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A Study of UHF Television Receiver Interference Immunities

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July 1987

Prepared by
Hector Davis

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A Study of UHF Television Receiver Interference Immunities

INTRODUCTION

The UHF taboos are mileage separations which restrict assignments of UHF television stations. Such restrictions do not apply to VHF assignments except for adjacent channel mileage separations, which are not strictly UHF taboos. Television receiver interference immunities and local oscillator radiation were the bases of the UHF taboos, given in the Sixth Report and Order, 1952.(1) From time to time additional UHF receiver data have been obtained.(2) This paper adds to the data base of UHF receiver performance and also presents some VHF performance data, used to represent mileage separations which are acceptable at VHF. UHF receiver performance can be compared to VHF performance. The comparisons can be used as one estimator of the continuing need for UHF taboo mileage separations.

The receiver data base was chosen to represent the emerging electronic tuner technology, circa 1983. The test sample consisted of 16 color television receivers, 15 of which had electronic tuners. Compared to mechanical tuners, electronic tuners offer ease of tuning, better noise figures, and lower oscillator radiation; but they are acknowledged to be generally poorer with respect to UHF interference immunities. This poorer immunity performance may be attributable to the RF amplifier circuitry and varactors used universally with electronic tuners but not with mechanical UHF tuners. The emphasis on electronic tuners in the sample not only reflects a "worse case" approach but also recognizes the probable dominance of electronic tuners by the time any substantive action would be taken to change UHF television assignment practices. In an industry-government meeting in 1985 1/ it was reported that some 77% of color television receivers being marketed today employ electronic tuners.

1/ Minutes of meeting, Land Mobile Radio/UHF Television Technical Advisory Committee, November 15, 1985

DESCRIPTIONS OF THE UHF TABOOS
("n" is the number of the tuned channel)

Intermodulation Taboos (n + or - 2, 3, 4, 5 channels)
20 miles separation 2/

Intermodulation results from a combination of input channels which produces a spurious signal or signals within the tuned channel. The spurious signals, fx, can be computed from fx = 2fa - fb where fa is the frequency of one station and fb is the frequency of the other station.

Intermediate Frequency (IF) Beat Taboos (n + or - 8 channels)
20 miles separation

When two stations are separated by a receiver's intermediate frequency, it is possible that the two signals will combine to produce a beat signal which will be picked up by the receiver's intermediate frequency amplifier. Where a 45.75 MHz IF is in use, such signals may exist in channels which are separated by seven or eight channels from the desired stations. (The seven channel separation is taken care of by the restriction based on local oscillator radiation, discussed below.)

Sound Image Taboos (n + or - 14 channels), 60 miles separation and
Picture Image Taboos (n + or - 15 channels), 75 miles separation

Image interference arises from a channel removed from the tuned channel by twice a receiver's intermediate frequency (IF). This can occur for the aural carrier of the sound image channel and the visual carrier of the picture image channel. The image frequency response is above the receiver's local oscillator frequency, differing from it by the IF. The tuned channel is below the receiver's local oscillator frequency, differing from it by the IF. A typical television receiver can distinguish between the tuned channel and image channels only by its tuner's filtering of the image frequency band.

Oscillator Taboo (n + or - 7 channels), 60 miles separation

A UHF television receiver's local oscillator frequency for a tuned channel "n" is located in channel n+7. Therefore, local oscillator radiation from a receiver tuned to channel n could cause cochannel interference to a receiver tuned to channel n+7. Protection against such interference is based on the principle of non-overlapping Grade A service areas of stations seven channels apart, so that receivers within the Grade A service area of one such station would not normally be tuned to receive service from the other stations which

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2/ Statements in this section regarding existing mileage separations are the minimum mileage separation between full power UHF television transmitters.

would not be as good in quality.

Adjacent Channel (n + or - 1 channel), 55 miles separation

In contrast to the above mileage separations which apply only to UHF television, adjacent channel minimum mileage separations also apply to VHF television. All receivers are more or less susceptible to signals immediately adjacent to their intended passband. This mileage separation is based on television receiver performance.

THE VHF INTERMODULATION REFERENCE CONCEPT FOR MILEAGE SEPARATIONS

The UHF taboos are minimum transmitter mileage separations, generally based on UHF desired to undesired (D/U) signal ratios which result in interference. That is, these UHF D/U ratios can be translated into UHF taboo mileage separations. Such translations can involve many assumptions which are more or less accurate. Also, the UHF D/U ratio data can be inadequate and can change with changes in receiver designs. Previous evaluations of the UHF taboos have been made on the basis of such translations.

We are now suggesting an alternative method of evaluating the UHF taboo mileage separations, that is the UHF D/U ratios. Let us compare them to VHF D/U ratios representing existing transmitter mileage separations which are acceptable for television service. The VHF D/U ratios chosen are those for channel combinations which can cause intermodulation, for example, channels 7, 9, 11, and 13. These channels are generally either collocated in a given community or assigned to communities several tens of miles apart.

If UHF receiver D/U ratios were found to be equal to (or greater than) the VHF intermodulation reference receiver D/U ratios, then the associated necessary UHF taboo mileage separations could be viewed as being the same as (or less than) those for VHF channels 7, 9, 11, and 13 as existing in a community.

Receiver performance for VHF two-channel intervals has been measured, as shown in Figure 1. The VHF intermodulation reference performance shown is based on median data obtained with 16 receivers. It is important to note, however, that there are underlying issues to be addressed. Among these are:

Changes in UHF assignments on the basis of the VHF reference concept would not be arbitrary but would follow assignment practices found at VHF, for example, collocation at population centers which are generally separated by several tens of miles

The VHF reference concept tacitly assumes UHF signal propagation effects which are not disadvantageous.

DATA PRESENTATION

Appendix A briefly describes the receivers tested. The interference test procedures are given in Appendix B. Appendix C presents tabulated receiver data, summarized in Figures 1 to 10.

The figures are arranged roughly by order of relationship to the defined VHF reference, starting with data "better than" the reference, that is having better interference immunity. Some inferences and comments about the figures are given below.

Figure 1

This figure displays the VHF reference itself, VHF channel n with n+2 and n+4. It also shows VHF channel n with n-2 and n-4. Note that having the undesired signals above the desired channel is slightly worse than having them below the desired channel. It is tempting to attribute the difference to a half-IF response effect from channel n+4. At any rate, the VHF reference is defined by the poorer performance.

Figure 2

A UHF channel combination producing cross modulation is illustrated here (n with n-4). Cross modulation is a phenomenon for which the modulation of a stronger undesired signal appears on a weaker desired signal. The phenomenon is not listed as a UHF taboo. This particular case will be mentioned later as showing that, in general, the further an undesired channel number is from a desired channel, the better the undesired signal is rejected. The figure also shows a UHF channel combination (low side only) which is better than the VHF reference performance.

Figure 3

The IF beat taboo shown here is relatively symmetrical for an undesired signal whether at n+8 or n-8 with respect to the desired channel n. Median performance exceeds the VHF reference performance except at a high desired signal level. This figure illustrates UHF taboo channel combinations for which UHF performance is generally superior to VHF, according to the VHF reference concept.

Figure 4

This illustration of cross modulation for n+2 or n-2 shows symmetry for an undesired channel whether above or below the desired channel n. The comparison with the VHF reference is not as favorable for this second adjacent channel case as for n-4, Figure 2. These two figures taken together

display the general rule that the further away the channel number, the less will be the effect of an undesired signal. (Note that Figure 3 shows an exception.

Figure 5

The particular channel combination, desired channel n with channel n+7 or n-7, is the oscillator taboo with mileage separations based on oscillator radiation, not television to television interference. However, an IF beat phenomenon could occur. As shown, the median data are better than the VHF reference. (An analysis of the oscillator taboo is given in the Discussion.) It is conceivable that two undesired signals, separated by seven or eight channels (n+3, n-4 for example) could produce an IF beat to a desired channel. Such cases, would be covered by the half-IF phenomenon for four channel separations as indicated by data given in the 1974 report.(2)

Figure 6

Medians of intermodulation data (desired channel n with n-2 and n-4) are shown in the figure. Based on the previously illustrated increase of receiver interference immunities with increasing channel numbers and the 1974 report (2), the figure is assumed to represent the poorest intermodulation taboo performance.

Figure 7

The sound image (n+14) taboo illustrated here is another exception to the general rule that the larger the undesired channel number the greater a receiver's interference immunity. On the other hand, this is an assymmetrical taboo. Channel n-14 would be expected to show interference immunities greater than Figure 2. Note than an assymmetrical taboo may be exploitable in an environment where a new lower numbered channel transmitter would be willing to accept interference from an existing higher numbered channel. The existing channel would probably not receive interference from the new transmitter.

Figure 8

Another assymmetrical case is shown here, desired channel n with undesired n+4, the half-IF. This channel combination would seem to merit special consideration in evaluating the UHF taboos for full power television stations. Such assignments already exist for mileage separations of tens of miles without reported interference. One might expect desired to undesired signal ratios such as those shown to be present in the environment.

Figure 9

The possibility of adjacent channel interference is common to both the UHF and VHF television services. The data shown here for an undesired channel

n+1 or n-1 would be assumed to represent VHF as well as UHF receiver performance. This is because the rejection of adjacent channels is not thought to be strongly dependent on UHF or VHF tuners. Note that this means that VHF adjacent channel performance as well as UHF is poorer than the VHF intermodulation reference. This is consistent with a restriction on assignments which applies to both UHF and VHF.

Figure 10

Picture image interference immunity medians (undesired n+15) are shown to be poorer than the VHF reference. The comments made about assymmetry in connection with Figure 7 are applicable to this case except to the degree that a new transmitter would have its service area impacted by an existing station at n+15.

DISCUSSION

Receiver manufacturers were roughly represented according to market share. The sample was chosen to investigate the characteristics of the emerging electronic tuner technology for possible effects on UHF television assignments. If all of the receivers were immune to the UHF taboo channel combinations, the analysis of the data in terms of the UHF taboos would be easy. That is, it could be argued that the taboos are unnecessary. Similarly, if all of the receivers had very poor interference immunities to the UHF channel combinations, it could be argued that the taboos are necessary.

It is interesting to assume that there is a "VHF reference performance", suitable as a factor in evaluating UHF receiver performance. The concept of VHF reference performance rests on the assumption that existing VHF assignments at intervals of two channels have not resulted in television interference. As mentioned previously, for example, Los Angeles has VHF assignments on channels 7, 9, 11, and 13. The UHF taboos prevent such assignments at two channel intervals in the UHF band. One would assume that VHF television receiver performance is adequate for two-channel interval assignments and expect that UHF performance is not.

Given adequate receiver performance, there could be the same efficiency of channel usage at UHF as at VHF. (In fact the UHF band is used less efficiently than the VHF band.) For example, intermodulation interference from the combination of channels 11 and 13 could cause interference to channel 9 just as the combination of channels 18 and 20 could cause interference to channel 16. Setting other factors aside for the moment, if VHF and UHF intermodulation performance were essentially the same, then assignments for channels 14 to 20 could be made much as those for channels 7 to 13.

In short, the VHF receiver reference performance is intended to represent signal conditions which can occur off-the-air. These signal conditions have not led to interference complaints. Thus we assert that equal or better UHF receiver performance would also not lead to interference complaints given UHF assignment practices analogous to VHF assignment practices. Therefore, the VHF reference concept can apparently be used as an evaluator of the UHF taboos.

Figure 1 shows the median data points of the receivers, tested for VHF intermodulation. The data are for "just perceptible" interference for equal level undesired television signals at intervals of two and four channels above the desired channel or at intervals of two and four channels below the desired channel. The VHF reference for Figures 1 to 10 was chosen to be the medians for desired channel n with n+2 and n+4, since the medians for this case were slightly poorer than those for n, n-2 and n-4.

The VHF reference concept pertains to interference from television transmitters. However, the local oscillator taboo is based on interference from one television receiver to another. That is, the local oscillator signal of a receiver tuned to UHF channel n is cochannel with UHF channel n+7 and could cause cochannel interference to a nearby receiver tuned to channel n+7.

Let us examine the possibility that television receivers now have oscillator radiation levels markedly less than assumed in establishing the oscillator taboo. Some receivers are achieving relatively low values of oscillator radiation as can be seen in Table A which lists some data submitted to the FCC by major television receiver manufacturers.

Table A

Manufacturers' UHF Local Oscillator (L.O.) Radiation Data

FCC ID	UHF L.O. Radiation at 100 feet	Date of Grant
AT090C221719971Z	46 to 260 uV/m	11/24/81
AT090C2034WMR40	17 to 62 uV/m	03/14/83
AT090C2253	52 to 293 uV/m	03/14/83
AT090C2034	17 to 86 uV/m	01/10/83
AHA9WU213-J44	18 to 250 uV/m	03/29/83
AHA9WW228-J59	Less than "1.0" uV threshold	03/31/83
AHA9WW245-J76	Less than "1.0" uV threshold	03/07/83
AHA9WW247-J78	Less than "1.0" uV threshold	03/02/83
AHA9WW251-J82	Less than "1.0" uV threshold	03/02/83
AJU9UFBC17100	52 to 260 uV/m	04/01/83
AJU9UFBC17400	86 to 245 uV/m	04/01/83
AK8949KV-2650RX	6 to 43 uV/m	02/22/83
AK8949KV-2649RX	6 to 43 uV/m	02/22/83
AK8949KV-2647RX	5 to 32 uV/m	02/15/83
AK8949KV-2654R	4 to less than 17 uV/m	01/27/83
AK8949KV-1918	5 to 19 uV/m	01/18/83

Note: Data were selected by choosing a manufacturers' file and then listing consecutive submissions.

Since the limit at the time was set at 1500 uV/m at 100 feet, it appears that the dominance of local oscillator radiation for a seven channel taboo has been diminished.

Figure 8 presents data for the half-IF receiver response. The interference effect can be explained as arising from the difference between the second harmonic of a receiver's local oscillator frequency and a receiver-generated second harmonic of the visual carrier of the interfering channel. The resulting spurious frequency is at 43.5 MHz in the 41 to 47 MHz intermediate frequency band. Separate recognition of this channel combination is necessary, because it is dominant among the present intermodulation taboos, although it requires only one undesired channel. This is in contrast to the other channel combinations in this group.

CONCLUSION

This presentation has limitations which should be addressed. For example:

The receiver sample consisted of "1983" models. It was biased toward the emerging electronic tuner technology. The sample consisted of sixteen color receivers, only one of which employed the older tuner technology, a mechanical UHF tuner.

Median receiver data were used for Figures 1 to 10. More sophisticated statistical analysis is desirable.

The VHF reference concept, representing median receiver data, is probably a conservative reference. There are no reports of VHF intermodulation interference even though the possibility for it exists.

The use of a "VHF reference concept" as an evaluator of the UHF taboos includes modeling of transmitter locations after those which exist in VHF television for channels 7 to 13 where VHF television intermodulation can occur.

A reference other than median VHF intermodulation data could have been used, such as VHF versus UHF performance for each receiver individually. Appendix C, receiver data tables, Tests 1 and 3, show that about half of the receivers perform about the same for VHF and UHF (desired n with n+2 and n+4) for moderate and strong signals. Note that the UHF intermodulation taboos were apparently intended for moderate and strong signals.

"Just perceptible" interference was the criterion for the data. This is a threshold condition used to improve data reproducibility. It does not represent viewable interference.

Only a few UHF channels were used as the desired channel. This could lead to an uncertainty of several decibels, according to Reference 3 at page B-6.

Figure 1: "Just Perceptible" Interference, VHF TV Intermod.

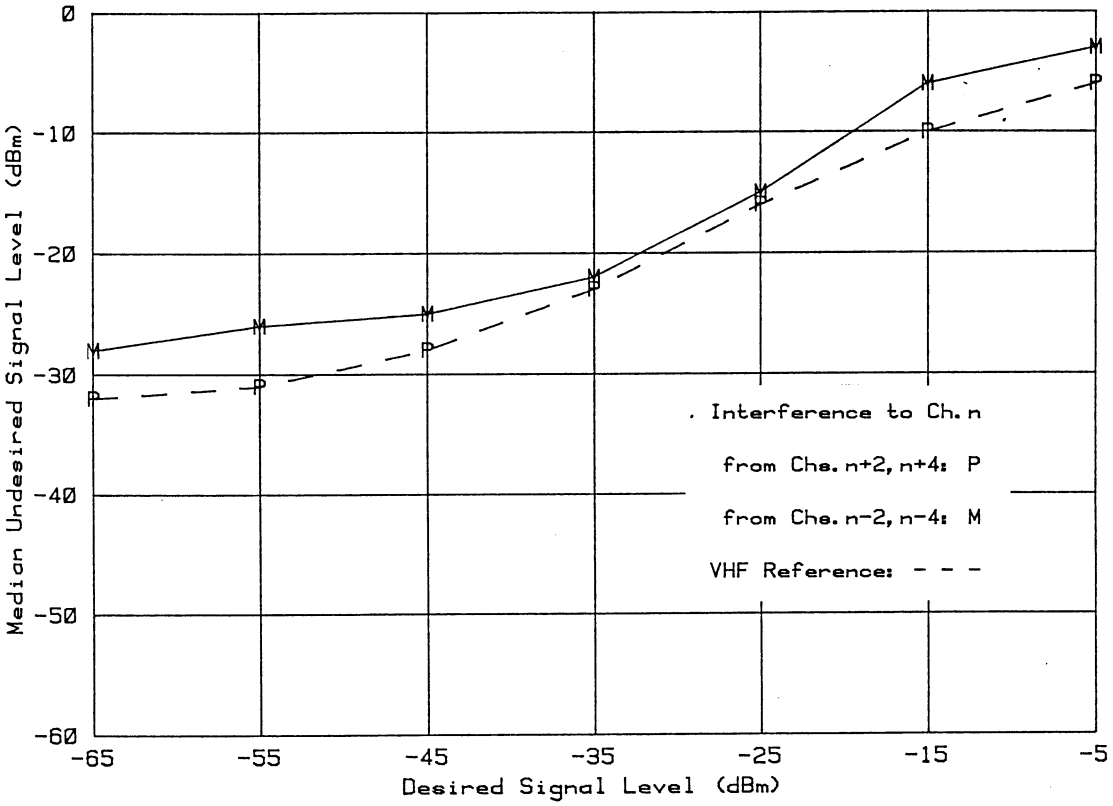


Figure 2: "Just Perceptible" Interference, UHF TV Cross Mod.

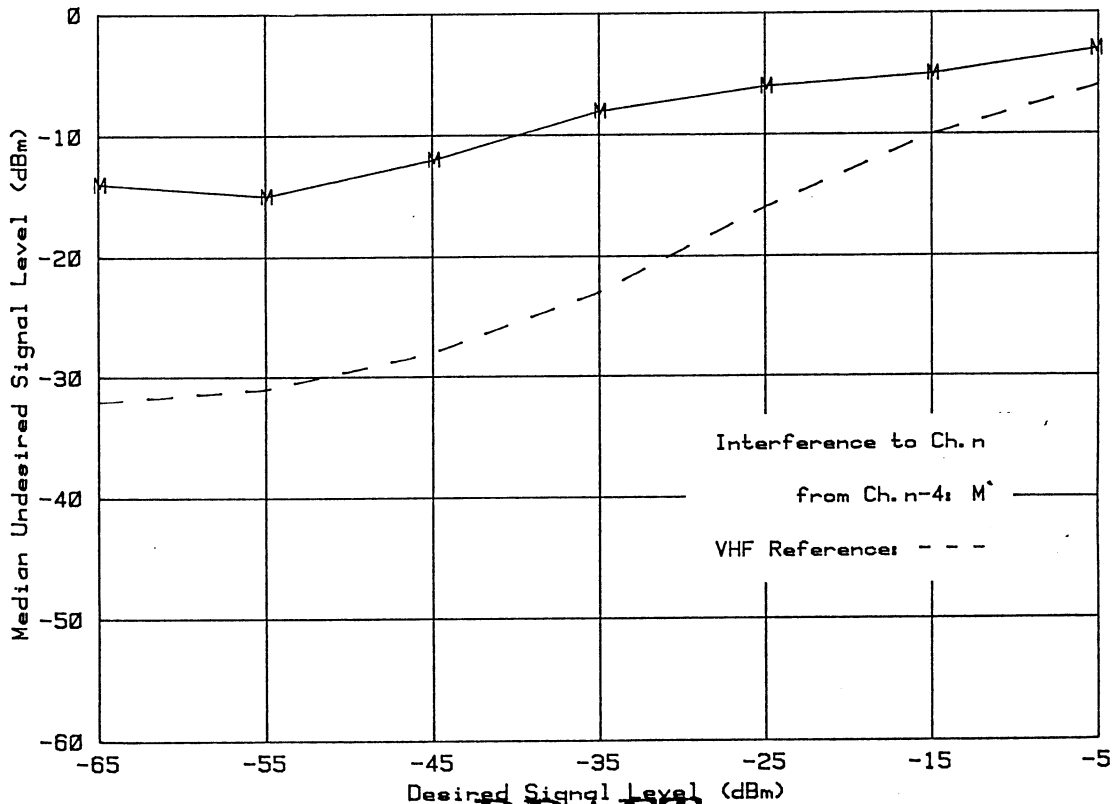


Figure 3: "Just Perceptible" Interference, UHF TV IF Beat

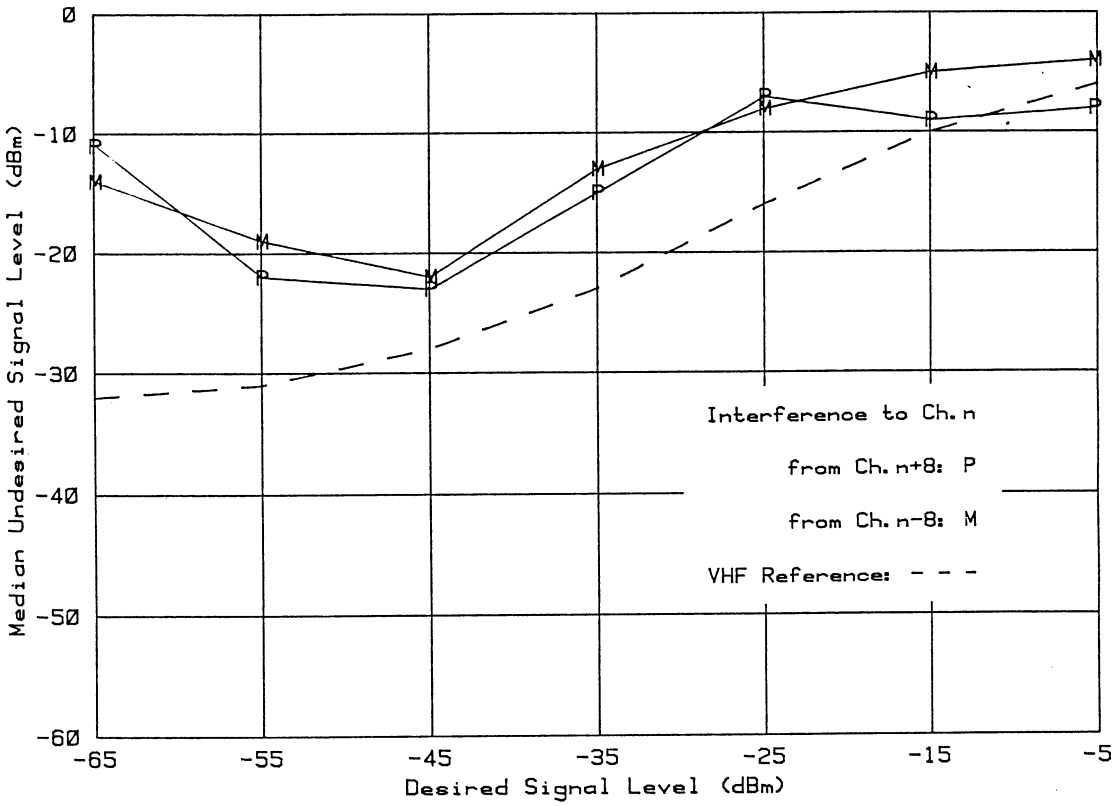


Figure 4: "Just Perceptible" Interference, UHF TV Cross Mod.

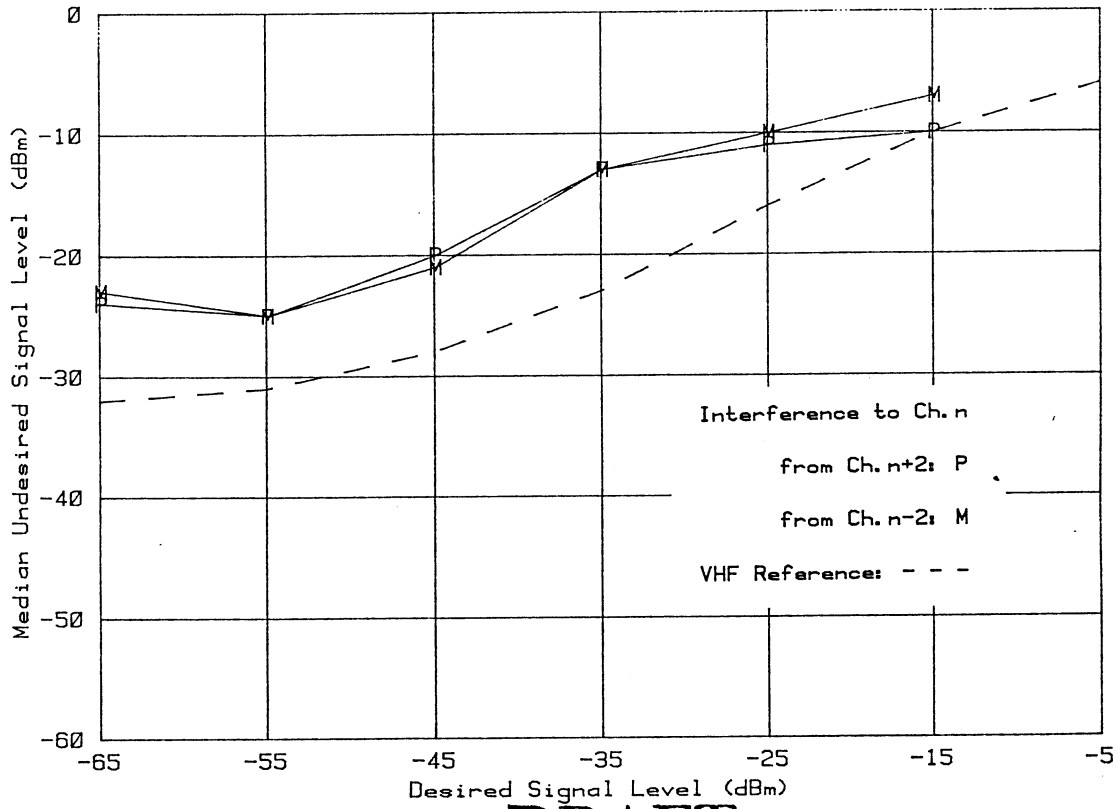


Figure 5: "Just Perceptible" Interference, UHF TV IF Beat

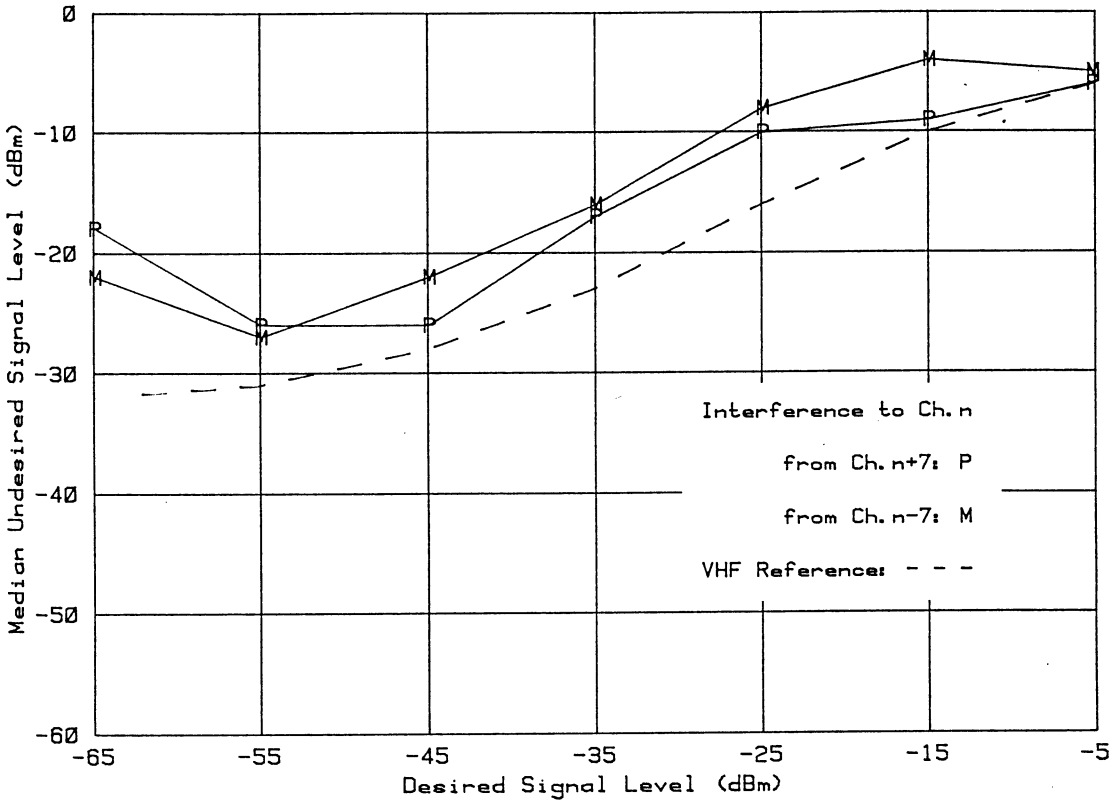


Figure 6: "Just Perceptible" Interference, UHF TV Intermod.

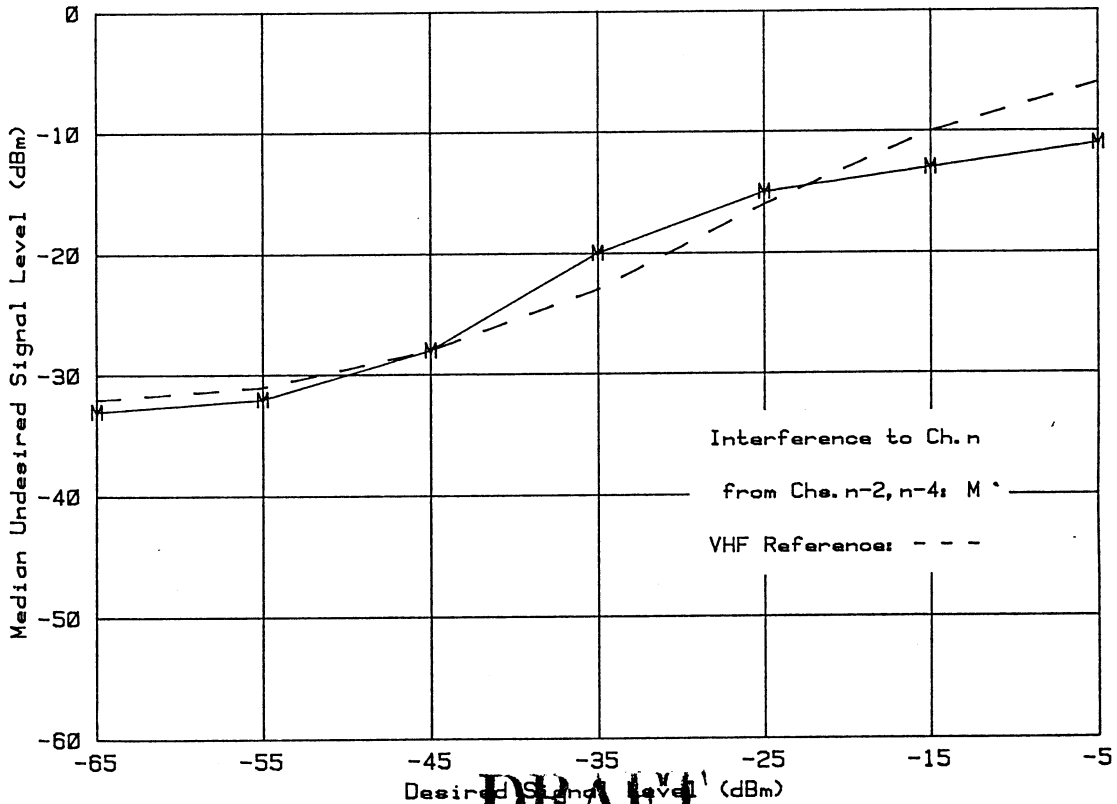


Figure 7: "Just Perceptible" Interference, UHF TV Sound Image

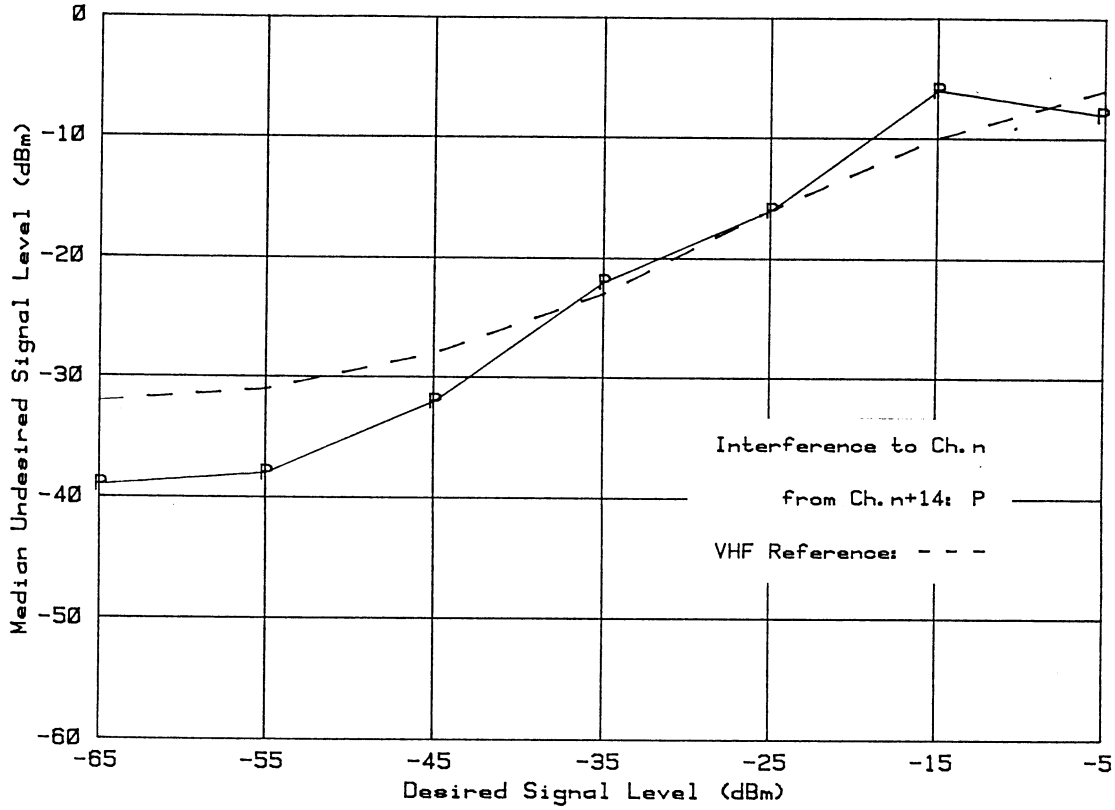


Figure 8: "Just Perceptible" Interference, UHF TV Half-IF

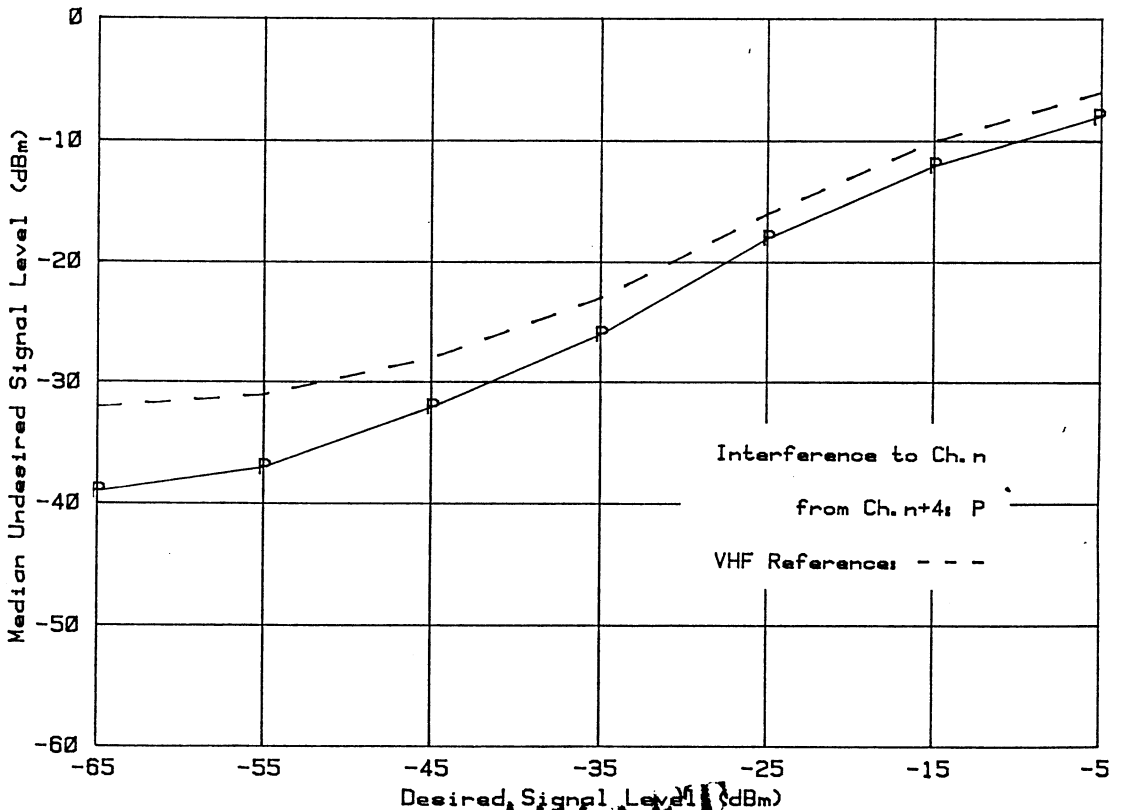


Figure 9: "Just Perceptible" Interference, UHF TV Adjacent Ch.

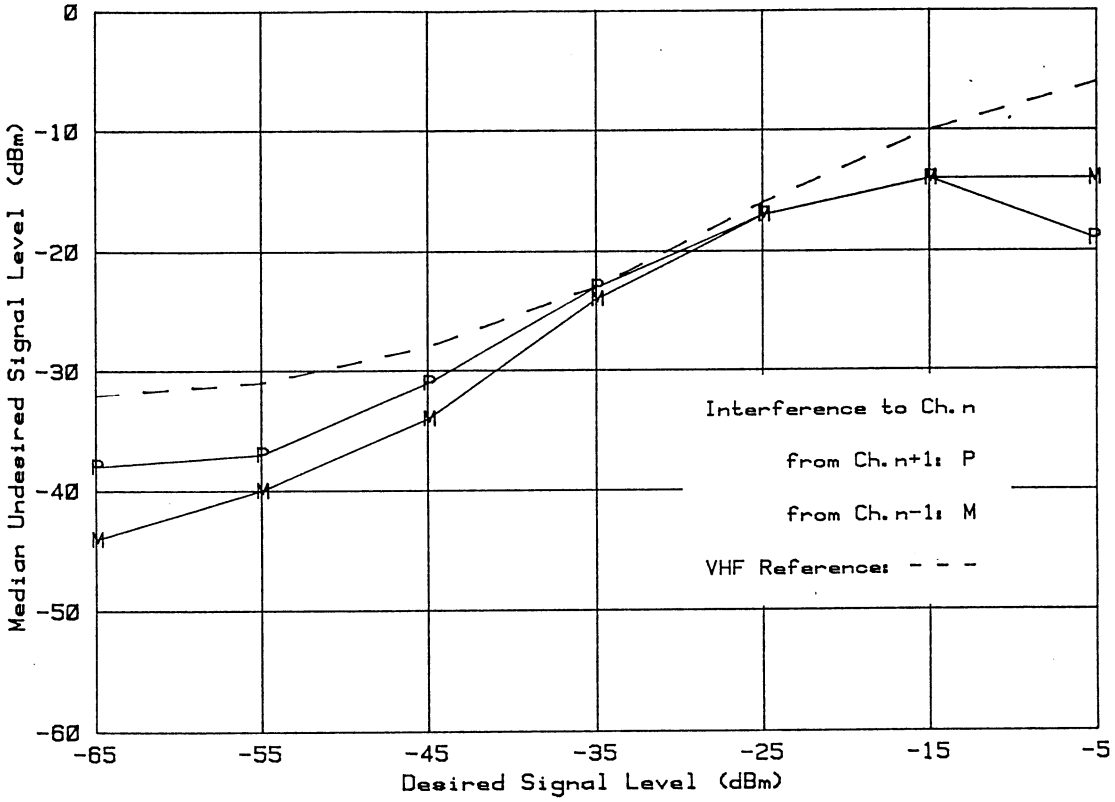
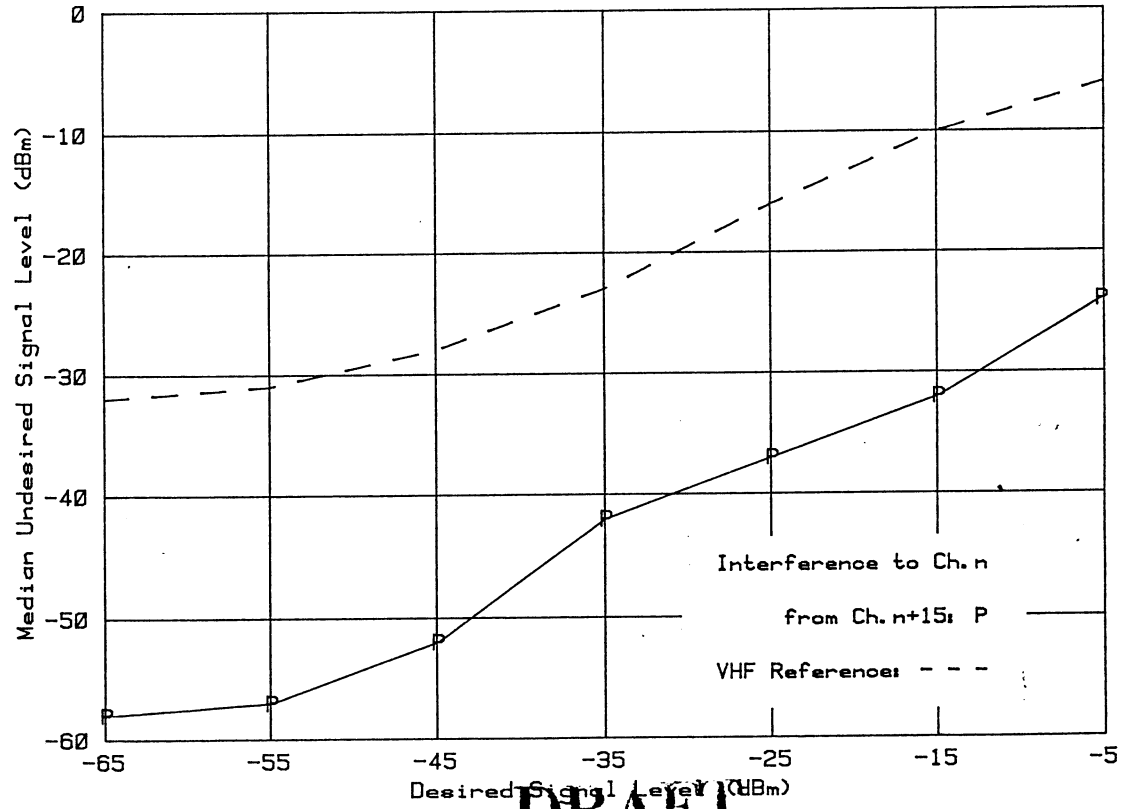


Figure 10: "Just Perceptible" Interference, UHF TV Picture Image



APPENDIX A

Brief Description of Receiver Sample
(Color Receivers, circa 1983 Models)

Rcvr No.	Tuner Description
1	Electronic, One-Knob
2	Electronic, Calculator-Type Pushbutton
3	Electronic, Calculator-Type Pushbutton
4	Electronic, Push "Up-Down"
5	Electronic, Calculator-Type Pushbutton
6	Electronic, A-L Pushbuttons
7	Electronic, Calculator-Type Pushbutton
8	Electronic, Calculator-Type Pushbutton
9	Electronic, Calculator-Type Pushbutton
10	Electronic, Calculator-Type Pushbutton
11	Electronic, Calculator-Type Pushbutton
12	Electronic, Calculator-Type Pushbutton
13	Electronic, One-Knob
14	Mechanical, Two-Knob
15	Electronic, Calculator-Type Pushbutton
16	Electronic, One-Knob

APPENDIX B

UHF Television Interference Test Procedures

For tests of the 1983 sample two engineers, experienced in picture quality judgements, made the subjective observations of "just perceptible" interference. Interfering signal levels were read to the nearest decibel in dBm, decibels referred to one milliwatt. If the data from the two observers were within two decibels, the mean was reported; otherwise the appropriate observations would be repeated until the two decibel range was obtained. (In relatively few cases was the latter procedure necessary.)

In making an interference level judgement, an observer was seated at a distance of four to six times the picture height from the face of the television receiver's picture tube. No light source was directed at the screen and specular reflections were avoided on the face of the picture tube. The room was illuminated with somewhat less light than may be typical in the ordinary home viewing.

With the television channel combinations established for a particular test, the level of the desired signal was set to the specified value. The levels of the interfering signal(s) were controllable through a single attenuator by the observer. His level for the criterion of "just perceptible" interference was obtained, in most cases, by adjusting the attenuator to the point at which a few dB increase gave an obvious visible interference while an equal decrease caused the visible effect to disappear; i.e., become imperceptible.

In previous tests of this kind, notably for the tests reported in 1974 (2), three observers were used, and the desired signal and undesired signal(s) were translated off-the-air television signals. This always gave a median value for the range of various video conditions present during programming. (Commercials were not used for observations because of their frequent shifts of scene and eye-catching effects.) Also, actual viewing conditions were represented to advantage, particular conditions of luminance and/or chrominance.

However, because of constraints of time and available personnel, changes were necessary. To reduce observation time, it was decided not to use program material on the desired channel. Obviously, this eliminated time previously spent waiting for usable video. This decision also eliminated differences in desired video during observations, making the use of only two observers acceptable.

As in the previous tests, the undesired television signal(s) were translated off-the-air television signals. This maintained effects observable because of such characteristics as lack of frame synchronization and saturation

changes in the undesired programming. The desired signal was video modulated with a 50% average picture level full-screen pedestal with color burst. Its aural carrier was unmodulated. The procedure used for these tests was judged acceptable, based on data obtained under the previous and present conditions with a control receiver, which agreed within ± 4 dB.

APPENDIX C

Receiver Data Tables

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Television Interference Study Test No. 1

Desired Channel: N Undesired Channels: N+2, N+4 Interference Type: VHF IM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-26	-26	-21	-16	-16	-7	>0
1	-34	-32	-28	-26	-22	-14	-4
2	-32	-31	-30	-21	-16	-10	-5
3	-34	-33	-32	-25	-20	-14	-6
4	-28	-27	-26	-24	-18	-10	-5
5	-26	-25	-24	-21	-14	-4	-6
6	-32	-30	-26	-26	-19	-9	>0
7	-24	-22	-17	-20	-14	-6	0
8	-36	-34	-31	-23	-14	-10	-9
9	-34	-33	-30	-26	-20	-14	-10
10	-36	-34	-30	-24	-17	-12	-8
11	-32	-31	-29	-26	-18	-10	-7
12	-30	-28	-27	-23	-16	-11	-8
13	-30	-27	-24	-18	-12	-4	-3
14	-18	-18	-18	-12	-10	-4	-4
15	-34	-32	-28	-22	-17	-10	-9
16	-34	-32	-28	-22	-14	-10	-9
Mean	-31	-29	-27	-22	-16	-9	- -
Median	-32	-31	-28	-23	-16	-10	-6
Range	-18/-36	-18/-34	-17/-32	-12/-26	-10/-22	-4/-14	>0/-10

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study

Test No. 2

Desired Channel: N Undesired Channels: N-2, N-4 Interference Type: VHF IM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-25	-24	-16	-14	-10	-2	-1
1	-36	-34	-26	-24	-17	-6	0
2	-26	-23	-23	-16	-8	-2	>0
3	-33	-32	-29	-20	-15	-6	>0
4	-22	-23	-22	-20	-14	-6	-2
5	-28	-25	-22	-19	-15	-6	-4
6	-28	-26	-28	-24	-18	-8	0
7	-26	-23	-22	-19	-12	-5	>0
8	-32	-28	-30	-30	-16	-12	-16
9	-30	-27	-30	-23	-15	-8	-8
10	-26	-25	-26	-25	-18	-12	-5
11	-28	-26	-24	-22	-16	-5	0
12	-29	-26	-26	-22	-15	-8	-6
13	-21	-18	-18	-18	-14	-8	0
14	-16	-14	-19	-14	-8	-5	-4
15	-35	-32	-28	-26	-15	-14	-14
16	-30	-26	-24	-22	-14	-3	-8
Mean	-28	-25	-25	-21	-14	-7	- -
Median	-28	-26	-25	-22	-15	-6	-3
Range	-16/-36	-14/-34	-18/-30	-14/-30	-8/-18	-2/-14	>0/-16

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 3

Desired Channel: N Undesired Channels: N+2, N+4 Interference Type: UHF IM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-21	-12	-5	-4	>0	>0	>0
1	-52	-49	-46	-36	-27	-14	-6
2	-42	-41	-34	-26	-18	-10	-2
3	-35	-34	-29	-24	-20	-10	-12
4	-36	-36	-26	-20	-13	-15	-14
5	-46	-46	-45	-34	-28	-18	-12
6	-41	-34	-33	-22	-20	-22	-24
7	-51	-50	-45	-34	-27	-16	-16
8	-38	-30	-24	-16	-12	-9	-6
9	-36	-30	-23	-18	-18	-4	-2
10	-46	-46	-38	-30	-22	-18	-8
11	-42	-41	-36	-28	-22	-16	-17
12	-52	-50	-41	-31	-21	-15	-8
13	-32	-30	-24	-19	-15	-12	-10
14	-38	-32	-26	-22	-19	-16	-23
15	-34	-34	-28	-20	-14	-9	-6
16	-43	-42	-36	-28	-20	-10	-9
Mean	-41	-39	-33	-25	-20	-13	-11
Median	-41	-38	-33	-25	-20	-14	-9
Range	-32/-52	-30/-50	-23/-46	-16/-36	-12/-28	-4/-22	-2/-24

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

Television Interference Study Test No. 4

Desired Channel: N Undesired Channels: N-2, N-4 Interference Type: UHF IM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-15	-14	-6	-4	>0	>0	>0
1	-39	-37	-33	-24	-15	-15	-19
2	-32	-30	-24	-17	-16	-18	-4
3	-33	-34	-30	-22	-15	-4	-12
4	-38	-36	-28	-21	-10	-15	-14
5	-32	-30	-30	-25	-15	-10	-9
6	-36	-32	-22	-16	-14	-15	-16
7	-37	-35	-30	-16	-11	-12	-15
8	-32	-30	-30	-22	-17	-13	-11
9	-34	-29	-27	-17	-20	-7	-4
10	-38	-37	-28	-18	-18	-16	-2
11	-34	-34	-30	-24	-18	-13	-16
12	-32	-30	-19	-14	-15	-12	-2
13	-32	-32	-28	-22	-14	-12	-8
14	-26	-25	-21	-18	-16	-16	-22
15	-32	-30	-26	-20	-16	-14	-12
16	-39	-38	-32	-20	-19	-9	-6
Mean	-34	-32	-27	-20	-16	-13	-11
Median	-33	-32	-28	-20	-15	-13	-11
Range	-26/-39	-25/-38	-19/-33	-14/-25	-10/-20	-4/-18	-2/-22

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 5

Desired Channel: N Undesired Channels: N-2 Interference Type: UHF CM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	0	>0	>0	>0	>0	>0	>0
1	-26	-28	-30	-22	-13	-14	-18
2	-22	-26	-23	-12	-8	-14	-2
3	-22	-24	-23	-16	-14	>0	-11
4	-21	-21	-18	-14	-1	-14	-16
5	-28	-30	-31	-24	-16	-3	-10
6	-24	-28	-21	-12	-6	-13	-14
7	-24	-24	-22	-12	-5	-6	-14
8	-20	-20	-14	-8	-8	-7	-7
9	-23	-22	-14	-10	-15	>0	>0
10	-28	-31	-22	-14	-11	-9	>0
11	-22	-24	-26	-16	-10	-8	-15
12	-27	-28	-17	-8	-6	-6	>0
13	-24	-26	-20	-5	-4	-3	-4
14	-12	-14	-14	-14	-14	-14	-20
15	-21	-23	-17	-10	-10	-8	-9
16	-31	-32	-30	-19	-12	-4	-6
Mean	-23	-25	-21	-13	-10	- -	- -
Median	-23	-25	-21	-13	-10	-7	-9
Range	-12/-31	-14/-32	-14/-31	-5/-24	-1/-16	>0/-14	>0/-20

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study

Test No. 6

Desired Channel: N Undesired Channels: N-4 Interference Type: UHF CM

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-3	>0	>0	>0	>0	>0	>0
1	-20	-24	-24	-16	-8	-13	-18
2	-16	-20	-18	-8	-9	-14	-2
3	-8	-14	-13	-12	-9	>0	-3
4	-10	-12	-14	-8	-1	-10	-12
5	-21	-24	-24	-16	-8	-5	-8
6	-16	-20	-10	-8	-5	-12	-14
7	-22	-22	-18	-8	-2	-5	-12
8	-4	-8	-4	0	-2	-1	0
9	-15	-14	-10	-4	-14	-14	>0
10	-15	-18	-12	-1	-8	-10	>0
11	-10	-14	-14	-11	-6	-2	-9
12	-14	-14	-6	>0	-4	-4	>0
13	-14	-16	-8	-8	-6	-6	-4
14	>0	0	0	0	0	0	-2
15	-5	-9	-8	-1	-2	-1	-6
16	-19	-22	-19	-8	-6	-11	-2
Mean	- -	-16	-13	- -	-6	- -	- -
Median	-14	-15	-12	-8	-6	-5	-3
Range	>0/-22	0/-24	0/-24	>0/-16	0/-14	>0/-14	>0/-18

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 7

Desired Channel: N Undesired Channels: N+4 Interference Type: UHF Half-I

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-1	>0	>0	>0	>0	>0	>0
1	-42	-42	-41	-38	-29	-21	-12
2	-36	-36	-30	-22	-12	-6	>0
3	-35	-34	-32	-24	-16	-12	-8
4	-38	-36	-28	-20	-10	-12	-16
5	-46	-46	-42	-34	-24	-15	-12
6	-38	-37	-30	-21	-12	-17	-19
7	-48	-46	-41	-31	-24	-11	-14
8	-36	-34	-26	-18	-11	-5	-4
9	-36	-32	-23	-16	-13	>0	>0
10	-48	-46	-37	-30	-20	-18	-8
11	-44	-43	-39	-29	-22	-16	-18
12	-53	-49	-41	-31	-20	-10	-9
13	-36	-35	-29	-21	-14	-8	-5
14	-40	-37	-32	-28	-26	-20	-18
15	-34	-34	-30	-20	-14	-10	-3
16	-44	-43	-38	-28	-20	-12	-4
Mean	-41	-39	-34	-26	-18	- -	- -
Median	-39	-37	-32	-26	-18	-12	-8
Range	-34/-53	-32/-49	-23/-42	-16/-38	-10/-29	>0/-21	>0/-19

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study

Desired Channel: N Undesired Channels: N+2 Interfe

Receiver No.	Undesired Channel Levels (dBm) for "Just" Percepti Desired Channel Levels (dBm) -65	-55	-45	-35	-25
0	-14	-3	>0	>0	>0
1	-30	-32	-32	-24	-16
2	-24	-26	-24	-14	-4
3	-16	-20	-20	-18	-16
4	-21	-22	-14	-12	-6
5	-32	-35	-36	-30	-20
6	-24	-25	-18	-12	-10
7	-21	-24	-22	-10	-4
8	-20	-23	-20	-12	-10
9	-29	-28	-19	-13	-18
10	-38	-36	-28	-20	-16
11	-31	-32	-31	-22	-11
12	-29	-30	-20	-12	-11
13	-20	-22	-19	-3	-3
14	-12	-14	-20	-16	-1
15	-21	-20	-11	-5	-2
16	-32	-35	-32	-22	-
Mean	-25	-26	-23	-15	-
Median	-24	-25	-20	-13	-
Range	-12/-38	-14/-36	-11/-36	-3/-30	-2

Note: The data for television receiver 0, the FCC (RF
television receiver, was not used in determinin
range of the sample.

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Television Interference Study Test No. 9

Desired Channel: N Undesired Channels: N+8 Interference Type: UHF IF

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-34	-44	-48	-44	-34	-24	-21
2	-12	-23	-21	-14	-3	-7	>0
3	-8	-20	-26	-16	-10	-10	-9
4	-6	-14	-12	-6	>0	-10	-12
5	-44	-56	-59	-52	-44	-33	-24
6	-4	-7	-4	-6	-2	-8	-13
7	-26	-41	-42	-32	-20	-24	-36
8	-4	-13	-13	-3	>0	>0	-2
9	-20	-22	-16	-8	-3	>0	>0
10	-34	-44	-38	-30	-22	-16	-8
11	-11	-22	-26	-16	-8	-10	-12
12	-38	-44	-34	-28	-20	-12	-14
13	-6	-14	-12	-5	-4	-4	0
14	>0	0	-3	-9	-6	-9	-4
15	-2	-12	-12	-4	-2	-1	0
16	-18	-29	-31	-22	-13	-6	-4
Mean	- -	-25	-25	-18	- -	- -	- -
Median	-11	-22	-23	-15	-7	-9	-8
Range	>0/-44	0/-56	-3/-59	-3/-52	>0/-44	>0/-33	>0/-36

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

Television Interference Study Test No. 10

Desired Channel: N Undesired Channels: N-8 Interference Type: UHF IF

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-30	-39	-42	-39	-31	-22	-23
2	-24	-36	-38	-29	-20	-18	-4
3	-10	-19	-24	-14	-5	>0	-2
4	-23	-34	-26	-16	-10	-6	-6
5	-4	-14	-16	-6	>0	-2	-4
6	-14	-26	-23	-14	-4	-9	-12
7	-35	-46	-44	-34	-25	-13	-12
8	>0	-4	-4	0	-2	-2	-2
9	-6	-10	-6	-6	-10	>0	>0
10	-4	-18	-15	-6	-4	-8	>0
11	-16	-27	-29	-19	-12	-5	-12
12	-14	-18	-10	>0	-2	>0	>0
13	-14	-19	-21	-12	-12	-12	-10
14	>0	0	-11	-9	-6	-6	-10
15	-2	-5	-5	-2	-4	-3	-4
16	-24	-34	-33	-22	-14	-2	-3
Mean	- -	-22	-22	- -	- -	- -	- -
Median	-14	-19	-22	-13	-8	-5	-4
Range	>0/-35	0/-46	-4/-44	>0/-39	>0/-31	>0/-22	>0/-23

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

Television Interference Study Test No. 11

Desired Channel: N Undesired Channels: N-7 Interference Type: UHF IF

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-40	-44	-46	-41	-32	-23	-23
2	-38	-41	-38	-33	-18	-16	-4
3	-22	-26	-25	-16	-8	>0	-2
4	-29	-34	-26	-14	-5	-6	-6
5	-10	-18	-18	-8	-5	-4	-6
6	-22	-32	-26	-17	-4	-11	-12
7	-39	-40	-34	-24	-12	-4	-10
8	-7	-6	-8	>0	-3	-4	-4
9	-7	-13	-8	-6	-13	>0	>0
10	-17	-23	-17	-8	-8	-11	>0
11	-22	-28	-28	-21	-8	-5	-12
12	-22	-18	-10	-10	-2	0	>0
13	-28	-30	-16	-17	-20	-21	-19
14	0	-8	-20	-16	-16	-14	-15
15	-3	-7	-5	-2	-3	-4	-3
16	-34	-38	-34	-22	-14	-4	-4
Mean	-21	-25	-22	- -	-11	- -	- -
Median	-22	-27	-22	-16	-8	-4	-5
Range	0/-40	-6/-44	-5/-46	>0/-41	-2/-32	>0/-23	>0/-23

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 12

Desired Channel: N Undesired Channels: N+7 Interference Type: UHF IF

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-28	-35	-39	-32	-22	-16	-14
2	-20	-28	-28	-18	-9	-5	-2
3	-14	-24	-26	-18	-13	-7	-8
4	-15	-20	-12	-8	>0	-10	-14
5	-41	-50	-56	-48	-38	-30	-20
6	-14	-20	-16	-10	-9	-11	-15
7	-26	-36	-36	-26	-16	-21	-32
8	-10	-19	-18	-10	-7	-6	-4
9	-17	-20	-14	-3	-5	>0	>0
10	-32	-39	-36	-28	-20	-16	-5
11	-20	-30	-33	-26	-20	-17	-14
12	-29	-33	-26	-17	-8	-7	-4
13	-7	-17	-16	-8	-6	-6	-4
14	-13	-10	-14	-14	-16	-16	-12
15	-6	-10	-8	>0	0	>0	>0
16	-22	-30	-28	-20	-11	-8	-4
Mean	-20	-26	-25	- -	- -	- -	- -
Median	-18	-26	-26	-17	-10	-9	-6
Range	-6/-41	-10/-50	-8/-56	>0/-48	>0/-38	>0/-30	>0/-32

Note: The data for television receiver C, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 13

Desired Channel: N Undesired Channels: N+14 Interference Type: UHF Image

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-44	-40	-32	-26	-18	-6	-11
2	-39	-40	-34	-24	-16	-4	>0
3	-42	-40	-34	-28	-20	-16	-11
4	-24	-23	-18	-18	-14	-17	-14
5	-49	-48	-40	-30	-25	-16	-13
6	-16	-14	-14	-17	-18	-17	-16
7	-56	-56	-46	-38	-28	-22	-18
8	-48	-41	-34	-28	-19	-6	-5
9	-29	-22	-14	-4	-2	-2	>0
10	-36	-34	-26	-14	-10	-4	>0
11	-40	-37	-32	-20	-12	-4	-11
12	-38	-34	-25	-16	-14	-16	-14
13	-48	-44	-37	-28	-16	-9	>0
14	-24	-21	-12	-3	>0	>0	>0
15	-42	-42	-38	-30	-18	-7	>0
16	-33	-32	-26	-18	-6	-5	>0
Mean	-38	-35	-29	-21	- -	- -	- -
Median	-39	-38	-32	-22	-16	-6	-8
Range	-16/-56	-14/-56	-12/-46	-3/-38	>0/-28	>0/-22	>0/-18

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study

Test No. 14

Desired Channel: N Undesired Channels: N+15 Interference Type: UHF Image

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	>0	>0	>0	>0	>0	>0	>0
1	-69	-68	-62	-52	-44	-34	-24
2	-63	-64	-56	-48	-40	-32	-24
3	-54	-54	-52	-45	-36	-30	-26
4	-46	-44	-40	-37	-36	-36	-35
5	-64	-63	-60	-50	-42	-34	-31
6	-36	-36	-36	-38	-39	-39	-38
7	-73	-73	-59	-50	-44	-38	-34
8	-64	-66	-63	-44	-40	-33	-30
9	-46	-42	-36	-34	-34	-32	-22
10	-58	-56	-52	-42	-34	-30	-18
11	-61	-59	-54	-42	-36	-28	-24
12	-59	-58	-50	-40	-38	-41	-38
13	-64	-62	-55	-44	-38	-28	-21
14	-48	-44	-40	-30	-17	-14	-4
15	-56	-56	-50	-42	-34	-22	-13
16	-50	-50	-46	-38	-28	-24	-17
Mean	-57	-56	-51	-42	-36	-31	-25
Median	-58	-57	-52	-42	-37	-32	-24
Range	-36/-73	-36/-73	-36/-63	-30/-52	-17/-44	-14/-41	-4/-38

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

Television Interference Study Test No. 15

Desired Channel: N Undesired Channels: N+1 Interference Type: UHF Adj C

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-21	-18	-11	-4	>0	>0	>0
1	-40	-40	-37	-30	-21	-14	-31
2	-56	-54	-44	-32	-29	-16	-8
3	-33	-29	-27	-20	-16	-5	-15
4	-36	-36	-26	-19	-14	-18	-30
5	-36	-36	-37	-30	-21	-12	-19
6	-40	-40	-33	-24	-18	-20	-35
7	-36	-35	-30	-20	-14	-16	-36
8	-35	-35	-32	-21	-16	-14	-16
9	-42	-38	-30	-22	-20	-5	-4
10	-46	-44	-38	-30	-22	-18	-8
11	-46	-39	-37	-26	-18	-14	-29
12	-40	-38	-28	-20	-16	-14	-1
13	-36	-36	-26	-17	-16	-15	-20
14	-30	-28	-29	-24	-17	-16	-35
15	-32	-32	-27	-17	-14	-10	-12
16	-42	-42	-37	-28	-20	-19	-19
Mean	-39	-38	-32	-24	-18	-14	-20
Median	-38	-37	-31	-23	-17	-14	-19
Range	-30/-56	-28/-54	-26/-44	-17/-32	-14/-29	-5/-20	-1/-36

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

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Television Interference Study Test No. 16

Desired Channel: N Undesired Channels: N-1 Interference Type: UHF Adj Ch

Receiver No.	Undesired Channel Levels (dBm) for "Just" Perceptible Interference — Desired Channel Levels (dBm)						
	-65	-55	-45	-35	-25	-15	-5
0	-40	-36	-30	-18	-10	-2	>0
1	-38	-38	-34	-27	-18	-14	-27
2	-37	-36	-32	-21	-12	-15	-2
3	-52	-48	-39	-32	-23	-8	-10
4	-58	-54	-46	-36	-26	-16	-18
5	-46	-45	-38	-29	-20	-12	-14
6	-38	-40	-34	-24	-14	-16	-24
7	-50	-49	-42	-29	-22	-14	-29
8	-46	-42	-34	-24	-17	-15	-11
9	-39	-36	-26	-18	-16	>0	>0
10	-62	-61	-52	-42	-33	-22	-10
11	-47	-36	-35	-24	-15	-10	-15
12	-44	-42	-36	-24	-16	-10	-2
13	-44	-40	-32	-22	-16	-12	-16
14	-44	-38	-28	-29	-30	-29	-45
15	-36	-36	-32	-22	-20	-18	-18
16	-38	-37	-34	-24	-17	-10	-11
Mean	-45	-42	-36	-27	-20	- -	- -
Median	-44	-40	-34	-24	-17	-14	-14
Range	-36/-62	-36/-61	-26/-52	-18/-42	-12/-33	>0/-29	>0/-45

Note: The data for television receiver 0, the FCC (RFM) advanced technology television receiver, was not used in determining the mean, median or range of the sample.

DRAFT

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