
Interference Rejection Thresholds of Consumer Digital Television Receivers on Channel 6 with FM Broadcast Signals

December 17, 2007



National Public Radio
635 Massachusetts Ave. NW
Washington, DC 20001

© Copyright 2008 National Public Radio, Inc.

Executive Summary

This report presents the results of measurements of current digital television receivers to determine the level of interference from signals transmitted by FM stations to reception of DTV Channel 6. Specifically, the tests of FM channels 201 to 220 (88.1 to 91.9 MHz) are reported, which are required by FCC rules to protect full-service TV Channel 6 stations (47CFR73.525). These rules were adopted in 1985, using interference measurements of analog television receivers taken in 1979. In anticipation of the conversion to digital television broadcasting and termination of analog TV transmission in early 2009 it is appropriate to reconsider the FM interference performance of receivers available to consumers for digital television reception.

The measurements were carried out in the test facility at NPR Labs, in the Washington, DC headquarters of National Public Radio. The results are based on 17 digital television receivers selected for NPR Labs by the firm of Meintel, Sgrignoli and Wallace (“MSW”), to represent a wide range of currently-available digital television receivers. The receivers included the two low-cost set-top boxes certified by the NTIA for coupon rebate, personal computer tuners, table-top TVs and flat screen TVs from 19 to 50 diagonal inches.

Tests were carried out from a plan developed with MSW, observing to the test procedures used by The Advanced Television Systems Committee. The measurements were conducted at high, medium and low signal levels representing most signal conditions of the public. Impairment was determined by staff engineers at the TOV (threshold of visibility), representing the lowest critical ratios of interference. In addition to visual tests, channel tuning was checked to ensure that FM interference did not affect signal acquisition. Video was streamed from a recorded broadcast of Olympic skiing, providing active motion to reveal temporal impairments.

The undesired-to-desired signal ratios for DTV receivers are compared to the original ratios for analog TV receivers, on which the existing Channel 6 protection rules are based. The median receiver data reported herein show FM thresholds from 20 to 50 dB above the DTV-6 signal on all FM channels in tests at a medium signal power of -53 dBm (60 dBu). For the high signal level tests, at an equivalent Channel 6 field strength of -28 dBm (85 dBu), the ratios ranged from 27 dB to 43 dB across all FM channels. At the lowest signal level of -68 dBm (45 dBu), TOV ratios began at 20 dB on the lowest frequency channels, eventually declining to 10 on the highest channels. However, the actual ratios approached 50 dB above the DTV-6 level, where these ratios were limited by noise within the RF test bed.

Test Description

Introduction

The objective of the tests was to determine the interference threshold of consumer digital television (DTV) receivers operating on channel 6 to signals in the FM broadcast band. Channel 6 (82 to 88 MHz) is located adjacent to the channel frequencies allocated for FM broadcast (88 to 108 MHz), resulting in the possibility of interference to reception. Interference thresholds were originally measured by the FCC in 1979, using analog receivers with “just perceptible” impairment criteria. These threshold ratios were incorporated into FCC rules (47CFR73.525) to protect analog TV Channel 6 stations from excessive interference from new FM stations operating in the Reserved Band, allocated for non-commercial educational FM broadcasting. The Reserved Band comprises the FM channels lowest in frequency and closest to Channel 6, extending up to 91.9 MHz. Non-reserved channels, starting at 92.1 MHz, were exempted from this rulepart. Television receivers have not been re-measured for FM interference by the FCC in the past 28 years.

The interference threshold tests were performed on 17 consumer DTV receivers that are on the market as of the date of this study (November 2007). Fifteen of the receivers were selected by the consulting engineering firm Meintel, Sgrignoli & Wallace, LLC, to have fifth-generation multipath-handling tuners, to cover major brands, and to represent a wide cross-section of receiver types and sizes. Nine of the receivers have LCD or plasma screens varying in size from 19 to 50 diagonal inches, three have cathode ray tube screens, two are computer USB-stick tuners and three are set-top boxes, of which two are certified by the NTIA’s coupon rebate program. The receivers are listed in the following table.

Table 1- DTV Receivers tested.

Receiver Manufacturer	Model Number	Type	Screen Size
Sharp	LC32AV22U	LCD	32"
Philips	37PFL5322D	LCD	37"
Westinghouse	TX-42H4303	LCD	42"
Sony	KDL46XBR2	LCD	46"
Hitachi	P50H401	Plasma	50"
LG	37LC7D	LCD	37"
Samsung	LNT4061F	LCD	40"
Sanyo	DP32647-05	LCD	32"
Toshiba	19HLV87	LCD	19"
RCA	20F514TD	CRT	20"
Insignia	NS-F24TV	CRT	24"
Durabrand	DTV1307	CRT	13"
Samsung	DTB-H260F	STB	N/A
LG/Zenith	Engineering sample	STB -NTIA	N/A
Digital Stream Technologies	D2A1D20	STB -NTIA	N/A
Pinnacle Systems	PCTV Pro Stick	USB/PC	N/A
OnAir Solutions	OnAir GT	USB/PC	N/A

Methodology

The current measurements were conducted by supplying an ATSC 8-VSB¹ signal (the desired signal), along with an undesired FM signal, to the antenna terminal of a DTV receiver and then adjusting the level of the undesired signal to the point at which picture degradation begins to be observed—a point known as the threshold of visibility (TOV) of degradation. In our testing, the DTV receiver was tuned to channel 6 while the level of the FM signal (the potential interferer) was adjusted until TOV impairment occurred.

Tests were performed on every FM channel from 201 to 220 (88.1 to 91.9 MHz). These channels comprise the Reserved Band, allocated for non-commercial educational FM broadcasting, which are specifically subject to the TV Channel 6 protection rules (47CFR73.525). Non-reserved channels, starting at 92.1 MHz, are exempted from this rulepart.

An RF test bed was assembled as shown in Figure 2. Digital TV signals were generated by a Harris Broadcast CD-1A exciter, configured by Harris staff engineers for TV Channel 6. The exciter received a standard SMPTE 310M-1998 serial video stream from a computer workstation, which was changed at the USB port to an asynchronous serial data stream by a Dektec Fantasi USB-ASI converter. This serial data was finally changed to a SMPTE video data stream with a Lynx LX-5000 converter, connected to the exciter. The exciter power output was calibrated with a Hewlett-Packard 437B power meter with square-law detector probe designed for complex signal measurement. This power meter was used to measure RF generator outputs and losses in the overall test bed.

Each DTV receiver was first tested to ensure that its carrier-to-noise threshold performance met typical ATSC specifications. Using an input power of -53 dBm at the antenna input of the receivers the output of the Noisecom 6110 additive white Gaussian noise generator was adjusted to the failure point of the picture and the noted. Receivers were expected to operate at a carrier-to-noise ratio of at least 15 dB.

Interference tests were performed with a hybrid IBOC DAB signal, which includes both the host analog FM carrier and the digital OFDM carriers. The FM carrier was modulated continuously with a 1 kHz sinusoid at 75 kHz peak deviation (100% modulation). The FM test signal combined the output of a Hewlett-Packard 8647A RF generator with a Harris Dexstar IBOC exciter at a standard power ratio of 100:1.

The FM test signal was amplified with a Mini-Circuits ZHL-3A linear power amplifier to overcome cumulative losses and to ensure that the test bed was capable of producing high undesired-to-desired signal ratios. Maximum undesired power level was +11.5 dBm into 75 ohms. The equivalent maximum field strength for a dipole antenna with this test bed is:

¹ 8-level Vestigial Side Band (8-VSB) is the over-the-air digital television (DTV) transmission format specified by the Advanced Television Systems Committee's (ATSC) Digital Television Standard (A/53) and adopted by the FCC as the U.S. standard for terrestrial DTV broadcasting.

$$E = \left(\frac{\pi}{\lambda}\right) \sqrt{P_i \cdot 480} = 1.8V / m = 125dB\mu V$$

where :

$$\lambda = 3.60m @ 83.25MHz$$

$$P_i = 0.00867W_{isotropic} = 0.0142W_{dipole}$$

A 100 kW FM station would also produce a field strength of 125 dBμV at one mile, assuming free space signal propagation. At the highest test level of -28 dBm, the equivalent DTV-6 field strength is 85 dBμV, allowing a maximum U/D ratio of approximately 40 dB (125 – 85). During tests it was learned that many of the receivers tested required higher interference ratios than could be produced in the test bed. It should be noted that the power-limited ratio of the test bed was assumed for interference, even though the actual interference ratio could have been higher.

Visual assessment of TOV was performed with trained engineers using full-motion video to reveal temporal artifacts of interference. Most viewing was done with a several-minute loop of Olympic skiing recorded from an NBC network broadcast. Distances from the screen to the viewer were adjusted to permit comfortable viewing and to reveal artifacts. Audio was also monitored for interference effects, although this rarely occurred. For each FM channel tested, RF interference levels were raised until an instance of impairment appeared, usually a momentary picture “blockiness” occurring randomly on the screen. The TOV criteria was defined as any potential impairment witnessed within a half-minute viewing period.

Figure 1 - Digital TV under test, viewed by test engineer



A very high interfering signal powers it was noticed that some receivers had difficulty tuning in to Channel 6, although they would deliver an unimpaired picture if they were receiving before the interference was raised. Consequently, tests were performed at every interference

level to verify that the receiver could be tuned away from the desired channel and back without failure.

Tables 2, 3, and 4 show the numeric results of TOV measurements on all receivers at all FM channels from 88.1 to 91.9 MHz for DTV-6 signal powers of -68, -53 and -28 dBm, respectively. The bottom row of each table provides the median results for each FM channel. The median values are shown in the graph below each table. For comparison, analog “TV6 Protection Ratios” measured by the FCC (OST Lab Report 79-01) are shown on the graph at the analog TV signal powers matching to the DTV signals. These ratios were read directly from the graphs developed by the Ad Hoc Committee for Docket 20735,² which in 1983 developed the method for calculating interference on FM channels 201-220 to TV channel 6. This method was adopted by the Commission in 1985 as “TV Channel 6 Protection” rules in 47CFR73.525.

Figure 2 - Comparison of DTV-6 Interference Ratios to Analog TV-6 Ratios

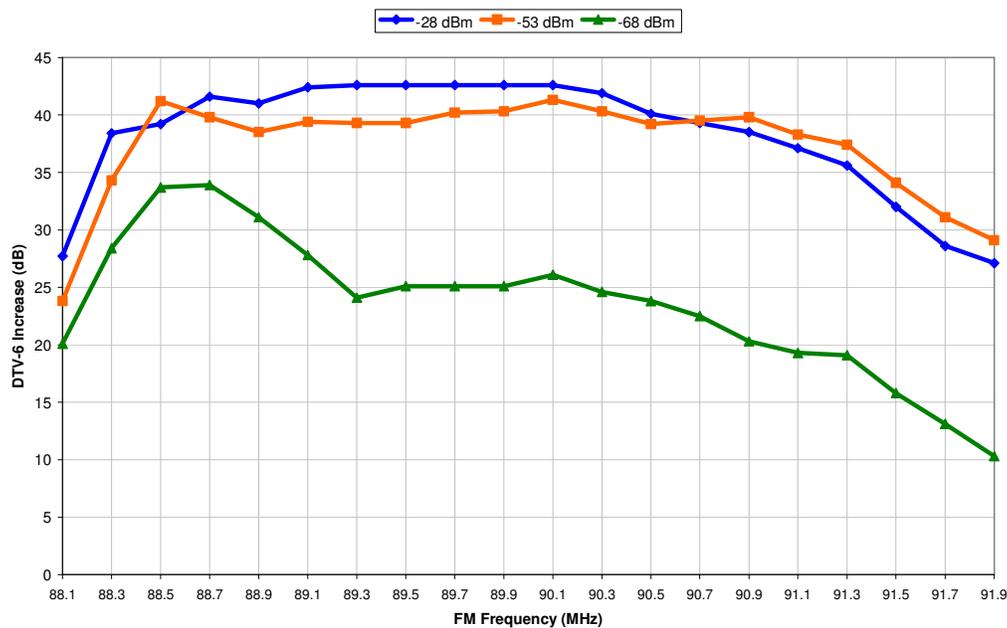


Figure 2 is a graph summarizing the difference between the TOV ratios measured for 17 digital television receivers and the protection ratios of analog television receivers measured by the FCC in 1979. At the medium and higher levels (-53 and -28 dBm, respectively) the DTV-6 ratios are 24 dB higher (more resistant to interference) than the analog TV-6 receivers. At the lowest DTV signal power (-68 dBm) the ratios begin at 20 dB on the 88.1 MHz (FM channel 201) and gradually decrease to 10 dB at 91.9 MHz (FM channel 220).

² The Ad Hoc Committee for FCC Docket 20735 was formed in 1982 to study matters relating to interference to television channel 6 from noncommercial FM broadcast stations operating in the band from 88.1 to 91.9 MHz. The Committee participants included the National Association of Broadcasters, the Association of Maximum Service Telecasters, a number of television station licensees and consulting engineers, the Corporation for Public Broadcasting, and National Public Radio. The analog protection ratios for “just perceptible” interference reported herein are taken from the Committee’s curves, representing “20 newer [TV] receiver tests”, which were filed with the FCC in September, 1983 as part of the Committee’s final report.

The -28 dBm curve appears to flatten on the middle channels, and turn downward on higher-frequency channels. However, the effect is partly the result of a limitation in the interference signal power of the RF test bed, rather than by DTV receiver performance. A flat-topping in the ratios is evident in the graphs accompanying Table 2, Table 3 and Table 4, extending through FM channel 219. (This effect is not significant in practice, since the high field strengths required to produce interference at -28 dBm result in very small interference distances.) The DTV-to-analog TV ratios at -28 dBm decline as the ratios of the old analog receivers, which continue rising with frequency, are subtracted from the flat-topped measurement data. This effect is limited to the highest few channels at -53 dBm. The apparent peak in the -68 dBm curve is caused by steeper initial IF filter slopes in the DTV receivers, compared to the analog receivers, whereas at higher frequencies the DTV ratios are affected by the bandwidth of the tracking filters in the DTV receiver tuners.

Figure 3 - RF Test Bed for DTV interference measurements

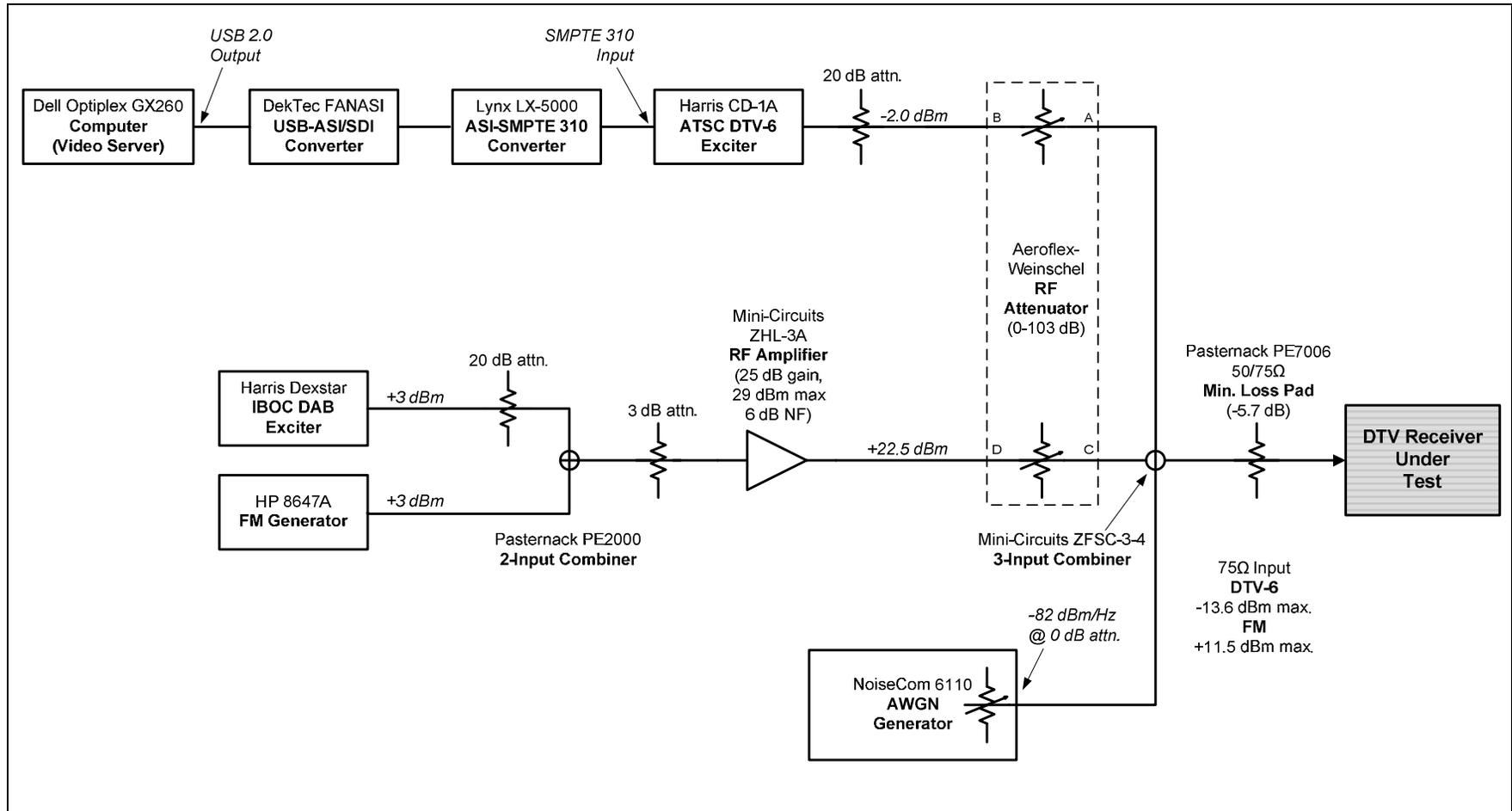


Table 2 - Measurements of FM to DTV-6 signal ratios for TOV at -68 dBm DTV

	MHz:	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9	
Make	Model																					
DigitalStream	D2A1D20	32.2	42.2	43.2	43.2	43.2	43.2	44.2	45.2	45.2	45.2	45.2	46.2	47.2	47.2	48.2	49.2	49.2	49.2	49.2	49.2	50.2
Durabrand	DTV1307	26.2	41.2	43.2	44.2	45.2	45.2	46.2	46.2	47.2	47.2	48.2	48.2	48.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	50.2
Hitachi	P50H401	15.1	32.1	37.1	41.1	43.1	44.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1	47.1	47.1	47.1	48.1	48.1	49.1	49.1	49.1
Insignia	NS-F24TV	22.1	45.1	46.1	47.1	48.1	48.1	48.1	49.1	49.1	49.1	50.1	50.1	51.1	51.1	51.1	51.1	52.1	52.1	53.1	53.1	53.1
LG	37LC7D	34.2	39.2	44.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	51.2	51.2	51.2	52.2	53.2	53.2
LG (Zenith)	LSX300-4DM	33.3	38.3	39.3	39.3	39.3	40.3	41.3	41.3	41.3	41.3	41.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	45.3	45.3	45.3
Philips	37PFL5332D	5.3	28.3	30.3	43.3	43.3	45.3	45.3	45.3	47.3	47.3	48.3	49.3	50.3	51.3	52.3	53.3	52.3	53.3	54.3	54.3	54.3
OnAir Solutions	HDTV GT	17.1	27.1	37.1	38.1	38.1	39.1	39.1	40.1	40.1	41.1	41.1	41.1	42.1	43.1	43.1	44.1	45.1	45.1	46.1	47.1	47.1
Pinnacle	PCTV HD	7.3	14.3	26.3	41.3	44.3	44.3	45.3	45.3	45.3	47.3	47.3	47.3	46.3	48.3	43.3	43.3	43.3	48.3	44.3	48.3	48.3
RCA	20F514TD	29.2	41.2	44.2	45.2	45.2	45.2	46.2	46.2	47.2	47.2	48.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	50.2	51.2	51.2
Samsung	DTB-H260F	16.2	30.2	40.2	42.2	43.2	43.2	43.2	44.2	44.2	44.2	45.2	45.2	45.2	45.2	46.2	46.2	47.2	47.2	47.2	47.2	47.2
Samsung	LN-T4061F	26.3	29.3	29.3	41.3	41.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	45.3	45.3	45.3	46.3	47.3	47.3	48.3	49.3	49.3
Sharp	LC-32D43U	19.1	32.1	46.1	46.1	46.1	45.1	44.1	43.1	42.1	42.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	45.1	45.1
Sanyo	DP32647	17.3	29.3	36.3	38.3	40.3	44.3	44.3	45.3	45.3	46.3	47.3	48.3	49.3	49.3	50.3	51.3	52.3	53.3	53.3	54.3	54.3
Sony	KDL-46XBR2	21.1	41.1	41.1	41.1	41.1	41.1	41.1	41.1	42.1	42.1	43.1	43.1	43.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1	46.1
Toshiba	19HLV87	22.3	23.3	36.3	43.3	44.3	44.3	45.3	45.3	45.3	45.3	46.3	46.3	46.3	46.3	47.3	47.3	47.3	47.3	48.3	48.3	48.3
Westinghouse	SK-42H240S	18.3	34.3	41.3	43.3	43.3	44.3	45.3	45.3	46.3	46.3	47.3	47.3	48.3	49.3	49.3	49.3	50.3	51.3	51.3	52.3	52.3
Median		21.1	32.1	40.2	43.2	43.3	44.3	44.3	45.3	45.3	45.3	46.3	46.3	46.3	47.2	47.3	47.3	48.1	48.3	49.1	49.3	49.3

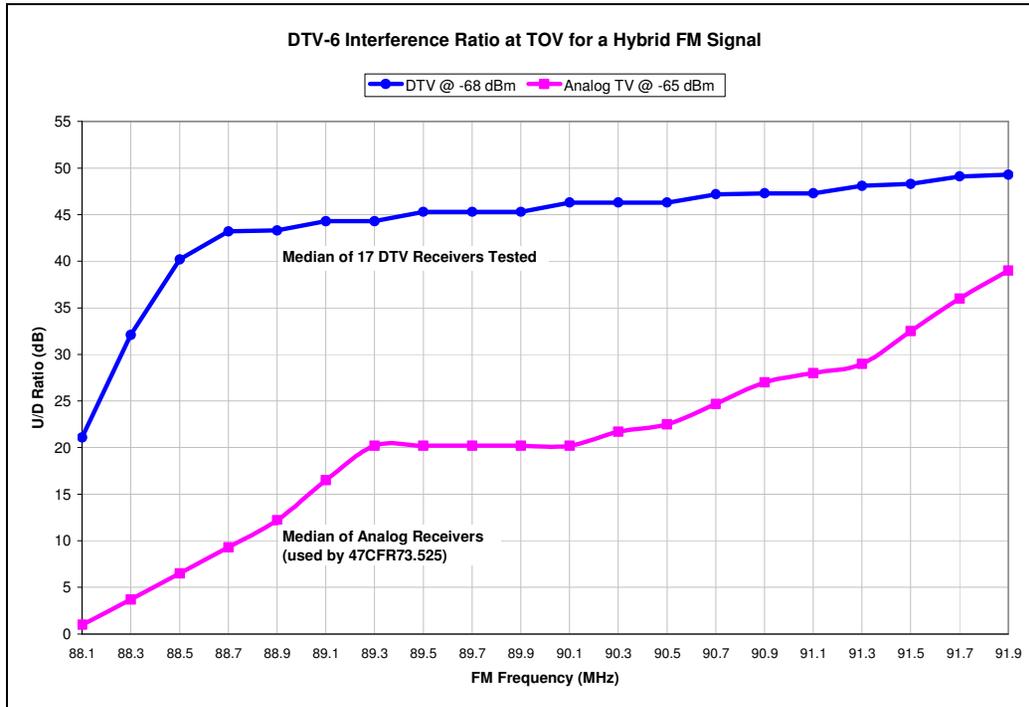


Table 3 - Measurements of FM to DTV-6 signal ratios for TOV at -53 dBm DTV

	MHz:	88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9	
Make	Model																					
DigitalStream	D2A1D20	31.2	42.2	42.2	42.2	43.2	43.2	42.2	44.2	44.2	45.2	45.2	46.2	47.2	47.2	48.2	48.2	49.2	50.2	50.2	50.2	50.2
Durabrand	DTV1307	25.2	42.2	43.2	44.2	45.2	46.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	49.2	49.2	50.2	50.2	50.2	50.2
Hitachi	P50H401	15.1	32.1	37.1	42.1	43.1	44.1	44.1	45.1	45.1	45.1	46.1	46.1	46.1	46.1	47.1	47.1	48.1	48.1	49.1	49.1	49.1
Insignia	NS-F24TV	23.1	45.1	46.1	47.1	47.1	48.1	48.1	48.1	49.1	50.1	50.1	50.1	50.1	50.1	51.1	51.1	52.1	52.1	52.1	52.1	52.1
LG	37LC7D	34.2	40.2	44.2	46.2	46.2	46.2	46.2	47.2	48.2	48.2	49.2	49.2	50.2	50.2	50.2	51.2	51.2	52.2	52.2	52.2	52.2
LG (Zenith)	LSX300-4DM	32.3	40.3	41.3	41.3	42.3	42.3	42.3	43.3	43.3	43.3	44.3	44.3	44.3	45.3	56.1	45.3	46.3	46.3	46.3	46.3	46.3
Philips	37PFL5332D	9.3	32.3	33.3	45.3	45.3	46.3	46.3	47.3	48.3	48.3	50.3	50.3	51.3	51.3	52.3	53.3	54.3	54.3	54.3	54.3	54.3
OnAir Solutions	HDTV GT	17.1	27.1	38.1	38.1	38.1	39.1	39.1	40.1	40.1	41.1	41.1	42.1	42.1	42.1	43.1	44.1	44.1	45.1	46.1	46.1	46.1
Pinnacle	PCTV HD	6.3	14.3	26.3	42.3	43.3	43.3	45.3	44.3	46.3	45.3	46.3	46.3	46.3	45.3	47.3	40.3	45.3	44.3	45.3	45.3	45.3
RCA	20F514TD	28.2	42.2	44.2	44.2	44.2	45.2	45.2	46.2	46.2	46.2	47.2	47.2	48.2	48.2	49.2	49.2	50.2	50.2	50.2	50.2	50.2
Samsung	DTB-H260F	15.2	30.2	41.2	43.2	44.2	44.2	44.2	44.2	45.2	45.2	46.2	46.2	46.2	46.2	47.2	47.2	47.2	48.2	48.2	48.2	48.2
Samsung	LN-T4061F	26.3	29.3	30.3	41.3	42.3	42.3	42.3	42.3	42.3	42.3	43.3	43.3	44.3	44.3	45.3	46.3	84.3	47.3	47.3	48.3	48.3
Sharp	LC-32D43U	18.1	32.1	46.1	46.1	46.1	45.1	45.1	44.1	43.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	46.1	46.1	46.1
Sanyo	DP32647	17.3	28.3	38.3	38.3	40.3	43.3	44.3	44.3	44.3	45.3	46.3	47.3	48.3	49.3	50.3	50.3	52.3	52.3	53.3	54.3	54.3
Sony	KDL-46XBR2	20.1	40.1	41.1	41.1	41.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	43.1	43.1	44.1	44.1	45.1	45.1	46.1	46.1	46.1
Toshiba	19HLV87	21.3	21.3	36.3	42.3	44.3	44.3	44.3	45.3	45.3	45.3	46.3	46.3	46.3	46.3	46.3	47.3	47.3	48.3	48.3	48.3	48.3
Westinghouse	SK-42H240S	19.3	34.3	42.3	42.3	43.3	44.3	44.3	45.3	46.3	46.3	47.3	47.3	48.3	49.3	50.3	50.3	50.3	51.3	51.3	52.3	52.3
Median		20.1	32.3	41.2	42.3	43.3	44.2	44.3	44.3	45.2	45.3	46.3	46.3	46.3	46.3	47.3	47.3	48.2	48.3	49.1	49.1	49.1

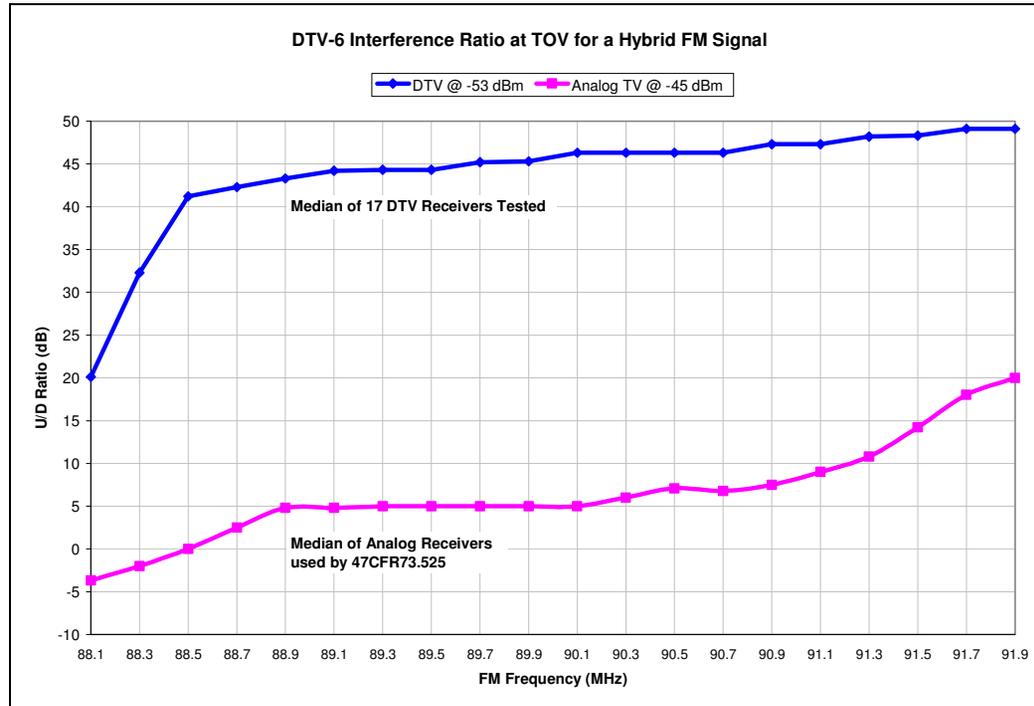


Table 4 - Measurements of FM to DTV-6 signal ratios for TOV at -28 dBm DTV

Make	Model	MHz: 88.1	88.3	88.5	88.7	88.9	89.1	89.3	89.5	89.7	89.9	90.1	90.3	90.5	90.7	90.9	91.1	91.3	91.5	91.7	91.9		
DigitalStream	D2A1D20	31.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	
Durabrand	DTV1307	24.2	38.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Hitachi	P50H401	16.1	33.1	36.1	39.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Insignia	NS-F24TV	23.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
LG	37LC7D	30.2	34.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
LG (Zenith)	LSX300-4DM	35.3	37.3	38.3	38.3	38.3	38.3	38.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Philips	37PFL5332D	9.3	30.3	33.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
OnAir Solutions	HDTV GT	17.1	28.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Pinnacle	PCTV HD	7.3	14.3	27.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	39.3	39.3	39.3	39.3	40.3
RCA	20F514TD	31.2	37.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Samsung	DTB-H260F	17.2	33.2	38.2	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Samsung	LN-T4061F	25.3	31.3	33.3	38.3	38.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sharp	LC-32D43U	18.1	32.1	39.1	39.1	39.1	40.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sanyo	DP32647	17.3	28.3	34.3	35.3	35.3	36.3	36.3	36.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Sony	KDL-46XBR2	21.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1
Toshiba	19HLV87	21.3	21.3	34.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Westinghouse	SK-42H240S	17.3	36.3	38.3	38.3	39.3	39.3	39.3	39.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Median		21.1	33.1	36.1	39.1	39.3	40.1	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3

