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Extending Your HD Radio Footprint

A paper at the 2010 NAB Broadcast Engineering Conference (BEC, April 10-15, 2010, Las Vegas, NV) entitled "Extending Your HD Radio Footprint" discusses the facility planning requirements and technology choices involved in improving FM IBOC digital radio coverage. Among other techniques, the paper discusses increasing the digital power in an FM in-band/on-channel (IBOC) digital radio signal (see the February 1, 2010 issue of *Radio TechCheck* for information on FCC approval of the increase).

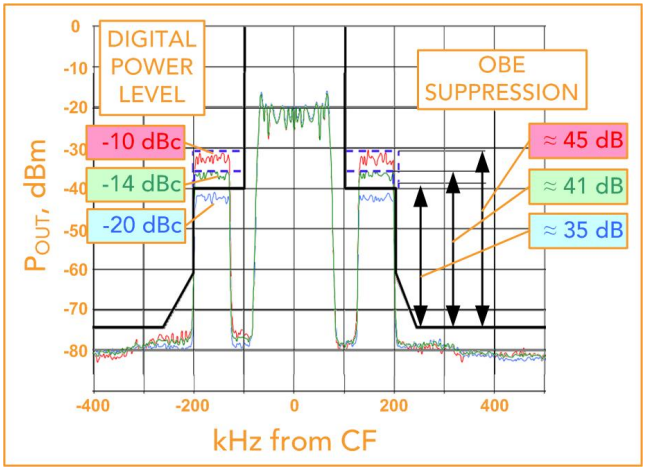
This paper, excerpted here, was written by Geoff Mendenhall, Vice President – Transmission Research and Technology with Harris Corporation, Mason, Ohio. For his effort, Geoff was awarded the first ever *NAB Best Paper Award* for "…a paper of exceptional merit published in the 2010 NAB BEC Proceedings, which was presented to him at the NAB Technology Luncheon on April 14. " NAB plans to make the selection of a BEC "Best Paper" an annual tradition at future BECs.

THE NEED FOR FULL HD RADIO COVERAGE – as HD Radio multicast services become more important to the broadcaster's business model, the need for an enhanced coverage footprint has become an imperative for reliable digital reception on mobile and desktop devices. The HD Radio multicast channels do not have the protection of fall-back to analog when the edge of the digital signal coverage is reached.

On January 29, 2010, the FCC's Media Bureau adopted an order to modify the FM digital audio broadcasting rules to expand digital coverage (available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-10-208A1.pdf). This change in the rules will allow virtually all stations to increase their HD Radio digital power by +6 dB from the current -20 dBc below the FM analog power level to -14 dBc, and some stations up to -10 dBc. This amounts to a digital power increase of four to ten times the current HD Radio power. The goals of increasing HD Radio power are:

- Reliable reception of multicast channels that do not have analog fall back;
- Better building penetration of HD Radio signal to portable and desktop receivers;
- Better mobile HD Radio digital reception in suburban areas;
- Better digital reception on portable receivers with poor antennas.

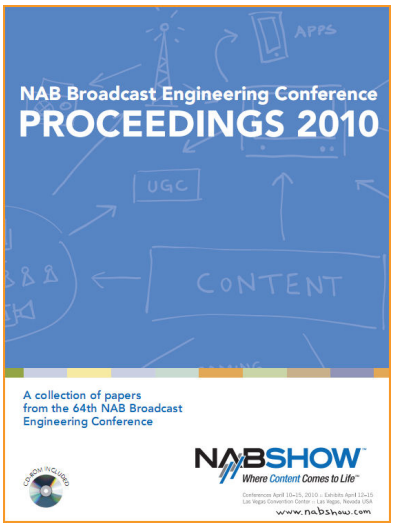
SPACE COMBINING OR COMMON AMPLIFICATION – space combining is often the most cost effective way to increase the HD Radio power using the existing antennas and analog FM transmitter. If the new transmission system isolation and power handling requirements can be met, increasing the digital transmitter power is the only equipment change. The shortcoming of space combining is the potential for mis-tracking between the analog FM and digital HD Radio signal levels in the far field. The causes of signal level tracking error include the differences in the radiation center and the radiation patterns of the two antennas. Even systems that use a single radiator array with opposite circular polarizations for the FM and HD



Radio signals still suffer from mis-tracking at receive locations with multipath signal reflections where the two different polarizations add up differently.

LINEARITY CHALLENGE WITH HIGHER IBOC SIDEBANDS – the more the amplitude of the IBOC carriers is increased, the more the transmitter must be de-rated. At -10 dBc (10%) injection, the RF intermodulation products need to be suppressed an additional 10 dB (see figure) at the same time the power output is increased by 10 dB. This is a 20 dB net improvement (100x) in linearity from that needed at -20 dBc (1%) to maintain the original RF mask compliance. Due to the higher (3-5 dB) peak-to-average AM component added to the constant envelope FM signal by the higher IBOC carriers, the common amplification, FM + HD Radio transmitter must be further de-rated from class "C" saturated FM operation. Common amplification transmitters operating at -14 dBc will typically need an additional back-off of about 1.4 dB or 72% of the -20 dBc rated power using standard crest factor reduction.

ASYMMETRICAL HD RADIO SIDEBANDS – unequal HD Radio sidebands can be used in both common amplification and separate amplification, space combined systems to prevent interference to adjacent channels. This will be a very important technique to maximize HD Radio coverage for stations that cannot implement a full +10 dB increase for both sidebands. Due to the redundancy of information transmitted in both the upper and lower digital sidebands, HD Radio is still receivable on standard receivers even if the upper and lower digital sidebands are unequal. Operating with asymmetrical digital sidebands can allow many stations to further increase in HD Radio digital power above -14 dBc on one side of the station's channel while still protecting adjacent channel stations with a closer spaced protection contour on the other side.



ON-CHANNEL GAP FILLERS AND TRANSLATORS – single frequency, on-channel gap fillers and two-frequency translators offer another tool to improve HD Radio coverage without interference to others. Both gap fillers and translators can be digital-only or analog and digital both. In addition, asymmetrical sideband techniques can be used with or without gap fillers and translators. HD Radio gap fillers must be located with antenna patterns so that the guard interval is met in those areas where the primary and secondary (and/or tertiary) signals are all within 4 dB of each other. The location of gap fillers that take advantage of terrain shielding and directional antennas can expand the area over which HD Radio digital reception is possible even outside of the guard interval.

The full text of this 10-page paper is included in the Proceedings of the 2010 NAB Broadcast Engineering Conference, which is available for purchase online (book plus CD-ROM or CD-ROM only) from the NAB Store at www.nabstore.com.