The future of AM and FM radio

Answering questions about HD Radio technology

BY JOHN GARDNER

With a feature known as Tomorrow Radio, iBiquity Digital Corp.'s trademark HD Radio technology causes one to pause and consider what the future of AM and FM radio holds. So what is HD Radio? Before getting the more consumer-friendly name of HD Radio, broadcast audio's next incarnation was dubbed in-band, on channel or IBOC. This system places two digital sidebands on either edge of the existing broadcast analog band (Fig. 1). The two bands can carry up to 150Kbps of digital data without compromising the analog signal.

Analog vs. Digital Tuner Specs

HD Radio Audio: How Much Better Is It?

	AM Analog	AM HD Radio	FM Analog	FM HD Radio
Separation	Mono	37dB > 8khz 90dB < 8khz	40dB	90dB
Signal to Noise	55dB	90dB	70dB	90dB
Frequency response	70-1.5khz (receiver dependent)	0-15khz	50hz-15khz (receiver dependent)	0-20khz
Total Harmonic Distortion (THD)	0.7%	<0.11%	0.6% (mono), 1% (stereo)	< 0.04%

Fig. 2: Comparison of analog AM and FM to HD Radio AM and FM (Source: iBiquity Digital Corp.)

HD Radio technology employs a proprietary codec called HDC that provides near CD-quality even down to 48Kbps

Most stations plan to deploy only 96 of these 150Kbps initially, until they become more comfortable with the system. In technical terms, the more data you want to send, the wider the digital sidebands and the closer they are to the analog signal. This has the potential to introduce interference, but signal enhancement techniques from companies like Texas Instruments and iBiquity Digital can help ensure the full quality of the analog and digital signals.

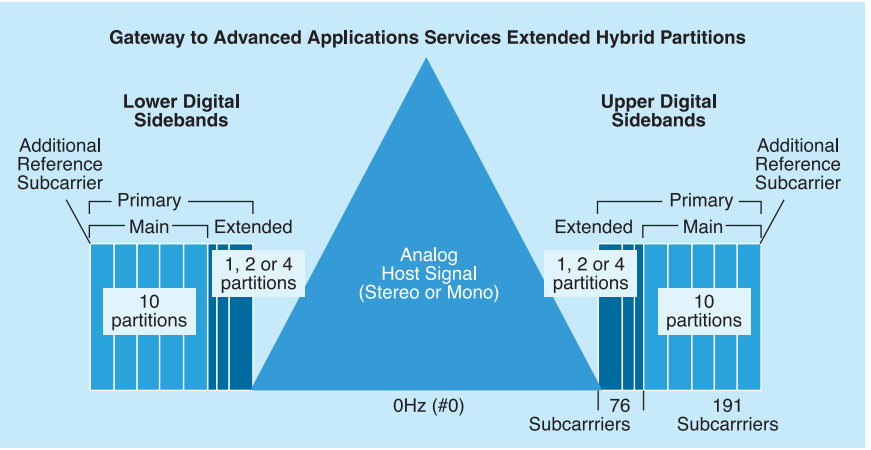

Fig. 1: HD Radio technology places two digital sidebands on either edge of the existing broadcast analog band, carrying up to 150Kbps of digital data without compromising the analog signal

The digital advantage

For audiophiles, quality of sound is the paramount consideration. Broadcast radio, especially in the car, just hasn't been able to match what consumers have come to expect from their home theaters or CD and DVD players. HD Radio technology changes this.

With 96Kbps, HD Radio technology doubles the number of bits, reaching near CD-quality sound. There is no static, no impulse noise, and listeners are able to crank up the sound and hear subtleties that they simply couldn't hear before (Fig. 2).

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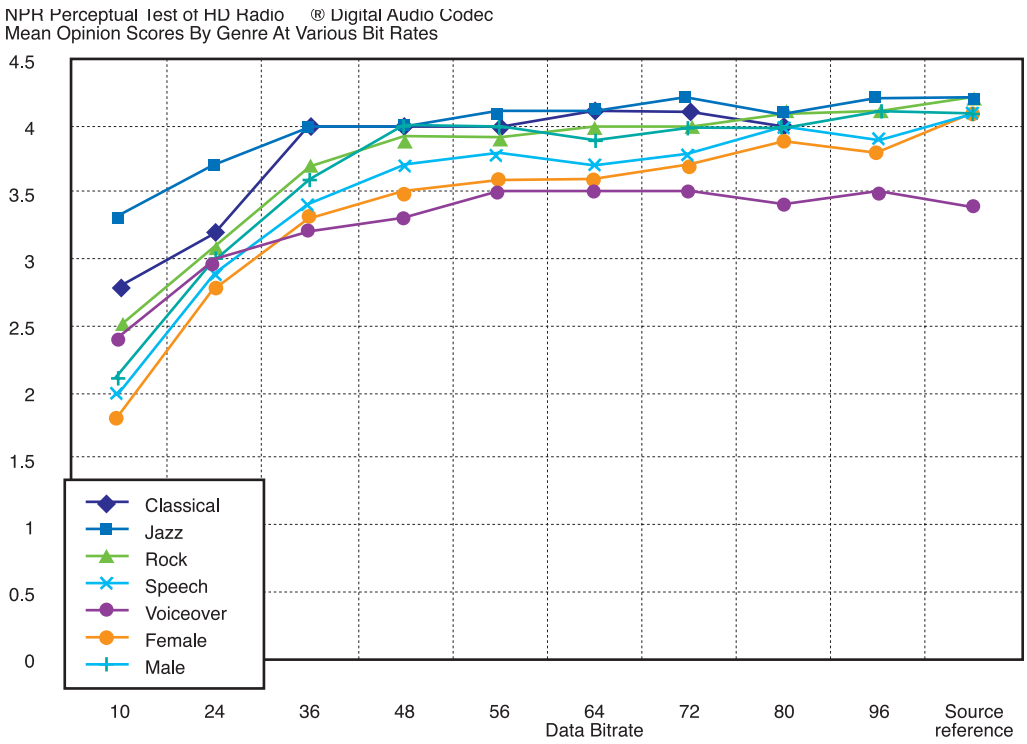

Fig. 3: By delaying the analog signal approximately five seconds behind the digital signal, an HD Radio receiver can buffer up to five seconds of audio. By blending between the analog and digital signals, the receiver can eliminate signal drops up to five seconds long, improving the overall listening experience

to 48Kbps and offers superior quality to existing FM analog.

"Even demanding engineers noted as having Golden Ears have quickly become believers that HDC is far better than analog," said Mike Starling, VP for Engineering and Operation at National Public Radio (NPR). Starling's words are based on extensive subjective audio testing by NPR throughout the summer of 2004, the results of which have been recently filed with the FCC. In general, and somewhat counter-intuitively, voice quality is more difficult to code transparently than music. Jazz quality, for example, has been shown to hold up at 36Kbps with close to CD quality while voice generally can go as low as 56Kbps with near transparency (Fig. 3).

Beyond audio

Beyond the improved sound quality, HD Radio technology gives broadcasters the ability to lower the bit rate for main channel programming and to introduce exciting new digital services. Starting with the artist name and song title, stations can begin to offer information feeds providing real-time news, weather, traffic, sports and stock information that will be displayed in the form of scrolling text on HD Radio receivers. As HD Radio technology becomes more established, more advanced services become possible, such as navigation systems that can tap into digital traffic reports and reroute drivers around accidents and other hold-ups.

Supplemental Audio Services would allow for the creation of a secondary, or B, channel to offer consumers more diverse content choices

For broadcasters, the high quality of digital radio offers a compelling business alternative: the ability to broadcast two distinct streams of programming on the same FM channel. "Supplemental Audio Services" (pending approval from the FCC) would allow for the creation of a secondary, or B, channel that will give stations the ability to offer consumers more diverse content choices. Consider a jazz station that wants to provide more than just music. Some of its listeners may want the latest news, traffic and weather, while other listeners complain that these extras are annoying breaks in their music. The station can now serve both listeners by playing jazz on the main channel and news on the supplemental channel. In this way, a listener who wants to hear about traffic can switch to the supplemental channel.

One of the strongest supporters of HD Radio technology is NPR, which coined the term Tomorrow Radio for its ability to broadcast multiple channels of audio from one radio station. Starling isn't shy about his excitement. "HD Radio is the high growth driver for broadcast audio. Numerous studies conducted over the past 15 years show that when there are multiple stations in a market, listenership goes up significantly," says Starling. With Supplemental Audio Services, both public and commercial FM broadcasters who adopt this technology will be able to double their broadcast capabilities without requiring any new spectrum.

How a station splits the channel actually depends upon how they are going to use the secondary, or supplemental, channel, and on the quality they require. Stations can split the 96Kbps bandwidth to fit their programming. The

split could even be dynamic; for example, a station could broadcast at 96Kbps and then scale back the main channel to a 64-32 split to enable a newsbreak on channel B.

Mixing analog and digital

It's important not to forget about the analog broadcast signal. Stations will still broadcast content over the analog channel to reach existing analog listeners with their primary content. However, one may ask, why not run alternate content over the analog channel, giving stations two or three channels instead of just one or two?

Analog also serves as a backup to the main digital channel

The reason is that the analog also serves as a backup to the main digital channel, so that if the digital signal is lost for any reason, the system will seamlessly blend back to analog without disruption to the listener.

This is accomplished by delaying the analog signal approximately five seconds behind the digital signal. Here's what happens when listeners turn on their digital radio. For the first five seconds, they'll hear the analog signal (the digital data itself is not delayed and, for digital services such as news or traffic feeds, the digital data is available for use immediately). Meanwhile, the radio will buffer the digital signal. When the analog signal catches up to the digital signal that the radio has stored up (to existing AM and FM in this example), the radio will blend over to the buffered digital signal. Whenever the digital signal is lost, the receiver can blend seamlessly back to the analog signal until the digital signal is restored. Blending between the analog and digital channels lets the receiver completely and transparently eliminate signal drops up to five seconds long.

HD Radio has already begun with more than 150 stations across the country

Home theater in the car

One of the most exciting possibilities of HD Radio technology is the ability to broadcast full 5.1-channel Surround sound. Many high-end car audio systems already support DVD audio and thus have the necessary speaker configuration to support Surround sound. The challenge lies in getting 5.1-channel content to the radio.

One method for achieving 5.1-channel Surround sound is the matrix approach. The station encodes a 5.1-channel track into 96Kbps stereo. If the HD Radio receiver supports matrixing, it can extract the 5.1-channel information. An alternative approach from SRS is Circle Surround technology, which converts a 96Kbps track down to 80Kbps. This leaves 16Kbps for steering information, telling the system which sounds go to which speaker with what delay. In either case, if the receiver doesn't support these technologies, it will ignore the encoded steering information and listeners still will hear high-quality stereo.

One exciting possibility of HD Radio technology is the ability to broadcast 5.1-channel surround sound

Given that there is no formal standard for implementing 5.1-channel audio, it is likely that different stations may choose to use different Surround sound standards. As a consequence, many radio manufacturers will base their radios on a single programmable digital signal processor (DSP) instead of several dedicated decoders. This will establish a less complex and less costly system.

What's on the horizon?

HD Radio technology is still emerging. Initial deployments will offer superior audio quality, information feeds, and the potential for a second content channel. However, it's not hard to imagine where HD Radio technology can go. Time-shifting will allow a listener to pause a live program or even rewind. The length of pause or rewind time will depend upon how much memory the radio has available for buffering. Reading services for the blind can provide access to newspapers or magazines. Receivers could buffer broadcast downloads offering more information about a subject being discussed on the content channel, reducing loads on station servers. Wireless interfaces would allow users to connect to their home networks for downloads or receiver configuration. Listeners could define the kind of content they want to hear. Work has already begun on creating a return channel where listeners can press a Buy button to get more information on a product through email.

Initial deployment of HD Radio technology has already begun with more than 150 stations across the country broadcasting in digital and HD Radio receivers available from Kenwood, Panasonic and JVC. You can hear the quality of HD Radio technology for yourself today by visiting www.hd-radio.com for a list of stations broadcasting digitally.

"I've been in the radio business for 30 years now, and it is so energizing and invigorating that HD Radio technology will bring the original wireless medium to such an exciting new level for consumers," says Starling.

John Gardner is marketing manager of digital radio & infotainment at Texas Instruments.

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Mailing Address: Texas Instruments
Post Office Box 655303
Dallas, Texas 75265