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Review On AM/FM In-Band On-Channel Digital Radio

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Abstract

AM/FM In-Band On-Channel (IBOC) is used as next generation digital radio technology in most of the countries which uses the existing analog AM/FM broadcast frequencies. The National Radio Systems Committee (NRSC) has published recommended standards that specify IBOC signals, both hybrid and digital which must be transmitted below the defined spectral emission limits. Using the IBOC technology it will replace stereo quality FM transmission with CD quality sound using the same FM channel. This paper outlines the basic technical fundamentals of IBOC, the present status of the technology and the possible impact of IBOC on the broadcasting environment.

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

1. Introduction

IBOC digital radio technology facilitates the introduction of Digital Sound Broadcasting (DSB) by allowing present FM stations to send the same programming in analog and digital which need no new spectrum allocations for the digital signal. IBOC can transmit audio and a variety of wireless data services. At the basic level, it will enable senders to transmit data relating digital audio programming, including song title, artist and station information. The initial receiver models are having ability to display simple text information related to audio programming. Additional data services are expected to include the delivery of paging services which includes weather, sports scores, stock quotes, traffic, etc. The IBOC technology concentrates on a transition to digital that works within existing broadcasting infrastructure. The IBOC digital signal is placed within the existing analog FM spectral emissions mask, and as a result IBOC can be the digital solution which may be used without the need for new frequency allocations or without affecting to the existing broadcasting infrastructure. It presents that broadcasters use their existing transmission facilities and studio equipment with the addition of an IBOC exciter and in limited cases it upgrades to the station transmitter.

IBOC systems have been proposed for AM band. Digital audio is transmitted simultaneously with an analog host signal. For improving the reliability in the presence of channel impairments these systems use convolutional encoding to add redundancy to the digital data in each logical channel. The size of the logical channel vectors is increased in inverse proportion to the code rate and most service modes require puncturing of the mother codeword to produce a slightly greater code rate which allows a higher information rate through the same physical bandwidth. But the physical restriction of the wireless transmission environment presents a fundamental technical challenge for reliable high-speed communications. The technique of diversity is attracting more and more attention in these aspects. This paper outlines the technical basics of IBOC, the present scenario of the technology and the possible impact of IBOC on the broadcasting environment.

2. Literature Review

In 1920 radio become the essential need in everyday life and also the first commercial radio station is established throughout the world. The pioneers for this development as follows:

In 1886 Henrich Hertz concluded that the rapid variation of electric current could be projected into space in the form of radio waves.[2]

In 1895, Gugielmo Marconi uses the radio waves for sending and receiving the radio signals. In 1899 again the Marconi sends the wireless English Channel. In 1901 and 1907 Marconi succeeded in transmitting the radio telegraph message and hence he established the American-European wireless telegraph service.[2]

In 1907 Lee de Forest, make a patented device called as Audion. It is a triode vaccume tube which is able to boost radio waves when they are received and it is also called as wireless telephony. Because of this the signals which are broadcasted can be heard across the air.The first experimental FM

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station is constructed in 1930 by Edwin Howard Armstrong.[4]

`By the use of satellite technology in 1980 the first digital broadcasting system was developed which provide the CD like audio quality. The frequency range of this new system is 10-12Hz hence this is not suitable for mobile reception and it employed a low data compression.[5]

In 1986 from the different parts of the world such as France, Germany, UK and Netherland some organization are come together for the development of the new standard of radio technology for that they signed an agreement result of all this was Eureka-147.[9]

After that in 1993 the first ever DAB was adopted by ETSI as European standard used for digital radio. The new system Eureka-147 was not accepted by Japan and USA only, they developed their own standard for digital radio.[8]

3. What Is IBOC?

IBOC digital radio technology, also referred to internationally as Digital System, facilitates the introduction of DSB by allowing existing FM stations to broadcast the same programming in analog and digital without the need for new spectrum allocations for the digital signal. It is capable of transmitting audio services and a variety of wireless data services. At the basic level, it will enable receiver to receive data related to station information digital audio programming, including song title, artist. The initial receiver has ability to display simple text information related to audio programming. Additional data services include traffic, weather, sports scores, stock quotes and targeted messages. The IBOC technology developed by IBOC Digital Corporation focuses on a transition to digital that works within existing broadcasting infrastructure. The IBOC digital signal is placed within the existing analog FM spectral emissions mask, and hence IBOC is proposed as the digital solution which may be implemented without the need for new frequency allocations or without disruption to the existing broadcasting infrastructure. It is proposed that broadcasters use their existing transmission facilities and studio equipment with only the addition of an IBOC exciter and, in limited cases, an upgrade to the station transmitter. The IBOC system utilizes the existing AM and FM bands by attaching a digital side-band signal to the standard analogue signal. So if a station is currently located at 99.9 on the FM band, it will remain at 99.9 FM whether in analogue or IBOC digital radio. For digital compression, the IBOC uses a perceptual audio coder (PAC) developed by Lucent Technology.

4. Why Digital Radio?

Digitalization gives radio a new lease of life. Because of digitalization usual distortion associated with analogue radio such as hissing, popping and phasing was removed. It is far away from distortion such as multipath, adjacent stations, overly weak or overly strong signals, etc. Hence we get a new array of data-rich services including traffic information, sports score and weather updates, stock prices, etc. This data is displayed on the Liquid Crystal Display (LCD) on receiver in the form of text. With the help Electronic Programme Guides (EPGs) the audio features such as time-shift recording/digital recording of playlists is implemented. The different types of compelling end products such as MP3 players, cell phones and Personal Digital Assistants (PDAs) converge with digital radio. Hence the digital radio provides new advertising and electronic commerce opportunities to radio broadcasters. The signals arriving at the receiver is free of the usual noise associated with typical analogue, AM- or FM-generated signals because it does not have any interference.

5. IBOC Modes Of Operation

The mode of operation of IBOC is divided into 3 types:

1) Hybrid Mode
2) Extended Hybrid Mode
3) All Digital Mode

In IBOC the large number of subcarriers and OFDM is used for transmitting the signals simultaneously. Before adapting the all-digital mode IBOC has a transition from analog to digital through Hybrid and Extended hybrid.

5.1 Hybrid Mode

In hybrid mode 69.041 KHz bandwidth is used to insert the digital signal. The digital signals are inserted 129.361 Khz either side of the analog FMsignal. In this the digital signal are transmitted in sidebands either side of the analog FM signal and the total power in the FM signal is below 23 db.

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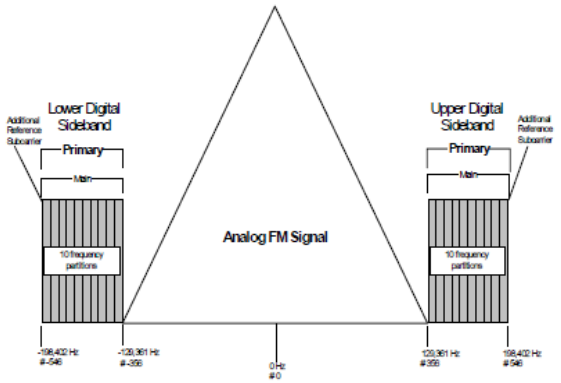

Fig.1 Hybrid Mode Of Operation

5.2 Extended Hybrid Mode:-

In this mode 97.617 Khz bandwidth is used to insert the digital signal. The digital signals are inserted 101.744 Khz on either side of analog FM signal. Hence the additional digital signal are inserted closer to analog signal. To increase the digital capacity digital sidebands are extended towards analog. The total power in the FM signal is below 20 db.

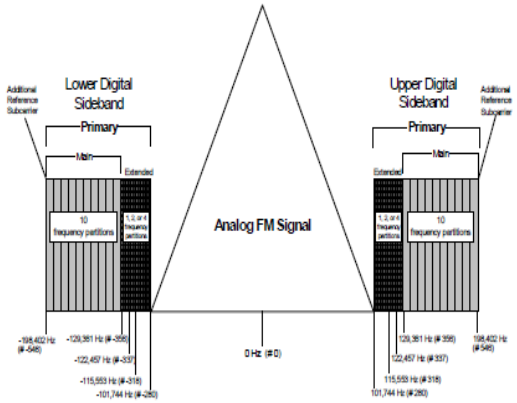

Fig.2 Extended Hybrid Mode

5.3 All Digital Mode

In this mode all the analog signals of hybrid and extended hybrid mode are replaces by digital signals. The total power in the FM signal is below 10 db.

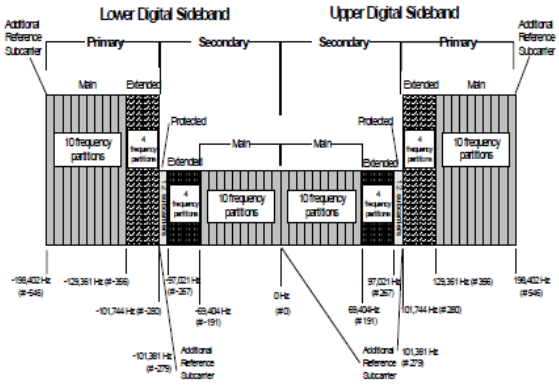

Fig.3 All Digital Mode

6. Conclusion

In this paper we have seen the different types of mode of operation of IBOC and the advantages of digital radio over analog radio system. Why the digital radio is beneficial over analog and how. Digital radio can deliver the high quality digital sound and services. DAB becomes more important technology in future.

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