FM IBOC ANTENNA CHOICES

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BACKGROUND The current implementation concept of FM IBOC includes an interim period where the digital component of IBOC will be transmitted at a reduced carrier level along with the present analog FM broadcast service. Two antenna configurations have been proposed for FM IBOC.

The choice of antenna configurations available to a given broadcaster depends on the method used to generate and combine the analog and digital components of the IBOC signal, outlined below.

1. Single Antenna (A) Common Amplification. A single transmitter generates both digital and analog components. (B) Separate Amplification. Separate transmitters are used for the analog and digital components. The outputs of the transmitters are combined after the transmitter output connectors.

In both cases, a single antenna radiates all components of the FM IBOC signal.

2. Separate Antennas A combining variation exists for separate amplification systems where the digital and analog transmitters radiate their components via separate antenna systems, or "space combining." This method has the advantage of eliminating the high-power combiner used in separate amplification systems. As this combiner can be quite lossy (especially for the digital component), space combining has an additional benefit because it may allow the use of a smaller, less expensive digital transmitter—as well as eliminate the cost and installation space of the combiner. Of course, there is a corollary cost involved in this approach to provide the second antenna system, and adequate structural support for it.

Space combining has not been utilized widely for FM broadcast systems. Following is an overview of this method, and its implications for FM IBOC.

SPACE COMBINING CONSIDERATIONS

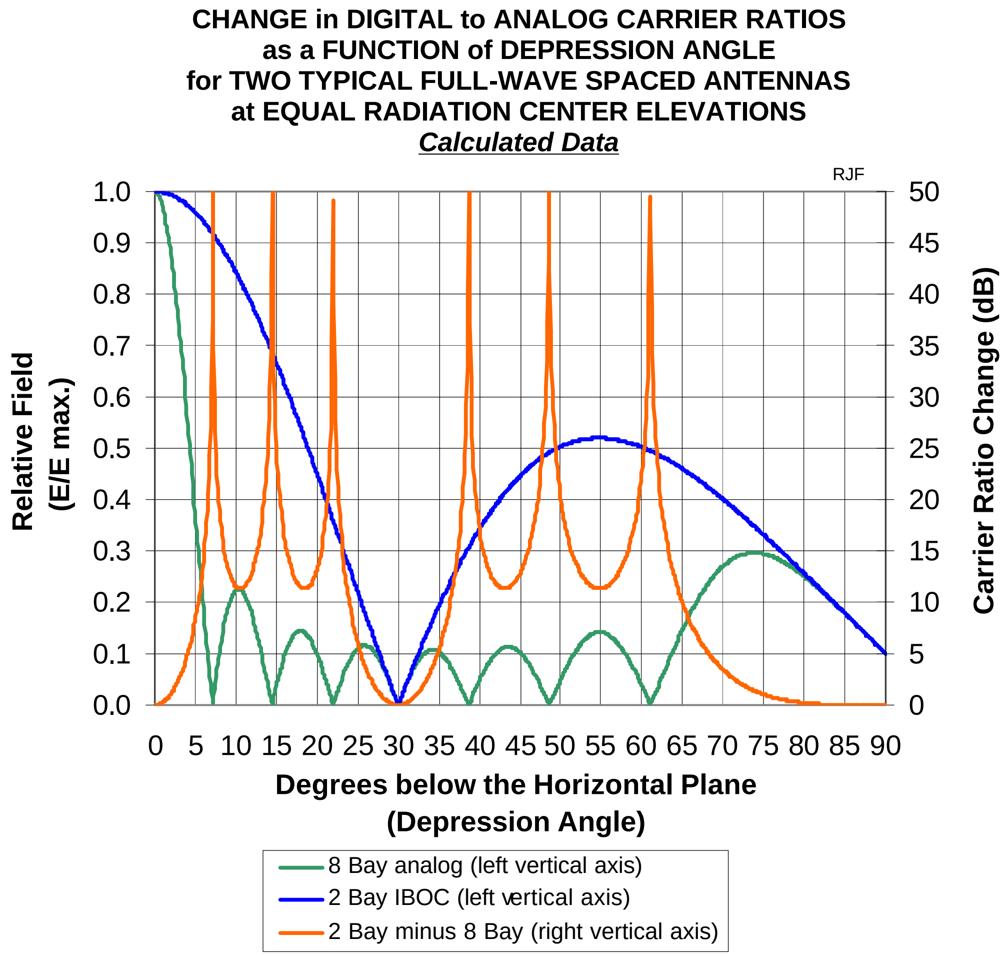
Carrier Ratio For reasons of compatibility, FM IBOC requires that a certain carrier ratio must be maintained between its digital and analog components. At first, it seems that all that would be needed for space combining would be to correctly specify the analog and digital transmitter output powers, accounting for any combining losses and antenna system gains for the two components. However, when separate antennas are involved, the azimuth and elevation radiation patterns of the antennas also are a factor in setting the ratio between the analog and digital components seen at the receiver. This reality adds constraints on the use of this method.

The affect of space combining FM IBOC components can be quite significant. It almost certainly eliminates any possibility of using one antenna site for the analog component and another one some distance away for the digital component, because it will be virtually impossible for radiated fields from separated sites to track each other at the required carrier ratio over an adequate amount of the service area.

Even the radiation patterns of separate antennas installed on the same tower typically will not match each other well at many azimuth and elevation angles, which will change the carrier ratios seen by receivers in the areas affected. This point is explored further in the following paragraphs.

Elevation Patterns Figure 1 describes a space-combined FM IBOC system where a 2-bay antenna is co-located on the same support and at the same radiation center as an 8-bay antenna. The 8-bay antenna radiates the analog signal, and the 2-bay radiates the digital signal. This configuration might be a fairly typical approach to space combining. The plot shows the elevation patterns of the two antennas, along with the changes in radiated carrier ratios that result from the pattern differences.

Figure 1.



The calculated changes in carrier ratios in Figure 1 are significant: from 6dB to >50dB for some depression angles greater than about four degrees. While the nulls of installed FM antennas typically are not as deep in reality as they are in theory, their effects on the performance of FM IBOC could be an issue for highly elevated antennas, and/or where best close-in performance is required.

Azimuth Patterns Another factor affecting received carrier ratios are the azimuth patterns of the separate antennas. Azimuth patterns vary markedly when antennas are sidemounted on a large cross-section support, and independently so for the two antennas, and for the polarization planes. Variations in the azimuth pattern of an "omnidirectional" sidemounted FM antenna can be 10dB peak-to-peak or more, depending on the mounting structure and other factors. Azimuth patterns can vary with elevation angle, as well—again, independently so for the two antennas and polarizations.

With separate antennas for analog and digital IBOC components, all of this introduces further levels of uncertainty and difficulty in maintaining the desired IBOC carrier ratio for receivers.

Antenna Coupling Using co-located, separate antennas for the digital and analog components of IBOC also requires consideration of the coupling between them. The transmitter most affected will be the IBOC transmitter, because the effective radiated power of the analog system is 100 times higher than that of the digital system. Depending on the installation geometry and true patterns of the two antennas, it may be possible for the analog power present at the output connector of the IBOC transmitter to force the IBOC system into a VSWR foldback mode. Due to lack of accurate near-field performance data for FM antennas, and the need for specific siting information, the amount and performance impact of this antenna coupling will be difficult to predict. Problems may be recognizable only after operations have begun, and their resolution could require additional time and cost.

IBOC Single Antennas Although the radiation patterns from the installed antenna may vary widely from their classic "free space" values, the affect of the patterns will be the same on all components of the IBOC signal. Therefore the single antenna approach will assure that IBOC radiated carrier ratio will be a constant in every direction, and that the compatibility assumptions of FM IBOC will not be compromised by the radiation pattern characteristics of the antenna system.

Conclusion Several methods are available for generating and combining the analog and digital components of FM IBOC, each with its own set of costs and performance issues. However the data presented shows that the most predictable performance of FM IBOC will be achieved by using a single antenna to radiate both components. This information should be useful to those making long-range plans to implement FM IBOC into their operations.

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