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Radio TechCheck

NAB NATIONAL ASSOCIATION OF BROADCASTERS

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FM+HD Booster Design Criteria

FM radio signals are often blocked due to shielding by terrain or man-made objects such as buildings in “urban canyons.” In such situations, on-channel boosters can sometimes be used to fill in the coverage area of a station as long as these boosters don’t extend the reach of the station’s protected service level, however these boosters must be used carefully because they can create new areas of interference.

A session at this year’s NAB Broadcast Engineering Conference (BEC, April 14-19, 2012, Las Vegas, Nev.) entitled “*Advancements in Radio Technology*” included a paper, excerpted here, which describes the development of optimum design criteria for an FM+HD Radio booster in Seattle, Wash., to avoid harmful multipath distortion effects caused by signal overlap with the primary station. This paper is entitled “*Optimal Deployment of an FM+HD Booster with a New Over-the-air Repeater*,” and was co-authored by Ellen Sheffield and Melinda Hines (Towson University, Towson, Md.), John Kean (NPR Labs, Washington, D.C.), and Geoff Mendenhall (Harris Broadcast Communications, Mason, Ohio).

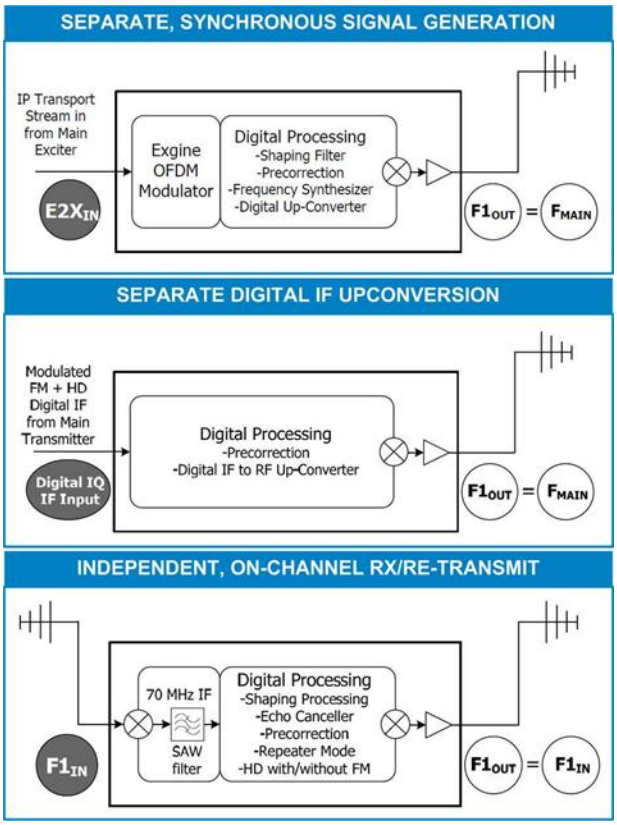
NABSHOW Where Content Comes to Life

INTRODUCTION – FM and FM+HD boosters have the almost unavoidable side effect of generating multipath distortion in reception areas that overlap signals from the booster and primary transmitter even when these signals are synchronized and modulation time-aligned. However, little study exists on the specific conditions under which booster multipath is excessive, or acceptable. To explore the design and selection of a potential booster for Everett, Wash. station KUOW, the authors developed a scientific study to determine the parameters which would define the limits of multipath, develop a computer mapping system to show the multipath effects geographically and select suitable booster hardware. The project was funded by the Corporation for Public Broadcasting with matching funds from Puget Sound Public Radio, which operates KUOW.

SELECTION OF POTENTIAL BOOSTER – one of the key considerations in choosing a potential booster system for KUOW is the spacing between the primary station’s transmitter and the booster. The City of Everett is located some 45 km north of KUOW’s transmitter, which would require at least two microwave links to reach the booster from the primary transmitter. Additionally, KUOW operates in HD Radio hybrid (analog + digital) transmission mode and the booster is to be designed to reinforce its two multicast streams as well as its main program service. There are three approaches to FM+HD signal boosters which are discussed in the paper:

● Separate, Synchronous Signal Generation: as shown in top diagram, this approach uses Exgine modulation at each site with transport of the E2X stream to each site;
● Separate Digital IF Upconversion: (shown in middle diagram) utilizes digital upconversion at each site with transport of a high bandwidth, digital IF signal;
● Independent, On-Channel Receive/Re-Transmit: (shown in lower diagram) this approach uses independent receive and re-transmission at each site without the need for any external data connection.

KUOW chose a Harris independent, on-channel receive/re-transmit booster for its signal improvement in Everett, Wash. The off-air capability of the primary station’s RF signal was a cost-effective solution, and the ability to adjust the ratio of FM-to-digital sidebands was an added benefit. Also, if the ultimate design criteria indicated that no acceptable location was possible due to the multipath effects of the FM signal, this design had the capability to remove the FM host signal and operate as a digital-only booster.



CRITERIA BASED ON LISTENER TESTING – the first phase of the project studied the effect that multipath distortion from proposed FM and FM+HD boosters would have on FM reception. To develop accurate data on the allowable signal ratios and modulation timing offsets, NPR Labs and Towson University performed a series of listener-based tests using controlled simulations of multipath. These tests determined the necessary parameter limits for booster location and operation, before construction of the booster began. These parameters were put into special mapping software developed by NPR Labs to geographically evaluate booster locations and optimize design.

The purpose of the listener tests was to determine how consumers would rate audio samples with various types and levels of multipath impairment and under what condition consumers would turn off the radio because of the impairment. Three different kinds of interference were tested with four different transmission/receiving conditions: fixed stereo, fixed monophonic, mobile stereo and mobile monophonic.

Additional sections of the paper (not excerpted here) describe the detailed results of the listener tests, a determination of the relationship between the time delay and RF ratio of the main transmitter and booster signals on HD Radio reception availability, information on computer simulations of main transmitter and booster coverage areas (and multipath prediction) for KUOW, and discussion of a different booster test case (in the Denver, Colo. area) with greater terrain shielding.

This paper is included in its entirety in the *2012 NAB BEC Proceedings*, available on-line from the NAB Store (www.nabstore.com). For additional conference information visit the NAB Show web page at www.nabshow.com.

This paper is also available on the NAB Online Learning Center (www.nabshow.com/olc). See the May 7, 2012 issue of *Radio TechCheck* for additional information on accessing the OLC.

Hilton Anatole – Dallas, Texas – September 19-21

RADIO SHOW
Produced by NAB and RAB

This year's all new technology program covers issues that are important to all radio engineers. Change is occurring very quickly and impacting the ways we conduct business and generate revenue. "It's not your father's radio station anymore…" is more appropriate today than ever. Technology is moving consumers to new platforms and generating competition for our products. We have assembled a program of sessions and discussions developed specifically for radio professionals who need to keep up with regulatory issues, HD radio developments, disaster preparedness and new Hybrid Radio technologies. You will have ample time to network with your peers and meet with Radio Show exhibitors who can assist with your technical challenges and offer fresh insights and solutions.

Registration details and more are available online at www.radioshowweb.com. See you in September!

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