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In Band on Channel Technology

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ABSTRACT-

In-Band On-Channel (IBOC) Digital Audio Broadcast (DAB) System for improved performance over existing FM broadcasting is under development by Westinghouse for USA Digital Radio. Both the analog FM and the DAB signals are transmitted simultaneously in the FM Hybrid IBOC system. Broadcasters can simultaneously transmit both analog and digital signals within the allocated channel mask, allowing full compatibility with existing analog receivers. The adoption of IBOC technology, with many broadcasters choosing to continue using traditional analog broadcasting methods. However, as the technology continues to evolve and the benefits become more widely recognized, it is expected that more stations will transition to digital broadcasting in the coming years.

Keywords: In-Band On-Channel, Digital Sound Broadcasting, Coded Orthogonal Frequency Division Multiplexing.

Introduction

In-Band On-Channel, is a digital radio broadcasting technology that allows radio stations to transmit digital signals over the same frequency as their analog signals. This means that radio stations can continue to broadcast on their existing FM and AM frequency bands, while also offering listeners high-quality digital audio and additional programming options.

IBOC technology was developed as a way to improve the quality of radio broadcasts and provide listeners with more features and options, while maintaining compatibility with existing analog radio receivers. IBOC technology works by using digital compression to reduce the size of the audio signal and then combining it with the analog signal. The digital signal is then transmitted in the same frequency band as the analog signal, but at a different time. When the. Overall, IBOC technology represents a significant advancement in radio broadcasting, providing listeners with better audio quality and more options while also allowing broadcasters to maintain their existing frequency bands.

The development of new highquality stereo codec algorithms indicates that virtual-CD stereo. This puts these digital signals within the analog radio channel used by stations operating on 1st-adjacent frequencies. For example the HD Radio carriers of a station licensed for 99.1 MHz would sit within the analog channel of stations operating on 99.3 MHz and 98.9 MHz. While HD Radio is referred to as an "in-band, on-channel" system, this is not an entirely accurate description of what actually happens. The digital signals are indeed "in-band" (i.e. in the FM band since their primary energy is transmitted in channels that are immediately above and below the channel on which theanalog signal is being transmitted.

Brief FM IBOC System Description

The power spectrum of IBOC (In-Band On-Channel) refers to the distribution of power in the frequency domain of a signal transmitted using the IBOC system. In an FM IBOC transmission, the power spectrum is divided into two parts: the analog and digital portions. The analog portion of the spectrum covers the same frequency range as traditional analog FM broadcasting, while the digital portion is typically located above or below the analog signal.

On the other hand, DAB uses a different frequency band than the analog signal, and the digital signal is transmitted using a technique called orthogonal frequency-division multiplexing (OFDM). This allows for more efficient use of the frequency spectrum and can provide higher quality sound and more robust reception.

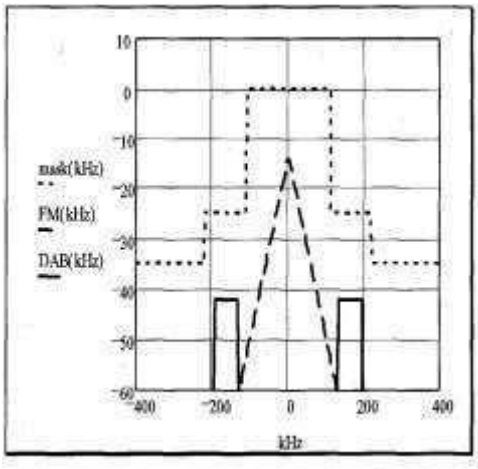

Fig : IBOC Power Spectrum

Why Digital Radio ?

We use digital radio in IBOC for several reasons, including improved sound quality, better reception, and the ability to transmit additional information alongside the audio signal. digital radio is improved sound quality. Analog radio signals are subject to noise and interference, which can degrade the sound quality. Digital radio signals, on the other hand, are less susceptible to noise and interference, and can provide higher audio. digital radio is better reception. Analog radio signals can suffer from fading interference due to factors such as distance from the transmitter, obstacles in the signal path, or electromagnetic interference. Digital radio signals are more robust and can provide better challenging environments.In addition to improved sound quality and better reception, digital radio also allows for the transmission of additional information alongside the audio signal.

Technology

In IBOC (In-Band On-Channel) broadcasting, diversity delay is a technique used to improve the reception quality of the digital IBOC signal in areas with poor signal conditions. The technique involves transmittingmultiple versions of the IBOC signal.

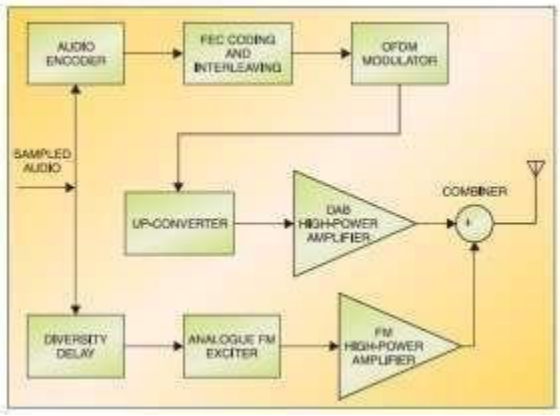

Fig 4:IBOC Dab Transmiter

An audio encoder is a software or hardware device thatis used to convert analog or digital audio signals into a compressed digital format.The purpose of an audio encoder is to reduce the size of the audio file while maintaining an acceptable level of audio quality.

FEC (Forward Error Correction) coding is a technique used in digital communication systems to improve the reliabilityof data transmission over a noisy channel.

Orthogonal Frequency Division Multiplexing (OFDM): In OFDM, the frequency band is divided into multiple sub- carriers, and each sub-carrier is modulated with a separate data stream.

In a DAB (Digital Audio Broadcasting) transmitter, an upconverter is used to convert the baseband signal, which contains the compressed digital audio and data services, to a higher radio frequency that can be transmitted over the air. Orthogonal Frequency Division Multiplexing (OFDM): In OFDM, the frequency band is divided into multiple sub-carriers, and each sub-carrier is modulated with a separate data stream.

In a DAB (Digital Audio Broadcasting) transmitter, an upconverter is used to convert the baseband signal, which contains the compressed digital audio and data services, to a higher radio frequency that can be transmitted over the air.An IBOC transmitter is designed to transmit digital signals alongside analogFM signals within the same FM broadcast band.

The transmitter uses a combination of amplitude and phase modulation techniques to insert the digital signal onto the analog FM carrier, allowing for backward compatibility with existing analog FM receivers would improve performance over the carrier spacings reported here.

These results indicate that moving the' DAB away from the FM carrier, increasing the number of DAB carriers, and pulse shaping the transmitted DAB symbols to reduce spectral sidelobes will significantly improve the pélformance of the host FM. Modulation and coding characteristics of the DAB Signal can be traded for spectral occupancy to meet these goals. Note that the new DAB .

Modes of IBOC Operation

There are three IBOC modes of operation. IBOC allows transition from analog to digital through a Hybrid and Extended Hybrid mode of operation, before adopting an All Digital mode of operation. The digital signal is modulated onto a large number of subcarriers, using orthogonal frequency division multiplexing (OFDM), which are transmitted simultaneously

Hybrid mode

The IBOC Hybrid mode digital signal is transmitted in sidebands either side of the analog FM signal and each sideband is approximately 23 dB below the total power in the FM signal. The hybrid sidebands are referred to as Primary Main (PM) sidebands.In hybrid mode, the digital signal is embedded within the existing analog signal, allowing both types of receivers (analog and digital) to receive the same broadcast. This approach is designed to ensure backward compatibility with older analog receivers while providing the benefits of digital transmission, such as improved sound quality and reduced susceptibility to interference.

Extended mode

The IBOC Extended Hybrid mode digital sidebands are extended towards the analog FM signal to increase digital capacity. The extended hybrid sidebands are referred to as Primary Extended (PX) sidebands. The total power of the digital sidebands is 20 dB below the nominal power of the FM analog carrier with power relative to total analog FM power of 41.39 dB/kHz. the extended hybrid mode, the digital signal is designed to fill in the gaps and correct errors in the analog signal. The digital signal can also provide additional audio information, such as song title, artist information, and album art, which can be displayed on a compatible receiver.

All Digital Mode

All-digital mode is that it provides more efficient use of the available radio spectrum. Because there is no analog signal being transmitted, more data can be transmitted in the same amount of bandwidth, resulting in higher quality audio and additional features such as metadata, program-associated data, and emergency alerts.
With IBOC All Digital, the primary digital sidebands are extended as in IBOC Extended Hybrid and the analog signal is removed and replaced by lower power digital secondary sideband.

Advantages

Improved Sound Quality: IBOC technology allows for the transmission of high-quality digital audio, which can result in clearer sound and fewer interruptions ordistortions than traditional analog radio.

Emergency alerts: IBOC technology can be used to transmit emergency alerts and warnings to listeners in real- time. This can be particularly useful during natural disasters or other emergencies

Almost full immunity from typical FM multipath receptionproblems

Significantly improved full stereo coverage Flexible data casting opportunities

Efficient means for FM broadcasters to begin thetransitionto digital broadcasting

Use of OFDM in IBOC allows on-channel digital repeaters IBOC enables the broadcaster to select the desired audio quality and data transmission rate however,as expected, there is a trade off between audio quality and the data transmission rate

Conclusion

The IBOC spectral emission, in all three modes of operation, falls within the emission standard for the Australian FM Sound Broadcasting Service.

Objective test results conclude that on introduction of a Hybrid IBOC digital transmission there is potential for reduction of the host analog audio quality in home stereo receivers and portable radio ,the digital radio is beneficial over analog and Digital radio can deliver the high quality digital sound and services. DAB becomes more important technology in future.IBOC is capable of transmitting audio services and a variety of wireless data services.

At the basic level, it will enable broadcasters to transmit data related to digital audio programming, including song title, artist and station information. The initial receiver applications are expected to include the ability to display simple text information related to audio programming. Additional data services are expected to include the delivery of paging-like services, including traffic, weather, sports scores, stockquotes and target.

The FM IBOC DAB system will provide virtual- CDquality stereo audio using redundant spectral sidebands to provide frequency diversity and immunity[t1ofirst-adjacent interference. Time diversity is provided through interleaving. A blend-to-analog feature, with time diversity on the order of seconds, permits virtually instant tuning time while filling DAB audio gaps due[7to]blockages or severe impairments. This feature will dramatically improve coverage in areas characterized by intermittent blockages.

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