



Appendix H – Discussion of Differences Between Laboratory and Field Subjective Evaluation Results

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DAB Subcommittee Evaluation of the iBiquity Digital Corporation IBOC System		
Part 1 – FM IBOC		

The data from the NRSC's FM IBOC compatibility tests seems to indicate that listeners were more critical of interference at a particular D/U ratio when the results came from the laboratory than when they came from the field.¹ To investigate why this might be the case, additional laboratory tests were conducted by the NRSC subsequent to the release of the FM IBOC Test Data Report. These tests included an expanded number of automobile receivers (six), an expanded desired RF input signal range (-47, -62, -72 and -82 dBm), and the D/U ratios +16, +6, -4 and -14 dB. Objective data was collected to show stereo separation and audio signal-to-noise for each receiver at each desired signal level and D/U ratio combination.

iBiquity provided the NRSC with the RF signal levels that were measured at each of the host and first-adjacent field test fixed locations during the NRSC FM IBOC compatibility tests. This data was provided subsequent to the release of the FM IBOC test report, and thus is not found in the report. It, and the specific data points from the post-FM IBOC Test Data Report laboratory results that most closely match each D/U and desired receiver input signal level combination from the field, are summarized in Table H-1 and Table H-2 for the two automobile receivers that were tested in the field.

When the RF signal levels measured in the field are compared with the receiver characterization stereo separation vs. signal level test data (see Appendix D) it is apparent that both automobile receivers were operating in monophonic mode under most field test conditions. However, the laboratory data that was collected during the NRSC FM IBOC compatibility tests was collected at desired signal levels that were considerably higher than the signal levels found in the field, levels at which the receivers would be operating in stereo mode. For example, when the Delphi receiver was measured at the +6 dB D/U ratio in the laboratory during the NRSC FM IBOC compatibility testing, the desired receiver input level was -62 dBm. However, when the same receiver was measured at the same D/U ratio in the field the desired receiver input levels recorded were -61.5, -62.5, -65.5, -74.5, -82.0, -83.5, -85.0, -86.0 and -92.0 dBm. The stereo separation vs. signal level data from the characterization test for the Delphi receiver indicates that the stereo separation at these desired receiver input levels is 31, 31, 16, 3, 0, 0, 0, 0 and 0 dB, respectively. For all of the remaining first adjacent compatibility data points taken in the field with the Delphi receiver (*i.e.*, at D/U ratios that were lower, or more negative, than +6 dB) the stereo separation is predicted to exceed 7 dB at only one desired signal input level. The results for the Pioneer receiver are similar. Its receiver characterization data suggests that, generally speaking, it has slightly more stereo separation over the range of receiver input levels tested in the field, though it is essentially operating in mono at most of these levels.

Thus it appears that in the vast majority of field test locations the receivers were operating in monophonic mode. It also appears that under the +16 dB D/U and -62 dBm desired input signal condition, and under the +6 dB D/U and -62 dBm desired input signal condition (which together accounted for two-thirds of the no-multipath laboratory tests that were subjectively evaluated) both automobile receivers were operating in the stereophonic mode. It appears that the fact that the laboratory tests were generally conducted in stereo while the field tests were generally conducted in mono caused the subjective evaluators to rate the laboratory audio more critically than they rated the field audio. That is, all else being equal, listeners are more likely to detect a particular level of interference when the desired signal is stereo than when the desired signal is mono.

¹ For example, at the +6 dB D/U ratio in the field listeners rated a station's analog audio quality with speech programming on the Delphi receiver at 2.5 MOS \pm 0.28 when the undesired signal was a first adjacent channel IBOC signal. Under the same conditions in the laboratory, however, listeners rated the desired station's analog audio quality at 2.2 MOS \pm 0.25 (lower first adjacent interferer) and 2.2 MOS \pm 0.21 (upper first adjacent interferer). Similar situations are found throughout the test results. Some differences are more pronounced, and some are not. FM IBOC Test Data Report, Appendix I.

This data suggests that both results (those collected in the lab and those collected in the field) are accurate representations of how listeners will perceive interference at the specific D/U ratio and receiver input signal levels tested. Many of the data points taken in the field are actually providing information about a different reception condition than the corresponding data points taken in the laboratory for the same D/U ratio because of the difference in receiver input signal level. Thus, rather than using the laboratory and field tests to corroborate one another, it is more appropriate to use them to complement one another because, together, they provide information about more reception conditions than either of them do alone.

Table H-1. Delphi Automobile Radio First Adjacent Field and Laboratory Data

Reference Number	Field Test Data						Stereo Separation at Field RF Level According to RX Characterization (dB)	Post FM IBOC Test Data Report Laboratory Test Data		Proximity of PFITDR Lab Data Point to Field	
	1 st Adj. D/U (dB)	Location Number	Station Call	Desired Frequency (MHz)	Format	RF Level @ RX Input (dBm)		Stereo Separation A->A / D ¹ -A (dB)	Signal Level / 1 st Adj. D/U	RF Level (Lab minus Field, dB)	D/U Ratio (Lab minus Field, dB)
1	6U	1	WMRA	90.7	Class/NPR	-61.5	31	28 / 28	-62 dBm / +6 dB	-0.5	0
2	6U	2	WMRA	90.7	Class	-65.5	16	28 / 28	-62 dBm / +6 dB	+3.5	0
3	6L	3	WHFC	91.1	Folk	-62.5	31	28 / 28	-62 dBm / +6 dB	+0.5	0
4	6L	1	WFLS	93.3	Country	-74.5	03	05 / 05	-72 dBm / +6 dB	+2.5	0
5	6L	2	WFLA	93.3	Country	-85.0	00	00 / 00	-82 dBm / +6 dB	+3.0	0
6	6U	3	WSDS	92.9	Country/Speech	-82.0	00	00 / 00	-82 dBm / +6 dB	0.0	0
7	6L	1	WMGK	102.9	Rock	-83.5	00	00 / 00	-82 dBm / +6 dB	+1.5	0
8	6L	2	WMGK	102.9	Country	-92.0	00	00 / 00	-82 dBm / +6 dB	+10.0	0
9	6L	3	WMGK	102.9	Rock	-86.0	00	00 / 00	-82 dBm / +6 dB	+4.0	0
10	-14L	1	WFLS	93.3	Country	-75.0	03	00 / 00	-72 dBm / -14 dB	+3.0	0
11	-11L	2	WFLS	93.3	Country	-72.5	04	00 / 00	-72 dBm / -14 dB	+0.5	-3
12	-10L	3	WFLS	93.3	Country	-70.5	07	00 / 00	-72 dBm / -14 dB	-1.5	-4
13	-8L	4	WFLS	93.3	Country	-70.0	07	00 / 00	-72 dBm / -4 dB	-2.0	+4
14	-6L	5	WFLS	93.3	Country	-71.0	07	00 / 00	-72 dBm / -4 dB	-1.0	+2
15	-4L	6	WFLS	93.3	Country	-69.5	07	00 / 00	-72 dBm / -4 dB	-2.5	0
16	-14L	7	WFLS	93.3	Country	-85.5	00	00 / 00	-82 dBm / -14 dB	+3.5	0
17	-13L	8	WFLS	93.3	Country	-77.5	01	00 / 00	-82 dBm / -14 dB	-4.5	-1
18	-18L	9	WFLS	93.3	Country	-75.5	02	00 / 00	-72 dBm / -14 dB	+3.5	+4
19	-8L	10	WFLS	93.3	Country	-74.5	03	00 / 00	-72 dBm / -4 dB	+2.5	+4
20	-6L	11	WFLS	93.3	Country	-74.5	03	00 / 00	-72 dBm / -4 dB	+2.5	+2
21	-4L	12	WFLS	93.3	Country	-74.0	02	00 / 00	-72 dBm / -4 dB	+2	0
22	-9U	1	WMRA	90.7	Class/NPR	-77.0	01	00 / 00	-72 dBm / -14 dB	+5	-5
23	-6U	2	WMRA	90.7	Class/NPR	-75.5	03	00 / 00	-72 dBm / -4 dB	+3.5	+2
24	-4U	3	WMRA	90.7	Class/NPR	-65.5	17	00 / 00	-62 dBm / -4 dB	+3.5	0

¹For the Post FM IBOC Test Data Report Laboratory Tests, the FM IBOC signal was simulated with AWGN.

Level Dependent Blend:

1. Four desired RF test levels produced stereo separation of 16dB or higher.
2. Twenty desired RF test levels produced stereo separation 7dB or lower.

Interference and Level Dependent Blend:

1. With 1st adjacent analog interference three tests produced stereo separation of 15dB or more.
2. For these tests scenarios the IBOC did not change stereo separation.

Table H-2. Pioneer Automobile Radio First Adjacent Field and Laboratory Data

Reference Number	Field Test Data						Stereo Separation at Field RF Level According to RX Characterization (dB)	Post FM IBOC Test Data Report Laboratory Test Data		Proximity of PFITDR Lab Data Point to Field	
	1 st Adj. D/U (dB)	Location Number	Station Call	Desired Frequency (MHz)	Format	RF Level @ RX Input (dBm)		Stereo Separation A->A / D ¹ -A (dB)	Signal Level / 1 st Adj. D/U	RF Level (Lab minus Field, dB)	D/U Ratio (Lab minus Field, dB)
1	6U	1	WMRA	90.7	Class/NPR	-61.5	35	38 / 37	-62 dBm / +6 dB	-0.5	0
2	6U	2	WMRA	90.7	Class	-65.5	27	38 / 37	-62 dBm / +6 dB	+3.5	0
3	6L	3	WHFC	91.1	Folk	-62.5	34	38 / 37	-62 dBm / +6 dB	+0.5	0
4	6L	1	WFLS	93.3	Country	-74.5	04	08 / 08	-72 dBm / +6 dB	+2.5	0
5	6L	2	WFLA	93.3	Country	-85.0	00	02 / 02	-82 dBm / +6 dB	+3.0	0
6	6U	3	WDSO	92.9	Country/Speech	-82.0	02	02 / 02	-82 dBm / +6 dB	0.0	0
7	6L	1	WMGK	102.9	Rock	-83.5	01	02 / 02	-82 dBm / +6 dB	+1.5	0
8	6L	2	WMGK	102.9	Country	-92.0	00	02 / 02	-82 dBm / +6 dB	+10.0	0
9	6L	3	WMGK	102.9	Rock	-86.0	00	02 / 02	-82 dBm / +6 dB	+4.0	0
10	-14L	1	WFLS	93.3	Country	-75.0	04	05 / 00	-72 dBm / -14 dB	+3.0	0
11	-11L	2	WFLS	93.3	Country	-72.5	10	05 / 00	-72 dBm / -14 dB	+0.5	-3
12	-10L	3	WFLS	93.3	Country	-70.5	12	05 / 00	-72 dBm / -14 dB	-1.5	-4
13	-8L	4	WFLS	93.3	Country	-70.0	12	08 / 08	-72 dBm / -4 dB	-2.0	+4
14	-6L	5	WFLS	93.3	Country	-71.0	11	08 / 08	-72 dBm / -4 dB	-1.0	+2
15	-4L	6	WFLS	93.3	Country	-69.5	12	08 / 08	-72 dBm / -4 dB	-2.5	0
16	-14L	7	WFLS	93.3	Country	-85.5	01	01 / 00	-82 dBm / -14 dB	+3.5	0
17	-13L	8	WFLS	93.3	Country	-77.5	03	01 / 00	-82 dBm / -14 dB	-4.5	-1
18	-18L	9	WFLS	93.3	Country	-75.5	04	05 / 00	-72 dBm / -14 dB	+3.5	+4
19	-8L	10	WFLS	93.3	Country	-74.5	04	05 / 00	-72 dBm / -4 dB	+2.5	+4
20	-6L	11	WFLS	93.3	Country	-74.5	04	08 / 08	-72 dBm / -4 dB	+2.5	+2
21	-4L	12	WFLS	93.3	Country	-74.0	04	08 / 08	-72 dBm / -4 dB	+2	0
22	-9U	1	WMRA	90.7	Class/NPR	-77.0	05	08 / 08	-72 dBm / -14 dB	+5	-5
23	-6U	2	WMRA	90.7	Class/NPR	-75.5	03	08 / 08	-72 dBm / -4 dB	+3.5	+2
24	-4U	3	WMRA	90.7	Class/NPR	-65.5	26	38 / 33	-62 dBm / -4 dB	+3.5	0

¹For the Post FM IBOC Test Data Report Laboratory Tests, the FM IBOC signal was simulated with AWGN.

Level Dependent Blend:

1. Four desired RF levels produced stereo separation of 26dB or higher.
2. Twenty desired RF levels produced stereo separation of 12dB or lower.

Interference and Level Dependent Blend:

1. With 1st adjacent analog interference four tests produced stereo separation of 15dB or higher.
2. For these scenarios the IBOC made little change in stereo separation.