5. Conclusions

USADR has performed laboratory tests to characterize the performance of the hybrid IBOC digital signal in the presence of Gaussian noise, multipath fading, and interference. The results are summarized in Table C-5.

The digital performance tests, in concert with the subjective evaluation of analog audio at the digital TOA, confirm the superior performance of the digital signal with respect to existing analog service. Block error rate curves were developed to quantify performance in a given environment in terms of available signal-to-noise ratio. In order to couch these results in the familiar context of existing analog service, analog audio from a consumer FM receiver was recorded in each of the test environments at the point where noticeable impairments could just be detected in the digital signal. This allows straightforward comparison between the performance of IBOC digital signals and existing analog signals.

The recordings indicate that, in all environments tested, at the point where the digital signal begins to degrade, the corresponding analog audio itself exhibits audible degradation. This implies that analog audio is degraded at signal levels where digital audio degradation is not yet perceptible. As a result, up to the point of digital TOA, the performance of the digital signal surpasses that of the existing analog signal. And when the digital signal finally begins to exhibit degradation, the IBOC receiver will automatically blend to analog. Therefore, the performance of the USADR FM IBOC DAB system is better than the performance of existing analog FM service.[8]

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[8] These findings are corroborated by the USADR field test results, which are reported in Appendix H.

Appendix D

Appendix D

Summary of ATTC FM IBOC Compatibility Tests

1. Background

USADR commissioned the Advanced Television Technology Center ("ATTC") of Alexandria, Virginia to test the compatibility of their FM hybrid IBOC system with existing analog radios. The ATTC is an independent system evaluation organization, with expertise in the verification and testing of broadcast systems.

2. Test Overview

2.1 Receiver Selection Process

Three consumer FM receivers were randomly selected from each of the following broad classes:

- Automotive - Delco 16195161 FM stereo
- Home HiFi - Yamaha HTR5130
- Portable - Philips AZ1020/17 boombox

2.2 ATTC Test Bed

An automated test bed was constructed at the ATTC facility for compatibility testing of the USADR FM hybrid IBOC system. The system is capable of testing receivers under static and fading conditions, with up to two simultaneous interferers. The desired signal and its undesired interferers can be configured as either conventional analog signals or hybrid IBOC signals.

The equipment employed in the test bed is controlled by a custom computer program that was designed to implement the NRSC test suite; it can be easily modified to accommodate additional tests, as necessary. This flexible architecture allows the ATTC to fully test a receiver by performing 558 tests and record 27,900 signal-to-noise ratios in a period of less than ten hours. This automated system ensures accurate recording of data, and allows the expeditious completion of the test program.

The test bed employs commercial off-the-shelf broadcast exciters, audio processing equipment, and subcarrier generators. The digital portion of the hybrid IBOC signal was generated using the USADR IBOC 2000 Exciter. The digital signal was subsequently summed with the output of the analog broadcast chain to create the hybrid IBOC signal. The level of the DAB sidebands was 22 dB below the level of the analog host. The equivalent of 100,000K

Gaussian noise was added to the signal to accurately reflect the actual environment in which receivers operate.[1]

2.3 Test Description

The ATTC essentially performed two tests to evaluate the compatibility of the USADR FM hybrid IBOC system.

2.3.1 Objective Evaluation

These tests measured the resulting change in audio signal-to-noise ratio ("SNR") and total harmonic distortion ("THD") when DAB sidebands were added to an existing analog host or interfering signals for each of the receivers in static conditions (i.e., no fading). This test is comprised of the following procedures:

- Single Interferers – These tests measured SNR and THD changes caused by the addition of DAB to the interfering signals, over a range of desired-to-undesired signal ("D/U") ratios, with single upper or lower, first or second adjacent interferers.

- Dual Interferers - These tests measured SNR and THD changes caused by the addition of DAB to the interfering signals, over a range of D/U ratios, with various combinations of dual upper and lower, first and second adjacent interferers.

- Co-channel interferers – These tests measured SNR and THD changes caused by the addition of DAB to the interfering signals, over a range of D/U ratios, with a single co-channel interferer.

- Host compatibility - These tests measured SNR and THD changes caused by the addition of DAB to the host signal, over a range of desired signal levels.

2.3.2 Subjective Evaluation

These tests recorded audio before and after DAB sidebands were added to an existing analog host or interfering signals for the automotive receiver in fading conditions. This test is comprised of the following procedures:

- Single Interferers – These tests recorded audio before and after the addition of DAB to the interfering signals, over a range of D/U ratios, with single upper or lower first adjacent interferers.

- Dual Interferers - These tests recorded audio before and after the addition of DAB to the interfering signals, over a range of D/U ratios, with dual upper and lower first adjacent interferers.

---

[1] Based on USADR's study of ambient noise levels, 100,000K was selected as a representative noise level for these tests.

- Co-channel interferers – These tests recorded audio before and after the addition of DAB to the interfering signals, at a fixed D/U ratio, with a single co-channel interferer.

- Host compatibility - These tests recorded audio before and after the addition of DAB to the host signal, over a range of desired signal levels.

3. Test Results

The ATTC reported the results of over 546 interference scenarios, 1674 desired to undesired signal ratios, and 83,700 SNR tests. The report in Appendix E focuses the presentation of results on the following interference scenarios, which might be expected at the edge of the protected contour of a typical FM station.

Desired Signal Levels	Level of Desired Signal Relative to the Interferer (D/U)		
	Co-Channel	1st Adjacent Channel	2nd Adjacent Channel
Moderate: -62 dBm	+20 dB	+6	-20

For these D/U ratios, the ATTC objective test report presents the changes in host analog SNR and THD caused by the addition of –22-dB DAB sidebands to an analog interferer or to the host. The ATTC also provided audio recordings from the automotive receiver in various interference and fading conditions, with both analog and hybrid signals.

3.1 Objective Test Results

The results presented by ATTC may be summarized as follows:

- Single first adjacent. The addition of –22-dB DAB sidebands to a single, -6-dB analog first adjacent degrades the audio SNR by an average of 4.2 dB.

- Single second adjacent. The addition of –22-dB DAB sidebands to a single, +20-dB analog second adjacent degrades the audio SNR by an average of 1.85 dB.

- Dual interferers. The addition of –22-dB DAB sidebands to various combinations of dual adjacent interferers degrades the audio SNR by an average of 4.1 dB. Simultaneous adjacent channel interference is generally not found in the real world, given the present allocation structure, at the levels tested in the ATTC compatibility document. However, that does represent the extreme and was worthy of investigation by the ATTC.

- Co-channel interference. The addition of –22-dB DAB sidebands to a single, -20-dB analog co-channel degrades the audio SNR by an average of 0.06 dB.

- Host compatibility: The addition of –22-dB DAB sidebands to a desired analog host degrades the audio SNR by an average of 0.4 dB over a range of desired signal levels.

3.2 Subjective Test Results

USADR has provided with this report eight samples of ATTC subjective recordings. The selections include cuts covering host compatibility, co-channel interference, and various combinations of first- and second-adjacent channel interference. Note that all selected samples were recorded using the EIA urban-fast fading scenario, since it represents the most challenging fading conditions.

4. Conclusions

The objective compatibility tests conducted by the ATTC have demonstrated that the addition of DAB sidebands to analog signals may slightly degrade the audio SNR. In the majority of signal environments, the addition of DAB sidebands to the analog host causes negligible degradation. Even though slight decreases in audio SNR were measured, the effects should largely go unnoticed in normal listening environments.

These conclusions are supported by the subjective audio recordings provided on the companion CD to this appendix. These tests demonstrate that the degradation of analog signals caused by the addition of DAB sidebands to co-channel or adjacent-channel interference in a mobile environment is virtually inaudible.

Appendix E

ADVANCED TELEVISION TECHNOLOGY CENTER

Digital Audio Broadcasting

Analog Compatibility of the USADR IBOC System in the FM Band

Summary of Test Results

Document #99-12

December 14, 1999

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Table of Contents

Table of Contents ii
List of Figures iii
List of Tables iv
1. Introduction 1
1.1. Scope 1
2. Description of the Test System and Parameters 2
2.1. Test Bed Description 2
2.2. FM Band Signals 2
2.2.1. Desired Analog 2
2.2.2. Undesired Analog Interferer 3
2.2.2.1. Undesired Hybrid Interferer 3
2.2.2.2. Additive White Gaussian Noise 3
2.3. Baseband Audio 3
2.3.1. Clipped Pink Noise 3
2.3.2. Processed Rock 4
3. Description of Test Receivers 5
4. Test Scenarios 6
4.1. Objective Test Scenarios 6
4.2. Subjective Test Scenarios 8
5. Summary Results 10
5.1. Analog Compatibility in the Presence of Hybrid IBOC Single Interferers, Linear Channel (NRSC F) 11
5.2. Analog Compatibility in the Presence of Hybrid IBOC Dual Interferers, Linear Channel (NRSC F) 14
5.3. Analog Compatibility in the Presence of Hybrid IBOC Co-Channel Interferers, Linear Channel (NRSC F) 17
5.4. Host Analog Compatibility in the Presence of IBOC, Linear Channel (NRSC L) 20
5.5. Analog Compatibility in a Multipath Impaired Channel (NRSC G) 23
6. Acknowledgements 25
Appendix A – Delco Receiver Selectivity Characterizations 27
Appendix B – Yamaha Receiver Selectivity Characterization 29
Appendix C – Philips Boombox Selectivity Characterization 31

List of Figures

Figure 1 - Summary results showing the difference in signal to noise ratio between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel 11
Figure 2 - Summary results showing the difference in THD+N between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel 12
Figure 3 - Summary results showing the difference in signal to noise ratio between Analog and Hybrid IBOC in the presence of Dual Adjacent Channel Interferers for a linear channel 14
Figure 4 - Summary results showing the difference in THD+N between Analog and Hybrid IBOC in the presence of Dual Adjacent Channel Interferers for a linear channel 15
Figure 5 - Summary results showing the difference in signal to noise ratio between Analog and Hybrid IBOC in the presence of a Co-Channel Interferer for a linear channel 17
Figure 6 - Summary results showing the difference in THD+N between Analog and Hybrid IBOC in the presence of a Co-Channel Interferer for a linear channel . 18
Figure 7 - Summary results showing the differences in signal to noise ratio caused by Digital IBOC to the Analog Host for a linear channel 20
Figure 8 - Summary results showing the differences in THD+N caused by Digital IBOC to the Analog Host for a linear channel 21

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List of Tables

Table 1 - FM Interference Objective Scenarios - Single Interferer (NRSC F) 6
Table 2 - FM Interference Objective Scenarios - Dual Interferers (NRSC F) 7
Table 3 - FM Objective Interference Scenarios - Co-Channel Compatibility (NRSC F) 7
Table 4 - FM Objective Interference Scenarios - Digital into Host Analog Compatibility (NRSC L) 7
Table 5 - FM Interference Subjective Scenarios - Single Interferer (NRSC G) 8
Table 6 - FM Interference Subjective Scenarios - Dual Interferers (NRSC G) 9
Table 7 - FM Interference Subjective Scenarios - Co-channel (NRSC G) 9
Table 8 - FM Interference Subjective Scenarios – Digital into Host Analog Compatibility (NRSC L) 9
Table 9 - Summary results showing the difference between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel 13
Table 10 - Summary results showing the difference between Analog and Hybrid IBOC in the presence of Dual Adjacent Channel Interferers for a linear channel 16
Table 11 - Summary results showing the difference between Analog and Hybrid IBOC in the presence of a Co-Channel Interferer for a linear channel 19
Table 12 - Summary results showing the differences caused by Digital IBOC to the Analog Host for a linear channel 22
Table 13 - Date/Time - Sorted Subjective Test List of Recordings 23

1. Introduction

This report contains the results of tests conducted by the Advanced Television Technology Center (ATTC) on the **USA Digital Radio (USADR) FM In-Band On-Channel (IBOC) Digital Audio Broadcasting (DAB) System** during the period of December 5 - 14, 1999.

1.1. Scope

The results reported in this document are collectively referred to as A*nalog Compatibility Testing.* The objective of analog compatibility testing is to evaluate and characterize the impact that an IBOC DAB system would have on the existing analog radio services within the FM broadcast band. These tests are to be performed under controlled laboratory conditions that simulate interference due to digital sidebands on both adjacent channels and the analog host channel.

These tests are *not* an attempt to measure the *absolute* performance of the radio broadcast bands. Rather, the objective is to evaluate the *difference* between the spectrum with and without IBOC present. This is an extremely important distinction to make, and the resulting test data is presented in a format where the data is presented *relative* to baseline measurements (where the baseline measurements are analog performance without IBOC modulation present).

2. Description of the Test System and Parameters

2.1. Test Bed Description

The ATTC DAB Test Bed configured for Analog Compatibility Testing is described in detail in ATTC Document No. 99-07[1]. The Test Bed was used to numerically quantify Signal-to-Noise (S/N) and Total Harmonic Distortion plus Noise (THD+N). The Test Bed was also used to produce digital audio recordings.

2.2. FM Band Signals

2.2.1. Desired Analog

In all cases, the desired analog FM signal had the following characteristics:

1) Main channel modulation:
   a) Stereo transmission
   b) 75μs pre-emphasis
   c) 9% pilot injection
   d) Test dependent
      i) **Objective Tests:** Sinusoidal test tone of 1kHz at 81% modulation (60.75kHz deviation) with no dynamic range processing. Subcarriers and pilot account for the remaining deviation; total=110%
      ii) **Subjective Tests:** Appropriate critical listening material peaking at 81% modulation (60.75kHz deviation) with 'General Purpose 2B Processing' Subcarriers and pilot account for the remaining deviation; total=110%
2) Subcarriers:
   a) 57kHz at 3% injection - RBDS modulation
   b) 67kHz at 8.5% injection - FM modulated by USASSI noise with 5kHz deviation
   c) 92kHz at 8.5% injection - FM modulated by USASSI noise with 5kHz deviation
3) Main Carrier:
   a) 97.9 MHz
4) Power
   a) Weak: -77dBm
   b) Moderate: -62dBm
   c) Strong: -47dBm

[1] Digital Audio Broadcasting, Analog Compatibility of the USADR IBOC System in the FM Band, Test Procedure, Document No. 99-07, Revision 3.0, December 14, 1999, Advanced Television Technology Center, Inc.

2.2.2. Undesired Analog Interferer

In all cases, an undesired analog FM interferer had the following characteristics:

1) Main channel modulation:
   a) Stereo transmission
   b) 75μs pre-emphasis
   c) 9% pilot injection
   d) Test dependent audio
      i) **Objective Tests:** Clipped Pink Noise
      ii) **Subjective Tests:** Processed Rock
2) Subcarriers:
   a) 57kHz at 3% injection – RBDS modulation
   b) 67kHz at 8.5% injection - FM modulated by USASSI noise
   c) 92kHz at 8.5% injection - FM modulated by USASSI noise
3) Main Carrier:
   a) For upper 1st adjacent: 98.1 MHz
   b) For upper 2nd adjacent: 98.3 MHz
   c) For co-channel: 97.9 MHz
   d) For lower 1st adjacent: 97.7 MHz
   e) For lower 2nd adjacent: 97.5 MHz

2.2.2.1. Undesired Hybrid Interferer

In all cases, the undesired hybrid interferer was the spectral sum of an analog undesired signal and the digital carriers as generated by an IBOC exciter in hybrid mode. The analog portion of the signal had the same characteristics as outlined above in 2.2.1.

The sum of all digital carriers in the hybrid signal shall have an *average* power that is **22dB** below the average analog power.

2.2.2.2. Additive White Gaussian Noise

For *all* analog compatibility tests, the channels of interest were subjected to Additive White Gaussian Noise (AWGN) at a level of 100,000 degrees Kelvin.

2.3. Baseband Audio

2.3.1. Clipped Pink Noise

In order to approximate the program material of a typical FM rock station; a CD recording was made of a 'clipped pink noise' signal. For cases where two simultaneous interferers are required a second CD recording was made. Each

recording is played on two different CD players so that the signals are not correlated with each other in time.

2.3.2. Processed Rock

In addition to the clipped pink noise described above, a standard interferer was generated which simulates "processed rock" (which is assumed to be one of the worst interferers). While clipped pink noise does an excellent job of producing maximum deviation with a low peak to average ratio, as an interferer it is missing one critical component which many *human* listeners find objectionable – a beat. For this reason a processed rock interferer was used for the subjective tests.

As in the case of clipped pink noise, a CD recording of "processed rock" was made. For the cases of two simultaneous interferers, two sources were used with time offset from each other.

3. Description of Test Receivers

The following FM Receivers were used for the objective tests:

Radio Model No:	Serial No:
Delco 16195161	9BKRMM38293G3788
Yamaha HTR5130	Y025169QS
Philips AZ1020/17	KT009917021837

The Delco 16195161 (Serial No. 9BKRMM38293G3788) was used for the subjective tests and recordings. The selectivity characterizations for the receivers are tabulated in the Appendices of this report.

4. Test Scenarios

4.1. Objective Test Scenarios

Each receiver was objectively measured under various interference scenarios over a range of D/U signal ratios[2]. Table 1 lists the objective compatibility test scenarios for Single FM interferers (NRSC F). Table 2 lists the objective compatibility test scenarios for Dual FM Interferers (NRSC F). Table 3 lists the objective compatibility test scenarios for Co-Channel FM interferers (NRSC F). Table 4 lists the objective test scenarios for Digital into Host Analog FM compatibility (NRSC L). Each row of the tables represents one test. In the 'Desired' column, the strength of the desired analog signal is indicated: Strong (-47 dBm), Moderate (-62 dBm), or Weak (-77 dBm). In the interferer columns, the mode of the interferer is indicated: Analog or Hybrid. Each interferer also has either a D/U range (e.g. +2→+26) or a fixed D/U number (e.g. +6) next to it. A range indicates that this interferer was stepped through the given range in 3 dB increments. A fixed number indicates that the strength of this interferer is fixed at that particular D/U ratio.

Table 1 - FM Interference Objective Scenarios - Single Interferer (NRSC F)

Test	Lower 2nd adj.	Lower 1st adj.	Desired	Upper 1st adj.	Upper 2nd adj.
0001			Strong	Analog: +2→+26	
0002			Moderate	Analog: -6→+18	
0003			Weak	Analog: -14→+10	
0004			Strong	Hybrid: +2→+26	
0005			Moderate	Hybrid: -6→+18	
0006			Weak	Hybrid: -14→+10	
0007			Strong		Analog: -25→-1
0008			Moderate		Analog: -40→-16
0009			Weak		Analog: -40→-16
0010			Strong		Hybrid: -25→-1
0011			Moderate		Hybrid: -40→-16
0012			Weak		Hybrid: -40→-16
0013		Analog: +2→+26	Strong		
0014		Analog: -6→+18	Moderate		
0015		Analog: -14→+10	Weak		
0016		Hybrid: +2→+26	Strong		
0017		Hybrid: -6→+18	Moderate		
0018		Hybrid: -14→+10	Weak		
0019	Analog: -25→-1		Strong		
0020	Analog: -40→-16		Moderate		
0021	Analog: -40→-16		Weak		
0022	Hybrid: -25→-1		Strong		
0023	Hybrid: -40→-16		Moderate		
0024	Hybrid: -40→-16		Weak		

Note: D/U was varied in 3dB steps

[2] Throughout the remainder of this document, the following conventions are used: D refers to a desired analog signal; U refers to a single undesired interferer (which could be analog, or hybrid). If a D/U ratio is positive, then the desired signal has *more* power than the undesired signal.

Table 2 - FM Interference Objective Scenarios - Dual Interferers (NRSC F)

Test	Lower 2nd adj.	Lower 1st adj.	Desired	Upper 1st adj.	Upper 2nd adj.
0025		Analog: +2→+26	Strong	Analog: +6	
0026		Analog: +2→+26	Strong	Analog: +12	
0027		Analog: +2→+26	Strong	Analog: +18	
0028		Analog: -6→+18	Moderate	Analog: +6	
0029		Analog: -6→+18	Moderate	Analog: +12	
0030		Analog: -14→+10	Weak	Analog: +6	
0031		Hybrid: +2→+26	Strong	Hybrid: +6	
0032		Hybrid: +2→+26	Strong	Hybrid: +12	
0033		Hybrid: +2→+26	Strong	Hybrid: +18	
0034		Hybrid: -6→+18	Moderate	Hybrid: +6	
0035		Hybrid: -6→+18	Moderate	Hybrid: +12	
0036		Hybrid: -14→+10	Weak	Hybrid: +6	
0037	Analog: 0		Moderate		Analog: -25→-1
0038	Analog: -20		Moderate		Analog: -40→-16
0039	Analog: -40		Moderate		Analog: -40→-16
0040	Hybrid: 0		Moderate		Hybrid: -25→-1
0041	Hybrid: -20		Moderate		Hybrid: -40→-16
0042	Hybrid: -40		Moderate		Hybrid: -40→-16
0043			Moderate	Analog: -6→+18	Analog: 0
0044			Moderate	Analog: -6→+18	Analog: -20
0045			Moderate	Analog: -6→+18	Analog: -40
0046			Moderate	Hybrid: -6→+18	Hybrid: 0
0047			Moderate	Hybrid: -6→+18	Hybrid: -20
0048			Moderate	Hybrid: -6→+18	Hybrid: -40
0049	Analog: 0		Moderate	Analog: -6→+18	
0050	Analog: -20		Moderate	Analog: -6→+18	
0051	Analog: -40		Moderate	Analog: -6→+18	
0052	Hybrid: 0		Moderate	Hybrid: -6→+18	
0053	Hybrid: -20		Moderate	Hybrid: -6→+18	
0054	Hybrid: -40		Moderate	Hybrid: -6→+18	

Note: D/U was varied in 3dB steps

Table 3 - FM Objective Interference Scenarios - Co-Channel Compatibility (NRSC F)

Test	Desired	Co-Channel
0055	Moderate	Analog: +8→+32
0056	Moderate	Hybrid: +8→+32

Note: D/U was varied in 3dB steps

Table 4 - FM Objective Interference Scenarios - Digital into Host Analog Compatibility (NRSC L)

Test	Desired Signal Level	Mode
0057	Strong	Analog
0058	Strong	Hybrid
0059	Moderate	Analog
0060	Moderate	Hybrid
0061	Weak	Analog
0062	Weak	Hybrid

Note: Analog Host to IBOC Digital Power Ratio was 22 dB

4.2. Subjective Test Scenarios

Table 5 and Table 6 tabulate the test scenarios that were used for Single and Dual FM interferer subjective measurements, respectively. The output of the receiver-under-test was recorded for each scenario. These recordings are available for subsequent subjective evaluation. The Desired channel and the Interferers were impaired using separate multipath fading channel simulators. Due to limitations in the dynamic range of the multipath simulator, results could not be obtained for those scenarios that contain either lower or upper second adjacent channel interferers. Table 7 tabulates the test scenarios for Co-Channel FM interferer subjective measurements. Table 8 lists the test scenarios for Digital into Host Analog FM compatibility in the presence of Hybrid IBOC interferers.

Table 5 - FM Interference Subjective Scenarios - Single Interferer (NRSC G)

Test	Multipath Scenario	Lower 2nd adjacent	Lower 1st adjacent	Desired	Upper 1st adjacent	Upper 2nd adjacent
1001	Urban Slow			Strong	Analog: +14	
1002	Urban Fast			Strong	Analog: +14	
1003	Urban Slow			Moderate	Analog: +6	
1004	Urban Fast			Moderate	Analog: +6	
1005	Urban Slow			Weak	Analog: -2	
1006	Urban Fast			Weak	Analog: -2	
1007	Urban Slow			Strong	Hybrid: +14	
1008	Urban Fast			Strong	Hybrid: +14	
1009	Urban Slow			Moderate	Hybrid: +6	
1010	Urban Fast			Moderate	Hybrid: +6	
1011	Urban Slow			Weak	Hybrid: -2	
1012	Urban Fast			Weak	Hybrid: -2	
1025	Urban Slow		Analog: +14	Strong		
1026	Urban Fast		Analog: +14	Strong		
1027	Urban Slow		Analog: +6	Moderate		
1028	Urban Fast		Analog: +6	Moderate		
1029	Urban Slow		Analog: -2	Weak		
1030	Urban Fast		Analog: -2	Weak		
1031	Urban Slow		Hybrid: +14	Strong		
1032	Urban Fast		Hybrid: +14	Strong		
1033	Urban Slow		Hybrid: +6	Moderate		
1034	Urban Fast		Hybrid: +6	Moderate		
1035	Urban Slow		Hybrid: -2	Weak		
1036	Urban Fast		Hybrid: -2	Weak		

Table 6 - FM Interference Subjective Scenarios - Dual Interferers (NRSC G)

Test	Multipath Scenario	Lower 2nd adjacent	Lower 1st adjacent	Desired	Upper 1st adjacent	Upper 2nd adjacent
1049	Urban Slow		Analog: +14	Strong	Analog: +14	
1050	Urban Fast		Analog: +14	Strong	Analog: +14	
1051	Urban Slow		Analog: +6	Moderate	Analog: +6	
1052	Urban Fast		Analog: +6	Moderate	Analog: +6	
1053	Urban Slow		Analog: -2	Weak	Analog: -2	
1054	Urban Fast		Analog: -2	Weak	Analog: -2	
1055	Urban Slow		Hybrid: +14	Strong	Hybrid: +14	
1056	Urban Fast		Hybrid: +14	Strong	Hybrid: +14	
1057	Urban Slow		Hybrid: +6	Moderate	Hybrid: +6	
1058	Urban Fast		Hybrid: +6	Moderate	Hybrid: +6	
1059	Urban Slow		Hybrid: -2	Weak	Hybrid: -2	
1060	Urban Fast		Hybrid: -2	Weak	Hybrid: -2	

Table 7 - FM Interference Subjective Scenarios - Co-channel (NRSC G)

Test	Multipath Scenario	Desired	Co-Channel
1105	Urban Slow	Moderate	Analog: +20
1106	Urban Fast	Moderate	Analog: +20
1107	Urban Slow	Moderate	Hybrid: +20
1108	Urban Fast	Moderate	Hybrid: +20

Table 8 - FM Interference Subjective Scenarios – Digital into Host Analog Compatibility (NRSC L)

Test	Multipath Scenario	Strength	Mode
1109	Urban Slow	Strong	Analog
1110	Urban Fast	Strong	Analog
1111	Urban Slow	Moderate	Analog
1112	Urban Fast	Moderate	Analog
1113	Urban Slow	Weak	Analog
1114	Urban Fast	Weak	Analog
1115	Urban Slow	Strong	Hybrid
1116	Urban Fast	Strong	Hybrid
1117	Urban Slow	Moderate	Hybrid
1118	Urban Fast	Moderate	Hybrid
1119	Urban Slow	Weak	Hybrid
1120	Urban Fast	Weak	Hybrid

5. Summary Results

The following sections summarize the *relative* performance of the USADR IBOC System for the case of analog compatibility that would be expected at the edge of the protected contour for a FM station. The following receiver signal levels and Desired-to-Undesired (D/U) ratios are in part based upon the FCC requirements for contour protection[3] and the NRSC guidelines[4].

Desired Receiver Signal Level: -62 dBm (Moderate)
Co-Channel D/U Ratio: +20 dB
First Adjacent Channel D/U Ratio: +6 dB D/U
Second Adjacent Channel D/U Ratio: -20 dB D/U
(if two second adjacents are present then: -20 dB (lower) and –22 dB (upper))

Detailed analog compatibility results over a range of D/U values and receiver characterizations are available in separate reports for each of the following receivers:

1) Delco auto receiver[5],

2) Yamaha home receiver[6],

3) Philips boombox[7].

The appendices of this summary report include the selectivity characterizations for each receiver.

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[3] Code of Federal Regulations, Title 47, Part 73, Subpart B – FM Broadcast Stations, Section 73.215, "Contour Protection for short-spaced assignments".
[4] National Radio Systems Committee, DAB Subcommittee, "IBOC DAB System Test Guidelines, Part I – Laboratory Tests", Rev. 1.0, December 3, 1998.
[5] Digital Audio Broadcasting, Analog Compatibility of the USADR IBOC System in the FM Band, Record of Test Results – Delco Auto Receiver, Document No. 99-09, December 1999, Advanced Television Technology Center, Inc.
[6] Digital Audio Broadcasting, Analog Compatibility of the USADR IBOC System in the FM Band, Record of Test Results – Yamaha Home Receiver, Document No. 99-10, December 1999, Advanced Television Technology Center, Inc.
[7] Digital Audio Broadcasting, Analog Compatibility of the USADR IBOC System in the FM Band, Record of Test Results – Philips Boombox Receiver, Document No. 99-11, December 1999, Advanced Television Technology Center, Inc.

5.1. Analog Compatibility in the Presence of Hybrid IBOC Single Interferers, Linear Channel (NRSC F)

Figure 1 and Figure 2 illustrate analog compatibility in the presence of single hybrid IBOC interferers showing the difference in signal-to-noise and THD+N, respectively, for each radio. Table 9 tabulates the results.

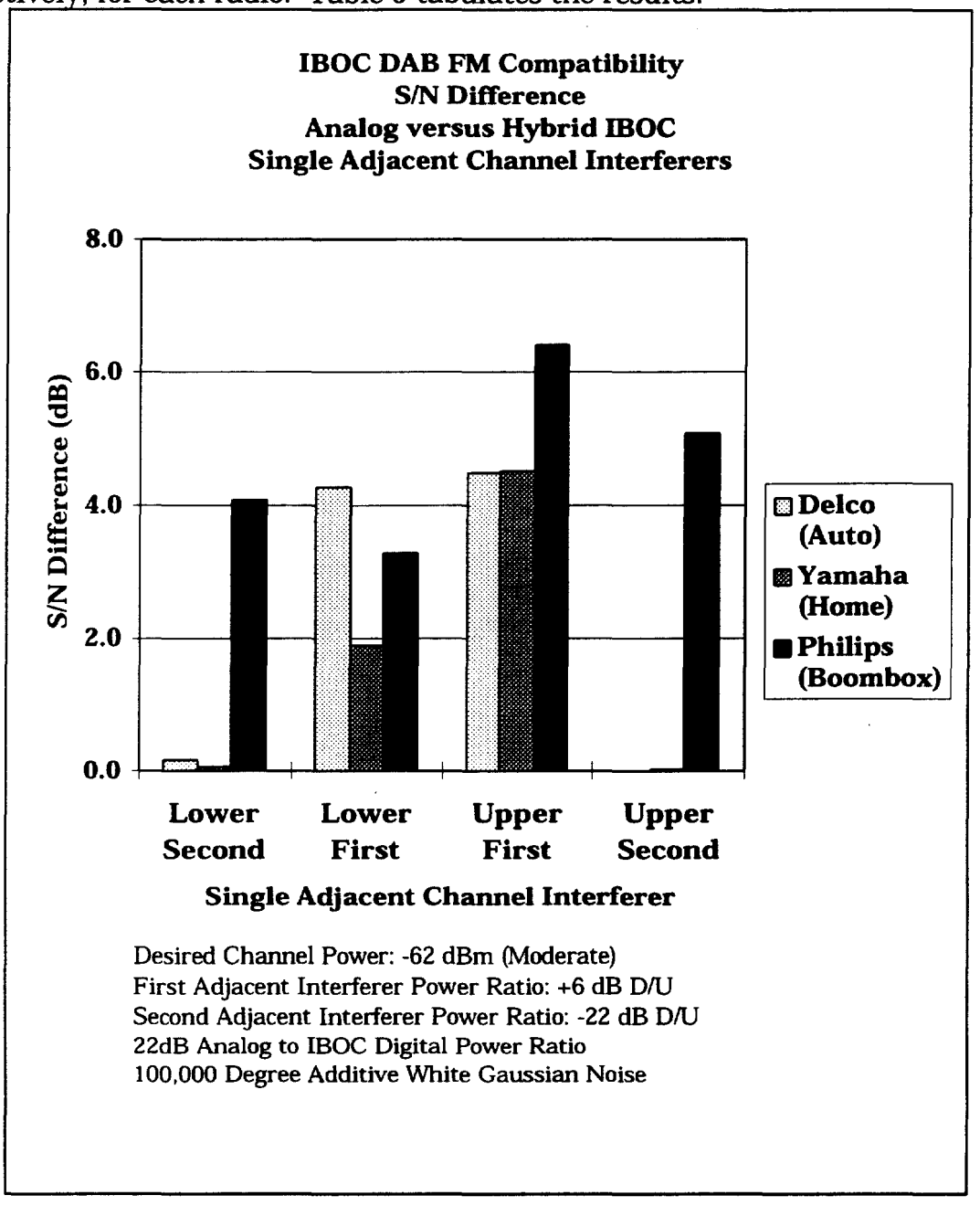

Figure 1 - Summary results showing the difference in signal to noise ratio between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel

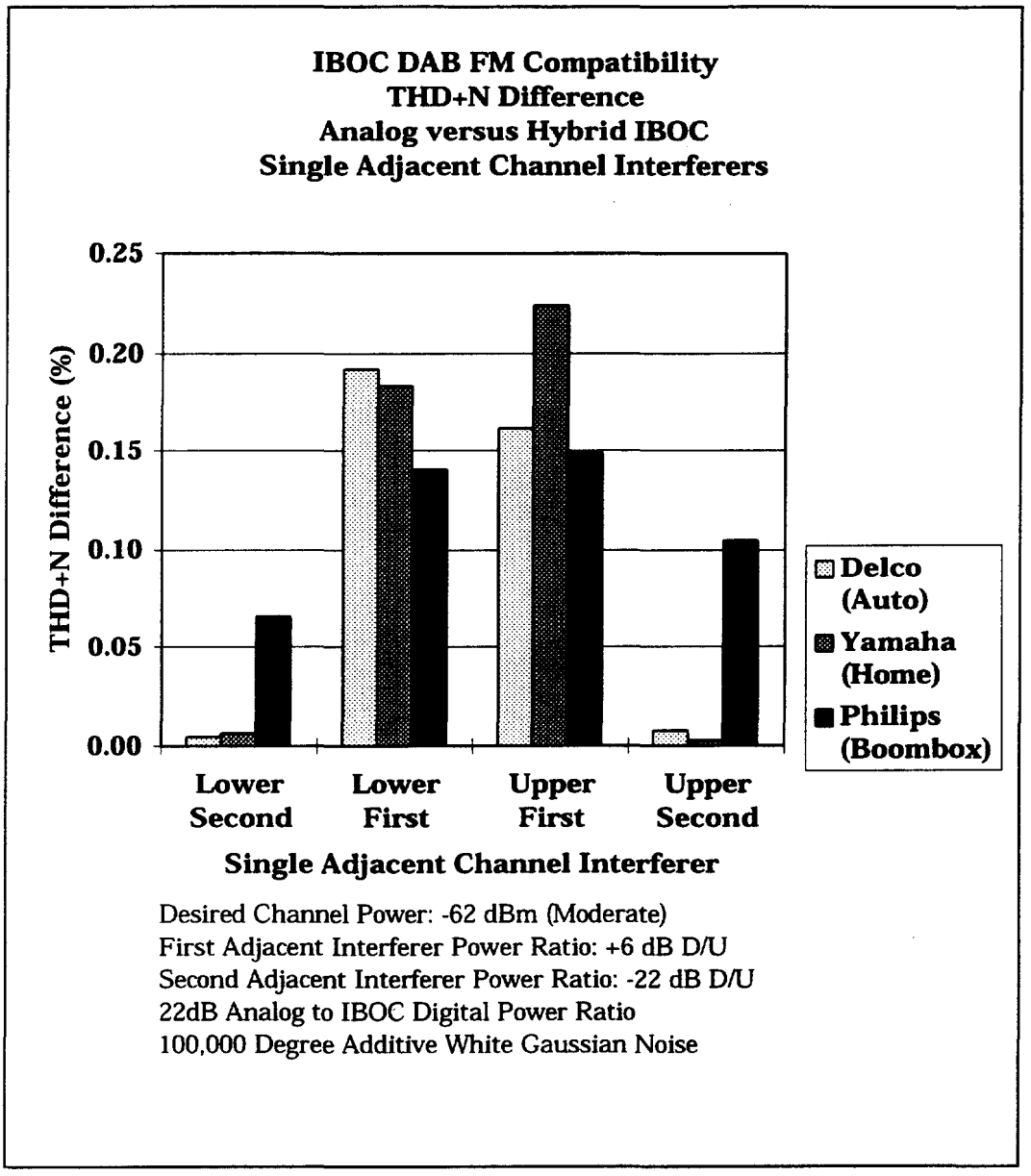

Figure 2 - Summary results showing the difference in THD+N between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel

Table 9 - Summary results showing the difference between Analog and Hybrid IBOC in the presence of Single Adjacent Channel Interferers for a linear channel

IBOC DAB FM Compatibility
Analog versus Hybrid IBOC
Single Adjacent Channel Interferers

Tests 2, 5, 8, 11, 14, 17, 20, and 23

Radio	Delco (Auto)	Yamaha (Home)	Philips (Boombox)
Interferer	**S/N Difference (dB)**	**S/N Difference (dB)**	**S/N Difference (dB)**
Lower Second	0.2	0.1	4.1
Lower First	4.3	1.9	3.3
Upper First	4.5	4.5	6.4
Upper Second	0.0	0.0	5.1

Radio	Delco (Auto)	Yamaha (Home)	Philips (Boombox)
Interferer	**THD+N Difference (%)**	**THD+N Difference (%)**	**THD+N Difference (%)**
Lower Second	0.00	0.01	0.07
Lower First	0.19	0.18	0.14
Upper First	0.16	0.22	0.15
Upper Second	0.01	0.00	0.10

Desired Power Level: Moderate -62 dBm

22dB Analog to IBOC Digital Power Ratio

Coverage Criteria	
First Adjacent:	+6 dB D/U
Second Adjacent:	-22 dB D/U

Radio Model No:	Serial No:
Delco 16195161	89BKRMM38293G378
Yamaha HTR5130	Y025169QS
Philips AZ1020/17	KT009917021837

5.2. Analog Compatibility in the Presence of Hybrid IBOC Dual Interferers, Linear Channel (NRSC F)

Figure 3 and Figure 4 illustrate analog compatibility in the presence of single hybrid IBOC interferers showing the difference in signal-to-noise and THD+N, respectively, for each radio. It should be noted in Figure 3 that dual second adjacent Analog interferers were found to cause significant interference in the Yamaha and Philips receivers. The addition of Digital IBOC does not cause further degradation. Also dual second adjacent Analog and Hybrid interferers do not cause significant interference in the Delco receiver. Table 10 tabulates the results.

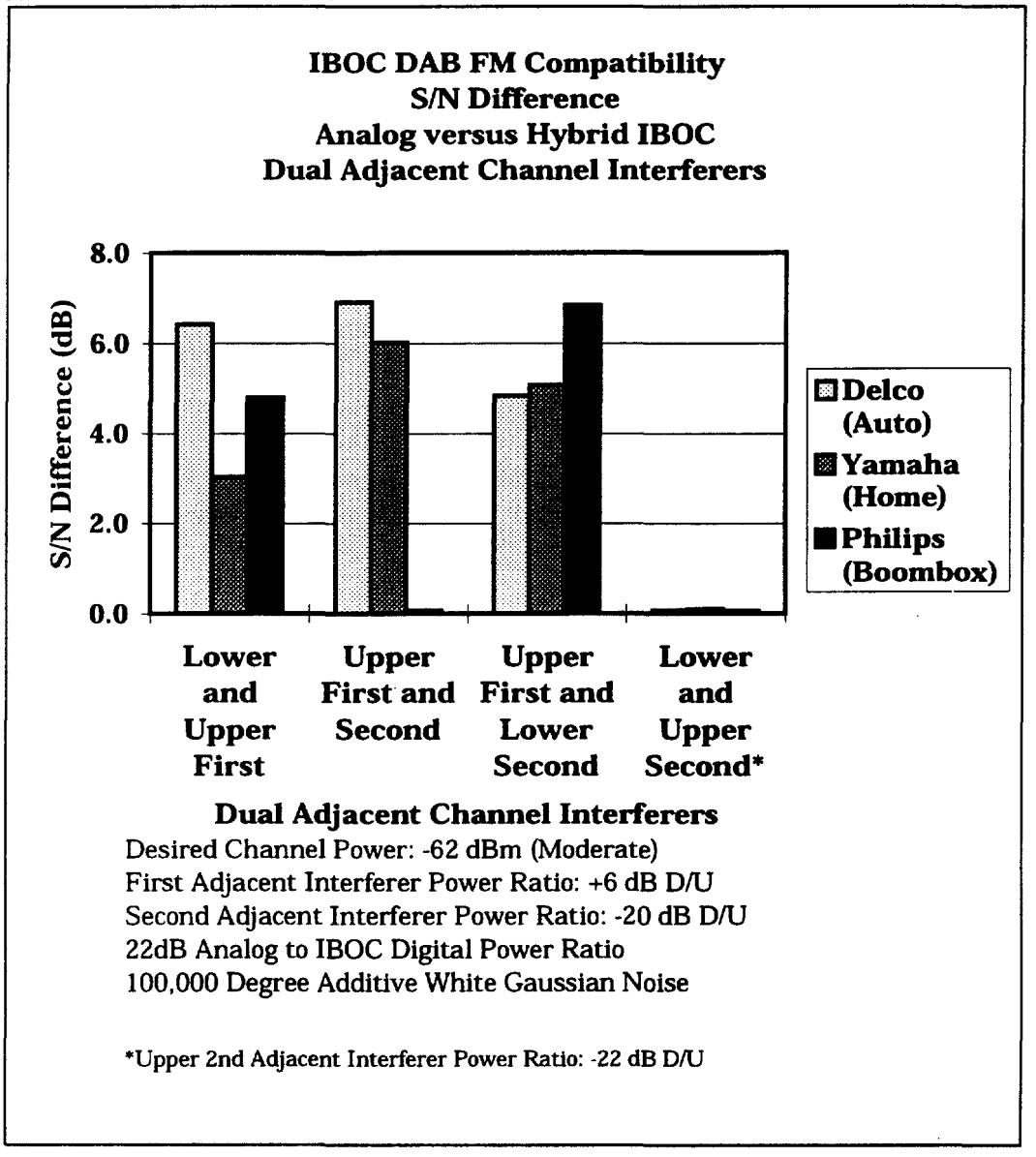

Figure 3 - Summary results showing the difference in signal to noise ratio between Analog and Hybrid IBOC in the presence of Dual Adjacent Channel Interferers for a linear channel