



L. S. Compliance, Inc.
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L. S. Compliance, Inc.

Compliance Testing of:

K & A WIRELESS

MODEL VTRAN-2500

SPREAD SPECTRUM TRANSMITTER MODULE



Prepared for:

K & A WIRELESS

Test Report Number: 90057a (revised)

Date(s) of Testing:

May 7, 12,19; July 2; Aug 14; Sept 30; Oct 1, 1999



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

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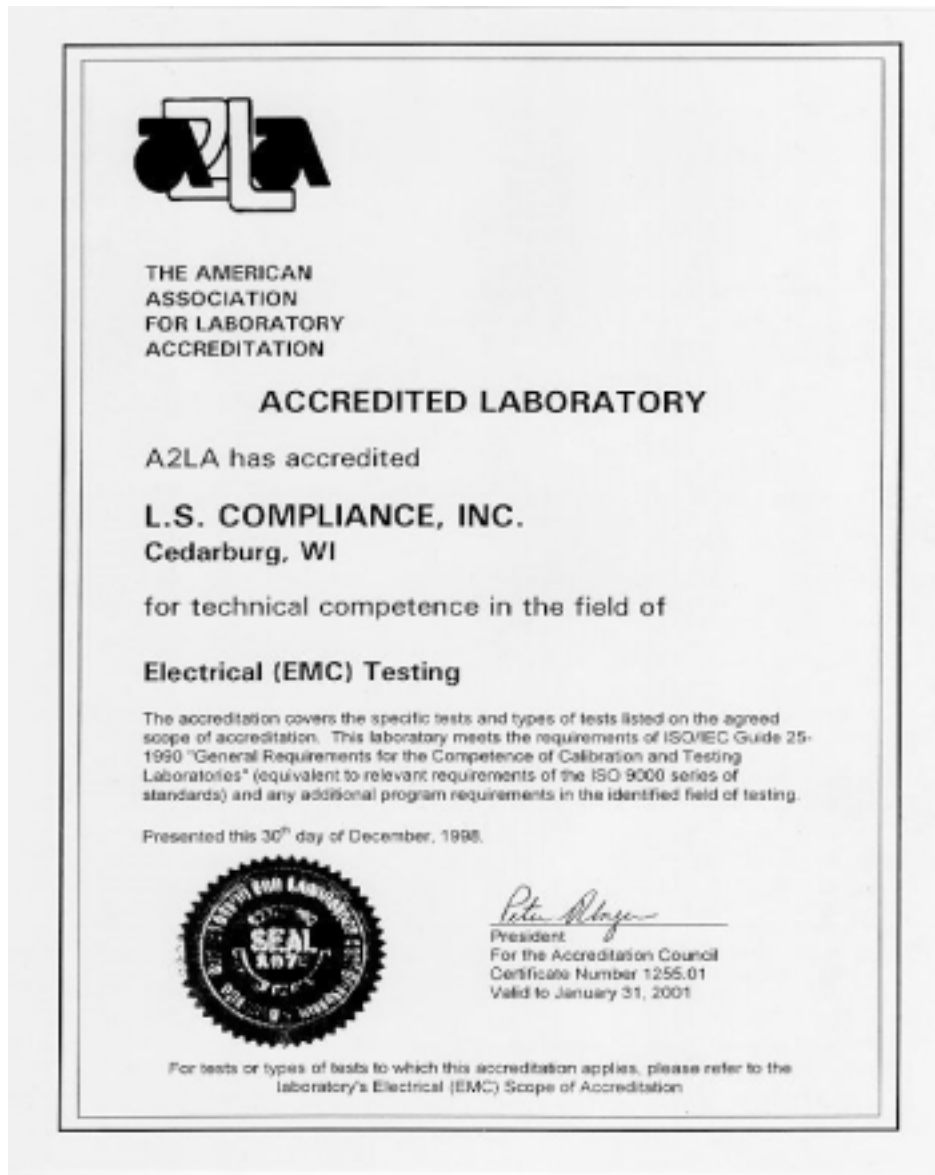
DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

ID Number: 31040/SIT

1300F2

*“ 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.”*





SIGNATURE PAGE

tested By:

Prepared By:

11
November
1999

Kenneth L. Boston, EMC Lab Manager

Date

PE #31926

Registered Professional Engineer

(State of Wisconsin)



2.3 SUMMARY OF TEST REPORT

MANUFACTURER:	K & A Wireless
MODEL:	VTRAN-2500
SERIAL:	pre-production
DESCRIPTION:	SPREAD SPECTRUM RADIO MODULE
FREQUENCY RANGE:	2400-2483.5

The K & A Wireless model VTRAN-2500 was found to **“meet”** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

This product is a small 2.4 GHz Spread Spectrum video transmitter module that is integrated with a camera, battery powered, and the resultant package is worn on the body. This package is designed for use by Emergency personnel (primarily firefighters); to monitor the environment at the scene of the fire; and to ensure the safety of the personnel. Therefore, this report will contain data that is pertinent to the certification of the transmitter module.



2.4 INTRODUCTION

During various dates spanning from May through October of 1999, a series of Emissions tests were performed on two sample models of the K & A Wireless model VTRAN-2500, a spread spectrum transmitter module, designed for short distance video transmission. 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 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 K & A Wireless model VTRAN-2500 with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

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

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). Measurement technique guidelines found in Appendix C to FCC 97-114 were also consulted. During all tests, video modulation consisting of color bars was supplied to the transmitter via a short cable from an NTSC pattern generator.

2.6 Power Output Test Performed

For the 15.247b measurement, the output of the K & A Wireless model VTRAN-2500 module was connected via a short jumper cable created only for this measurement, into the input of the HP E4407B Spectrum Analyzer. The unit was configured to run in a continuous transmit mode, while being supplied with NTSC color bars as a modulation source. The HP receiver was set to a 5 MHz Bandwidth, and the transmit signal was then stored, with the peak signal level stored. This power level was collected for all four channels and can be seen in the chart presented below.



CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
1	2412	30 dBm	14.63	15.37
2	2427	30 dBm	16.21	13.79
3	2442	30 dBm	16.81	13.19
4	2457	30 dBm	14.81	15.19



2.7 Conducted RF Test Setup and measurements

FCC part 15.247 (c) requires an antenna conducted measurement of conducted harmonic and spurious levels, as reference to the carrier frequency in a 100 kHz bandwidth. For this test, the video transmitter module was directly connected to the HP E4407B spectrum analyzer, through a very short coaxial cable and a 10 DB attenuator. Plots were then taken, with any noticeable spurious or harmonic signals identified. No significant levels at any spurious products could be found within -20 dBc of the fundamental of the transmitter. Signals that were observed were greater than 50 dB down. (In the 100 kHz bandwidth)

2.8 Occupied Bandwidth Measurements

The 6 dB bandwidth requirement found in 15.247.a.2 is a minimum of 500 kHz. Direct measurement of the transmitted signal, via a direct cabled connection to the HP E4407B analyzer, was then used to determine the signal bandwidth. For each of the representative channels, refer to the graphs found in Appendix C. From this data, the bandwidth of channel 3 and 4, which is the closest data to the specification limit, is 3.05 MHz, which is above the minimum of 500 kHz.

CHANNE L	CENTER FREQ (MHz)	MEASURED 6 dB BW (kHz)	MINIMUM LIMIT (kHz)
1	2412	10,150	500
2	2427	3800	500
3	2442	3050	500
4	2457	3050	500

2.9 Power Spectral Density

In accordance with FCC part 15.247(d), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in section 2.6. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP analyzer. The resultant density was then corrected to a 3 kHz bandwidth, and can be determined by inspection of the graphs found in Appendix C. The highest density was found to be no greater than -16.4 dBm, which is under the allowable limit by 24.4 dB.

CHANNE L	CENTER FREQ	MEASURED P	3khz corr.	CORRECTE D	SPEC	MARGI N
-------------	----------------	---------------	------------	---------------	------	------------



1	2413	-55.9	34.8	-21.1	+8.0dBm	29.1
2	2428	-54.4	34.8	-19.6	+8.0dBm	27.6
3	2442	-51.2	34.8	-16.4	+8.0dBm	24.4
4	2456	-55.4	34.8	-20.6	+8.0dBm	28.6



2.10 Processing Gain

A report detailing the results of a jamming margin test performed upon a typical system containing the Harris Prism chipset, which is attached to this report, wherein the processing gain of the system was determined by using the CW jamming margin method. Because this product contains the same base-band processing chipset, reference is made to this report as fulfilling the processing gain requirement. The justification for this means of showing compliance is contained in an E-mail from the FCC engineering staff, a copy of which is found in appendix D. This test was performed within a screened room located on the L.S. Compliance facility, by Brian Petted, of L.S. Research, which is co-located with L. S. Compliance in Cedarburg.

2.11 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 set up on a small fixture and placed on a wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on its own [new] internal power supply, a regulator and gel-cell battery. The test sample while powered from the battery package, was configured to run in a continuous transmit mode during the 15.247 and 15.205 measurements. Video modulation was supplied to the unit during the testing, and was supplied from an NTSC Pattern Generator. One test sample was set to operate on either channel 1 (2412mhz), channel 2 (2427MHz), channel 3 (2442MHz), or channel 4 (2457MHz) while being tested as an intentional radiator, in order to determine compliance within a frequency range of 2400-2483.5 MHz, as dictated by FCC part 15.31m

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

2.12 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.(25 GHz) 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 2.14. The sample was positioned on an 80 CM high pedestal and placed in the 3 Meter chamber and 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 set 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 8563E analyzer and 8348A preamplifier.

No significant emissions were found aside from the transmitter fundamental and some spurious signals. The unit was scanned for emissions, over the range 30 to 25000 MHz to establish compliance with Part 15.247c and 15.205 for the system. The results of the system measurements are found in Appendix B, with graphs of the signature scans found in Appendix



2.13 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 2.17, 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 upper microwave region, a HP 8563E microwave spectrum analyzer and a HP 8348A preamplifier was leased from Hewlett Packard Corporation. Subsequently, a HP E4407B Spectrum analyzer was purchased from Hewlett Packard. Being that this instrument is an integrated system, all antenna factors, cable factors, and preamp gain factors are stored and recalled when initially calibrated and configured for use. Data appearing on the screen and measured during emissions testing is then presented as corrected readings. Data derived from the HP 8563E analyzer was raw data, and was corrected for preamplifier, cable and antenna factors in the tabular presentation. 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. Signal levels were also inspected using the 100 kHz bandwidth and compared to the maximum radiated signal in a 100 kHz bandwidth of the fundamental modulated carrier for the four channels tested.

2.14 - Restricted Bands affecting this product

3 Meter limits

Frequency (MHz)	Limit (μ V)	Limit (dB/ μ V / m)
162.013-167.17	150	43.5
167.72-173.2	150	43.5
240-285	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
10600-12700	500	54.0
13250-13400	500	54.0
14470-14500	500	54.0
15350-16200	500	54.0
17700-21400	500	54.0
22010-23120	500	54.0
23600-24000	500	54.0

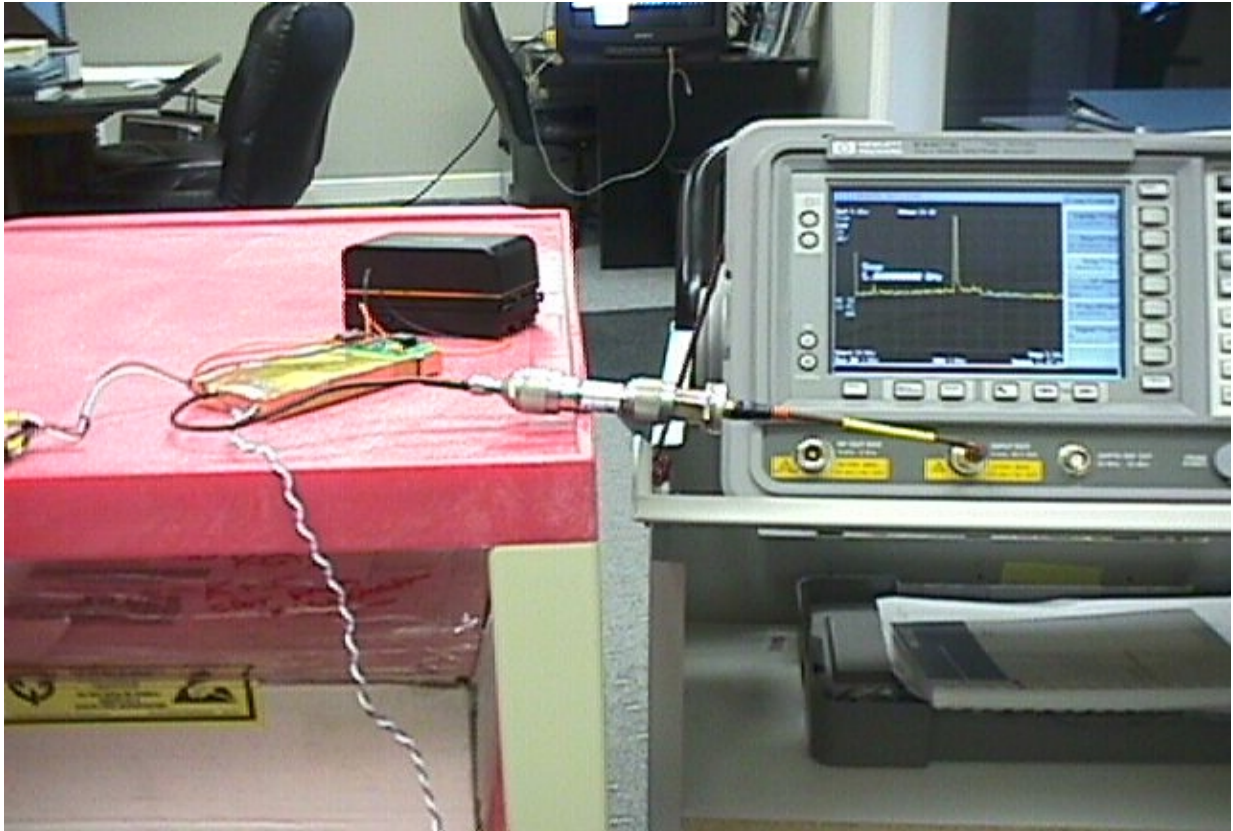
2.15 – Photos taken during testing



View of the K & A Wireless model VTRAN-2500 module during the Radiated Emissions tests.
This view shows the orientation of the product during tests of the emission from the system.



View of the K & A Wireless model VTRAN-2500 module during the Radiated Emissions tests.



View of the K & A Wireless model VTRAN-2500 module during conducted emission testing.



2.16 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 K & A Wireless model VTRAN-2500 module does **“meet”** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. Some of the emissions, at 167 MHz and in the restricted bands immediately adjacent to the 2.4 GHz ISM are within 4 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.



2.17 - Test Equipment

Asset #	Manufacturer	Model #	Serial#	Description	Due Date
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	3aug2000
AA960005	EMCO	3110B	9601 / 2280	Biconical Antenna	3aug2000
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	1aug2000
EE960004	EMCO	2090	9607-1164	Mast/Ttable controller	I.O.
EE960014	HP	85460	3617A00320	EMI receiver Display section	23aug2000
EE960013	HP	85462	3205A00103	EMI receiver Preselector section	23aug2000
CC000221	HP	E4407b	Us39160256	26.5 GHz Spectrum Analyzer	16june2000
Leased	HP	8563E	3305A00780	Spectrum Analyzer	19dec1999
leased	HP	8348A	3111A00472	Microwave Preamplifier	20oct1999
CC000156C	Leader	LCG400	1040108	NTSC pattern generator	I.O.
N / a	LSC	Cable	0011	3 meter 1 / 2 " heliax Cable	23 feb 2000
N / a	LSC	Cable	0038	1 meter RG214 Cable	30 dec 1999
N / a	LSC	cable	0050	10 meter RG214 Cable	30 dec 1999
N / a	Maury Microwav	attenuato r	N / a	10 db attenuator	I.O.



APPENDIX A:

SAMPLE CALCULATIONS



Manufacturer: K & A Wireless
Model: VTRAN-2500
Serial Number(s): pre-production

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 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 μV/m)	1m limit (dB μV/m)
960 MHz up	54	63.54

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

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

$$3\text{m limit} = 10\text{m limit} + \text{factor}$$

$$= 54 \text{ dB } \mu\text{V/m} + 9.54 \text{ dB } \mu\text{V/m}$$

$$= 63.54 \text{ dB } \mu\text{V/m}$$



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:	October 1, August 14, 1999	Manufacturer:	K & A Wireless
Location:	L. S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	Vtran-2500
Specifications:	47CFR FCC Part 15.247, 15.205	Serial No.:	Pre-production
Distance:	3 meters	Configuration:	Continuous Tx on channel 1,2 or 4; worst case
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Quasi-peak, below 1 GHz Average above 1 GHz
	EMCO 3146A Log Periodic EMCO 3110B Biconical		

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

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB μ V / m)	15.109 Limit (dB μ V / m)	Margin (dB)
163.0	H	1.8	270	41.7	43.5	1.8
163.0	V	1.75	30	41.3	43.5	2.2
167.0	H	1.8	270	36.7	43.5	6.8
167.0	V	1.75	30	34.1	43.5	9.4
169.0	H	1.8	270	36.1	43.5	7.4
169.0	V	1.75	30	33.2	43.5	10.3
273.0	H	1.0	125	40.1	46.0	5.9
279.0	H	1.0	125	39.8	46.0	6.2
284.0	H	1.0	125	38.4	46.0	7.6
2387.4	V	1.1	250	50.5	54.0	3.5
2483.6	V	1.08	125	45.1	54.0	8.9
2486.7	V	1.08	125	46.3	54.0	7.7
2494.6	V	1.08	240	48.3	54.0	5.7
4887.0	V	1.0	120	46.1	54.0	7.9



Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 5 to 25 GHz

Date of Test:	7,12 May 1999	Manufacturer:	K & A Wireless
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	Vtran-2500
Specifications:	47CFR, FCC Part 15.247(c), 15.205	Serial No.:	Pre-production
Distance:	1 meter	Configuration:	Tx on Ch 1,4
Equipment:	HP 8546A EMI Receiver HP 84125C microwave EMI system EMCO 3115 Double Ridged Waveguide	Detector(s) Used:	Average

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

Frequency (GHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured Value (dBuV / m)	Correction (ant, cbl, preamp)	Final Value (dBuV / m)	Limit (dB μV / m)	Margin (dB)
6.44	H	1.0	90	39.2	6.6	45.8	63.54	17.7
7.28	H	1.0	135	49.5	8.5	58.0	63.54	5.5
9.71	H	1.0	135	53.7	3.4	57.1	63.54	6.4
10.52	H	1.0	90	37.8	3.9	41.7	63.54	21.8
12.14	H	1.0	225	46.3	11.1	57.4	63.54	6.1
14.56	H	1.0	90	37.7	4.1	41.8	63.54	21.7



Measurement of Conducted Emissions with direct connection

Date of Test:	October 1, 1999	Manufacturer:	K & A Wireless
Location:	L. S. Compliance, Inc.	Model No.:	Vtran-500
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	Title 47CFR, FCC Part 15.247	Serial No.:	Pre-production
Distance:	N / A	Configuration:	Channel 1-4 TX
Equipment:	HP 85460A, 85462A EMI Receiver	Detector(s)	Peak
	HP-E4407B	Used:	
Lab Conditions:	Temp.: 72° F	Humidity:	50%

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

Frequency (MHz)	Channel	EMI Meter Reading (dBm)	FCC Limit (output P) (dBm)	Delta (dBc)
456	1	-59.6	2.5	-62.1
472	2	-64.0	5.0	-69.0
484	3	-56.4	6.5	-62.9
497	4	-58.0	3.0	-61.0
13300	1	-55.7	2.5	-58.2
7300	2	-55.7	5.0	-60.7
7300	3	-59.8	6.5	-66.3
7350	4	-60.7	3.0	-63.7



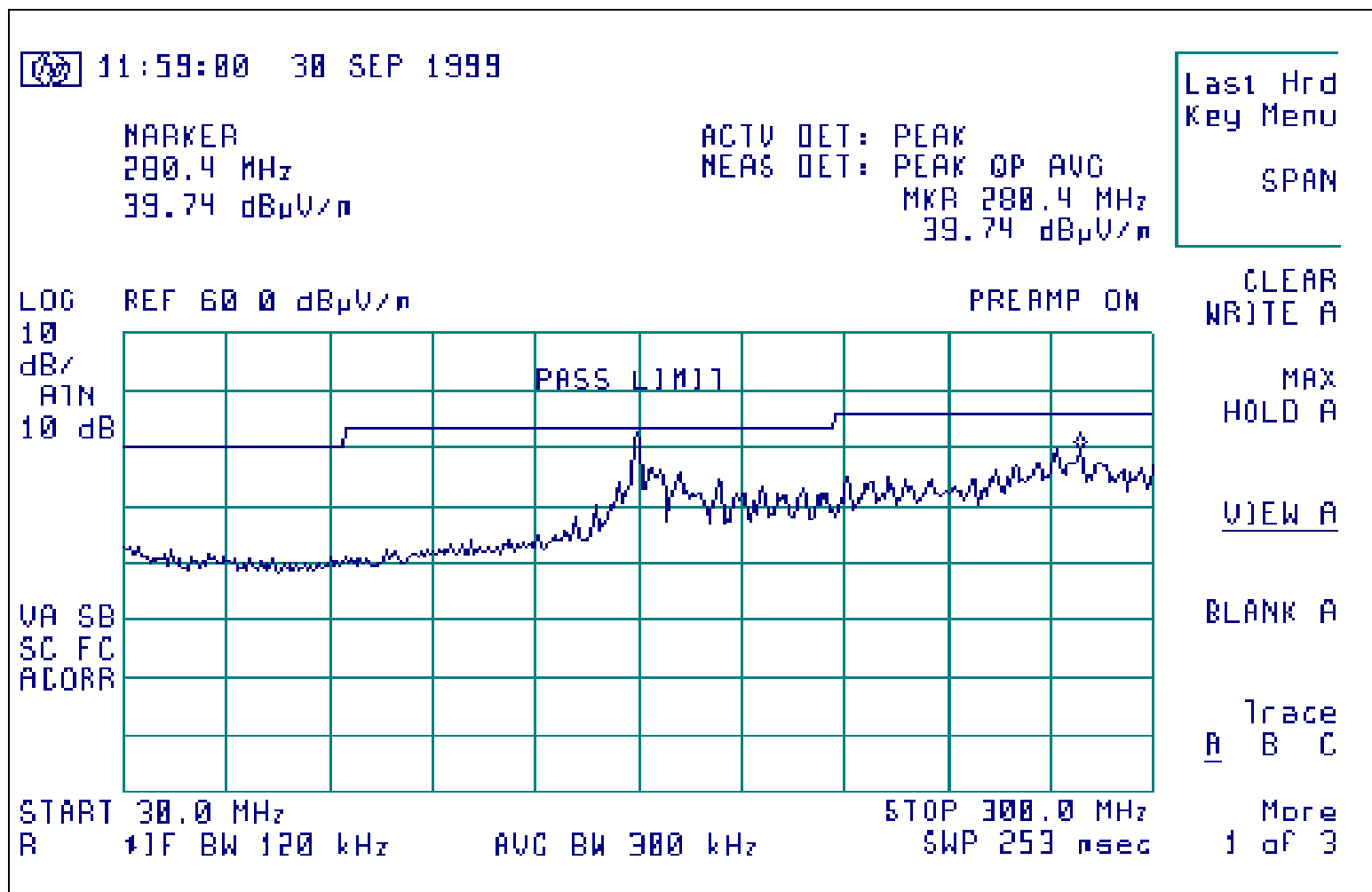
APPENDIX C:

GRAPHS



FCC ID : OPH-KAW1000

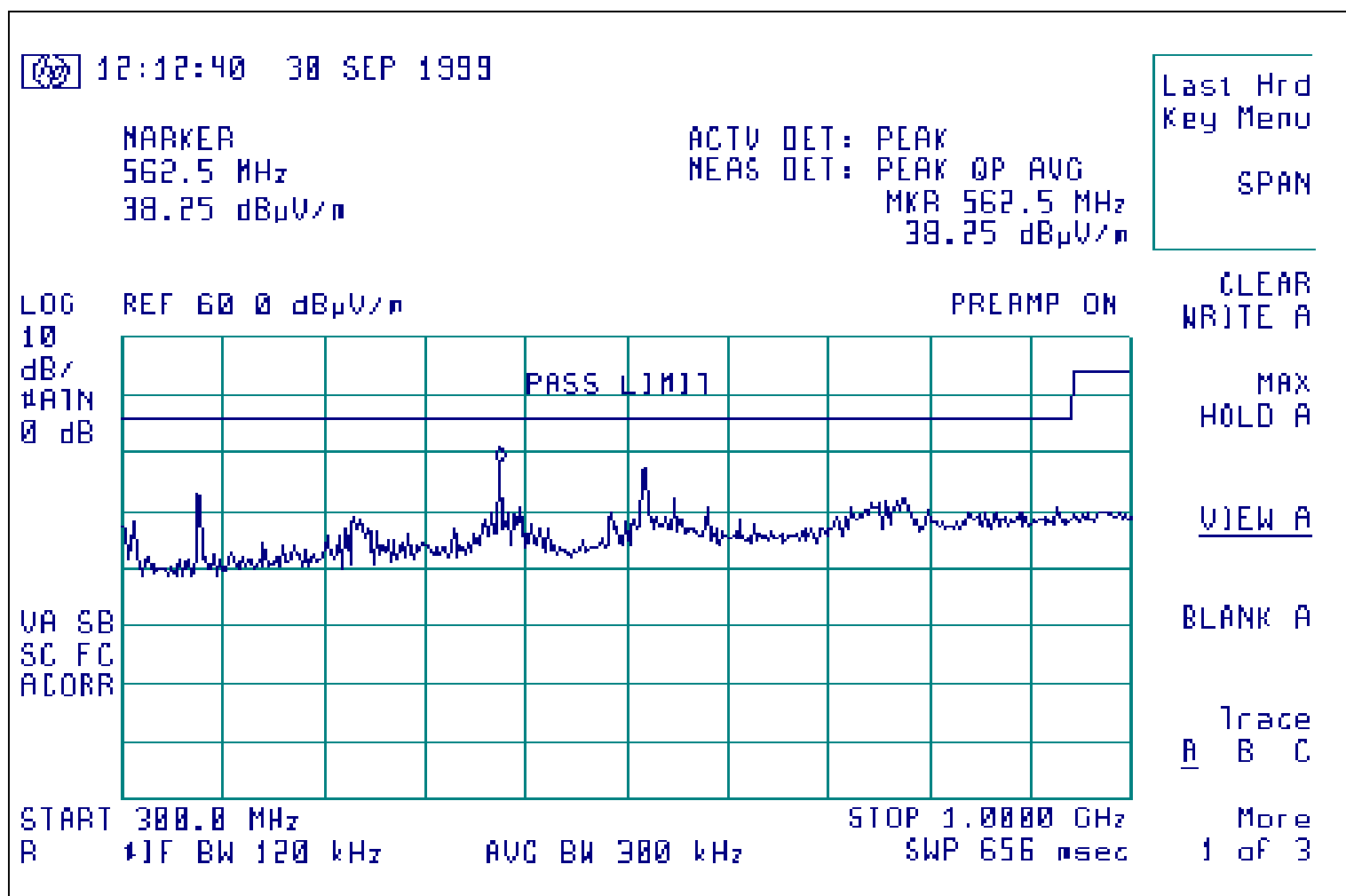
TX channel 2, 30-300 MHz, horizontal polarity





FCC ID : OPH-KAW1000

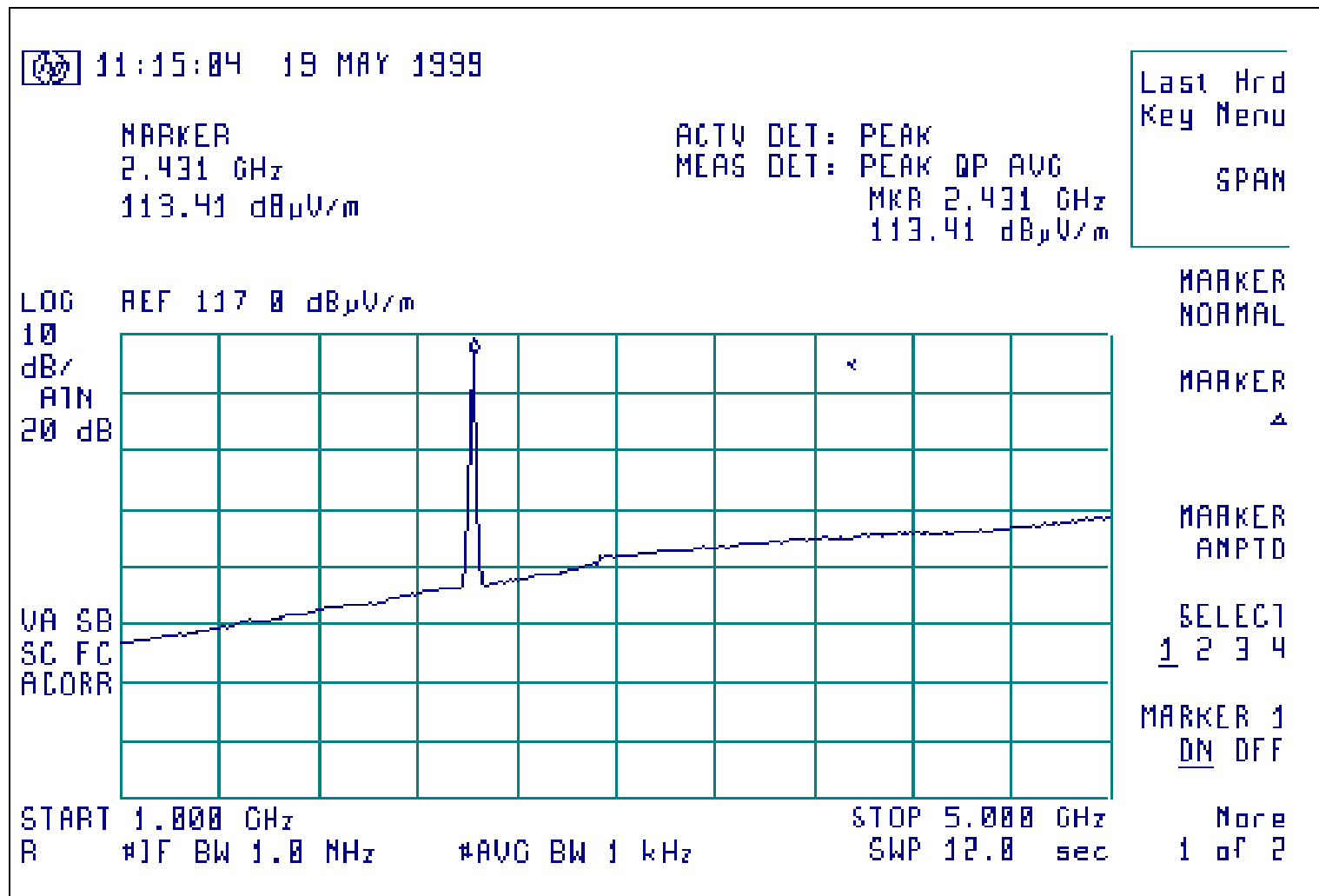
TX channel 2, 300-1000 MHz, vertical polarity





FCC ID : OPH-KAW1000

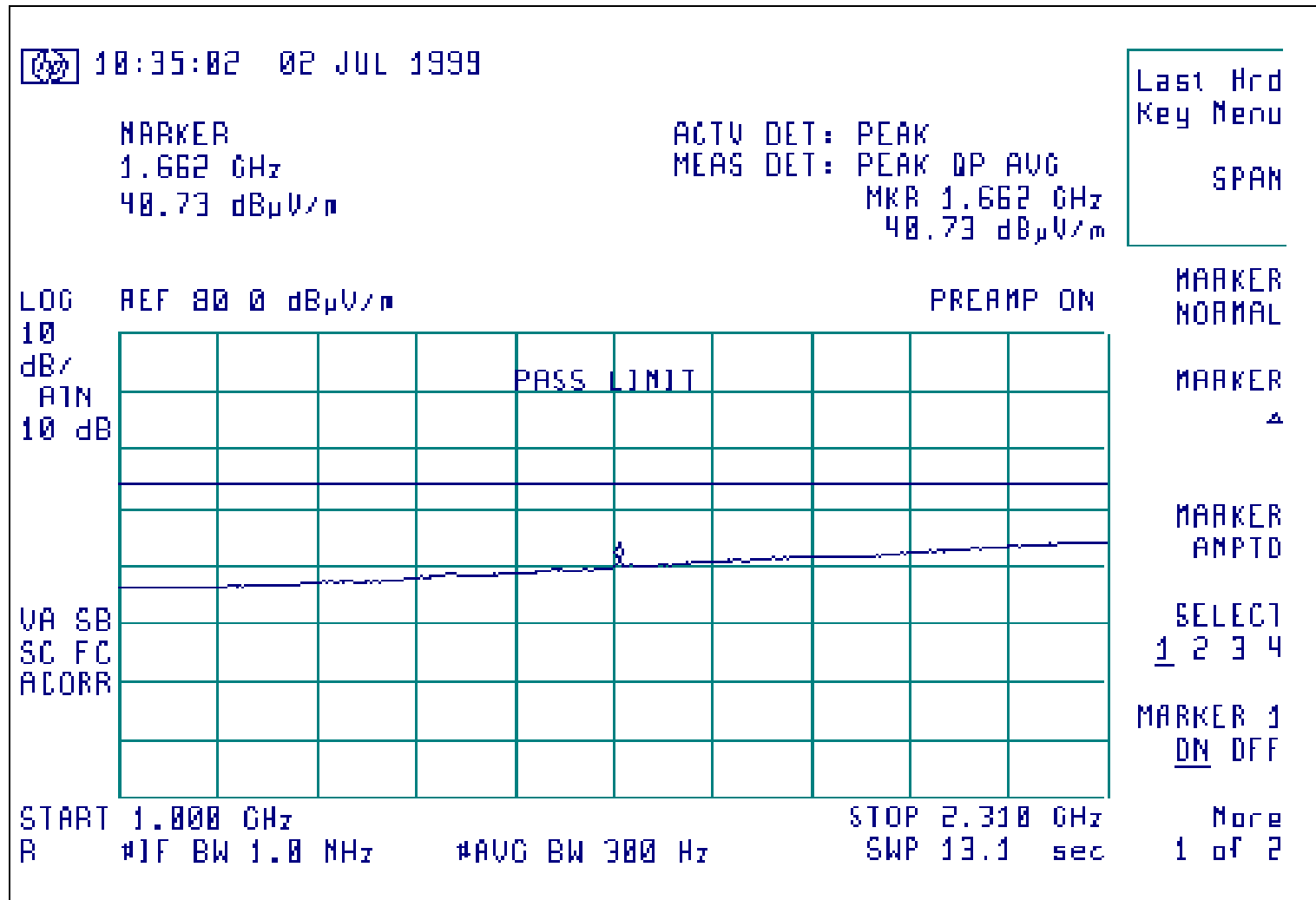
TX channel 2, 1-5 GHz, vertical polarity





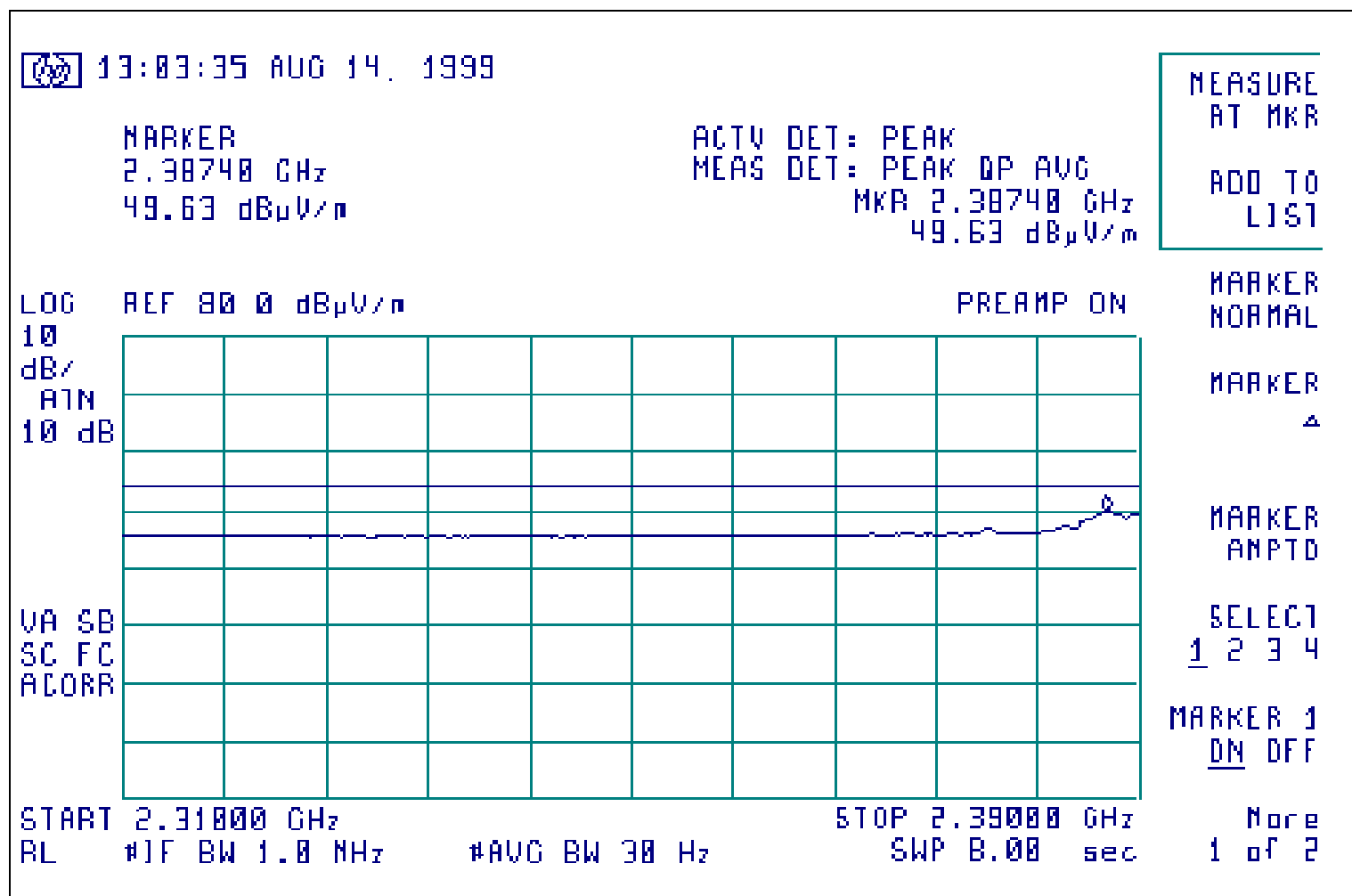
FCC ID : OPH-KAW1000

TX channel 1, 1-2.31 GHz, vertical polarity



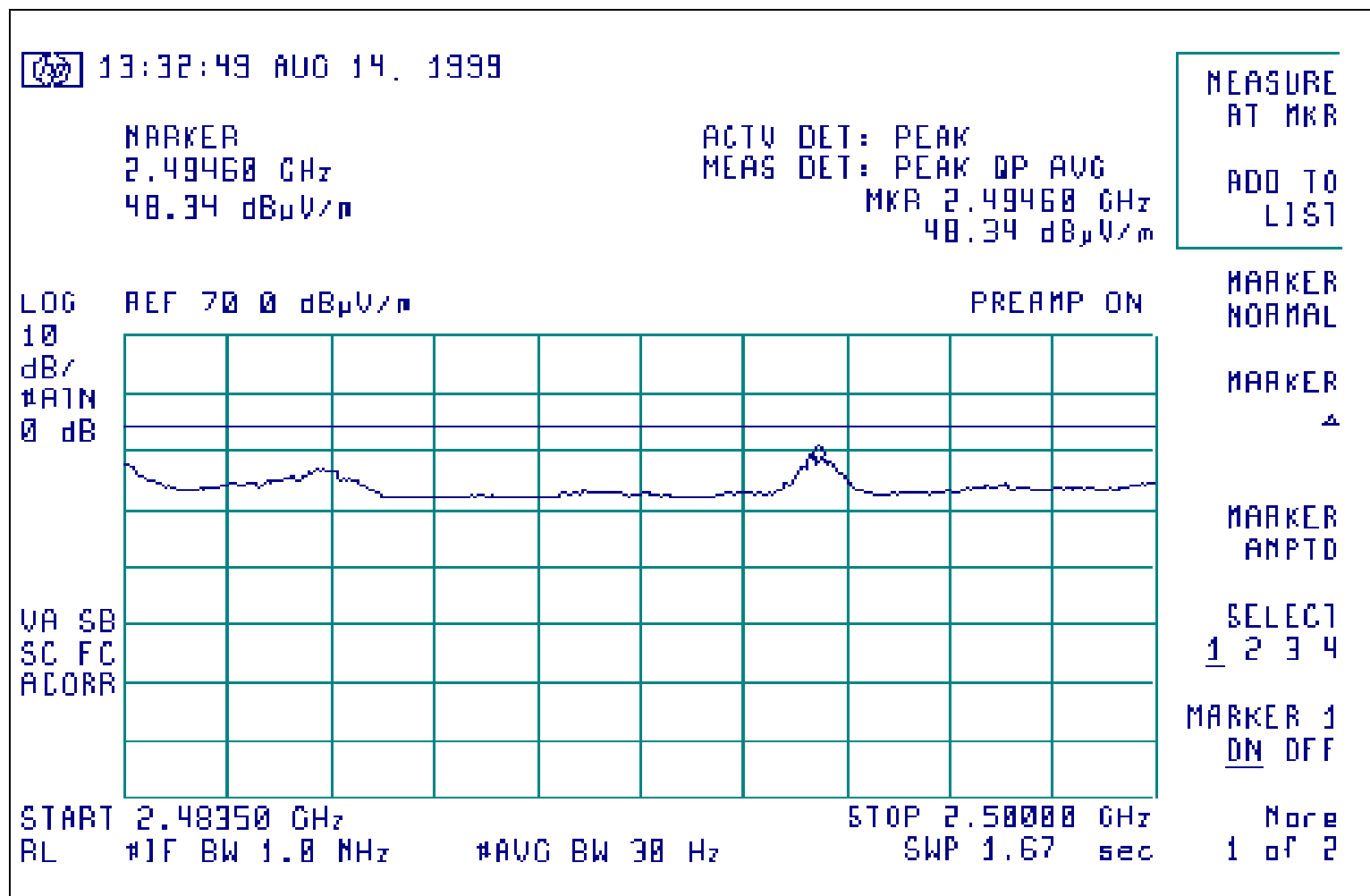


TX channel 1, 2.31-2.39 GHz (15.205), vertical Polarity





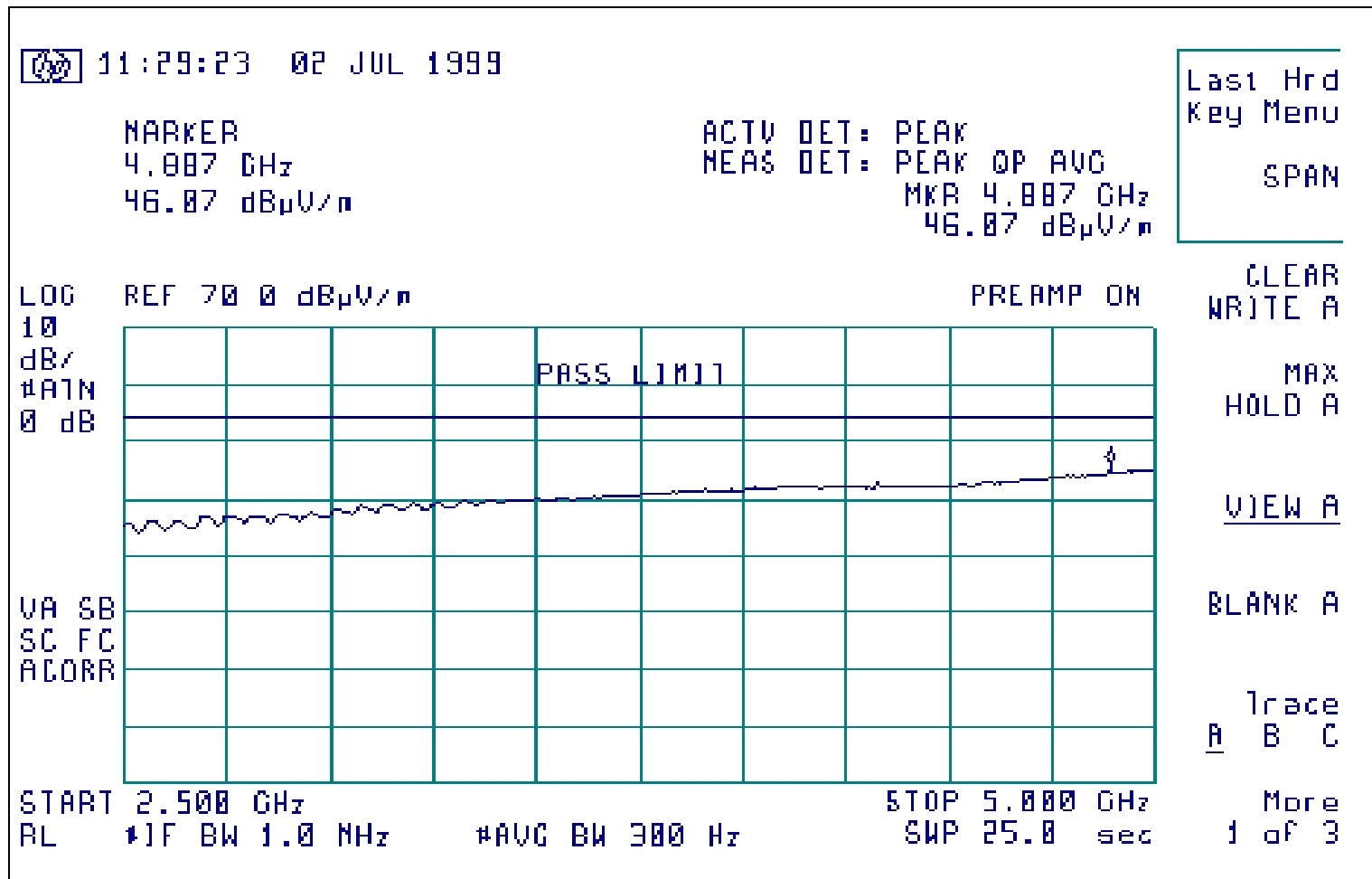
TX channel 4, 2.48-2.5 GHz (15.205), vertical polarity





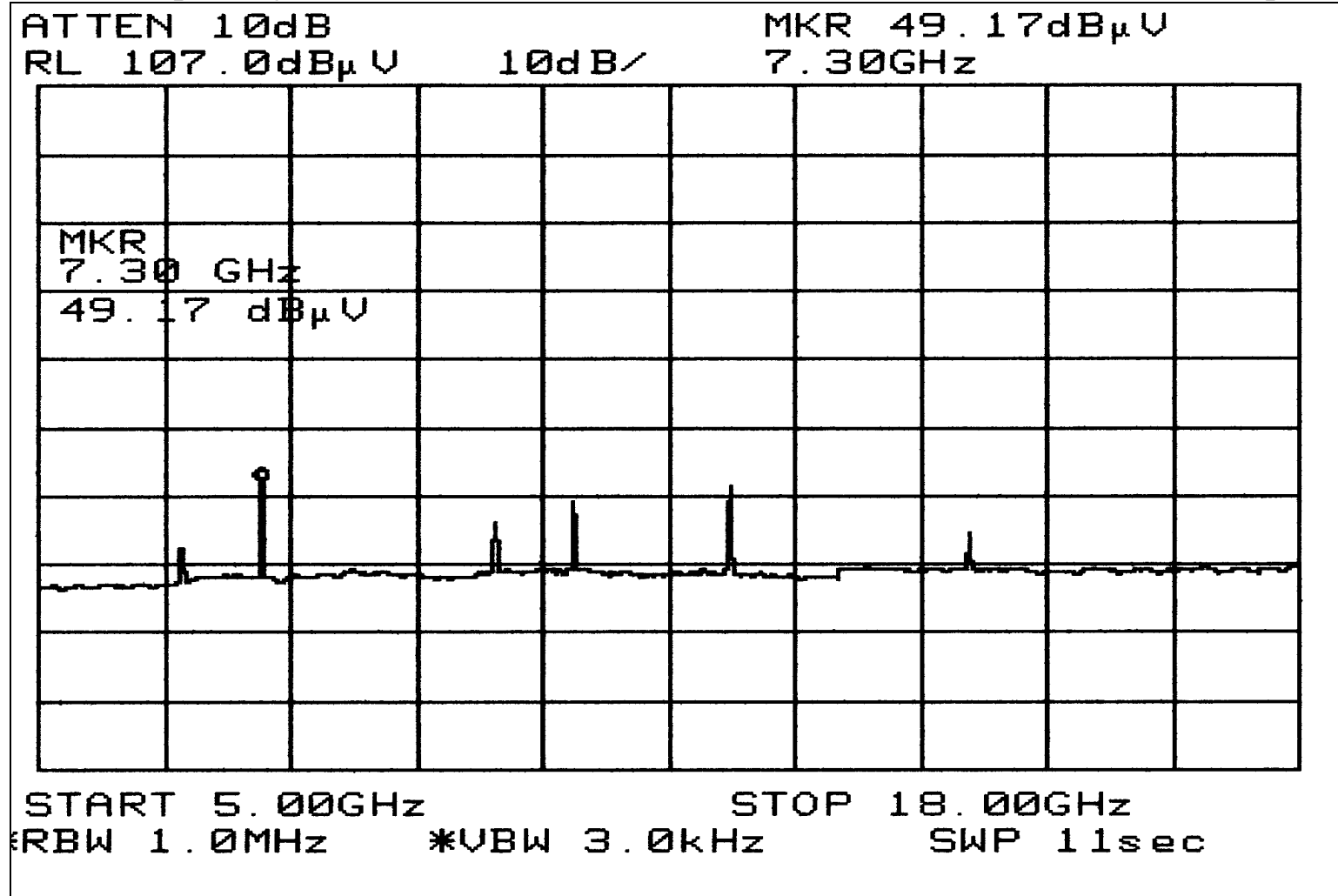
FCC ID : OPH-KAW1000

TX channel 4, 2.5-5 GHz, vertical Polarity





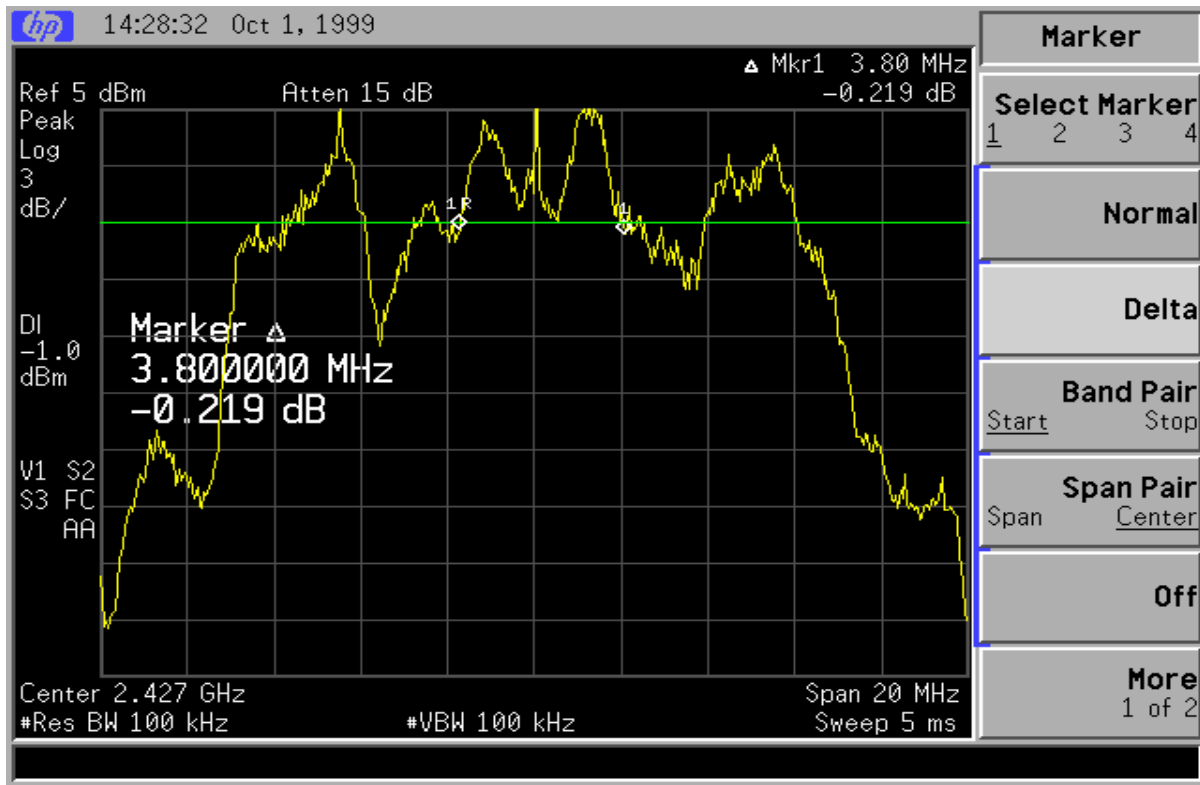
5-18 GHz, vertical polarity, TX on channel 1 and 4., uncorrected for antenna, short cable and preamplifier.



Channel 1 TX, 6dB occupied bandwidth



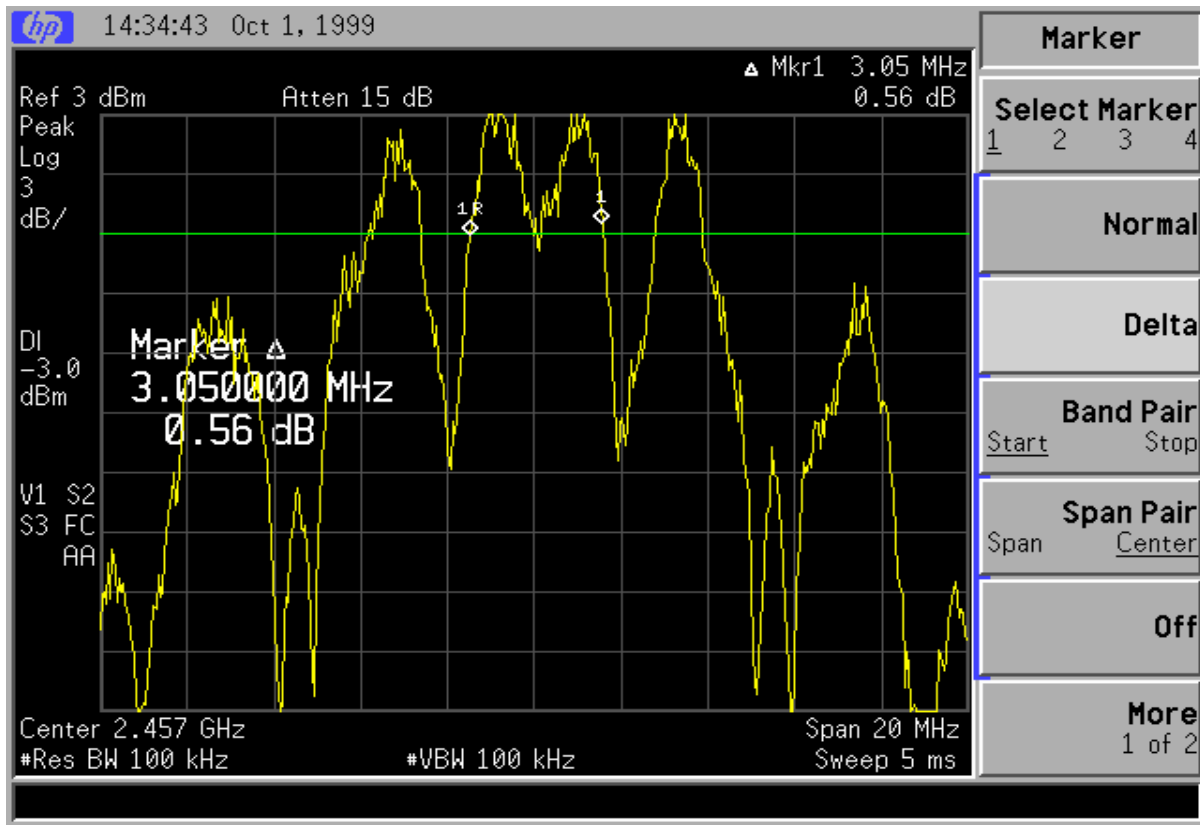
Channel 2 TX, 6dB occupied bandwidth



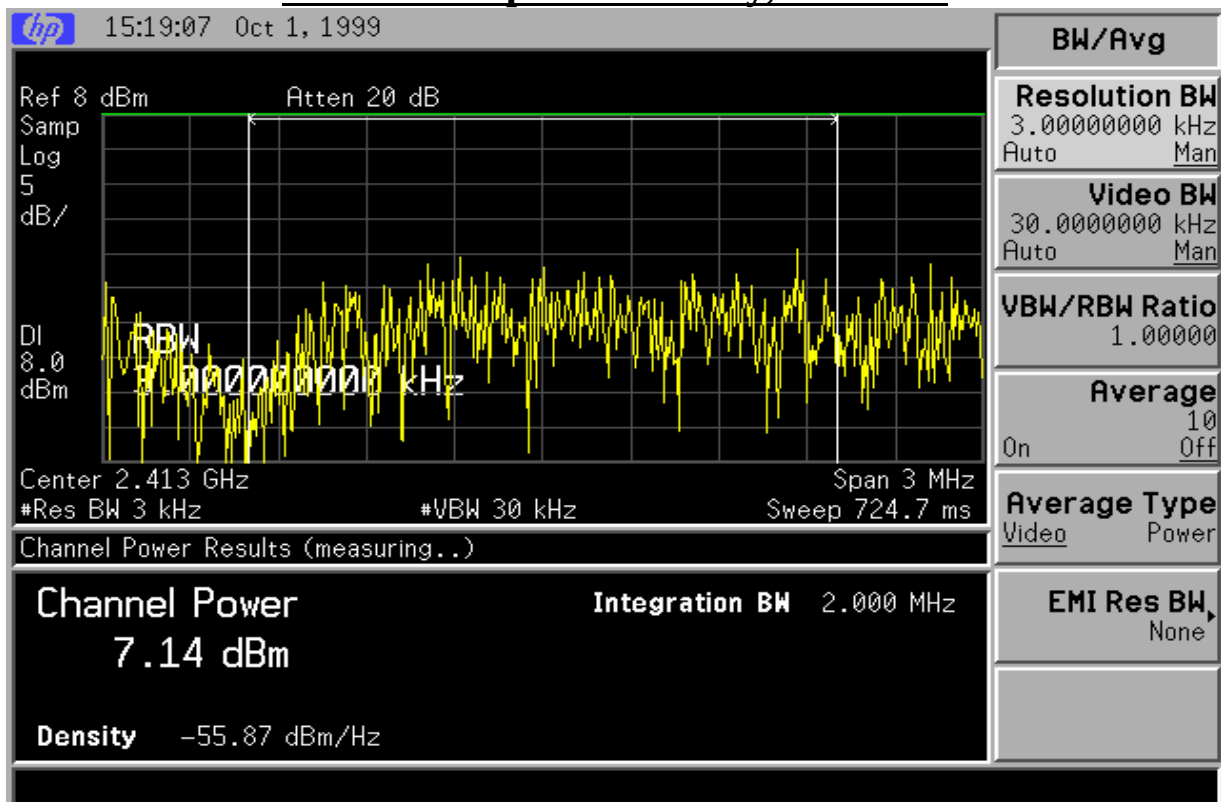
Channel 3 TX, 6dB occupied bandwidth



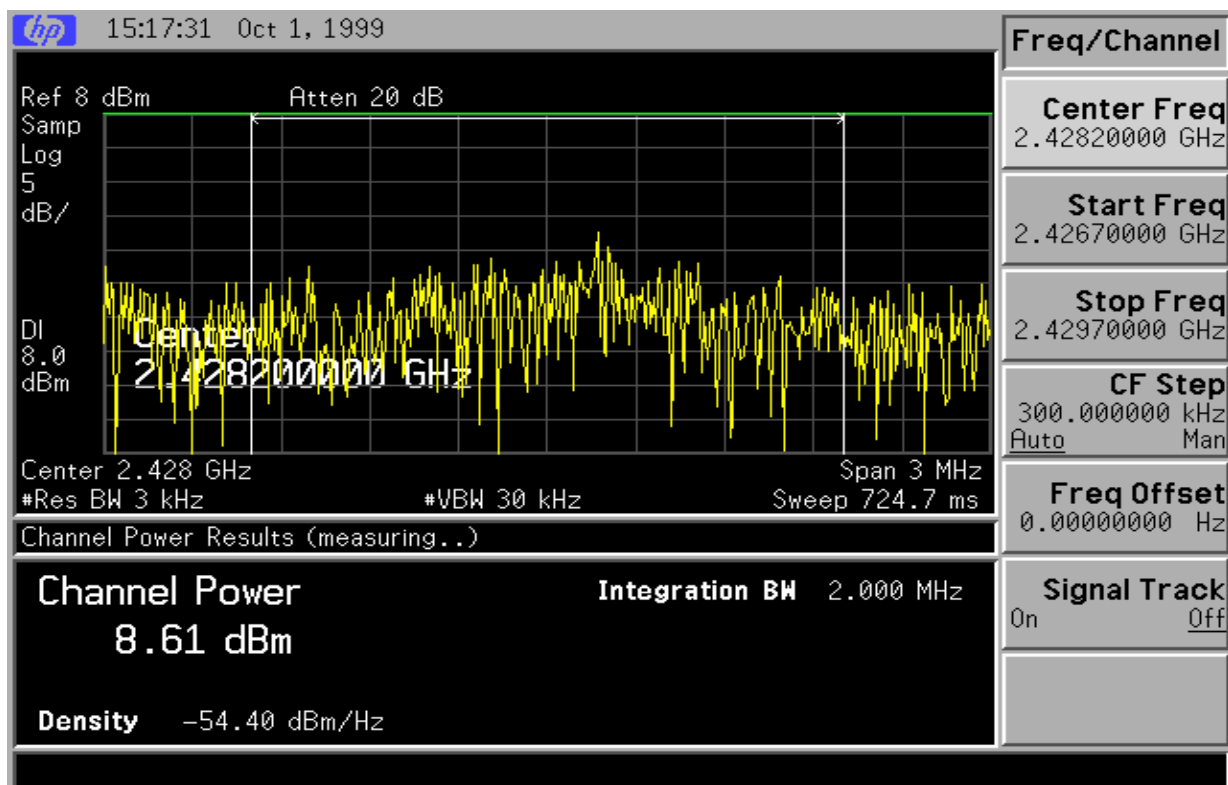
Channel 4 TX, 6dB occupied bandwidth



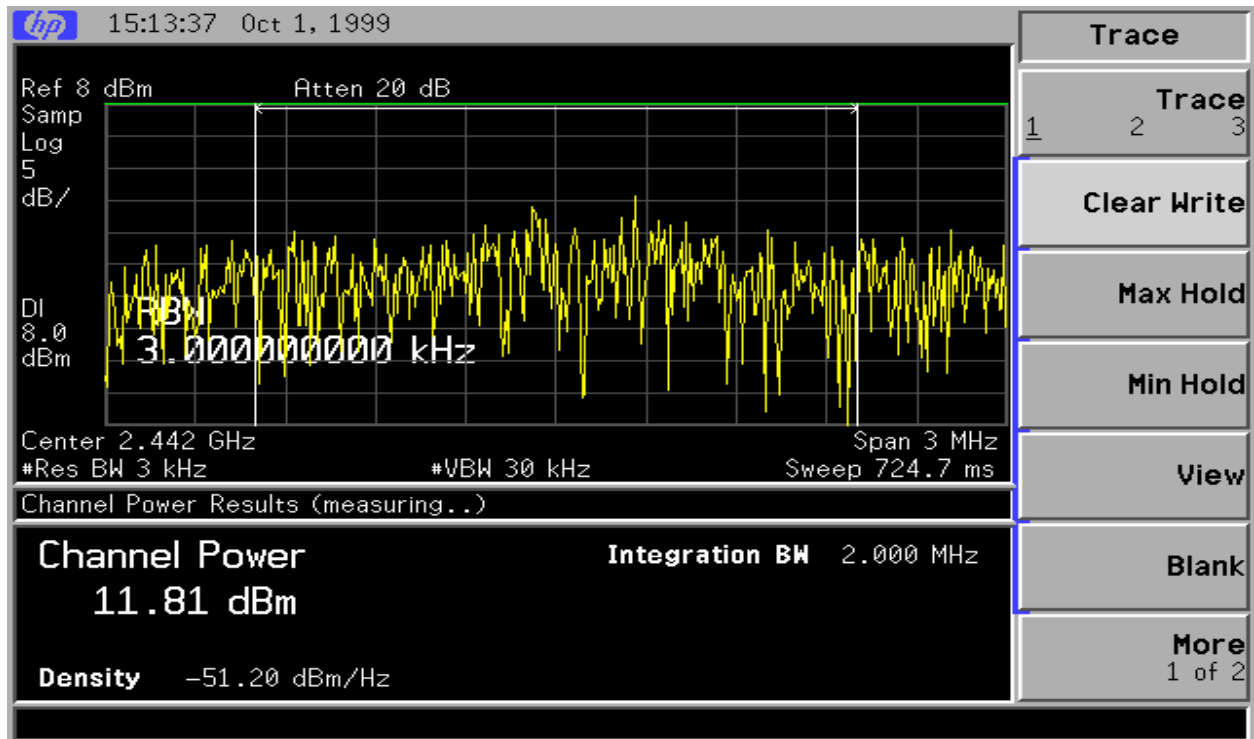
3 KiloHertz Spectral Density; channel 1



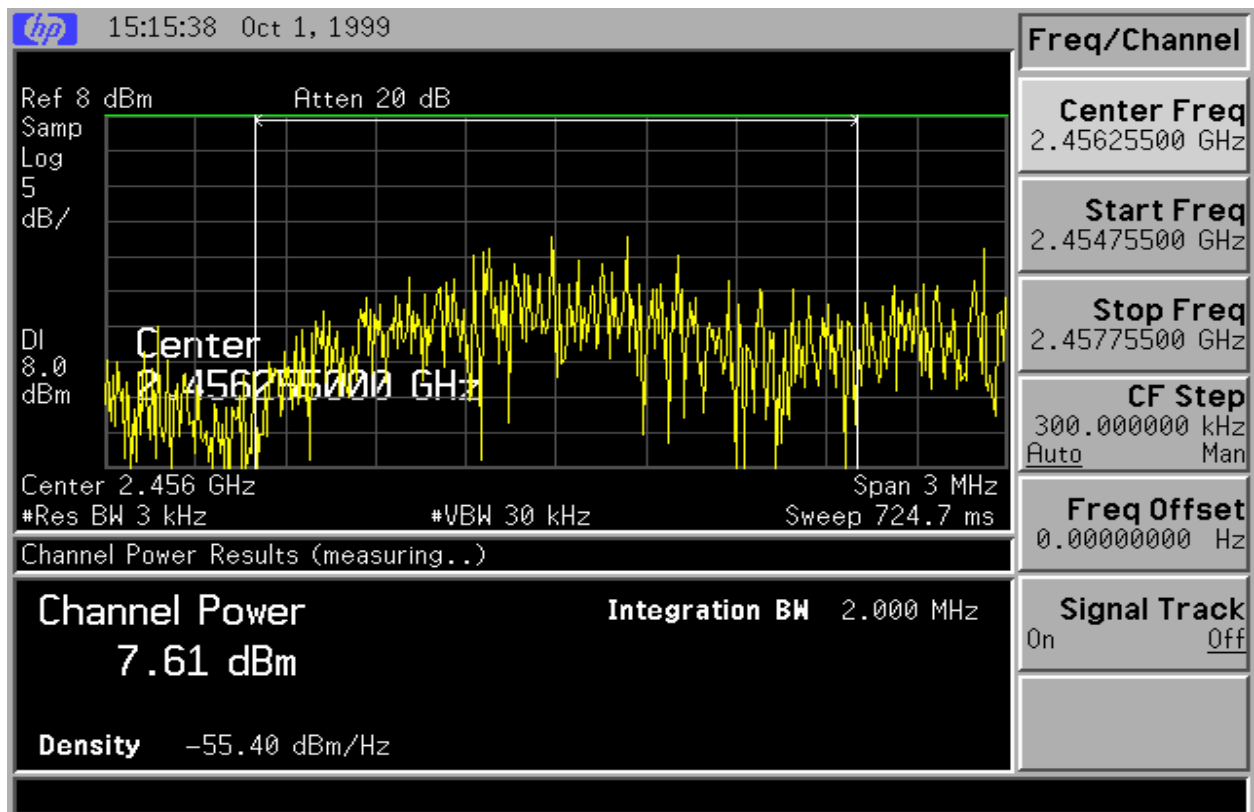
3 KiloHertz Spectral Density; channel 2



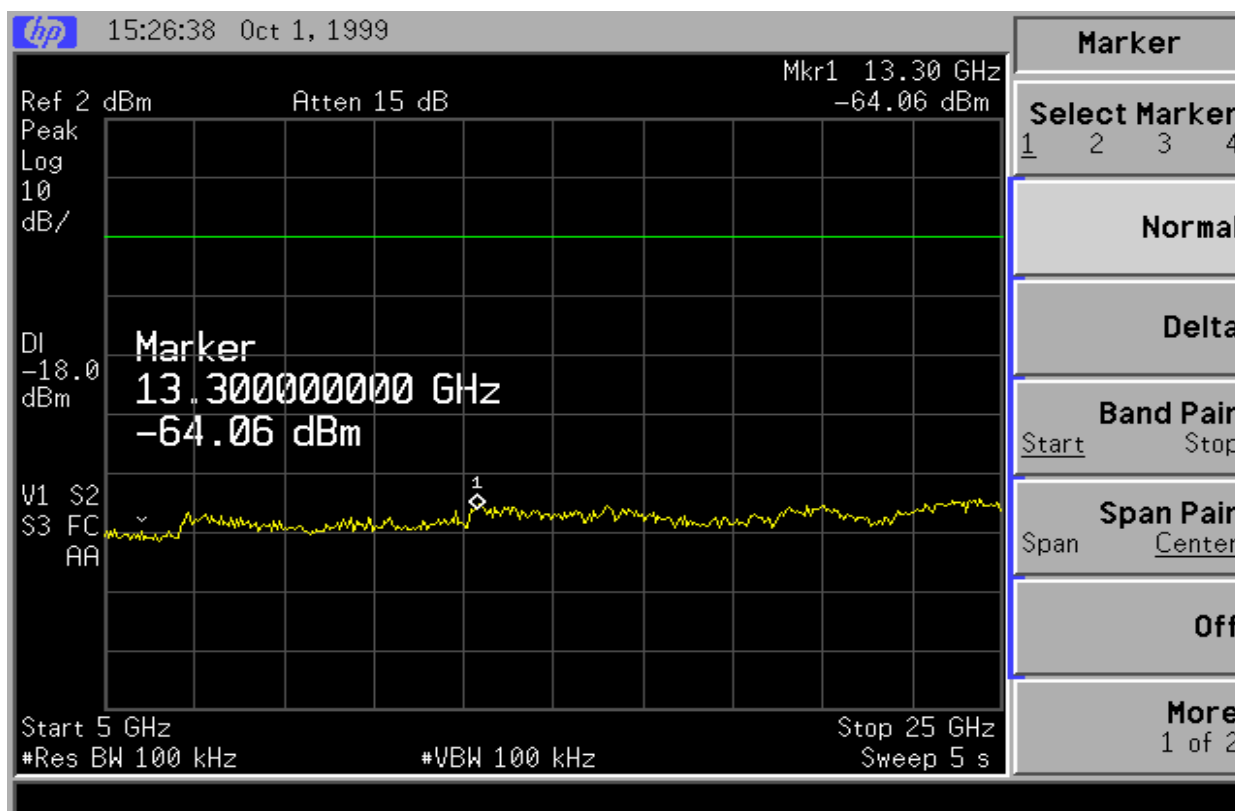
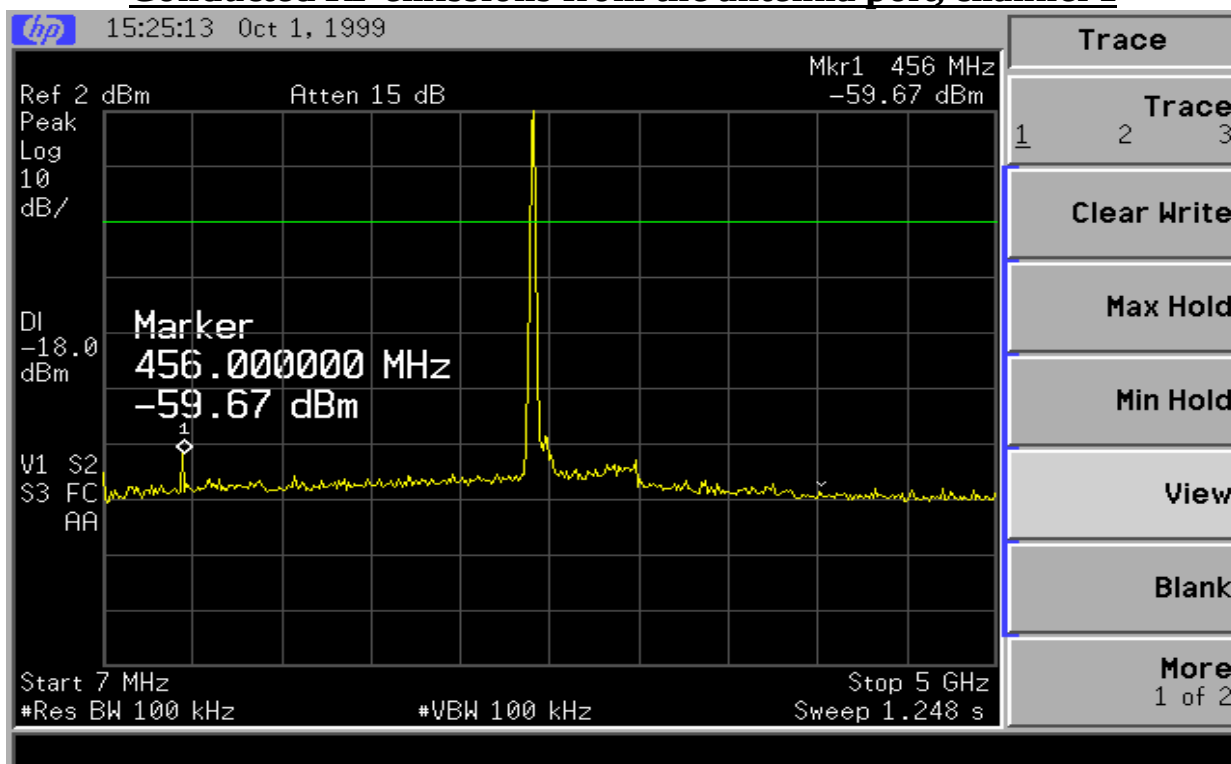
3 KiloHertz Spectral Density; channel 3



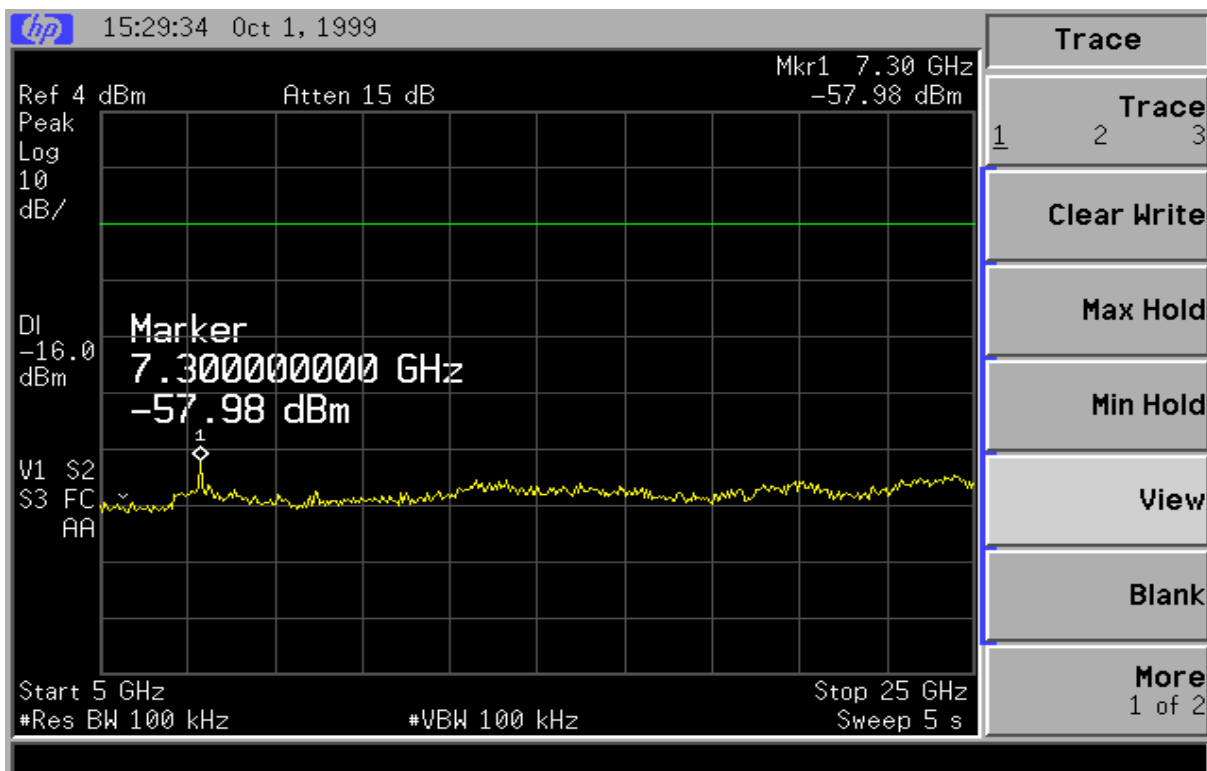
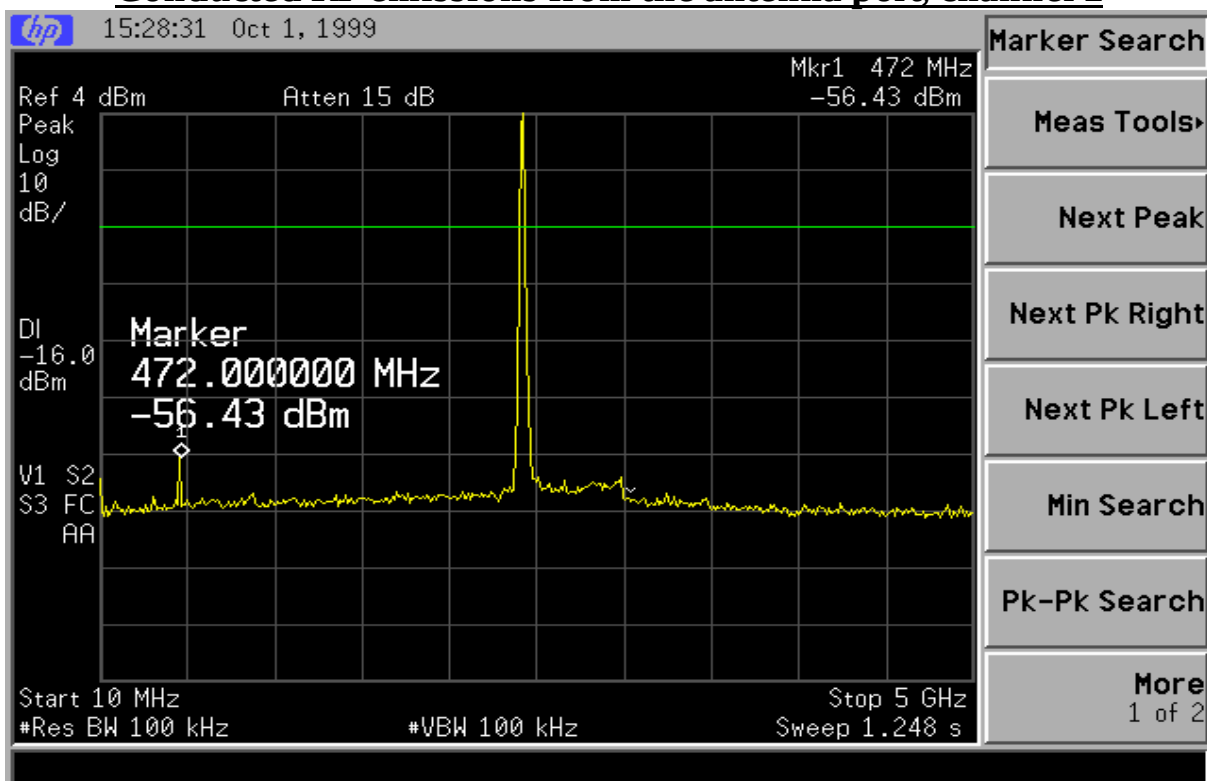
3 KiloHertz Spectral Density; channel 3



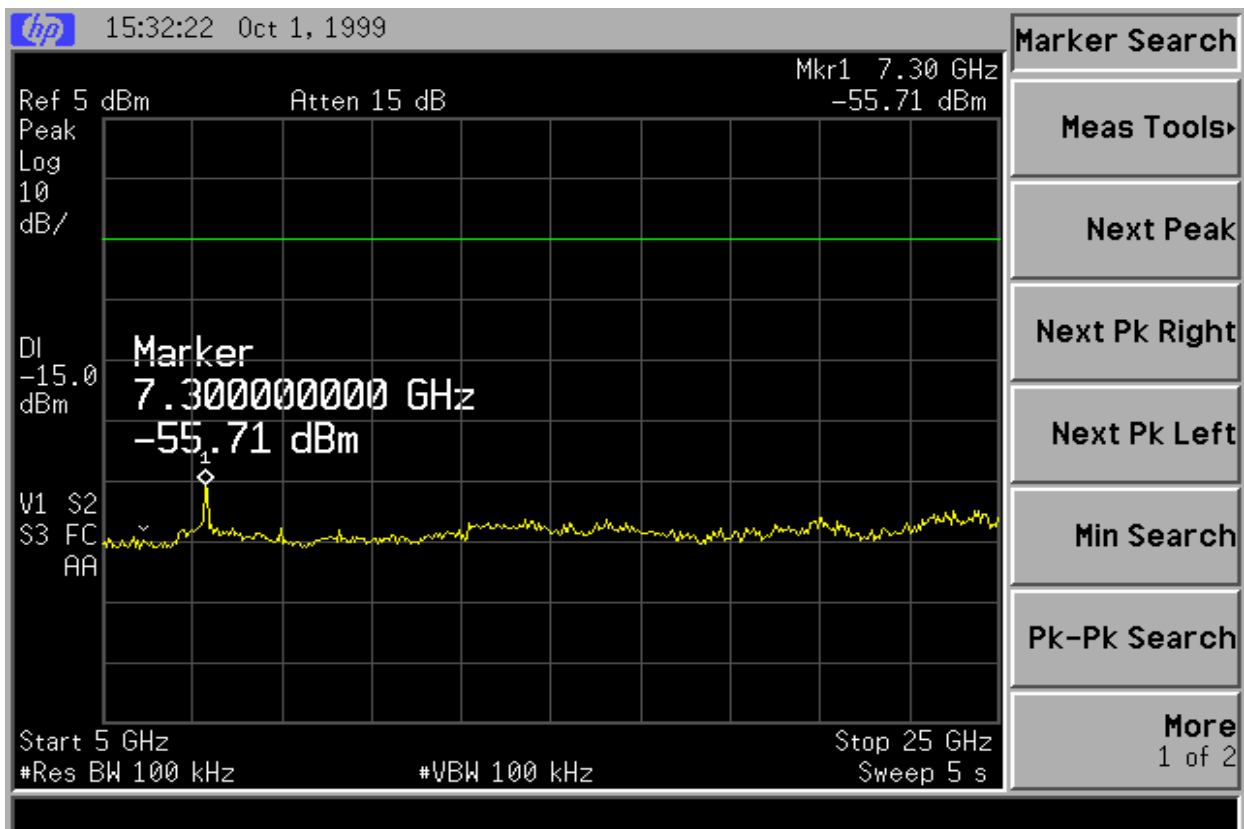
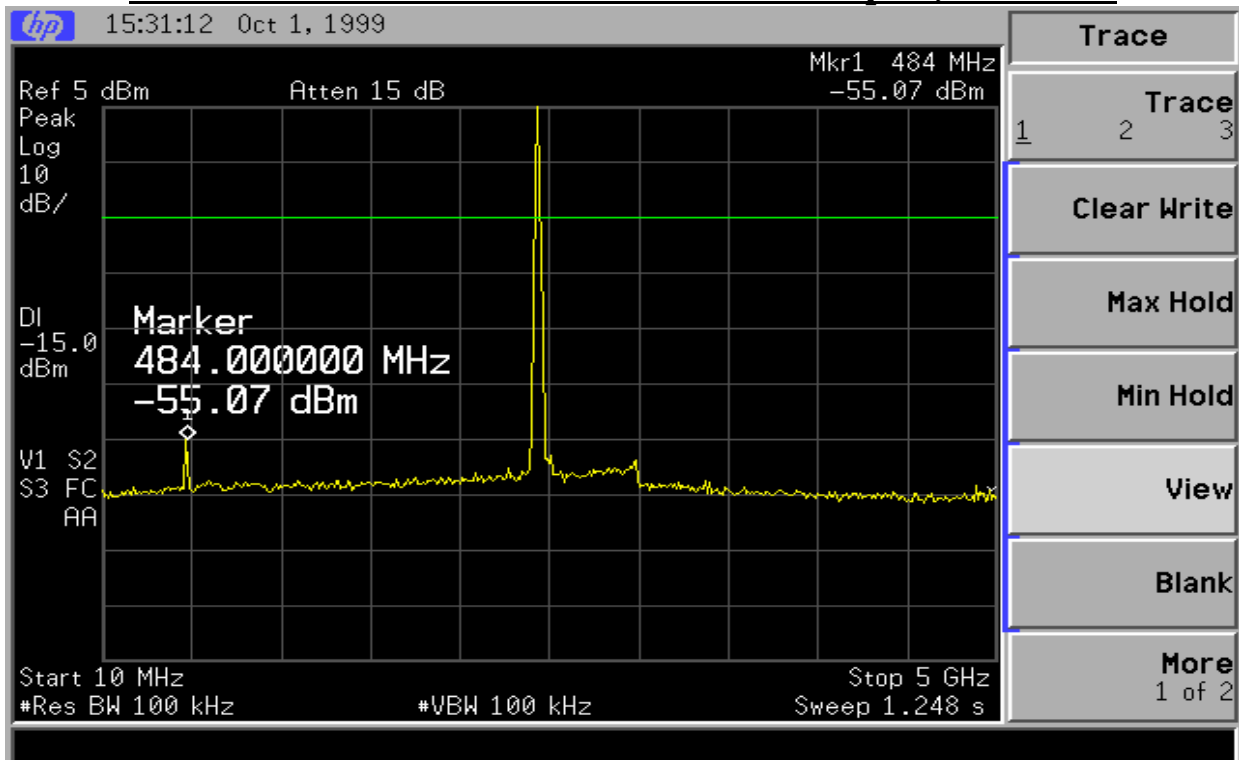
Conducted RF emissions from the antenna port, channel 1



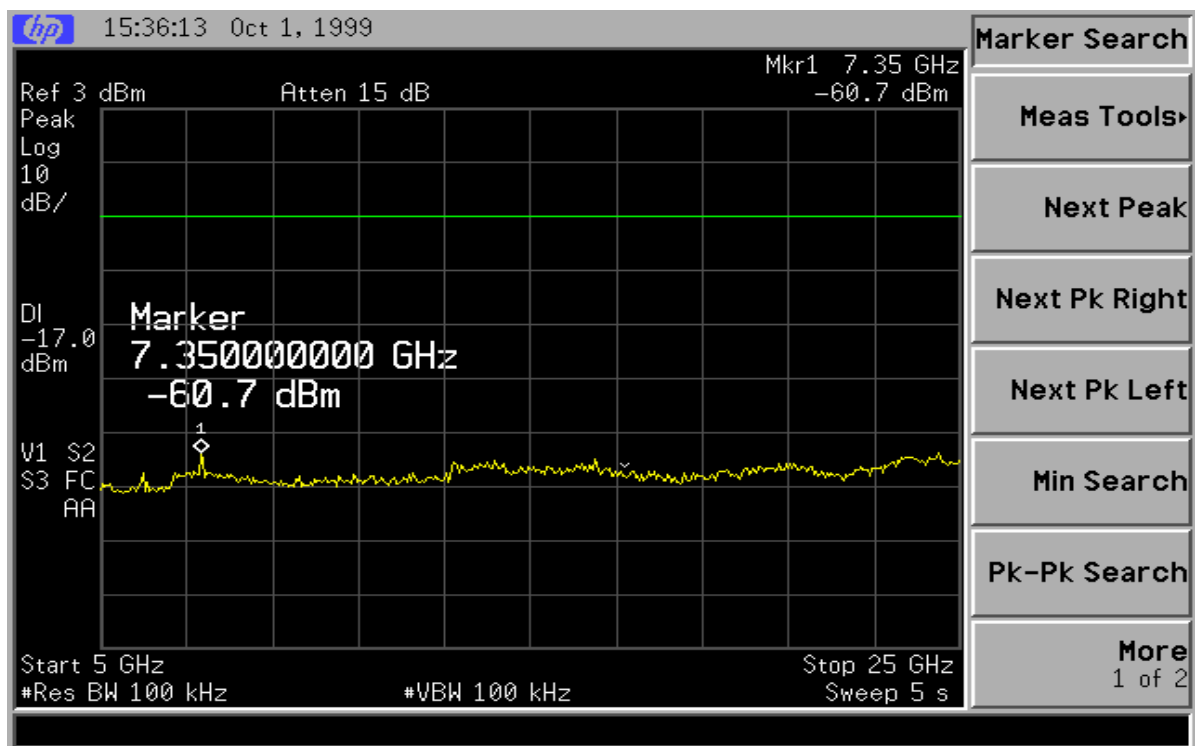
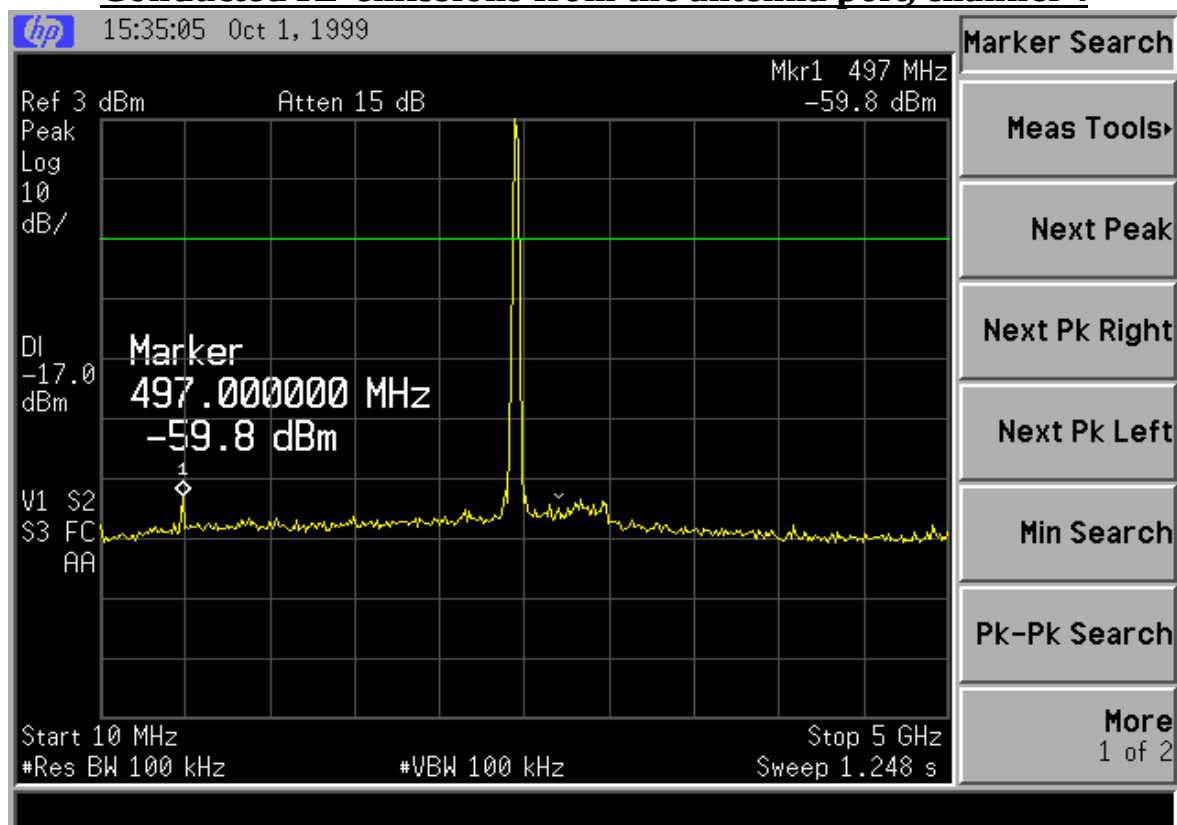
Conducted RF emissions from the antenna port; channel 2



Conducted RF emissions from the antenna port; channel 3



Conducted RF emissions from the antenna port, channel 4





APPENDIX D:

Abrahams, Richard

From: Greg Czumak [GCZUMAK@fcc.gov]
Sent: Tuesday, December 29, 1998 8:51 AM
To: Abrahams, Richard
Cc: Willingham, J B Bartow; Andren, Carl; Fakatselis, John; Ciaccia, Larry; Rood, Robert

Subject: Processing Gain Measurements -Reply

This is in response to your e-mail dated December 4, 1998. With respect to your proposed "Reference Design," after discussing the issue here, we have decided that Harris should obtain an authorization (FCC ID) for the reference design (even if you never actually market this product). In this way, your customers may submit a copy of the processing gain (jamming margin) data from the granted application with their own applications, assuming they are using the exact same design. They would simply have to submit a statement verifying that the design is identical, along with the copied data. The advantage of this approach is that they will be referencing an authorized product, and not some unapproved design, thus avoiding any appearance of impropriety.

I hope this has been responsive to your inquiry. Please contact me with any additional questions.

FCC 15.247(e) Jamming Margin Test