DUAL INPUT ANTENNA FOR FM/HD RADIO

RF SYSTEMS ANALYSIS AND
APPLICATIONS INFORMATION

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Three main methods have been used so far to combine the analog and digital components of FM HD Radio. The methods could be summarized as high level, low level, and dual antennas (space combining). Each method and its implications already have been fairly well covered in various papers and periodicals.

Another method has been introduced by an antenna manufacturer recently, with the promise of overcoming some of the undesirable characteristics of earlier methods. In this new method, a single antenna is used having separate inputs for the digital and analog signals, while maintaining a nominal 30dB isolation[1] between those inputs. This has two immediate benefits:

- eliminates the high losses required in high-level combining, and
- ensures that the ratio of analog to digital energy will not be changed from the required 20 dB value at the receiver, by differences in the radiation patterns of separate antenna systems

Following is some applications information for those considering the use of this new antenna configuration.

A station might logically consider replacing their present, 6-bay, 1-wave spaced, omni antenna with the dual input antenna having about the same gain. This would permit not having to replace their present (analog) FM transmitter when adding HD to their operation. As the dual input antenna recently introduced is ½-wave spaced, achieving about the same gain with it in this case will need either 10 or 12 bays.

Table 1 compares some of the specifications for this proposed antenna change, for ~ 98 MHz arrays. The lengths include clearance for a 1/4-wave stub, plus a few feet.

Table 1: Comparison of Standard and Dual Input Antennas

Antenna Configuration	RMS Gain (X)	Weight (lbs.)	C_aA_a (square feet)	Length (feet)	Input Power (watts)
6-Bay, standard	3.3028	672	31	50	Reference
10-Bay, dual input	3.126	1,375	60	45	Reference X 1.06
12-Bay, dual input	3.732	1,650	72	55	Reference X 0.885

The weight and windload of the dual input antennas listed above are about twice (or more) than the standard 6-bay—significant. The tower may need modifications to use them, if practical.

[1] Value given in the press release of the antenna manufacturer.

If a station is constrained by aperture and weight-windload issues not to exceed any of the mechanical specs of their present 6-bay, 1-wave spaced, omni antenna, that would limit the choice to 4 bays or less, with the 4-Bay specifications shown in Table 2.

Table 2: 4-Bay Dual Input Antenna Specifications

Antenna Configuration	RMS Gain (X)	Weight (lbs.)	C_aA_a (square feet)	Length (feet)	Input Power (watts)
4-Bay, dual input	1.307	550	24	15	Reference X 2.53

Note in this situation that the station would have to more than double the RF power supplied to the dual input antenna in order to maintain its pre-HD ERP—and probably upsize its present analog transmission line to handle that added power.

RFR Issues Another consideration when using the 4-bay, dual input antenna in the scenario just above is that its elevation patterns will be much broader than the antenna it is replacing, which will impact RFR issues for the site. Power density near the ground immediately around the tower will be lower with this dual input antenna, but further away will peak about 8-10X higher than from the 6-bay, 1-wave array, and over a much greater area. This may increase blanketing interference for listeners in those locations.

Circulator/Isolator Requirements The manufacturer's press release for this dual input antenna states "This new antenna is capable of transmitting both the analog and digital FM signals without requiring a high loss hybrid combiner or the use of a circulator to attain the required isolation between the digital and analog transmitters." However this statement may need to confirmed when specifying this antenna configuration.

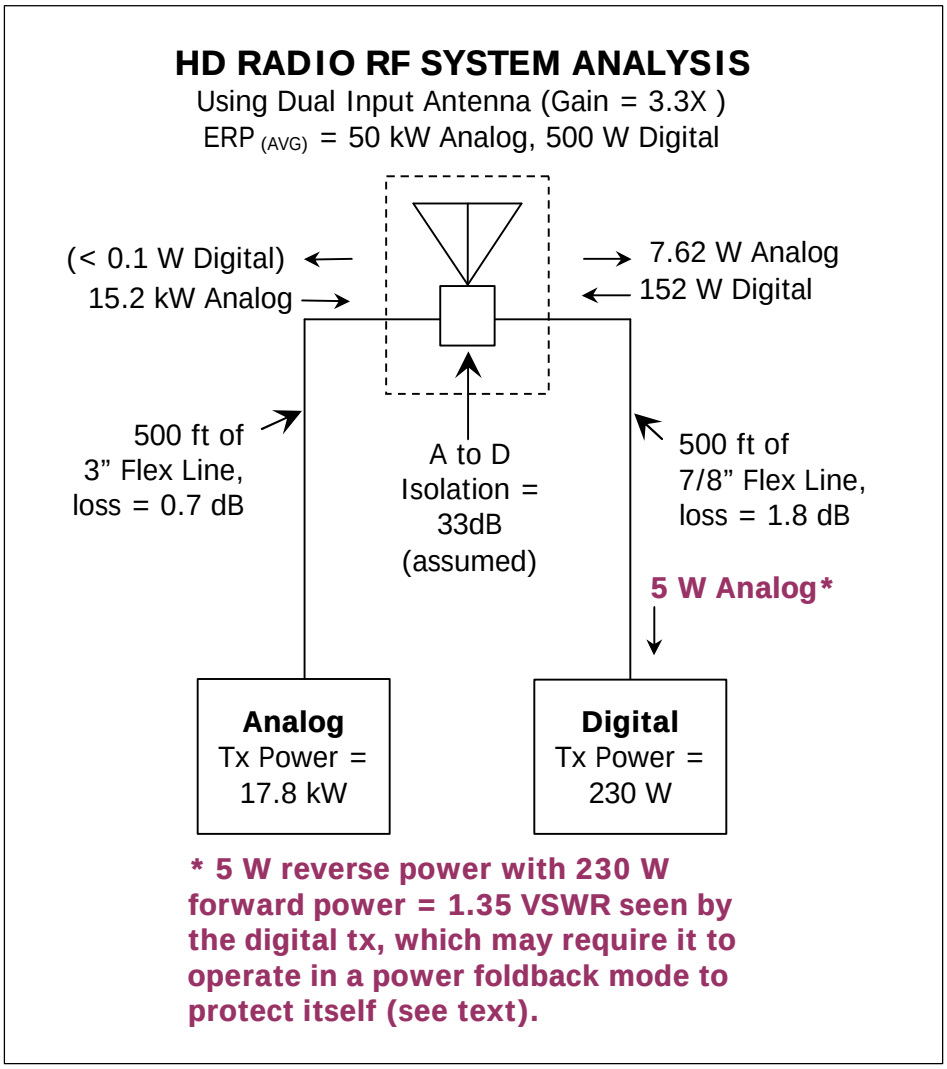
The RF system graphic in Figure 1 (page 3) shows a typical installation using the dual input antenna. The power levels, gains and losses correspond to a 50 kW analog operation in the middle of the FM band.

At first, the manufacturer's stated 30 dB of isolation between the analog and digital inputs of the antenna appears to be sufficient for good performance of this RF system. However, as the antenna has equal gain for both the analog and digital signals, the digital input power at the antenna input must be 20 dB below the analog power at the antenna in order for the A+D signal to be radiated in the correct ratio. This means that 20 dB of antenna input isolation is offset by the fact that the analog input power must be 20 dB higher than digital. Therefore the amount of analog power present at the output of the digital transmitter is considerably higher than that 30 dB isolation number first implies.

The powers shown in Figure 1 are based on 33 dB of antenna isolation, to be liberal. Yet even then, the digital transmitter sees the equivalent of ~ 1.35:1 VSWR as a result of the analog power, alone. This allows little or no ''headroom" for any system VSWR that the digital antenna input port and interconnecting line might have, or for antenna system icing that might temporarily degrade the antenna input VSWR.

Most transmitters are designed to begin reducing their forward power when reverse power at their output connector exceeds about 1.3:1, in which case they may not be able to generate their licensed ERP. Therefore when using a dual input antenna, additional equipment, such as an isolator, may be needed at the output of the digital transmitter. Possibly the manufacturer of this antenna may decide to modify his original claim on this issue as field experience becomes available.

Figure 1



As with any major facilities upgrade, stations considering the use of a dual input antenna probably should review the complete RF system with their consultant and/or equipment supplier to ensure that their system is well defined, and will include all the hardware needed to perform as required.

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