock and timer
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Make Good Choices for Studio Success

Plan Ahead for a New Studio Location to Avoid Common Mistakes

BY CRIS ALEXANDER

In a company the size of the one I work for, it seems like we are always dealing with a studio lease somewhere. Most of the time, because moving is such a colossal pain, this is simply a renewal, but from time to time we do have to move. When that is the case, I have a long, difficult process to go through that starts more than a year before the actual move.

I do this sort of thing on a regular basis, but my guess is that most radio engineers do not. A studio move may be a singular event for many. Hopefully, knowing some of the pitfalls to watch out for in the process can save a lot of grief. While this discussion is targeted at lease situations, much of it also applies to property purchases for studio use.

It's common for a manager or owner to go out and find a studio leasehold on his or her own without consulting with the station's engineer. That is a mistake. At the very least, it might result in a less than optimum situation — one that the station will be stuck with for years to come. The task of building out the new facility and moving is likely to be more difficult than it should be. In the worst case, the location may not work at all. It's even possible that the station may not qualify as a "main studio" location.

To avoid making a big mistake, the chief engineer should be involved in the process from the very start.

In this first part of a two-part series, we'll deal with the go/no-go due diligence items. In the December issue, we'll finish up with some pointers on studio leases and tenant finishes.

THE ESSENTIALS

We've all heard that the three most important factors in any real estate transaction are "location, location, location." There is a lot of truth in that statement, and it is especially true when it comes to radio station studio leaseholds. There are many important factors to consider with respect to location, a few of which are:

- Main studio eligibility
- Zoning
- Line of sight to the tower
- STL frequency availability
- Telco service availability (ISDN, T1 and DSL)
- Satellite antenna siting

The FCC rules are very specific as to main studio location. Section 73.1125 spells out the criteria. The location must be within the community of license *or* within the city-grade contour of any station licensed to that community *or* within 25 miles of the reference coordinates of the community of license.

Scout the rooftop for potential STL antenna mounting locations. Parapets and elevator penthouses often make good antenna mounts.

If you're locating within your city of license, you're good to go, but if you're in a situation where your city of license is some distance from your desired location, one of the other two criteria applies.

The reference coordinates for most communities can be looked up on the FCC's Web site at the following URL: *www.fcc.gov/mb/audio/bickel/atlas2.html*. Finding out whether a location being considered is within 25 miles of the reference coordinates is a simple matter of finding the coordinates of the new location, looking up the community reference coordinates and doing a distance calculation between the two.

One important caveat: Be careful that you use the same datum for both sets of coordinates. Community reference point coordinates use the NAD27 datum. If you use a GPS to determine the coordinates of the site under consideration, be sure to switch the datum in the GPS unit to NAD27 or else convert those coordinates to NAD27.

Be sure to check the availability of satellite antenna siting at a prospective leasehold.

The other option is a bit more of a challenge — determining whether a location is within the city-grade contour (3.16 mV or 70 dBu for FM and 5 mV for AM) of any station licensed to your station's community of license. There are tools on the FCC Web site that can help with this, but one method I have used for AM stations doesn't require a lot of work. Simply take the field meter out to the new location and see if your station produces a 5 mV or better field intensity. If it does, by definition that locale is within the contour.

A Longley-Rice study is a good way to determine whether a site is within an FM station's contour. This type of study is generally not something a station engineer can do on his own; the services of a consulting engineer will be needed. The good news is that for a main studio eligibility study, only one radial need be run, and that should help keep costs down. Be sure to keep the study handy in case an FCC inspector later challenges the site's eligibility.

Zoning is often the last thing anyone thinks about when it comes to studio leaseholds. That's the landlord's problem, right? Wrong! If radio station studios are not included in the permitted uses for a particular

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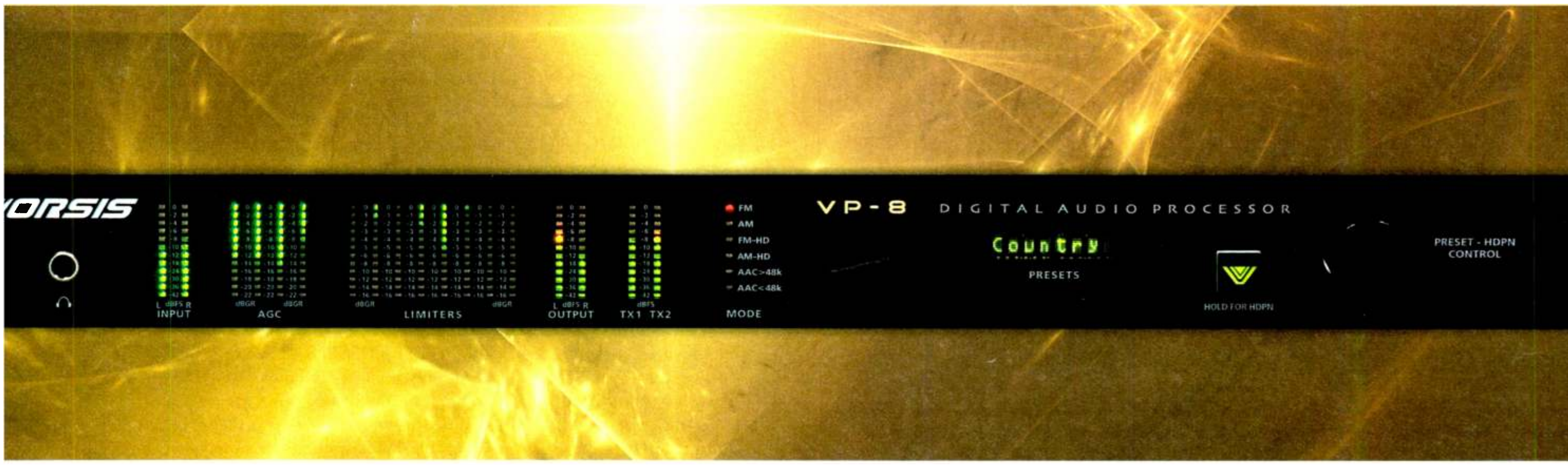

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World Radio History

STUDIO SUCCESS

(continued from page 18)

location, when the building permit application is filed you're going to get a big surprise — you'll have to go through the conditional use permit process, rezone the property or get a variance, none of which is easy or fast.

In reality, you can forget about rezoning because the landlord is unlikely to go along with that, so that leaves conditional use and variance. Count on at least 90 days in most venues to get an answer, and there is no guarantee that you'll get the answer you want. It's entirely possible that the application will be rejected and you'll have to look elsewhere for that new studio space.

The lesson here is to check the property zoning first and make sure you're covered.

CAN YOU BUILD AN STL?

The next couple of items on the list are related: line of sight to the tower and clear frequency availability. Without a clear line of sight to the tower, it won't matter if there is a clear frequency, so that's a good place to start.

If you can stand on the roof and see the tower, you should, in most cases, be good to go unless there are obstructions along the path that would make it a "grazing" path. Probably the worst-case situation is where there is an obstacle close to the studio — a building across the street, a line of trees or a hill. Such obstacles may not obstruct the direct path but they do produce considerable attenuation and will likely cause scatter that can interfere with other stations.

If the path is anything other than absolutely clear with no obstacles on either end, part of your due diligence should be to retain a consulting engineer to do a path study, or, if you have the tools and expertise, to conduct such a study yourself. You can do a path study using the profile tools available in many mapping programs. One of my favorites is DeLorme TopoUSA. Version 8 is the current release. You can plot a point for each end of the path, draw a line between them and have the program generate a profile. You can then analyze the path topography to make sure it is clear. Always drive the path and note the location and height of any obstacles.

Once you have a clear line of sight, finding a clear frequency is next on the list. Assuming you have an existing frequency, the best course of action is to see if it's possible to use that frequency from the new location. The services of a consulting engineer or frequency coordinator should be used for this. Companies such as Terrestrial RF Licensing and Micronet offer such services and can in many cases give a quick answer. When the time comes, they can then perform the FCC-required PCN coordination and even file the FCC application. If the existing frequency is unavailable in the new locale, they can do a search for a new one.

There are options other than the 944–952 MHz aural STL band for studio-to-transmitter links. Licensed point-to-point microwave links above 18 GHz are a good, cost-effective option in many parts of the country, especially if the path is relatively short. Unlicensed 5.7 or 2.4 GHz links may also be viable in many locations. I have used such links with success in several major markets. The bottom line is that if you have a clear path, chances are you can find a frequency to use, even if it is outside the normal STL band.

WHAT ABOUT TELEPHONE SERVICES?

Telco service is a critical component of just about any radio station operation. Who doesn't have ISDN these days? We use it for all sorts of program delivery purposes, from remote broadcasts to play-by-play. But it isn't available everywhere. Don't assume that just because a building has a 100-pair telco cable coming in that ISDN service is available.

Some stations also use T1 lines for various purposes, from STL to PRI (regular phone service) to Internet. Again, don't assume that a T1 circuit can be installed. In older buildings in particular, many cable pairs may have failed over the years, leaving just a few (if any) available for new circuits. Talk to the telephone company and make sure before you commit.

5.8 GHz unlicensed links can be used as an alternative to traditional 950 MHz STL systems.

DSL is another important service that we can't do without these days, and it's not available everywhere. There is an important go/no-go factor with DSL — distance to the central office — that must be below a certain threshold value. Check with the phone company and don't make any assumptions, regardless of the geographic distance to the nearest C.O. You may be surprised to find that the C.O. feeding the location is not the one just down the street!

THOSE PESKY ANTENNAS

Satellite antennas are an everyday part of radio station operation. We need them to bring in network feeds and other programming. The problem is that they're big and ugly. Many communities require a special or conditional use permit for satellite antennas, and others also require them to be fenced or hidden.

Is the landlord willing to allow you to put one or more satellite antennas in the parking lot or on the roof? Is the roof structurally capable of supporting such an antenna? Is there terrestrial interference at the new locale? These are all questions that must be answered before you commit to a new studio location.

One possibility, if you employ a high-bandwidth link to the transmitter, is placing the satellite antenna(s) at the transmitter site. You can use the bi-directional STL link to backhaul satellite audio (digital or analog) and control (relay) signals to the studio, keeping the satellite antennas out where they are not an issue. This might well become the deciding factor when selecting an STL frequency.

A couple of additional thoughts in closing: Watch out for buildings in historical districts or office "condos" where there is a Home Owners Association or architectural committee in place. In historical districts, you are unlikely to get clearance to install an STL or satellite antenna unless it can be completely hidden inside an existing parapet. If there is an HOA or architectural committee, you will have to get their approval for any outside antennas.

Finally, make sure that radio reception is good in the proposed new location. FM stations shouldn't have too much trouble unless the building is in an urban canyon. Remember that you need to hear not only your own signal but that of the EAS LP-1 and LP-2 stations as well. AM stations probably would not want to locate across the street from or next door to a welding shop. I have been involved in leasehold situations where it was impossible to get a clean off-air signal, with everything else being fine. Don't forget to check that important item.

Cris Alexander is the director of engineering at Crawford Broadcasting and a recent recipient of SBE's Broadcast Engineer of the Year award.

PRODUCTS & SERVICES SHOWCASE

World Radio History

FREE

(continued from page 22)

receiving news and entertainment.

Analogously, the time line for investors has been progressing through stages. Once, a financier might be content for the return on an investment to be realized over generations. Companies like Microsoft were content to see returns over a decade or more. In the 21st century, returns are expected in few years. The shortening time line reflects the uncertainty about changes in properties of the social system.

In the last decade, we have seen an evolution that now combines marketing and investment: collecting larger quantities of eyeballs and earlids (harvested heads) that are expected to be manipulated into buying goods and services through advertising. Captured heads are by themselves the investment.

Google, Twitter, YouTube and dozens of other companies around the world rapidly are increasing the quantity of eyes and ears in their herds. The radio industry is now in a deadly competition with these more recent head-space farmers. There is only a finite number of heads to be harvested.

MONETIZED HEAD-SPACE FARMS

Because there are now so many players in the fight for eyes and ears, the risk in managing the time line has become very complicated.

Successful head-space farmers struggle with the task of how to monetize their collection of heads. Investors are finding it more difficult to profit from investments that can take years, if not decades, to be realized. Head-space farms are being raided by new farmers, making the long interval between investment and profit very risky. The cattle farmer of the 19th century went bankrupt if he could not protect his herd.

My first experience being a harvesting target occurred in the early 1990s. I was a passionate consumer of Microsoft products and services because, compared to their competitors, their products were high in quality, low in cost and with excellent technical support. Investors supported this company because they knew that eventually Microsoft would own the software industry. I, and everyone else, would eventually pay for what we received years earlier. I was surprised to discover the hidden debt that I was paying years later: expensive and low-quality software with no competitive alternative.

But like all cultural shifts, there are both defensive reactions and successful adaptations to paying for something that I thought was free. At least for me, I do not like selling my head space. Rather than being captive in a cinema theater with loud penetrating advertising while waiting for the movie to begin, I have installed a home theater where I can control access to my head. My Internet browser has software to block and filter unwanted advertising pop-up windows.

When I buy a new computer, I discover that it has dozens of pre-installed trial software that is "free" for three months but then requires me to pay for a subscription. These software farmers pay the computer manufacturers to install their head-space capturing programs. Such payments allow the computer manufacturers to charge less, effectively an advertising subsidy. Since I routinely invest many hours on removing those head-space programs, I actually pay by investing my time, rather than paying directly to the computer manufacturer.

From the social system perspective of commercial entities using free as a currency, I am violating a hidden contract. I receive immediate goods and services but find ways of avoiding the final payment. This disruption undermines the model that has been evolving over the last few decades, and commercial radio is also one of the victims.

Unlike commercial radio, public broadcasting began with a different model, being paid out of the pool of money collected through taxes. Although equally indirect, this model actually was a prepayment for services to be rendered in the future. The model was stable, but limited. To augment their resources, public radio also collects payments from listeners and underwriters. They contribute to acquire brand awareness with benevolent overtones. They too are now buying access to head-space.

WHAT DOES IT MEAN FOR RADIO?

Successful broadcast professionals now understand that their survival depends on adjusting the connection between services and payment. Farms of captured listeners are being raided, which breaks the payment system.

From my perspective, the current attitude towards free cannot be salvaged because it is too complicated and fragile. Some companies have experimented with a subscription model, which is a form of direct payment, while others have been expanding free. Nothing appears to be working.

While we need to return to a more direct payment model, the culture has become addicted to "free" without either an initial or final payment. I, like many others, expect *free* to be really free, and that assumption is not sustainable on a large scale. While this may be a temporary state, the transformation to a more stable compromise is likely to be painful because it will not happen quickly. Patience may be the final answer: waiting until this phase of the life cycle progresses into the next stage.

READER'S FORUM

WHO IS THAT MASKED MAN?

First of all, thanks for printing an excellent publication and a tremendous resourse for those of us in the radio industry, most especially those of us in the engineering field. Of all the trade publications and magazines I subscribe to, Radio World and Radio World Engineering Extra are the only ones I religiously read cover to cover.

I wanted to comment on the article by Robert C. Savage that appeared in the most recent edition of RWEE (Aug. 19). I've been reading with some interest the exchange that's been going back and forth between Mr. Savage and Guy Wire. While I'm all for debate and lively discussion as I feel this type of interaction can help improve our industry and brings out some great ideas and helps move us forward, one paragraph in particular struck a real chord with me, and Mr. Savage put into words something I've been thinking for a few years now.

Mr. Savage signs his name to every article he's written, and in this past edition, he has provided his photograph to be printed for the readers to see as well. However, "Guy Wire" is allowed to make some fairly bold statements and offer some pretty opinionated content for your magazine while hiding behind the guise and using the pseudonym "Guy Wire." To be honest, I'm a bit surprised that a publication that expects to be taken seriously would allow this to happen. My guess is that none of your readers who would submit a letter to the editor or an article without signing their name to it could expect to have it published. However, Mr. Wire is held to a completely different standard and I don't think it's a fair one.

If Guy Wire were writing a non-opinionated column such as *Workbench*, which simply offered information, I wouldn't have as much of an issue with it. However, Guy Wire is allowed to write some opinionated material and even get into a bit of a heated exchange back and forth with readers who disagree with him, without anyone knowing who he/she is, who he works for, what his background and qualifications are, and with all of that being said, whether or not he carries some kind of personal or professional agenda.

Personally, I think it's time to remove the mask and let this person's true identity be known. If that's not a possibility, then I think he or she should stop having their opinionated columns printed in your publications. Let "Guy Wire" be held to the same standard and follow the same policies as the rest of your readers would have to do when submitting content for your magazines, and keep the playing field fair.

Mike Richardson

WRITE TO RWEE

To send a letter to the editor: E-mail *rwee@nbmedia.com* with "Letter to the Editor" in the subject field. Please include issue date.

ADVERTISER INDEX

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World Radio History

Free But Fragile

Deferred Payment Business Model Under Pressure From New Entrants

BY BARRY BLESSER

In my previous *Last Word* article (Aug. 19), I developed the idea that groups of individual elements — be they ants in an ant hill, radio engineers in the broadcast industry or teenagers on their social network sites — are social systems that have a life cycle.

Such groups can be large, as with major religions, or small, as with a nuclear family. Like living organisms, social systems have a life cycle that begins with conception and then proceeds through the stages of infancy, childhood, adult, maturity and finally death. Along the way, they spawn "children," who themselves progress through the stages.

When the life cycle of an industry is longer than the professional life cycle of an individual, it is hard to see the patterns. We seldom remember earlier stages other than with an occasional reference to the "good old days."

The radio industry in 1949 was at a different point in its life cycle than in 2009 because the social, political, economic and technical context of the larger culture has changed during this half century. The life cycle of radio, however, can only be understood by examining the life cycle of the culture within which it is embedded.

At the end of the previous article, I challenged you to analyze how life in the broadcast industry has been changed by the evolving social system that we inhabit in our personal and professional lives. This article is my view of an answer.

VARIATIONS IN PAYMENT PARADIGMS

Let's look at one component of the life-cycle within our social systems: the payment process for goods and services.

Over the centuries, the relationship between the market price of goods and the cost of producing them has evolved from simple, direct and reliable, to complex, indirect and fragile.

A 19th century shoemaker would price his shoes based on the cost of leather and the time required to make the shoes. Because of the simplicity of direct pricing, small businesses still use this relationship. I can remember how my first radio equipment invention in 1965 was priced using a formula based on the cost of components. In these cases, the market pricing and production costs are tightly linked.

With the advent of large powerful commercial organizations in the 19th and early 20th centuries, monopolies could

> **Let's look** at one component of the life-cycle within our social systems.

dominate a market with prices that could be dramatically higher than the cost of producing goods. In these cases, there was no coupling between price and cost.

From the experience with monopolies, now limited by anti-trust laws, all modern businesses of the 21st century learned to distinguish market price, which reflects the value to buyers, from production cost, which reflects the effort for creating goods. Today, a manufacturer of DVD players may have 10 models with different features and prices, but the production and distribution costs may be identical for all of them. In fact, the lower-priced models may simply have advanced features disabled with software flags. Price and cost are decoupled.

In a later stage of our economic life cycle, manufacturers discovered the economic power of "free." In the 19th century, oil lamps could be given away as long as a company could make money selling oil. In the 21st century, the cost of an ink jet printer is essentially free because the profit is in selling cartridges at very high margins. Cell phone companies will give you the phone for free, if you sign up for a long-term subscription with high prices. The model of free is now well-established: Google started with everything free and without advertising, as did Craigslist and sites such as YouTube, Mapquest, OnLine news and so on.

But "free" is never actually free; rather it is actually an indirect payment process that occurs long after the goods or services have been received.

In the early 20th century, radio broadcasting and newspapers were some of the first industries to embrace the model of free using a payment process that was delayed and indirect through advertising and sponsorship. Listeners and readers receive news and entertainment at no cost but they pay for those services when they buy brand-named food, beer or automobiles at a higher cost. The price of an automobile includes the payment for

(continued on page 21)

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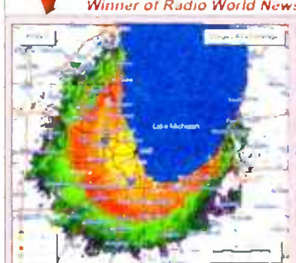

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