April 9, 2012

Radio TechCheck

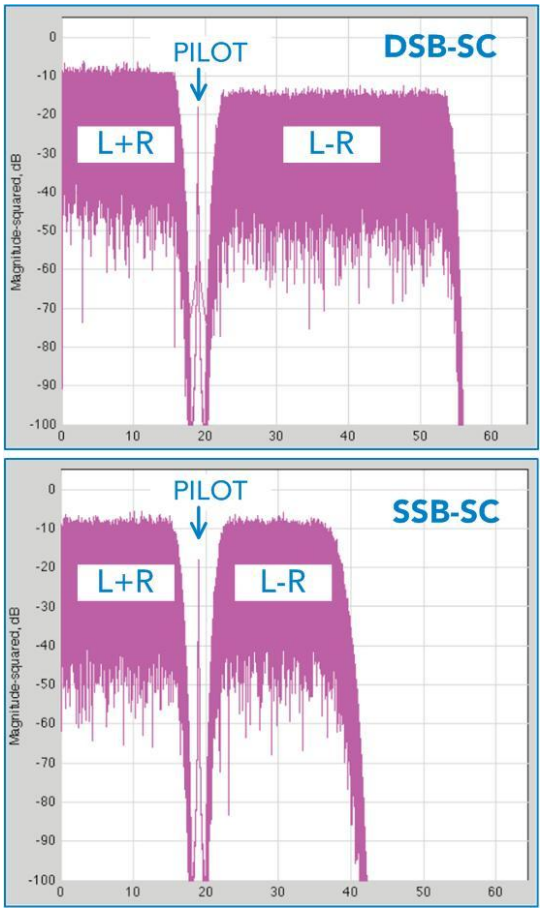
NAB NATIONAL ASSOCIATION OF BROADCASTERS

The Weekly NAB Newsletter for Radio Broadcast Engineers

FM-Stereo Transmission Using Single Sideband Suppressed Carrier (SSB-SC) Modulation

As codified in the FCC rules, FM stereo transmission uses double sideband suppressed carrier (DSB-SC) within the multiplex baseband signal as the means to transport the stereo sound field to the receiver. This method, while robust and reliable, is prone to the effects of multipath fading. A session at the upcoming NAB Broadcast Engineering Conference (BEC, April 14-19, 2012, Las Vegas, Nev.) entitled "*Advancements in Radio Technology*" includes a paper, excerpted here, which will discuss a different approach, utilizing single sideband suppressed carrier (SSB-SC) modulation, as a backwards-compatible alternative. This paper is entitled "*FM Stereo Transmission using Single Sideband Suppressed Carrier (SSB-SC) Modulation*," and was written by Frank Foti, President, Omnia Audio.

INTRODUCTION – FM radio has a good fight on its hands. As a media transom to the public, it battles a multitude of additional delivery services like never before. The FM stereo system, as described above, has worked quite well for 50 years, but not without challenges. Most notable is multipath distortion, especially in areas of congested buildings, hills and/or mountainous terrain. Also, radio broadcasters have added incremental signals within the multiplexed spectra. Radio Data System (RDS) services based at 57 kHz, as well as a 92 kHz SCA can additionally occupy the signal. The modulation index of the FM carrier is further reduced with each and every added signal, thus increasing the sensitivity of multipath distortion in the receiver. What can FM radio do, technically, to improve sonic performance so a listener has less reason to abandon it as an outlet?



ALTERNATE APPROACH – SINGLE SIDEBAND SUPPRESSED CARRIER – an alternative approach for stereo transmission would be the use of single sideband suppressed carrier (SSB-SC) as the mechanism to carry to the L-R payload. Shown in the figure is the existing method (DSB-SC, top image) and the alternative SSB-SC method (bottom image). The lower sideband is chosen as it reduces the occupied spectrum from 53 kHz down to 38 kHz. In order to support the correct L+R/L-R matrixing in the receiver, the amplitude of the lower sideband is increased by 6dB. This offers numerous benefits to the receiver including:

- Reduction of occupied bandwidth in the L-R subchannel range increases the FM modulation index by a factor of two. This directly reduces multipath distortion;
- Narrows the overall FM transmission bandwidth and reduces degradation of stereo performance caused by finite bandwidth of passband filters, cavities, multiplexing systems and antennas;
- Backward compatible with all existing modulation monitoring systems;
- Backward compatible with conventional receivers;
- Less harmonic content generated throughout the channel spectrum when composite clipping is employed in the transmission audio processor.

SSB-SC AND MODULATION PEAK CONTROL – implementing SSB-SC can be accomplished using numerous techniques. The most common method is through use of the Hilbert function, where a 90 degree broadband phase shift is used to cancel the undesired sideband. It can also be achieved using a Weaver modulator, or a low pass filter set to critically limit the desired passband, and the undesired sideband is removed through filtering. All of these methods provide satisfactory SSB-SC operation, but there is a critical element that must be considered – peak control of the overall multiplexed signal. In each of the aforementioned SSB-SC methods, there will be alteration to the phase relationship of the sideband signal. This alone will generate overshoot to the multiplexed encoded signal. It is paramount that SSB-SC modulation must not add any overshoot to the signal, and it must not add any unwanted non-linear components, in the form of audible overshoot peak limited harmonic content, *i.e.*, clipping by-products. The sonic performance of the SSB-SC modulator must perform sonically, exactly the same as the DSB-SC counterpart. Switching from DSB-SC mode to SSB-SC should not change the resulting sound in stereo separation, audio quality and peak control.

REAL-WORLD ACTIVITY: IN THE FIELD AND IN THE LAB – As of this writing, SSB-SC is on-the-air in multiple major markets (under FCC experimental authority), and all users report a reduction in perceived multipath. While most feedback is of the subjective anecdotal variety, there has been some initial lab testing done to determine, at the very least, if SSB-SC offers any degradation to FM service. Using a multipath generator that offered repeatable multipath profiles in a controlled environment, it was possible to gather data from a receiver operating under an impaired signal. This test indicated that SSB-SC offers no perceivable degradation to the FM service signal.

Mr. Foti will present this paper on Sunday, April 15, 2012 starting at 10:30 a.m. in room S228 of the Las Vegas Convention Center. It will also be included in its entirety in the *2012 NAB Broadcast Engineering Conference Proceedings*, on sale at the 2012 NAB Show Store and available on-line (after the Show) from the NAB Store (www.nabstore.com). Other papers being presented during this session include the following:

- *A New Approach to High Power Circulator Solutions for FM Dual Input Antenna Systems*, Nicholas Paulin, RF engineer, and Tom Silliman, president, both with Electronic Research, Inc.
- *Optimal Deployment Of An FM+HD Booster With A New Over-The-Air Repeater*, John Kean, senior technologist, NPR Labs, and Geoff Mendenhall, vice president transmission research and technology, Harris Corporation
- *Characterizing Digital SNR Improvement with FM IBOC Asymmetric Sideband Operation*, David Layer, sr. director, advanced engineering, NAB
- *Interactive HD Radio Opportunities*, Paul Donahue, Co-founder and CEO, Swan Digital Media Partners

For additional conference information visit the NAB Show webpage at www.nabshow.com.

IEEE Broadcast Technology Society Issues Call for Papers

A Call for Papers has been issued for the 2012 IEEE Broadcast Symposium, to be held October 17-19, 2012, in Alexandria, Va. The Symposium Committee seeks timely and relevant technical papers relating to all aspects of broadcast technology, in particular on the following topics:

- Digital radio and television systems: terrestrial, cable, satellite, Internet, wireless
- Mobile DTV systems (all aspects, both transmission and reception)
- Technical issues associated with the termination of analog television broadcasting
- Transmission, propagation, reception, re-distribution of broadcast signals
- AM, FM, and TV transmitter and antenna systems
- Tests and measurements
- Cable and satellite interconnection with terrestrial broadcasters
- Transport stream issues – ancillary services
- Unlicensed device operation in TV white spaces
- Advanced technologies and systems for emerging broadcasting applications
- DTV and IBOC reception issues and new technologies
- ATSC and other broadcast standards developments
- Broadcast spectrum issues – re-packing, sharing

The submission deadline for abstracts is May 15, 2012. Visit http://bts.ieee.org/images/files/2012_IEEE_BS_Call_for_papers.pdf for additional information. This Symposium is produced by the IEEE Broadcast Technology Society.