D_{MIN} is approached, as was illustrated in Figures 8-1 through 8-4. Consequently, both measurements and extrapolations can be subject to greater errors as D approaches D_{MIN}, due to high sensitivity to the D/D_{MIN} ratio. As an example, when D/D_{MIN} is expected to be 1 dB, misjudging the D/D_{MIN} ratio by 0.25 dB could cause the threshold undesired signal level to change by amounts ranging from 0.3 to 1.1 dB, depending on the direction of the error and the order of the interference process.

The extrapolation will consist of two parts:

- a straight-line projection part based on the slopes identified in Table 8-1 for each of the interference categories;
- an estimate of the deviation from straight-line projection based on the deviations listed in Table 8-2; more specifically, we will use the difference between the straight line deviation for D/D_{MIN} = 1 dB and that for D/D_{MIN} = 3 dB.

The first part will require that we categorize each interference case (each channel offset for each receiver) into one of four categories: (1) linear or AGC-stabilized; (2) second order; (3) third order; (4) cross-modulation. The second part will require additional categorization within the linear or AGC-stabilized category.

The category of each interference process will be estimated from the *adjusted slope* of the log-D versus log-U data from D = -68 dBm to D = D_{MIN} + 3 dB, computed as described in the previous section. The boundary between third-order interference and cross-modulation will be set at an adjusted slope of 5. The categories will serve as the basis for defining the slope of the straight-line portion of the extrapolation (Table 8-1), as well as for estimating the deviation from the straight-line projection. The measurement data at D = D_{MIN} + 3 dB will serve as the anchor point for the extrapolation.

The deviation from straight-line behavior will create a need to adjust the threshold undesired signal downward from the straight-line projection by an amount equal to the difference between the deviation for D_{MIN} + 1 dB and that for D_{MIN} + 3 dB, as determined by Table 8-2 (Chapter 8). Those differences range from -1.3 to -3.8 dB*—a span of 2.5 dB.

But selection of the correct values from Table 8-2 will, in some cases, require more knowledge than we have. For cases that appear to be nonlinear (order higher than 1) based on the above, the appropriate values from Table 8-2 can be used directly; however, for channel offsets that appear to exhibit linear behavior based on the above, Table 8-2 shows that the expected offset depends on whether the underlying interference mechanism was truly linear or was made to appear linear by AGC action. We will assume that the underlying mechanism is linear only for N+14 and N+15, the mixer image frequencies. For the other cases, the correction depends both on the order of the nonlinearity and on whether the AGC action was driven primarily by *desired* signal level or primarily by the *undesired* signal level. In the former case the deviation matches that for the underlying nonlinear process, which we don't know; in the latter, the deviation will be the same as for a linear process.

Though we have enough information to resolve some of these questions for receiver D3, on which detailed tests were performed, the limited measurements performed on the other receivers are inadequate for such resolution. Consequently, we take the following approach to computing the deviation from a straight-line projection for all receivers:

- If the interference behavior appears nonlinear, use the values from Table 8-2 for the estimated order of the interference;
- For N+14 and N+15, use the values from Table 8-2 for linear processes;
- For all other cases that appear linear, select a deviation from straight line behavior as the midpoint between the two extremes that could be occur—*i.e.*, nonlinear with U driving the AGC (-3.8 dB

* The differences of the rounded numbers is the table, -6.9 - (-3.0) is -3.9, however, if the calculation is performed before rounding, and the answer is then rounded, the result is -3.8 dB.

adjustment) and third-order with D driving the AGC (-1.3 dB); we will accept the error of up to 1.3 dB in either direction that could result from adjustments based on the midpoint (-2.6 dB).

Table 12-2 summarizes the entire extrapolation process.

Table 12-2. Process for Extrapolation from D = D_{MIN}+3dB to D_{MIN}+1dB

Undesired Channel	Adjusted Slope of Log-D Versus Log-U (dB/dB)	Assumed Interference Mechanism	Extrapolation of Threshold U From D = D_{MIN}+3dB to D_{MIN}+1dB (dB)		
			Straight-Line Projection	Deviation From Straight Line	Total
N+14 or N+15		Linear	-2.0	-3.8	-5.8
All others	< 1.5	AGC Stabilized Nonlinear	-2.0	-2.6	-4.6
All others	1.5 to 2.5	2nd Order	-1.0	-1.9	-2.9
All others	2.5 to 5	3rd Order	-0.7	-1.3	-1.9
All others	Magnitude >5	Cross Modulation	0	-1.9	-1.9

Extrapolation Test

In Table 12-3 we have applied this extrapolation process to data from the detailed measurements that were made on receiver D3 on channel 51 (Chapter 11). Values of threshold U at D = D_{MIN} + 1 dB extrapolated from measurements at D = D_{MIN} + 3 dB and -68 dBm are compared to measurements at D = D_{MIN} + 1 dB. The extrapolation errors were less than 1 dB in each case.

Extrapolation of Channel-30 Measurements on All Eight Receivers

Extrapolations of threshold undesired signal level to a desired signal level of D_{MIN} + 1 dB were performed for all channel-30 measurements of single-channel rejection performance for the eight fifth-generation DTV receivers.

Figure 12-4 shows D/U ratios for the eight receivers based on the extrapolation. Note that the plot includes data for a given receiver at a given channel offset only if a valid measurement was obtained at D_{MIN} + 3 dB, from which to extrapolate, and if the slope could be estimated. Slope estimation requires a valid measurement at D = -68 dBm, except in the cases of N+14 and N+15, where the interference process was assumed to be linear.

The plot also includes the ATSC performance guidelines corresponding to a desired signal level of -68 dBm. (ATSC does not specify rejection performance at a lower desired signal level.)

The extrapolated data are combined with measured data in graphs in Chapter 13 and tabulations in Appendix A.

Table 12-3. Error Test for Extrapolation From D = D_{MIN} + 3 dB to D_{MIN} + 1 dB

	Adjusted *Slope of* Log-D Versus Log-U (dB/dB)	Modeled Interference Mechanism	Change in U as D goes from D_{MIN}+3dB to D_{MIN}+1dB (dB)				Extrapolation Error (dB)
			Extrapolated Change In U				
			Straight-Line Portion of Projection	Deviation From Straight Line	Total	Measured Change in U	
N+1	1.3	AGC-Stabilized Nonlinear	-2.0	***-2.6***	-4.6	-4.2	0.4
N+2	1.2	AGC-Stabilized Nonlinear	-2.0	***-2.6***	-4.6	-4.7	-0.2
N+3	5.5	Cross-Modulation	0.0	-1.9	-1.9	-1.7	0.2
N+4	3.0	3rd Order	-0.7	-1.3	-1.9	-1.8	0.1
N+5	3.2	3rd Order	-0.7	-1.3	-1.9	-1.6	0.3
N+6	4.5	3rd Order	-0.7	-1.3	-1.9	-1.2	0.8
N+7	6.3	Cross-Modulation	0.0	-1.9	-1.9	-2.4	-0.4
N+14	1.1	Linear	-2.0	-3.8	-5.8	-5.0	0.8
N+15	1.1	Linear	-2.0	-3.8	-5.8	-5.6	0.3
N+1/ N+2	1.1	AGC-Stabilized Nonlinear	-2.0	***-2.6***	-4.6	-5.2	-0.6
N+2/ N+4	3.4	3rd Order	-0.7	-1.3	-1.9	-1.4	0.6
N+3/ N+6	3.3	3rd Order	-0.7	-1.3	-1.9	-2.1	-0.1
N+4/ N+8	3.4	3rd Order	-0.7	-1.3	-1.9	-2.4	-0.5

Notes

[1] For cases shown in bold italics, the apparent linearity is assumed to be a possible result of AGC action and deviation from straight line is calculated as described in text.

Rounding to 0.1 dB after calculations are performed may cause some apparent discrepancies of up to 0.1 dB.

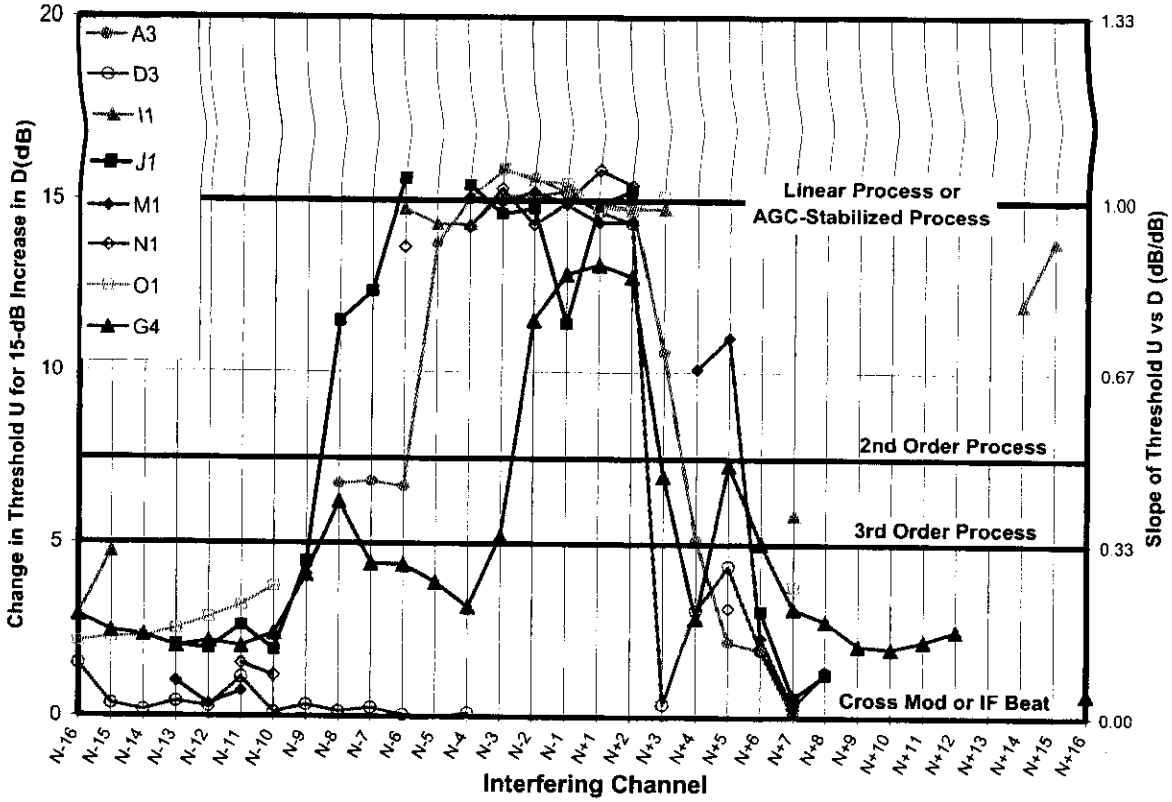

Figure 12-1. Slope of Threshold U Versus D from D = -68 dBm to -53 dBm

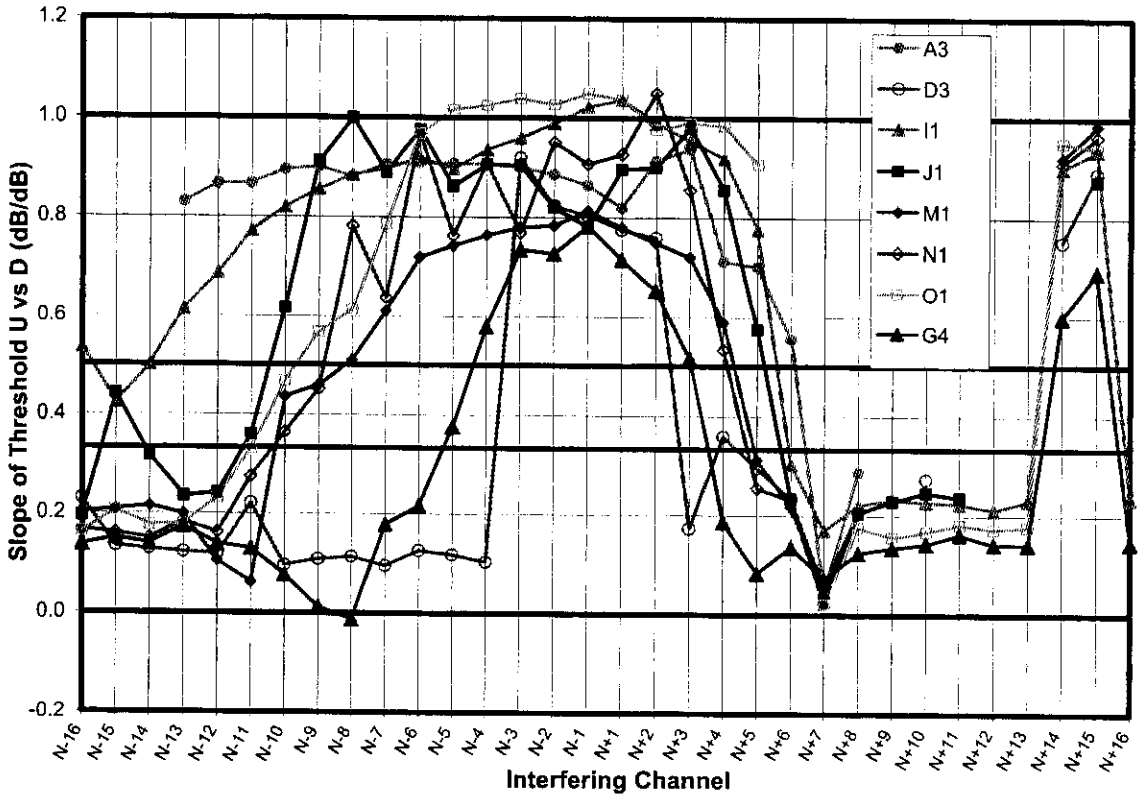

Figure 12-2. Slope of Threshold U Versus D from D =D_{MIN}+3dB to -68 dBm

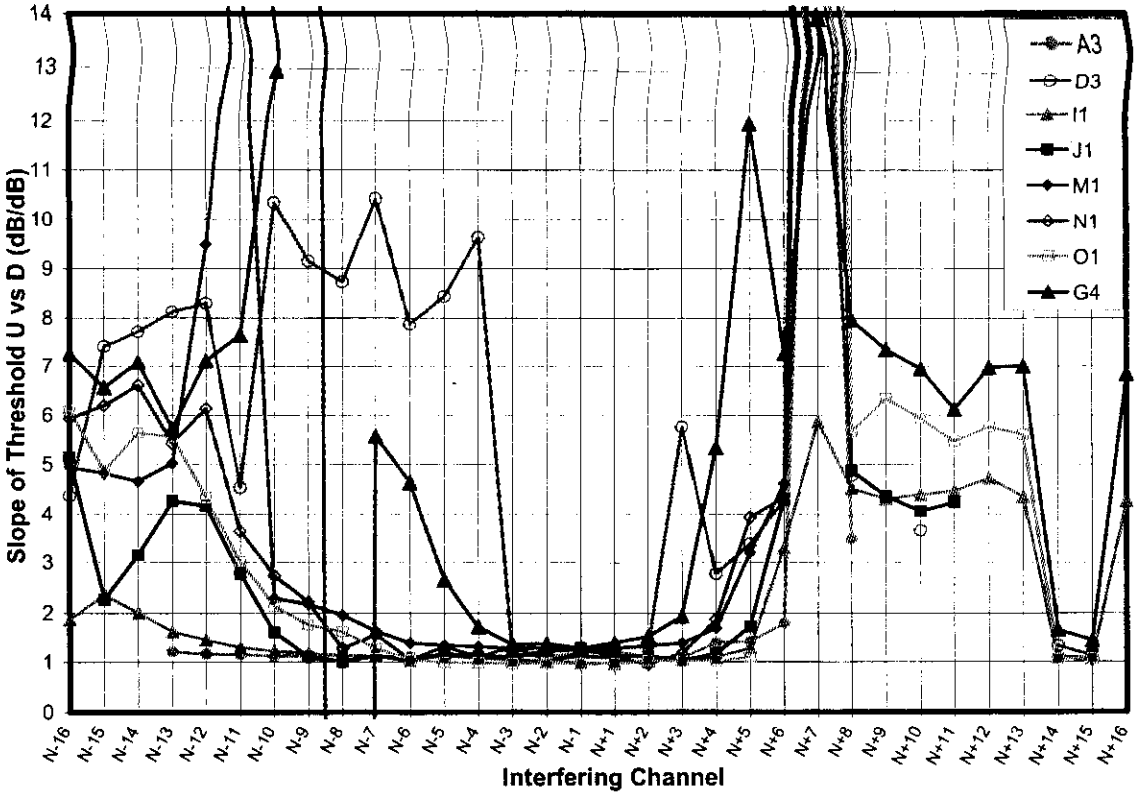

Figure 12-3. Slope of Threshold D Versus U from D =D_{MIN}+3dB to -68 dBm

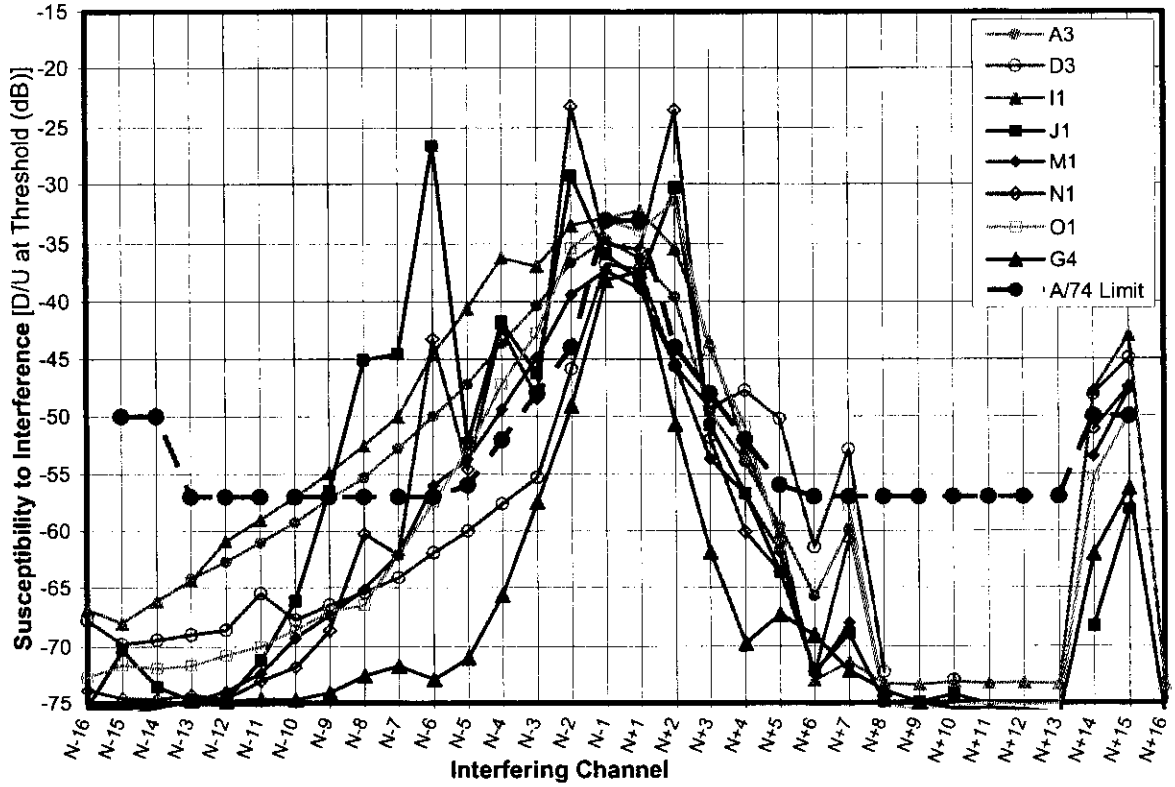

Figure 12-4. D/U of 8 Receivers at D = D_{MIN} + 1 dB on Channel 30 (Extrapolation)

CHAPTER 13
COMBINING MEASURED AND EXTRAPOLATED RESULTS

This chapter shows single-channel rejection performance for eight DTV receivers for a desired signal on channel 30. The results shown combine the measurements of Chapter 5 (D = -28 dBm, -53 dBm, -68 dBm, and D_{MIN} + 3 dB) with the extrapolations of Chapter 12 (D = D_{MIN} + 1 dB).

Figure 13-1 shows D/U ratios for receiver A3. Figure 13-2 shows the same information as Figure 13-1, but shows it as the threshold value for undesired signal power. The first graph will be useful for those who prefer to work in terms of D/U ratios and for identifying channel offsets that behave in a linear manner (constant D/U ratio as D changes) either because the interference mechanism is linear (N+14 and N+15) or due to AGC action. The second is useful for identifying the absolute signal levels that cause interference effects and for identifying channel offsets where thresholds tend to be constant in terms of absolute power of the undesired signal (*e.g.*, N+7).

Figures 13-3 to 13-16 are the same pair of plot formats for each of the remaining seven receivers.

We note that the D/U plots (odd-numbered Figures 13-1 through 13-15) show four measurement limit curves. From top to bottom, these correspond to limits at D = -28 dBm, -53 dBm, -68 dBm, and D_{MIN} + 3 dB, respectively. In the top two curves, all points are determined by the maximum undesired signal power that the test setup could deliver to the input of a TV receiver. The third curve, for D = -68 dBm, has two sources of measurement limits: at N-1 and N+1, the measurement limitation is based on leakage of the undesired signal into the desired channel; at all other channel offsets, the measurements are limited by maximum undesired signal level. For D = D_{MIN} + 3 dB, the measurement limitation (shown by the bottom, shaded region of the graph) is caused by leakage of the undesired signal into the desired channel; since this is a soft limit, values below the limit are shown, but their accuracies are influenced by the leakage. In the case of data extrapolated to D_{MIN} + 1 dB, data points are shown only if the measurements on which they were based were not subject to measurement limits.

The undesired signal threshold plots (even-numbered Figures 13-2 through 13-16) show only one measurement limit curve—the curve associated with the maximum undesired signal power that the test setup could inject into the receiver. The N-1 and N+1 offsets for D = -68 dBm and all of the offsets for D = D_{MIN} + 3 dB are subject to an additional limitation, shown only in the D/U plots, based on leakage of the undesired signal into the desired channel.

We note in particular the case of receiver D3 in Figures 13-3 and 13-4. In Chapter 5 we stated that the smooth rise in D/U (or corresponding smooth fall in threshold U) as one moves from N-15 to N-4 is suggestive of a particular broadband interference mechanism—cross-modulation. Chapter 8 showed that cross-modulation is expected to exhibit a constant threshold U with changes in desired signal level except as the desired signal level approaches D_{MIN} or if the AGC begins to reduce gain prior to the tuner nonlinearity at which the cross-modulation is occurring. We see in Figure 13-4 that the curves corresponding to D = -53 dBm and D = -68 dBm are essentially identical from N-15 to N-4 (except for a small bump associated with a single-channel interference susceptibility at N-11. Interference susceptibility increases by a few dB as one moves past the curve for D = D_{MIN} + 3 dB to the curve corresponding to D = D_{MIN} + 1 dB; the increased susceptibility is an expected result of receiver noise becoming significant at lower signal levels. All four of the curves appear to be the result of cross-modulation.

At N-3 things change. The D/U ratio, which had been smoothly increasing as the undesired channel moved toward the desired channel, takes an abrupt drop—indicating that the receiver's AGC has acted to decrease the RF gain prior to the mixer—the likely point of the nonlinearity that caused the cross-

modulation. Since each curve corresponds to fixed desired signal level, it is clear that the AGC must have been engaged by the undesired signal, which is likely to be larger in amplitude at the AGC sampling point when the undesired signal is on N-3 than when it was on N-4 and beyond because of the tuner's RF tracking filter response. The smaller change in the D_{MIN} + 3 dB curve as compared to the -68 dBm curve suggests that the AGC gain reduction was relatively small in the former case (where U is about -22 dBm). Thus, it is clear that the AGC engages on an undesired signal level somewhat lower than -22 dBm on N+3—a factor that will become important in some analysis in the next chapter.

Chapter 15 includes composite charts for median, second-worst, and worst performance among the receivers.

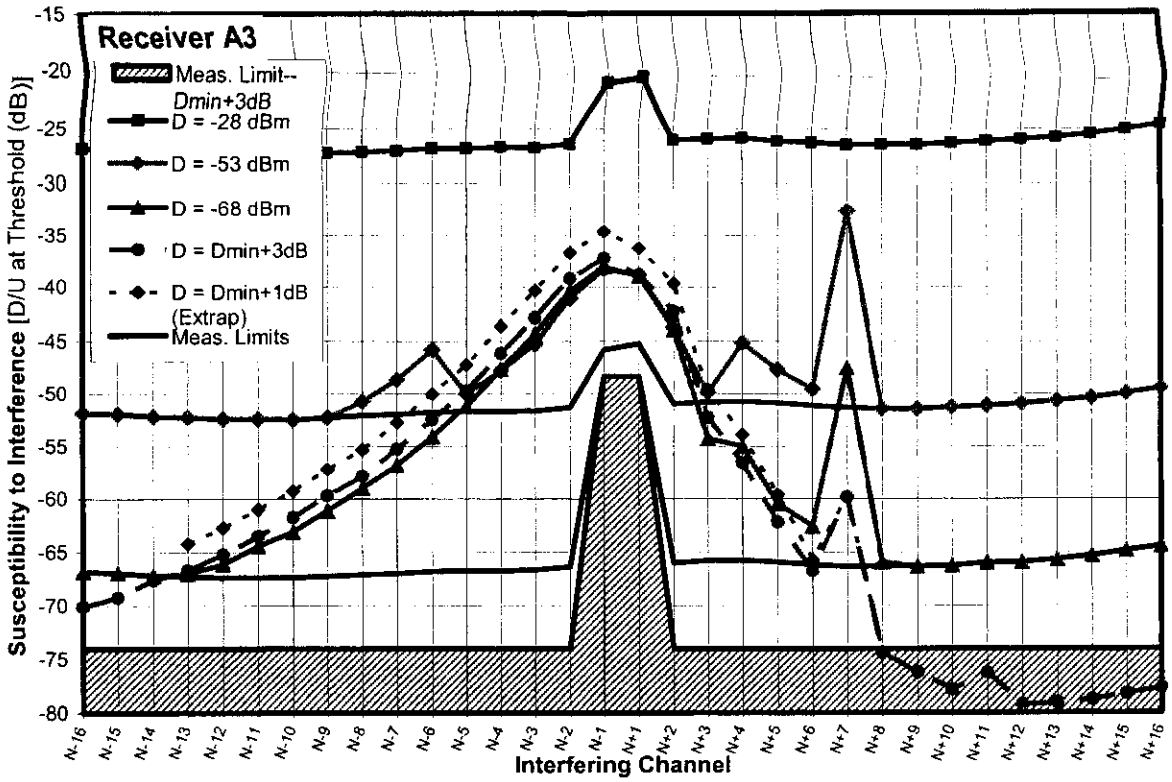

Figure 13-1. D/U of Receiver A3 at Five Desired Signal Levels on Channel 30

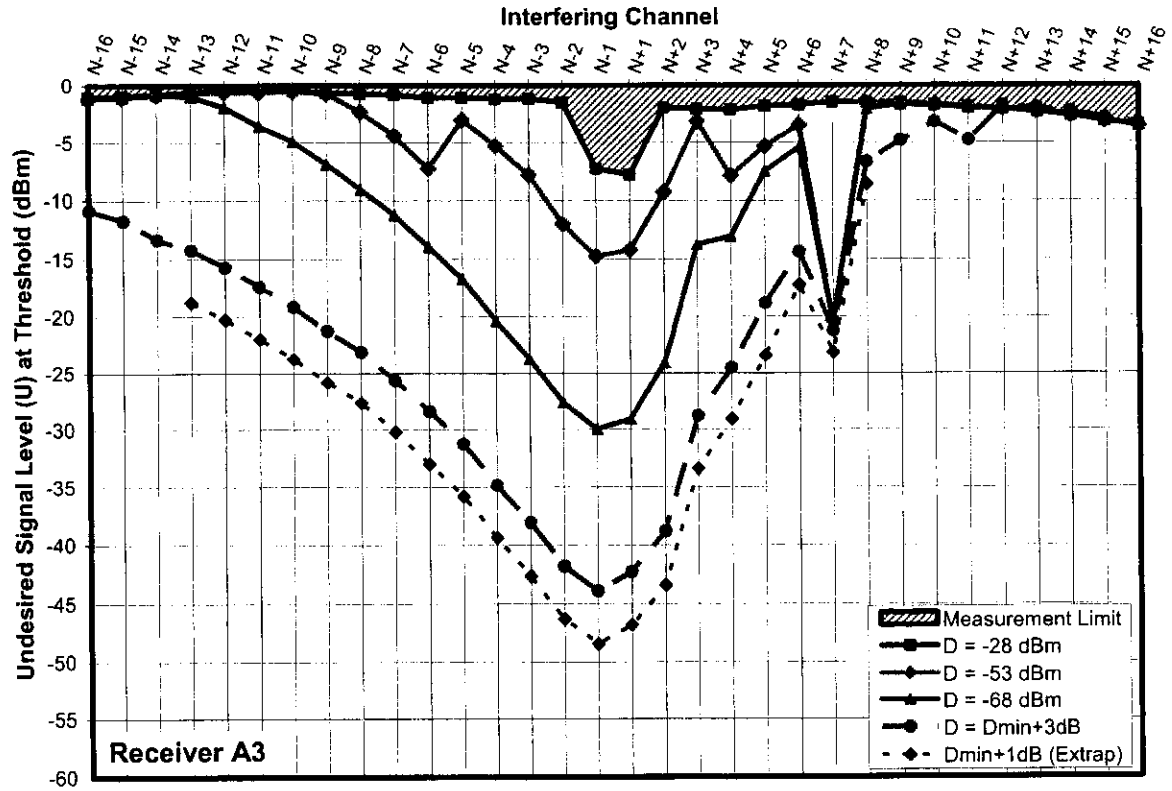

Figure 13-2. Threshold U of Receiver A3 at Five Desired Signal Levels on Channel 30

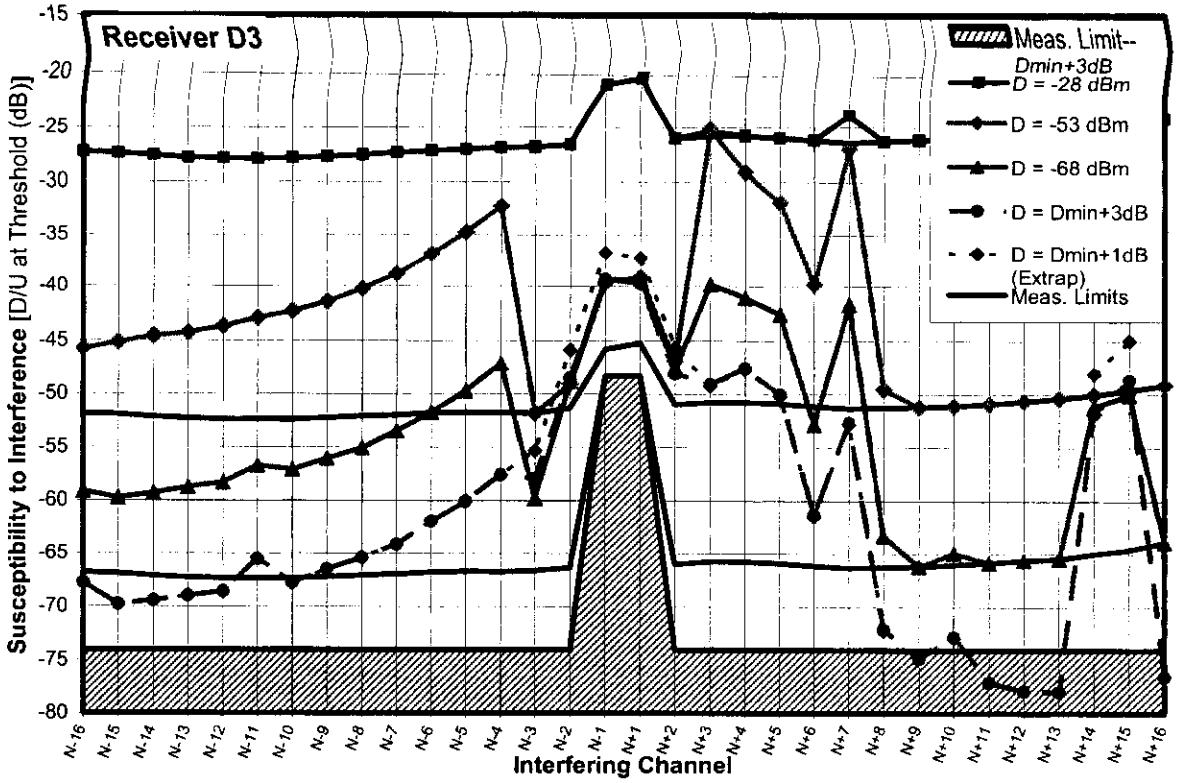

Figure 13-3. D/U of Receiver D3 at Five Desired Signal Levels on Channel 30

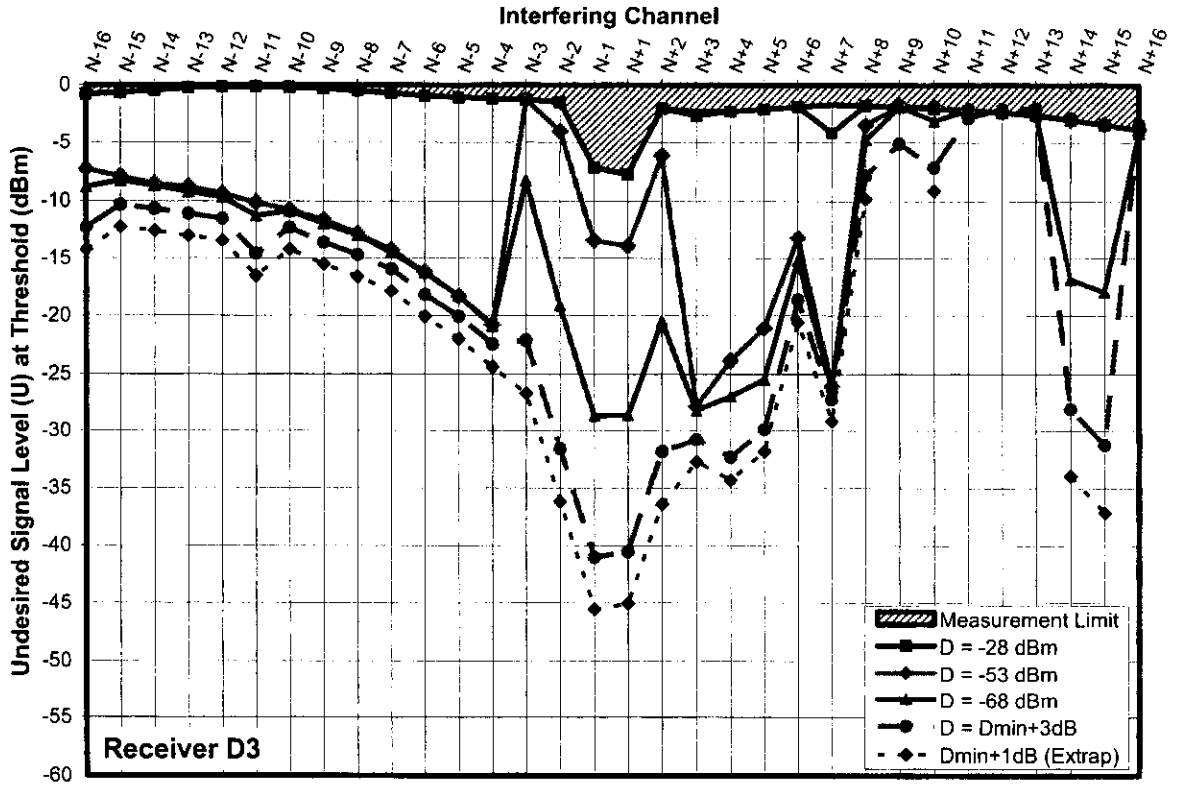

Figure 13-4. Threshold U of Receiver D3 at Five Desired Signal Levels on Channel 30

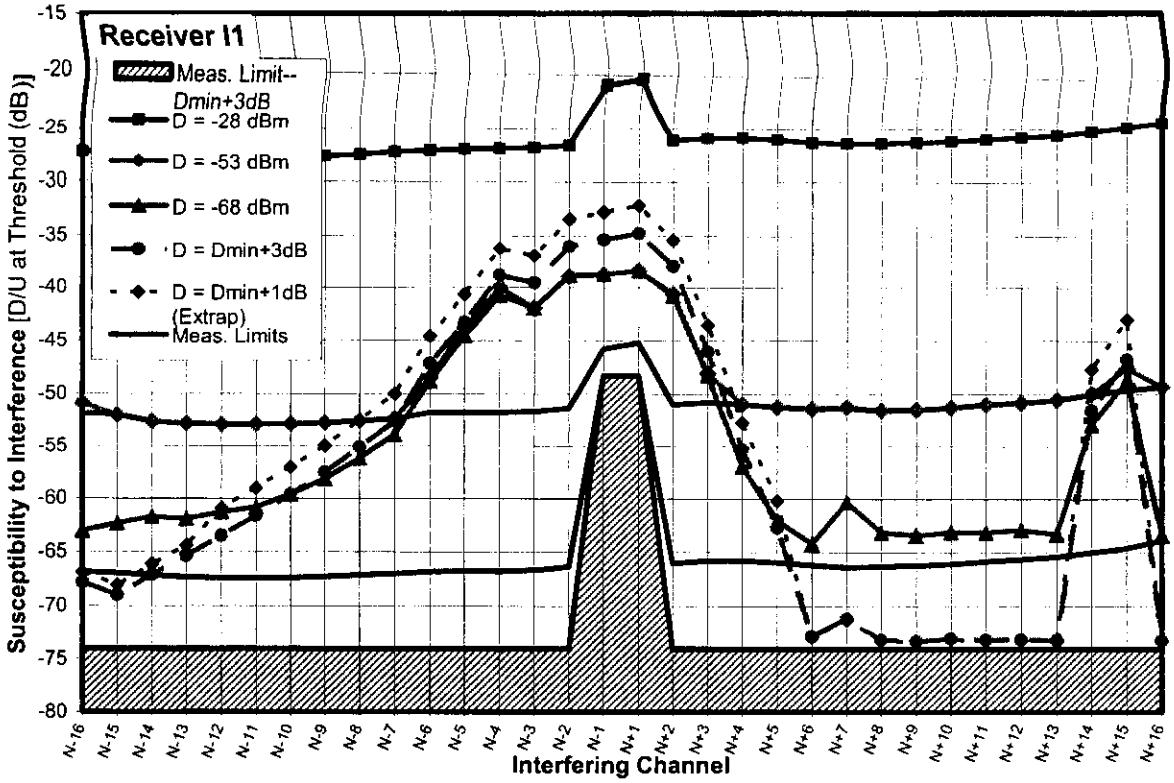

Figure 13-5. D/U of Receiver I1 at Five Desired Signal Levels on Channel 30

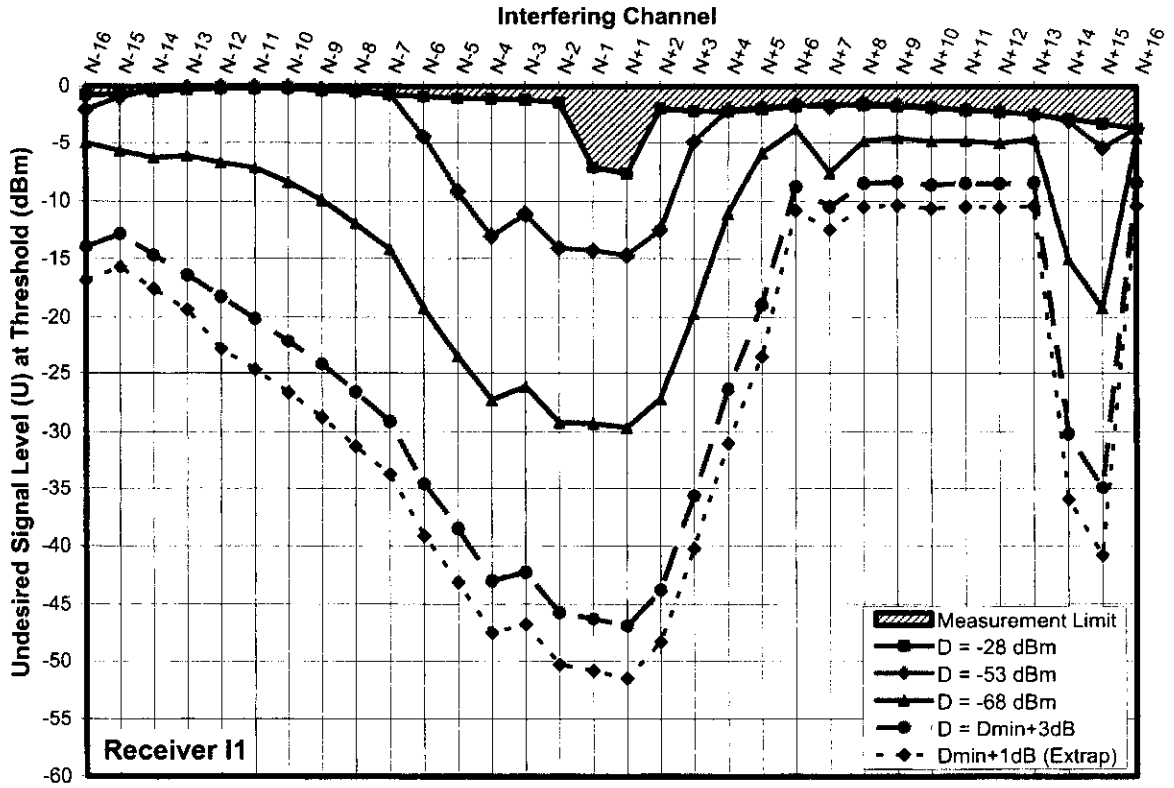

Figure 13-6. Threshold U of Receiver I1 at Five Desired Signal Levels on Channel 30

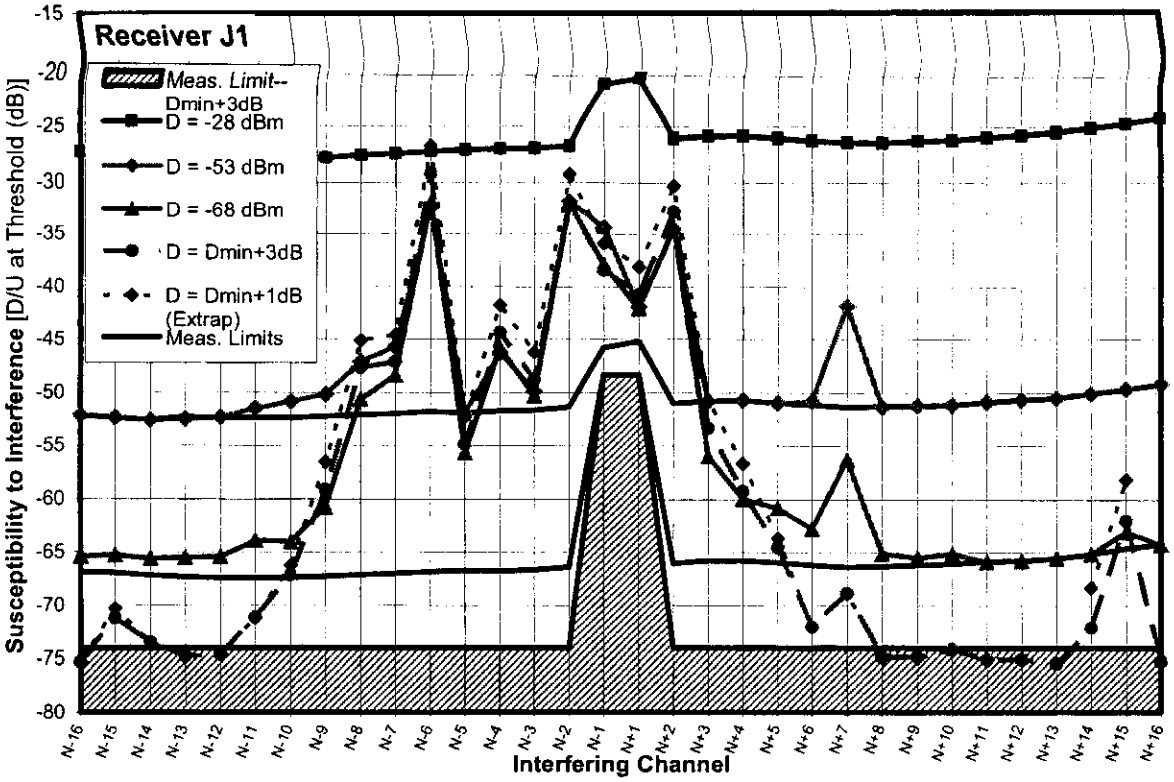

Figure 13-7. D/U of Receiver J1 at Five Desired Signal Levels on Channel 30

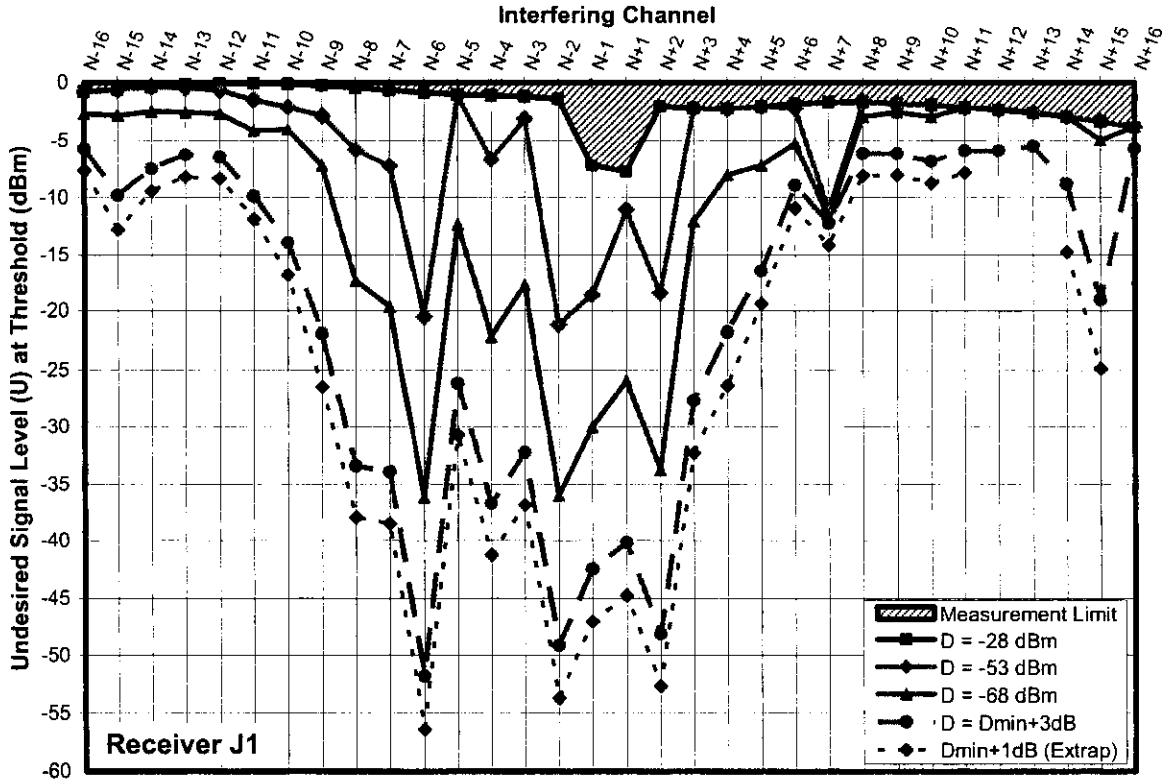

Figure 13-8. Threshold U of Receiver J1 at Five Desired Signal Levels on Channel 30

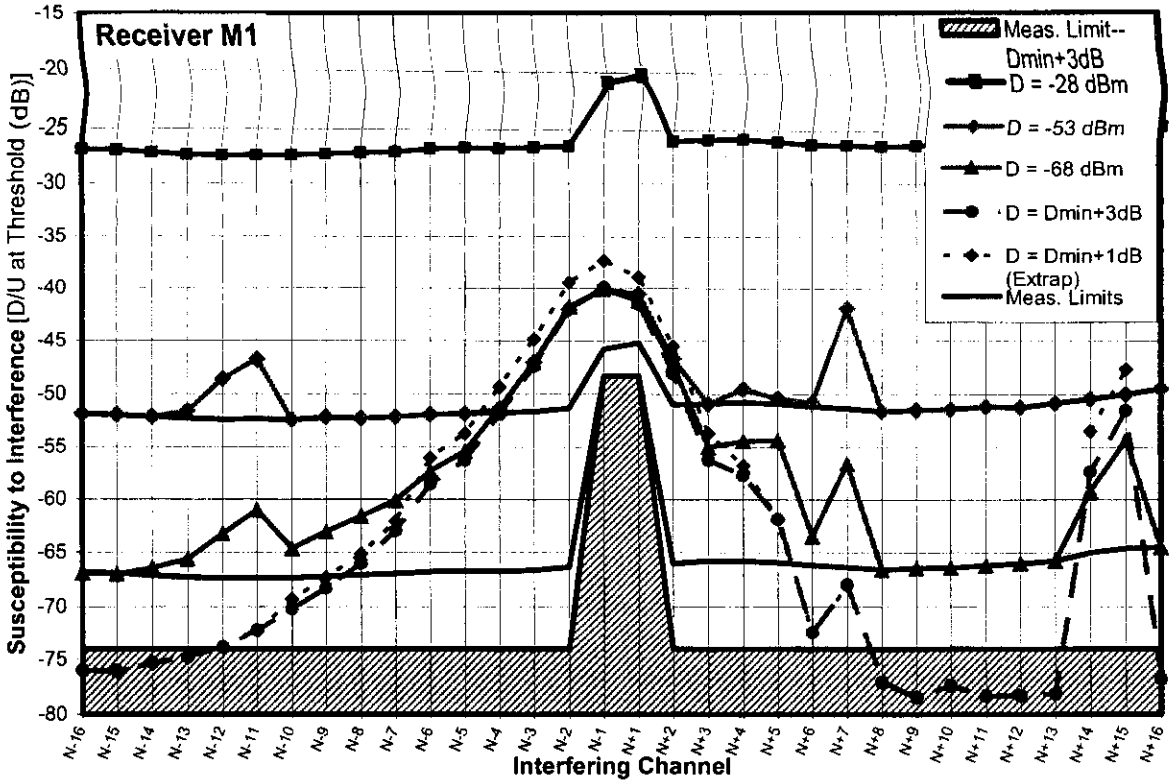

Figure 13-9. D/U of Receiver M1 at Five Desired Signal Levels on Channel 30

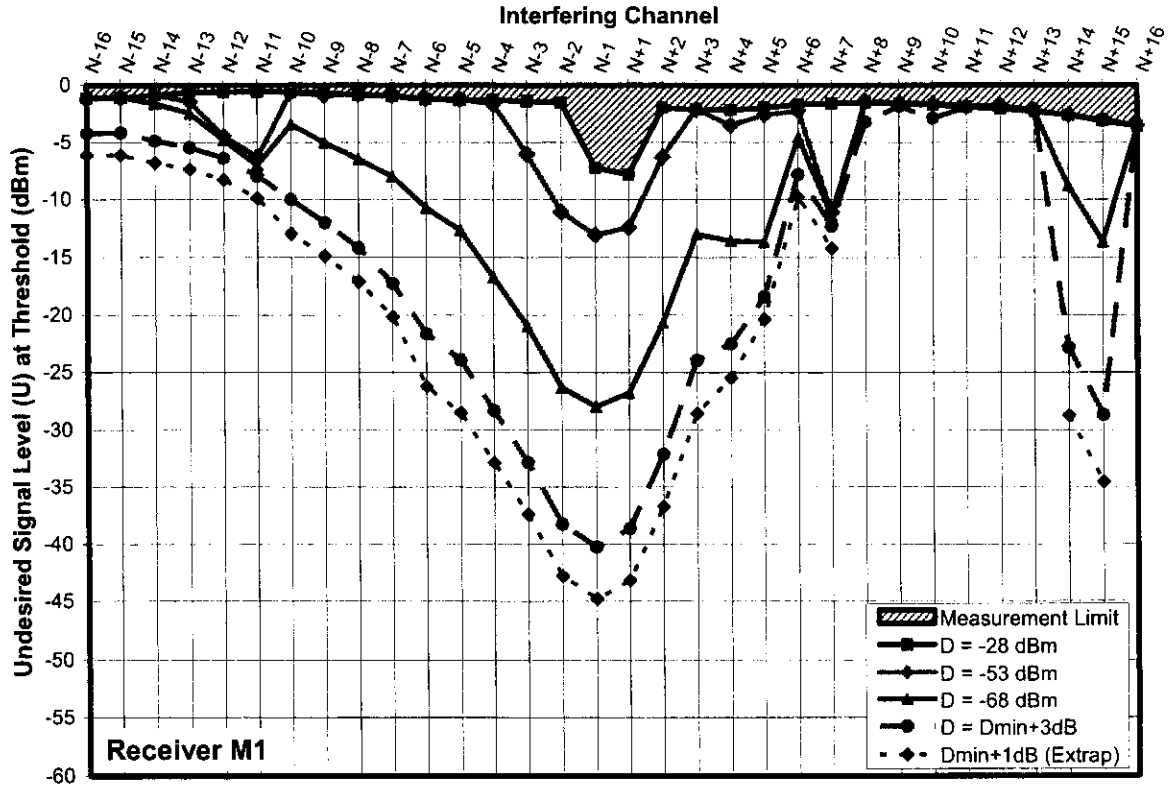

Figure 13-10. Threshold U of Receiver M1 at Five Desired Signal Levels on Channel 30

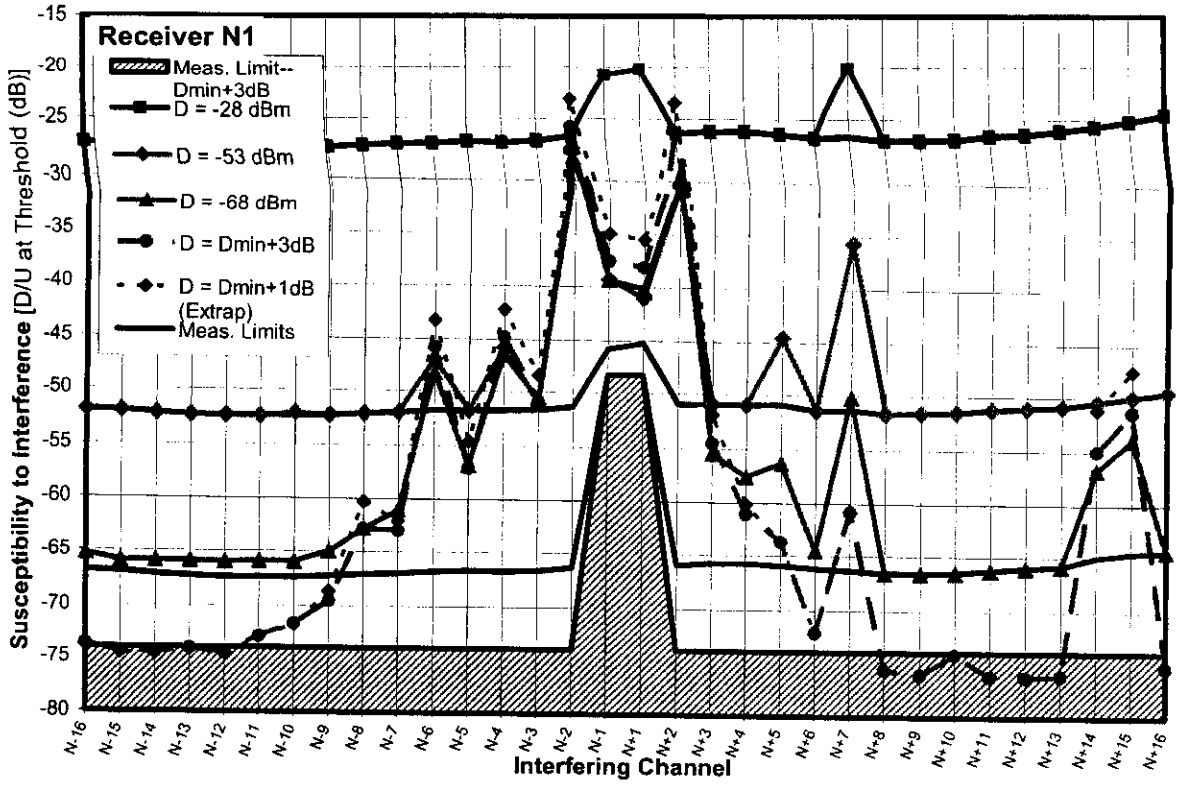

Figure 13-11. D/U of Receiver N1 at Five Desired Signal Levels on Channel 30

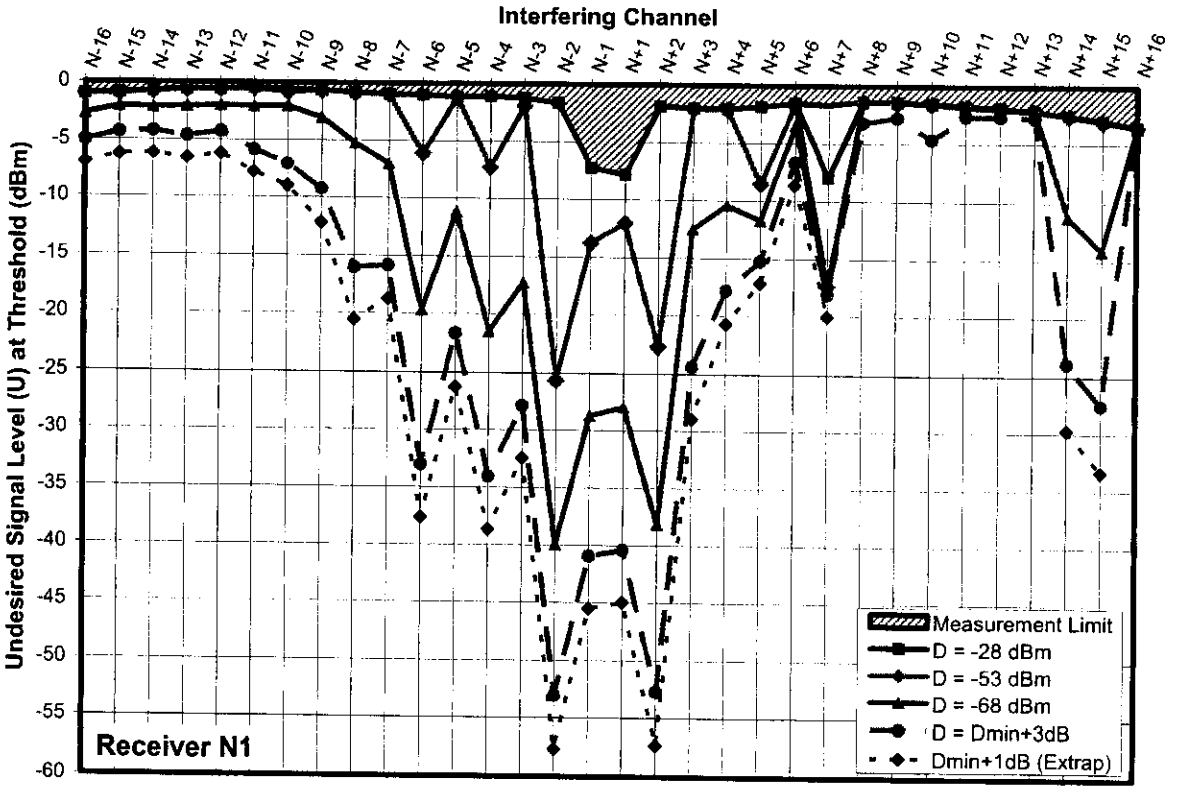

Figure 13-12. Threshold U of Receiver N1 at Five Desired Signal Levels on Channel 30