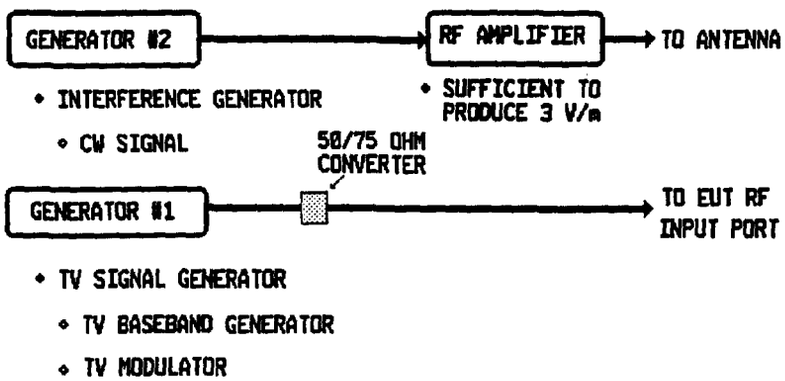

Figure 3.10 Radiated Susceptibility Test Generator Configuration

STEP #4 Repeat STEP #3, performing measurements at 45 degree increments of rotation referenced to the orientation of maximum susceptibility (seven additional measurements).

STEP #5 Repeat STEPS 2 through 4 for each of the remaining three test channels.

STEP #6 Calculate the shielding effectiveness figure of merit by subtracting the generator output level recorded in STEP #3 from the generator output level recorded in STEP #2 of the DPU Test Chamber Calibration Procedure. Subtract the difference from 69.5 dBmV/m (3 V/m). This yields the field strength required to produce an equivalent 55 dB D/U at the input of the EUT. The figure of merit can be calculated by adding 55 dB to this field strength (see Eq. 3.1).

Example:

A.	Interfering Generator Output Level (Susceptibility Test Procedure, STEP #3)	= 14.2 dBmV
B.	Interfering Generator Output Level (3 V/m) (Test Chamber Calibration, STEP #2)	= 40.2 dBmV
C.	B. - A. = 40.2 dBmV - 14.2 dBmV	= 26.0 dB
D.	FS = 69.5 dBmV/m - 26 dB	= 43.5 dBmV/m
E.	Calibration Interference Level (IS)	= -55.0 dBmV
F.	FM = 43.5 dBmV/m -(-55 dBmV)	= 98.5 dB

In this example, the shielding effectiveness figure of merit for the orientation of maximum susceptibility was determined to be 98.5 dB. It is also apparent that an impinged field strength of 43.5 dBmV/m (149.6 mV/m) produces an equivalent D/U ratio at the EUT input of 55 dB (nominal value for "just perceptible" interference).

3.3.5 Conducted Current Susceptibility Test Procedure

In the conducted current susceptibility test procedure, an RF current at the DPU interfering frequency is injected onto the shield of the input coaxial cable and onto the AC power cable using a toroidal injection clamp. A similar toroidal monitor is used to measure the current flowing on the cable at the input to the EUT. The figure of merit is the ratio of the measured current required to match the reference interference signal to the equivalent calibration interference signal level at the input of the EUT. It is important that a good quality, double shielded test cable be used for the input coaxial cable.

Conducted current susceptibility tests are performed on two of the four standard test channels, cable channels 6 and 12. The interference test signal frequencies will be the same as those of the radiated susceptibility test for the two selected test channels.

To prevent over-current injection, the tests are performed at injected current levels below those which would be present if the cables were subjected to an approximate 3 V/m field strength. MIL-STD-461D provides some indication of the current which might flow on a cable when subjected to such a field strength. Based on this standard, an approximate current limit for a 3 V/m field strength is given by the equation:

$$LIMIT_{(dB\mu A)} = 85.6 - 10 \, Log_{10} \, F(MHz) \qquad \text{(Eq. 3.3)}$$

The maximum current for the two DPU interfering frequencies is:

TEST CHANNEL	INTERFERING FREQUENCY	CURRENT
6	85.8 MHZ	66.2 dBuA
12	207.8 MHZ	62.4 dBuA

A step by step procedure for measuring the conducted current susceptibility is presented below.

STEP #1 Configure the test system and signal generators as shown in Figures 3.5 and 3.11. Allow 15 minutes for test equipment and EUT to warm up.

STEP #2 Place the MONITOR probe on the input coaxial cable, as close to the EUT input port as possible. Place the CLAMP probe next to the MONITOR probe.

STEP #3 Adjust the television signal generator (generator #1) for the first test channel and a desired video carrier level of 0 dBmV at the input port of the EUT. While monitoring the output of the MONITOR probe on a spectrum analyzer or tuned RF voltmeter, adjust the interfering generator (generator #2) output until a measurable signal is present. Do not exceed the maximum level shown in the table above.

STEP #4 While continuing to monitor the output of the MONITOR probe, slide the CLAMP probe along the cable under test until the current, as indicated by the monitor probe, is maximized. [**Note:** This STEP is performed to minimize the standing wave that forms along the length of the cable.] Affix the CLAMP probe to the cable at the point of maximum current.

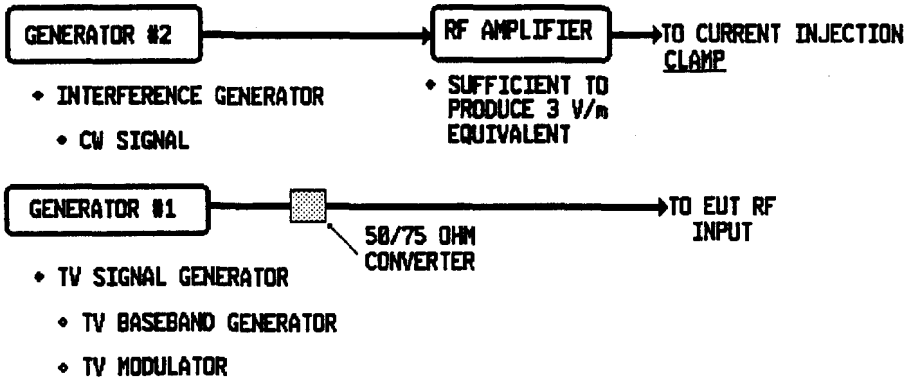

Figure 3.11 Conducted Current Susceptibility Test Generator Configuration

STEP #5 While monitoring the interfering signal at the EUT's baseband/IF measurement test point location, adjust generator #2 until the interference signal matches the "reference interference level" obtained in STEP #6 of the Susceptibility Calibration Test Procedure. Record the measured current from the MONITOR probe for this condition in units of dBuA. This is the current required to produce an equivalent 55 dB D/U at the input to the EUT.

[**Note:** To convert the voltage output of the MONITOR probe to a current, add the MONITOR probe transfer impedance dB(s) to the measured output voltage (dBuV)].

$$dB\mu A_{(\text{Conductor Current})} = dB\mu V_{(\text{Analyzer})} - dB(s) \qquad \text{(Eq. 3.4)}$$

STEP #6 Calculate the figure of merit by adding 55 dB to the measured current in STEP #5.

STEP #7 Repeat STEPS 3 through 6 for the second test channel.

STEP #8 Repeat STEPS 3 through 7 with the current CLAMP and MONITOR probe installed on the EUT AC power cable.

3.4 Receiver DPU Susceptibility Test Results

This Section presents the results of the DPU radiated and conducted current susceptibility tests for a test sample population of 35 television receivers, 8 VCR's, and 13 cable converters. The test results are presented in both tabular and graphic formats for ease of comparative analysis. The tabular results are presented in terms of the shielding effectiveness figure of merit for each test sample. Graphical results are presented in terms of the ambient field strength or current required to produce an equivalent 55 dB D/U ratio at the receiver input port. The 55 dB D/U ratio is considered the nominal value required to produce "just perceptible" co-channel interference in the received picture and is, therefore, the threshold of receiver susceptibility to co-channel DPU interference.

3.4.1 Radiated Susceptibility Test Results

Radiated susceptibility tests were performed at eight different receiver orientations with respect to the DPU source. Each test sample was first oriented for maximum susceptibility and the figure of merit measured in accordance with the procedures contained in Section 3.3.4. Seven additional measurements were then performed at 45 degree increments referenced to the orientation of maximum susceptibility.

Radiated susceptibility test results for each of the three receiver types (TV's, VCR's, and cable converters) are presented in the following Sections.

3.4.1.1 Television Receiver Radiated Susceptibility Test Results

Contained in Tables 3.1 through 3.4 are tabulations of the shielding effectiveness figures of merit for the 35 television receivers at each of the four test channels. For each test sample and at each test channel, a figure of merit is presented for the orientation of "maximum susceptibility" (shaded column on the left-hand side of the tabulation) followed by the figures of merit for each of the seven additional incremental orientations. In the shaded column on the right-hand side of the tabulation is the average of the eight figures of merit, referred to as the "average susceptibility" figure of merit.

The median performing receiver is also identified on each tabulation. ***By definition, half of the receiver test sample population performs better than the median receiver, and half performs worse than the median receiver.*** Where there is an even number of test samples, the median receiver performance is interpolated between the performance of two receivers. Note that the median

TABLE 3.1
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

TELEVISION RECEIVERS

CABLE CHANNEL 6 (82–88 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
021	52.5	53.5	53.5	53.0	54.5	55.0	56.5	55.5	54.4
034	53.5	54.5	75.0	61.0	62.5	55.0	58.0	62.0	59.3
019	55.0	56.0	56.5	60.5	64.5	56.0	57.0	60.5	58.9
018	56.0	60.0	63.5	64.5	62.0	58.5	59.0	60.0	60.9
027	56.5	57.0	58.5	62.5	67.0	58.0	61.5	62.5	61.2
028	57.0	59.0	62.5	65.5	70.0	62.5	59.5	60.0	63.0
016	61.5	64.0	68.0	73.0	76.5	62.0	64.0	73.5	69.6
003	62.0	66.5	69.0	71.0	65.0	65.5	69.0	65.0	67.1
029	62.0	65.0	67.0	69.0	70.0	63.0	65.0	66.0	66.3
009	63.0	64.0	64.5	64.0	65.5	65.5	64.0	65.0	64.5
014	63.0	66.0	68.0	69.0	70.0	63.5	64.5	65.5	66.6
005	63.0	65.5	65.0	71.0	69.5	63.0	66.0	66.0	66.6
033	64.5	67.5	69.0	71.5	67.5	66.0	68.0	68.5	68.1
007	65.0	66.0	67.0	67.5	78.0	66.5	69.0	80.5	72.0
011	65.5	67.0	69.0	71.5	71.0	67.0	69.5	70.5	69.1
013	66.5	67.0	68.0	68.5	69.0	67.5	67.5	68.0	67.8
035	71.0	71.5	73.5	75.0	77.5	72.0	74.0	76.5	74.2
010	72.0 –MEDIAN	72.5	76.0	79.0	81.5	74.5	79.0	83.0	78.1
032	72.9	73.9	82.4	85.4	83.4	73.4	77.4	80.4	79.9
002	73.9	75.9	80.9	81.9	78.4	74.9	75.9	76.9	77.8
015	74.0	76.0	76.5	81.5	81.5	76.5	76.0	76.5	77.8 –MEDIAN
022	75.0	75.5	78.0	81.5	84.5	76.0	79.0	83.0	79.8
001	76.5	80.0	81.0	81.0	81.0	83.0	86.0	82.0	81.7
008	77.0	77.5	79.5	90.5	83.0	77.5	79.5	80.5	81.9
020	77.5	79.0	80.5	82.0	85.0	79.0	85.0	85.5	82.2
006	79.0	80.5	81.5	85.5	85.5	79.5	80.5	86.0	82.7
025	79.0	80.0	81.5	84.5	83.0	82.5	82.5	82.0	82.1
017	79.5	83.0	86.0	88.0	85.0	80.5	80.5	82.0	83.6
004	81.0	84.5	85.5	86.5	86.0	82.0	83.0	84.0	84.3
030	81.5	82.0	80.5	82.5	83.0	81.5	81.0	82.5	81.9
012	82.0	82.5	83.0	87.0	90.5	82.5	85.0	88.0	85.6
024	83.0	85.0	85.5	85.5	85.0	84.5	85.0	85.5	85.0
023	84.0	89.5	87.5	85.5	89.5	85.0	87.0	89.5	87.5
026	87.0	95.0	96.0	96.5	90.5	95.0	109.0	93.5	97.9
031	87.0	89.5	90.0	89.0	89.0	89.0	88.5	88.0	88.8

TABLE 3.2
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

TELEVISION RECEIVERS

CABLE CHANNEL 12 (204–210 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
027	46.7	55.2	58.2	58.7	58.7	52.2	65.2	54.2	57.7
028	52.7	58.7	61.7	58.7	63.2	55.7	68.7	63.7	61.7
007	62.2	66.2	72.2	77.7	72.7	68.2	72.7	69.7	71.3
021	62.2	64.2	67.7	63.2	63.7	65.7	77.2	94.7	79.1
034	66.7	75.7	74.7	80.2	83.7	69.2	80.7	87.2	79.8
016	68.7	72.7	79.7	76.7	75.2	71.2	79.7	84.7	77.5
001	72.2	78.7	77.7	90.2	80.7	76.2	76.2	82.7	81.1
011	74.2	79.2	81.2	77.2	81.7	75.7	83.2	89.2	81.5
013	74.7	77.2	79.7	83.2	86.2	79.2	87.7	89.2	80.5
018	75.2	78.7	77.7	75.7	81.7	77.2	77.2	84.7	79.1
032	76.1	78.6	83.1	81.6	87.1	76.6	79.6	83.6	81.6
002	80.6	85.6	86.6	88.6	106.6	81.1	85.1	87.6	92.7
025	81.2	85.7	86.2	97.2	86.7	85.2	85.7	86.7	88.2
019	81.2	83.2	86.7	83.7	87.7	83.7	86.7	91.2	86.1
017	81.7	86.7	84.7	85.7	89.2	83.7	85.7	89.2	86.2
029	82.2	88.7	87.2	89.2	86.2	85.7	83.2	87.7	86.5
009	82.7	85.7	90.2	88.7	97.2	84.7	94.7	91.7	90.8
033	83.7 –MEDIAN	86.2	86.2	86.2	85.7	85.7	89.7	86.2	86.4
020	83.7	86.2	86.7	90.2	91.7	89.7	90.2	86.2	88.5
022	83.7	88.2	101.7	97.2	98.7	85.7	91.7	97.2	95.1
008	84.7	90.2	90.2	83.7	90.2	90.2	93.2	109.2	95.9
005	84.7	90.2	95.7	89.2	94.2	87.2	93.7	91.2	91.5
014	85.2	89.2	91.7	91.2	100.2	86.2	91.7	94.7	92.5
031	86.2	88.7	90.2	95.7	100.2	88.7	100.2	95.7	94.7
010	87.2	90.2	89.2	97.7	89.2	88.2	97.7	93.7	92.6
035	87.2	88.7	93.2	100.2	98.2	94.7	97.7	93.7	95.2
003	87.7	89.2	90.7	95.7	101.7	87.7	89.7	109.7	98.0
023	88.2	92.2	93.2	97.7	100.2	92.7	99.2	98.7	96.2
026	89.2	93.2	93.7	92.7	98.2	92.2	91.2	98.7	94.2
004	89.7	92.7	96.2	97.2	96.2	91.7	98.7	97.2	95.5
030	89.7	93.2	101.7	94.7	90.2	91.7	93.2	94.2	94.4
024	89.7	93.7	105.2	99.2	99.2	91.7	99.7	102.7	99.1
015	91.2	93.7	94.2	103.2	101.2	92.7	103.2	98.7	98.5
012	91.2	97.2	103.7	106.7	106.7	94.7	101.2	100.7	101.7
006	92.7	95.2	97.2	101.2	99.7	93.7	94.2	93.2	96.5

TABLE 3.3
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

TELEVISION RECEIVERS

CABLE CHANNEL 78 (546–552 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
027	58.1	55.1	55.6	57.1	58.6	61.6	53.6	56.1	56.7
007	54.1	61.1	61.1	56.1	62.6	60.6	64.6	66.1	61.6
028	55.6	63.1	64.6	65.1	64.1	59.1	65.6	66.1	63.6
016	64.6	70.1	68.6	87.1	76.6	73.6	71.6	82.1	77.2
008	65.1	71.6	70.6	76.6	79.1	65.6	77.6	81.6	75.5
021	66.6	73.6	70.1	75.6	73.6	68.1	70.1	74.1	72.0
013	69.6	71.1	72.1	78.6	78.1	83.1	74.6	85.6	76.4
011	72.6	86.1	82.1	88.1	86.1	78.1	92.1	80.6	85.0
010	76.1	81.1	88.6	90.1	82.6	83.1	86.6	78.6	84.6
032	76.6	81.1	84.6	92.6	87.1	82.1	85.1	82.6	85.3
017	81.6	89.6	82.6	88.6	103.6	99.1	89.1	87.1	93.5
020	82.1	91.6	86.6	84.6	95.1	83.1	98.6	95.1	91.6
022	82.1	92.1	89.1	91.1	104.1	85.6	86.6	96.1	94.6
035	82.6	83.6	84.1	88.1	91.6	86.1	99.6	86.6	89.8
019	83.1	100.1	84.6	89.1	85.1	84.6	86.6	86.1	88.5
029	83.1	91.1	91.1	88.6	92.1	88.6	92.1	97.6	91.4
014	84.1*	89.6	94.1	94.6	92.6	89.6	86.1	96.1	91.7
002	84.1*	88.6	97.6	94.1	92.6	95.6	91.1	92.6	92.8*
025	84.6	86.6	89.1	86.6	96.6	91.6	107.1	88.1	95.0
024	85.6	91.1	104.1	93.6	103.1	92.6	87.1	91.1	96.1
005	85.6	92.6	87.6	91.6	104.1	89.1	89.6	93.6	93.8
034	86.6	94.6	89.1	88.1	90.1	87.1	91.6	95.6	91.0
018	87.1	90.1	90.1	90.6	90.1	97.1	100.6	89.6	93.1*
015	87.1	91.6	99.1	95.1	98.1	95.1	96.1	104.1	97.1
023	87.6	95.1	93.1	94.6	94.1	95.1	89.1	105.6	96.1
009	89.6	110.1	99.6	90.1	89.6	90.6	96.6	96.1	98.5
033	90.6	107.1	96.1	113.1	104.6	93.6	102.1	109.1	104.9
026	90.6	98.6	91.6	97.6	99.1	93.6	100.1	98.6	96.9
006	91.1	98.6	97.1	103.1	100.1	94.6	101.1	101.6	99.2
012	91.6	96.6	99.1	104.1	110.1	96.1	107.1	96.1	102.2
031	92.6	97.6	106.6	98.1	99.6	98.1	98.1	108.6	101.4
001	94.1	105.1	98.1	97.6	103.6	96.6	104.1	111.1	103.0
030	95.6	99.1	106.6	103.6	110.6	101.6	97.1	105.6	103.8
003	96.1	99.6	107.1	98.6	99.6	109.1	104.1	103.1	103.2

NOTE: EUT 004 is not included in the sample population because it did not tune to Channel 78.
Because there are an even number of samples in this test, no single median sample is indicated above.
An interpolated figure of merit pertaining to the average of the two median samples (*) is represented in the graphical analysis of Section 3.4.1.4.

TABLE 3.4
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

TELEVISION RECEIVERS

BROADCAST CHANNEL 59 (740–746 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
007	88.5	77.5	64.0	58.5	60.0	64.5	64.5	64.5	68.8
027	80.5	68.0	74.0	63.5	71.5	67.5	67.5	71.5	69.0
021	81.0	83.0	70.0	74.0	64.5	71.0	61.5	73.5	72.8
008	83.0	72.5	67.5	87.0	70.5	71.5	83.5	73.0	77.1
028	84.0	70.0	65.0	66.0	70.0	87.5	64.0	65.5	73.8
011	87.5	87.0	89.0	74.0	76.5	70.0	87.5	80.0	82.1
016	70.5	74.0	78.5	71.5	75.0	77.0	74.5	75.5	74.9
013	72.0	76.5	81.5	83.0	81.5	78.5	78.5	82.0	79.8
032	72.5	81.3	74.3	77.8	84.8	73.8	77.8	82.3	79.1
034	77.0	82.0	78.5	82.0	81.5	81.0	80.5	79.0	80.4
019	75.5	82.5	86.0	87.5	97.5	89.0	86.5	89.5	88.6
022	78.5	85.0	99.0	90.5	86.5	83.5	81.5	82.5	88.4
020	78.5	84.5	86.0	97.0	101.0	85.5	85.0	84.0	90.8
025	81.0	83.0	93.0	91.0	118.0	87.0	87.0	99.0	102.3
035	83.0	83.0	83.5	87.5	91.0	85.5	99.0	86.0	89.2
017	83.5	99.0	87.0	91.5	102.5	94.0	86.0	106.0	97.0
010	85.5 –MEDIAN	106.0	93.5	101.0	96.0	96.0	87.0	90.0	95.8
002	84.8	91.3	90.3	104.8	100.8	85.8	84.3	106.3	97.7
001	86.0	88.0	92.0	93.0	89.5	94.5	99.0	88.5	92.3
012	87.0	93.0	97.0	95.0	98.0	101.0	102.0	102.0	98.1
023	87.0	104.0	97.5	96.0	97.0	97.0	97.0	110.0	100.5
033	89.0	124.0	106.5	111.5	121.5	109.0	98.5	115.5	114.6
029	89.0	100.0	97.0	98.0	113.0	92.0	93.0	99.5	101.1
024	89.0	98.5	103.0	105.0	101.5	99.0	94.0	100.5	100.0
026	89.0	91.5	97.5	106.0	95.0	97.5	93.5	94.0	97.1 –MEDIAN
009	90.0	109.0	101.5	104.0	101.0	98.0	101.0	108.5	103.3
031	90.0	98.5	100.5	102.5	103.5	98.0	92.5	99.0	99.1
018	90.5	100.0	114.5	112.0	99.0	94.5	99.0	95.5	104.6
015	91.0	94.0	102.0	98.5	97.0	102.0	96.0	102.0	98.6
005	91.5	93.5	98.0	96.5	100.0	92.5	97.0	105.0	97.9
030	92.0	98.5	99.5	99.5	100.5	103.0	103.5	102.0	100.4
006	92.5	101.5	98.5	106.0	98.0	98.0	112.5	99.5	103.0
014	92.5	96.0	103.0	100.0	104.5	104.0	94.0	96.5	99.9
003	95.0	97.5	104.0	103.0	104.5	108.5	105.5	108.5	104.4

performing receiver for the orientation of "maximum susceptibility" may be different than the median performing receiver in the "average susceptibility" column.

The receiver data is tabulated in order of performance, worst to best, with respect to the maximum susceptibility orientation. ***The worst performing receiver is defined as the receiver which is most susceptible to DPU interference and, therefore, exhibits the lowest figure of merit.*** The performance order may be significantly different for the "average susceptibility" figure of merit.

A review of the best and worst performing receivers for each test channel demonstrates the tremendous range in DPU susceptibility performance in modern television receivers. The difference in the figures of merit between the best and worst performing receivers, averaged over the four test channels, is 41.7 dB. This means that a field strength 122 times greater is required to achieve "just perceptible" interference in the best performing receiver compared to the worst performing receiver.

As was described in the example of Section 3.2.1, it is possible to calculate the ambient field strength required to produce "just perceptible" interference (D/U ratio of 55 dB) when the figure of merit is known. This is accomplished by simply subtracting 55 dB from the figure of merit to yield the field strength in units of decibels above a millivolt per meter (dBmV/m). Dividing this value by 20 and taking the inverse logarithm yields the field strength in millivolts per meter (mV/m). Table 3.5 below shows the ambient field strength required to produce "just perceptible" interference in the best, median, and worst performing television receivers for each of the four test channels.

Test Sample	Channel 6		Channel 12		Channel 78		Channel 59	
	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.
Best	40.0	49.1	77.1	217.0	114.0	314.1	100.5	971.6
Median	7.1	13.7	27.4	61.4	28.6	79.6	23.8	127.1
Worst	0.8	0.9	0.5	1.4	0.7	1.2	0.8	3.7

Table 3.5 Ambient Field Strength (mV/m) Required to Produce "Just Perceptible" Interference (55 dB D/U) in Television Receivers

Table 3.5 clearly shows that the worst performing television receivers are extremely sensitive to radiated co-channel ambient fields. Even in the median performing receiver, DPU interference occurs at relatively low ambient field strengths, particularly

at VHF frequencies. In contrast, the susceptibility performance of the best performing television receiver, for each test channel, is comparable to the performance of a cable converter (Section 3.4.1.3 contains cable converter test results).

The figure of merit data shows a general improvement in susceptibility performance with increasing frequency. The "average susceptibility" figure of merit for the median performing receiver increases by 20 dB between cable channel 6 (82 - 88 MHz) and broadcast channel 59 (740 - 746 MHz). The improvement is only 10 dB for the "maximum susceptibility" orientation for the same two test channels.

The figure of merit is highly dependent on the orientation of the receiver with respect to the DPU source, particularly at higher frequencies. For this reason, a single measurement performed on a television receiver at an arbitrary orientation can be misleading with regard to the maximum and/or average susceptibility. Figures 3.12 and 3.13 demonstrate the variation in relative susceptibility of a television receiver, as a function of orientation, for cable channel 6 and broadcast channel 59, respectively. These plots were created by first radiating the television receiver with a constant ambient interfering field. The turntable was then slowly rotated through a 360 degree arc while the magnitude of the interfering signal, at the measurement test point location, was measured on a spectrum analyzer. For this test, the spectrum analyzer was placed in the "zero span" mode (tuned RF receiver), and the sweep time was adjusted to approximate the time required for one full rotation of the turntable. As can be seen from the two figures, the variation in relative susceptibility to radiated fields is much more pronounced on the higher test channel.

In general, television receivers connected to a cable source are least susceptible to DPU ambient fields when the picture screen is oriented toward the radiation source, and most susceptible when the assembly, consisting of the RF input connector, interconnect cable, and tuner shielded enclosure, is oriented broadside to the plane of the impinged field. The maximum susceptibility orientation, for 84% of the DPU tests, fell within one of the shaded arcs depicted in Figure 3.14.

3.4.1.2 VCR Radiated Susceptibility Tests Results

Tables 3.6 through 3.9 present the shielding effectiveness figures of merit for the test sample population of 8 VCR's. The tabular data format is the same as that described for television receiver susceptibility in the previous Section. Because there are an even number of test samples in this category, a median figure of merit was interpolated between the pair of median performing test samples indicated by an asterisk. This median value is used in Table 3.10 below and in the graphs of Section 3.4.1.4.

The range in performance between the best performing VCR and worst performing VCR, averaged over the four test channels, is approximately 18.5 dB (less than a

FIGURE 3.12 TYPICAL PLOT OF TELEVISION RECEIVER RELATIVE SUSCEPTIBILITY VERSUS ORIENTATION

CABLE CHANNEL 6

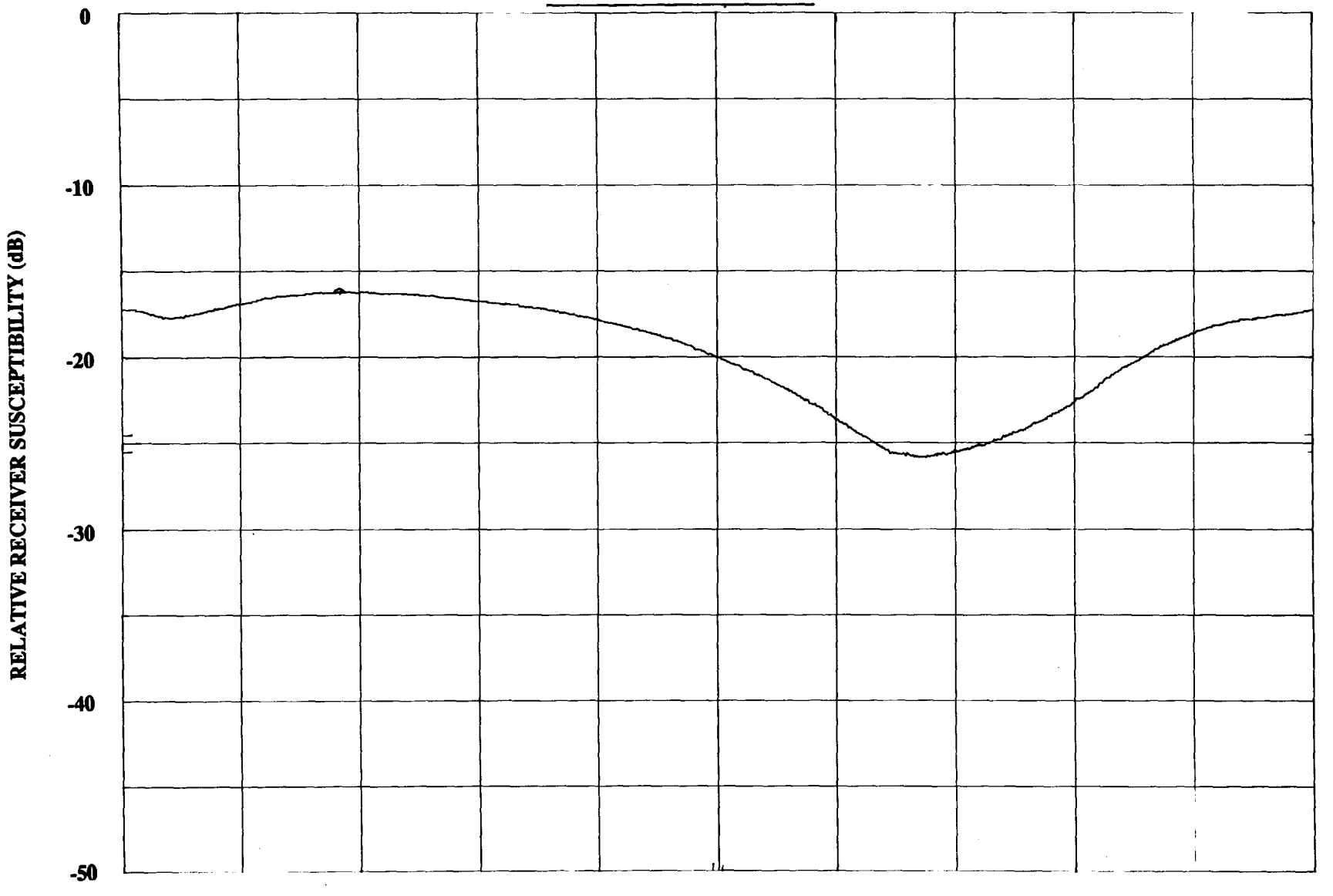

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FIGURE 3.13 TYPICAL PLOT OF TELEVISION RECEIVER RELATIVE SUSCEPTIBILITY VERSUS ORIENTATION

BROADCAST CHANNEL 59

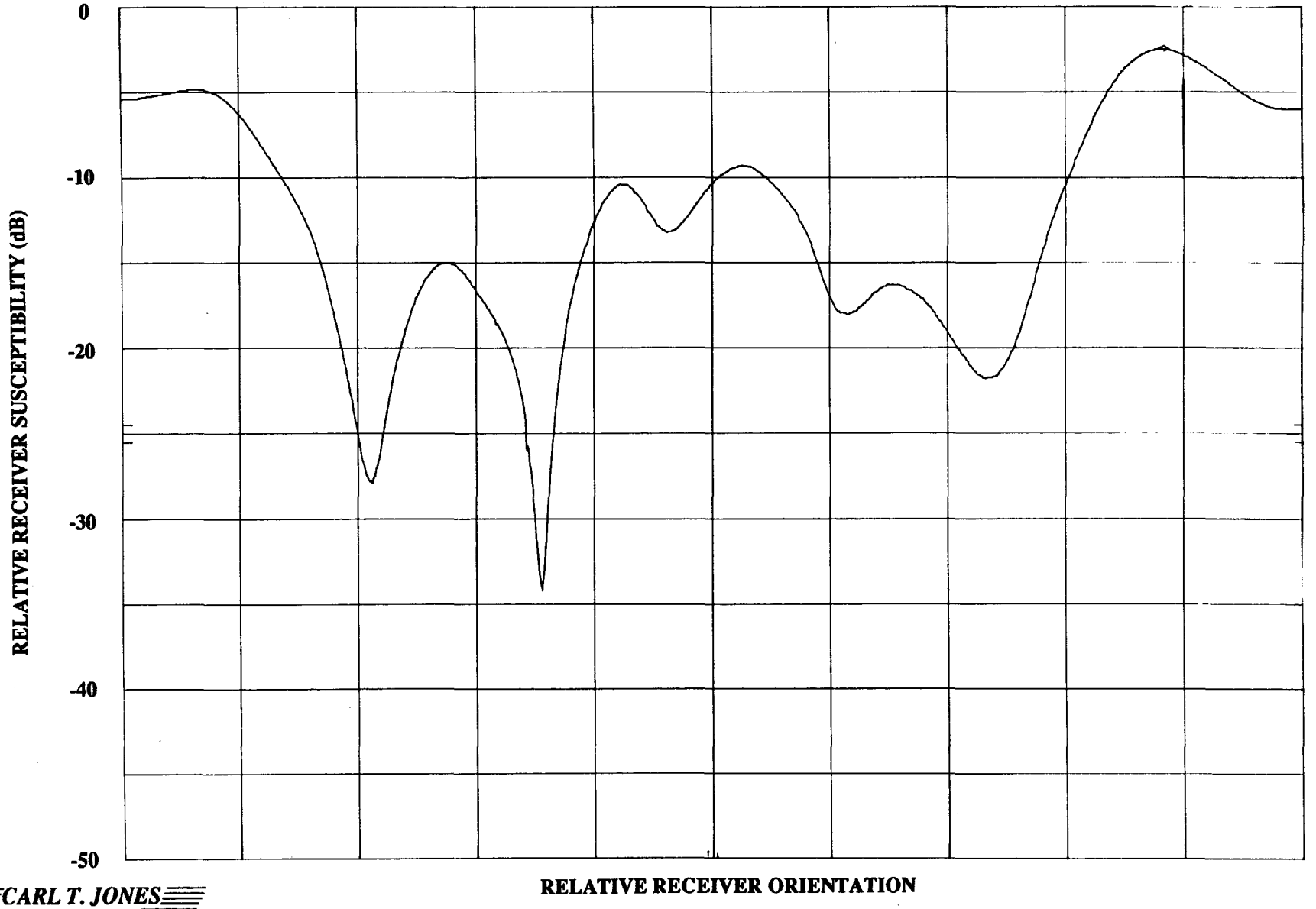

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FIGURE 3.14 TELEVISION RECEIVER MAXIMUM SUSCEPTIBILITY ORIENTATION

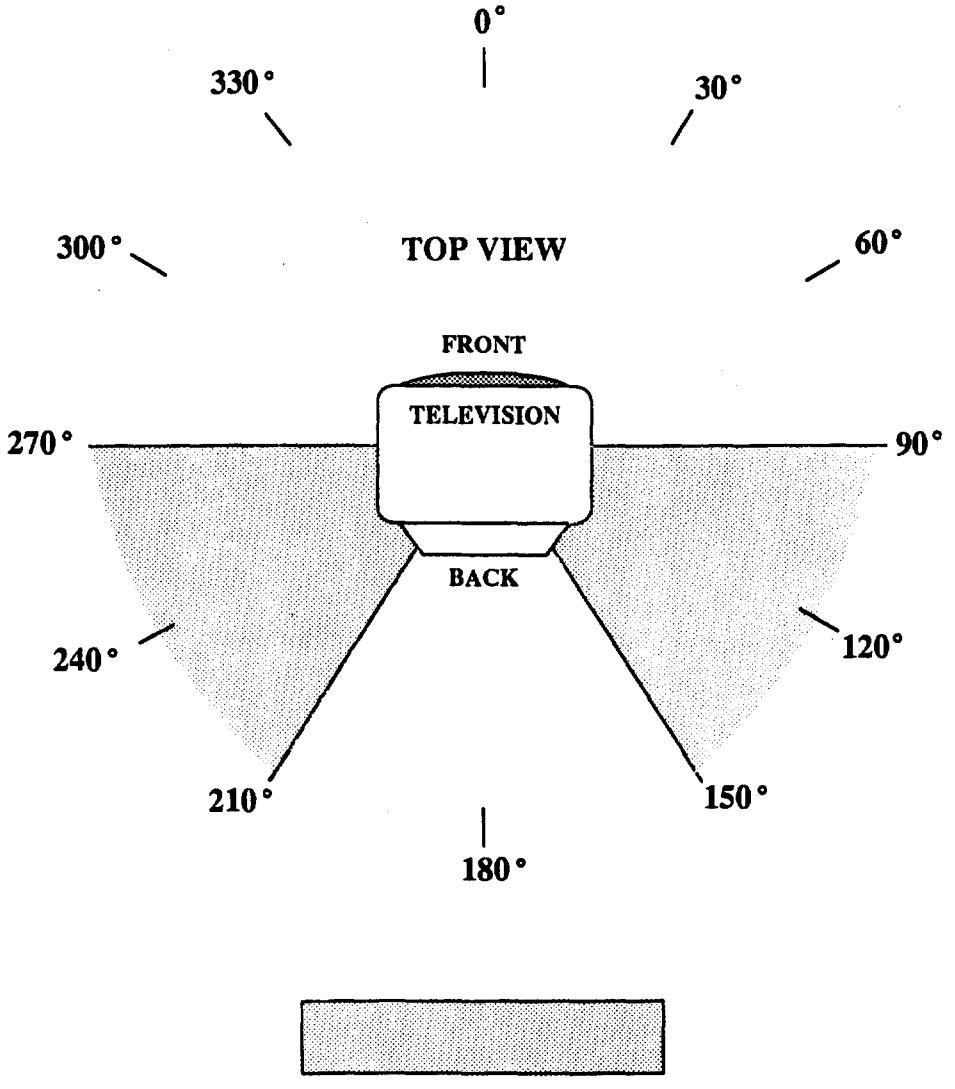


TABLE 3.6
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

VIDEO CASSETTE RECORDERS

CABLE CHANNEL 6 (82–88 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
102	62.0	69.5	74.0	76.0	65.0	63.0	64.0	64.5	68.8
106	63.5	69.5	73.0	75.0	75.0	64.0	66.0	67.5	70.3
103	65.5	65.5	70.5	70.5	72.0	69.0	72.5	73.5	70.4
104	71.5 *	79.0	76.5	83.5	85.5	80.5	83.0	84.5	81.5 *
107	76.0 *	77.5	81.0	82.5	81.0	82.5	82.5	81.0	80.8 *
101	81.0	81.5	82.5	86.0	88.5	82.5	91.5	88.5	86.1
108	81.0	87.0	88.0	85.0	86.0	82.0	84.5	86.5	85.3
105	87.0	90.5	94.5	98.5	95.5	89.0	90.0	90.0	92.7

NOTE: Because there are an even number of samples in this test no single median sample is indicated above.
An interpolated figure of merit pertaining to the average of the two median samples (*) is represented in the graphical analysis of Section 3.4.1.4.

TABLE 3.7
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

VIDEO CASSETTE RECORDERS

CABLE CHANNEL 12 (204–210 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
102	77.2	83.7	86.2	85.7	92.7	79.2	80.2	85.7	85.1
106	78.2	80.2	80.7	79.7	85.7	84.2	85.7	90.7	84.1
103	81.2	83.2	88.2	103.2	88.2	86.7	88.2	90.2	91.6 *
107	82.2 *	86.7	92.7	91.2	91.2	84.2	84.2	84.7	88.0
108	85.2 *	90.7	96.2	103.2	99.2	89.2	92.2	103.7	97.2
101	86.2	89.7	91.7	91.2	89.7	89.2	89.2	87.7	89.5 *
104	91.2	93.2	95.7	111.7	96.7	91.7	94.2	101.7	100.1
105	95.7	98.7	106.7	105.7	109.7	106.7	97.7	97.2	103.8

NOTE: Because there are an even number of samples in this test no single median sample is indicated above.
An interpolated figure of merit pertaining to the average of the two median samples (*) is represented in the graphical analysis of Section 3.4.1.4.

TABLE 3.8
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

VIDEO CASSETTE RECORDERS

CABLE CHANNEL 78 (546–552 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
106	80.1	89.1	94.6	98.6	102.1	93.6	89.6	103.1	96.4
107	82.6	88.6	90.1	107.1	97.6	87.6	91.1	105.1	97.8
103	83.6	86.1	90.1	91.1	86.6	88.1	96.1	91.6	90.0
102	84.6 *	90.1	94.1	91.1	94.1	95.6	97.1	97.1	93.8
101	85.1 *	92.1	96.6	94.6	102.1	95.6	97.6	102.1	97.1
108	87.1	96.6	90.6	82.6	96.6	93.1	86.6	82.6	91.1 *
105	89.1	91.1	87.6	86.6	97.6	92.6	87.6	89.1	90.9
104	89.1	90.6	87.6	98.6	92.1	92.1	95.6	101.1	94.6 *

NOTE: Because there are an even number of samples in this test no single median sample is indicated above.
An interpolated figure of merit pertaining to the average of the two median samples (*) is represented in the graphical analysis of Section 3.4.1.4.

TABLE 3.9
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

VIDEO CASSETTE RECORDERS

BROADCAST CHANNEL 59 (740–746 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
105	78.0	85.0	81.5	92.0	94.5	91.5	108.5	96.0	95.9
107	80.5	88.0	88.5	85.5	92.5	90.0	86.0	100.5	90.9
106	81.5	85.0	84.5	91.0	91.0	89.5	87.0	88.0	87.8
102	85.5 *	91.0	90.5	97.5	96.0	94.0	92.5	91.5	93.0
103	88.0 *	92.5	96.5	96.0	90.0	88.5	91.0	99.0	93.6 *
101	88.5	90.5	92.0	103.5	95.0	90.0	96.5	95.0	95.2 *
104	88.5	99.0	96.5	100.0	109.0	90.0	100.0	103.5	100.5
108	90.0	94.5	95.5	92.5	96.0	96.0	98.0	102.0	96.3

NOTE: Because there are an even number of samples in this test no single median sample is indicated above.
An interpolated figure of merit pertaining to the average of the two median samples (*) is represented in the graphical analysis of Section 3.4.1.4.

factor of 10). This range is considerably less than the range for television receivers (41.7 dB).

The field strength required to produce "just perceptible" interference in the best, median, and worst performing VCR is tabulated in Table 3.10 below.

Test Sample	Channel 6		Channel 12		Channel 78		Channel 59	
	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.
Best	40.0	76.8	108.9	274.2	50.9	137.2	56.5	188.8
Median	8.7	20.3	27.4	59.8	31.2	91.7	38.9	93.4
Worst	2.3	4.9	12.9	28.6	18.1	56.2	14.2	43.5

Table 3.10 Ambient Field Strength (mV/m) Required to Produce "Just Perceptible" Interference (55 dB D/U) in VCR's

The worst and median performing VCR's, on each test channel, exhibit DPU interference at relatively low ambient field strengths, particularly at VHF frequencies. The performance of the worst performing VCR, however, is approximately 18 times (25 dB) better than the performance of the worst performing television receiver (averaging maximum and average susceptibility field strengths across the four test channels). In contrast, the performance of the median VCR is almost identical to the performance of the median television receiver when averaged across the four test channels.

DPU susceptibility performance of the median VCR improves approximately 10 dB between cable channel 6 and cable channel 12, and then exhibits only gradual improvement between cable channel 12 and broadcast channel 59.

3.4.1.3 Cable Converter Radiated Susceptibility Tests Results

Contained in Tables 3.11 through 3.13 are the shielding effectiveness figures of merit for the test sample population of 13 cable converters. The tabular data format is the same as that described in the previous sections for television receivers and VCR's.

Because cable converters do not tune to broadcast channel 59, no results are presented for this channel. Further, four of the thirteen cable converters did not tune to cable channel 78 and, therefore, only nine cable converters were tested on channel 78.

TABLE 3.11
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

CABLE CONVERTERS

CABLE CHANNEL 6 (82–88 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
206	81.0	84.0	85.5	90.5	96.5	83.5	93.5	99.5	91.6
203	89.0	90.0	90.5	92.0	97.0	89.5	91.0	102.5	94.1
208	89.0	89.5	90.0	92.0	93.5	91.5	93.0	93.5	91.7
209	90.0	90.0	94.5	91.5	90.5	100.0	93.5	91.5	93.4
218	90.0	91.0	94.0	104.0	93.5	92.0	92.0	91.5	94.9 –MEDIAN
201	90.5	91.5	94.5	95.5	94.5	91.5	91.5	91.0	92.8
222	92.0 –MEDIAN	93.5	93.0	94.5	96.5	96.0	97.5	98.0	95.4
214	92.0	93.0	94.5	95.0	95.0	91.5	93.5	93.0	93.6
216	92.5	95.0	95.5	104.5	99.0	93.5	94.0	93.0	96.9
224	93.0	95.0	96.5	97.5	99.0	97.0	99.0	100.5	97.5
212	93.5	98.0	109.0	106.5	109.5	95.0	102.0	108.5	104.7
220	97.0	98.0	99.5	101.0	104.0	99.0	101.0	103.0	100.6
204	101.0	104.5	110.5	108.5	103.5	104.5	102.5	101.5	105.2

NOTE: Of the 24 cable converters received, there are a total of 13 unique cable converters in the sample population.

TABLE 3.12
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

CABLE CONVERTERS

CABLE CHANNEL 12 (204–210 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
206	85.2	90.2	94.7	94.2	90.2	92.2	93.2	86.2	91.4
222	96.2	97.2	102.2	104.7	101.2	100.7	104.7	100.2	101.4
201	96.7	105.7	107.7	109.2	106.2	102.2	106.2	99.7	105.1
214	98.2	100.2	101.2	101.7	118.2	112.2	99.7	102.7	107.4
216	99.7	103.7	110.7	109.2	108.7	111.2	105.2	105.2	107.5
209	102.2	111.2	110.7	113.2	113.7	111.7	108.2	109.7	110.7
218	102.2 –MEDIAN	103.7	109.7	108.7	109.7	106.7	106.7	106.7	107.2
212	103.2	105.2	108.2	115.2	111.7	109.7	107.2	107.7	109.3 –MEDIAN
204	103.2	108.2	117.2	109.2	110.2	108.7	112.2	105.7	110.3
224	107.7	111.2	111.2	110.2	110.2	119.7	125.2	112.7	115.7
220	107.7	115.7	122.7	118.7	118.2	113.7	113.2	112.7	116.4
203	108.2	110.2	121.1	125.7	117.7	120.2	113.2	112.2	118.0
208	111.2	116.2	126.2	115.7	114.7	116.2	116.2	113.2	117.5

NOTE: Of the 24 cable converters received, there are a total of 13 unique cable converters in the sample population.

TABLE 3.13
DPU SHIELDING EFFECTIVENESS FIGURE OF MERIT
RADIATED SUSCEPTIBILITY

CABLE CONVERTERS

CABLE CHANNEL 78 (546–552 MHz)

SAMPLE NO.	MAXIMUM SUSCEPT-IBILITY	ORIENTATION (degrees) 45.0	90.0	135.0	180.0	225.0	270.0	315.0	AVERAGE SUSCEPT-IBILITY
206	87.1	94.6	95.6	114.6	97.6	94.1	94.1	89.6	100.9
214	87.6	95.1	99.1	103.1	91.1	88.6	101.6	88.6	96.4
201	88.6	91.1	93.1	94.6	98.6	99.1	93.1	95.1	94.8
216	95.0	99.5	113.0	109.5	96.5	104.0	99.0	97.0	104.1
209	95.1 –MEDIAN	96.6	97.1	95.6	96.1	103.6	97.1	100.6	98.2
212	96.1	98.6	101.1	105.1	102.1	101.1	111.1	102.1	103.3 –MEDIAN
222	96.1	99.1	116.6	107.1	97.1	103.1	96.6	102.6	105.3
220	102.1	103.6	115.6	105.1	107.6	112.1	105.6	105.6	106.4
218	102.6	106.6	102.1	105.6	105.1	103.1	107.1	116.1	107.3

NOTE: Of the 24 cable converters received, there are a total of 13 unique cable converters in the sample population.

There are several sample numbers missing in the tabular data in this category. The reason is that several of the cable converters received by CTJC were duplicate models, and it was decided not to test these units. Therefore, although the duplicate units were assigned a test sample number on receipt, they were not tested.

In general, the figure of merit for the best performing cable converter is approximately 10 times (20 dB) better than the worst performing cable converter. There is a marked increase in the figures of merit for cable converters when compared to both television receivers and VCR's on each of the three test channels.

The field strength required to produce "just perceptible" interference in the best, median, and worst performing cable converter for each of the three test channels is tabulated in Table 3.14 below.

Test Sample	Channel 6		Channel 12		Channel 78	
	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.	Max. Suscept.	Avg. Suscept.
Best	199.5	323.6	648.6	1407.7	241.0	465.6
Median	70.8	98.8	230.1	518.2	101.6	261.2
Worst	19.9	67.6	32.5	66.0	40.4	98.1

Table 3.14 Ambient Field Strength (mV/m) Required to Produce "Just Perceptible" Interference (55 dB D/U) in Cable Converters

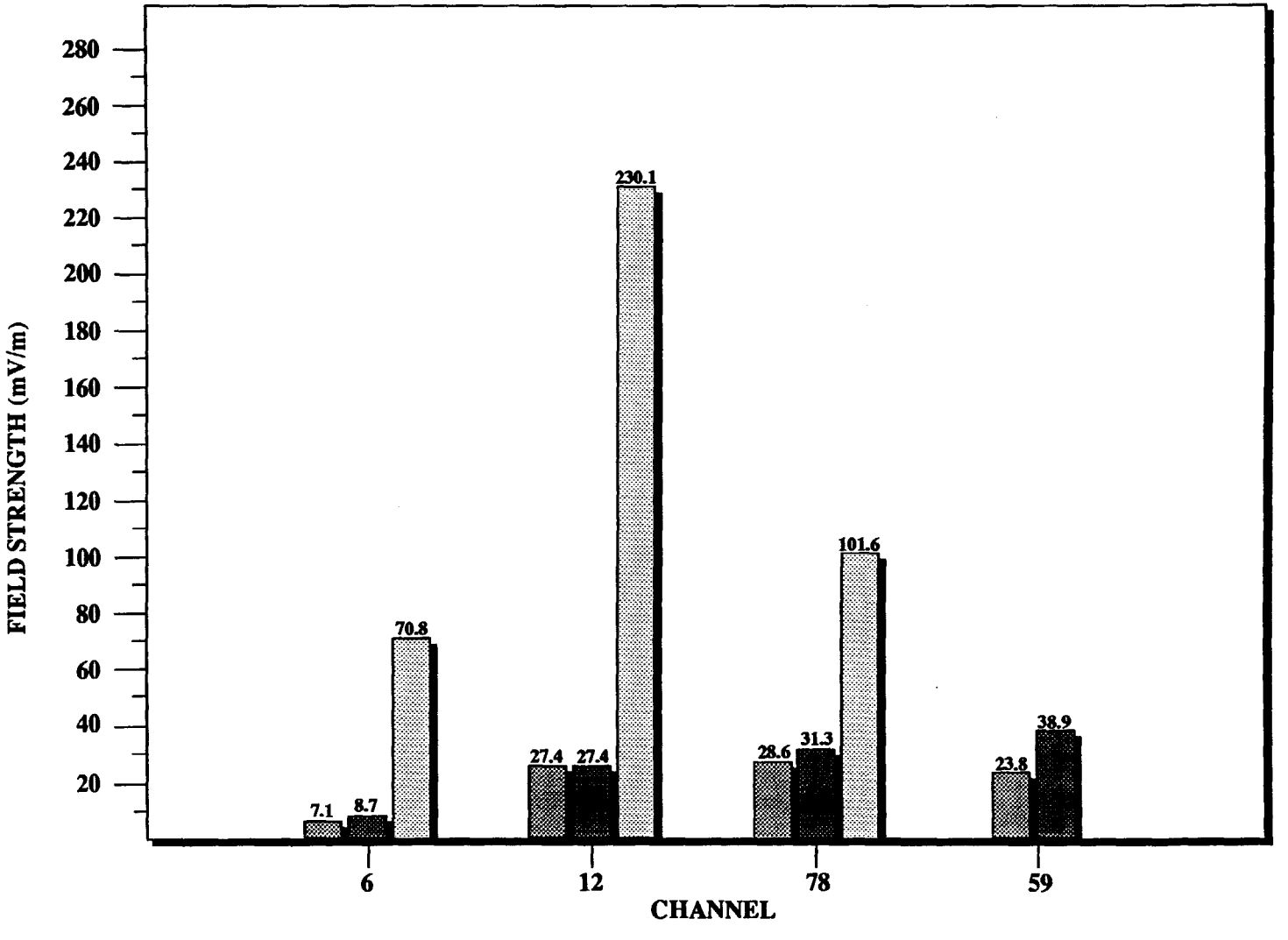
The table indicates that a significantly higher field strength is required to produce "just perceptible" interference in a cable converter than in a television receiver or VCR. This means that cable converters are significantly less sensitive to radiated DPU interference than are television receivers or VCR's. The field strength required to produce "just perceptible" interference in the worst performing cable converter is greater than that required to produce "just perceptible" interference in the median performing television receiver or VCR. Comparison of the performance of the median performing cable converter with the median performing television receiver or VCR shows greater than a 15 dB improvement in performance.

3.4.1.4 Graphical Comparison of Radiated Susceptibility Results

A graphical comparison of the radiated susceptibility performance of television receivers, VCR's, and cable converters is presented in Figures 3.15 and 3.16 in terms of the field strength required to produce "just perceptible" interference. The figures

FIGURE 3.15 FIELD STRENGTH REQUIRED TO PRODUCE "JUST PERCEPTIBLE" INTERFERENCE IN THE MEDIAN TEST SAMPLE

ORIENTATION OF MAXIMUM SUSCEPTIBILITY



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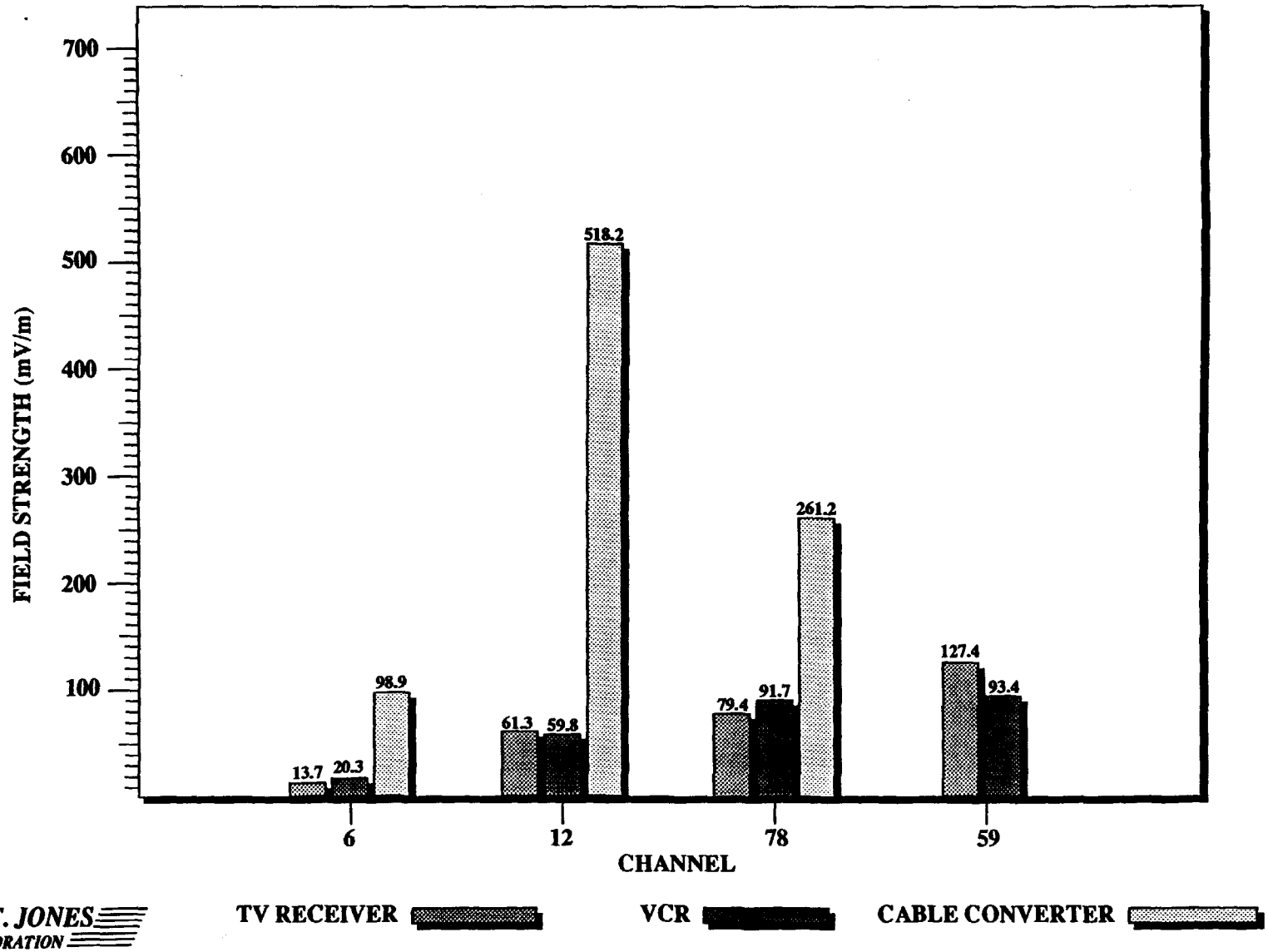
TV RECEIVER VCR CABLE CONVERTER

FIGURE 3.16 FIELD STRENGTH REQUIRED TO PRODUCE "JUST PERCEPTIBLE" INTERFERENCE IN THE MEDIAN TEST SAMPLE

AVERAGE SUSCEPTIBILITY



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