



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

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# L. S. Compliance, Inc.

*Compliance Testing of:*

*Arial Aphone-100*

*Prepared for:*

*ArialPhone L.L.C.*

*Gerald L Hansberger*

*Test Report Number:*

*Date(s) of Testing:*

*January 23-24, 2001*

***All results of this report relate only to the items that were tested.***

**FCC ID:**

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## DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

ID Number: 31040/SIT

1300F2

*“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 30<sup>th</sup> day of December, 1998.



*Peter Abrey*  
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:



12 feb  
2001

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Thomas T. Lee

Date

Testing By:



12 feb  
2001

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Kenneth L. Boston PE

Date

Prepared by:

Approved by



12 feb  
2001

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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: APhone-100

SERIAL: engineering sample

DESCRIPTION: Voice based wireless earset

FREQUENCY RANGE: 902-928 MHz

The Arial APhone-100 was found to **meet** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

The Arial APhone-100 was also found to **meet** the radiated emission specification of Title 47 CFR, FCC Part 15, subpart B 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 primary contain data that is pertinent to the certification of the transmitter section of the product.

## 2.4 INTRODUCTION

On January 23 and 24, of 2001, a series of Radiated Emissions tests were performed on a sample model of the Aphone-100, a spread spectrum transceiver designed for hands free communication with a base station. 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 Aphone-100 product with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

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

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

Due to the fact that the product operates on internal battery power, no conducted emissions tests were performed at 0.45 to 30 MHz on AC lines.



## 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 its internal battery 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 1 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.

L. S. COMPLIANCE, Inc. 

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**FCC ID : PHIAP100**



## 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.

For measurements in the microwave region, an 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.

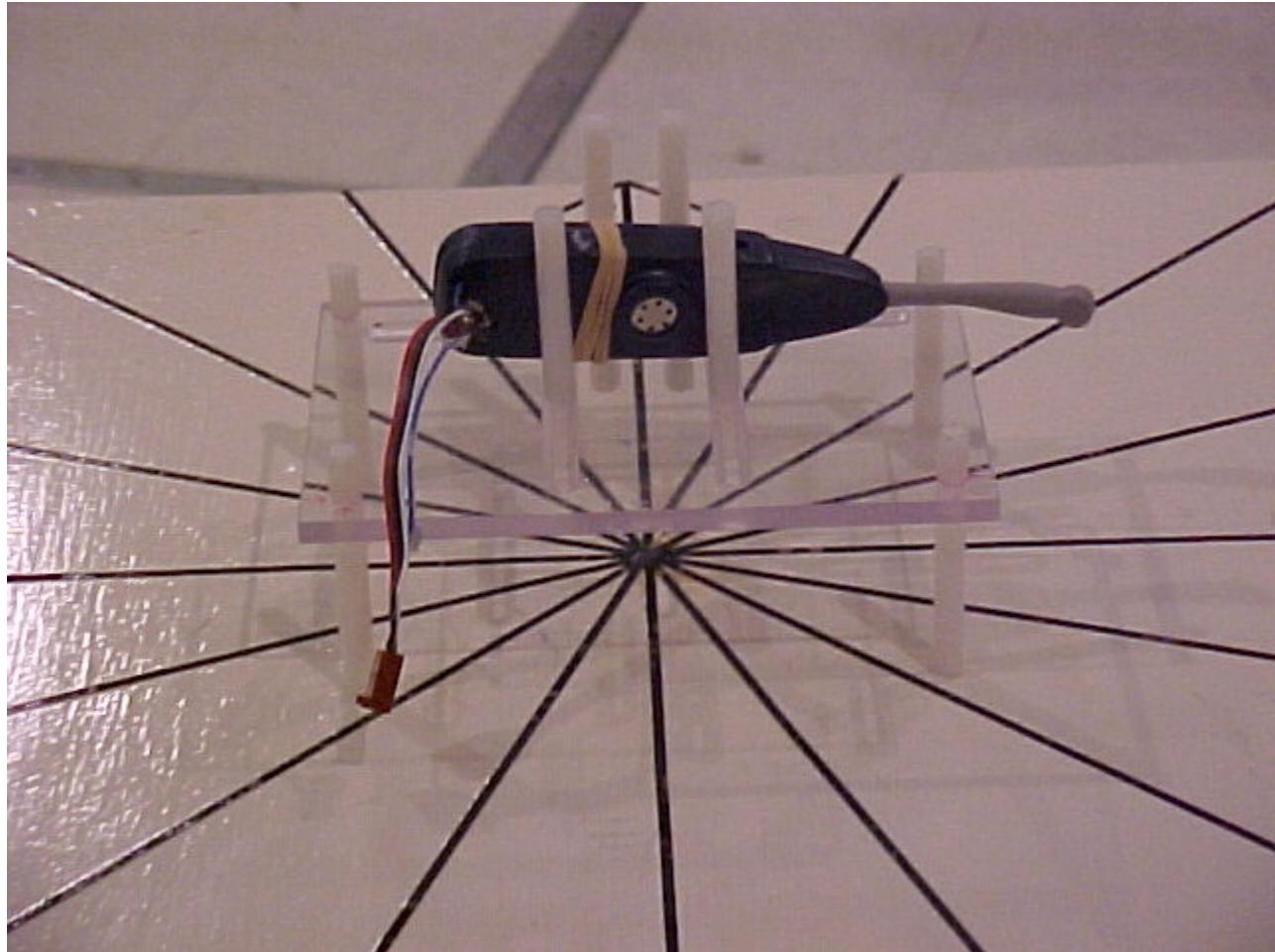
## 2.10- Restricted Bands affecting this product

3 Meter limits

Frequency (MHz)	Limit ( $\mu$ V)	Limit (dB/ $\mu$ 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 Aphone-100, on the pedestal, during the Radiated 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 Aphone-100 does “**meet**” the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. Third harmonic levels of all 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
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
EE9900xx	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 $\mu$ V/m)	1m limit (dB $\mu$ V/m)
960 MHz up	54	63.54

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

$$20\log_{10}(3/1) = 9.54 \text{ dB } \mu\text{V/m}$$

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

## 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:	December 23,24, 2000	Manufacturer:	ArialPhone
Location:	L. S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	Aphone-100
Specification s:	47CFR FCC Part 15.10	Serial No.:	prototype
Distance:	3 meters	Configuration:	TX; Channels 01,09,13(hex)
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Quasi-peak
	EMCO 3146A Log Periodic		
	EMCO 3110B Biconical		

The following table depicts the level of significant spurious emissions found in restricted bands

Frequenc y (MHz)	Antenna Polarity	Height (meters )	Azimuth (0° - 360°)	EMI Meter Reading (dB μV/m)	15.205 Limit (dB μV/m)	Margin (dB)
991.2	H	2.3	230	36.3	54.0	17.7
964.2	H	1.5	175	46.8	54.0	7.2
973.8	H	1.5	175	47.8	54.0	6.2
962.4	H	1.5	190	52.3	54.0	1.7
972.0	H	1.4	0	48.1	54.0	5.9

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	Frequenc y (MHz)	Antenna Polarity	Position	EMI Meter Reading (dB μV/m)	-20dBc	3 to 1 meter correction (+9.5dB)

01	904.2	H	Side	103.3	83.3	92.8
09	913.2?	H	Side	104.6	84.6	94.1
13	925.7	H	Side	104.4	84.4	93.9



Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed  
Chamber

Frequency Range inspected: 1 to 10 GHz

Date of Test:	December 23,24, 2000	Manufacturer:	ArialPhone
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	Aphone-100
Specification s:	47CFR, FCC Part 15.247(c), 15.205	Serial No.:	prototype
Distance:	1 meter	Configuration:	TX; Channels 1,9,13 (hex)
Equipment:	EMCO 3115 Double Ridged Waveguide	Detector(s) Used:	Average

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

Frequency (MHz)	Antenna Polarity	Height (meters )	Azimuth (0° - 360°)	Channel (hex)	EMI Meter Reading (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
1810	V	1.0	90	01	68.3	92.8	24.5
2463	V	1.0	90	01	57.1	92.8	35.7
2715	V	1.0	90	01	62.1**	63.5	1.4
3610	H	1.0	0	01	56.4**	63.5	7.1
4533	H	1.0	0	01	56.5**	63.5	7.0
5433	H	1.0	270	01	54.7**	63.5	8.8
6333	V	1.0	270	01	54.0	92.8	38.8
1833	V	1.0	0	09	69.9	94.1	24.2
2755	V	1.0	0	09	63.3**	63.5	0.2
3655	H	1.0	300	09	55.6**	63.5	7.9
4578	H	1.0	300	09	59.7**	63.5	3.8
5480	H	1.0	300	09	57.8	94.1	36.3
6400	V	1.0	180	09	55.0	94.1	39.1
1855	V	1.0	270	13	70.8	93.9	23.1
2778	H	1.0	180	13	63.3**	63.5	0.2
3700	H	1.0	180	13	57.7**	63.5	5.8
4623	H	1.0	120	13	59.6**	63.5	3.9
5547	H	1.0	90	13	59.4	93.9	34.5

6490	V	1.0	0	13	56.4	93.9	37.5
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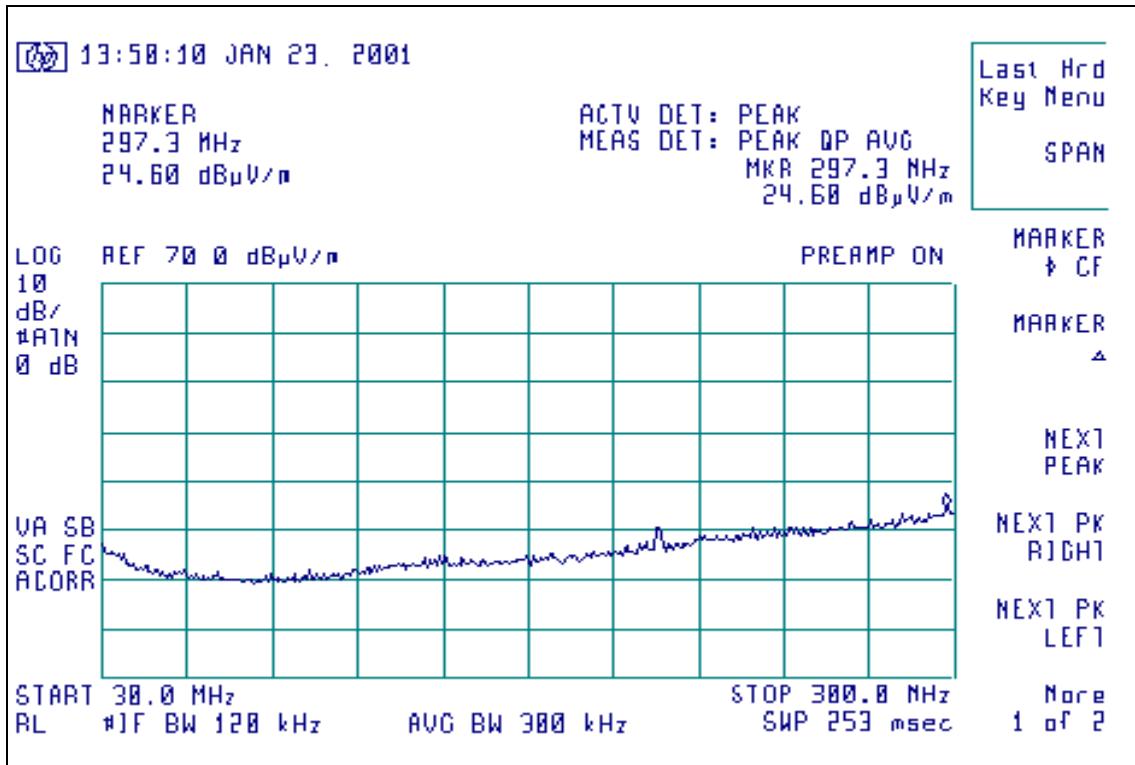
\*\* indicates harmonics that fall within the restricted bands indicated in 15.205

All others measured to 15.247(c)

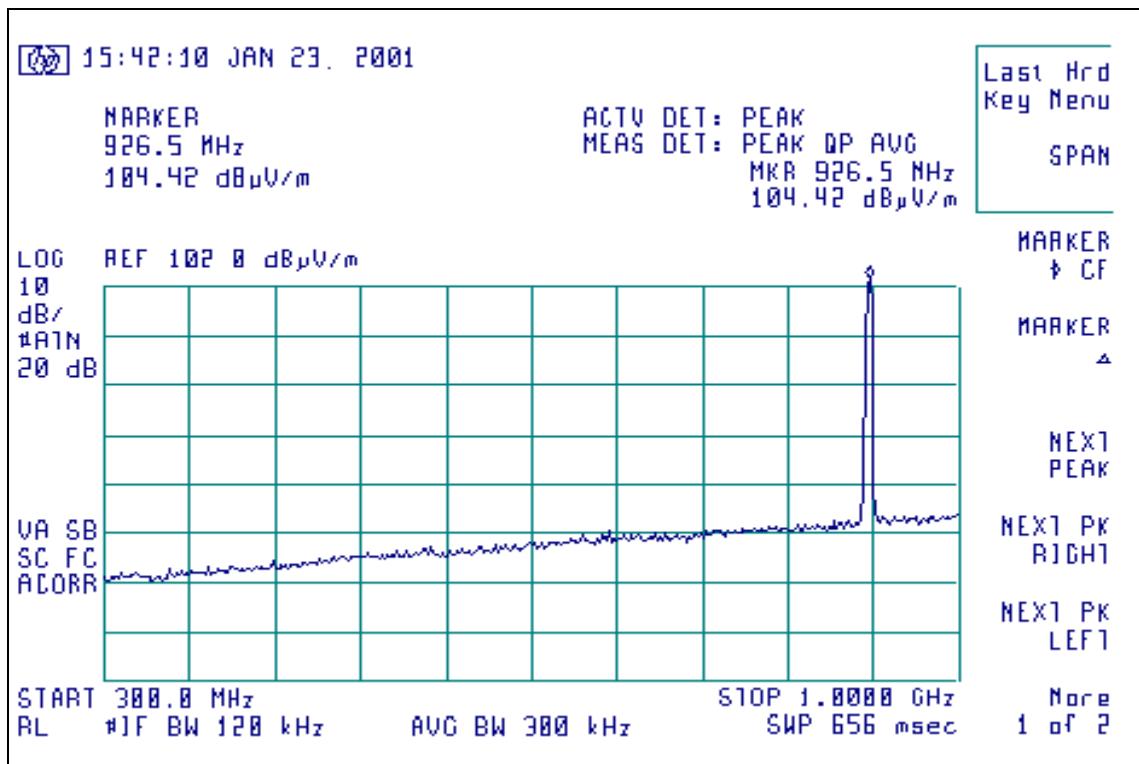
## APPENDIX C:

### GRAPHS

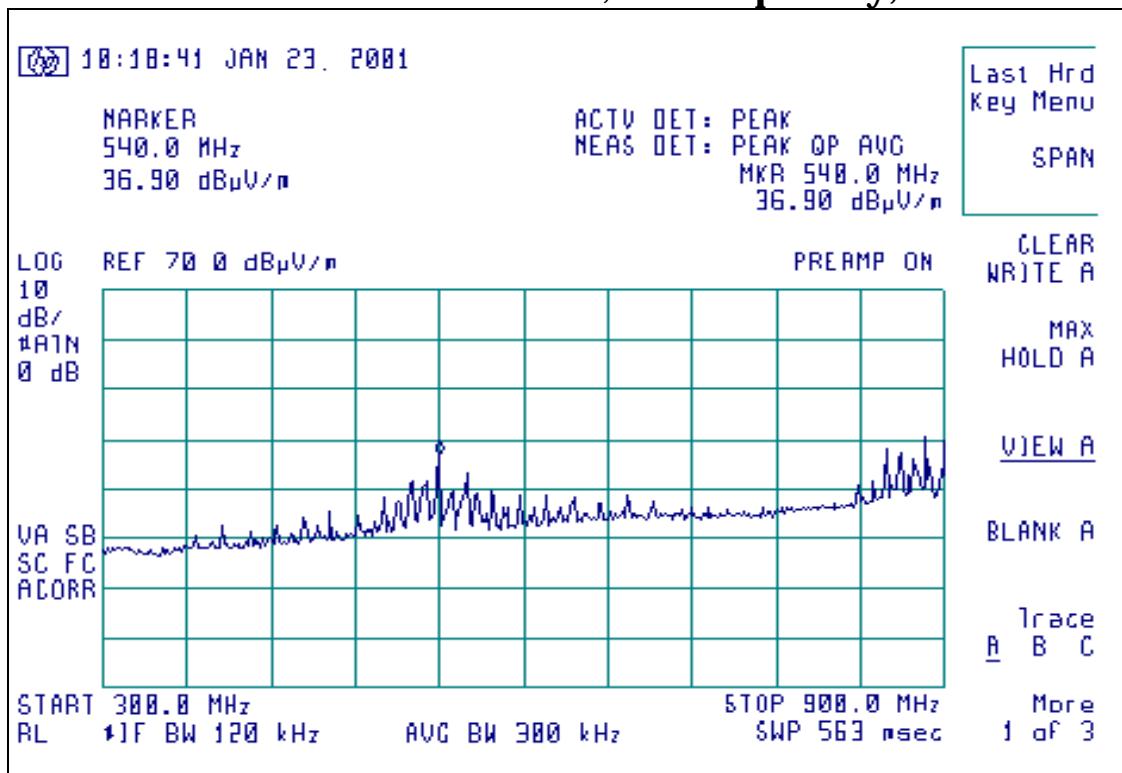
**Radiated Emissions 30-300 MHz, vertical polarity, channel 13**



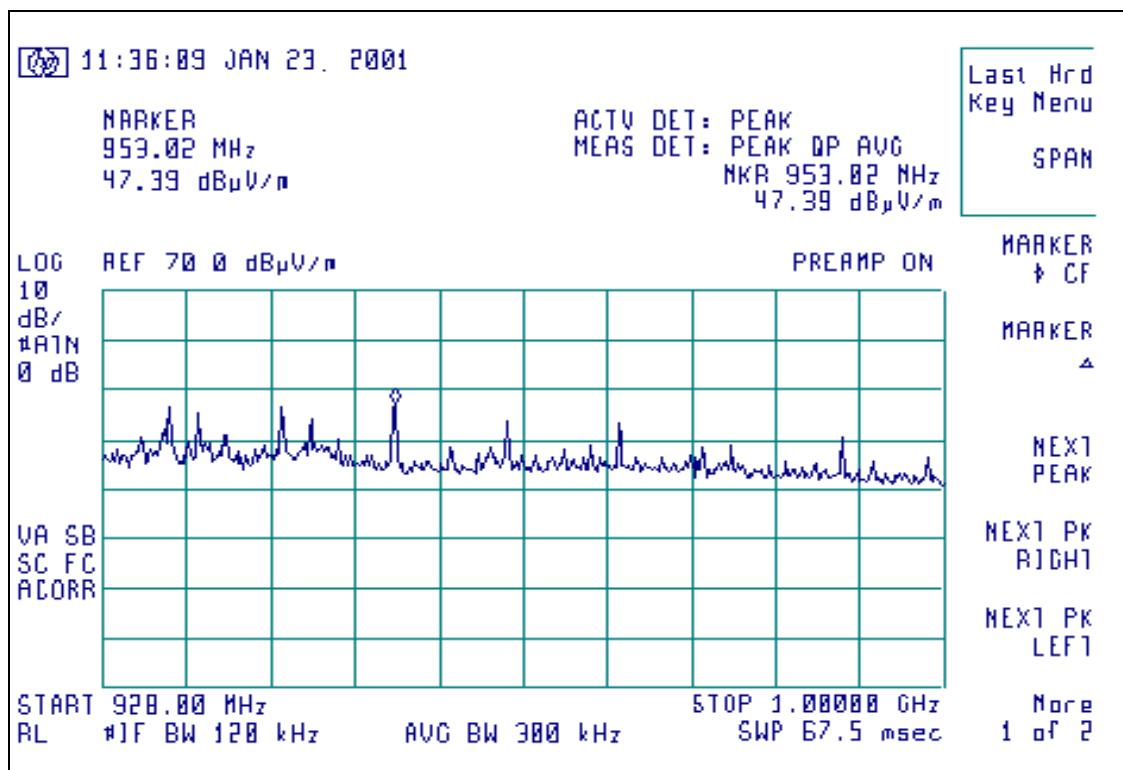
**Radiated Emissions 300-1000 MHz, horizontal polarity, channel 13**



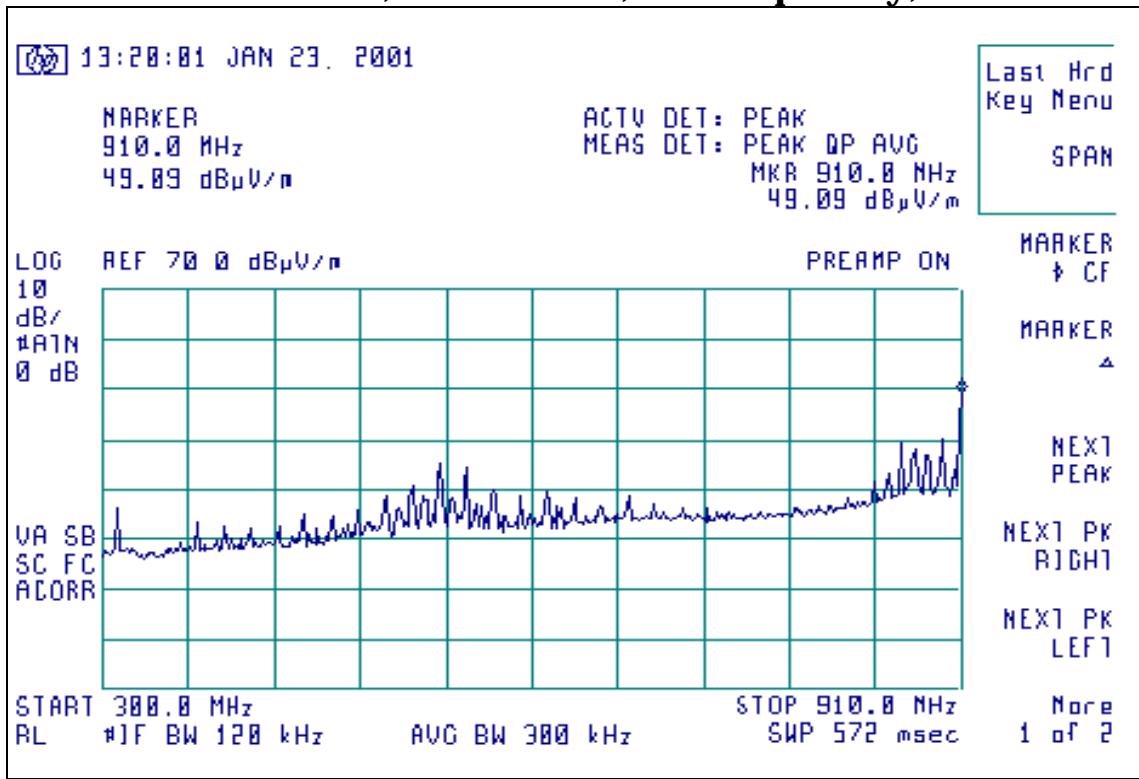
**Radiated Emissions 30-900 MHz, vertical polarity, channel 01**



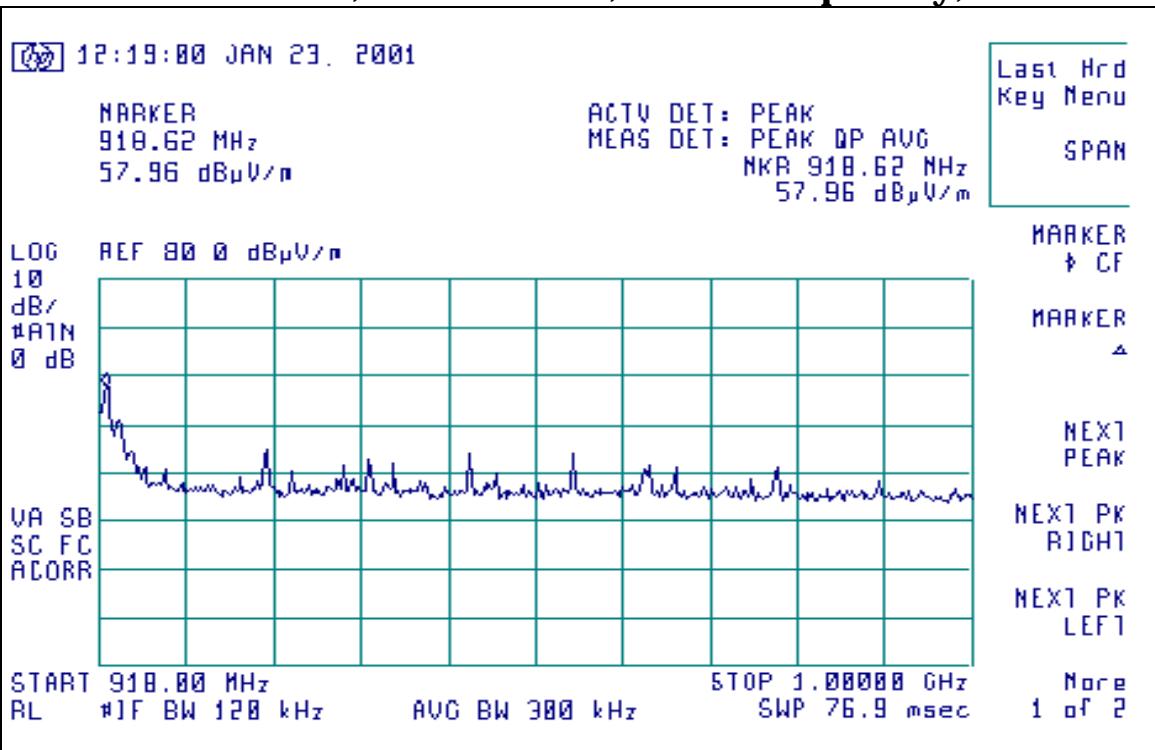
**Radiated emissions, 920-1000 MHz, Horizontal Polarity, channel 01**



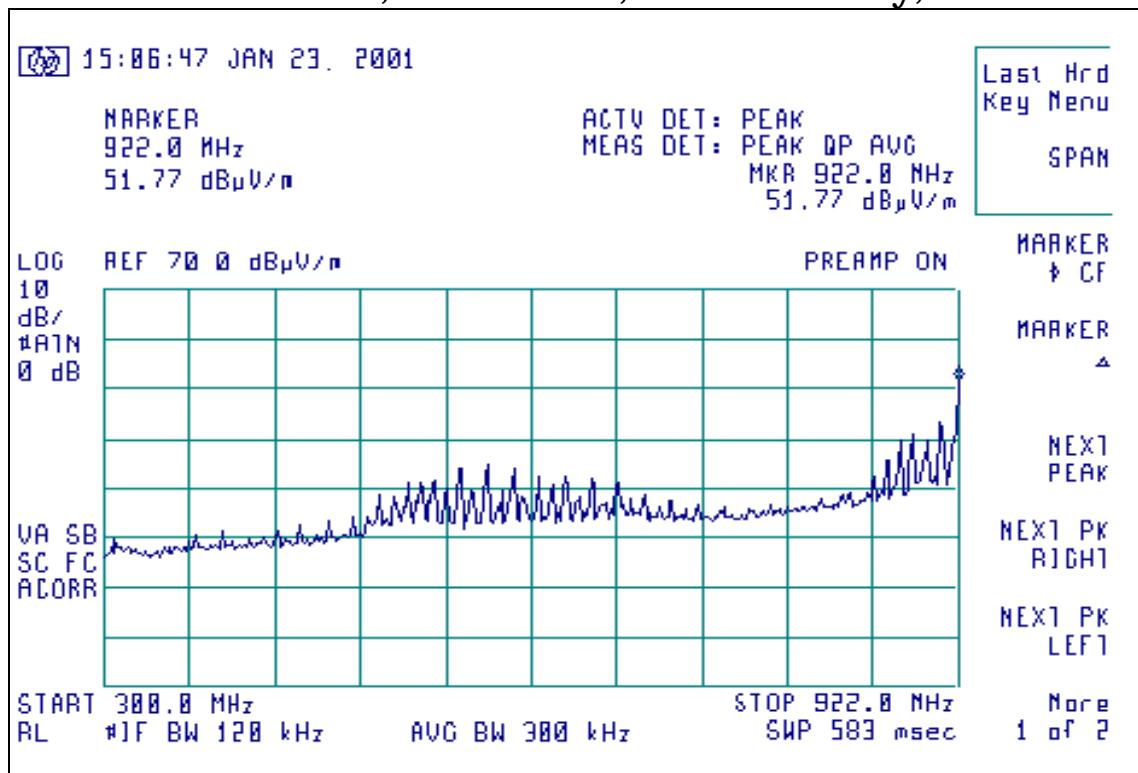
**Radiated emissions, 300-910 MHz, vertical polarity, channel 09**



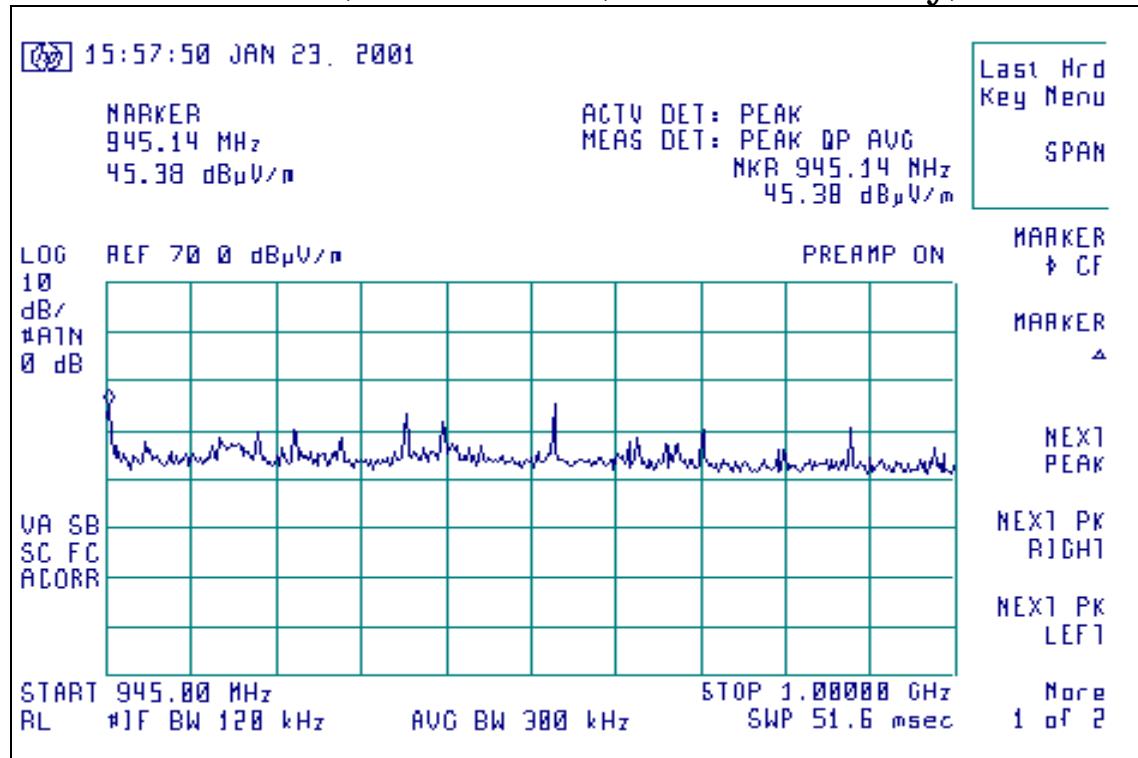
**Radiated Emissions, 918-1000 MHz, Horizontal polarity, channel 09**



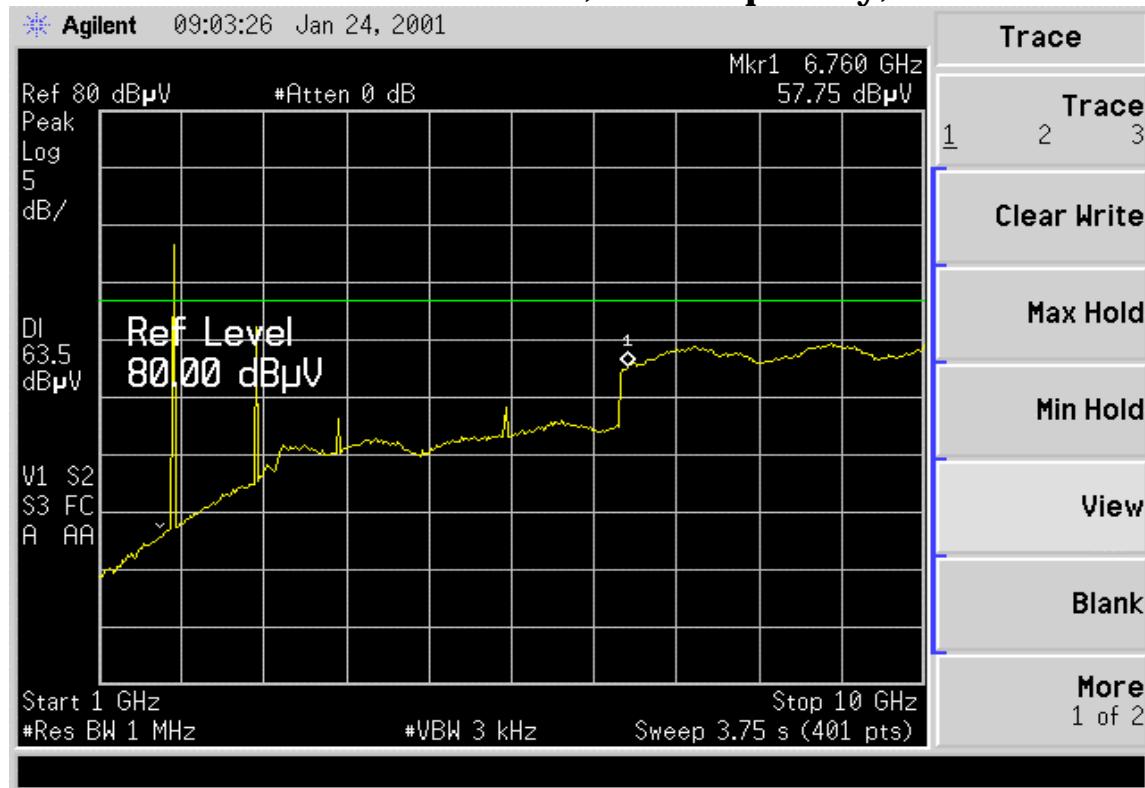
**Radiated Emissions, 300-920 MHz, Vertical Polarity, channel 13**



**Radiated Emissions, 940-1000 MHz, Horizontal Polarity, channel 13**



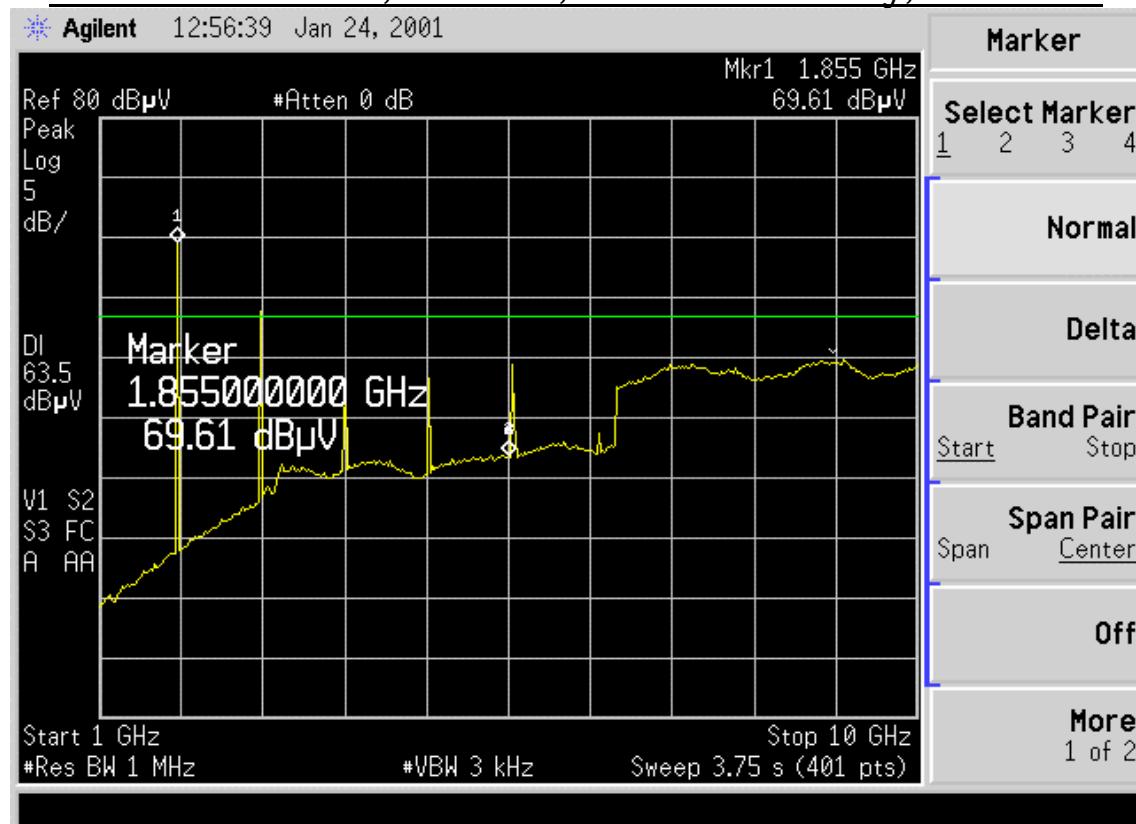
**Radiated Emissions 1-10 GHz, Vertical polarity, channel 01**



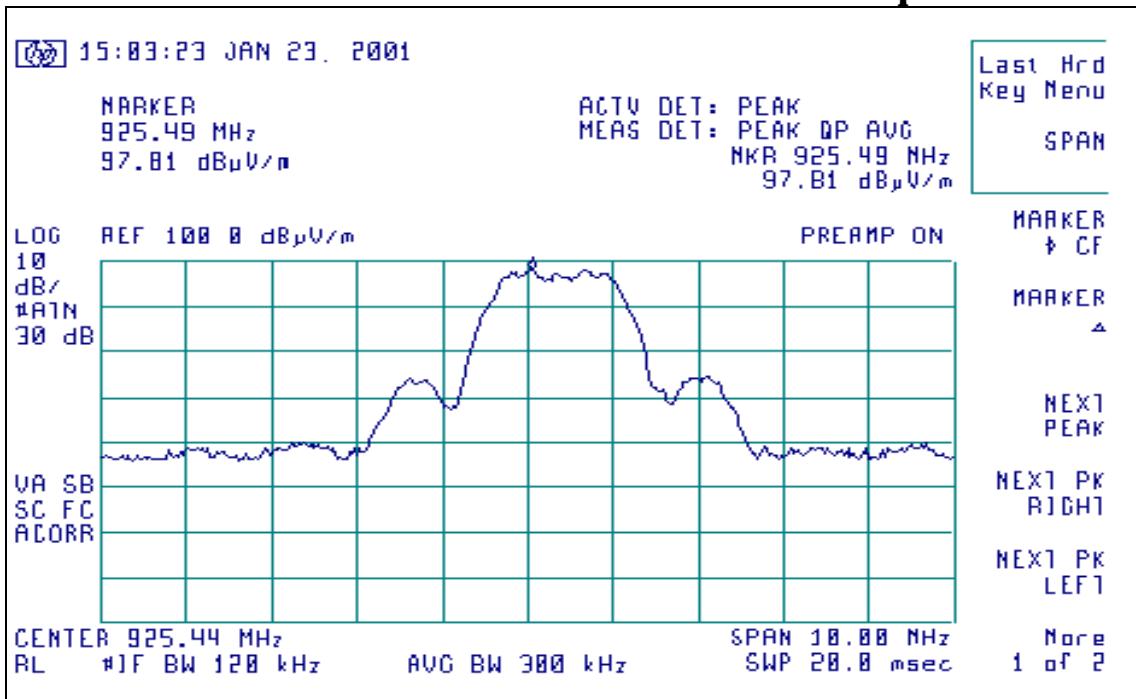
**Radiated Emissions, 1-10 GHz, Horizontal Polarity, channel 09**



**Radiated Emissions, 1-10 GHz, Horizontal Polarity, channel 13**



**Detail of Channel 13 modulation envelope**



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