



L. S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, Wisconsin 53012

Phone: 414 - 375 - 4400 Fax: 414 - 375 - 4248

L. S. Compliance, Inc.

Compliance Testing of:

*Arial Basestation
AP100BS*

Prepared for:

*ArialPhone L.L.C.
Gerald L Hansberger*

Test Report Number: 301165 (rev 2)

Date(s) of Testing:

January 31, February 12, March 8, 19, 2001

*All results of this report relate only to the items that were tested.
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DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

ID Number: 31040/SIT

1300F2

Site on file with Industry Canada: ID number IC 3088

“The site referenced above has been found to comply with the test site criteria found in ANSI C63.4-1992 and 47CFR Section 2.948.”



THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical (EMC) Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.

Presented this 30th day of December, 1998.



Peter R. Rabe
President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2001

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical (EMC) Scope of Accreditation

SIGNATURE PAGE

Testing By:



March
21
2001

Thomas T. Lee

Date

Testing By:



March
21
2001

Kenneth L. Boston PE

Date

Prepared by:

Approved by



March
21
2001

Kenneth L. Boston, EMC Lab Manager

Date

PE #31926

Registered Professional Engineer

(State of Wisconsin)



2.3 SUMMARY OF TEST REPORT

MANUFACTURER: ArialPhone L.L.C.
MODEL: AP100BS
SERIAL: engineering sample
DESCRIPTION: Voice based wireless base
FREQUENCY RANGE: 902-928 MHz

The Arial AP100BS was found to meet the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C., and also Industry Canada RSS-210 section 6.2.2 (o) for an intentional radiator

The Arial AP100BS was also found to meet the radiated emission specification of Title 47 CFR, FCC Part 15, subpart B (I.C. RS-210) for emissions with regards to the receiver and digital sections of the product.

This product is a composite device, with the digital sections subject to verification. Therefore this technical report will primarily contain data that is pertinent to the certification of the transmitter section of the product.

2.4 INTRODUCTION

On January 31, February 12, March 8, 19, of 2001, a series of Radiated and Conducted Emissions tests were performed on a sample model of the AP100BS, a spread spectrum transceiver designed to be the base station in a hands free communication system. These tests were performed using the test procedures outlined in ANSI C63.4-1992 for intentional radiators, and in accordance with the requirements set forth in FCC Part 15.247 for a direct sequence spread spectrum transmitter. Tests were also performed as outlined in ANSI C63.4-1992 for non-intentional radiators, in order to verify compliance with the limits set forth in part 15.109 for and to allow verification of emissions for the digital section of the product. These tests were performed by Thomas T. Lee and Kenneth L. Boston PE, of L. S. Compliance, Inc.



2.5 PURPOSE

The above mentioned tests were performed in order to determine the compliance of the AP100BS product with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.109	15.209	15.247c
15.205	15.247a2	15.247d
15.207	15.247b	15.247e

(Industry Canada RSS-210, 6.2.2.(o))

Various of these tests, including the conducted RF out the antenna port and the jamming margin test are contained in an additional test report that is attached to this report. All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-1992). Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference (CISPR) number 16-1 (1993).

2.6 Conducted (AC LINE) Test Setup and measurements

The Conducted Emission tests were performed within an 8 by 10 foot shielded room located at L. S. Compliance, Inc. in Cedarburg, WI. The test item was placed on a non-conductive rubber cart, with a height of 80 cm above the reference ground plane. The test object was spaced 40 cm from the rear wall of the shielded room and further than 80 cm from adjacent walls, and the test object power supply was plugged into a 50 Ω (ohm) 50/250 μ H Line Impedance Stabilization Network (LISN). The test area and set-up are in accordance with ANSI C63.4-1992, sections 5, 6, and 7. The AC power supply to the LISN was fed into the shielded room via an appropriate broadband EMI filter. The test sample was set to operate on the middle channel in continuous transmit during the measurements, and operation was also checked on the low and high channels.

After the equipment under test was set-up in the shielded room and connected to the LISN, the RF sampling port of the LISN was cabled to a 10dB attenuator-limiter, and then to the EMI analyzer. The EMC LISN used has the facility to terminate the unused port with a 50 Ω (ohm) load when switched to either L1 (line) or L2 (neutral). The appropriate frequency range and bandwidths were entered into the HP 8564A EMC receiver, and measurements were made. The test object cables and position were varied to find the maximum signal levels. Final readings were then taken and recorded. The test procedure guidelines used are found in ANSI C63.4-1992: Sections 7 and 11 including Annex E1 and E2.

The limits for conducted emissions for this test object are found in Title 47CFR, FCC Part 15.207 (b) for an intentional radiator. The levels of these limits are 250 μ V (48dB μ V) from 450 kHz to 30 MHz. Test results are located in Appendix II and pictures of the test setup are in section 1.11.



2.7 RADIATED EMISSIONS TEST SETUP

The test sample was operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. The sample was positioned on a small wood pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on an AC power pack supply. The test sample was configured to run in a continuous transmit mode during the 15.247 and 15.205 measurements. One test sample was set to operate on either channel 01 (low), channel 09(medium) or channel 13 (high) while being tested as an intentional radiator, in order to determine compliance within a frequency range of 902-928 MHz, as dictated by FCC part 15.31m

Please refer to Section 2.15 for pictures of the test setup.

2.8 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 15.247c limits for Direct Sequence Spread Spectrum systems, and the 15.205 general limits, within the restricted bands. For the calculations used to determine the 1 meter limits, see Appendix A. The test sample was tested from the lowest frequency generated by the transmitter to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed where any spurious signals were located within any of the restricted bands as described in Part 15.205a. These frequencies, and their associated limits, are referenced in Section 2.10. The sample was placed on the pedestal and placed in the 3 Meter chamber; then the antenna mast was placed such that the antenna was either 1 meter or 3 meters from the test object. A biconical antenna was used to measure emissions from 30 to 200 MHz, a log periodic was used to measure emissions from 200 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1 GHz. The test object was programmed to operate in continuous transmit, and the resultant signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters. The test object was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities. Emissions above 5 GHz were also measured at a 1 meter separation, using the HP Microwave spectrum analyzer.

Significant emissions that were found included the transmitter fundamental, lower order harmonics, and some spurious signals. The unit was scanned for emissions in both transmit and receive modes, over the range 30 to 10000 MHz to establish compliance with Part 15.247c and 15.205 for the system. Also, the scans were performed to evaluate the microprocessor clock emissions of the product, which is subject to verification as a Class B digital device. The same procedures as detailed for the transmitter tests described above were used to perform these measurements. The results of the system measurements are found in Appendix B, with graphs of the signature scans found in Appendix C.



2.9 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 2.13, which includes the calibration information as well as the equipment description. All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database. The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic changes in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. The HP 8546A EMI receiver was operated with a bandwidth of 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16. Both the peak and Quasi-peak detector functions were used. Peak values were obtained while the Transceiver was operated in the TDD mode, where it was caused to switch repeatedly between transmit and receive. IF and average bandwidth were both set to 1 MHz for this measurement.

For measurements in the microwave region, the HP E4407B 26.5 GHz spectrum analyzer was used. Antenna factors for the horn antenna, a short jumper cable and a high pass filter were entered into the analyzer as correction factors. This allowed for direct readings to be made of the field strength. During emissions testing, signals where significant levels were noted were measured using the 1 MHz IF bandwidth, and a 10 or 100 Hz video bandwidth, resulting in an average measurement mode of the analyzer.



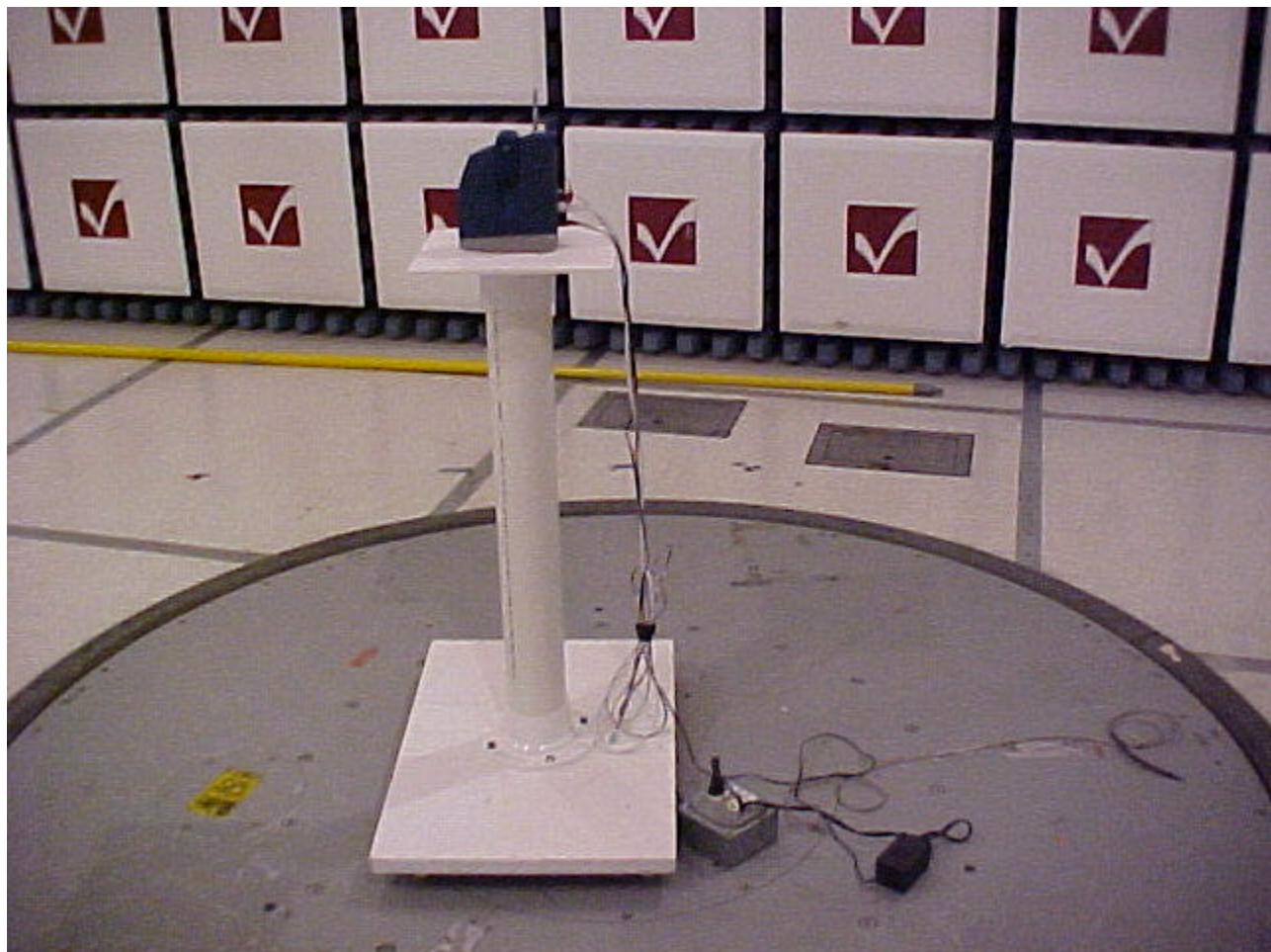
2.10- Restricted Bands affecting this product

3 Meter limits

Frequency (MHz)	Limit (μ V)	Limit (dB/ μ V/m)
608-614	200	46.0
960-1240	500	54.0
1300-1427	500	54.0
1435-1626.5	500	54.0
1645.5-1646.5	500	54.0
1660-1710	500	54.0
1718.8-1722.2	500	54.0
2200-2300	500	54.0
2310-2390	500	54.0
2483.5-2500	500	54.0
2655-2900	500	54.0
3260-3267	500	54.0
3332-3339	500	54.0
3345.8-3358	500	54.0
3600-4400	500	54.0
4500-5150	500	54.0
5350-5460	500	54.0
7250-7750	500	54.0
8025-8500	500	54.0
9000-9200	500	54.0
9300-9500	500	54.0

Plus others in the frequency range below 960 MHz,

2.11 – Photos taken during testing



View of the AP100BS, on the pedestal, during the Radiated Emissions tests.



View of the AP100BS, on the table, during the Conducted Emissions tests.



2.12 SUMMARY OF RESULTS AND CONCLUSIONS

Based on the procedures outlined in this report, and the test results included in appendices B and C, it can be determined that the AP100BS does meet the emission requirements of Title 47 CFR, FCC Part 15 Subpart C, and Industry Canada RSS-210, sect 6.2.2 (o), for an intentional radiator. Third harmonic levels of two of three channels measured were found to be within 3 dB of the limits respectively, and could be found to be over the limits if these samples, or others were to be tested by another agency.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.



2.13 - Test Equipment

Asset #	Manufacturer	Model #	Serial #	Description	Due Date
AA960003	EMCO	3121C	786	Dipole Set Antenna	7/8/02
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	8/21/01
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	9/28/01
AA960007	EMCO	3115	99111-4198	Double Ridged Guide/Horn Antenna	9/18/01
EE960004	EMCO	2090	9607-1164	Mast/Ttable Controller	I.O
EE960008	EMCO	3816	9301/1057	16 A Line Impedance Stabilization Network	8/21/01
EE960013	HP	8546A	3617A00320	Receiver RF Section W/Display and RF filter section	11/1/01
EE960014	HP	85460A	3448A00296	Receiver RF Section Preselector	11/1/01
CC000221	HP	E4407b	39060256	26.5 GHz Spectrum Analyzer	11/8/01



APPENDIX A:

SAMPLE CALCULATIONS



Calculation of Radiated Emissions limits for FCC Part 15.209 (above 1 GHz)

The following table depicts the Class B limits for an unintentional radiator: Limits are established at a measurement distance of 3 meters and limits corrected for a 1 meter measurement distance which are extrapolated from the 3 meter limit.

Frequency (MHz)	3m limit (dB μ V/m)	1m limit (dB μ V/m)
960 MHz up	54	63.54

➤ The 1 meter limits were calculated by adding a factor of 9.54 dB, derived from:

$$\begin{aligned} 20\log_{10}(3/1) &= 9.54 \text{ dB uV/m} \\ 1\text{m limit} &= 3\text{m limit} + \text{factor} \\ &= 54 \text{ dB } \mu\text{V/m} + 9.54 \text{ dB } \mu\text{V/m} = 63.54 \text{ dB uV/m} \\ \text{rounded off} &= 63.5 \text{ dB } \mu\text{V/m} \end{aligned}$$

Calculation of Radiated Emission Limits for 15.247(c)

Limits for signals in the restricted bands are those given in 15.209; for all other signals, the limits are calculated to be 20 dB below the fundamental signal levels, at 1 or 3 meters distance.



APPENDIX B:

DATA CHARTS



Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber
 Frequency Range inspected: 30 to 1000 MHz

Date of Test:	January 31, February 12, 2001	Manufacturer:	ArialPhone
Location:	L. S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	AP100BS
Specifications:	FCC Part 15.109,209, 247 (RSS-210)	Serial No.:	Engineering sample
Distance:	3 meters	Configuration:	TX; Channels 01,09,13(hex)
Equipment:	HP 8546A EMI Receiver EMCO 3146A Log Periodic EMCO 3110B Biconical	Detector(s) Used:	Quasi-peak

NO EMISSIONS BELOW 1GHZ, OTHER THAN THE DESIRED SIGNAL WITHIN THE 902-928 MHZ BAND WERE SEEN TO BE WITHIN 20 DB OF THE -20BDC LEVELS OF THE FUNDAMENTALS. ALTHOUGH SPURIOUS SIGNALS WERE PRESENT, NONE OF THE SIGNIFICANT SIGNALS WERE SEEN TO BE WITHIN THE 15.205 RESTRICTED BANDS. THE FOLLOWING TABLE LISTS THE STRONGEST EMISSIONS SEEN: (emissions seen to be similar for all three channels tested)

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB µV/m)	15.247 Limit (dB µV/m)	Margin (dB)
48.02	V	1.0	195	28.4	93.5	>20
72.01	V	1.0	230	36.1	93.5	>20
96.02	V	1.0	105	34.1	93.5	>20
566.4	H	1.4	275	39.0	93.5	>20
585.6	H	1.4	275	38.8	93.5	>20
604.8	H	1.5	70	37.9	93.5	>20
624.0	H	1.5	70	40.1	93.5	>20

The following table depicts the maximum Radiated Emission level of the Center Channel for each of the three channels tested, used to derive the limits used for the 15.247c harmonics.

Channel	Frequency (MHz)	Antenna Polarity	Position	EMI Meter Reading (dB µV/m)	-20dBc	3 to 1 meter correction (+9.5dB)
01	904.2	H	On base	114.5	94.5	104.0
09	913.2	H	On base	114.1	94.1	103.6
13	925.7	H	On base	113.5	93.5	103.0



Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 1 to 10 GHz

Date of Test:	February 12, March 19, 2001	Manufacturer:	ArialPhone
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	AP100BS
Specifications:	FCC Part 15.247(c), 15.205 (RSS-210)	Serial No.:	Engineering sample
Distance:	1 meter, 3 meter	Configuration:	TX; Channels 1,9,13 (hex)
Equipment:	HP 8546A EMI rx, HP E4407 S. A. EMCO 3115 Double Ridged Waveguide	Detector(s) Used:	Average Peak (when TX in TDD)

The following table depicts the level of significant harmonic emissions found:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Channel (hex)	EMI Meter Reading (dB μV/m)	Limit (dB μV/m)	Margin (dB)
1810	V	1.0	260	1	58.0	93.5	35.5
2714*	V	1.1	310	1	50.1	54.0	3.9
4524*	H	1.1	310	1	50.0	54.0	4.0
5429*	H	1.0	310	1	54.5	63.5	9.0
1833	V	1.0	270	9	59.7	93.5	33.8
2744*	V	1.0	270	9	51.5	54.0	2.5
3658*	H	1.1	300	9	46.0	54.0	8.0
5487	H	1.05	300	9	53.6	63.5	9.9
1852	V	1.0	27	13	61.5	93.5	32.0
2777*	H	1.1	300	13	51.4	54.0	2.6
4629*	H	1.1	300	13	49.5	54.0	4.5
5555	H	1.05	300	13	52.8	63.5	10.7

(*): indicates harmonics that fall within the restricted bands indicated in 15.205; All others measured to 15.247(c)

The table below indicates peak readings taken with the device set to transmit in TDD mode, which creates the worst case peak emissions; and readings compared to the regulatory limits, plus a 20 dB cap applied for transient behavior.

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Channel (hex)	EMI Meter Reading (dB μV/m)	Limit (dB μV/m)	Margin (dB)
2714*	V	1.1	350	1	69.5	74.0	4.5
2744*	H	1.2	285	9	64.8	74.0	9.2
3658*	H	1.1	270	9	54.3	74.0	19.7
2777*	H	1.0	300	13	66.2	74.0	7.8

L. S. COMPLIANCE, Inc.



FCC ID : PHIAP100BS

Measurement of Electromagnetic Conducted Emission within FCC Listed Shielded Room

Frequency Range inspected: 1 to 10 GHz

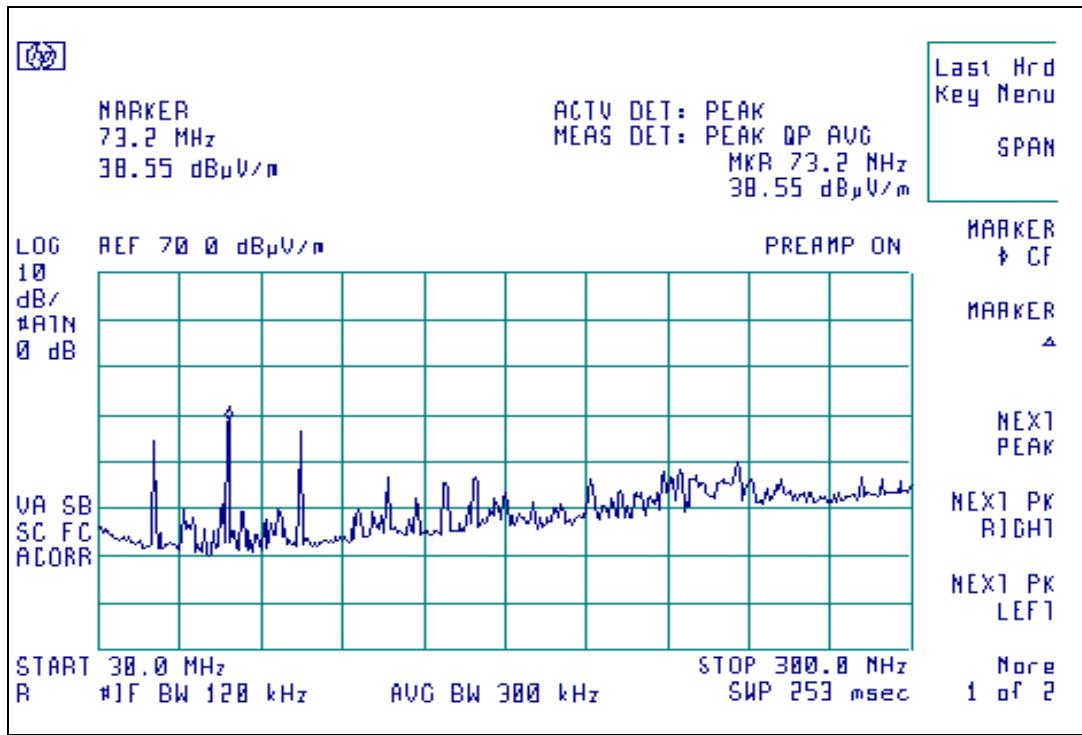
Date of Test:	March 8, 2001	Manufacturer:	ArialPhone
Location:	L.S. Compliance, Inc.	Model No.:	AP100BS
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	FCC Part 15.247(c), 15.205, (RSS-210)	Serial No.:	prototype
Distance:	1 meter, 3 meter	Configuration:	TX; Channels 1,9,13 (hex)
Equipment:	HP 8546a EMI receiver	Detector(s) Used:	Quasi-peak
	EMCO 3816/2NM 16 A LISN		

No emissions seen were closer than 20 dB to the limit. (Quasi-peak)

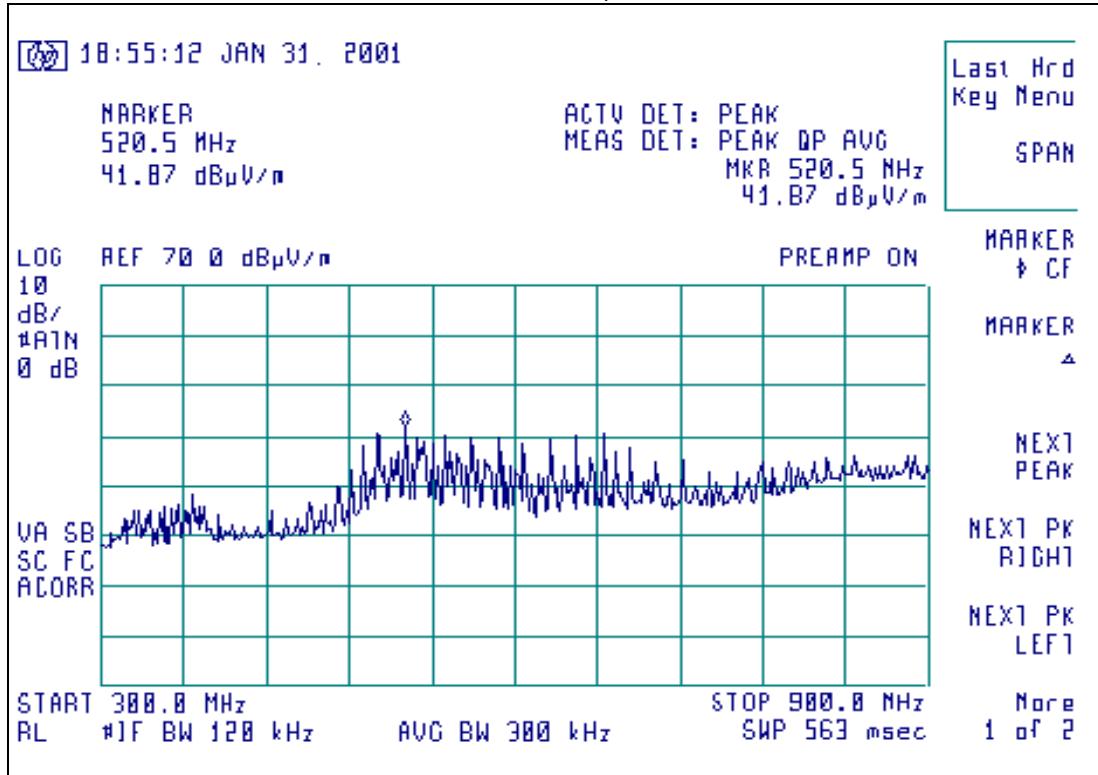
APPENDIX C:

GRAPHS

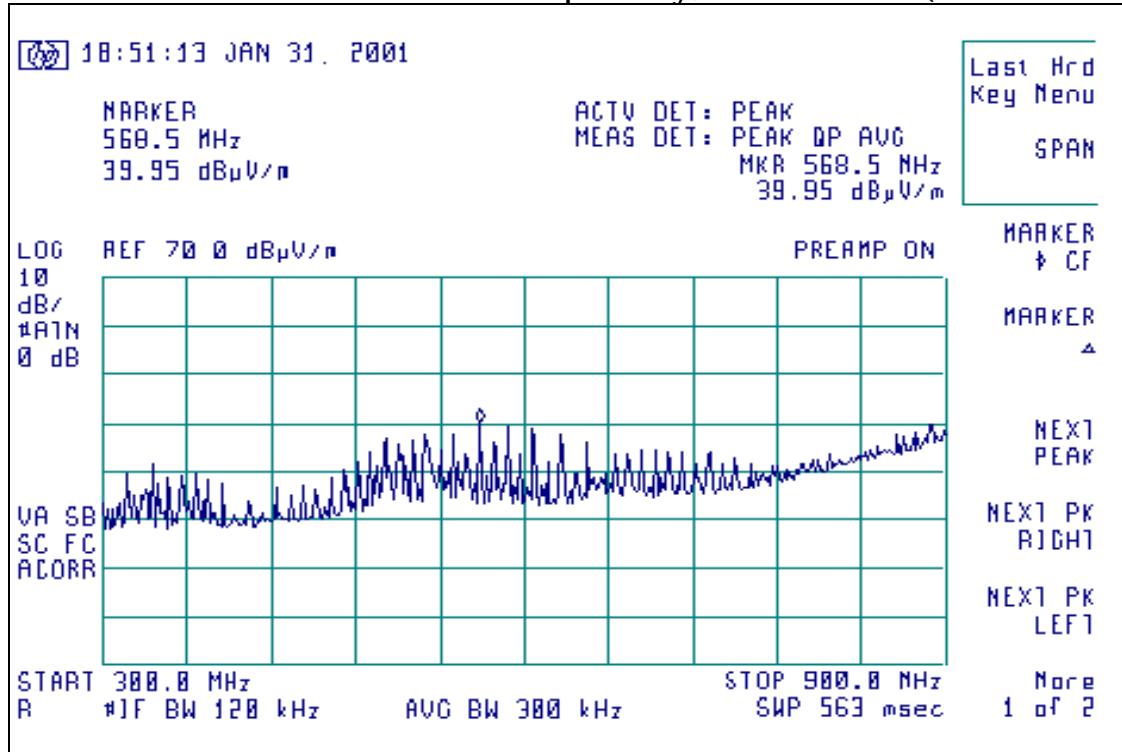
Radiated Emissions 30-300 MHz, vertical polarity, channel 01 (other channels similar)



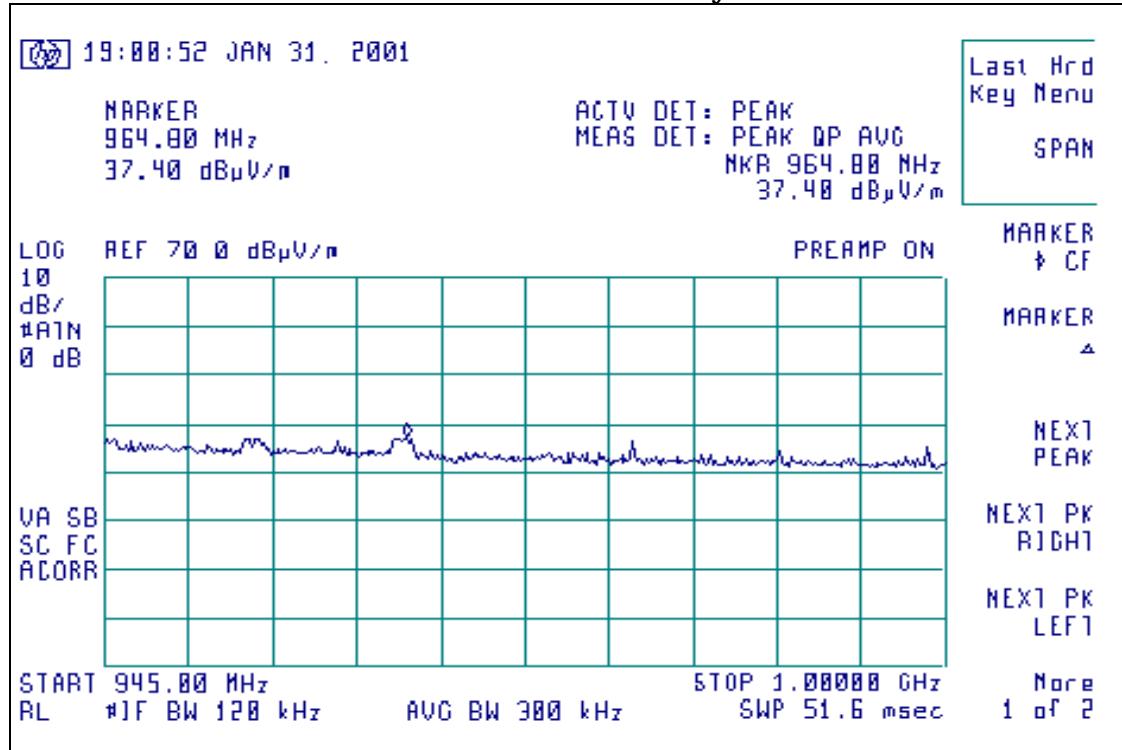
Radiated Emissions 300-902 MHz, horizontal polarity, channel 13 (other channels similar)



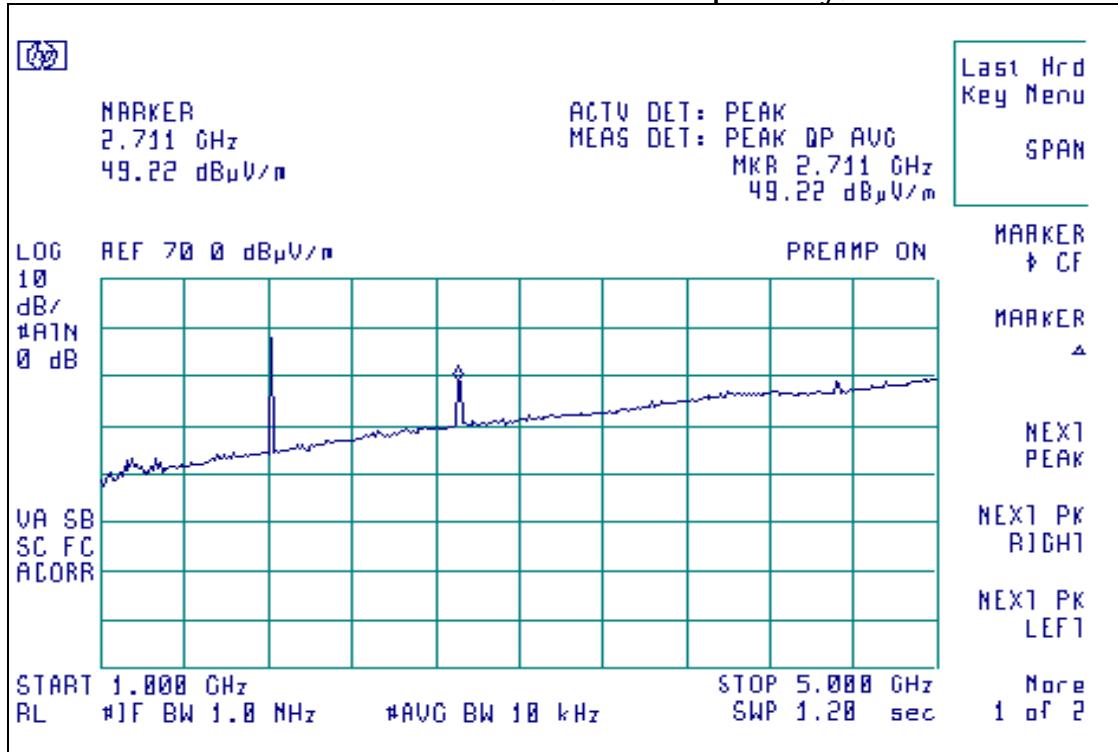
Radiated Emissions 30-902 MHz, vertical polarity, channel 13 (other channels similar)



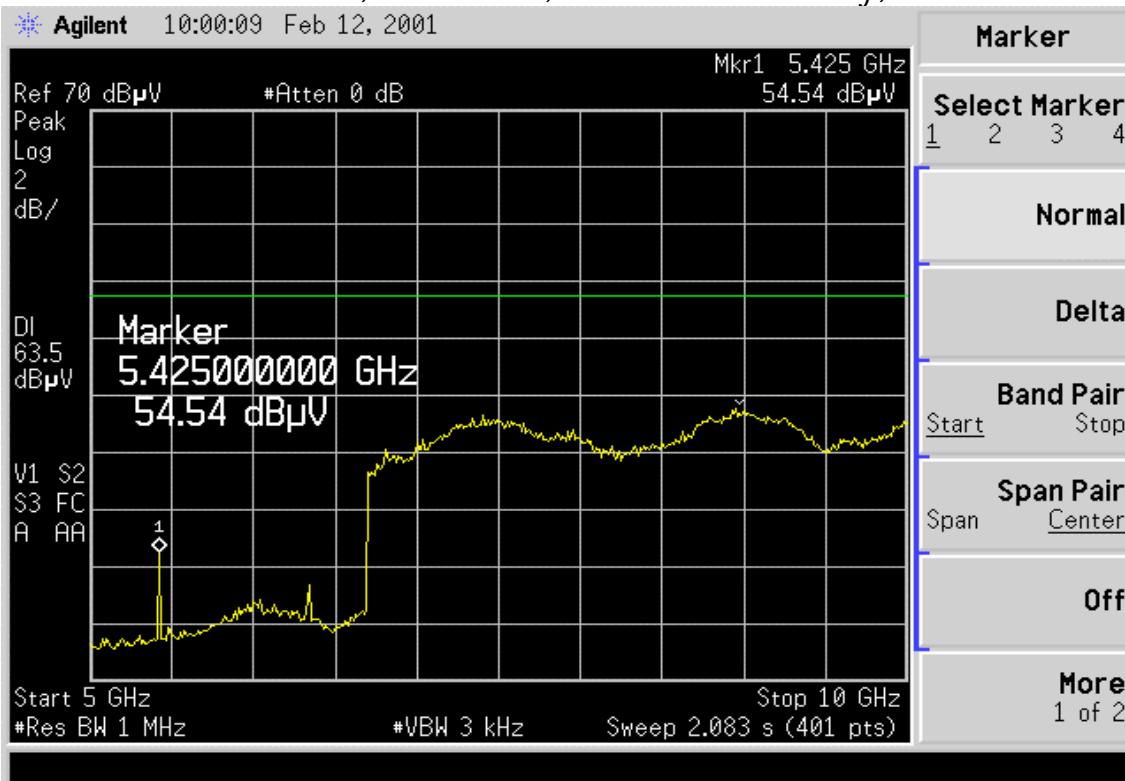
Radiated emissions, 945-1000 MHz, Vertical Polarity, channel 13 (other channels similar)



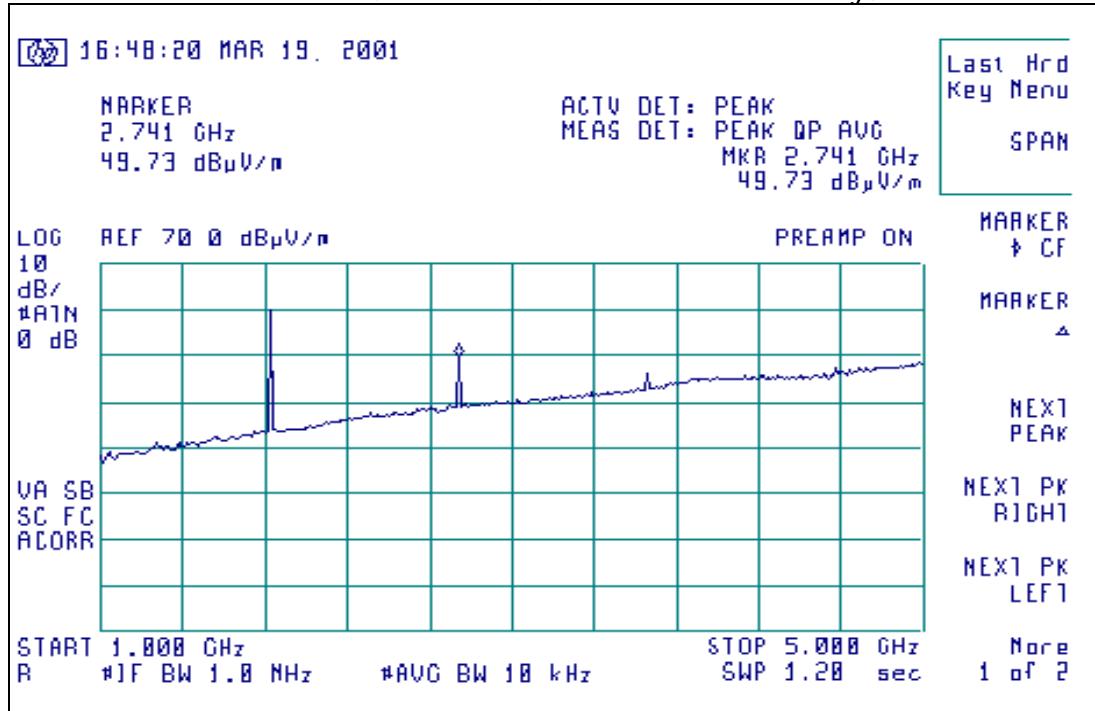
Radiated Emissions 1-5 GHz, Vertical polarity, channel 01



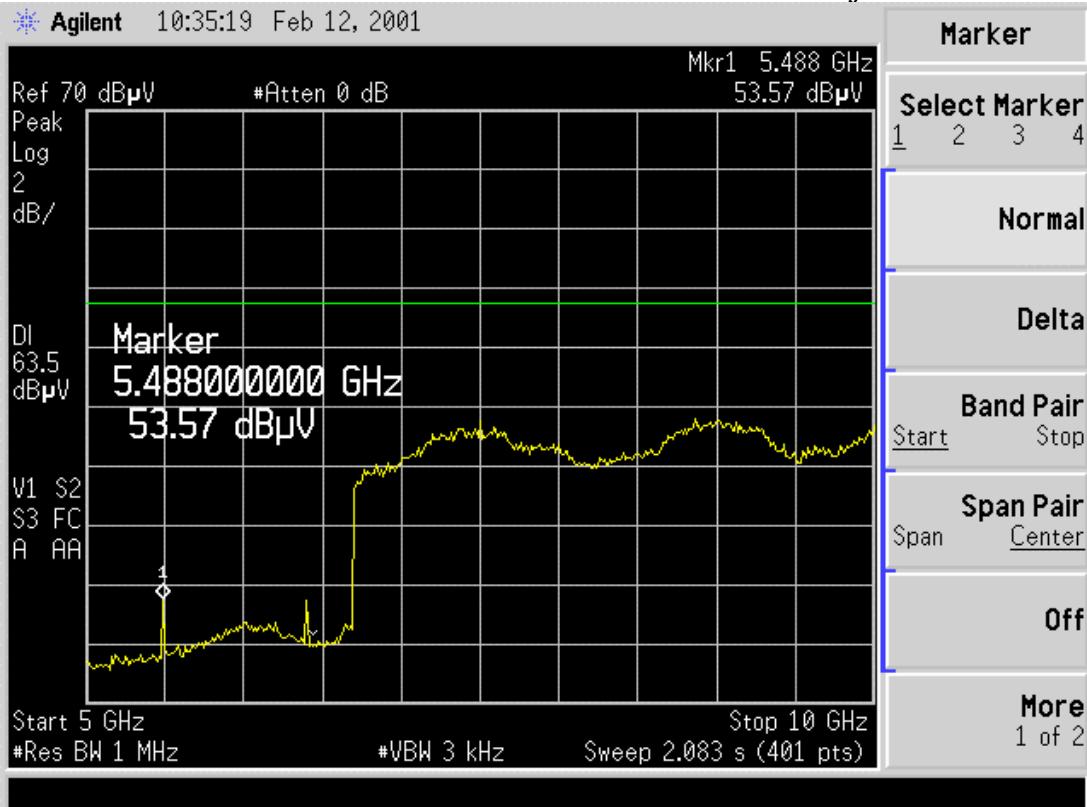
Radiated Emissions, 5-10 GHz, Horizontal Polarity, channel 01



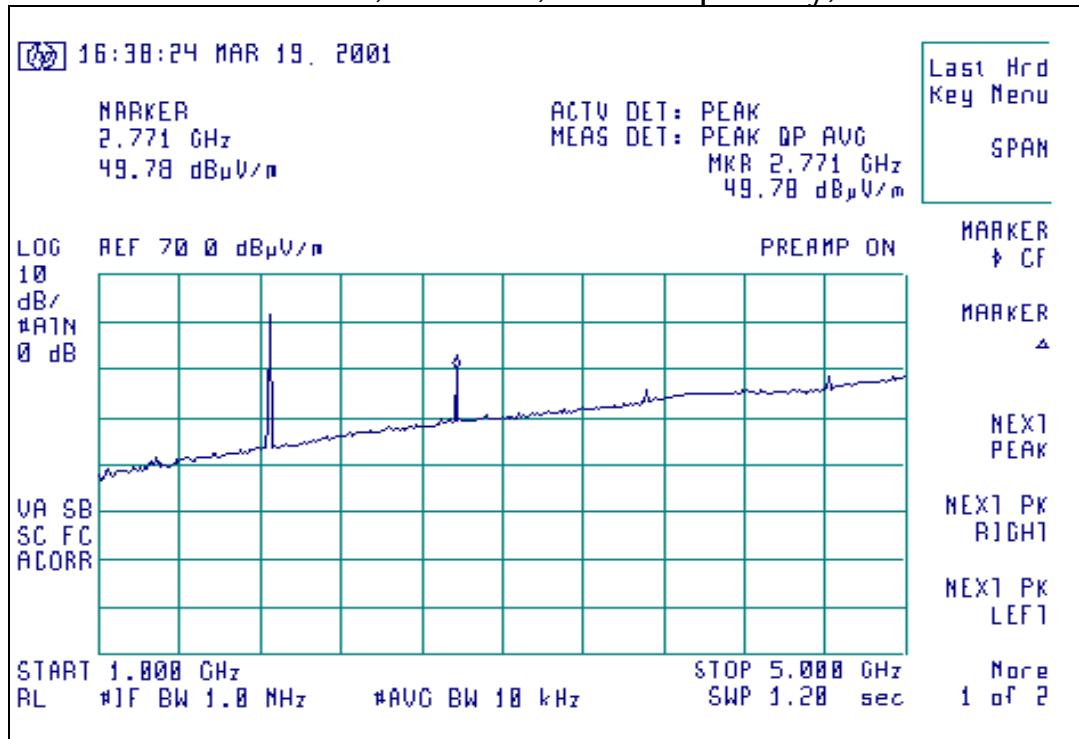
Radiated Emissions, 1-5 GHz, Horizontal Polarity, channel 9



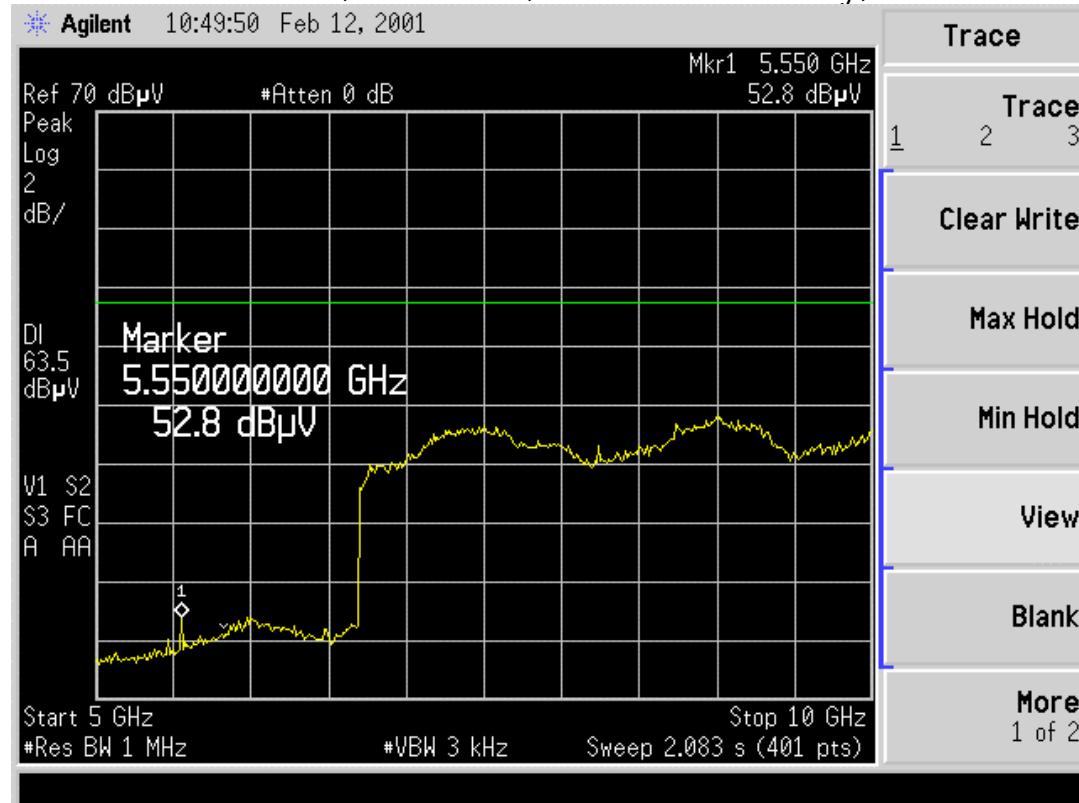
Radiated Emissions, 5-10 GHz, Horizontal Polarity, channel 9



Radiated Emissions, 1-5 GHz, Vertical polarity, channel 13



Radiated Emissions, 5-10 GHz, Horizontal Polarity, channel 13



AC line Conducted Emissions, L and N, any channel.

