A Report To

National Association of Broadcasters

Regarding Study and Measurements of Part 15 Devices Operating in the FM Broadcast Band

June 2, 2006

Prepared By:

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Background:

Increasingly, broadcasters are receiving complaints from listeners that their FM receivers are intercepting unwanted transmissions from nearby Part 15 devices being used with Satellite radio and MP3 players such as iPods. In particular these unwanted transmissions are being found in the automotive environment, on highways and such, where Part 15 device users are sending their satellite radio or MP3 player audio to the FM receivers installed in their vehicles.

This problem is a concern to incumbent spectrum licensees for several reasons. First, these devices interfere with licensed broadcast operations. In addition, some audio programs that are broadcast with these devices do not comply with the FCC's rules regarding indecency and can be mistakenly attributed to the licensed broadcaster. These devices can certainly create an annoying experience for a radio listener when, for example, stopping at a traffic signal next to an automobile with such a device that is causing interference to the listener's FM reception.

It is important that regulatory agencies apply the Part 15 rules in an equitable manner to protect primary spectrum licensees, consumers, and other Part 15 device manufacturers that strive to manufacturer devices that are Part 15 rule compliant. Thus, enforcement of the Part 15 rules should be a priority for enforcement officials. Finally, interference caused by the devices hurts the goal of efficient spectrum management and impairs the introduction of HD Radio services in the FM broadcast bands.

In an effort to address some of these concerns, the National Association of Broadcasters (NAB) undertook a program to study the issue at hand. One goal of that study was to measure the field strength of signals emitted from a variety of Part 15 FM transmitter devices designed for use with satellite radio and MP3 or iPod devices under a variety of conditions, to determine whether these devices are in compliance with Part 15 of the FCC rules.

The National Association of Broadcasters (NAB) retained the firm of Meintel, Sgrignoli, & Wallace (MSW) to conduct a study of some of these Part 15 FM Transmitters and to determine their compliance with the requirements of Part 15 authorization. This report will detail the study conducted by MSW and report the results of that study.

Introduction:

A series of measurements were conducted on 17 "wireless" devices as well as 4 "wired" devices. Measurements of the field strength of the FM Broadcast Band signal transmitted by these devices were made. In addition, verification of the required FCC ID numbers and verification of the compliance with the antenna rules was also performed. This report describes recent measurements of measured field strengths from the devices and outlines the compliance of these devices with other Part 15 requirements.

FCC Part 15 Operation:

The FCC's Office of Engineering and Technology (OET) issued a Bulletin Number 63 in October 1993, which provides the correct method for calculation of the Maximum Emission Limit or Maximum Field Strength that is permissible from the subject Part 15 device. For frequencies in the FM Broadcast Band (88-108MHz) there are four limits depending upon the type of emission that the device transmits.

Intermittent Control Signals that do not have high duty cycles are allowed higher emission limits than those devices that are used to continuously transmit (such as an FM audio transmitter). For the devices under study the limit is 250µV/m at a distance of 3 meters from the device. The FCC limit can also be expressed as follows:

[20* LOG 250/1] = 47.95 dBµV/m.

For comparison purposes in the charts of the report we have rounded the FCC Part 15 limit to 48 dBµV/m. This limit is applied to devices that are equal to or less than 200 KHz in bandwidth. This is detailed in 47 C.F.R. § 15.239 of the FCC Rules.

For devices with bandwidths in excess of 200 KHz, or as the Rules describe "Any" bandwidth, the limit is 150µV/m (43.5 dBµV/m) at a distance of 3 meters from the device (47 C.F.R. § 15.209).

It is also noted that devices that operate pursuant to the Part 15 rules are required to provide to the FCC a "Certification" that the device complies with the requirements of Part of the FCC Rules. This certification is to include data from measurements conducted on the device as well as documentation regarding the measurement facilities, test procedures, and test results of the measurements. This data will be reviewed by the FCC and an appropriate FCC ID number assigned to the device by the FCC OET.

Part 15 Label Requirements:

The FCC Rules require that these devices have <u>two</u> labels attached to them. The first label required is the FCC ID number as described previously. Once certification is granted by the FCC this assigned ID number must be marked on the device. However, there is also the requirement that the device must have a "Compliance" label. The "Compliance" label serves as an indication to consumers that the device has been authorized by the FCC. As noted later in this report, the majority of these devices did not have a "Compliance" label affixed to them.

Antenna Requirements of Part 15:

Another requirement of devices that operate pursuant to Part 15 of the rules is the restriction on the type of antennas that may be provided with the device. In §15.203 of the FCC Rules, the Commission requires that the device be certified with the antenna that is to be provided with the device. And, the Commission adopts restrictions on the types of connectors that can be used for antenna connections to prevent consumers from using antennas other than those provided with the unit. The intent of these requirements is to prevent the use of an antenna that may allow the device to exceed the emission limits of the rules. (Antennas other than those used during the Certification Measurements for the device.) Essentially, the requirement is that these devices should have permanently attached antennas, or "unique connectors" that is not of a "standard" type found at an electronics store.

In the case of the devices that were studied there appear to be three devices that do not comply with these requirements. Device #9 is provided with a "rod" antenna with a standard "threaded" end for connection. But, more disturbing is that this device also has a standard "F" connector output for connection to an external antenna (or power amplifier).

Devices # 15 and #16 are provided with standard 2.5mm audio connectors for connection to the supplied external antenna. The supplied antenna is simply a piece of #20 gauge wire approximately 12 inches in length. This connector would also not comply with the Commission's requirements for using "unique" connectors as 2.5mm audio plugs are standard connectors that can be found in any electronics store.

Devices Under Test:

The Devices Under Test (DUT) are listed in the Tables A and B below. These devices were obtained in the standard commercial marketplace and are generally available to all consumers. The devices were chosen to represent a variety of manufacturers, device type, price, and features. These devices are believed to be fairly representative of the Part 15 FM devices that are commonly available to consumers and are representative of devices in general use by consumers.

The devices are broken into two different categories to allow a better comparison of various FM devices. The first group is called "Wireless" devices. These devices are wireless in nature and do not connect to the FM receiver being used to listen to the audio transmission other than by mutual RF coupling to the receiver from the transmitter. The second group of devices is called "Wired" devices. These units are designed to be inserted between the antenna input on an automobile radio receiver and the automobile antenna. Hence, they are directly "wired" to the automobile radio receiver.

The FCC Rules at 47 C.F.R. § 2.925 and § 15.19 require that the FCC ID number as well as a "Compliance" label be permanently marked on the device. An inspection of each device was conducted to determine the FCC ID number marked on each device as

the FCC Rules require. In two cases of the "wireless" devices, no such FCC ID was marked on the device. In the case of the "wired" devices none of them were marked with an FCC ID number. Only a few of the devices were marked with the appropriate "Compliance" label as required.

Table A: "Wireless" Devices Under Test

Device Number	Manufacturer	Model Number	FCC ID #
1	Akron	SF-150a	ME2-SF150
2	Akron	SF-250	ME2-SF250
3	Belkin	Tune Cast F8V367-APL	K7SF8V367
4	Belkin	Tune Cast II F8V3080	K7SF8V3080
5	C Crane Co.	FMT	BYG006
6	Dynex	DX-AC101	POSEF6208
7	Dynex	DX-MP3FM	POSEF6215
8	Griffin Technology	iTrip 9500 TRIPDA	PAV4026
9	Hobbytron	FM25B	NO FCC ID # On Case
10	iRiver	AFT-100	RKVATB350
11	iRock	450FM	QDNDGT201
12	Lenmar	AI-MODAM	NO FCC ID # On Case
13	Monster iCar Play	AI IP FM-CH	RJE160732-00
14	RCA	MM70FM	POSPC-7207
15	Sirius	S50	O6ZS50-C1
16	Sirius	Sportster SP-TK2	P3HSP-R2
17	Starvision	FT-07	RJX93FMT07

Table B: "Wired" Devices Under Test

Device Number	Manufacturer	Model Number	FCC ID #
18	Delphi	SA10003	No FCC ID # On Case
19	Pyle	PLMD2	No FCC ID # On Case
20	Scosche	FM-MOD01	No FCC ID # On Case
21	Starvision	FM-07	No FCC ID # On Case

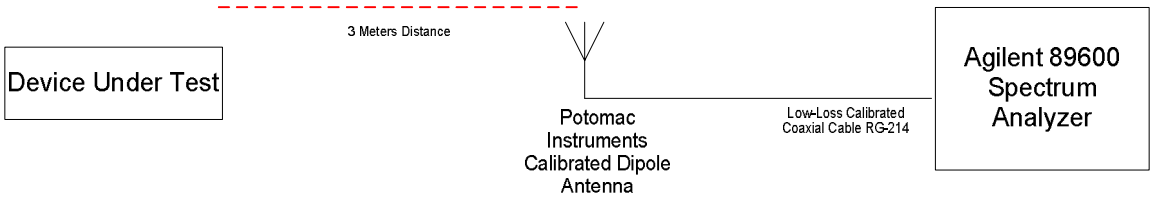
Description of Test Setup:

The FCC outlines the specific measurement procedures to be used for Part 15 Compliance measurements in both the FCC Rules and in a document authored by the FCC OET in Bulletin #63. Further, the FCC released a Public Notice on October 1993, further clarifying the applicable rules to these devices.

The tests conducted for this study utilized the methods described in these documents. A test location was chosen that was free from discernable co-channel FM Broadcast Stations to allow accurate measurements of the signals from the Device Under Test (DUT). The test setup included the use of a NIST-Traceable Calibrated VHF Dipole Antenna (Potomac ANT-71) mounted on a tri-pod and connected via low-loss coaxial cable to an Agilent 89600 series spectrum analyzer.

For the first series of tests, the Device Under Test (DUT) was placed on a wooden stand at a distance of 3 meters from the calibrated dipole antenna. The antenna element lengths were set to the corresponding frequencies based upon the chart supplied with the antenna (see **Appendix A**).

A series of measurements were made with the spectrum analyzer on the FM carrier emitted by the DUT. First, a measurement of the un-modulated FM carrier was made and a plot of the corresponding spectrum was made. Next, the device was modulated with audio and an additional measurement and spectrum plot were made. Finally, with the audio modulating the FM Carrier, a spectrum plot was made with the spectrum analyzer in the "peak-hold" mode, to establish the approximate deviation (occupied bandwidth) of the device when operating.



Device Testing Setup

Measurement Results:

The measurements summarized in this report were conducted during the time period May 14 – June 2, 2006. In the Table C a graph of the measured field strength emitted from the device at the prescribed distance of 3 meters is shown. You'll note that 76.5% of the devices exceed the 48 dBµV/m limits of Part 15 operation. Only four devices were found to be compliant with the emission limits. (Only 24.5% were compliant).

The devices that were found to be compliant with the emission limits were device numbers 5, 6, 8, and 13. All the other "wireless" devices were found to be above the limits. The worst offender was device #9 with the highest field strength of 99.9 dBµV/m. If we ignore this as a statistical "out-lyer" and use the other field strength for this device of 86.9 dBµV/m and 88.5 dBµV/m, the device exceeds the Part 15 limit by approximately 40dB. The average of all the measurements was 62 dBµV/m (1,259 µV/m) which exceeds the Part 15 limit by 14 dB (5 times the limit).

For the "Wired" devices, the tests indicate that the devices are generally compliant with the Part 15 limits. The highest measured field strength of these devices was # 18 with a field strength of 49.1 dBµV/m which is within 1dB of the prescribed limit. For the purposes here, it was determined that these devices were compliant. It is

noted that the average field strength for these devices was 46.96 dBµV/m, well within 1dB of the limit.

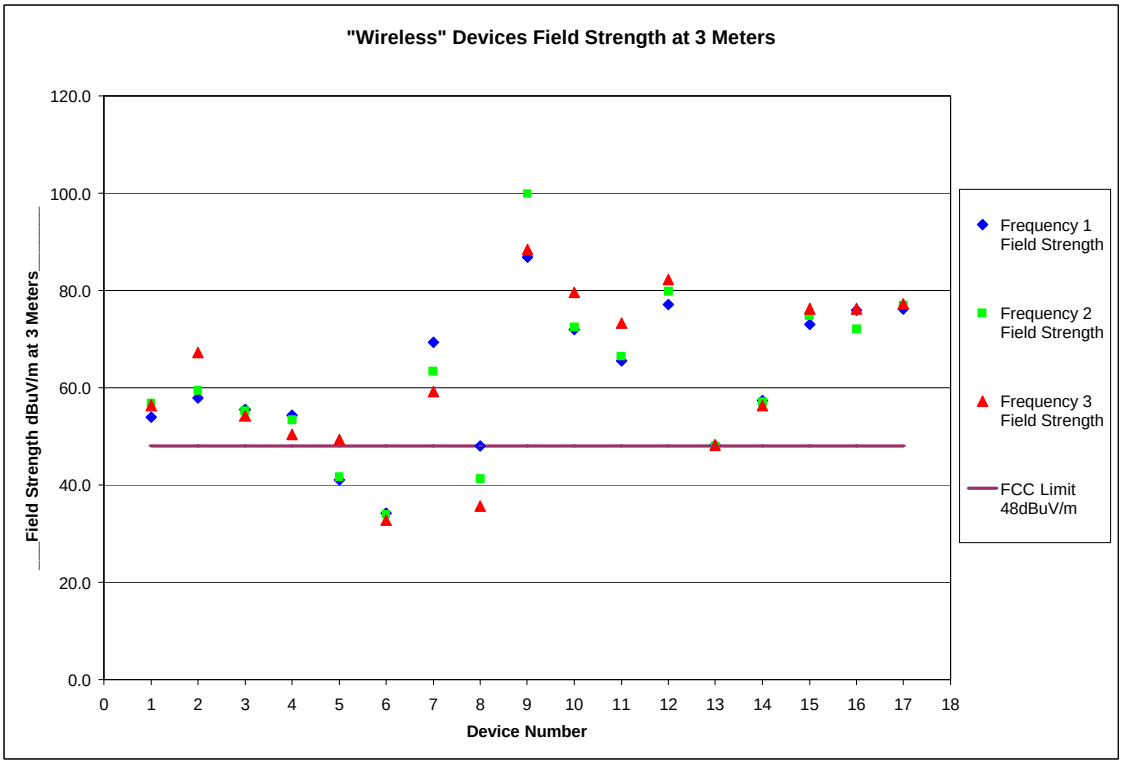
Table C: "Wireless" Devices Measurement Results

Device	Frequency 1	Field Strength w/ K Factor dBuV/m	Frequency 2	Field Strength w/ K Factor dBuV/m	Frequency 3	Field Strength w/ K Factor in dBuV/m
1	88.3	54.0	93.5	56.8	95.1	56.4
2	88.3	57.9	88.7	59.5	107.7	67.3
3	88.3	55.5	88.5	55.2	88.7	54.2
4	88.3	54.4	98.5	53.4	107.7	50.5
5	88.3	41.1	98.5	41.7	107.7	49.4
6	88.1	34.2	88.3	34.0	88.5	32.8
7	88.3	69.4	98.5	63.4	107.7	59.3
8	88.3	48.1	98.5	41.3	107.7	35.7
9	88.3	86.9	98.5	99.9	107.7	88.5
10	88.3	72.0	98.5	72.5	107.7	79.6
11	88.3	65.6	98.5	66.5	107.7	73.4
12	88.3	77.1	100.5	79.8	106.5	82.2
13	88.3	48.2	88.7	48.1	89.1	48.2
14	88.1	57.4	88.3	57.1	88.5	56.3
15	88.1	73.0	98.5	74.9	107.7	76.3
16	88.3	76.0	98.5	72.0	107.7	76.3
17	87.9	76.1	88.3	77.0	88.7	77.2

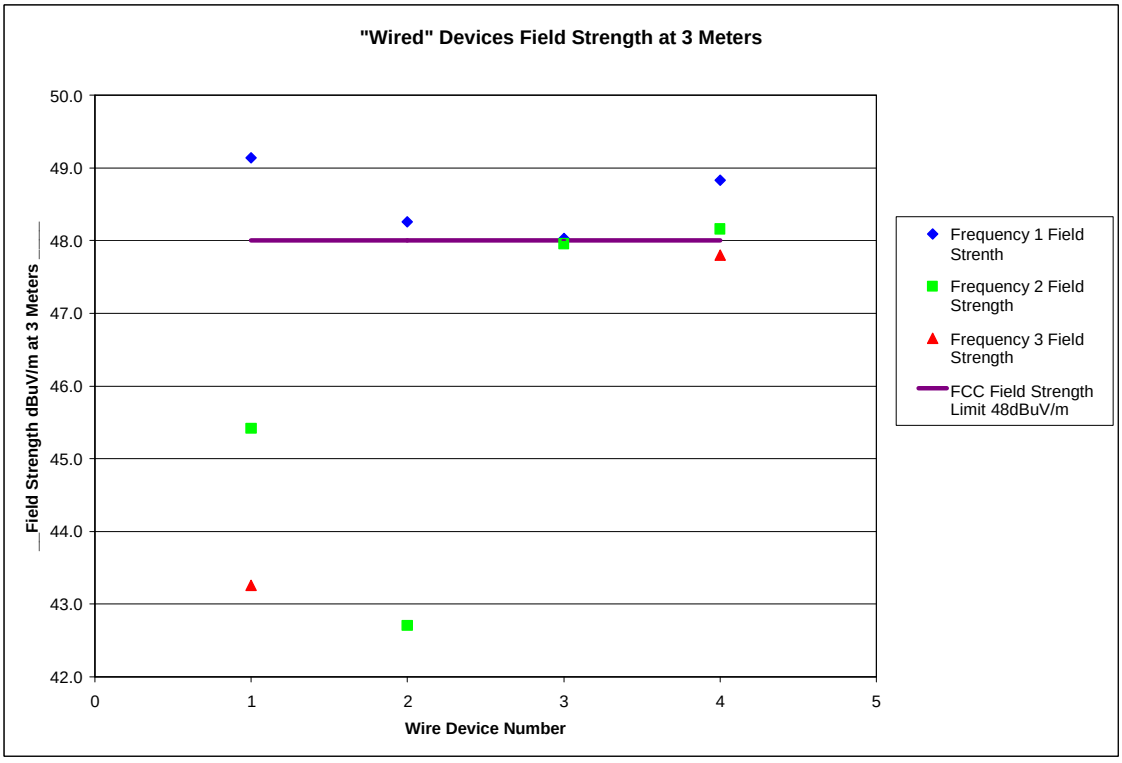
Devices highlighted in Yellow are above limits, compliant devices highlighted in Green.

Table D: "Wired" Devices Measurement Results

Device	Frequency 1	Field Strength w/ K Factor dBuV/m	Frequency 2	Field Strength w/ K Factor dBuV/m	Frequency 3	Field Strength w/ K Factor in dBuV/m
18	87.9	49.1	88.1	45.4	88.5	43.3
19	88.5	48.3	88.9	42.7	NA	NA
20	87.9	48.0	88.3	48.0	NA	NA
21	87.9	48.8	88.3	48.2	88.7	47.8

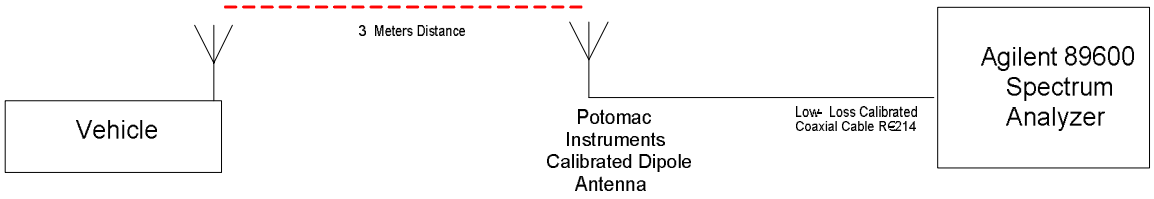


In order to better illustrate the results, these charts provide the measured values for each device and show the FCC limit of 48dBµV/m.



Additional Measurements:

At the request of the NAB, additional tests were conducted on a sub-set of devices to determine the field strength of these devices when they are operated in a vehicle. For this test, the device was installed as per normal operation in a vehicle. Then measurements were made of the field strength from the device at a distance of 3 meters from the vehicle's antenna. For this test, three "Wireless" devices were tested and two "Wired" devices were tested. The combined test results are shown in Table E.



Setup for "Car Test"

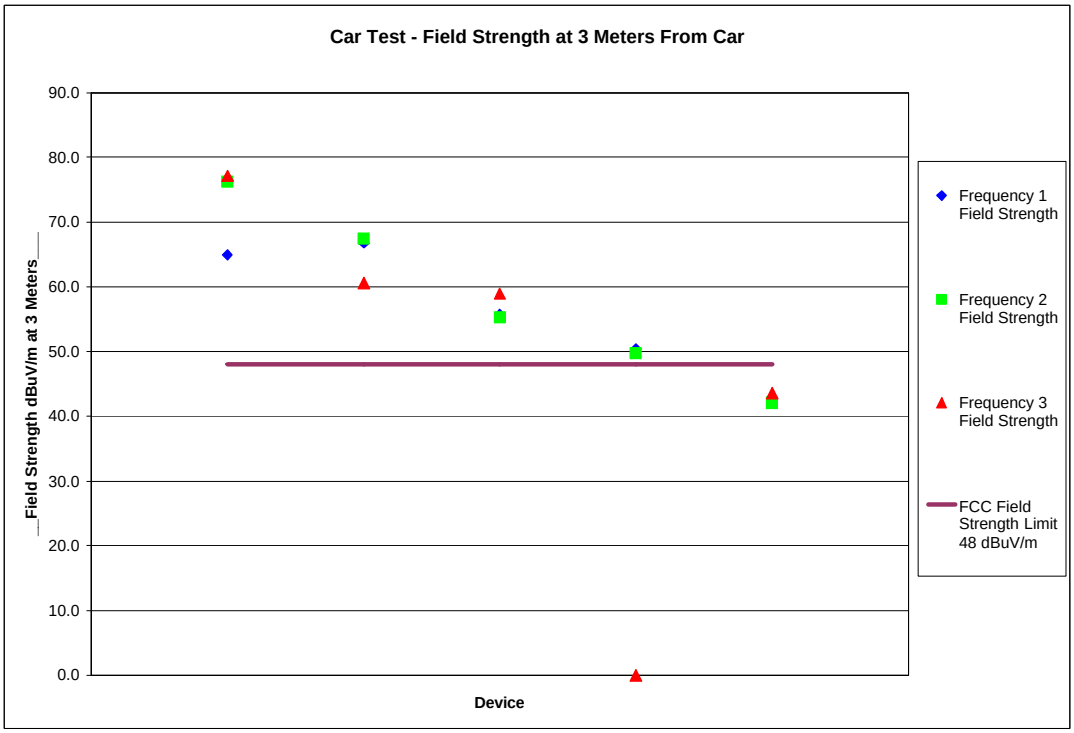
Table E: "Car Test" Devices Measurement Results

Device	Frequency 1	Field Strength w/ K Factor in dBuV/m	Frequency 2	Field Strength w/ K Factor in dBuV/m	Frequency 3	Field Strength w/ K Factor in dBuV/m
9	88.3	65.0	98.5	76.2	107.7	77.2
12	88.3	66.8	100.5	67.4	106.5	60.6
15	88.1	55.8	98.5	55.3	107.7	59.0
20	87.9	50.4	88.3	49.8	NA	NA
21	87.9	42.0	88.3	42.1	88.7	43.6

The results indicate that for the three "wireless" devices (9, 12, & 15); they generally exceeded the prescribed 48dBµV/m limit. Thus, the "attenuation" of the vehicle does reduce the field strength outside the vehicle by an average of approximately 11.2 dB. However, the devices are still well beyond the maximum permissible emissions.

The "wired" devices (20 & 21) were generally compliant (within a tolerance value of 1-2dB), although the "attenuation" of the vehicle was not as significant of a factor, as leakage through the vehicle antenna was the main radiator. In this case, the "average" attenuation was 2.6 dB.

"Car Test" Setup

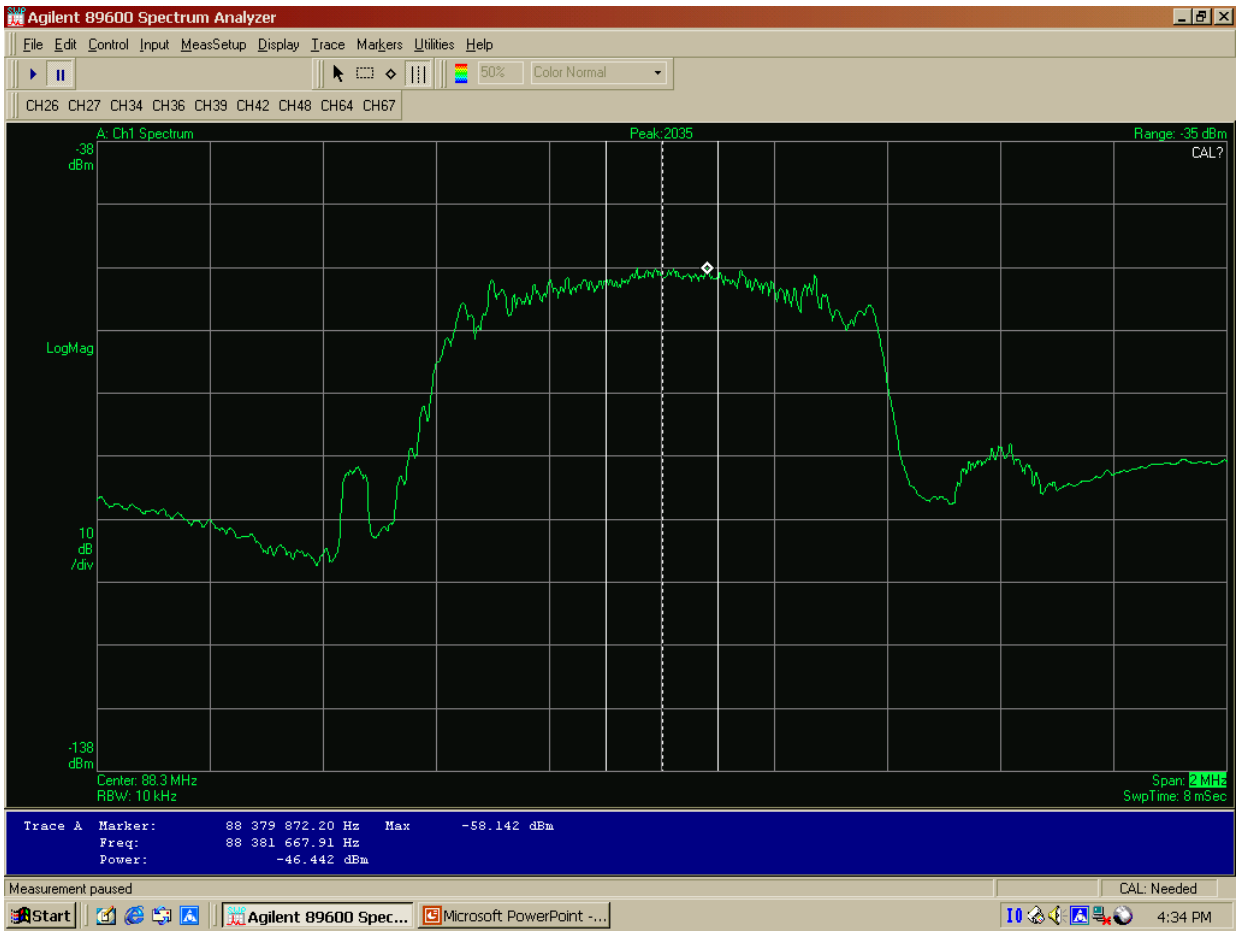


Car Test Results

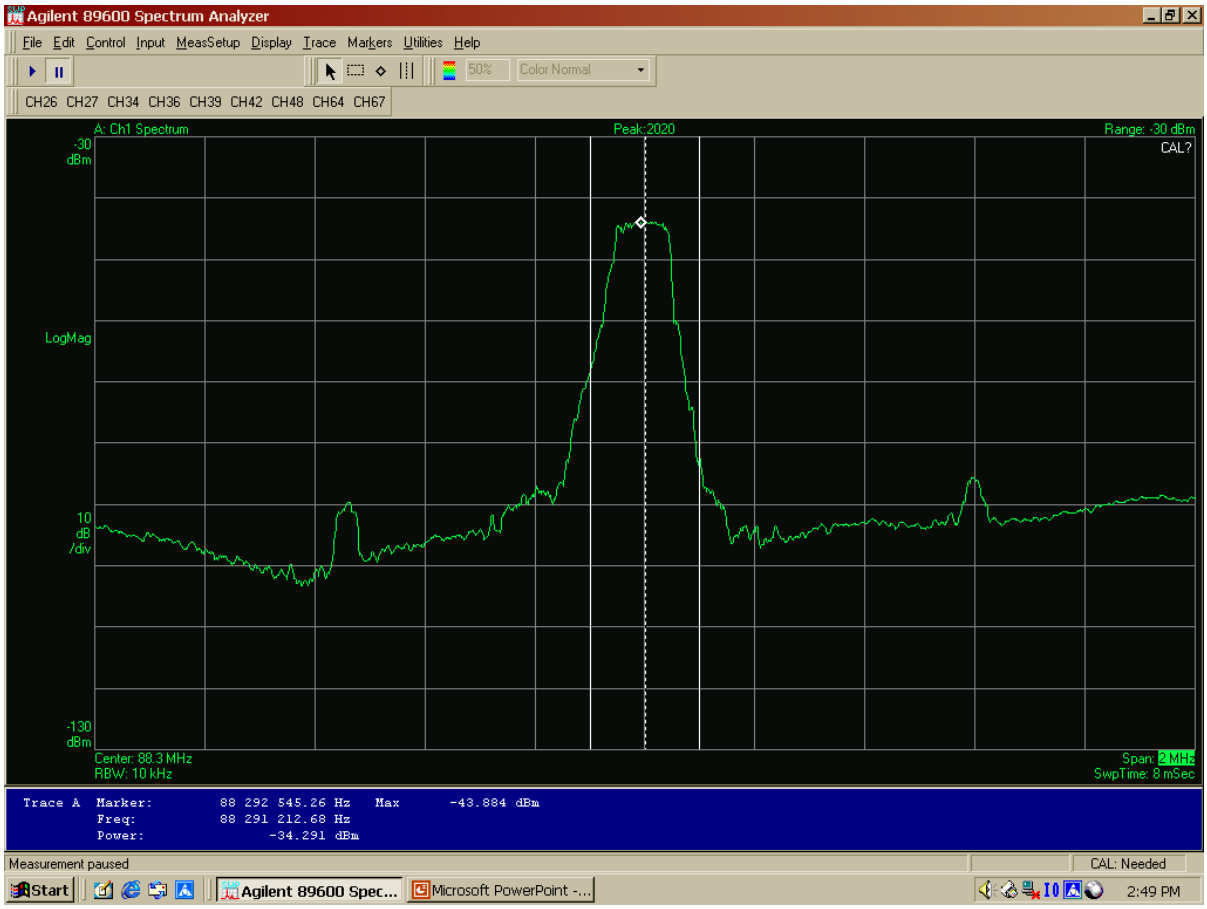
Modulation Capability:

As noted in the description of the measurements, the devices were operated with audio to deviate the FM carrier of the transmitter. During the tests, we noted the deviation of the FM carrier. It was noted that the majority of devices were modulating beyond the standard 200 KHz bandwidth of an FM Broadcast Station. For most of the devices, it appears that no audio limiting circuitry is present. This allows the FM Carrier to be modulated such that it actually occupies more than one standard FM Broadcast Channel. In FM Broadcast Stations, limiters are employed to keep stations from over-modulating. However, in these devices, there are no limiters to prevent the user from modulating the device up to 800KHz. The only limit appears to be the audio amplifier driving the device.

This is a cause for concern since the users may not know that they are occupying more than one broadcast channel. It may that a user would choose an un-occupied channel that is adjacent to a FM Broadcast Station. The users may believe that they are avoiding interference by operating on the adjacent channel. However, if the unit is modulated heavily (by turning up the volume control) it may well become co-channel and interfere with the licensed operation. To illustrate this point, this spectrum plot shows the deviation of device # 2. As can be seen from the plot, it occupies 800 KHz (4 channels).



Peak Hold –Deviation Device # 2 – 800KHz



Peak Hold – Deviation Device # 11 -150 KHz

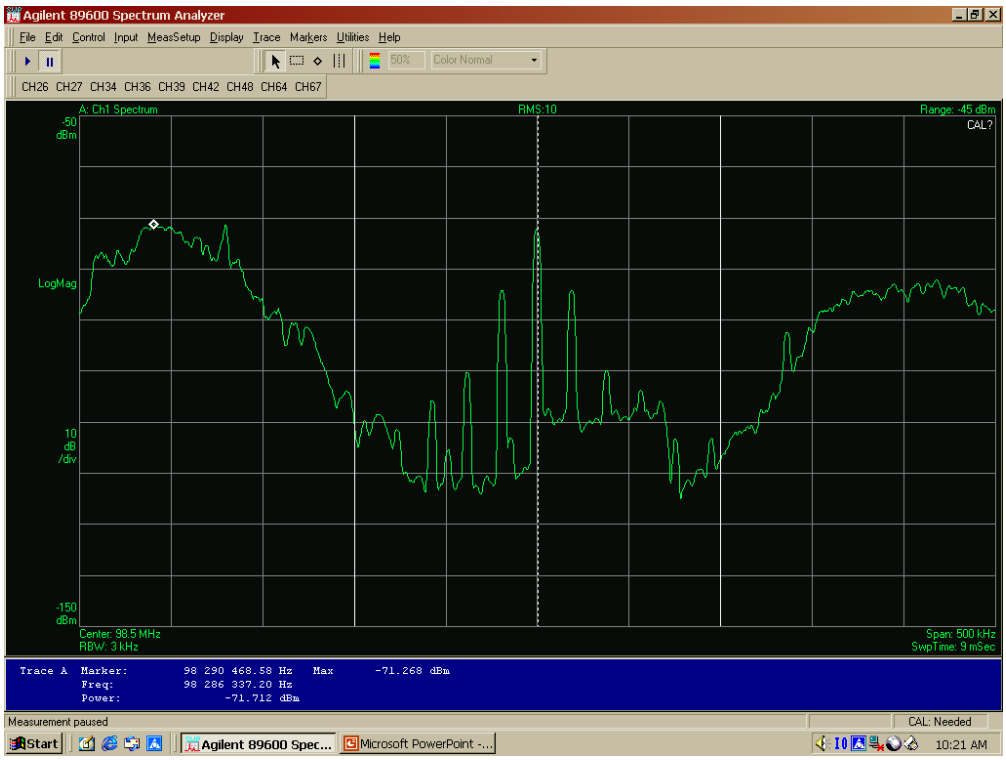
By contrast, the above plot shows the deviation from Device #11, which is well within the 200 KHz channel.

It is also noted that the Commission's Part 15 limit of 48dBµV/m applies to signals with bandwidths of equal to 200 KHz or less. In the case of most of the devices tested, the bandwidths are in excess of 200 KHz, in which case, the more stringent Part 15 limit of 43.5dBµV/m applies. Clearly, compliance with this value is also an issue.

HD Radio Impact:

Based upon the discussion above regarding the very wide deviation of the FM carrier in most of these devices, it is possible that these devices could become a significant problem with HD Radio receivers. Since the IBOC signals are occupying "vacant" adjacent channels, it is likely that these are the exact channels a user would choose upon which to operate one of these devices. To the user, the "noise" like HD Radio carrier appears to be a vacant channel. However, with the wide modulation capability and the strong signal levels emitted by these devices, it is likely that significant interference to the much lower power HD Radio signals would be caused. The spectrum plots below show an HD Radio carrier with the Part 15 device on and off.

Part 15 Device OFF - HD Radio carrier can be seen in the “vacant” channel



Part 15 Device ON – Co-Channel to HD Radio Carrier

Conclusions

The measurements summarized above show that many of the devices currently on the market that are required to be compliant with Part 15 of the FCC rules, are in fact, not meeting these requirements. Less than 25% of the devices tested met the field strength criteria of the Part 15 rules. Further, some of the devices did not meet the antenna, FCC ID label, and compliance labeling requirements of Part 15. From the sample of devices tested here, it is clear that a majority of devices on the market are violating the FCC rules.

Based upon these tests, it is reasonable to conclude that significant interference to licensed FM broadcast stations exists from these devices. The modulation capabilities of the devices allow them to occupy more than one FM channel simultaneously and may hinder the roll-out of HD Radio services. The strong field strengths emitted by some of these devices will exceed the co-channel and adjacent channel interference ratios (D/U ratios) at which consumer receivers will operate.

The OET Bulletin 63 makes clear that a "person (or company) that sold this non-compliant transmitter to the user has violated the FCC marketing rules in Part 2 as well as Federal Law." Violators are subject to an enforcement action by the Commission's Field Operations Bureau and can result in forfeiture of equipment, fines including criminal penalties, and administrative fines. Further, manufacturers that have submitted false certification documents to the FCC OET may be subject to penalties of perjury.

The undersigned hereby certifies that the foregoing report was prepared by him or under his direction, and that it is true and correct to the best of his knowledge and belief.

Submitted June 2, 2006

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Appendix A

Antenna Charts

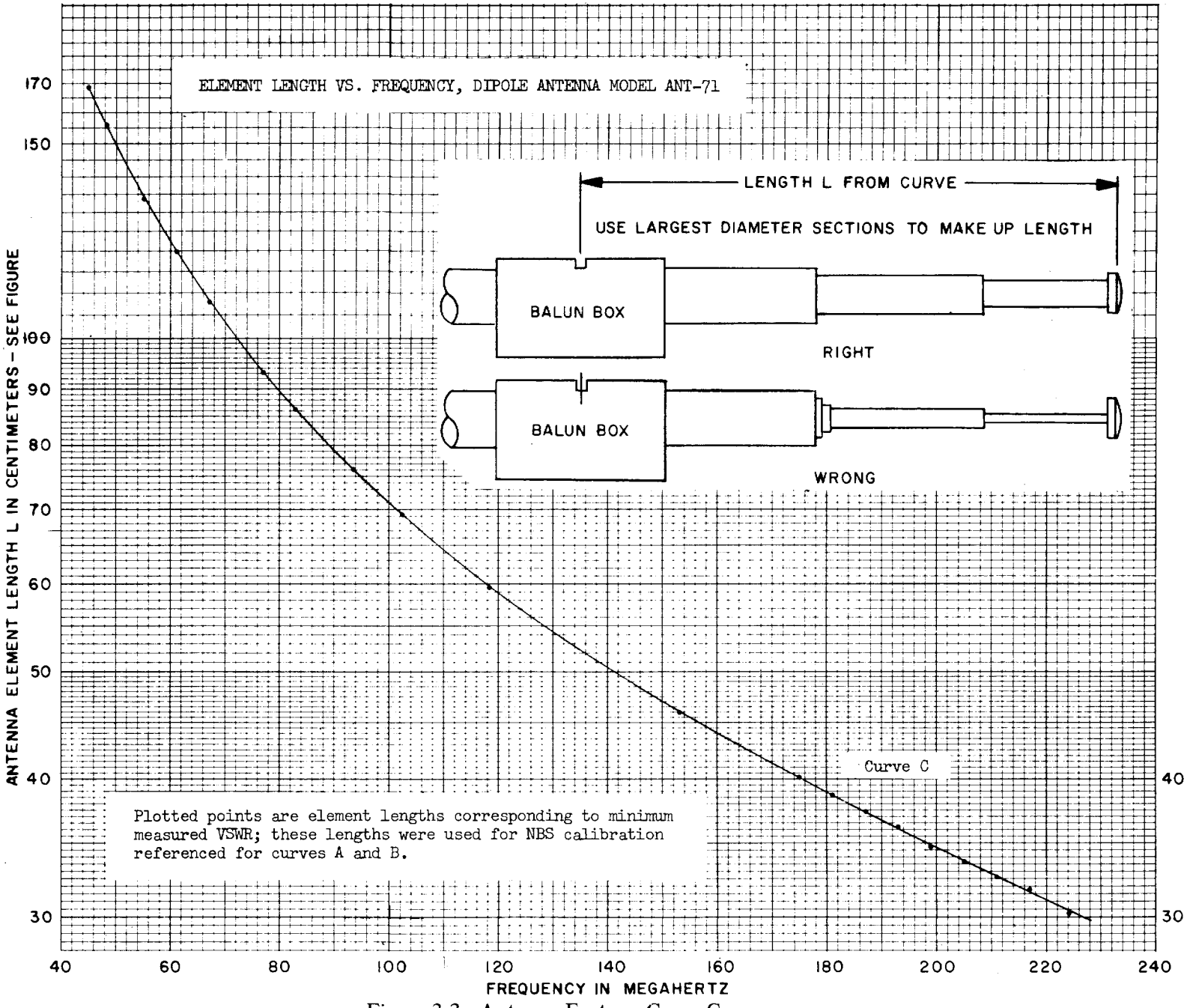


Figure 3-3. Antenna Factors, Curve C

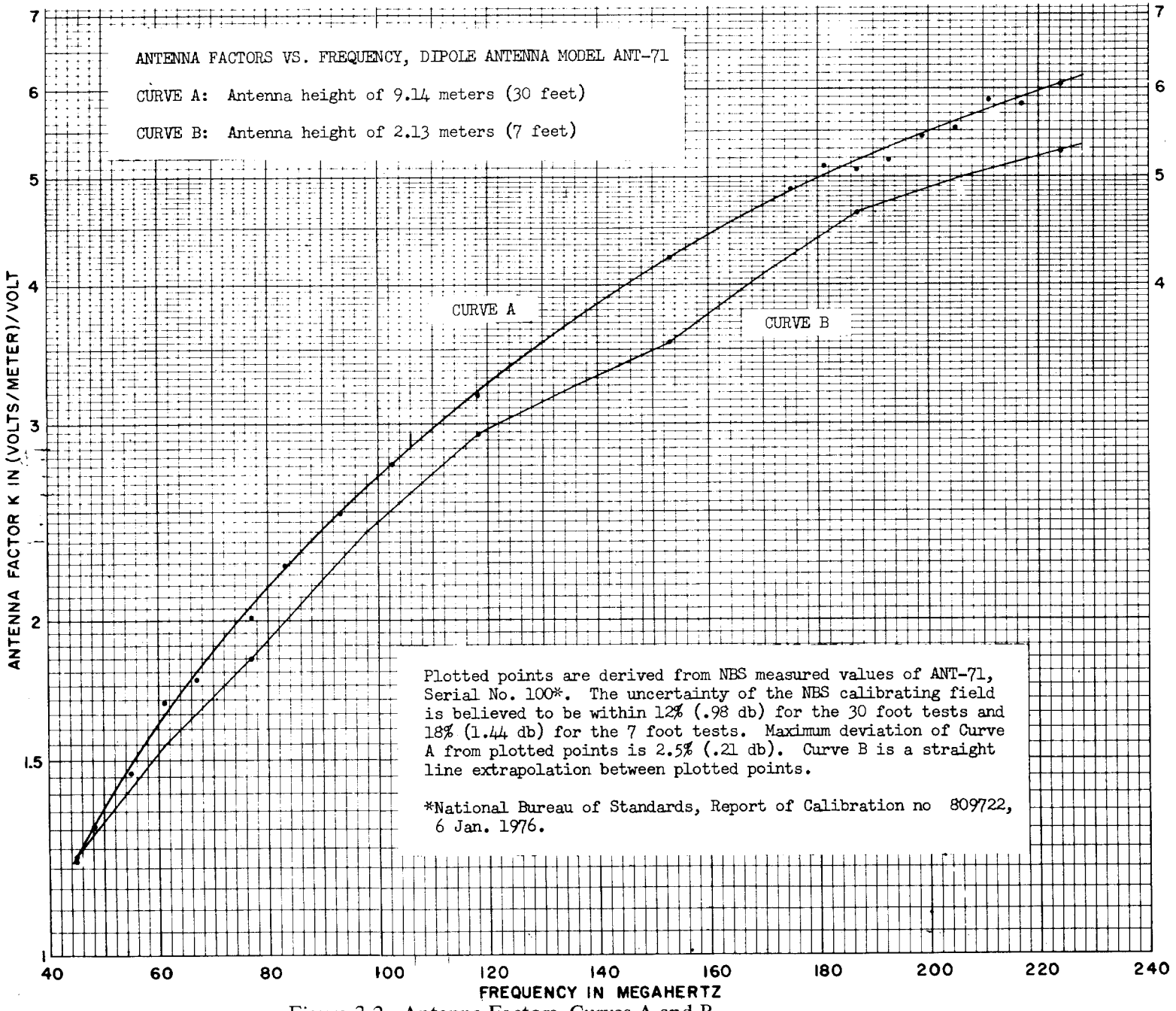


Figure 3-2. Antenna Factors, Curves A and B.

Appendix B

Measurement Data Spreadsheet

Device	Manufacturer	Model #	Frequency Range	# of Test Freq	Test Freq's.	# Tests	Type Antenna	FCC ID #
1	Akron	SF-150a	88-95MHz	3	88.3, 92.3 ,95.1	3	Integral	ME2-SF150
2	Akron	SF-250	88.1, 88.3, 88.5, 88.7, 107.1, 107.3, 107.5, 107.7	3	88.3, 88.7, 107.5	3	Integral	ME2-SF250
3	Belkin	Tune Cast F8V367-APL	88.1, 88.3, 88.5, 88.7	3	88.3, 88.5, 88.7	3	Integral	K7SF8V367
4	Belkin	Tune Cast II F8V3080	88.1-107.9	3	88.3, 99.7 ,107.5	3	Integral	K7SF8V3080
5	C Crane Co.	FMT	88.1-107.9	3	88.3, 99.7, 107.5	3	Rod	BYG006
6	Dynex	DX-AC101	88.1, 88.3, 88.5, 88.7	3	88.3, 88.5, 88.7	3	Integral	POSEF6208
7	Dynex	DX-MP3FM	88.1-107.9	3	88.3, 99.7, 107.5	3	Integral	POSEF6215
8	Griffin Technology	iTrip 9500 TRIPDA	88.1-107.9	3	88.3, 99.7, 107.5	3	Integral	PAV4026
9	Hobbytron	FM25B	88.1-107.9	3	88.3, 99.7, 107.5	3	External / Rod	NO FCC ID # On Case
10	iRiver	AFT-100	88.1-107.9	3	88.3, 99.7, 107.5	3	Integral	RKVATB350
11	iRock	450FM	88.1-107.9	3	88.3, 99.7, 107.5	3	Integral	QDNDGT201
12	Lenmar	AI-MODAM	88.1-106.7	3	88.3, 100.5, 106.5	3	Integral	NO FCC ID # On Case
13	Monster iCar Play	AI IP FM-CH	88.1, 88.3,88.5,88.7,88.9,89.1,89.3,89.5	3	88.3, 88.7, 89.3	3	Integral	RJE160732-00
14	RCA	MM70FM	88.1, 88.3, 88.5, 88.7	3	88.3, 88.5, 88.7	3	Integral	POSPC-7207
15	Sirius	S50	88.1, 99.1, 100.1	3	88.1, 99.1, 100.1	3	Wire	O6ZS50-C1
16	Sirius	Sportster SP-TK2	88.1-107.9	3	88.3, 99.7, 107.5	3	Wire	P3HSP-R2
17	Starvision	FT-07	87.7, 87.9, 88.1, 88.3, 88.5, 88.7, 88.9	3	87.9, 88.3, 88.7	3	Integral	RJX93FMT07
WIRED								
18	Delphi	SA10003	87.9, 88.1, 88.5	3	87.9, 88.1, 88.5	3	Motorola Plug	No FCC ID # On Case
19	Pyle	PLMD2	88.5, 88.9	2	88.5, 88.9	2	Motorola Plug	No FCC ID # On Case
20	Scosche	FM-MOD01	87.9, 88.3	2	87.9, 88.3	2	Motorola Plug	No FCC ID # On Case
21	Starvision	FM-07	87.7, 87.9, 88.1, 88.3, 88.5, 88.7, 88.9	3	87.9, 88.3, 88.7	3	Motorola Plug	No FCC ID # On Case

Device	Manufacturer	Model #	Frequency 1	Measured Power (dBm)	Cable Loss	Antenna Factor K	Convert Power to Voltage	Raw Field Voltage dBuV	Raw Field Voltage uV
1	Akron	SF-150a	88.3	-60.5	0.9	2.13	106.99	47.39	234.2
2	Akron	SF-250	88.3	-56.6	0.9	2.13	106.99	51.29	366.9
3	Belkin	Tune Cast F8V367-APL	88.3	-58.93	0.9	2.13	106.99	48.96	280.5
4	Belkin	Tune Cast II F8V3080	88.3	-60.1	0.9	2.13	106.99	47.79	245.2
5	C Crane Co.	FMT	88.3	-73.4	0.9	2.13	106.99	34.49	53.0
6	Dynex	DX-AC101	88.1	-80.2	0.9	2.12	106.99	27.69	24.2
7	Dynex	DX-MP3FM	88.3	-45.1	0.9	2.13	106.99	62.79	1378.8
8	Griffin Technology	iTrip 9500 TRIPDA	88.3	-66.4	0.9	2.13	106.99	41.49	118.7
9	Hobbytron	FM25B	**88.3**	**-27.6**	**0.9**	**2.13**	**106.99**	**80.29**	**10339.5**
10	iRiver	AFT-100	88.3	-42.5	0.9	2.13	106.99	65.39	1859.9
11	iRock	450FM	88.3	-48.9	0.9	2.13	106.99	58.99	890.2
12	Lenmar	AI-MODAM	88.3	-37.4	0.9	2.13	106.99	70.49	3345.8
13	Monster iCar Play	AI IP FM-CH	88.3	-66.3	0.9	2.13	106.99	41.59	120.1
14	RCA	MM70FM	88.1	-57.03	0.9	2.12	106.99	50.86	349.1
15	Sirius	S50	88.1	-41.4	0.9	2.12	106.99	66.49	2111.1
16	Sirius	Sportster SP-TK2	88.3	-38.5	0.9	2.13	106.99	69.39	2947.8
17	Starvision	FT-07	87.9	-38.2	0.9	2.1	106.99	69.69	3051.4
WIRED									
18	Delphi	SA10003	87.9	-65.2	0.9	2.1	106.99	42.69	136.3
19	Pyle	PLMD2	88.5	-66.2	0.9	2.13	106.99	41.69	121.5
20	Scosche	FM-MOD01	87.9	-66.3	0.9	2.1	106.99	41.59	120.1
21	Starvision	FM-07	87.9	-65.5	0.9	2.1	106.99	42.39	131.7
CAR TESTS:									
Wireless Devices									
9	Hobbytron	FM25B	88.3	-49.5	0.9	2.13	106.99	58.39	830.8
12	Lenmar	AIMODAM	88.3	-47.7	0.9	2.13	106.99	60.19	1022.1
15	Sirius	S50	88.1	-58.6	0.9	2.12	106.99	49.29	291.4
Wired Devices									
20	Scosche	FM-MOD-01	87.9	-63.9	0.9	2.1	106.99	43.99	158.3
21	Starvision	FM-07	87.9	-72.3	0.9	2.1	106.99	35.59	60.2

Field Strength w/ K Factor uV/m	Field Strength dBuV/m	Peak Hold Freq. 1	Frequency 2	Measured Power	Cable Loss	Antenna K Factor	Convert Power to Voltage	Raw Field Voltage dBuV	Raw Field Voltage uV	Raw Field Voltage in VOLTS	Field Strength w/ K Factor in VOLTS/METER	FIELD STRENGTH w/ K FACTOR in uV/m
498.7	54.0	-46.44	93.5	-58.22	1	2.25	106.99	49.77	308.0	0.0003080	0.0006929	692.9
781.4	57.9	-43.54	88.7	-55	0.9	2.14	106.99	52.89	441.1	0.0004411	0.0009439	943.9
597.6	55.5	-44.7	88.5	-59.24	0.9	2.13	106.99	48.65	270.7	0.0002707	0.0005766	576.6
522.3	54.4	-46.3	98.5	-62.2	1	2.4	106.99	45.79	194.8	0.0001948	0.0004674	467.4
112.9	41.1	-61	98.5	-73.9	1	2.4	106.99	34.09	50.6	0.0000506	0.0001215	121.5
51.4	34.2	-66.55	88.3	-80.5	0.9	2.13	106.99	27.39	23.4	0.0000234	0.0000499	49.9
2936.8	69.4	-32.1	98.5	-52.2	1	2.4	106.99	55.79	615.9	0.0006159	0.0014781	1478.1
252.9	48.1	-54.9	98.5	-74.3	1	2.4	106.99	33.69	48.4	0.0000484	0.0001161	116.1
22023.2	**86.9**	**-12.2**	**98.5**	**-15.7**	**1**	**2.4**	**106.99**	**92.29**	**41162.3**	**0.0411623**	**0.0987896**	**98789.6**
3961.7	72.0	-27.96	98.5	-43.1	1	2.4	106.99	64.89	1755.9	0.0017559	0.0042142	4214.2
1896.2	65.6	-29.2	98.5	-49.1	1	2.4	106.99	58.89	880.0	0.0008800	0.0021121	2112.1
7126.6	77.1	-24.6	100.5	-36.1	1	2.5	106.99	71.89	3931.0	0.0039310	0.0098274	9827.4
255.8	48.2	-53.2	88.7	-66.4	0.9	2.14	106.99	41.49	118.7	0.0001187	0.0002540	254.0
740.2	57.4	-43.7	88.3	-57.4	0.9	2.13	106.99	50.49	334.6	0.0003346	0.0007127	712.7
4475.4	73.0	-28.1	98.5	-40.7	1	2.4	106.99	67.29	2314.7	0.0023147	0.0055553	5555.3
6278.8	76.0	NA	98.5	-43.6	1	2.4	106.99	64.39	1657.7	0.0016577	0.0039784	3978.4
6408.0	76.1	-26.8	88.3	-37.5	0.9	2.13	106.99	70.39	3307.5	0.0033075	0.0070450	7045.0
286.2	49.1	-57.1	88.1	-69	0.9	2.12	106.99	38.89	88.0	0.0000880	0.0001866	186.6
258.7	48.3	-56.4	88.9	-71.9	1	2.14	106.99	36.09	63.8	0.0000638	0.0001364	136.4
252.2	48.0	-54.7	88.3	-66.5	0.9	2.13	106.99	41.39	117.4	0.0001174	0.0002500	250.0
276.5	48.8	-54.6	88.3	-66.3	0.9	2.13	106.99	41.59	120.1	0.0001201	0.0002558	255.8
1769.6	65.0	-40.1	98.5	-39.4	1	2.4	106.99	68.59	2688.4	0.0026884	0.0064523	6452.3
2177.1	66.8	-33.6	100.5	-48.5	1	2.5	106.99	59.49	943.0	0.0009430	0.0023574	2357.4
617.8	55.8	-45.3	98.5	-60.3	1	2.4	106.99	47.69	242.4	0.0002424	0.0005817	581.7
332.4	50.4	-50.8	88.3	-64.7	0.9	2.13	106.99	43.19	144.4	0.0001444	0.0003075	307.5
126.4	42.0	-61.4	88.3	-72.4	0.9	2.13	106.99	35.49	59.5	0.0000595	0.0001267	126.7

Field Strength / K Factor uV/m	Field Strength w/ K Factor dBuV/m	Peak Hold Freq 2	Frequency 3	Measured Power	Cable Loss	Antenna K Factor	Convert Power to Voltage	Raw Field Voltage dBuV	Raw Field Voltage uV	Raw Field Voltage in VOLTS
692.9	56.8	-43.57	95.1	-58.9	1	2.3	106.99	49.14	286.4	0.0002864
943.9	59.5	-43.37	107.7	-49.3	1.1	2.65	106.99	58.79	870.0	0.0008700
576.6	55.2	-45.08	88.7	-60.3	0.9	2.14	106.99	47.545	238.4	0.0002384
467.4	53.4	-48.2	107.7	-66.1	1.1	2.65	106.99	41.99	125.7	0.0001257
121.5	41.7	-61.3	107.7	-67.2	1.1	2.65	106.99	40.89	110.8	0.0001108
49.9	34.0	-67.6	88.5	-81.7	0.9	2.13	106.99	26.19	20.4	0.0000204
1478.1	63.4	-38.95	107.7	-57.3	1.1	2.65	106.99	50.79	346.3	0.0003463
116.1	41.3	-62.2	107.7	-80.9	1.1	2.65	106.99	27.19	22.9	0.0000229
98789.6	**99.9**	**-3.1**	**107.7**	**-28.1**	**1.1**	**2.65**	**106.99**	**79.99**	**9988.5**	**0.0099885**
4214.2	72.5	-29.15	107.7	-37	1.1	2.65	106.99	71.09	3585.1	0.0035851
2112.1	66.5	-35.6	107.7	-43.2	1.1	2.65	106.99	64.89	1755.9	0.0017559
9827.4	79.8	-23.5	106.5	-34.2	1.1	2.6	106.99	73.89	4948.8	0.0049488
254.0	48.1	-52.9	89.1	-66.5	0.9	2.2	106.99	41.39	117.4	0.0001174
712.7	57.1	-45.4	88.5	-58.2	0.9	2.13	106.99	49.69	305.1	0.0003051
5555.3	74.9	-25.4	107.7	-40.3	1.1	2.65	106.99	67.79	2451.9	0.0024519
3978.4	72.0	NA	107.7	-40.3	1.1	2.65	106.99	67.79	2451.9	0.0024519
7045.0	77.0	-26.5	88.7	-37.3	0.9	2.14	106.99	70.59	3384.5	0.0033845
186.6	45.4	-60.5	88.5	-71.3	1	2.13	106.99	36.69	68.3	0.0000683
136.4	42.7	-60.78	NA							
250.0	48.0	-58.4	NA							
255.8	48.2	-55.2	88.7	-66.7	0.9	2.14	106.99	41.19	114.7	0.0001147
6452.3	76.2	-25.6	107.7	-39.4	1.1	2.65	106.99	68.69	2719.6	0.0027196
2357.4	67.4	-35.4	106.5	-55.8	1.1	2.6	106.99	52.29	411.6	0.0004116
581.7	55.3	-45.2	107.7	-57.6	1.1	2.65	106.99	50.49	334.6	0.0003346
307.5	49.8	-52.9	NA							
126.7	42.1	-61.7	88.7	-70.9	0.9	2.14	106.99	36.99	70.7	0.0000707

Field Strength w/ K Factor in VOLTS/METER	Field Strength w/ K Factor in uV/m	Peak Hold Freq 3	4th Freq.	Power	Peak
0.00065876	658.8	-45			
0.00230540	2305.4	-35.9			
0.00051011	510.1	-46.92			
0.00033323	333.2	-51.9			
0.00029359	293.6	-53.9			
0.00004344	43.4	-69.77	88.7	-80.2	-68.7
0.00091780	917.8	44.19			
0.00006064	60.6	-69.1			
0.02646951	**26469.5**	**-15.98**			
0.00950049	9500.5	-24.9			
0.00465314	4653.1	-30.2			
0.01286688	12866.9	-21.04			
0.00025818	258.2	-52.8			
0.00064995	649.9	-45.6	88.7	-58.7	-46.1
0.00649749	6497.5	-25.3			
0.00649749	6497.5	NA			
0.00724292	7242.9	-25.8			
0.00014551	145.5	-68.3			
0.00024542	245.4	-55.8	NA		
0.00720686	7206.9	-26.2			
0.00107022	1070.2	-43.2			
0.00088664	886.6	-42.4			
0.00015133	151.3	-60.1			

Device	Frequency 1	Field Strength w/ K Factor dBuV/m	Frequency 2	Field Strength w/ K Factor dBuV/m	Frequency 3	Field Strength w/ K Factor in dBuV/m
1	88.3	54.0	93.5	56.8	95.1	56.4
2	88.3	57.9	88.7	59.5	107.7	67.3
3	88.3	55.5	88.5	55.2	88.7	54.2
4	88.3	54.4	98.5	53.4	107.7	50.5
5	88.3	41.1	98.5	41.7	107.7	49.4
6	88.1	34.2	88.3	34.0	88.5	32.8
7	88.3	69.4	98.5	63.4	107.7	59.3
8	88.3	48.1	98.5	41.3	107.7	35.7
9	88.3	86.9	98.5	99.9	107.7	88.5
10	88.3	72.0	98.5	72.5	107.7	79.6
11	88.3	65.6	98.5	66.5	107.7	73.4
12	88.3	77.1	100.5	79.8	106.5	82.2
13	88.3	48.2	88.7	48.1	89.1	48.2
14	88.1	57.4	88.3	57.1	88.5	56.3
15	88.1	73.0	98.5	74.9	107.7	76.3
16	88.3	76.0	98.5	72.0	107.7	76.3
17	87.9	76.1	88.3	77.0	88.7	77.2
Avg. Field		61.6		61.9		62.5
WIRED						
18	87.9	49.1	88.1	45.4	88.5	43.3
19	88.5	48.3	88.9	42.7	NA	
20	87.9	48.0	88.3	48.0	NA	
21	87.9	48.8	88.3	48.2	88.7	47.8
CAR TESTS:						
9	88.3	65.0	98.5	76.2	107.7	77.2
12	88.3	66.8	100.5	67.4	106.5	60.6
15	88.1	55.8	98.5	55.3	107.7	59.0
20	87.9	50.4	88.3	49.8	NA	NA
21	87.9	42.0	88.3	42.1	88.7	43.6

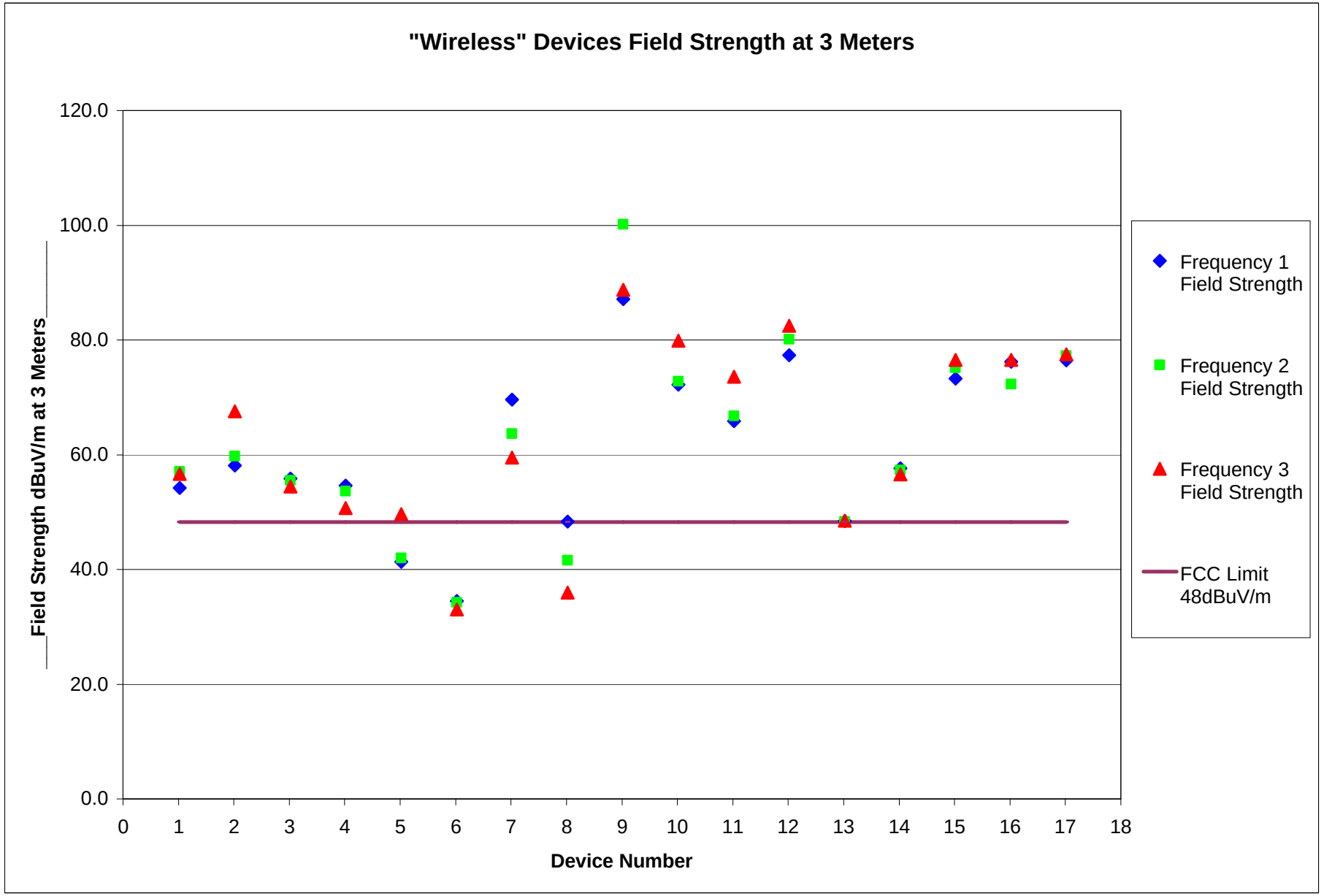
Car Attenuation Factor

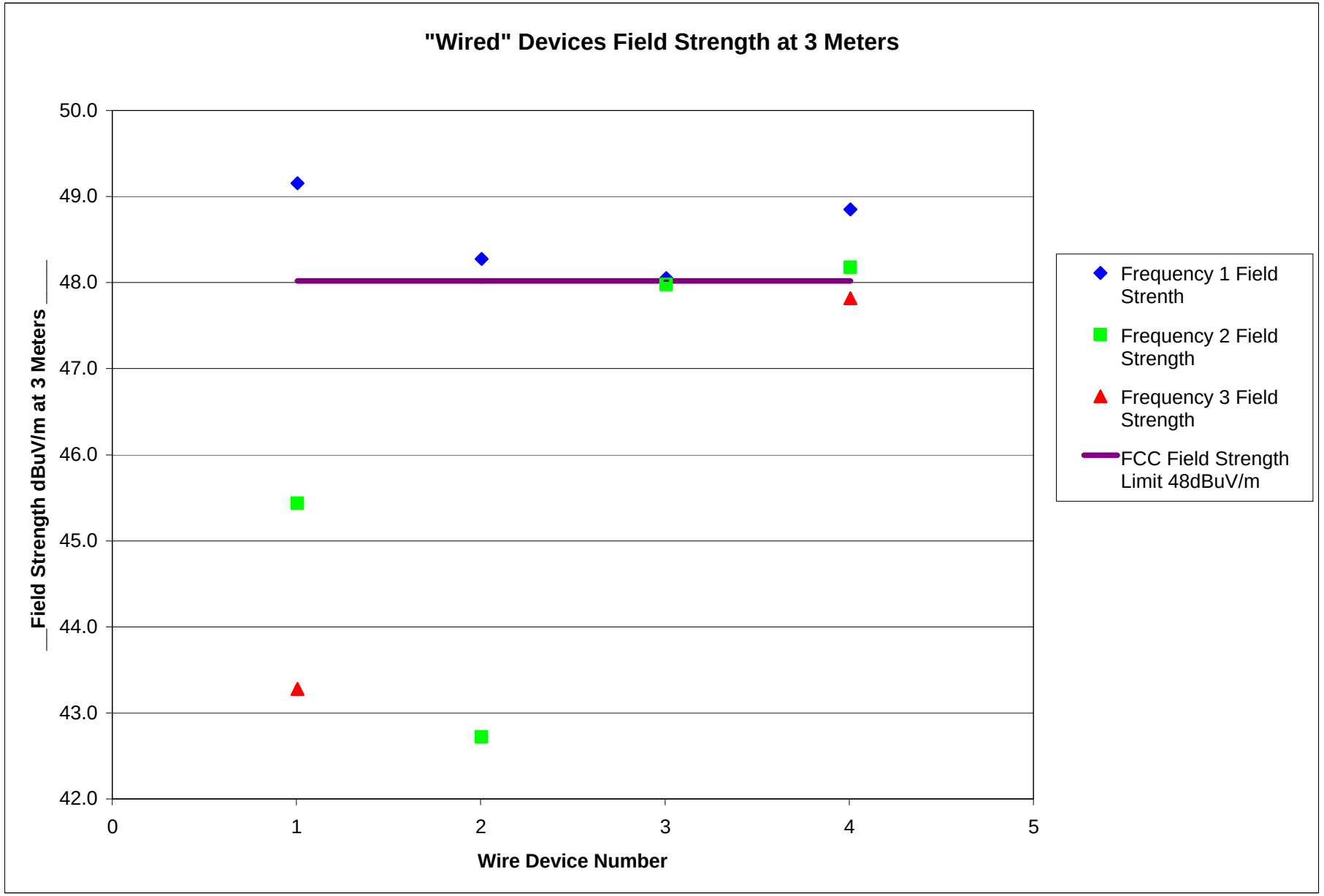
	Frequency 1			Frequency 2			Frequency 3		
Device	Air	Car	Atten	Air	Car	Atten	Air	Car	Atten
9	86.9	65.0	21.9	99.9	76.2	23.7	88.5	77.2	11.3
12	77.1	66.8	10.3	79.8	67.4	12.4	82.2	60.6	21.6
15	73.0	55.8	17.2	74.9	55.3	19.6	76.3	59.0	17.3
20	48.0	50.4	-2.4	48.0	49.8	-1.8			
21	48.8	42.0	6.8	48.2	42.1	6.1	47.8	43.6	4.2
Avg. Attenuation			**10.76**			**12.0**			**10.9**

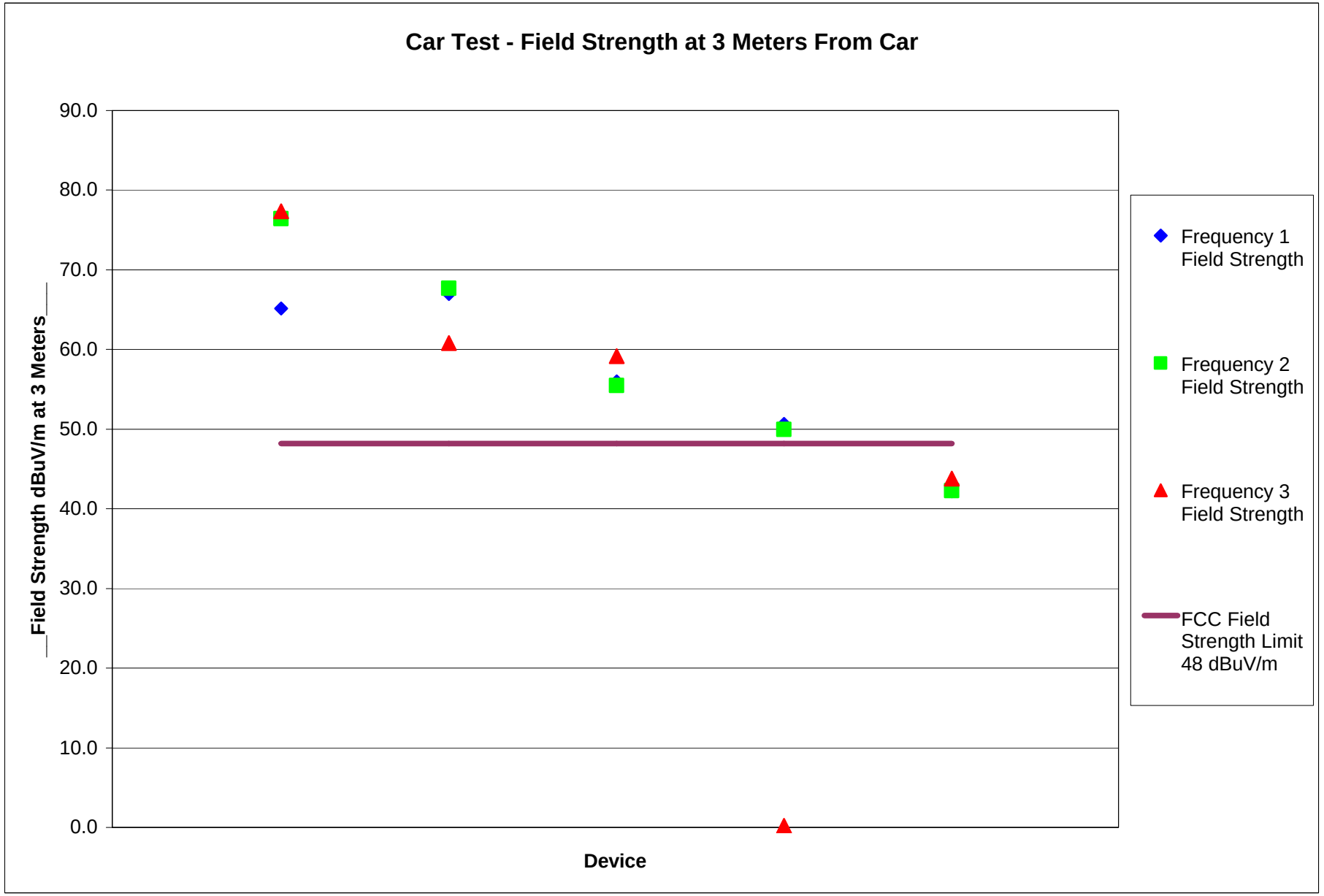
Avg. Atten (All Samples) **11.2**

Appendix C

Report Charts


"Wireless" Devices Field Strength at 3 Meters
Field Strength dBuV/m at 3 Meters
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Device Number
Frequency 1 Field Strength
Frequency 2 Field Strength
Frequency 3 Field Strength
FCC Limit 48dBuV/m


"Wired" Devices Field Strength at 3 Meters
Field Strength dBuV/m at 3 Meters
50.0
49.0
48.0
47.0
46.0
45.0
44.0
43.0
42.0
0
1
2
3
4
5
Wire Device Number
Frequency 1 Field Strenth
Frequency 2 Field Strength
Frequency 3 Field Strength
FCC Field Strength Limit 48dBuV/m


Car Test - Field Strength at 3 Meters From Car
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Field Strength dBuV/m at 3 Meters
Device
Frequency 1 Field Strength
Frequency 2 Field Strength
Frequency 3 Field Strength
FCC Field Strength Limit 48 dBuV/m

Appendix D

Spectrum Plots

See Separate Adobe Document Containing Spectrum Plots.